# ICES WGCSE REPORT 2011

ICES ADVISORY COMMITTEE

ICES CM 2011/ACOM:12

# Report of the Working Group for Celtic Seas Ecoregion (WGCSE)

11–19 May 2011

Copenhagen, Denmark

ICES
International Council for the Exploration of the Sea

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Conseil International pour l'Exploration de la Mer

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## Executive summary

ICES Working Group on the Assessment of Celtic Seas Ecoregions stocks (WGCSE) met at ICES headquarters in Copenhagen (Denmark) from 11 to 19 May 2011. 35 stocks distributed in ICES Subareas VI and VII (excluding VIId), with anglerfish (*Lophius piscatorius* and *L. budegassa*) extending its distribution to ICES Divisions IIa, IIIa and Subarea IV, and megrim (*Lepidorhombus whiffiagonis*) extending to ICES Division IVa, were assessed. In total, WGCSE assesses four stocks of cod (*Gadus morhua*), four stocks of haddock (*Melanogrammus aeglefinus*), one stock of anglerfish ((*Lophius piscatorius and L. budegassa*), two stocks of megrim (*Lepidorhombus whiffiagonis*), four stocks of whiting (*Merlangius merlangius*), five stocks of sole (*Solea solea*), five stocks of plaice (*Pleuronectes platessa*), and nine stocks of *Nephrops* (*Nephrops norvegicus*) distributed in eleven functional units (FU), upon which one stock was added this year, pollock (*Pollachius pollachius*) in Subareas VI and VII. There were 22 participants from six countries (Belgium, France, Ireland, Norway, Russia and UK), and some supportive help by correspondence in various institutes. The meeting was chaired by Pieter-Jan Schön (UK) and Joël Vigneau (France).

The meeting was tasked with carrying out stock assessments and providing catch forecasts and a first draft of ICES Advice for 2012 for all stocks in its remit. Particular attention was given this year to provide an advice for all the stocks where this was possible, following ICES guidelines. In accordance with the advisory framework, all assessments conducted by WGCSE in 2011 were update analyses, and were conducted on the basis of the stock annex, for those stocks having an agreed assessment method. In 2011, four stocks in the remit of WGCSE were subject to benchmark analysis, and only sole in VIIa received an agreed assessment. Plaice in VIIa and plaice in VIIfg were recommended to use trends only assessment for the provision of management advice but could not be used as a basis for predicting future catch options, and the benchmark was inconclusive for megrim IV, VI. During the meeting:

- eight stocks were assessed with an age-based model: haddock in VIb, plaice in VIIe, sole in VIIe, in VIIfg and in VIIa, (XSA), cod and haddock in VIa (TSA) and cod in VIIa (B-ADAPT);
- five stocks were assessed with an age-based assessment considered for trends only: haddock in VIIb–k, cod in VIIe–k, plaice in VIIfg and in VIIa and whiting in VIIe–k;
- seven *Nephrops* stocks were assessed with information from underwater TV surveys : FU11, 12, 13, 14, 15, 17 and the FU22 part of the FU20–22 stock;
- nine stocks were assessed for trends only: anglerfish in IV and VI, haddock in VIIa, megrim in IVa and VIa and megrim in VIb, *Nephrops* FU16, plaice in VIIh–k, sole VIIh–k, Whiting VIIa and whiting VIa. *Nephrops* FU20–21 part of the FU20–22 stock can also be added to this list.
- six stocks could not be assessed: cod and whiting in Vb, sole and plaice in VIIbc, pollock in Celtic Seas and *Nephrops* FU19.

Some difficulties were encountered preventing from applying strictly an update assessment, and solutions had to be accommodated during the WG. The major difficulties were the absence of one survey in 2010 for technical reasons, and the modification of one survey design. No special data deficiencies were reported this year, although all data poor stocks remained in the same situation.

The WG discussed the preparatory work for the benchmarks in 2012, and proposed seven stocks to be reviewed next year. These are cod in Division VIa, in Division VIIa and in Divisions VIIe–k, Haddock in Division VIa, Whiting in Division VIa, Anglerfish in Division IIa, IIIa, Subarea IV and VI and Sole in Division VIIe. In the longer run, plaice in Division VIIa, haddock in Divisions VIIb–k and in Division VIIa were put on the list to be subject to a benchmark in 2013 and sole in Divisions VIIfg in 2014. Another set of six stocks were said to be prone to benchmark without a proposed date.

# 1 General

## 1.1 Terms of reference

2010/2/ACOM12 The **Working Group for the Celtic Seas Ecoregion** (WGCSE), chaired by Pieter-Jan Schon (UK) and Joel Vigneau (France) will meet at ICES Headquarters, 11–19 May 2011 to:

- Address generic ToRs for Fish Stock Assessment Working Groups (see table below);
- Assess the progress on the benchmark preparation of Anglerfish (*Lophius budegassa* and *L. piscatorius*) in Divisions IIa, IIIa, Subarea IV, VI, VIIb–k and VIIIa,b, Cod in Division VIa, VIIa, VIIe–k; Sole in Divisions VIIf,g, and Sole in Division VIIe.

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

Material and data relevant to the meeting must be available to the group no later than 14 days prior to the starting date.

WGCSE will report by 23 May 2011 for the attention of ACOM.

| Fish Stock | Stock Name | Stock Coord. | Assessment Coord. 1 | Assessment Coord. 2 | Perform assessment | Advice |
|---|---|---|---|---|---|---|
| ang-ivvi | Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI | UK (Scotland) | UK (Scotland) | Denmark, Norway | Y | Update |
| cod-iris | Cod in Division VIIa (Irish Sea) | UK (England) | UK (England) | | Y | Update |
| cod-rock | Cod in Division VIb (Rockall) | UK (Scotland) | UK (Scotland) | | N | Catch statistics only |
| cod-scow | Cod in Division VIa (West of Scotland) | UK (Scotland) | UK (Scotland) | | Y | Update |
| cod VIIe–k | Cod in Division VIIe–k (Celtic Sea) | France | France | Ireland | Y | Update |
| had-7b–k | Haddock in Divisions VIIb–k | Ireland | Ireland | France | Y | Update |
| had-iris | Haddock in Division VIIa (Irish Sea) | UK (Scotland) | UK (Scotland) | | Y | Update |
| had-rock | Haddock in Division VIb (Rockall) | Russia | Russia | UK (Scotland) | Y | Update |
| had-scow | Haddock in Division VIa (West of Scotland) | UK (Scotland) | UK (Scotland) | | Y | Update |

| Fish Stock | Stock Name | Stock Coord. | Assessment Coord. 1 | Assessment Coord. 2 | Perform assessment | Advice |
|---|---|---|---|---|---|---|
| meg-scrk | Megrim (*Lepidorhombus* spp) in Subarea VI (West of Scotland and Rockall) and Subarea IV (North Sea) | Ireland | Ireland | UK (Scotland) | Y | Update |
| nep-11 | *Nephrops* in Division VIa (North Minch) | UK (Scotland) | UK (Scotland) | | Y | Update |
| nep-12 | *Nephrops* in Division VIa (South Minch) | UK (Scotland) | UK (Scotland) | | Y | Update |
| nep-13 | *Nephrops* in Division VIa (Firth of Clyde) | UK (Scotland) | UK (Scotland) | | Y | Update |
| nep-14 | *Nephrops* in Division VIIa (Irish Sea East) | UK (England) | | | Y | Update |
| nep-15 | *Nephrops* in Division VIIa (Irish Sea West) | UK (Northern Ireland) | UK (Northern Ireland) | Ireland | Y | Update |
| nep-7bcj | *Nephrops* in Division VIIb,c,j,k (Porcupine Bank) | Ireland | Ireland | | Y | Update |
| nep-17 | *Nephrops* in Division VIIb (Aran Grounds, FU17) | Ireland | Ireland | | Y | Update |
| nep-19 | *Nephrops* in Division VIIa,g,j (Southeast and West of IRL, FU19) | Ireland | Ireland | | Y | Update |
| nep-20–22 | *Nephrops* in Divisions VIIfgh (Celtic Sea, FU20–22 | France | France | Ireland | Y | Update |
| ple-7b–c | Plaice in Division VIIb,c (West of Ireland) | Ireland | | | Y | Update |
| ple-7h–k | Plaice in Divisions VIIh,k (Southwest of Ireland ) | Ireland | Ireland | Belgium | Y | Same advice as last year |
| ple-celt | Plaice in Divisions VIIf,g (Celtic Sea) | UK (England) | UK (England) | Belgium | Y | Update |

| Fish Stock | Stock Name | Stock Coord. | Assessment Coord. 1 | Assessment Coord. 2 | Perform assessment | Advice |
|---|---|---|---|---|---|---|
| ple-echw | Plaice in Division VIIe (Western Channel) | UK (England) | UK (England) | France | Y | Update |
| ple-iris | Plaice in Division VIIa (Irish Sea) | UK (England) | UK (England) | | Y | Update |
| sol-7b–c | Sole in Division VIIb, c (West of Ireland) | Ireland | | | N | Catch statistics only |
| sol-7h–k | Sole in Divisions VIIh–k (Southwest of Ireland) | Ireland | | | Y | Same advice as last year |
| sol-celt | Sole in Divisions VIIf,g (Celtic Sea) | Belgium | Belgium | UK (England) | Y | Update |
| sol-echw | Sole in Division VIIe (Western Channel) | UK (England) | UK (England) | France | Y | Update |
| sol-iris | Sole in Division VIIa (Irish Sea) | Belgium | Belgium | | Y | Update |
| whg-7e–k | Whiting in Divisions VIIe–k | Ireland | Ireland | France | Y | Update |
| whg-iris | Whiting in Division VIIa (Irish Sea) | Ireland | Ireland | UK (Northern Ireland) | Y | Update |
| whg-rock | Whiting in Division VIb (Rockall) | Ireland | | | N | Catch statistics only |
| whg-scow | Whiting in Division VIa (West of Scotland) | UK (Scotland) | UK (Scotland) | | Y | Update |
| Pol-celt | Pollock in the Celtic Seas | | | | | Collate data |

# 2 Data and methods

## 2.1 Data tables

As requested by ICES in recent years, this year the WG stock coordinators were asked to fill Data Tables concerning data transmitted to the WG for assessment purposes. These tables have been filled during the WG meeting and are available on the WGCSE 2011 SharePoint site, under the "Data Tables" folder. It seems clear to WG members that these tables have been used recently by the European Commission to check whether collected data under the DCF were being transmitted to ICES assessment WGs.

The WG members would like to highlight that the categories provided in the drop down boxes to fill these tables are not appropriate to all situations. To try to avoid possible confusions, WG stock coordinators have made extensive use of the comments box to make the situation as clear as possible. Therefore, the WG urges any potential users of these tables to read those comments carefully and to take them into consideration.

### 2.1.1 Data section

From the WGCSE 2010 report, a data section has been collated and provided as a Working Document to ICES WKDDRAC 2011. This initiative could not be repeated during the meeting due to time pressure, but is planned to be done during intersession to serve the needs for action planning (ICES PGCCDBS) and coordination (Regional Coordination Meeting). Moreover, a supplementary objective of such a work will be the setting of a template in order to ease its inclusion in future WGCSE reports.

For the moment, a data section is available in each of the stock sections.

## 2.1.2 Biological sampling

| Table 2.1 Biological sampling levels by stock and country | | Cod | | | | | Whiting | | | | Nephrops | | | | | | | | | Plaice | | | | | Sole | | | | | Haddock | | | | Megrim | | Anglerfish | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VIa | VIb | VIIa | VIIb,c | VIIe-k | VIIb,c | VIIe-k | VIa | VIIa | FU11 | FU12 | FU13 | FU14 | FU15 | FU16 | FU17 | FU19 | FU20-22 | VIIa | VIIb,c | VIIe | VIIf,g | VIIh-k | VIIa | VIIb,c | VIIe | VIIf,g | VIIh-k | VIIb-k | VIa | VIb | VIIa | VIa | VIb | IIa | IVa & VIa | VIa | VIb |
| Belgium | No. lengths (landings) | | | 277 | | 222 | | 3,258 | | 287 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| | No. ages (landings) | | | 230 | | 379 | | 438 | | 218 | | | | | | | | | | [illegible] | | 0 | [illegible] | | [illegible] | | 0 | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| | No. samples (landings)* | | | 3 | | 18 | | 18 | | 7 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| | No. lengths (discards) | | | 1,373 | | 3,504 | | 23,780 | | 11,587 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| | No. ages (discards) | | | 340 | | 653 | | 782 | | 487 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| | No. samples (discards)** | | | 3 | | 18 | | 18 | | 7 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | |
| UK (E&W) | No. lengths (landings) | | | 1,385 | | 4,132 | | 3,884 | | 0 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | | 0 | | | | 0 | | |
| | No. ages (landings) | | | 289 | | 1,158 | | 353 | | 0 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | | 0 | | | | 0 | | |
| | No. samples (landings)* | | | 3 | | 105 | | 78 | | 0 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | 0 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | | 0 | | | | 0 | | |
| | No. lengths (discards) | | | 21 | | 1,771 | | 14,589 | | 1,208 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | 0 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | | 0 | | | | [illegible] | | |
| | No. ages (discards) | | | 1 | | 128 | | 397 | | 0 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | 0 | [illegible] | | [illegible] | [illegible] | 0 | [illegible] | | | 0 | | | | [illegible] | | |
| | No. samples (discards)** | | | 18 | | 159 | | 159 | | 28 | | | | | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | | [illegible] | | |
| Northern Ireland | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| France | No. lengths (landings) | | | | | [illegible] | | [illegible] | | | | | | | | | | | [illegible] | | | [illegible] | [illegible] | | | | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | | | | |
| | No. ages (landings) | | | | | [illegible] | | [illegible] | | | | | | | | | | | 0 | | | 0 | 0 | | | | [illegible] | 0 | 0 | [illegible] | | | | | | | | | |
| | No. samples (landings)* | | | | | [illegible] | | [illegible] | | | | | | | | | | | [illegible] | | | [illegible] | [illegible] | | | | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | | | | |
| | No. lengths (discards) | | | | | [illegible] | | [illegible] | | | | | | | | | | | [illegible] | | | [illegible] | [illegible] | | | | [illegible] | 0 | [illegible] | [illegible] | | | | | | | | | |
| | No. ages (discards) | | | | | 0 | | 0 | | | | | | | | | | | 0 | | | 0 | 0 | | | | 0 | 0 | | 0 | | | | | | | | | |
| | No. samples (discards)** | | | | | [illegible] | | [illegible] | | | | | | | | | | | [illegible] | | | [illegible] | [illegible] | | | | [illegible] | 0 | [illegible] | [illegible] | | | | | | | | | |
| Spain | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ireland | No. lengths (landings) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | [illegible] | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | |
| | No. ages (landings) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | |
| | No. samples (landings)* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | [illegible] | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | |
| | No. lengths (discards) | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | | [illegible] | |
| | No. ages (discards) | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | | | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | | [illegible] | |
| | No. samples (discards)** | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | | [illegible] | |
| | No. lengths (catches) | | | | | | | | | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | | | | | | | | | | | | | | | | | | | | |
| | No. ages (catches) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (catches) | | | | | | | | | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | | | | | | | | | | | | | | | | | | | | |
| UK Scotland | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Norway | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | [illegible] | | | | [illegible] | [illegible] | | [illegible] |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | [illegible] | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | [illegible] | | | | [illegible] | [illegible] | | [illegible] |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | [illegible] | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | [illegible] | | | | |
| Russian Federation | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Denmark | No. lengths (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (landings) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (landings)* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. lengths (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. ages (discards) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | No. samples (discards)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

* Number of vessels sampled

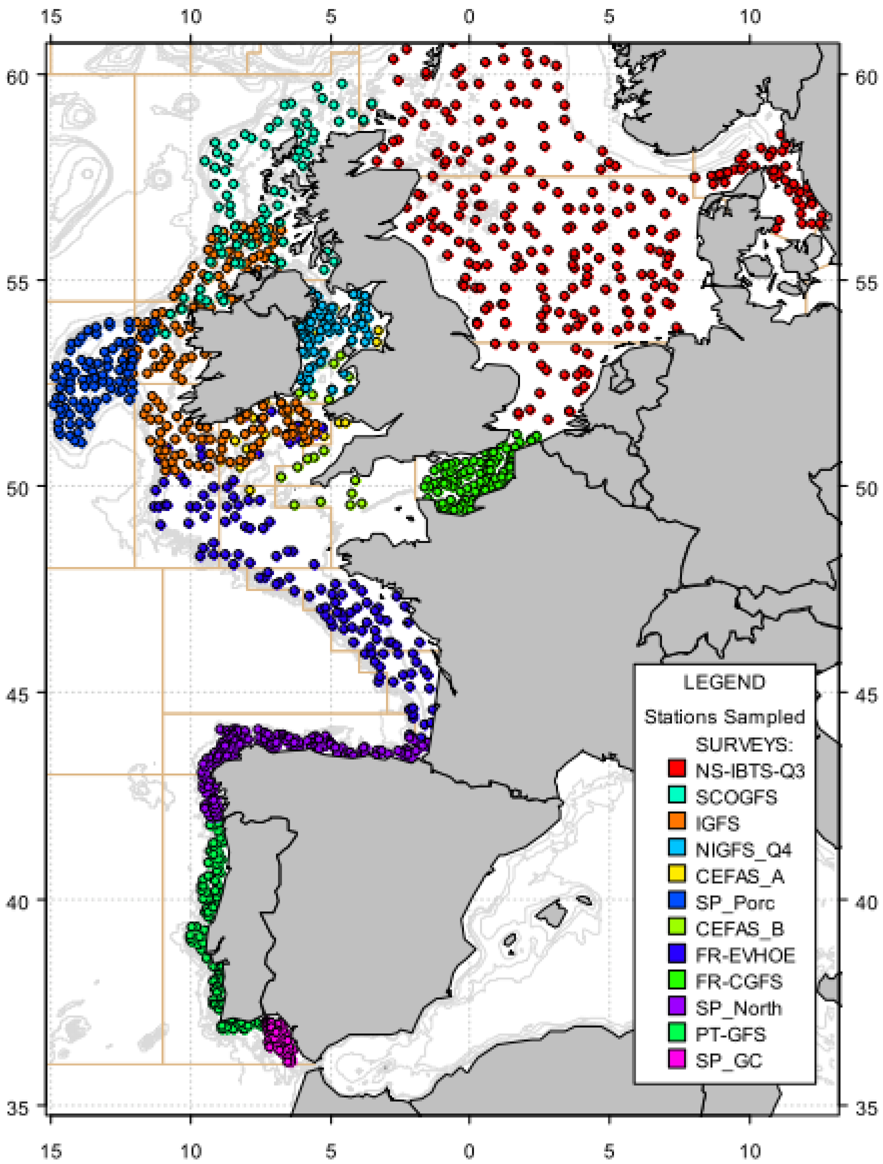
** Number of boats sampled

### 2.1.3 Survey information

This Section lists the surveys used in the assessment of stocks by this WG:

| Survey | WG name | DCF name |
|---|---|---|
| EVHOE Groundfish Survey | EVHOE-WIBTS-Q4 | IBTS Q4 |
| Irish groundfish survey-Q4 | IGFS-WIBTS-Q4 | IBTS Q4 |
| Joint science/industry survey anglerfish megrim Scottish survey | SCO-IV-VI-AMISS-Q2 | |
| Joint science/industry survey Irish anglefish survey | IRL-IV-VI-AMISS-Q2 | |
| Rockall haddock survey | ROCK-IBTS-Q3 | |
| Scottish west coast groundfish survey - 1Q | ScoGFS-WIBTS-Q1 | IBTS Q1 |
| Scottish west coast groundfish survey - 4Q | ScoGFS-WIBTS-Q4 | IBTS Q4 |
| Spanish Porcupine groundfish survey | SpPGFS-WIBTS-Q4 | IBTS Q4 |
| UK (England and Wales) beam trawl survey - 3Q | UK (E&W)-BTS-Q3 | ISBCBTS |
| UK (Northern Ireland) groundfish survey - March | NIGFS-WIBTS-Q1 | IBTS Q1 |
| UK (Northern Ireland) groundfish survey - October | NIGFS-WIBTS-Q4 | IBTS Q4 |
| UK (Northern Ireland) Methot-Isaacs–Kidd survey | NIMIK | |
| UK (Northern Ireland) *Nephrops* trawl survey - Summer | NI-NEP-Trawl-Summer | |
| UK Fishery Science Partnership western Irish Sea pelagic trawl survey | | |
| Underwater TV survey | UWTV (FU11–13) | UWTV (FU11–13) |
| Underwater TV survey | UWTV (FU14 & 15) | UWTV (FU15) |
| Underwater TV survey | UWTV (FU17) | UWTV (FU17) |
| Underwater TV survey | UWTV (FU20–22) | UWTV (FU20–22 |
| Western Channel Fisheries Science Partnership | FSP-7e | |
| Western English Channel beam trawl survey | UK-WEC-BTS | VIIe BTS |

The following figure, from the ICES IBTSWG 2010 report, shows the station positions for the IBTS surveys carried out in the Western and North Sea Area in autumn/winter of 2009. Many of the surveys used by WGCSE can be identified in the figure.




It is to be noted that the Scottish west coast groundfish survey - 4Q (ScoGFS-WIBTS-Q4) was not carried out in 2010 due to an engine breakdown of the research vessel, and the Scottish survey design and gears have been modified in 2011. Consequences for the assessment are discussed in the sections on cod, whiting and haddock in VIa.

### 2.1.4 Ecosystem information

A presentation by ICES was made on the ecosystem approach to fisheries, in the frame of the Marine Strategy Framework Directive (MSFD). ICES has established a Joint ACOM/SCICOM MSFD Steering Group to support Member States and Regional Conventions' implementation of the MSFD.

ICES has decided to develop Descriptor 3 on Commercially Exploited Fish and Shellfish and a Core Group has been established. The descriptor 3 proposes criteria to evaluate if *Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.*

These criteria are:

- level of pressure of the fishing activity: the indicators are fishing mortality in relation to $F_{msy}$, or ratio catch/biomass if not available;
- reproductive capacity: the indicators are spawning–stock biomass in relation to $SSB_{msy}$, or biomass indices if not available;
- age and size composition: the indicators are proportion of fish larger than size of first maturity, mean maximum length across all species found in research vessel surveys, 95% percentile of fish length distribution observed in research vessel surveys, and size at first sexual maturation.

This year the Expert Groups were tasked to:

1 ) Identify elements of the EGs work that may help determine status for the eleven descriptors set out in the Commission Decision;

2 ) Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

During the discussion, it was agreed that information on the three criteria for descriptor 3 were available in the report of the EG for the stocks subject to an assessment. It was also agreed that it was premature for the EG to go further and that the MSFD SG should propose guidance on how EG should address this issue in the coming years.

### 2.1.5 Intercatch

The InterCatch database has historically not been widely used by the WGCSE. During the 2011 meeting, a specific effort was made to try improving the coverage of the data uploaded in InterCatch. It has though not been possible to spend much time actually uploading new data during the meeting itself because of time pressure, but it is expected that further follow-up will take place intersessionally and improvements will be achieved in future. The actual level of InterCatch use by stock is described below.

**Table of use and acceptance of InterCatch.**

| Stock code for each stock of the expert group | InterCatch used as the:<br>• 'Only tool'<br>• 'In parallel with another tool'<br>• 'Partly used'<br>• 'Not used' | If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section. | Discrepancy between output from InterCatch and the so far used tool:<br>• Non or insignificant<br>• Small and acceptable<br>• significant and not acceptable<br>• Comparison not made | Acceptance test. InterCatch has been fully tested with at full data set, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in the future. |
|---|---|---|---|---|
| Sol-iris | In parallel with another tool | InterCatch was used, however it is not possible to make a combined age distribution from the raw data. There is also no option to upload a combined age distribution as "international" because an international code is not available. Therefore the country code "BE" is used for the moment. | Non or insignificant | Can be used, although further adaptations to InterCatch are needed. |
| Had-7b–k | In parallel with another tool | The current system of aggregating international data is fairly complicated and involves data that are supplied for combined divisions | Small and presumably acceptable | The differences will have to be investigated in more detail before intercatch can be used as only tool. |
| Sol-Echw | Not used | Not all national datasets were uploaded to Intercatch by stock co-ordinators. | Comparison not made – but 2009 and earlier years were Non or insignificant | Can be used |

| Stock code for each stock of the expert group | InterCatch used as the: • 'Only tool' • 'In parallel with another tool' • 'Partly used' • 'Not used' | If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section. | Discrepancy between output from InterCatch and the so far used tool: • Non or insignificant • Small and acceptable • significant and not acceptable • Comparison not made | Acceptance test. InterCatch has been fully tested with at full data set, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in the future. |
|---|---|---|---|---|
| Ple-Echw | Not used | Not all national datasets were uploaded to Intercatch by stock co-ordinators. | Comparison not made – but 2009 and earlier years were Non or insignificant | Can be used |
| Ple-Celt | Not used | Not all national datasets were uploaded to Intercatch by stock co-ordinators. | Comparison not made – but 2009 and earlier years were Non or insignificant | Can be used to international landings level – discards estimates are now included in the assessment and this may be problematic. |
| Ple-Iris | Not used | Not all national datasets were uploaded to Intercatch by stock co-ordinators. | Comparison not made – but 2009 and earlier years were Non or insignificant | Can be used to international landings level – discards estimates are now included in the assessment and this may be problematic. |
| Cod-Iris | Not used | Not all national datasets were uploaded to Intercatch by stock coordinators. | Comparison not made– but 2009 and earlier years were Non or insignificant | Can be used |
| Sol-Celt | In parallel with another tool | Compared at the WG as not all national datasets were uploaded to intercatch before the meeting | Non or insignificant | Can be used |

| Stock code for each stock of the expert group | InterCatch used as the:<br>• 'Only tool'<br>• 'In parallel with another tool'<br>• 'Partly used'<br>• 'Not used' | If InterCatch have not been used what is the reason? Is there a reason why InterCatch cannot be used? Please specify it shortly. For a more detailed description please write it in the 'The use of InterCatch' section. | Discrepancy between output from InterCatch and the so far used tool:<br>• Non or insignificant<br>• Small and acceptable<br>• significant and not acceptable<br>• Comparison not made | Acceptance test. InterCatch has been fully tested with at full data set, and the discrepancy between the output from InterCatch and the so far used system is acceptable. Therefore InterCatch can be used in the future. |
|---|---|---|---|---|
| Ple-7bc<br>Ple-7h–k<br>Sol-7bc<br>Sol-7h–k | Not used | No assessment | NA | NA |
| Cod-scow | In parallel with another tool | | Non or insignificant | Can be used |
| Had-scow | In parallel with another tool | | Non or insignificant | Can be used |
| Whg-scow | In parallel with another tool | | Non or insignificant | Can be used |
| Nep-11 | Not used | Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future. | Comparison not made | Not tested |
| Nep-12 | Not used | Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future. | Comparison not made | Not tested |
| Nep-13 | Not used | Trials to upload sex specific length structured data successful for 2009 data. No reason why it cannot be used in future. | Comparison not made | Not tested |

### 2.1.6 Celtic Seas Stocks and Mixed Fisheries Forecasts

Starting in 2010 the ICES working group WGMIXFISH has performed mixed fisheries short-term forecasts specific to stocks in the North Sea and Kattegat. A broad outline of the method involved and the types of basic scenarios considered to date was presented.

At the 2011 meeting of WGCHAIRS it was clear ICES would like the sort of projections performed at WGMIXFISH extended to other regions. Three criteria are required for mixed fisheries considerations to be worthwhile. First, there must be potential (or known) inconsistencies between TAC advice for stocks in a region because of technical interactions between those stocks. Second, all major stocks prosecuted by the fisheries in an area need an accepted fishing mortality or harvest rate. Third, landings (preferably catches) and effort data needs to be available by all main fleet-métier combinations.

The current situation in ICES Division VIa did not make it an obvious candidate for WGMIXFISH style considerations. All three main gadoid stocks-cod, haddock and whiting-have been considered at dangerously low biomass levels with advice for low or zero catch, although this may change with the latest haddock assessment (see Section 3.3). For VIa cod there is also currently no accepted value for fishing mortality.

Celtic Sea stocks (ICES VIIb–k) were considered a more appropriate choice. There is an opportunity to develop management plans for all major stocks in the region that are consistent in the mixed fisheries context after making use of mixed fisheries forecasts. A lack of accepted stock assessments or complete datasets might be obstacles to overcome but it was agreed in principle that WGMIXFISH could consider Celtic Sea stocks in 2012.

The ICES MICC report 2010 concluded that mixed fisheries considerations at this stage should not be considered formal advice but information and that WGMIXFISH output should be presented in this context. It is not clear whether long term the current WGMIXFISH will assume responsibility to conduct mixed fisheries forecasts for additional areas or whether new area specific working groups will be formed.

Because of the fleet-métier nature of the data required for WGMIXFISH and the desire by ACOM to make reporting of the mixed fishery projections before or coincident with single-species advice in June, WGMIXFISBH has begun a consultation with data providers around the possibility of data submissions to ICES that would fulfil the needs of WGNSSK and WGMIXFISH and still conform to sound sampling practice (the current métier definitions are not considered ideal). Similar considerations to do with fleet-métier definitions that are consistent with national sampling schemes would be necessary if mixed fisheries projections were adopted for stocks from the Celtic Seas. Métier definitions need not be the same as for the North Sea region.

The WGCSE considered that work needs to be done in the definition of métier for raising procedures in preparation of the benchmarks 2012. The recent availability of the final report of the EU study on the development of tools for logbook and VMS data analysis (Study 2008–2010 lot 2) could serve as a basis for revisiting the métiers used for sampling and raising in the different countries operating in the Celtic Seas.

### 2.1.7 Summary of benchmark 2011

<u>Plaice in VIIa (Irish Sea) and Plaice in VIIfg (Celtic Sea)</u>: Several alternative methods were investigated to explore options for incorporating a short time-series of discard

observations into the assessment. None of the approaches examined proved to be entirely satisfactory. The group concluded that the Aarts and Poos (2009) method, developed initially for North Sea plaice, could be used as a trends only assessment for the provision of management advice but could not be used as a basis for predicting future catch options.

Sole in VIIa (Irish Sea): Alternative methods for raising the international catch-at-age matrix were investigated in order to reduce the impact of recent changes in sampling levels that have occurred at the national level. The existing assessment method (XSA) was retained with only minor modifications to the parameter settings.

Megrim in VI and IV: Only very limited data were available to WKFLAT. The group considered the basis for the stock definition and concluded that there was little evidence that megrim in Subdivisions VI and IV comprise separate stocks. WKFLAT applied several assessment methods to the data but was unable to recommend a preferred assessment for this stock.

### 2.1.8 Proposal for benchmark 2012

Seven stocks within the remit of WGCSE are scheduled to be benchmarked in 2012. These stocks are:

- Cod (*Gadus morhua*) in Division VIa;
- Cod (*Gadus morhua*) in Division VIIa;
- Cod (*Gadus morhua*) in Divisions VIIe–k;
- Haddock (*Melanogramus aeglefinus*) in Division VIa;
- Whiting (*Merlangius merlangus*) in Division VIa;
- Anglerfish (*Lophius piscatorius* and *Lophius budegassa*) in Division IIa, IIIa, Subarea IV and VI;
- Sole (*Solea solea*) in Division VIIe.

The rationale for benchmarking all cod stocks together is detailed in the reasoning for cod VIIa. Additionally, a number of stocks were listed as candidates for benchmarking, but not included in the 2012 list. The reasons vary from further analysis to be carried out to further data and/or longer time-series to be collected. All details can be found in the relevant stock sections.

The proposed benchmarks for 2013 and 2014 are the following:

- Plaice (*Pleuronectes platessa*) in Division VIIa (in 2013);
- Haddock (*Melanogramus aeglefinus*) in Divisions VIIb–k (in 2013);
- Haddock (*Melanogramus aeglefinus*) in Division VIIa (in 2013);
- Sole (*Solea solea*) in Divisions VIIfg (in 2014).

The following stocks are considering the need for a benchmark, without proposed date and pending the resolution of current known issues :

- Megrim (*Lepidorhombus spp*) in Subarea IV and VI;
- Haddock (*Melanogramus aeglefinus*) in Division VIb;
- Whiting (*Merlangius merlangus*) in Division VIIa;
- Whiting (*Merlangius merlangus*) in Division VIIe–k;
- *Nephrops* (*Nephrops novegicus*) FU16;

- *Nephrops* (*Nephrops novegicus*) FU20–22.

#### 2.1.8.1 Planning future benchmarks

Planning table [used for preparing the ACOM proposal of upcoming benchmarks]

| | Ass status | Last benchmark | Planning Year +1 | Planning Year +2 | Year +3 | Comments |
|---|---|---|---|---|---|---|
| cod-iris | Update | | 2012 | | | See Section 6.2 |
| cod-7e–k | Update for trends only | 2009 | 2012 | | | See Section 7.2 |
| had-iris | Survey trends | | | 2013 | | Along with had 7b–k. See Section 6.3 |
| had-7b–k | Update for trends only | | | 2013 | | See Section 7.4 |
| whg-iris | Survey trends | | | | | Benchmark pending construction of catch numbers/ weights-at-length and age. See Section 6.6. |
| whg-7e–k | Update for trends only | | | | | Demand for a future benchmark. See Section 7.15 |
| ple-iris | Update for trends only | 2011 | | 2013 | | See Section 6.7 |
| ple-celt | Update for trends only | 2011 | | | | |
| ple-echw | Update | 2010 | | | | |
| ple-7h–k | Catch curve | | | | | |
| ple-7b–c | No assessment | | | | | |
| sol-iris | Update | 2011 | | | | |
| sol-celt | Update | | | | 2014 | See Section 7.13 |
| sol-echw | Update | 2009 | 2012 | | | See Section 8.3 |
| cod-scow | Update | | 2012 | | | See Section 3.2 |
| cod-rock | No assessment | | | | | |
| had-scow | Update | | 2012 | | | See Section 3.3 |
| had-rock | Update | | | | | Benchmark pending improvement in model input data. See Section 4.3 |
| whg-scow | Update for trends only | | 2012 | | | See Section 3.4 |
| whg-rock | No assessment | | | | | |

| | Ass status | Last benchmark | Planning Year +1 | Planning Year +2 | Year +3 | Comments |
|---|---|---|---|---|---|---|
| meg-ivvi | Update for trends only | 2011 | | | | Benchmark pending complete landings-at-age information. See Section 5.3 |
| meg-rock | Survey trends | 2011 | | | | |
| ang-ivvi | Survey trends | | 2012 | | | See Section 5.2 |
| nep-11 | Update | 2009 | | | | |
| nep-12 | Update | 2009 | | | | |
| nep-13 | Update | 2009 | | | | |
| nep-14 | Update | 2009 | | | | |
| nep-15 | Update | 2009 | | | | |
| nep-16 | Trends only | | | | | Benchmark pending better growth information and improvement in sampling of catches. See Section 7.6 |
| nep-17 | Update | 2009 | | | | |
| nep-19 | No assessment | | | | | |
| nep-2022 | Update(FU22) Trends only(FU20–21) | | | | | Demand for a future benchmark. See Section 7.7 |
| sol-7h–k | Catch curve | | | | | |
| sol-7b–c | No assessment | | | | | |
| Ecosystem issues that need generic work | | | | | | |

#### 2.1.8.2 Issue lists for stocks or ecosystem issues with upcoming benchmarks

| Cod VIa | | |
|---|---|---|
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| problem | solution | expertise necessary | suggested time |
|---|---|---|---|
| Misreporting of landings. Unknown level prevents adjustment of reported catch and inclusion in assessment. | To estimate misreporting due to area misreporting; analysis of VMS data compared with landings declarations to estimate the degree of area misreporting. | Requires someone familiar with VMS analysis (plus provision of trip specific landings declarations). | Uncertain. Suitable expert needs to be identified. |
| Bias in discard estimates | New discard raising methodology has been developed at Marine Scotland Science. | | |
| Inappropriate modelling of discards within TSA model | Revision of TSA to allow fitting of discards at higher ages. | Requires someone familiar TSA routines. | New model available. |

| problem | solution | expertise necessary | suggested time |
| --- | --- | --- | --- |
| Variance and bias in survey index | 1 -Adoption of new aggregation methods to form final indices from haul by haul data, (combinations of new post stratification, weighting of strata and/or adoption of statistical approaches such as fitting of GAM or delta distribution models).<br><br>2 - Inclusion of additional surveys (ScoGFS-4Q and IRGFS-WIBTS-Q4). ScoGFS-WIBTS-Q4 indices to be formed in same manner as ScoGFS-WIBTS-Q1 after conclusion of above project.<br><br>3 - Addition of new survey effort and/or revision of survey design. | Work being undertaken as a Marine Scotland Science research project. | 1 - Project due for completion in 2011.<br><br>2 -Comparison with existing assessment setup (single survey) possible in 2011 (after conclusion of above project).<br><br>3 - Anglerfish survey records cod numbers at length, now has 5 years of data and cpue indices can be formed. Data from charter surveys in 2009 available. A random stratified design for the Scottish surveys was implemented in 2011. |
| Uncertainty in natural mortality (level and trend) because of unquantified predation from large and increasing seal population. | Revision of TSA to allow inclusion of different fleets, (this in turn allows estimates of age specific consumption of cod by seals to be input as if from an additional fleet). | Requires someone familiar with TSA routines. | Method for estimating age specific consumption of cod by seals presented at 2008 ICES ASC. Work to adjust TSA scheduled for 2011. |
| Possible trend in mean weight-at-age in landings | Compare mean weights-at-age with that from survey data. Apply F test to determine if fitted smooth significantly different from straight line with zero gradient. | | Work possible in 2011. |

| Cod VIIa | | |
| --- | --- | --- |
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Candidate stocks | Supporting justification and comment(s) | Indicated expertise necessary at the benchmark meeting |
|---|---|---|
| Western waters cod stocks (Area VI and VII excl. VIId). | Cod stocks in Divisions VI and VII comprise an assemblage of metapopulations with varying degrees of mixing. Fishing effort, predation and other environmental drivers including climate change impact the populations in different ways across the range of the stocks. The stocks have proven difficult to assess due to data deficiencies and an inability to demonstrate responses to changes in fishing effort and other management controls. Improved management advice may benefit more from quantifying the spatial dynamics of cod in relation to spatial variations in fishing and other pressures than by trying to refine the current modelling approaches applied to the current stock definitions and management units. To make progress towards this, an initial Data Workshop is proposed to collate and interpret existing and new data on cod stock structure and mixing, distribution patterns, spatial variations in size/age structure and biological characteristics as well as pressures including predation, fishing and climate. Such analyses will be facilitated by high-resolution spatial data on fishery catches and effort by métier using VMS, rectangle data, employing GIS methods. It will be necessary to develop an international database holding spatially resolved datasets (landings, discards, effort, size/age/biological data, surveys, environmental variables) and data manipulation routines to allow evaluation of the effect on the assessments of altering the stock unit definition. Data on cod movement parameters will be required to allow development of operating models for testing assessment and management procedures and ultimately developing and testing spatially disaggregated assessment models. New datasets e.g. on discarding, biology, predation, surveys and fishing effort/cpue would be evaluated. The Data Workshop would build on and review the outcomes of a major UK collaborative programme on cod stock structure and spatial dynamics, which will be completed in 2011. The ensuing Benchmark Assessment workshop would evaluate the appropriateness of current assessment methods in the light of the Data Workshop outcomes, and explore alternative approaches as candidates for providing management advice. This could potentially include changes to the spatial units for assessment or the development of spatially disaggregated assessment models including mixing coefficients. | |

| Cod VIIe–k | | |
|---|---|---|
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Discards | WKROUND 2009 concluded that more work is required before Celtic Sea cod can be benchmarked successfully | WGCSE 2011 reviewed the available information and several improvements have occurred since WKROUND. There is now a time-series of self-sampling highgrading estimates. Discard and misreporting rates appear to have changed between years and fleets. Historical time-series of discards are required in order to include discards into the assessment. | | Expert group members |
| Biological parameters | There is evidence from sampling on the Irish “biological survey” that maturity has changed for this stock | If new information is available for the next benchmark (e.g from the Irish Celtic Sea cod survey), the use of new ogive should be investigated<br><br>There is a growing body of new tagging information (e.g. Irish tagging studies) that may prove useful to assess stock structure and possible mortality rate. | | Tagging experts |
| Surveys | | There is a new dedicated survey for the stock that need to be considered and the two other IBTS survey-series should be examined to see if a combined index might be possible | | Survey experts |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Assessment method | WKROUND 2009 considered the use of other models than XSA (B-Adapt, SAMS). Due to time constraints and lack of data, analysis have been preliminary during WKROUND | Further work is needed to investigate the suitability of those models and to identify the proper settings to use for assessment. | | Modelling experts |
| Advice | | the Benchmark should aim to develop an assessment and advice framework for the provision of MSY and precautionary advice form the information available | | |

| Haddock VIa | | |
|---|---|---|
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Tuning-series | commercial cpue or lpue data cannot be used in the assessment | A VMS-based analysis of lpue could help to address the concern. With the increased requirement for vessels to operate with VMS it is likely that the quality of effort data will improve. This will lead to an improved time-series of effort data in future but still leaves the uncertainties regarding the earlier years in the time-series. | VMS data | |
| Discards | There should be a full analysis of the precision and bias of catch-at-age data. Although catch data between 2006–2010 are thought to represent a large proportion of the true catch, further analysis would help to put a clearer estimate on the uncertainty of this. | Measures such as the UK Registration of Buyers and Sellers legislation seem to have greatly improved the reliability of commercial landings data for the last three years. Also, the landings misreporting; in, out and within Area VIa should be addressed in the next benchmark and assess their impact in the assessment | | |
| Biological Parameters | The growth characteristics of this haddock stock are very variable, and seem to be strongly driven by cohort effects rather than year effects: that is, early life-history events determine the subsequent growth potential of each cohort. | Work is underway at Marine Scotland (Aberdeen) and elsewhere to develop improved models of growth, and it is hoped that these will improve stock forecasts in future. Consideration of using stock weights from the survey, instead of the estimated weights-at-age could also be addressed at a benchmark assessment. | | |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
| --- | --- | --- | --- | --- |
| Surveys | Despite of not being currently used in the assessment, IGFS-WIBTS-Q4 survey was used as an index to corroborate the strength of the 2009 year class.<br>Also due to the lack of the ScoGFS-WIBTS Q4 2010 survey it would assume a great importance the introduction of the IGFS survey into the assessment. | There are now seven years of data from the IGFS-WIBTS-Q4 and should be evaluated at the next benchmark for this stock<br>Figure 3.1.16 shows the indices of all three surveys in a comparison plot. These seem to agree but further investigation is necessary before its introduction in the assessment. | | |
| Assessment method | | Other assessment models could be considered where information from the age structure of the catch data could be incorporated in the assessment for the years where the catch data are currently excluded (1995–2005). | | |
| Forecast method | | Growth modelling could help with forecasts of mean weights-at-age. It may also be of interest to use bioeconomic models to address questions to do with feedbacks between quota, uptake of quota and strong drivers of quota uptake and fishers' behaviour, for example, fuel price. | | |

| Whiting VIa | | |
| --- | --- | --- |
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Discards | | A landings and discards disaggregated assessment may potentially be a reliable basis for determining the status of the whiting stock in Via | | |
| Surveys | The potential for improvement in the quality of survey data needs to be investigated. The issue of changes in survey catchability needs to be addressed | The location of sampling stations may be reconsidered to better match the distribution of commercial landings and maximize coordinated survey effort in the area. | | |
| Assessment method | Currently, the main problem is the discrepancy between survey and catch data prior to 1995 | Unless this discrepancy can be resolved, truncating the catch data from 1995 may be an option, which proved satisfactory in previous exploratory XSA runs carried out at this working group. Given the new legislation on reporting landings, the quality of landings data is likely to continue to improve. | | |

| Anglerfish in in Division IIa, IIIa, Subarea IV and VI | | |
|---|---|---|
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Input data | ICES has previously advised a two-stage approach for management of the anglerfish fishery. The first stage was to substantially improve the quality and quantity of data collected in the fishery while maintaining exploitation at its current level. It has stated that this was expected to take at least five years to establish useable time-series. The second stage would then be to use these data to examine alternative management approaches and harvest control rules | The data collection stage of this process is ongoing and an assessment approach is in preparation. WGCSE 2010 considers that significant progress towards assessment has been made for this stock | | |
| Discards | | | | |
| Biological Parameters | There are still uncertainties about the validity of age readings of anglerfish. | 1 - : this will be addressed by an age determination exchange. Depending on the outcome of this exchange, the catch-at-age data should then be evaluated for use in any assessment<br><br>2 - The biological data associated with the anglerfish surveys should be evaluated and compared with existing estimates (e.g. maturity-at-age, growth rates, length distributions, sex ratios and species compositions). | | |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Surveys | 1 - Irrespective of any ageing concerns, the survey estimates have underestimated the younger ages. This is despite the recent incorporation of a correction to account for escapes of small fish under the footrope of the survey trawl, which clearly has not accounted for all small fish.<br><br>2 - A number of recommendations were made at ICES WKAGME for the improvement of the anglerfish surveys.<br><br>3 - efforts to extrapolate estimates of abundance into areas that have not been surveyed (southern North Sea and Subarea IIIa) have not proved particularly successful | 1 - Some developments of the latter bias correction are still possible; however, it seems likely that a survey based assessment model could also be developed to determine the absolute abundance of the total population.<br><br>2 - Some of these have been addressed and other will be addressed in the coming year in advance of the Benchmark. These include: improving the survey design in the light of previous estimates of density (allocation of samples to strata); providing estimates for the two species separately so that they may be incorporated separately in any assessment model (for cohort tracking for example); accounting for areas not surveyed in the North Sea using IBTS data; and improving the estimates of footrope escapes.<br><br>3 - Additional participation of nations with an interest in this fishery should be encouraged before the next Benchmark. In 2009 only Scotland and Ireland participated in this survey and in 2010 and 2011 only Scotland was able to conduct a survey. | | |
| Assessment method | | See the point above | | |
| Forecast method | | | | |

| Sole VIIe | | |
|---|---|---|
| Benchmark | Year: 2012 | |
| (Stock) coordinator | Name: | E-mail: |
| (Stock ) assessor | Name: | E-mail: |
| Data contact | Name: | E-mail: |

| Issue | Problem/Aim | Work needed/possible direction of solution | Data needed to be able to do this: are these available/where should these come from? | External expertise needed at benchmark |
|---|---|---|---|---|
| Surveys and tuning series | WKFLAT 2009 could not recommend an appropriate assessment procedure for this stock for the following reasons:<br>Closed population and complete mixing assumptions of the assessment are violated. Tuning data indicate differences in trends in F and recruitment resulting in a serious retrospective pattern in the assessment.<br>Survey information only partially covers the stock area | Effort correction parameters / methodologies may require updating as the main beam trawl fleet has restructured substantially recently.<br>This effort would be greatly enhanced by an internationally coordinated survey that more appropriately covers the management area and is able to assess recruitment dynamics irrespective of the sources of recruitment and environmental drivers | | Experts with expertise in spatial modelling of stock dynamics and survey specialist to help evaluate the new stratified random survey in the area |
| Assessment method | | . | | |

## 2.2 Methodology and software; MSY estimation for *Nephrops* stocks

The different *Nephrops* stocks (Functional Units, FUs) for which ICES delivers advice cover a wide range of fisheries including single, twin, triple and even quadruple trawls, creeling (potting), with activity covering inshore and offshore grounds. The timing of these fisheries varies; which due to the different emergence patterns of the different sexes due to moulting and egg-brooding, leads to very different relative exploitation rates (between the sexes) in different FUs. Local ecosystem type is also highly variable with a range of *Nephrops* densities, different composition and density of organisms competing for space as well as different assemblages of predators. Ground types also cover a wide range including large contiguous sediment beds, fragmented patches of suitable sediment in rocky areas, shallow sea-lochs and patches of mud on relatively deep shelf edges. Given these differences in fishery and ecology it is inevitable that estimates of the exploitation rate leading to long-term MSY will vary between the FUs, the difficulty for scientists is how to estimate these rates given the inherent difficulty in assessing crustacean stocks, for which no practical method routine of age determination is available. Some assessments take the observed length frequency data and slice it into age classes according to the von Bertalanffy growth parameters. These numbers-at-age are then taken forward into standard stock assessment packages. This practice was ceased in 2005 within this Group due to concerns over both the reliability of reported landings in some FUs (particularly the UK fisheries) and the use of the 'pseudo' age-structured data in an age-based assessment. As a result of this, no dynamic population model is fitted to the data and consequently there are no estimates of spawning–stock and recruitment which are fundamental to the determination of $F_{msy}$ and proxies for $F_{msy}$ must therefore be sought. WKFrame (ICES 2010) made several recommendations for defining $F_{msy}$ proxies where no direct estimation of $F_{msy}$ was possible (i.e. for stocks for which there is no analytic assessment, but length- or age-structured catch data are available). The suggested approach focused on per-recruit analysis with the following guidelines:

Use input parameters which reflects the current situation (selection and discard ogive, maturity and weight-at-age/length).

If there is clear peak at low F in the YPR analysis and no evidence of recruitment dependence on biomass, then $F_{max}$ may be an appropriate proxy.

Where $F_{max,}$ is undefined then $F_{0.1}$ might be considered as a 'lower bound' to the range of F suitable for $F_{msy}$, as it is assumed to be low risk.

Spawning biomass per recruit analysis should be routinely evaluated in addition to YPR. There is not a single level of % SPR that is optimal for all stocks and the proposal for $F_{msy}$ should include some consideration of life history. Further studies by Clark (1991; 1993) concluded that $F_{35\%}$ and higher were robust proxies for $F_{msy}$, considering uncertainty in stock–recruitment functions and or recruitment variability.

Conduct a sensitivity analysis to the input parameters and consider the variability of estimates over time.

Within the Celtic Sea areas, assessment of *Nephrops* stocks falls into three categories, those with TV surveys, those monitored by lpue/mean size and those with only landing information. Only for those stocks with TV surveys is the catch advice determined by an exploitation rate, advice for the other stocks is based on changes to landings. For those stocks with a TV survey, the Harvest Rates (removals divided by abundance as estimated by the TV survey) associated with fishing at $F_{0.1}$ and $F_{max}$

were estimated at the 2009 benchmark meeting WK*Neph* (ICES 2009). In response to the recommendations of WKFrame, estimates of $F_{35\%SpR}$ and the corresponding Harvest Rate have also been determined and these estimates typically lie between the estimates of $F_{0.1}$ and $F_{max}$. Suggestions for a TV-abundance based proxy for $B_{trigger}$ have been made on the basis of the lowest observed TV-abundance (median survey value) unless the stock has shown signs of stress at a higher TV-abundance in which case this value becomes $B_{trigger}$.

The remaining challenge is determining which $F_{msy}$ proxy is appropriate to which stock and this becomes an exercise in expert judgment based upon knowledge of the fishery and the ecosystem. The implications for exploitation rate can vary considerably depending upon which proxy is chosen ($F_{0.1}$, $F_{35\%SpR}$ or $F_{max}$) and whether to account for the differences in relative exploitation rate between the sexes. Given that there is often a distinct difference in the exploitation rate between the two sexes (males>females) it is usually impossible to simultaneously achieve the target fishing mortality on both sexes (i.e. the stock cannot be fished such that both the male and female YPRs are maximized simultaneously). The following text table shows the F-multipliers required to achieve various $F_{msy}$ proxies for the sexes of a typical *Nephrops* stock (FU8 in this example), the Harvest Rates which correspond to those F multipliers and the resulting level of spawner-per-recruit expressed as a percentage of the virgin level.

| | | Fbar(20–40 mm) | | | | SPR (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | Fmult | Male | Female | HR (%) | Male | Female | Combined |
| $F_{0.1}$ | Male | 0.2 | 0.13 | 0.06 | 7.47 | 42.33 | 64.50 | 51.72 |
| | Female | 0.43 | 0.29 | 0.13 | 14.23 | 22.96 | 44.80 | 32.21 |
| | Combined | 0.24 | 0.16 | 0.07 | 8.75 | 37.29 | 60.04 | 46.92 |
| $F_{max}$ | Male | 0.36 | 0.24 | 0.11 | 12.31 | 26.94 | 49.50 | 36.49 |
| | Female | 0.81 | 0.54 | 0.24 | 23.38 | 12.11 | 28.95 | 19.24 |
| | Combined | 0.46 | 0.31 | 0.14 | 15.03 | 21.55 | 43.02 | 30.64 |
| $F_{35\%SpR}$ | Male | 0.27 | 0.18 | 0.08 | 9.67 | 34.13 | 57.04 | 43.83 |
| | Female | 0.63 | 0.42 | 0.19 | 19.28 | 15.79 | 34.96 | 23.91 |
| | Combined | 0.39 | 0.26 | 0.12 | 13.15 | 25.10 | 47.38 | 34.53 |

The yield-per-recruit and spawner-per-recriut plots for this stock are shown in Figure 2, emphasizing the disparity in f-multipliers required to achieve $F_{max}$. The general tradition in fisheries science is to concentrate on the mortality on females because in a freely distributing population, one male should be able to fertilize several females and therefore a higher exploitation rate on males should not affect spawning potential. *Nephrops* are slightly different in that the adults have a fairly limited range of movement (100’s of metres) and therefore very low densities of males could result in sperm limitation. Ensuring that the fishing mortality target on males is not exceeded will usually result in an underutilization of the females, but due to the faster growth rate of males the underutilization of total yield is not likely to be large. The alternative, of trying to achieve $F_{msy}$ on females, carries a potentially serious risk to the production of future recruits and may result in very high exploitation of males. The use of a combined $F_{msy}$ (or proxy thereof) would obviously deliver higher long-term yield than either of the two separate sex values but the implication for male stock level should be noted. The Working Group suggested that a combined sex $F_{msy}$ proxy should be considered appropriate provided that the resulting percentage of virgin spawner-per-recruit for males does not fall below 20%. In such a case the male $F_{msy}$ proxy should be picked over the combined proxy.

In cases where recruitment rates are typically low and/or highly variable then a more cautious $F_{msy}$ proxy would be appropriate as the stock may have reduced resilience to periods of poor recruitment and in this case $F_{0.1}$ is recommended. Conversely where recruitment rates are considered to be regularly high and the stock appears to have supported a harvest rate at or above $F_{max,}$ (or in the case of a short TV time-series a particular landing level) without showing signs of recruitment overfishing, then $F_{max}$ is recommended. In all other cases $F_{35\%SpR}$ should deliver high long-term yield with a low probability of recruitment overfishing and is recommended as the "default" value.

In order to assist communication of the decision process the following bullet list is suggested as a standard checklist for describing the rationale behind the choice of a particular $F_{msy}$.

- Describe the absolute density. Is it high (i.e. >1 per $m^2$), medium (i.e. 1.0–0.2 per $m^2$) or low (i.e. <0.2 per $m^2$)
- Variability of density. Is there large interannual variability, spatial complexity?
- Understanding of biological parameters. Is the growth rate particularly fast or slow, high or low estimates of natural mortality?
- Fishery timing and operation. Is there a strong seasonal pattern leading to different exploitation rates on the sexes, does this pattern vary much between years?
- Observed Harvest Rate or landings compared to stock status. Is the harvest rate consistently around or above $F_{max}$? Have landings been stable? Have the indicators of stock status shown signs of difficulty?

Accompanying this text should be a table listing the $F_{msy}$ proxies $F_{max}$, $F_{35\%SpR}$ and $F_{0.1}$ for males and females, the Harvest Rates they correspond to along with the implied %spawner-per-recruit for males and females.

Following changes to UK legislation in 2006 the reliability of UK landings data is considered to have significantly improved (representing ~80% of the landings). Provided that this is both true and continues into the future, assessment scientists will eventually have data which could be used to parameterize dynamic stock assessment models which in turn will enable estimation of $F_{msy}$ directly rather than have to rely upon proxies thereof. Until this point the decision of which $F_{msy}$ proxy is suitable for which FU will inherently be a subjective process but the process outlined above should provide sufficient justification to support the decision.

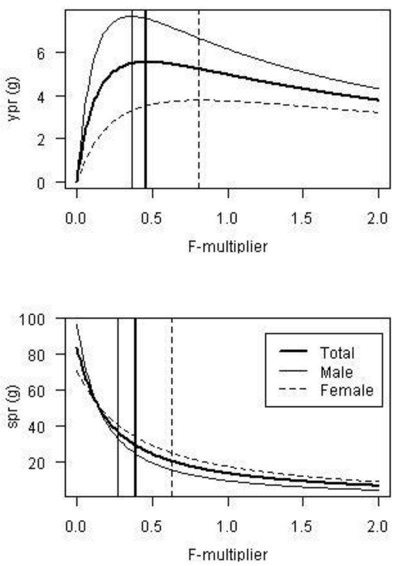



**Figure 2.1. Yield-per-recruit and spawning–stock biomass-per recruit for males, females (dotted line) and combined (bold) with $F_{max}$ and $F_{35\%spr}$ reference points.**

## 3.2 Cod in Subarea VIa

Cod in Division VIa is included in the EU long-term management plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). An update assessment was conducted this year by the WG.

### ICES advice applicable to 2010

#### Single-stock exploitation boundaries

ICES evaluated the long-term management plan and has not yet been able to confirm that it is precautionary. Considering the options below, ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that no fishing should take place on cod in Division VIa.

#### Exploitation boundaries in relation to existing management plans

Due to the uncertainty in the level of fishing mortality, ICES is not in a position to give quantitative forecasts. Given the stock status it is likely that the stock will fall into the category defined in Article 9.a of the plan which implies a 25% TAC reduction.

#### Exploitation boundaries in relation to precautionary considerations

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach.

### ICES advice applicable to 2011

| Management Objective (s) | Catches in 2011 |
|---|---|
| Transition to an MSY approach with caution at low stock size | Zero catch |
| Cautiously avoid impaired recruitment (Precautionary Approach) | Zero catch |
| Cautiously avoid impaired recruitment and achieve other objective(s) of a management plan (e.g. catch stability) | n/a |

#### *MSY approach*

Estimates of $F_{MSY}$ for this stock are uncertain due to the absence of fisheries data in the assessment since 1994. However, the estimates are consistent with the proposed $F_{MSY}$ for the neighbouring North Sea cod stock. There is no estimate for current fishing mortality for this stock. However, it is likely that current F is above $F_{MSY}$. SSB has declined to a very low level. Therefore, catches (mainly discards) of cod should be reduced to the lowest possible level.

#### *PA Considerations*

Given the low SSB and low recruitments in recent years, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach. No targeted fishing should take place on cod in Division VIa. Bycatches including discards of cod in all fisheries in Division VIa should be reduced to the lowest possible level.

The 2008 year class is estimated to be more abundant and consequently additional measures (such as real-time closures) to protect it are essential to ensure that it contributes to the rebuilding of the stock. It will be necessary to reduce all sources of fishing mortality on cod to as close to zero as possible if the stock is to recover above $B_{pa}$ as quickly as possible

#### Management plan

The stock is considered data poor. Following the cod long-term management plan (EC 1342/2008) article 9(a) implies a TAC and associated effort reduction of 25%. This translates to a TAC of less than 180 t. ICES considers that article 10(2) may also apply. Because it is not possible at present to assess unaccounted mortality accurately, ICES cannot yet evaluate if the management plan is in accordance with the precautionary approach.

### 3.2.1 General

#### Stock definition and the management unit

General information about the stock can be found in the stock annex and an overview of the fisheries West of Scotland can be found in Section 3.1. The assessment unit is VIa and a TAC is set for ICES Areas VIa and Vb (EC waters). The 2010 and 2011 TACs for cod in the management unit were 240 t and 182 t respectively.

#### Management applicable to 2010 and 2011

The minimum landing size of cod in the human consumption fishery in this area is 35 cm. Before 2009 a TAC was set for ICES Subarea VI and EC and international waters of ICES Subareas XII and XIV and Subdivision Vb1. From 2009 a TAC for VIa and Vb1 was given.

**TAC for 2010**

| Species: Cod *Gadus morhua* | | Zone: VIa; EU and international waters of Vb east of 12° 00' W (COD/5B6A-C) |
|---|---|---|
| Belgium | 0 | |
| Germany | 4 | |
| France | 38 | |
| Ireland | 53 | |
| United Kingdom | 145 | |
| EU | 240 | |
| TAC | 240 | Analytical TAC |

**TAC for 2011**

| Species: Cod *Gadus morhua* | | Zone: VIa; EU and international waters of Vb east of 12° 00' W (COD/5BE6A) |
|---|---|---|
| Belgium | 0 | |
| Germany | 3 | |
| France | 29 | |
| Ireland | 40 | |
| United Kingdom | 110 | |
| EU | 182 | |
| TAC | 182 | Analytical TAC |

Technical measures applicable to the West of Scotland, including those associated with the cod recovery plan in force in 2008 (Council Regulation No. 423/2004), the cod long-term management plan in force from 2009 (Council Regulation No. 1342/2008) and the Restrictions on fishing for cod, haddock and whiting in ICES zone VI contained in Council Regulation No. 43/2009 (Annex III paragraph 6), are described in Section 3.1.

#### The fishery in 2010

Cod is believed to be no longer targeted in any fisheries now operating in ICES Division VIa. The table of official landings statistics is given in Table 3.2.1. This indicates the full TAC was taken in 2010.

Because of restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition the probability of misreporting and underreporting of cod in the past is considered to have been high. From 2006 the Registration of Buyers and Sellers legislation in the UK and Sales Notes management system in Ireland are considered to have reduced to low levels under reporting (see Section 3.1). Area misreporting, however, is still believed to take place in the UK. Area misreporting will, for example, see cod caught in VIa declared as taken from the Faroe region or ICES Area IVa. The UK and Irish legislation introduced in 2006 is also believed responsible for a significant increase in discards starting in 2006. Since 2006, the estimated weight of discards has exceeded landings (Table 3.2.2), and discarding has taken place over an increased range of age groups (Tables 3.2.6 and 3.2.7 and Figure 3.2.1). Discard numbers as a percentage of catch numbers-at-age for 2009 and 2010 are shown in the following text table.

| Age<br>year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 2009 | 99.8 | 95.7 | 94.8 | 82.1 | 0.0 | 88.0 | 0.0 |
| 2010 | 100 | 96.9 | 75.6 | 42.3 | 27.8 | 0.0 | 0.0 |

The absolute level of numbers discarded from the 2005 year class at age 1 in 2006 through to age 4 in 2009 were high relatively to the same age class from adjacent cohorts (Table 3.2.6). There are indications a similar pattern is emerging with respect to the 2008 year class.

Tables and figures of total effort by the fleets operating in Division VIa can be found in Section 3.1.

### 3.2.2 Data

An overview of the data provided and used by the WG is provided in the following text table.

| | Commercial Data | | | | Survey Data | | | |
|---|---|---|---|---|---|---|---|---|
| | Landings | | Discards | | Cpue at age | | | |
| | No.-at-age | Wght.-at-age | No.-at-age | Wght.-at-age | ScoGFS-WIBTS-Q1 | ScoGFS-WIBTS-Q4 | IreGFS | IRGFS-WIBTS-Q4 |
| Available | 1978–2010<br>Ages : 1–7+ | 1978–2010<br>Ages : 1–7+ | 1978–2010<br>Ages : 1–7+ | 1978–2010<br>Ages : 1–7+ | 1985–2011<br>Ages : 1–7 | 1996–2009<br>Ages : 0–8 | 1993–2002<br>Ages : 0–3 | 2003–2010<br>Ages : 0–3 |
| Used | 1978–1994<br>Ages : 1–7+ | 1978–2010<br>Ages : 1–7+ | 1978–1994<br>Ages : 1–7+ | 1978–2010<br>Ages : 1–7+ | 1985–2011<br>Ages : 1–6 | NOT USED | NOT USED | NOT USED |

A plot of log catch curve gradient derived from commercial catch data (landings plus discards) is shown in Figure 3.2.2. The trend in gradients over time appear fairly consistent between the age ranges considered (2–5, 2–4 and 3–5) except for the most recent cohorts. The implication from the figure is of an increasing rate of mortality for cohorts spawned during the 1990s, a considerable reduction in mortality for the 2002, 2003 and 2004 cohorts, but a return to a higher mortality rate for the 2005 and 2006 cohorts. The final value (estimated over age range 2–5) is as high as any in the time-series. Landings and discard data numbers-at-age are, however, only included in the assessment up to 1994 because of concerns over deteriorating quality of landings data.

Annual mean weights-at-age in landings, discards and catch are given in Tables 3.2.5, 3.2.7 and 3.2.9. Weights-at-age for the stock are still required to obtain biomass estimates and so the full series of stock weights are used. Figure 3.2.1 shows the mean weights-at-age in the landings and discards. There is no evidence of a trend in weight-at-age for ages 1 and 2 for VIa cod landings, but some evidence of a gradual long-term decline at age 3 and above. Mean weight-at-age of discarded fish at age 2 has increased in recent years.

Raised discard numbers-at-age are given in Table 3.2.6. Discard data were supplied by Scotland and Ireland. Discard rates at age for the Irish fleet were very low and considerably different from those of the Scottish fleet. Applying combined Scottish-Irish discard rates to the international fleets resulted in significantly lower international discard totals. With no evidence other nations had achieved the low discards of the Irish fleet discards for the international fleet (except Ireland) were raised from Scottish observations. Observer coverage 2008–2010 (number of trips) is detailed in the following text table.

| **AREA VI** | | | | | |
|---|---|---|---|---|---|
| | Scotland | | | Ireland | |
| Year | Other trawlers | *Nephrops* trawlers | Total | OTB trawlers | Total |
| 2008 | 9 | 8 | 17 | | |
| 2009 | 10 | 22 | 32 | | |
| 2010 | 5 | 6 | 11 | 9 | 9 |

Increased discards from 2006 are considered an indicator of the combined effect of restrictive quotas and new regulation. The larger 2005 cohort can be tracked through the discards. A consequence of the current assessment model configuration is that the change in discarding practices from 2006 as shown in Tables 3.2.2 and 3.2.6 have no influence on the final assessment.

All available survey data are given in Table 3.2.3, with the data used in the assessment highlighted in bold. Survey descriptions are given in the stock annex.

For 2011 the rig and sampling design of the ScoGFS-WIBTS-Q1 survey was changed. A new groundgear capable of tackling challenging terrain was introduced broadly modelled around the rig used by Ireland for the IRGFS-WIBTS-Q4. The move to a more robust groundgear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4) as the previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year was considered a bias prone method for surveying the area. It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland. New survey strata were designed using cluster analysis on aggregated data from the previous ScoGFS-WIBTS-Q1 data (1999–2010) as well as the data collected from a dedicated gadoid survey which took place during quarter 1 of 2010. Species considered were cod, haddock, whiting, saithe and hake. Cluster analysis yielded four specific clusters. Two additional strata were added; the Clyde area and the 'windsock' which is an area that has been designated as a recovery zone since 2002 and has therefore experienced no mobile gear exploitation during this time. The new strata are shown if Figure 3.2.3. Each individual polygon was treated as a separate stratum and the number of survey stations for each was allocated according to polygon size and the variability of indices within each stratum. Strata were weighted by surface area to build the final indices.

The ScoGFS-WIBTS-Q4 did not take place in 2010. Figure 3.2.4 shows cpue by survey haul from 2010 for the IRGFS-WIBTS-Q4 survey and from 2011 for the ScoGFS-WIBTS-Q1 survey. The data from the Scottish surveys show cpue for ages 1+, that from the Irish survey a proxy for fish at ages 1+ (fish at lengths >23 cm). In a pattern relatively consistent between 2007–2009 the quarter four surveys have shown catches of cod in the northern part of the region (north Minches and north of 58.5 degrees N) and in the southern part of the region (off the north coast of Ireland and along the shelf edge south of 56 degree N) but mostly zero returns in the intervening latitudes. The 2010 IRGFS-WIBTS-Q4 demonstrates the same pattern as in previous years with the exception of one large haul at 56 degrees N.

Since 2000 the ScoQ1 survey has caught very few cod in the southern region (south of 56 degrees N) especially west of 7 degrees west (see also Figure A9.3 in the stock annex). In 2011 however two hauls caught 10–20 fish in the Clyde area. The ScoGFS-WIBTS-Q4 and IRGFS-WIBTS-Q4 are not currently used in the VIa cod assessment but their suitability as tuning indices will be considered in preparation for the benchmark meeting in 2012.

Figures 3.2.5 and 3.2.6 show the log mean standardized indices from the ScoGFS-WIBTS-Q1 survey by year and by cohort respectively. Figure 3.2.5 does not exhibit any exceptional year effects. Figure 3.2.6 shows the survey is able to track cohorts to some extent at younger ages. The extent to which this occurs seems little affected by the 2011 data points coming from a revised survey.

Figure 3.2.7 shows log catch curves for the ScoGFS-WIBTS-Q1 survey. It shows a strong "hook" at the younger ages, with abundance-at-age two often higher than at age one. The index of the 2005 and 2008 year classes also increased from age 2 to age 3 and the survey's ability to track recent cohorts seems poor relative to the 1990s and early 2000s.

Values for natural mortality (0.2 for all ages and years) and the proportion of fish mature-at-age are unchanged from the last meeting.

| Age | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|
| Proportion mature-at-age | 0.0 | 0.52 | 0.86 | 1.0 |

The proportion of F and M acting before spawning is set to zero.

A study by the sea mammal research unit (SMRU) on seal predation has indicated that seal predation on cod probably constitutes significant natural mortality over and above values assumed in the assessment. A working document looking at the significance of seal predation to perceptions of the VIa cod stock was submitted to WGNSDS_08 and work is ongoing for incorporation into the VIa cod benchmark. Any increase in predation mortality would be incorporated into estimates of total mortality by the stock assessment model.

A plot of log catch curve gradient derived from the ScoGFS-WIBTS-Q1 data is shown in Figure 3.2.8. For cohorts after 1995 index values of zero have sometimes been recorded at age five. For the age ranges considered (2–5, 2–4 and 3–5) this means the slope has not always been fitted to data from all the ages indicated. There is little consistancy in results between age ranges chosen and this appears to worsen after the 1995 or 1996 cohort. The series for ages 2–5 seems more stable than the others in this later period although large variations in the final years occur over all age ranges. There is no evidence of a long-term trend in catch curve gradient. In contrast to the commercial data the result for the 2005 cohort shows a large decline in mortality rate on this cohort. Overall, information on mortality trends from all survey-series (including the ScoGFS-WIBTS-Q1) appears weak.

### 3.2.3 Historical stock development

This update assessment uses a TSA run as outlined in the stock annex.

Model settings and input parameter settings for the final run are given in Table 3.2.10 and final parameter estimates from the TSA run are given in Table 3.2.11, alongside final run estimates for VIa cod from previous WGs. Standardized prediction errors at age from the update assessment run (which can be interpreted as residuals) are shown in Figure 3.2.9 (landings), Figure 3.2.10 (discards) and Figure 3.2.11 (ScoGFS-WIBTS-Q1). Errors within ±2 are considered reasonable. The prediction error for age 2 from the 2011 survey data initially fell significantly outside of ±2 and the data point was downweighted. Table 3.2.11 shows final parameter estimates have remained very consistent over the last five assessments.

It is important to note that the assessment is based on survey estimates of mortality with corresponding population abundance. Whereas the assumed natural mortality rate (M=0.2) is excluded from the estimates of 'fishing mortality', unallocated removals from the stock due to the fishery or other sources are not and are therefore also included in the estimates of 'fishing mortality' used in the forecast. The WG consider the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. These mortality estimates are here referred to as 'Z-0.2'. For management purposes, however, this combined mortality would still need to fall below the level of $F_{lim}$, as higher levels of mortality over and above M are considered to have led to stock decline in the early 1980s.

Table 3.2.12 gives the TSA population numbers-at-age and Table 3.2.13 gives their associated standard errors. Estimated Z-0.2 at age is given in Table 3.2.14 and standard errors on the log of this mortality are given in Table 3.2.15. Full summary output is given in Table 3.2.16.

A summary plot for this run is shown in Figure 3.2.12. The disparity between the estimated removals compared to the supplied commercial catch data is clear. Figure 3.2.13 shows the ratio between the estimated removals and observed catch. The disparity has reduced since the largest values in 2004 and 2005 but the lower limit of the confidence intervals on the estimated removals are still above the line showing a 1:1 ratio.

From Figure 3.2.12 there is a noticeable long-term downward trend in recruitment although the values for the 2005 and 2008 year classes are the highest since the 1996 year class. The value for the 2009 year class is also higher than many since 2000. There has been a modest increase in SSB since 2007 and the estimate for 2011 is the highest since 2001. The value is still well below $B_{lim}$ however. Despite a drop in the final year, mean Z-0.2 is above $F_{lim}$ and comparable to values since 1995.

Retrospectives for the final assessment run are shown in Figure 3.2.14. This figure also shows lines at ± 2 se (approximate 95% confidence limits) around the run using all years of data. Retrospective bias is small with respect to SSB. With respect to recruitment the runs terminating in 2006 and 2009 sit below the lower confidence limit. Higher levels of Z-0.2 from the run terminating in 2006 appear untypically high and fall outside the confidence limits for this metric. The confidence interval for mean Z-0.2 is wide, reflecting uncertainty in estimation of mean Z-0.2 when that estimation is based on the age structure present in survey data.

The TSA estimated stock–recruit relationship is shown in Figure 3.2.15. It includes the data point of the 1986 year class which from inspection of Figure 3.2.11 appears an outlier.

The precautionary approach plot for this stock is given in Figure 3.2.16. It shows clearly how the stock has moved and remained in the zone indicating reduced reproductive capacity and (substituting Z-0.2 for F) unsustainable removals.

#### Comparison with last year's assessment

Compared to last year's assessment SSB in 2009 has been revised down from 5166 t to 5028 t while the estimate of mean Z-0.2 has remained constant at 0.89. The estimate of recruitment in 2009 is revised up from 10.4 million to 12.4 million. The estimate of SSB in 2010 from this update assessment is 6581 t with a s.e. of 838 t. The short-term forecast from last year's assessment predicted SSB in 2010 at 6230 t which is less than one s.e. difference from the update assessment. Figure 3.2.14 shows these revisions represent comparatively small retrospective adjustments.

### 3.2.4 Short-term stock projections

A short-term projection was made using WGFRANSW following the procedure outlined in the stock annex.

#### Estimating recruiting year-class abundance

The recruitment values (000 fish) used in the forecast are given in the following table:

| Year | TSA | STF |
|---|---|---|
| 2011 | 4122 (ScoGFS-WIBTS-Q1) | 4122 (ScoGFS-WIBTS-Q1) |
| 2012 | 7697 (Ricker) | 5032 (GM 00-09) |
| 2013 | | 5032 (GM 00-09) |

Three-year means of the Z-0.2 estimates were taken to represent status quo mortality. The cod long-term management plan introduced in 2009 (Council Regulation No. 1342/2008, article 6, paragraph 4), directs that forecasts "assume that in the year prior to the year of application of the TAC the stock is fished with an adjustment in fishing mortality equal to the reduction in maximum allowable fishing effort that applies in that year." At WGCSE_2010 the Z-0.2 value was reduced by 25% for the intermediate year to reflect reductions in maximum allowed fishing effort (kWdays) or incorporation of vessels in schemes designed to achieve a 25% reduction in mortality.

Effort reductions for two of the main trawl gear fleets in Area VIa are again 25% in 2011 compared to 2010. Consistent with last year the *status quo* Z-0.2 was reduced by 25% for the intermediate year in the forecast (2011). The management options table from this first run showed SSB to be below $B_{lim}$ at the start of 2012. Following article 6, paragraph 2(a) of the cod management plan *status quo* Z-0.2 was reduced by a further 25% for 2012 with the aim of producing more representative detailed tables. This was again consistent with the procedure adopted last year.

Input data to the short-term projection is shown in Table 3.2.17. Management options from the forecast are shown in Table 3.2.18 and detailed tables of catch numbers-at-age are shown in Table 3.2.19.

A plot of the short-term forecast is shown in Figure 3.2.17. Results from sensitivity analysis from this forecast are shown in Figure 3.2.18 and probability profiles in Figure 3.2.19. It is emphasized again that the outputs from the forecasting software include figures labelled as "H-cons" do not refer to the human consumption fishery but in the present application refer to all removals over and above the losses due to the assumed natural mortality rate of M=0.2. These values will include estimates of unallocated fishery removals that may be due to misreporting, or additional natural mortality not encompassed by the standard value of M=0.2. The WG recommends that these forecasts are not used to determine a future TAC using the procedure specified in Article 7 of the long-term management plan for cod, as it is not possible to determine figures for unallocated fishery removals to deduct from the forecasted total removals to calculate the TAC for 2011.

Estimates of SSB corresponding to the different levels of the Z-0.2 mortality should, however, remain appropriate. From Table 3.2.18 it can be seen that an assumption of zero removals in 2012 give an estimate of SSB in 2013 between $B_{lim}$ and $B_{pa}$. From Figure 3.2.19 the probability of SSB in 2013 being above Blim is approximately 0.15.

### 3.2.5 MSY explorations

Prior to 2010 ICES defined the following PA reference points:

| Reference point | Technical basis |
|---|---|
| $B_{pa}$ = 22 000 t | Previously set at 25 000 t, which was considered a level at which good recruitment is probable. This has since been reduced to 22 000 t due to an extended period of stock decline. |
| $B_{lim}$ = 14 000 t | Smoothed estimate of $B_{loss}$ (as estimated in 1998). |
| $F_{pa}$ = 0.6 | Consistent with $B_{pa}$. |
| $F_{lim}$ = 0.8 | F values above 0.8 led to stock decline in the early 1980s. |

In 2010 WGCSE derived an $F_{MSY}$ estimate using the srmsymc package. Mortalities from removals in the range 0.17 to 0.33 were concluded as consistent with $F_{MSY}$. A description of the runs performed is given in the stock annex. The current level of Z-02 is higher than the median $F_{crash}$ value for all three stock–recruit relationships tested.

The same input data files as used for the short-term forecast were used. An alternative run using ten year means for stock weights-at-age and mortality-at-age showed there to be little sensitivity to the averaging period used. Figure 3.2.## shows the three stock–recruit relationships fitted by the package; Ricker, Beverton–Holt and smooth hockey-stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships all resamples allowed $F_{MSY}$ and $F_{crash}$ values to be determined. As such, there was no basis to reject any of the recruitment models as unsuitable for this stock. For each of the stock–recruit relationships (SRR) Figures 3.2.## to 3.2.## show box plots of $F_{MSY}$ and $F_{crash}$ together with the values of $F_{pa}$ and $F_{lim}$. For the Ricker and Beverton–Holt SRR the estimated value of $F_{crash}$ is very close to $F_{lim}$. For the smooth hockey-stick SRR $F_{crash}$ is estimated between $F_{lim}$ and $F_{pa}$. For all three SRR the current level of Z-02 is higher than the median $F_{crash}$ value. Also the value of $F_{MSY}$ is well defined and considerably lower than $F_{pa}$ for all three SRR. The level of removals possible at the estimated $F_{MSY}$ is poorly defined however. Circles showing the data points show values of Z-0.2 repeatedly in excess of the upper percentile for $F_{crash}$. As expected removals and SSB have declined such that values for both are now inside confidence limits for these metrics at the estimated Z-0.2 mortality rates.

Figure 3.2.27 shows estimation of yield-per-recruit. $F_{max}$ is well defined for this stock. Comparison of $F_{max}$ to $F_{MSY}$ estimated using the three SRRs (Figures 3.2.24–26) shows $F_{MSY}$ estimated as lower than $F_{max}$ for the Beverton–Holt model, equal for the smooth hockey-stick and higher than $F_{max}$ in the Ricker model reflecting the downward slope of the stock–recruit relationship at higher SSBs.

In conclusion mortalities from removals in the range 0.17 to 0.33 were considered consistent with $F_{MSY}$.

### 3.2.6 Management plans

Cod in VIa is included in Council Regulation No. 1342/2008 establishing a long-term plan for cod stocks and fisheries exploiting those stocks. The plan and its evaluation by ICES are discussed in Section 9.

### 3.2.7 Uncertainties and bias in assessment and forecast

Figure 3.2.20 shows a comparison of SSB, recruitment-at-age one and mean Z-0.2 (ages2–5) estimates produced by final run assessments between this year's assessment and assessments going back to 2001.

#### Landings

Since the early 1990s the most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings-species, quantity and management area-is known to have occurred and directly affects the perception of the stock.

#### Effort

Commercial effort data for Division VIa from the Scottish fleets is considered very uncertain and was not used in the assessment.

#### Discards

The current assessment model removes discard information for the same years for which landings data are removed. The increase in discards at ages one and two and additional ages of cod discarded since 2006 are not therefore able to influence the assessment. A new version of the model is now capable of fitting discard proportions across more ages and can be considered at the planned benchmark in 2012. To consider discards from 2006 requires commercial data (landings and discards) to be reintroduced from 2006.

Available discard estimates are calculated mainly from the Scottish sampling programme. The method used is to sample on a stratified basis then raise by some auxiliary variable to, initially, total strata discards, and ultimately international discards. These estimates are prone to bias. An alternative method of raising discard data using the same raw data, and which reduces estimation bias, is being applied and tested on data from both the Northern Shelf and North Sea regions before the resulting revised data are released to assessment working groups. Data using the new method was not available for this year's assessment.

#### Surveys

The survey used for this assessment changed vessel and tow duration in 1999. Although a correction has been made based on comparative tows, there will be an additional variance associated with this correction factor which will affect the survey index. The current spatial aggregation of the survey (weighted arithmetic mean) can result in hauls catching large numbers of fish having a strong influence on index values (as was the case in the ScoGFS-WIBTS-Q1 in 2008). This in turn can cause a 'noisy' set of indices that can lead to high prediction errors from TSA (residuals from other models) and downweighting of data points. The current weighting of strata (weighting by number of valid hauls) is also not consistent between years leading to further increase in the overall estimation of survey variance. Ways of compiling the historical survey data that can better incorporate extreme values, including new post stratification and strata weightings, are currently under investigation and are proposed for consideration at a scheduled benchmark in 2012.

The survey gear changed in 2011 to bring it in line with other surveys in the area so that these can be combined in future to provide a more robust and precise survey index. The opportunity was also taken to improve the survey design at this time: it is now random stratified with strata weighted by surface area. This only effects our perception of stock metrics in 2011 and does not influence the basis for the advice.

#### Biological factors

Assumptions on mean weight-at-length and mean maturity-at-age have remained unchanged for a long period. However, biological responses of cod in VIa as a localized species to high exploitation and low population numbers are so far unknown to the working group. Estimates of high predation consumption of cod relative to total-stock biomass have raised concerns that natural mortality of cod at younger ages may be significantly greater than the standard value of 0.2. Also that it will have changed significantly over the period of the historical assessment.

#### Forecasts

Short-term forecasts are sensitive to the estimation of *status quo* mean fishing mortality. The WG considers mortality estimates arising from an assessment heavily or wholly based on survey data are poorly estimated and therefore noisy and sensitive to survey catchability. In addition, for VIa cod only one survey-series has been considered sufficiently long and self-consistent for use in assessment.

Natural mortality on cod at some or all ages is considered to have become greater than can be accommodated by the standard natural mortality figure of M=0.2. It is also possibly subject to a persistent upward trend. As a consequence, mortality outputs from TSA (or any model reliant on survey data) are not considered to represent a fishing mortality F at age for recent years in the time-series but rather estimates, (referred to here as 'Z-0.2'), of total mortality that cannot be accounted for by the standard value used for natural mortality. It is not possible to determine the proportion of the mortality caused by fishing and therefore not possible to partition F into landings and discard F. Until a better estimate of natural mortality can be determined short-term forecasts are only appropriate to considering the SSB corresponding to the different levels of the Z-0.2 mortality.

### 3.2.8 Recommendation for next benchmark

| problem | solution | expertise necessary | suggested time |
|---|---|---|---|
| Misreporting of landings. Unknown level prevents adjustment of reported catch and inclusion in assessment. | To estimate misreporting due to area misreporting; analysis of VMS data in comparison to landings declarations to estimate the degree of area misreporting. | Requires someone familiar with VMS analysis (plus provision of trip specific landings declarations). | Uncertain. Suitable expert needs to be identified. |
| Bias in discard estimates | New discard raising methodology has been developed at Marine Scotland Science. | | |
| Inappropriate modelling of discards within TSA model | Revision of TSA to allow fitting of discards at higher ages. | Requires someone familiar TSA routines. | New model available. |

| problem | solution | expertise necessary | suggested time |
|---|---|---|---|
| Variance and bias in survey index | Adoption of new aggregation methods to form final indices from haul by haul data, (combinations of new post stratification, weighting of strata and/or adoption of statistical approaches such as fitting of GAM or delta distribution models). | Work being undertaken as a Marine Scotland Science research project. | Project due for completion in 2011. |
| | Inclusion of additional surveys (ScoGFS-4Q and IRGFS-WIBTS-Q4). ScoGFS-WIBTS-Q4 indices to be formed in same manner as ScoGFS-WIBTS-Q1 after conclusion of above project. | | Comparison with existing assessment setup (single survey) possible in 2011 (after conclusion of above project). |
| | Addition of new survey effort and/or revision of survey design. | | Anglerfish survey records cod numbers at length, now has 5 years of data and cpue indices can be formed. Data from charter surveys in 2009 available. A random stratified design for the Scottish surveys was implemented in 2011. |
| Uncertainty in natural mortality (level and trend) because of unquantified predation from large and increasing seal population. | Revision of TSA to allow inclusion of different fleets, (this in turn allows estimates of age specific consumption of cod by seals to be input as if from an additional fleet). | Requires someone familiar with TSA routines. | Method for estimating age specific consumption of cod by seals presented at 2008 ICES ASC. Work to adjust TSA scheduled for 2011. |
| Possible trend in mean weight-at-age in landings | Compare mean weights-at-age with that from survey data. Apply F test to determine if fitted smooth significantly different from straight line with zero gradient. | | Work possible in 2011. |

### 3.2.9 Management considerations

The fishery is managed by a combination of TAC, area closures, technical measures and effort restrictions. These do not seem to have been effective in controlling catches. Despite considerable reductions in fishing effort over the past decade, the stock structure is still truncated with few older fish present. The 25% effort reduction imposed as part of the cod long-term management plan in 2010 has not been reflected in the latest estimate of Z-0.2.

Although the UK 'Buyers and Sellers' and Irish 'Sales Notes' legislation is considered to have reduced underreporting from 2006, discard data shows increased discards-at-ages one and two and a change in discard practices such that fish are discarded at older ages. In 2008, Scotland introduced a voluntary programme known as "Conservation Credits", which involved seasonal closures, real-time closures (RTCs) and various selective gear options. This was designed to reduce mortality and discarding of cod. The number of RTCs west of Scotland were four in 2008, 17 in 2009 and 17 in 2010, representing 27, 12 and 10% of total RTCs in each year. RTCs are determined by lpue, based on fine scale VMS data and daily logbook records and also by on-board inspections. The small number of RTCs west of Scotland result from few instances of high lpue in the area. Early indications are that the scheme has not so far been as effective as in the North Sea with discard rates remaining high in Area VIa. In 2010 discards as a percentage of catch were 100% for age 1 and 97% and 75% for ages 2 and 3 (although discards-at-age 4 fell to 42% compared to over 80% in 2009). There are also anecdotal reports of continued area misreporting.

Mortality estimates arising from an assessment heavily or wholly based on survey data are poorly estimated and therefore noisy and sensitive to survey catchability. In contrast, historical trends in spawning biomass and recruitment appear to be robust measures of stock dynamics.

Population estimates using the ScoGFS-WIBTS-Q1 survey data indicated the 2005 and 2008 year classes to be the biggest within the last decade. Both discards at higher ages and area misreporting reduce the potential for these year classes to contribute to increases in SSB. It is important good observer coverage is conducted in Division VIa to record discard trends in future and that work is done to estimate area misreporting (comparing declared landings to VMS data).

Cod is taken in mixed demersal fisheries, and in Division VIa is now regarded as a bycatch species. To greatly reduce cod catch would likely result in having to greatly reduce harvesting of other stocks such as haddock, whiting and anglerfish. It is also important the bycatch from the *Nephrops* fleet is closely monitored (including discard observations). The STECF report (STECF-SGMOS-10-05) assessing effort and catch of fishing regimes subject to fishing effort limitations shows trawl gear vessels targeting finfish (TR1 gear) to take roughly 80–85%% of cod catch and the *Nephrops* fleet (TR2 gear) to take 15–20% of cod catch in ICES Area VIa.

The EU cod long-term management plan, (Council Regulation No. 1342/2008) is complemented by a system of fishing effort limitation and in waters west of Scotland landings composition restrictions. For vessels of length 15 m and over operating west of a management line shown in Figure 3.2.21 effort is restricted to a lesser degree. Figure 3.2.21 also shows locations of fishing activity using TR1 gear (from VMS data) linked to cod landings. It can be seen a large proportion of the effort falls outside the cod management area. The landings composition restrictions do not restrict discards.

Article 7 (paragraph 1) of the current management plan requires TACs to be calculated after removal of quantities of discards and fish corresponding to other sources of cod mortality caused by fishing. The current assessment of VIa cod is considered to estimate a mortality that is a combination of mortality from fishing and natural mortality not accounted for by the standard long-term input value (termed Z-0.2). As such mortality from landings, discards and other causes due to fishing cannot be defined. For management purposes this combined Z-0.2 mortality would still need to fall below the level of $F_{lim}$, as higher levels of mortality over and above M are considered to have led to stock decline.

A report by the Sea Mammal Research unit (SMRU, 2006) gives estimates of cod consumed by grey seals to the west of Scotland and although highly uncertain, the estimates suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for gadoid species in ICES Division VIa. It has not been possible using an update assessment to quantify the level of mortality caused by seal predation. This is proposed for a benchmark assessment, (see Section 3.2.9).

**Table 3.2.1. Cod in Division VIa. Official catch statistics in 1985–2009, as reported to ICES.**

| Country | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 48 | 88 | 33 | 44 | 28 | - | 6 | - | 22 | 1 | 2 | + | 11 | 1 | + | + | 2 | + |
| Denmark | - | - | 4 | 1 | 3 | 2 | 2 | 3 | 2 | + | 4 | 2 | - | - | + | - | - | - |
| Faroe Islands | - | - | - | 11 | 26 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| France | 7,411 | 5,096 | 5,044 | 7,669 | 3,640 | 2,220 | 2,503 | 1,957 | 3,047 | 2,488 | 2,533 | 2,253 | 956 | 714* | 842* | 236 | 391 | 208 |
| Germany | 66 | 53 | 12 | 25 | 281 | 586 | 60 | 5 | 94 | 100 | 18 | 63 | 5 | 6 | 8 | 6 | 4 | + |
| Ireland | 2,564 | 1,704 | 2,442 | 2,551 | 1,642 | 1,200 | 761 | 761 | 645 | 825 | 1,054 | 1,286 | 708 | 478 | 223 | 357 | 319 | 210 |
| Netherlands | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 1 | - | - | - | - |
| Norway | 204 | 174 | 77 | 186 | 207 | 150 | 40 | 171 | 72 | 51 | 61 | 137 | 36 | 36 | 79 | 114* | 40* | 88 |
| Spain | 28 | - | - | - | 85 | - | - | - | - | - | 16 | + | 6 | 42 | 45 | 14 | 3 | 11 |
| UK (E., W., N.I.) | 260 | 160 | 444 | 230 | 278 | 230 | 511 | 577 | 524 | 419 | 450 | 457 | 779 | 474 | 381 | 280 | 138 | 195 |
| UK (Scotland) | 8,032 | 4,251 | 11,143 | 8,465 | 9,236 | 7,389 | 6,751 | 5,543 | 6,069 | 5,247 | 5,522 | 5,382 | 4,489 | 3,919 | 2,711 | 2,057 | 1,544 | 1,519 |
| UK | | | | | | | | | | | | | | | | | | |
| Total landings | 18,613 | 11,526 | 19,199 | 19,182 | 15,426 | 11,777 | 10,634 | 9,017 | 10,475 | 9,131 | 9,660 | 9,580 | 6,992 | 5,671 | 4,289 | 2,767 | 2,439 | 2,231 |

| Country | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|
| Belgium | | | | | | | | 0 |
| Denmark | | | | | | | | |
| Faroe Islands | | 2 | 0 | 0.8 | 12 | 1 | | 0.2 |
| France | 172 | 91 | 107 | 100.7 | 92 | 82 | 74 | 60.3 |
| Germany | + | | | 2 | 2 | 1 | 0 | 0 |
| Ireland | 120 | 34 | 27.9 | 18 | 70 | 58.2 | 24.4 | 48.7 |
| Netherlands | - | | | | | | 0 | |
| Norway | 45 | 10 | 17 | 30 | 30 | 65 | 18 | 20.7 |
| Spain | 3 | | | | | | | |
| UK (E., W., N.I.) | 79 | 46 | 25 | | 21 | 6 | 14 | |
| UK (Scotland) | 879 | 413 | 243 | | 260 | 232 | | |
| UK | | | | 332.1 | | | 104 | 118.6 |
| Total landings | 1,298 | 596 | 419.9 | 483.6 | 487 | 445.2 | 234.4 | 248.5 |

*** Preliminary.**

**Table 3.2.2. Cod in Division VIa. Landings, discards and catch estimates 1978–2009, as used by the WG. Values are totals for fish over the ages 1 to 7+.**

| Year | Landings | Discards | Catch |
|---|---|---|---|
| 1978 | 13521 | 3678 | 17199 |
| 1979 | 16087 | 54 | 16141 |
| 1980 | 17879 | 996 | 18875 |
| 1981 | 23866 | 520 | 24386 |
| 1982 | 21510 | 1652 | 23162 |
| 1983 | 21305 | 2026 | 23331 |
| 1984 | 21271 | 635 | 21906 |
| 1985 | 18608 | 8812 | 27420 |
| 1986 | 11820 | 1201 | 13022 |
| 1987 | 18975 | 8767 | 27742 |
| 1988 | 20413 | 1217 | 21629 |
| 1989 | 17171 | 2833 | 20004 |
| 1990 | 12176 | 326 | 12503 |
| 1991 | 10926 | 917 | 11843 |
| 1992 | 9086 | 2897 | 11983 |
| 1993 | 10315 | 192 | 10507 |
| 1994 | 8929 | 186 | 9115 |
| 1995 | 9438 | 257 | 9696 |
| 1996 | 9425 | 87 | 9513 |
| 1997 | 7033 | 354 | 7387 |
| 1998 | 5714 | 423 | 6137 |
| 1999 | 4201 | 98 | 4298 |
| 2000 | 2977 | 607 | 3584 |
| 2001 | 2347 | 224 | 2571 |
| 2002 | 2242 | 169 | 2412 |
| 2003 | 1241 | 49 | 1291 |
| 2004 | 540 | 75 | 615 |
| 2005 | 479 | 57 | 535 |
| 2006 | 463 | 478 | 940 |
| 2007 | 525 | 2104 | 2629 |
| 2008 | 451 | 909 | 1360 |
| 2009 | 222 | 1401 | 1623 |
| 2010 | 239 | 1183 | 1422 |

**Table 3.2.3. Cod in Division VIa. Survey data made available to the WG. Data used in update run are highlighted in bold. For ScoGFS-WIBTS-Q1, numbers are standardized to catch-rate per 10 hours.**

| ScoGFS-WIBTS-Q1 | Scottish west coast groundfish survey | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1985 | 2011 | | | | | | | |
| 1 | 1 | 0 | 0.25 | | | | | |
| 1 | 7 | | | | | | | |
| 10 | 1.5 | 23.7 | 8.6 | 13.6 | 3.9 | 2.5 | 1.2 | 1985 |
| 10 | 1.5 | 6.9 | 26.8 | 5.6 | 7.3 | 2.5 | 1.9 | 1986 |
| 10 | 57.4 | 16.2 | 15.3 | 22.8 | 3.0 | 2.8 | 0.0 | 1987 |
| 10 | 0.0 | 64.9 | 14.2 | 3.4 | 2.1 | 0.7 | 0.2 | 1988 |
| 10 | 4.5 | 7.2 | 45.1 | 8.6 | 1.9 | 0.5 | 0.8 | 1989 |
| 10 | 2.0 | 24.6 | 4.1 | 14.7 | 4.2 | 1.6 | 0.8 | 1990 |
| 10 | 4.8 | 5.4 | 17.4 | 5.2 | 13.4 | 2.8 | 0.5 | 1991 |
| 10 | 7.3 | 11.5 | 5.4 | 7.6 | 3.4 | 2.3 | 0.5 | 1992 |
| 10 | 1.7 | 38.2 | 12.7 | 1.7 | 1.4 | 1.1 | 0.0 | 1993 |
| 10 | 13.6 | 14.7 | 25.1 | 5.8 | 1.0 | 0.0 | 0.0 | 1994 |
| 10 | 6.4 | 23.8 | 14.0 | 16.5 | 1.2 | 1.9 | 0.7 | 1995 |
| 10 | 2.8 | 20.9 | 24.1 | 4.1 | 2.8 | 1.3 | 0.0 | 1996 |
| 10 | 11.1 | 7.7 | 11.6 | 7.9 | 4.2 | 4.7 | 1.0 | 1997 |
| 10 | 2.8 | 30.9 | 5.3 | 8.7 | 3.7 | 0.6 | 2.0 | 1998 |
| 10 | 1.5 | 8.2 | 8.2 | 1.4 | 3.2 | 0.5 | 0.5 | 1999 |
| 10 | 13.3 | 5.4 | 6.9 | 1.3 | 0.0 | 0.4 | 0.0 | 2000 |
| 10 | 2.7 | 18.4 | 5.7 | 13.2 | 19.5 | 1.1 | 1.6 | 2001 |
| 10 | 5.3 | 4.3 | 10.6 | 2.6 | 0.5 | 3.0 | 0.0 | 2002 |
| 10 | 2.7 | 16.7 | 2.0 | 4.7 | 1.8 | 0.7 | 0.4 | 2003 |
| 10 | 5.7 | 3.0 | 5.6 | 2.3 | 1.7 | 0.0 | 0.0 | 2004 |
| 10 | 1.3 | 1.5 | 1.2 | 0 | 0 | 0.4 | 0 | 2005 |
| 10 | 2.2 | 1.9 | 1.1 | 0.3 | 0 | 0 | 0.3 | 2006 |
| 10 | 2.1 | 18.8 | 3.4 | 1.2 | 0 | 0.6 | 0 | 2007 |
| 10 | 0.8 | 2.1 | 44.2 | 6.3 | 0.8 | 0 | 0 | 2008 |
| 10 | 1.8 | 2.6 | 2.3 | 0.4 | 0 | 0 | 0 | 2009 |
| 10 | 4.6 | 16.2 | 3.7 | 1.0 | 0.7 | 0 | 0 | 2010 |
| 10 | 0.6 | 33.9 | 20.8 | 0.9 | 1.0 | 1.0 | 0 | 2011 |

**Table 3.2.3. cont. Cod in Division VIa. Survey data made available to the WG. For IreGFS, effort is given as minutes towed, numbers are in units.**

| IreGFS | Irish groundfish survey | | | |
|---|---|---|---|---|
| 1993 | 2002 | | | |
| 1 | 1 | 0.75 | 0.79 | |
| 0 | 3 | | | |
| 1849 | 0.0 | 312.0 | 49.0 | 13.0 |
| 1610 | 20.0 | 999.0 | 56.0 | 13.0 |
| 1826 | 78.0 | 169.0 | 142.0 | 69.0 |
| 1765 | 0.0 | 214.0 | 89.0 | 18.0 |
| 1581 | 6.0 | 565.0 | 31.0 | 10.0 |
| 1639 | 0.0 | 83.0 | 53.0 | 6.0 |
| 1564 | 0.0 | 24.0 | 14.0 | 3.0 |
| 1556 | 0.0 | 124.0 | 4.0 | 1.0 |
| 755 | 3.0 | 82.0 | 28.0 | 2.0 |
| 798 | 0.0 | 50.6 | 2.2 | 1.2 |

**Table 3.2.3. cont. Cod in Division VIa. Survey data made available to the WG. For ScoGFS-WIBTS-Q4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.**

| ScoGFS-WIBTS-Q4 | | Quarter 4 Scottish groundfish survey | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 2010 | | | | | | | | | |
| 1 | 1 | 0.75 | 1.00 | | | | | | | |
| 0 | 8 | | | | | | | | | |
| 10 | 0 | 1 | 14 | 5 | 3 | 1 | 0 | 0 | 0 | 1996 |
| 10 | 1 | 11 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 1997 |
| 10 | + | 15 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 1998 |
| 10 | 2 | 4 | 6 | 9 | 1 | 0 | 0 | 0 | 0 | 1999 |
| 10 | 0 | 16 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 |
| 10 | 1 | 2 | 9 | 1 | 1 | 0 | 0 | 0 | 0 | 2001 |
| 10 | 1 | 10 | 3 | 7 | 1 | 0 | 0 | 0 | 0 | 2002 |
| 10 | 1 | 2 | 11 | 3 | 1 | 0 | 0 | 0 | 0 | 2003 |
| 10 | 0 | 5 | 4 | 0 | + | 0 | 0 | 0 | 0 | 2004 |
| 10 | + | 2 | 3 | 0 | 1 | + | 0 | 0 | 0 | 2005 |
| 10 | 0 | 17 | 6 | 1 | 1 | 0 | 0 | 0 | 0 | 2006 |
| 10 | 0 | 12.0 | 20.0 | 1.3 | 0.6 | 0 | 0.3 | 0 | 0 | 2007 |
| 10 | 2 | 8 | 5 | 7 | 1 | 0 | 0 | 0 | 0 | 2008 |
| 10 | 2 | 14 | 4 | 1 | 1 | + | 0 | 0 | 0 | 2009 |
| 10 | na | na | na | na | na | na | na | na | na | 2010 |

**Table 3.2.3. cont. Cod in Division VIa. Survey data made available to the WG. For IRGFS-WIBTS-Q4, effort is given as minutes towed, numbers are in units. Values for 2007 are revised compared to last year's assessment**

| IRGFS-WIBTS-Q4 | Irish West Coast groundfish | | | | | |
|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | |
| 0 | 4 | | | | | |
| 1127 | 0 | 10 | 11 | 0 | 0 | 2003 |
| 1200 | 0 | 24 | 10 | 1 | 0 | 2004 |
| 960 | 63 | 13 | 7 | 0 | 2 | 2005 |
| 1510 | 0 | 95 | 12 | 0 | 0 | 2006 |
| 1173 | 0 | 161 | 12 | 0 | 1 | 2007 |
| 1135 | 0 | 23 | 24 | 4 | 0 | 2008 |
| 1378 | 1 | 75 | 4 | 5 | 0 | 2009 |
| 1291 | 0 | 70 | 31 | 4 | 3 | 2010 |

**Table 3.2.4. Cod in Division VIa. Landings-at-age (thousands).**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1966 | 384 | 2883 | 629 | 999 | 825 | 78 | 52 |
| 1967 | 261 | 2571 | 3705 | 670 | 442 | 264 | 67 |
| 1968 | 333 | 1364 | 3289 | 1838 | 215 | 171 | 151 |
| 1969 | 64 | 1974 | 1332 | 1943 | 759 | 149 | 170 |
| 1970 | 256 | 1176 | 1638 | 571 | 476 | 153 | 74 |
| 1971 | 254 | 1903 | 550 | 841 | 240 | 201 | 95 |
| 1972 | 735 | 2891 | 1591 | 409 | 501 | 108 | 110 |
| 1973 | 1015 | 1524 | 1442 | 583 | 161 | 193 | 104 |
| 1974 | 843 | 2318 | 778 | 1068 | 288 | 72 | 102 |
| 1975 | 1207 | 1898 | 1187 | 533 | 325 | 90 | 35 |
| 1976 | 970 | 3682 | 1467 | 638 | 256 | 215 | 56 |
| 1977 | 1265 | 1314 | 1639 | 624 | 269 | 87 | 79 |
| 1978 | 723 | 1761 | 999 | 695 | 286 | 97 | 75 |
| 1979 | 929 | 1612 | 2125 | 682 | 342 | 134 | 69 |
| 1980 | 1195 | 3294 | 2001 | 796 | 191 | 77 | 37 |
| 1981 | 461 | 7016 | 3220 | 904 | 182 | 29 | 20 |
| 1982 | 1827 | 1673 | 3206 | 1189 | 367 | 111 | 33 |
| 1983 | 2335 | 4515 | 1118 | 1400 | 468 | 148 | 60 |
| 1984 | 2143 | 2360 | 2564 | 448 | 555 | 185 | 59 |
| 1985 | 1355 | 5069 | 1269 | 1091 | 140 | 167 | 79 |
| 1986 | 792 | 1486 | 2055 | 411 | 191 | 40 | 30 |
| 1987 | 7873 | 4837 | 988 | 905 | 137 | 56 | 26 |
| 1988 | 1008 | 8336 | 2193 | 278 | 210 | 39 | 20 |
| 1989 | 2017 | 1082 | 3858 | 709 | 113 | 69 | 33 |
| 1990 | 513 | 4024 | 432 | 924 | 170 | 23 | 11 |
| 1991 | 1518 | 1728 | 1805 | 188 | 266 | 70 | 23 |
| 1992 | 1407 | 1868 | 575 | 720 | 69 | 58 | 24 |
| 1993 | 328 | 3596 | 1050 | 131 | 183 | 24 | 36 |
| 1994 | 942 | 1207 | 1545 | 280 | 56 | 51 | 20 |
| 1995 | 753 | 2750 | 700 | 630 | 70 | 15 | 11 |
| 1996 | 341 | 2331 | 1210 | 247 | 204 | 31 | 13 |
| 1997 | 1414 | 1067 | 989 | 281 | 66 | 62 | 7 |
| 1998 | 310 | 3318 | 293 | 174 | 57 | 16 | 9 |
| 1999 | 132 | 884 | 1047 | 64 | 48 | 24 | 9 |
| 2000 | 765 | 532 | 211 | 231 | 15 | 12 | 13 |
| 2001 | 96 | 1241 | 155 | 63 | 52 | 3 | 4 |
| 2002 | 337 | 340 | 522 | 41 | 13 | 14 | 4 |
| 2003 | 62 | 516 | 85 | 107 | 6 | 2 | 1 |
| 2004 | 44 | 92 | 85 | 11 | 26 | 2 | 1 |
| 2005 | 31 | 121 | 43 | 37 | 7 | 6 | 0.5 |
| 2006 | 17 | 91 | 72 | 21 | 13 | 2 | 1 |
| 2007 | 5 | 165 | 62 | 33 | 3 | 3 | 2 |
| 2008 | 0.07 | 27 | 88 | 16 | 10 | 1 | 2 |
| 2009 | 2 | 10 | 9 | 30 | 4 | 1 | 0.1 |
| 2010 | 0 | 19 | 33 | 15 | 13 | 2 | 0.5 |

**Table 3.2.5. Cod in Division VIa. Mean weight-at-age in landings (kg).**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1966 | 0.730 | 1.466 | 3.474 | 5.240 | 4.868 | 8.711 | 9.250 |
| 1967 | 0.681 | 1.470 | 2.906 | 4.560 | 6.116 | 7.394 | 8.058 |
| 1968 | 0.745 | 1.776 | 2.766 | 4.721 | 6.304 | 7.510 | 8.278 |
| 1969 | 0.860 | 1.284 | 2.821 | 4.259 | 6.169 | 6.374 | 7.928 |
| 1970 | 0.595 | 0.955 | 2.533 | 4.678 | 6.016 | 7.120 | 8.190 |
| 1971 | 0.674 | 1.046 | 2.536 | 4.167 | 6.023 | 6.835 | 8.100 |
| 1972 | 0.609 | 1.192 | 2.586 | 4.417 | 6.226 | 7.585 | 8.538 |
| 1973 | 0.597 | 1.181 | 2.784 | 4.601 | 5.625 | 7.049 | 8.611 |
| 1974 | 0.611 | 1.103 | 2.834 | 4.750 | 6.144 | 7.729 | 9.339 |
| 1975 | 0.603 | 1.369 | 3.078 | 5.302 | 6.846 | 8.572 | 10.328 |
| 1976 | 0.616 | 1.397 | 3.161 | 5.005 | 6.290 | 8.017 | 9.001 |
| 1977 | 0.629 | 1.160 | 2.605 | 4.715 | 6.269 | 7.525 | 9.511 |
| 1978 | 0.630 | 1.373 | 3.389 | 5.262 | 7.096 | 8.686 | 9.857 |
| 1979 | 0.693 | 1.373 | 2.828 | 4.853 | 6.433 | 7.784 | 9.636 |
| 1980 | 0.624 | 1.375 | 3.002 | 5.277 | 7.422 | 8.251 | 9.331 |
| 1981 | 0.550 | 1.166 | 2.839 | 4.923 | 7.518 | 9.314 | 10.328 |
| 1982 | 0.692 | 1.468 | 2.737 | 4.749 | 6.113 | 7.227 | 9.856 |
| 1983 | 0.583 | 1.265 | 2.995 | 4.398 | 6.305 | 8.084 | 9.744 |
| 1984 | 0.735 | 1.402 | 3.168 | 5.375 | 6.601 | 8.606 | 10.350 |
| 1985 | 0.628 | 1.183 | 2.597 | 4.892 | 6.872 | 8.344 | 9.766 |
| 1986 | 0.710 | 1.211 | 2.785 | 4.655 | 6.336 | 8.283 | 9.441 |
| 1987 | 0.531 | 1.312 | 2.783 | 4.574 | 6.161 | 7.989 | 10.062 |
| 1988 | 0.806 | 1.182 | 2.886 | 5.145 | 6.993 | 8.204 | 9.803 |
| 1989 | 0.704 | 1.298 | 2.425 | 4.737 | 7.027 | 7.520 | 9.594 |
| 1990 | 0.613 | 1.275 | 2.815 | 4.314 | 7.021 | 9.027 | 11.671 |
| 1991 | 0.640 | 1.095 | 2.618 | 4.346 | 6.475 | 8.134 | 10.076 |
| 1992 | 0.686 | 1.293 | 2.607 | 4.268 | 6.190 | 7.844 | 10.598 |
| 1993 | 0.775 | 1.316 | 2.940 | 4.646 | 6.244 | 7.802 | 8.409 |
| 1994 | 0.644 | 1.292 | 2.899 | 4.710 | 6.389 | 8.423 | 8.409 |
| 1995 | 0.606 | 1.148 | 2.857 | 4.956 | 6.771 | 8.539 | 9.505 |
| 1996 | 0.667 | 1.221 | 2.738 | 5.056 | 6.892 | 8.088 | 10.759 |
| 1997 | 0.595 | 1.210 | 2.571 | 4.805 | 6.952 | 7.821 | 9.630 |
| 1998 | 0.605 | 1.061 | 2.264 | 4.506 | 6.104 | 8.017 | 9.612 |
| 1999 | 0.691 | 1.039 | 2.194 | 4.688 | 6.486 | 8.252 | 9.439 |
| 2000 | 0.689 | 1.261 | 2.457 | 4.126 | 6.666 | 7.917 | 8.392 |
| 2001 | 0.654 | 0.988 | 2.679 | 4.568 | 5.860 | 7.741 | 9.386 |
| 2002 | 0.668 | 1.140 | 2.330 | 4.841 | 6.175 | 7.192 | 9.548 |
| 2003 | 0.671 | 1.016 | 2.312 | 3.854 | 6.220 | 8.075 | 8.839 |
| 2004 | 0.609 | 1.027 | 2.194 | 4.396 | 6.003 | 8.258 | 9.678 |
| 2005 | 0.776 | 1.172 | 2.624 | 4.118 | 4.908 | 6.753 | 10.240 |
| 2006 | 0.656 | 1.169 | 2.236 | 3.822 | 6.172 | 7.796 | 11.1 |
| 2007 | 0.476 | 0.976 | 2.512 | 4.285 | 6.491 | 7.733 | 8.810 |
| 2008 | 0.557 | 1.195 | 2.943 | 4.775 | 6.329 | 7.957 | 8.471 |
| 2009 | 1.048 | 1.960 | 2.916 | 4.743 | 5.853 | 8.171 | 8.646 |
| 2010 | n/a | 1.385 | 2.284 | 3.797 | 5.029 | 5.605 | 7.974 |

**Table 3.2.6. Cod in Division VIa. Discard dataset from Scottish and Irish sampling programmes, ages 1–7, years 1978–2008. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 and 2005 to date).**

A. Discards-at-age (thousands).

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1978 | 8904 | 1203 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 11 | 119 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 2758 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 289 | 1475 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 5264 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 7371 | 1005 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 2117 | 10 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 43508 | 3122 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 4483 | 10 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 52582 | 159 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 714 | 3256 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 8443 | 25 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 1835 | 158 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 3255 | 319 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 12498 | 143 | 2 | 0 | 0 | 0 | 0 |
| 1993 | 595 | 51 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 773 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 1111 | 126 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 233 | 86 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 1074 | 27 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 472 | 837 | 3 | 0 | 0 | 0 | 0 |
| 1999 | 283 | 16 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 2081 | 53 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 216 | 373 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 508 | 32 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 77 | 38 | 8 | 0 | 0 | 0 | 0 |
| 2004 | 232 | 21 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 108 | 20 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 1242 | 48 | 25 | 2 | 3 | 1 | 0.1 |
| 2007 | 627 | 1651 | 56 | 42 | 3 | 3 | 0 |
| 2008 | 89 | 133 | 368 | 1 | 0 | 0 | 0 |
| 2009 | 883 | 219 | 160 | 138 | 0 | 7 | 0 |
| 2010 | 531 | 592 | 99 | 11 | 5 | 0 | 0 |

**Table 3.2.7. Cod in Division VIa. Discard dataset from Scottish and Irish sampling programmes, ages 1–7, years 1978–2006. Data from 1978–2001 raised from Scottish sampling only; later data raised from Scottish sampling and Irish sampling when available (2004 and 2005 to date).**

B. Mean weight-at-age in discards (kg).

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1978 | 0.37 | 0.321 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 0.276 | 0.43 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 0.361 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 0.135 | 0.326 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0.314 | 0.392 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0.223 | 0.374 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0.298 | 0.435 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0.178 | 0.346 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 0.267 | 0.305 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0.166 | 0.37 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 0.296 | 0.283 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0.332 | 0.59 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0.132 | 0.454 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0.245 | 0.351 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 0.22 | 1.03 | 2.382 | 0 | 0 | 0 | 0 |
| 1993 | 0.239 | 0.812 | 3.723 | 0 | 0 | 0 | 0 |
| 1994 | 0.24 | 0.365 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0.203 | 0.256 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 0.226 | 0.389 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 0.321 | 0.328 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0.23 | 0.367 | 0.59 | 0 | 0 | 0 | 0 |
| 1999 | 0.294 | 0.299 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0.28 | 0.421 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 0.248 | 0.417 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 0.263 | 1.021 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 0.272 | 0.57 | 0.39 | 0 | 0 | 0 | 0 |
| 2004 | 0.258 | 0.581 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 0.285 | 0.501 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 0.259 | 1.291 | 2.649 | 3.499 | 6.24 | 5.581 | 11.122 |
| 2007 | 0.198 | 0.940 | 3.016 | 4.453 | 5.018 | 10.627 | 0 |
| 2008 | 0.220 | 0.976 | 2.046 | 4.047 | 7.937 | 0 | 0 |
| 2009 | 0.261 | 1.312 | 2.248 | 3.324 | 0 | 6.448 | 0 |
| 2010 | 0.252 | 1.312 | 2.268 | 3.218 | 3.245 | 0 | 0 |

**Table 3.2.8. Cod in Division VIa. Total catch-at-age (thousands).**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 9627 | 2965 | 999 | 695 | 286 | 97 | 75 |
| 1979 | 940 | 1731 | 2125 | 682 | 342 | 134 | 69 |
| 1980 | 3953 | 3294 | 2001 | 796 | 191 | 77 | 37 |
| 1981 | 749 | 8491 | 3220 | 904 | 182 | 29 | 20 |
| 1982 | 7091 | 1676 | 3206 | 1189 | 367 | 111 | 33 |
| 1983 | 9706 | 5520 | 1118 | 1400 | 468 | 148 | 60 |
| 1984 | 4260 | 2371 | 2564 | 448 | 555 | 185 | 59 |
| 1985 | 44863 | 8191 | 1269 | 1091 | 140 | 167 | 79 |
| 1986 | 5275 | 1495 | 2055 | 411 | 191 | 40 | 30 |
| 1987 | 60456 | 4996 | 988 | 905 | 137 | 56 | 26 |
| 1988 | 1722 | 11592 | 2193 | 278 | 210 | 39 | 20 |
| 1989 | 10459 | 1107 | 3858 | 709 | 113 | 69 | 33 |
| 1990 | 2348 | 4182 | 432 | 924 | 170 | 23 | 11 |
| 1991 | 4773 | 2047 | 1805 | 188 | 266 | 70 | 23 |
| 1992 | 13905 | 2011 | 577 | 720 | 69 | 58 | 24 |
| 1993 | 923 | 3647 | 1050 | 131 | 183 | 24 | 36 |
| 1994 | 1715 | 1209 | 1545 | 280 | 56 | 51 | 20 |
| 1995 | 1864 | 2877 | 700 | 630 | 70 | 15 | 11 |
| 1996 | 574 | 2417 | 1210 | 247 | 204 | 31 | 13 |
| 1997 | 2488 | 1094 | 989 | 281 | 66 | 62 | 7 |
| 1998 | 783 | 4155 | 296 | 174 | 57 | 16 | 9 |
| 1999 | 415 | 900 | 1047 | 64 | 48 | 24 | 9 |
| 2000 | 2846 | 585 | 211 | 231 | 15 | 12 | 13 |
| 2001 | 312 | 1614 | 155 | 63 | 52 | 3 | 4 |
| 2002 | 845 | 372 | 522 | 41 | 13 | 14 | 4 |
| 2003 | 139 | 554 | 93 | 107 | 6 | 2 | 1 |
| 2004 | 267 | 113 | 85 | 11 | 26 | 2 | 1 |
| 2005 | 139 | 141 | 43 | 37 | 7 | 6 | 0.5 |
| 2006 | 1259 | 139 | 97 | 23 | 15 | 2 | 1 |
| 2007 | 632 | 1816 | 118 | 75 | 5 | 7 | 2 |
| 2008 | 89 | 160 | 456 | 18 | 10 | 1 | 2 |
| 2009 | 885 | 229 | 168 | 168 | 4 | 8 | 0.1 |
| 2010 | 531 | 611 | 131 | 26 | 18 | 2 | 0.5 |

**Table 3.2.9. Cod in Division VIa. Mean weight-at-age (kg) in total catch.**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 0.389 | 0.946 | 3.389 | 5.262 | 7.096 | 8.686 | 9.857 |
| 1979 | 0.688 | 1.308 | 2.828 | 4.853 | 6.433 | 7.784 | 9.636 |
| 1980 | 0.440 | 1.375 | 3.002 | 5.277 | 7.422 | 8.251 | 9.331 |
| 1981 | 0.390 | 1.020 | 2.839 | 4.923 | 7.518 | 9.314 | 10.328 |
| 1982 | 0.411 | 1.467 | 2.737 | 4.749 | 6.113 | 7.227 | 9.856 |
| 1983 | 0.310 | 1.103 | 2.995 | 4.398 | 6.305 | 8.084 | 9.744 |
| 1984 | 0.518 | 1.398 | 3.168 | 5.375 | 6.601 | 8.606 | 10.350 |
| 1985 | 0.191 | 0.864 | 2.597 | 4.892 | 6.872 | 8.344 | 9.766 |
| 1986 | 0.334 | 1.205 | 2.785 | 4.655 | 6.336 | 8.283 | 9.441 |
| 1987 | 0.213 | 1.282 | 2.783 | 4.574 | 6.161 | 7.989 | 10.062 |
| 1988 | 0.595 | 0.929 | 2.886 | 5.145 | 6.993 | 8.204 | 9.803 |
| 1989 | 0.404 | 1.282 | 2.425 | 4.737 | 7.027 | 7.520 | 9.594 |
| 1990 | 0.237 | 1.244 | 2.815 | 4.314 | 7.021 | 9.027 | 11.671 |
| 1991 | 0.371 | 0.979 | 2.618 | 4.346 | 6.475 | 8.134 | 10.076 |
| 1992 | 0.267 | 1.274 | 2.606 | 4.268 | 6.190 | 7.844 | 10.598 |
| 1993 | 0.430 | 1.309 | 2.940 | 4.646 | 6.244 | 7.802 | 8.409 |
| 1994 | 0.462 | 1.291 | 2.899 | 4.710 | 6.389 | 8.423 | 8.409 |
| 1995 | 0.365 | 1.109 | 2.857 | 4.956 | 6.771 | 8.539 | 9.505 |
| 1996 | 0.487 | 1.191 | 2.738 | 5.056 | 6.892 | 8.088 | 10.759 |
| 1997 | 0.477 | 1.188 | 2.571 | 4.805 | 6.952 | 7.821 | 9.630 |
| 1998 | 0.379 | 0.921 | 2.248 | 4.506 | 6.104 | 8.017 | 9.612 |
| 1999 | 0.420 | 1.025 | 2.194 | 4.688 | 6.486 | 8.252 | 9.439 |
| 2000 | 0.390 | 1.186 | 2.457 | 4.126 | 6.666 | 7.917 | 8.392 |
| 2001 | 0.372 | 0.856 | 2.679 | 4.568 | 5.860 | 7.741 | 9.386 |
| 2002 | 0.424 | 1.130 | 2.330 | 4.841 | 6.175 | 7.192 | 9.548 |
| 2003 | 0.450 | 0.986 | 2.15 | 3.854 | 6.220 | 8.075 | 8.839 |
| 2004 | 0.314 | 0.945 | 2.194 | 4.396 | 6.003 | 8.258 | 9.678 |
| 2005 | 0.395 | 1.078 | 2.624 | 4.118 | 4.908 | 6.753 | 10.240 |
| 2006 | 0.264 | 1.211 | 2.341 | 3.797 | 6.184 | 7.031 | 11.103 |
| 2007 | 0.200 | 0.943 | 2.752 | 4.380 | 5.729 | 9.166 | 8.810 |
| 2008 | 0.220 | 1.013 | 2.219 | 4.731 | 6.371 | 7.957 | 8.471 |
| 2009 | 0.262 | 1.340 | 2.283 | 3.577 | 5.853 | 6.654 | 8.646 |
| 2010 | 0.252 | 1.314 | 2.272 | 3.555 | 4.582 | 5.605 | 7.974 |

**Table 3.2.10. Cod in Division VIa. TSA parameter settings for the assessment run.**

| Parameter | Setting | Justification |
| --- | --- | --- |
| Age of full selection. | am = 4 | Based on inspection of previous XSA runs. |
| Multipliers on variance matrices of measurements. | Blandings(a) = 2 for ages 6, 7+<br>Bsurvey(a) = 2 for age 1, 5, 6 | Allows extra measurement variability for poorly sampled ages. |
| Multipliers on variances for fishing mortality estimates. | H(1) = 4 | Allows for more variable fishing mortalities for age 1 fish. |
| Downweighting of particular data points (implemented by multiplying the relevant q by 9) | Landings:<br>age 2 in 1981 and 1987, age 7 in 1989.<br>Discards:<br>age 1 in 1985 and 1992, age 2 in 1998.<br>Survey:<br>age 1 in 2000,<br>age 2 in 1993 and 2011,<br>age 3 in 2008 (large haul near 4W line),<br>age 4 in 2001,<br>age 5 in 2001,<br>age 6 in 1995 and 2001. | Large values indicated by exploratory prediction error plots.<br>Downweighting in 2001 resulted from a single large haul, 24 fish > 75 cm in 30 mins. |
| Discards | Discards are allowed to evolve over time constrained by a trend. Ages 1 and 2 are modelled independently. | |
| Recruitment. | Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta_1 S \exp(-\eta_2 S)$, where S is the spawning-stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed. | |
| Large year classes. | The 1986 year class was large, and recruitment-at-age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, N(1, 1987) is taken to be normally distributed with mean $5\eta_1 S \exp(-\eta_2 S)$. The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966-1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant. | |

**Table 3.2.11. Cod in Division VIa. TSA parameter estimates for 2002–2004, 2006–2009 assessments and final assessment presented this year. No final assessment using TSA was conducted in 2005. Run 3 from 2004 used a similar approach to this year's assessment.**

| Parameter | Notation | Description | 2002 WG | 2003 WG | 2004 WG Run 3 | 2006 WG | 2007 WG | 2008 WG | 2009 WG | 2010 WG | 2011 WG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial fishing mortality | F (1, 1978) | Fishing mortality-at-age a in year y | 0.03 | 0.64 | 0.64 | 0.6378 | 0.6337 | 0.6366 | 0.6373 | 0.6334 | 0.6329 |
| | F (2, 1978) | | 0.25 | 0.62 | 0.57 | 0.5333 | 0.5889 | 0.5803 | 0.5797 | 0.5853 | 0.5978 |
| | F (4, 1978) | | 0.67 | 0.82 | 0.66 | 0.5743 | 0.6879 | 0.5888 | 0.5886 | 0.5955 | 0.6241 |
| Survey selectivities | Φ(1) | Survey selectivity at age a | 0.83 | 0.33 | 0.47 | 0.6275 | 0.5425 | 0.4746 | 0.4809 | 0.4791 | 0.4530 |
| | Φ(2) | | 4.41 | 1.98 | 3.19 | 3.5857 | 3.7292 | 3.2855 | 3.3317 | 3.3463 | 3.3290 |
| | Φ(4) | | 18.28 | 10.65 | 14.92 | 15.9096 | 14.1997 | 14.0472 | 13.7891 | 13.6507 | 13.9381 |
| Fishing mortality standard deviations | σF | Transitory changes in overall fishing mortality | 0.10 | 0.04 | 0.07 | 0.0947 | 0.0741 | 0.0846 | 0.0850 | 0.0834 | 0.0819 |
| | σU | Persistent changes in selection (age effect in F) | 0.10 | 0.06 | 0.03 | 0.0242 | 0.0507 | 0.00 | 0.00 | 0.0057 | 0.0129 |
| | σV | Transitory changes in the year effect in fishing mortality | 0.00 | 0.07 | 0.10 | 0.0844 | 0.0984 | 0.1120 | 0.1117 | 0.1144 | 0.1143 |
| | σY | Persistent changes in the year effect in fishing mortality | 0.16 | 0.07 | 0.00 | 0.0425 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Survey catchability standard deviations | σΩ | Transitory changes in survey catchability | 0.24 | 0.00 | 0.00 | 0.1224 | 0.2374 | 0.2276 | 0.2498 | 0.2275 | 0.1990 |
| | σβ | Persistent changes in survey catchability | 0.00 | 0.45 | 0.00 (f) | 0.00 (f) | 0.00 (f) | 0.00 (f) | 0.00(f) | 0.00(f) | 0.00(f) |

| Parameter | Notation | Description | 2002 WG | 2003 WG | 2004 WG Run 3 | 2006 WG | 2007 WG | 2008 WG | 2009 WG | 2010 WG | 2011 WG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measurement standard deviations | σlandings | Standard error of landings-at-age data | 0.12 | 0.13 | 0.10 | 0.0935 | 0.0891 | 0.0892 | 0.0889 | 0.0897 | 0.0904 |
| | σdiscards | Standard error of discards-at-age data | n/a | 0.94 | 1.42 | 1.2669 | 1.367 | 1.3756 | 1.3681 | 1.3819 | 1.4102 |
| | σsurvey | Standard error of survey data | 0.36 | 0.56 | 0.35 | 0.3887 | 0.364 | 0.3875 | 0.3930 | 0.3926 | 0.3999 |
| Discards | σlogit p | Transitory trends in discarding | n/a | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | σpersistent | Persistent trends in discarding | n/a | 0.16 | 0.68 | 0.5735 | 0.6742 | 0.7032 | 0.6959 | 0.7112 | 0.7429 |
| Recruitment | η1 | Ricker parameter (slope at the origin) | 0.82 | 0.62 | 0.80 | 0.6584 | 0.7882 | 0.9634 | 0.8913 | 1.0233 | 1.0986 |
| | η2 | Ricker parameter (curve dome occurs at 1/η2) | 0.03 | 0.003 | 0.01 | 0.0049 | 0.0124 | 0.0203 | 0.0177 | 0.0223 | 0.0251 |
| | cvrec | Coefficient of variation of recruitment data | 0.36 | 0.56 | 0.49 | 0.4184 | 0.5116 | 0.5627 | 0.5530 | 0.5671 | 0.6224 |

**Table 3.2.12. Cod in Division VIa. TSA population numbers-at-age (millions).**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 21.2379 | 9.5054 | 2.5814 | 1.4206 | 0.5313 | 0.1631 | 0.1316 |
| 1979 | 28.8208 | 10.2923 | 4.2324 | 1.1283 | 0.5317 | 0.1890 | 0.1031 |
| 1980 | 31.3080 | 13.7790 | 4.3650 | 1.3568 | 0.2825 | 0.1227 | 0.0634 |
| 1981 | 10.6823 | 16.2539 | 6.1773 | 1.8109 | 0.4963 | 0.0996 | 0.0667 |
| 1982 | 26.0569 | 5.1030 | 6.8296 | 2.3944 | 0.6771 | 0.1895 | 0.0594 |
| 1983 | 15.5670 | 12.0287 | 2.1643 | 2.5968 | 0.8559 | 0.2382 | 0.0879 |
| 1984 | 24.2650 | 6.0582 | 4.5391 | 0.7583 | 0.8458 | 0.2773 | 0.1012 |
| 1985 | 12.5220 | 12.0384 | 2.2196 | 1.4580 | 0.2276 | 0.2281 | 0.1094 |
| 1986 | 19.4670 | 4.2415 | 3.8831 | 0.6918 | 0.3265 | 0.0627 | 0.0779 |
| 1987 | 61.4969 | 9.8610 | 1.7572 | 1.3687 | 0.2272 | 0.1032 | 0.0460 |
| 1988 | 6.1191 | 16.7088 | 3.6519 | 0.5521 | 0.3565 | 0.0662 | 0.0422 |
| 1989 | 20.0814 | 2.4792 | 5.4715 | 1.1637 | 0.1861 | 0.1082 | 0.0346 |
| 1990 | 6.4821 | 8.7792 | 0.9434 | 1.4903 | 0.3408 | 0.0555 | 0.0408 |
| 1991 | 11.3121 | 2.9437 | 3.4386 | 0.3625 | 0.4842 | 0.1213 | 0.0349 |
| 1992 | 17.6739 | 4.5555 | 0.9729 | 1.1375 | 0.1237 | 0.1493 | 0.0482 |
| 1993 | 7.3395 | 8.1848 | 1.8327 | 0.3065 | 0.3435 | 0.0417 | 0.0671 |
| 1994 | 15.8467 | 3.3418 | 3.2962 | 0.6062 | 0.1097 | 0.1149 | 0.0372 |
| 1995 | 13.1793 | 7.7974 | 1.5014 | 1.2945 | 0.2305 | 0.0410 | 0.0574 |
| 1996 | 4.9971 | 6.0632 | 3.1608 | 0.5353 | 0.4525 | 0.0799 | 0.0340 |
| 1997 | 18.4078 | 2.0707 | 2.3605 | 1.0589 | 0.1789 | 0.1525 | 0.0379 |
| 1998 | 8.7956 | 8.1808 | 0.7781 | 0.7874 | 0.3420 | 0.0584 | 0.0622 |
| 1999 | 5.0068 | 3.8213 | 3.0777 | 0.2466 | 0.2509 | 0.1084 | 0.0384 |
| 2000 | 10.5275 | 2.1352 | 1.4733 | 1.0167 | 0.0791 | 0.0806 | 0.0473 |
| 2001 | 3.2356 | 4.7867 | 0.8535 | 0.5128 | 0.3464 | 0.0268 | 0.0433 |
| 2002 | 8.8398 | 1.3174 | 1.8227 | 0.2798 | 0.1649 | 0.1145 | 0.0227 |
| 2003 | 1.4542 | 3.8705 | 0.4900 | 0.5905 | 0.0894 | 0.0529 | 0.0440 |
| 2004 | 3.7698 | 0.4646 | 1.4036 | 0.1551 | 0.1817 | 0.0271 | 0.0299 |
| 2005 | 5.2773 | 1.3162 | 0.1266 | 0.4191 | 0.0445 | 0.0542 | 0.0170 |
| 2006 | 11.5938 | 2.2641 | 0.4393 | 0.0273 | 0.1260 | 0.0131 | 0.0213 |
| 2007 | 2.6895 | 5.1914 | 0.8979 | 0.1502 | 0.0088 | 0.0421 | 0.0115 |
| 2008 | 3.0811 | 1.2439 | 2.1318 | 0.3204 | 0.0514 | 0.0030 | 0.0184 |
| 2009 | 12.4446 | 1.3334 | 0.4748 | 0.6772 | 0.0995 | 0.0158 | 0.0067 |
| 2010 | 8.9661 | 5.5570 | 0.5156 | 0.1568 | 0.2149 | 0.0315 | 0.0072 |
| 2011 | 4.1218 | 4.1944 | 2.2893 | 0.1789 | 0.0533 | 0.0730 | 0.0131 |
| 2012 | 7.6974 | 1.8756 | 1.6829 | 0.7932 | 0.0593 | 0.0178 | 0.0287 |
| | | | | | | | |
| GM(78–10) | 10.3157 | 4.5652 | 1.7597 | 0.6275 | 0.2159 | 0.0709 | 0.0406 |

***2011 and 2012 values are TSA-derived projections of population numbers.**

**Table 3.2.13. Cod in Division VIa. Standard errors on TSA population numbers-at-age (millions).**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 2.9806 | 0.5647 | 0.1235 | 0.0837 | 0.0495 | 0.0288 | 0.0211 |
| 1979 | 2.2027 | 0.5782 | 0.1761 | 0.0599 | 0.0432 | 0.0292 | 0.0183 |
| 1980 | 2.609 | 0.8087 | 0.2338 | 0.0977 | 0.0307 | 0.0258 | 0.0189 |
| 1981 | 1.1784 | 1.2426 | 0.3429 | 0.1017 | 0.0372 | 0.0134 | 0.0123 |
| 1982 | 2.2157 | 0.3687 | 0.3871 | 0.137 | 0.0373 | 0.0143 | 0.0045 |
| 1983 | 1.5773 | 0.9268 | 0.1152 | 0.1651 | 0.0648 | 0.024 | 0.0087 |
| 1984 | 1.8004 | 0.5459 | 0.2894 | 0.0511 | 0.071 | 0.0348 | 0.0133 |
| 1985 | 1.5175 | 0.8142 | 0.1503 | 0.1149 | 0.023 | 0.037 | 0.0185 |
| 1986 | 1.5104 | 0.3257 | 0.2373 | 0.052 | 0.0406 | 0.0111 | 0.0171 |
| 1987 | 10.6337 | 0.6544 | 0.1013 | 0.0963 | 0.0216 | 0.0186 | 0.0089 |
| 1988 | 1.1519 | 1.6205 | 0.1948 | 0.0378 | 0.0355 | 0.0107 | 0.0086 |
| 1989 | 2.1079 | 0.1812 | 0.4761 | 0.0763 | 0.0141 | 0.0155 | 0.0063 |
| 1990 | 1.1802 | 0.4893 | 0.0527 | 0.1318 | 0.0284 | 0.007 | 0.0066 |
| 1991 | 1.6492 | 0.221 | 0.1976 | 0.0198 | 0.0424 | 0.013 | 0.0039 |
| 1992 | 1.7576 | 0.3241 | 0.0707 | 0.0771 | 0.0088 | 0.0191 | 0.0063 |
| 1993 | 1.0557 | 0.5247 | 0.1269 | 0.0256 | 0.0328 | 0.0047 | 0.0083 |
| 1994 | 3.0578 | 0.3615 | 0.2971 | 0.0678 | 0.0115 | 0.0174 | 0.0049 |
| 1995 | 3.1557 | 1.5772 | 0.226 | 0.1916 | 0.0403 | 0.0073 | 0.0106 |
| 1996 | 2.1082 | 1.3872 | 0.6568 | 0.0946 | 0.08 | 0.0166 | 0.0068 |
| 1997 | 4.2723 | 0.8139 | 0.5595 | 0.2506 | 0.037 | 0.0323 | 0.0087 |
| 1998 | 2.6301 | 1.879 | 0.3125 | 0.2045 | 0.0939 | 0.015 | 0.016 |
| 1999 | 1.9422 | 1.1024 | 0.7533 | 0.1077 | 0.0746 | 0.0357 | 0.0113 |
| 2000 | 3.0407 | 0.7341 | 0.4297 | 0.268 | 0.0368 | 0.0275 | 0.0162 |
| 2001 | 1.5202 | 1.2523 | 0.2752 | 0.1532 | 0.093 | 0.0127 | 0.0139 |
| 2002 | 2.529 | 0.5224 | 0.4925 | 0.0951 | 0.0553 | 0.0342 | 0.0081 |
| 2003 | 1.3062 | 1.0363 | 0.1896 | 0.1752 | 0.0332 | 0.0201 | 0.0148 |
| 2004 | 1.8239 | 0.3726 | 0.3937 | 0.0631 | 0.0623 | 0.0121 | 0.0111 |
| 2005 | 1.2259 | 0.5898 | 0.121 | 0.1328 | 0.0216 | 0.0226 | 0.0071 |
| 2006 | 1.7159 | 0.4133 | 0.1992 | 0.036 | 0.0441 | 0.0075 | 0.0096 |
| 2007 | 0.8534 | 0.6993 | 0.1534 | 0.0638 | 0.0115 | 0.0151 | 0.0049 |
| 2008 | 1.0532 | 0.3179 | 0.3268 | 0.053 | 0.0213 | 0.0039 | 0.0064 |
| 2009 | 2.0335 | 0.411 | 0.1221 | 0.1375 | 0.0218 | 0.0075 | 0.0029 |
| 2010 | 2.4167 | 0.8552 | 0.1557 | 0.042 | 0.0498 | 0.0086 | 0.003 |
| 2011 | 2.9595 | 1.174 | 0.3752 | 0.0559 | 0.0145 | 0.0186 | 0.0039 |
| 2012 | 4.8677 | 1.3691 | 0.5038 | 0.1639 | 0.0199 | 0.0055 | 0.0084 |
| | | | | | | | |
| GM(78–10) | 1.9395 | 0.6323 | 0.2248 | 0.0878 | 0.0355 | 0.0156 | 0.0090 |

***2011 and 2012 values are standard errors on TSA-derived projections of population numbers.**

**Table 3.2.14. Cod in Division VIa. TSA estimates for mortality-at-age.**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 0.5331 | 0.6128 | 0.6291 | 0.7657 | 0.793 | 0.7928 | 0.7887 |
| 1979 | 0.5914 | 0.7171 | 0.8649 | 1.0174 | 1.001 | 0.9881 | 0.9722 |
| 1980 | 0.4746 | 0.6373 | 0.6809 | 0.7906 | 0.8144 | 0.794 | 0.7855 |
| 1981 | 0.49 | 0.6619 | 0.7488 | 0.7527 | 0.6852 | 0.7299 | 0.7385 |
| 1982 | 0.6127 | 0.6608 | 0.7602 | 0.8259 | 0.8438 | 0.839 | 0.8447 |
| 1983 | 0.6874 | 0.7491 | 0.8397 | 0.9069 | 0.9136 | 0.9492 | 0.9605 |
| 1984 | 0.5772 | 0.7524 | 0.8832 | 0.9634 | 1.0276 | 0.9864 | 0.9655 |
| 1985 | 0.7983 | 0.9064 | 0.9321 | 1.1488 | 1.0362 | 1.1147 | 1.0998 |
| 1986 | 0.5108 | 0.676 | 0.819 | 0.8973 | 0.8971 | 0.893 | 0.8683 |
| 1987 | 0.8048 | 0.8028 | 0.9293 | 1.0754 | 1.0088 | 1.0133 | 1.0138 |
| 1988 | 0.6477 | 0.7746 | 0.9294 | 0.887 | 0.964 | 0.9426 | 0.9289 |
| 1989 | 0.6313 | 0.7595 | 0.9749 | 1.0084 | 1.0012 | 1.0234 | 1.0086 |
| 1990 | 0.5734 | 0.7309 | 0.7554 | 0.9064 | 0.833 | 0.8172 | 0.8065 |
| 1991 | 0.688 | 0.855 | 0.8967 | 0.8756 | 0.9586 | 0.9669 | 0.9811 |
| 1992 | 0.5693 | 0.7106 | 0.9148 | 0.983 | 0.8885 | 0.8746 | 0.894 |
| 1993 | 0.5892 | 0.7095 | 0.8998 | 0.8272 | 0.892 | 0.8785 | 0.8711 |
| 1994 | 0.5092 | 0.5958 | 0.7332 | 0.7662 | 0.7833 | 0.7701 | 0.784 |
| 1995 | 0.5767 | 0.7026 | 0.831 | 0.8513 | 0.8599 | 0.8613 | 0.8621 |
| 1996 | 0.617 | 0.738 | 0.8857 | 0.8962 | 0.8877 | 0.9004 | 0.9013 |
| 1997 | 0.6099 | 0.7481 | 0.891 | 0.9222 | 0.9139 | 0.9116 | 0.9152 |
| 1998 | 0.6253 | 0.7638 | 0.9114 | 0.9342 | 0.9362 | 0.9334 | 0.9332 |
| 1999 | 0.6259 | 0.7515 | 0.9026 | 0.9295 | 0.9285 | 0.927 | 0.9261 |
| 2000 | 0.5888 | 0.7189 | 0.8555 | 0.8738 | 0.8818 | 0.8838 | 0.8832 |
| 2001 | 0.6301 | 0.7532 | 0.8992 | 0.9253 | 0.9091 | 0.9209 | 0.9216 |
| 2002 | 0.6206 | 0.7555 | 0.9098 | 0.9312 | 0.9297 | 0.9266 | 0.9296 |
| 2003 | 0.655 | 0.784 | 0.9287 | 0.9608 | 0.9628 | 0.9577 | 0.9581 |
| 2004 | 0.6905 | 0.7995 | 0.9664 | 0.9922 | 0.9853 | 0.987 | 0.9853 |
| 2005 | 0.6461 | 0.8072 | 0.9679 | 0.9951 | 0.9934 | 0.9883 | 0.988 |
| 2006 | 0.541 | 0.7129 | 0.8747 | 0.9062 | 0.8955 | 0.8978 | 0.8968 |
| 2007 | 0.5842 | 0.6904 | 0.8126 | 0.8733 | 0.8759 | 0.8693 | 0.8701 |
| 2008 | 0.6336 | 0.7669 | 0.9411 | 0.9634 | 0.9648 | 0.9623 | 0.9608 |
| 2009 | 0.5769 | 0.7498 | 0.9075 | 0.9483 | 0.9479 | 0.9395 | 0.9383 |
| 2010 | 0.5543 | 0.6811 | 0.8605 | 0.8752 | 0.8783 | 0.8803 | 0.8785 |
| 2011 | 0.5874 | 0.7132 | 0.86 | 0.9042 | 0.8978 | 0.899 | 0.8994 |
| 2012 | 0.5908 | 0.7214 | 0.874 | 0.908 | 0.908 | 0.908 | 0.908 |
| | | | | | | | |
| GM(78–10) | 0.6038 | 0.7317 | 0.8606 | 0.9105 | 0.9086 | 0.9093 | 0.9077 |

***Estimates for 2011 and 2012 are TSA projections.**

**Table 3.2.15. Cod in Division VIa. Standard errors of TSA estimates for log mortality-at-age.**

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1978 | 0.1982 | 0.1054 | 0.0648 | 0.0641 | 0.0768 | 0.0905 | 0.0917 |
| 1979 | 0.2052 | 0.1069 | 0.0591 | 0.0564 | 0.0681 | 0.086 | 0.089 |
| 1980 | 0.2008 | 0.1047 | 0.0636 | 0.0639 | 0.0684 | 0.0868 | 0.09 |
| 1981 | 0.2078 | 0.0918 | 0.0608 | 0.0629 | 0.0741 | 0.0895 | 0.0926 |
| 1982 | 0.202 | 0.0964 | 0.0639 | 0.0654 | 0.079 | 0.0903 | 0.0973 |
| 1983 | 0.1754 | 0.0868 | 0.0602 | 0.0625 | 0.0742 | 0.0875 | 0.0921 |
| 1984 | 0.1988 | 0.0967 | 0.0623 | 0.0633 | 0.0706 | 0.0869 | 0.0919 |
| 1985 | 0.1844 | 0.0791 | 0.0632 | 0.0593 | 0.0741 | 0.0837 | 0.0898 |
| 1986 | 0.2101 | 0.0917 | 0.0638 | 0.066 | 0.0734 | 0.0918 | 0.0901 |
| 1987 | 0.1796 | 0.0908 | 0.0597 | 0.0598 | 0.0778 | 0.0884 | 0.0937 |
| 1988 | 0.2076 | 0.0766 | 0.0581 | 0.0651 | 0.0711 | 0.0934 | 0.0947 |
| 1989 | 0.1896 | 0.0844 | 0.0647 | 0.061 | 0.0732 | 0.085 | 0.0955 |
| 1990 | 0.2035 | 0.071 | 0.0647 | 0.0658 | 0.0742 | 0.0901 | 0.092 |
| 1991 | 0.1971 | 0.069 | 0.0617 | 0.064 | 0.0704 | 0.0871 | 0.0944 |
| 1992 | 0.1951 | 0.0779 | 0.0645 | 0.0657 | 0.0797 | 0.0881 | 0.0954 |
| 1993 | 0.208 | 0.0842 | 0.076 | 0.0785 | 0.0879 | 0.1003 | 0.0984 |
| 1994 | 0.2168 | 0.1206 | 0.1135 | 0.1169 | 0.1237 | 0.1244 | 0.1248 |
| 1995 | 0.2339 | 0.1439 | 0.1394 | 0.1396 | 0.1403 | 0.141 | 0.1411 |
| 1996 | 0.2353 | 0.1446 | 0.1399 | 0.1401 | 0.1406 | 0.1414 | 0.1414 |
| 1997 | 0.2312 | 0.1474 | 0.1416 | 0.1412 | 0.1418 | 0.1426 | 0.1426 |
| 1998 | 0.2354 | 0.1461 | 0.1433 | 0.1418 | 0.1423 | 0.1431 | 0.1431 |
| 1999 | 0.2366 | 0.1492 | 0.1435 | 0.1439 | 0.1436 | 0.1444 | 0.1444 |
| 2000 | 0.2366 | 0.151 | 0.1466 | 0.1453 | 0.1459 | 0.1459 | 0.146 |
| 2001 | 0.2358 | 0.1487 | 0.1448 | 0.1431 | 0.1438 | 0.1445 | 0.1446 |
| 2002 | 0.2338 | 0.1505 | 0.1442 | 0.144 | 0.1442 | 0.1449 | 0.145 |
| 2003 | 0.2362 | 0.1487 | 0.1465 | 0.1439 | 0.1445 | 0.1452 | 0.1453 |
| 2004 | 0.2296 | 0.1511 | 0.1441 | 0.1439 | 0.1443 | 0.1451 | 0.1451 |
| 2005 | 0.2377 | 0.1524 | 0.1486 | 0.1458 | 0.1465 | 0.1471 | 0.1472 |
| 2006 | 0.2392 | 0.1549 | 0.15 | 0.1485 | 0.1482 | 0.1489 | 0.149 |
| 2007 | 0.2368 | 0.1519 | 0.1483 | 0.1475 | 0.1478 | 0.148 | 0.1481 |
| 2008 | 0.2398 | 0.1535 | 0.1455 | 0.1454 | 0.1464 | 0.147 | 0.1471 |
| 2009 | 0.2401 | 0.1548 | 0.1493 | 0.1471 | 0.1478 | 0.1487 | 0.1488 |
| 2010 | 0.2436 | 0.1549 | 0.1506 | 0.1499 | 0.1496 | 0.1504 | 0.1506 |
| 2011 | 0.2466 | 0.1599 | 0.1558 | 0.154 | 0.154 | 0.154 | 0.1541 |
| 2012 | 0.2473 | 0.1609 | 0.1568 | 0.155 | 0.155 | 0.155 | 0.155 |
| | | | | | | | |
| GM(78–10) | 0.2160 | 0.1149 | 0.0962 | 0.0966 | 0.1044 | 0.1141 | 0.1166 |

***Estimates for 2011 and 2012 are standard errors of TSA projections of log *F*.**

**Table 3.2.16. Cod in Division VIa. TSA summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.**

| Year | Landings (000 tonnes) | | | Discards (000 tonnes) | | | Total catch (000 tonnes) | | | Mean Z-0.2 (2–5) | | SSB (000 tonnes) | | TSB (000 tonnes) | | Recruitment at age 1 (millions) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Pred. | SE | Obs. | Pred. | SE | Obs. | Pred. | SE | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE |
| 1978 | 13.5205 | 13.2804 | 0.5792 | 3.6808 | 3.479 | 0.8787 | 17.2013 | 17.5665 | 1.2281 | 0.7001 | 0.032 | 26.159 | 0.7598 | 39.9728 | 1.5533 | 21.2379 | 2.9806 |
| 1979 | 16.0887 | 15.8363 | 0.6526 | 0.0541 | 4.3856 | 0.7941 | 16.1427 | 27.4287 | 2.1024 | 0.9001 | 0.0365 | 28.6559 | 0.7861 | 56.6294 | 1.99 | 28.8208 | 2.2027 |
| 1980 | 17.8789 | 17.4229 | 0.7937 | 0.9958 | 3.5779 | 0.8554 | 18.8747 | 24.3403 | 1.7351 | 0.7308 | 0.0328 | 31.9817 | 1.0949 | 56.7011 | 2.0364 | 31.308 | 2.609 |
| 1981 | 23.8646 | 22.0777 | 1.3705 | 0.5198 | 0.9691 | 0.3056 | 24.3843 | 24.1054 | 1.469 | 0.7121 | 0.0309 | 37.9663 | 1.2613 | 52.5474 | 1.8668 | 10.6823 | 1.1784 |
| 1982 | 21.5108 | 23.3391 | 1.0284 | 1.6539 | 2.4482 | 0.7641 | 23.1647 | 26.0074 | 1.5518 | 0.7727 | 0.0355 | 37.432 | 1.194 | 54.3604 | 1.7277 | 26.0569 | 2.2157 |
| 1983 | 21.3052 | 20.968 | 0.9205 | 2.0195 | 1.6501 | 0.4799 | 23.3247 | 22.8087 | 1.2666 | 0.8523 | 0.0353 | 32.0726 | 1.0791 | 44.1671 | 1.551 | 15.567 | 1.5773 |
| 1984 | 21.2717 | 19.8097 | 0.9667 | 0.6355 | 2.6718 | 0.6762 | 21.9071 | 24.5075 | 1.6022 | 0.9067 | 0.0389 | 29.8634 | 1.1393 | 48.5059 | 1.828 | 24.265 | 1.8004 |
| 1985 | 18.6071 | 17.6954 | 0.8028 | 8.8246 | 1.3061 | 0.3651 | 27.4317 | 17.3967 | 1.0228 | 1.0059 | 0.0404 | 22.0341 | 0.8878 | 30.2328 | 1.18 | 12.522 | 1.5175 |
| 1986 | 11.8201 | 11.6098 | 0.6343 | 1.1998 | 1.7837 | 0.4298 | 13.0199 | 13.786 | 0.9082 | 0.8223 | 0.0363 | 18.5027 | 0.7459 | 28.9634 | 1.0749 | 19.467 | 1.5104 |
| 1987 | 18.9705 | 18.1948 | 0.9561 | 8.7876 | 4.0576 | 1.4857 | 27.7581 | 21.1777 | 2.2156 | 0.9541 | 0.0409 | 19.7267 | 0.7274 | 39.611 | 2.5822 | 61.4969 | 10.6337 |
| 1988 | 20.4133 | 18.572 | 1.2918 | 1.133 | 0.8486 | 0.3025 | 21.5462 | 18.6358 | 1.3983 | 0.8888 | 0.0354 | 23.4299 | 1.0147 | 35.9977 | 1.871 | 6.1191 | 1.1519 |
| 1989 | 17.1693 | 15.0977 | 1.0157 | 2.818 | 2.2638 | 0.696 | 19.9873 | 17.2997 | 1.3621 | 0.936 | 0.039 | 21.0287 | 1.106 | 32.519 | 1.5939 | 20.0814 | 2.1079 |
| 1990 | 12.1755 | 11.9297 | 0.6227 | 0.3141 | 0.3836 | 0.1383 | 12.4896 | 12.3662 | 0.7411 | 0.8064 | 0.0332 | 17.761 | 0.7092 | 24.9112 | 0.9558 | 6.4821 | 1.1802 |
| 1991 | 10.9267 | 10.8487 | 0.5208 | 0.9095 | 0.9296 | 0.3376 | 11.8362 | 11.7264 | 0.7693 | 0.8965 | 0.0349 | 15.2891 | 0.5737 | 22.1251 | 0.9319 | 11.3121 | 1.6492 |
| 1992 | 9.0862 | 8.9356 | 0.4241 | 2.9024 | 1.4258 | 0.3994 | 11.9886 | 10.0989 | 0.6554 | 0.8742 | 0.0386 | 12.5012 | 0.4987 | 20.3642 | 0.8276 | 17.6739 | 1.7576 |
| 1993 | 10.3142 | 10.4311 | 0.4552 | 0.1846 | 0.7797 | 0.245 | 10.4988 | 11.5943 | 0.657 | 0.8321 | 0.0468 | 14.6636 | 0.6293 | 23.7129 | 1.0804 | 7.3395 | 1.0557 |
| 1994 | 8.9279 | 9.1759 | 0.4413 | 0.1863 | 1.2052 | 0.4053 | 9.1142 | 11.3814 | 0.9003 | 0.7196 | 0.0677 | 15.2964 | 1.0868 | 26.0236 | 1.9976 | 15.8467 | 3.0578 |
| 1995 | 9.4385 | 11.2864 | 1.7122 | 0.258 | 0.9649 | 0.3568 | 9.6965 | 12.8403 | 1.952 | 0.8112 | 0.0946 | 17.0562 | 1.9484 | 26.6266 | 3.0126 | 13.1793 | 3.1557 |
| 1996 | 9.4267 | 11.9326 | 2.0208 | 0.086 | 0.4722 | 0.2539 | 9.5127 | 12.8761 | 2.2067 | 0.8519 | 0.0994 | 18.0363 | 2.3795 | 25.1532 | 3.3717 | 4.9971 | 2.1082 |
| 1997 | 7.0336 | 9.4928 | 1.8904 | 0.3537 | 2.1116 | 0.8525 | 7.3872 | 12.5115 | 2.3177 | 0.8688 | 0.1026 | 14.3873 | 2.2376 | 25.1932 | 3.5614 | 18.4078 | 4.2723 |
| 1998 | 5.7139 | 9.0563 | 1.8471 | 0.4175 | 0.8192 | 0.3824 | 6.1314 | 9.8199 | 1.8636 | 0.8864 | 0.1047 | 12.1244 | 1.9084 | 19.3179 | 2.8953 | 8.7956 | 2.6301 |
| 1999 | 4.201 | 7.9745 | 1.6657 | 0.0879 | 0.5649 | 0.3156 | 4.2889 | 8.7386 | 1.7753 | 0.878 | 0.1049 | 11.8871 | 2.0373 | 16.8186 | 2.7655 | 5.0068 | 1.9422 |
| 2000 | 2.9771 | 6.6439 | 1.528 | 0.6049 | 1.0424 | 0.5101 | 3.582 | 7.8642 | 1.5924 | 0.8325 | 0.1011 | 10.1864 | 1.7995 | 16.0125 | 2.5881 | 10.5275 | 3.0407 |
| 2001 | 2.347 | 6.2979 | 1.3103 | 0.2093 | 0.3501 | 0.2354 | 2.5563 | 6.5083 | 1.3165 | 0.8717 | 0.1034 | 9.0826 | 1.476 | 12.5743 | 2.0587 | 3.2356 | 1.5202 |
| 2002 | 2.2426 | 5.3044 | 1.3305 | 0.1662 | 0.8735 | 0.4461 | 2.4089 | 6.5475 | 1.4003 | 0.8816 | 0.1048 | 7.8395 | 1.42 | 12.8998 | 2.1908 | 8.8398 | 2.529 |
| 2003 | 1.2411 | 4.6116 | 1.059 | 0.0458 | 0.2148 | 0.2265 | 1.2869 | 4.8505 | 1.1256 | 0.9091 | 0.1079 | 6.537 | 1.1676 | 9.1697 | 1.7782 | 1.4542 | 1.3062 |
| 2004 | 0.5402 | 3.4653 | 0.9232 | 0.0718 | 0.3848 | 0.2734 | 0.612 | 3.8413 | 0.9753 | 0.9359 | 0.1104 | 5.163 | 1.0656 | 6.9889 | 1.4902 | 3.7698 | 1.8239 |
| 2005 | 0.5114 | 2.6409 | 0.9439 | 0.0406 | 0.5757 | 0.3046 | 0.552 | 3.2605 | 0.8544 | 0.9409 | 0.1133 | 3.5073 | 0.8567 | 6.3181 | 1.2993 | 5.2773 | 1.2259 |
| 2006 | 0.4545 | 2.7638 | 1.154 | 0.4777 | 1.0551 | 0.5226 | 0.9323 | 3.6362 | 0.7187 | 0.8473 | 0.1037 | 3.4707 | 0.6769 | 7.9956 | 1.0852 | 11.5938 | 1.7159 |
| 2007 | 0.5242 | 4.0093 | 0.7609 | 2.0833 | 0.319 | 0.3798 | 2.6076 | 4.3584 | 0.6919 | 0.8131 | 0.0978 | 5.8665 | 0.7036 | 9.1018 | 1.0237 | 2.6895 | 0.8534 |
| 2008 | 0.4501 | 5.4789 | 0.9145 | 0.9084 | 0.2832 | 0.1865 | 1.3585 | 4.7181 | 0.7325 | 0.909 | 0.1075 | 6.7466 | 0.8085 | 8.6926 | 1.0276 | 3.0811 | 1.0532 |
| 2009 | 0.222 | 4.993 | 2.1667 | 1.3803 | 1.155 | 0.605 | 1.6023 | 4.5546 | 0.7755 | 0.8884 | 0.1068 | 5.0282 | 0.7467 | 9.3028 | 1.1629 | 12.4446 | 2.0335 |
| 2010 | 0.239 | 4.922 | 1.0294 | 1.1834 | 0.9466 | 0.7285 | 1.4224 | 5.7613 | 0.9261 | 0.8238 | 0.1002 | 6.5809 | 0.838 | 12.51 | 1.5387 | 8.9661 | 2.4167 |
| 2011 | NA | 7.1687 | 1.4178 | NA | 0.4907 | 0.5307 | NA | 6.4274 | 1.1371 | 0.8438 | 0.1066 | 8.7198 | 1.2484 | 12.9142 | 2.077 | 4.1218 | 2.9595 |
| 2012 | NA | 6.2827 | 1.6807 | NA | 0.7151 | 0.5711 | NA | 5.9877 | 1.4149 | 0.8528 | 0.1084 | 8.2887 | 1.7131 | 11.8063 | 2.7807 | 7.6974 | 4.8677 |
| **Min** | 0.2220 | 2.6409 | 0.4241 | 0.0406 | 0.2148 | 0.1383 | 0.5520 | 3.2605 | 0.6554 | 0.7001 | 0.0309 | 3.4707 | 0.4987 | 6.3181 | 0.8276 | 1.4542 | 0.8534 |
| **GM** | 4.9184 | 9.3715 | 0.9841 | 0.5467 | 1.0386 | 0.4269 | 6.6491 | 10.6964 | 1.2015 | 0.8534 | 0.0618 | 13.5835 | 1.0391 | 21.5023 | 1.6675 | 10.3157 | 1.9395 |
| **AM** | 9.7398 | 11.0939 | 1.0828 | 1.3695 | 1.4030 | 0.4890 | 11.1093 | 12.8762 | 1.2973 | 0.8564 | 0.0702 | 16.6019 | 1.1323 | 26.1218 | 1.8030 | 13.8953 | 2.2368 |
| **Max** | 23.8646 | 23.3391 | 2.1667 | 8.8246 | 4.3856 | 1.4857 | 27.7581 | 27.4287 | 2.3177 | 1.0059 | 0.1133 | 37.9663 | 2.3795 | 56.7011 | 3.5614 | 61.4969 | 10.6337 |

*** Estimates for 2011 and 2012 are TSA projections.**

**Table 3.2.17. Cod in Division VIa. Inputs to short-term predictions from TSA run. Mean weights assumed from final three years. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.**

```
Label     Value     CV     Label     Value     CV

 Number-at-age                Weight in the stock
 N1          4122   0.72      WS1         0.24   0.09
 N2          4194   0.28      WS2         1.22   0.15
 N3          2289   0.16      WS3         2.26   0.01
 N4           179   0.31      WS4         3.95   0.17
 N5            53   0.27      WS5         5.60   0.16
 N6            73   0.26      WS6         6.74   0.17
 N7            13   0.30      WS7         8.36   0.04

 H.cons selectivity           Weight in the HC catch
 sH1         0.59   0.07      WH1         0.24   0.09
 sH2         0.73   0.06      WH2         1.22   0.15
 sH3         0.90   0.04      WH3         2.26   0.01
 sH4         0.93   0.05      WH4         3.95   0.17
 sH5         0.93   0.05      WH5         5.60   0.16
 sH6         0.93   0.05      WH6         6.74   0.17
 sH7         0.93   0.05      WH7         8.36   0.04

 Natural mortality            Proportion mature
 M1          0.20   0.10      MT1         0.00   0.10
 M2          0.20   0.10      MT2         0.52   0.10
 M3          0.20   0.10      MT3         0.86   0.10
 M4          0.20   0.10      MT4         1.00   0.10
 M5          0.20   0.10      MT5         1.00   0.00
 M6          0.20   0.10      MT6         1.00   0.00
 M7          0.20   0.10      MT7         1.00   0.00

 Relative effort              Year effect for natural mortality
 in HC fishery
 HF11        0.75   0.05      K11         1.00   0.10
 HF12        0.56   0.05      K12         1.00   0.10
 HF13        1.00   0.05      K13         1.00   0.10

 Recruitment in 2012 and 2013
 R12         5032   0.73
 R13         5032   0.73

 Proportion of F before spawning = .00
 Proportion of M before spawning = .00

 Stock numbers in 2011 are TSA survivors.
```

**Table 3.2.18. Cod in Division VIa. Results of short-term forecasts from TSA run. Management options. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.**

| | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | | | | | | |
| Mean F Ages | | | | | | | | |
| H.cons 2 to 5 | 0.66 | 0.00 | 0.17 | 0.35 | 0.52 | 0.70 | 0.87 | 1.05 |
| Effort relative to 2010 | | | | | | | | |
| H.cons | 0.75 | 0.00 | 0.20 | 0.40 | 0.60 | 0.80 | 1.00 | 1.20 |
| Biomass | | | | | | | | |
| Total 1 January | 12.91 | 12.97 | 12.97 | 12.97 | 12.97 | 12.97 | 12.97 | 12.97 |
| SSB at spawning time | 8.72 | 9.84 | 9.84 | 9.84 | 9.84 | 9.84 | 9.84 | 9.84 |
| Catch weight (,000t) | | | | | | | | |
| H.cons | 5.38 | 0.00 | 1.84 | 3.39 | 4.71 | 5.83 | 6.78 | 7.59 |
| Biomass in year.... 2013 | | | | | | | | |
| Total 1 January | | 21.86 | 18.81 | 16.23 | 14.04 | 12.18 | 10.60 | 9.25 |
| SSB at spawning time | | 17.64 | 14.95 | 12.67 | 10.75 | 9.12 | 7.75 | 6.59 |

| | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | | | | | | |
| Effort relative to 2010 | | | | | | | | |
| H.cons | 0.75 | 0.00 | 0.20 | 0.40 | 0.60 | 0.80 | 1.00 | 1.20 |
| Est. Coeff. of Variation | | | | | | | | |
| Biomass | | | | | | | | |
| Total 1 January | 0.15 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| SSB at spawning time | 0.15 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| Catch weight | | | | | | | | |
| H.cons | 0.15 | 0.00 | 0.23 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Biomass in year.... 2013 | | | | | | | | |
| Total 1 January | | 0.25 | 0.25 | 0.26 | 0.26 | 0.27 | 0.27 | 0.28 |
| SSB at spawning time | | 0.23 | 0.24 | 0.24 | 0.24 | 0.25 | 0.25 | 0.26 |

**Table 3.2.19. Cod in Division VIa. Results of short-term forecasts from TSA run. Detailed tables. Note: Text is presented as it was output from WGFRANSW but data referred to as that for the human consumption fishery should be regarded as that for removals in addition to the assumed value of natural mortality.**

**Detailed forecast tables.**

**Forecast for year 2011**
**F multiplier H.cons=0.75**

| | Populations | Catch number | |
|---|---|---|---|
| Age | Stock No. | H.Cons | Total |
| 1 | 4122 | 1342 | 1342 |
| 2 | 4194 | 1622 | 1622 |
| 3 | 2289 | 1032 | 1032 |
| 4 | 179 | 82 | 82 |
| 5 | 53 | 24 | 24 |
| 6 | 73 | 34 | 34 |
| 7 | 13 | 6 | 6 |
| Wt | 13 | 5 | 5 |

**Forecast for year 2012**
**F multiplier H.cons=0.56**

| | Populations | Catch number | |
|---|---|---|---|
| Age | Stock No. | H.Cons | Total |
| 1 | 5032 | 1292 | 1292 |
| 2 | 2171 | 670 | 670 |
| 3 | 1982 | 722 | 722 |
| 4 | 952 | 355 | 355 |
| 5 | 73 | 27 | 27 |
| 6 | 22 | 8 | 8 |
| 7 | 35 | 13 | 13 |
| Wt | 13 | 4 | 4 |

**Table 3.2.20. Cod in Division VIa. Output from srmsymc ADMB package.**

| Stock name | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cod-6a | | | | | | | | | |
| Sen filename | | | | | | | | | |
| sum_and_sen_files/codvia10runspalyhf075hf0563.sen | | | | | | | | | |
| pf, pm | | | | | | | | | |
| 0 | 0 | | | | | | | | |
| Number of iterations | | | | | | | | | |
| 1000 | | | | | | | | | |
| Simulate variation in Biological parameters | | | | | | | | | |
| TRUE | | | | | | | | | |
| SR relationship constrained | | | | | | | | | |
| TRUE | | | | | | | | | |
| | | | | | | | | | |
| Ricker | | | | | | | | | |
| 1000/1000 Iterations resulted in feasible parameter estimates | | | | | | | | | |
| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
| Deterministic | 0.83 | 0.35 | 107615.00 | 33631.40 | 0.77 | 0.32 | 0.86 | 1.22E-05 | 64.52 |
| Mean | 0.79 | 0.34 | 248654.55 | 80885.39 | 0.78 | 0.38 | 0.93 | 1.45E-05 | |
| 5%ile | 0.59 | 0.26 | 42534.56 | 16130.92 | 0.61 | 0.05 | 0.68 | 1.73E-06 | |
| 25%ile | 0.69 | 0.30 | 64432.03 | 23129.35 | 0.70 | 0.18 | 0.80 | 7.03E-06 | |
| 50%ile | 0.78 | 0.33 | 94637.85 | 32832.15 | 0.77 | 0.35 | 0.90 | 1.35E-05 | |
| 75%ile | 0.88 | 0.37 | 176432.50 | 56775.68 | 0.85 | 0.53 | 1.04 | 2.02E-05 | |
| 95%ile | 1.03 | 0.42 | 692590.35 | 217198.55 | 0.97 | 0.82 | 1.32 | 3.16E-05 | |
| CV | 0.17 | 0.15 | 3.43 | 3.41 | 0.14 | 0.65 | 0.21 | 0.65 | |

**Table 3.2.20. (Cont): Cod in Division VIa. Output from srmsymc ADMB package.**

| **Beverton–Holt** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1000/1000 Iterations resulted in feasible parameter estimates | | | | | | | | | |
| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
| Deterministic | 0.85 | 0.18 | 401035.00 | 66296.50 | 0.39 | 1.31 | 53828.10 | 60405.70 | 64.48 |
| Mean | 0.83 | 0.17 | 830128.89 | 113018.89 | 0.54 | 1.41 | 91481.79 | 119568.27 | |
| 5%ile | 0.59 | 0.11 | 110359.80 | 21448.08 | 0.07 | 1.10 | 18394.14 | 11822.00 | |
| 25%ile | 0.70 | 0.15 | 195133.00 | 35526.05 | 0.28 | 1.26 | 28078.33 | 26150.93 | |
| 50%ile | 0.79 | 0.17 | 322891.50 | 55212.35 | 0.48 | 1.40 | 44006.65 | 47156.45 | |
| 75%ile | 0.91 | 0.19 | 630754.50 | 96558.98 | 0.76 | 1.55 | 76202.40 | 97400.13 | |
| 95%ile | 1.15 | 0.21 | 2769898.00 | 341061.90 | 1.15 | 1.78 | 298192.60 | 417604.45 | |
| CV | 0.25 | 0.21 | 2.78 | 1.97 | 0.65 | 0.15 | 2.22 | 2.75 | |
| | | | | | | | | | |
| Smooth hockeystick | | | | | | | | | |
| 1000/1000 Iterations resulted in feasible parameter estimates | | | | | | | | | |
| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
| Deterministic | 0.75 | 0.22 | 135085.00 | 27314.90 | 0.45 | 1.54 | 0.37 | 26047.10 | 64.56 |
| Mean | 0.70 | 0.21 | 173441.36 | 30090.20 | 0.47 | 1.58 | 0.38 | 26727.73 | |
| 5%ile | 0.53 | 0.13 | 68545.05 | 17722.69 | 0.37 | 0.99 | 0.30 | 16778.00 | |
| 25%ile | 0.62 | 0.19 | 98326.80 | 23808.10 | 0.42 | 1.33 | 0.34 | 22442.08 | |
| 50%ile | 0.69 | 0.22 | 129465.50 | 28856.20 | 0.46 | 1.58 | 0.37 | 26719.35 | |
| 75%ile | 0.77 | 0.24 | 171332.00 | 34618.58 | 0.50 | 1.87 | 0.41 | 31474.53 | |
| 95%ile | 0.89 | 0.27 | 306434.25 | 46886.99 | 0.58 | 2.17 | 0.47 | 36539.60 | |
| CV | 0.16 | 0.22 | 1.38 | 0.31 | 0.16 | 0.23 | 0.16 | 0.23 | |
| | | | | | | | | | |
| Per recruit | | | | | | | | | |
| | F35 | F40 | F01 | Fmax | Bmsypr | MSYpr | Fpa | Flim | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Deterministic | 0.18 | 0.15 | 0.14 | 0.22 | 7.10 | 1.44 | 0.60 | 0.80 |
| Mean | 0.16 | 0.14 | 0.13 | 0.21 | 8.70 | 1.51 | | |
| 5%ile | 0.06 | 0.05 | 0.06 | 0.13 | 3.97 | 1.07 | | |
| 25%ile | 0.14 | 0.12 | 0.12 | 0.19 | 5.23 | 1.27 | | |
| 50%ile | 0.17 | 0.14 | 0.14 | 0.22 | 6.48 | 1.47 | | |
| 75%ile | 0.20 | 0.17 | 0.16 | 0.24 | 8.31 | 1.66 | | |
| 95%ile | 0.23 | 0.19 | 0.18 | 0.27 | 15.11 | 2.16 | | |
| CV | 0.31 | 0.31 | 0.28 | 0.22 | 1.36 | 0.22 | | |

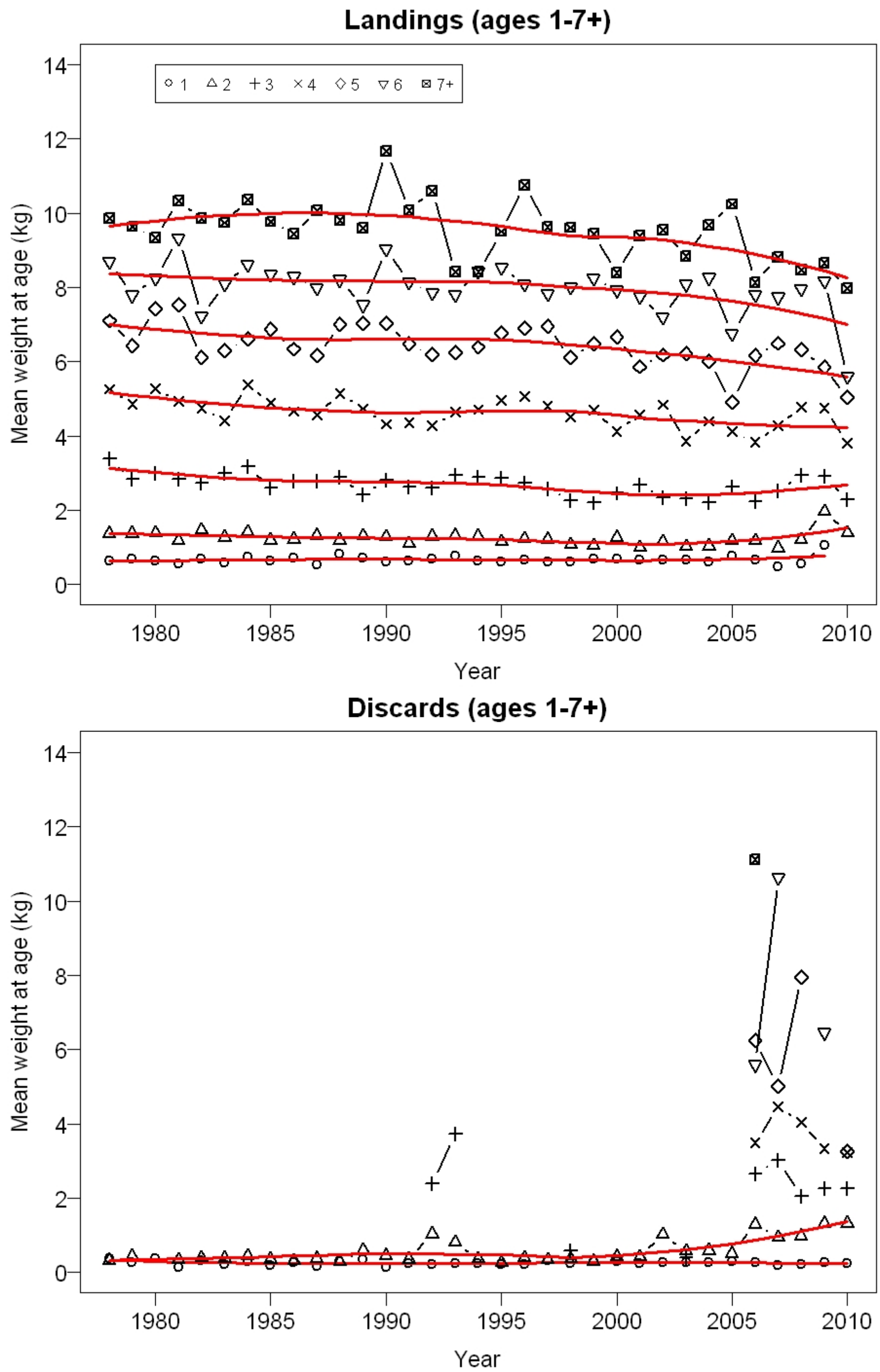



**Figure 3.2.1. Cod in Division VIa. Mean weights-at-age in landings and discards. A loess smooth has been fitted to the data at each age, with a span including three quarters of the data points.**

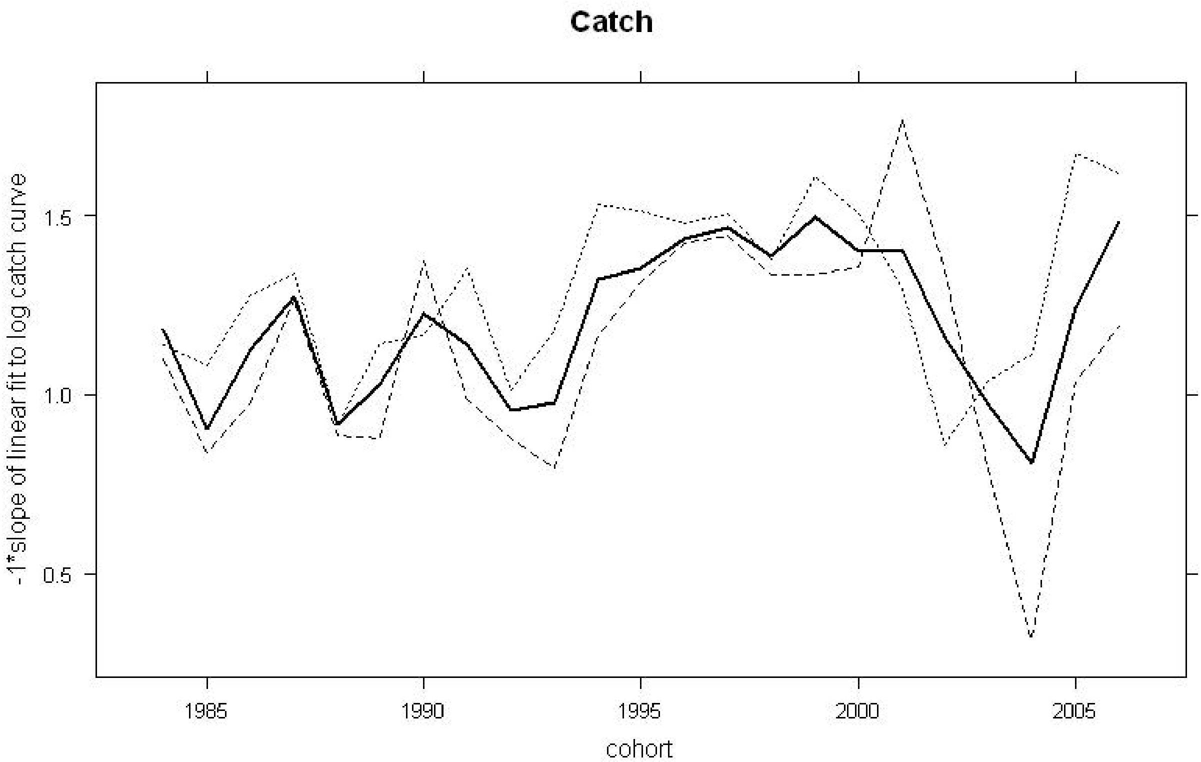



**Figure 3.2.2. Cod in Division VIa. Log catch (landings + discards) curve gradient plot using WG commercial catch-at-age data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality.**

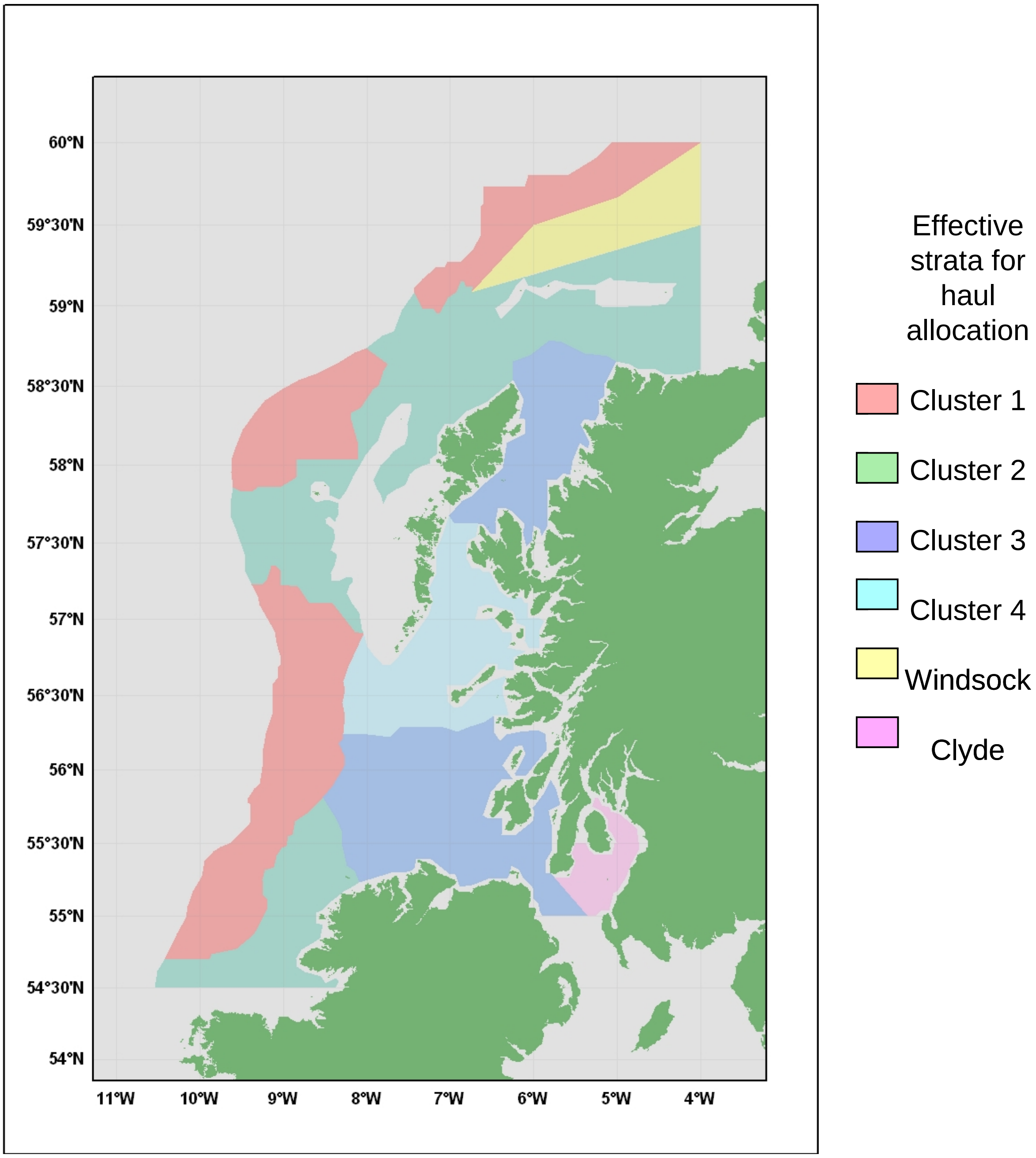



**Figure 3.2.3. Cod in Division VIa. Sampling strata of revised Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1).**

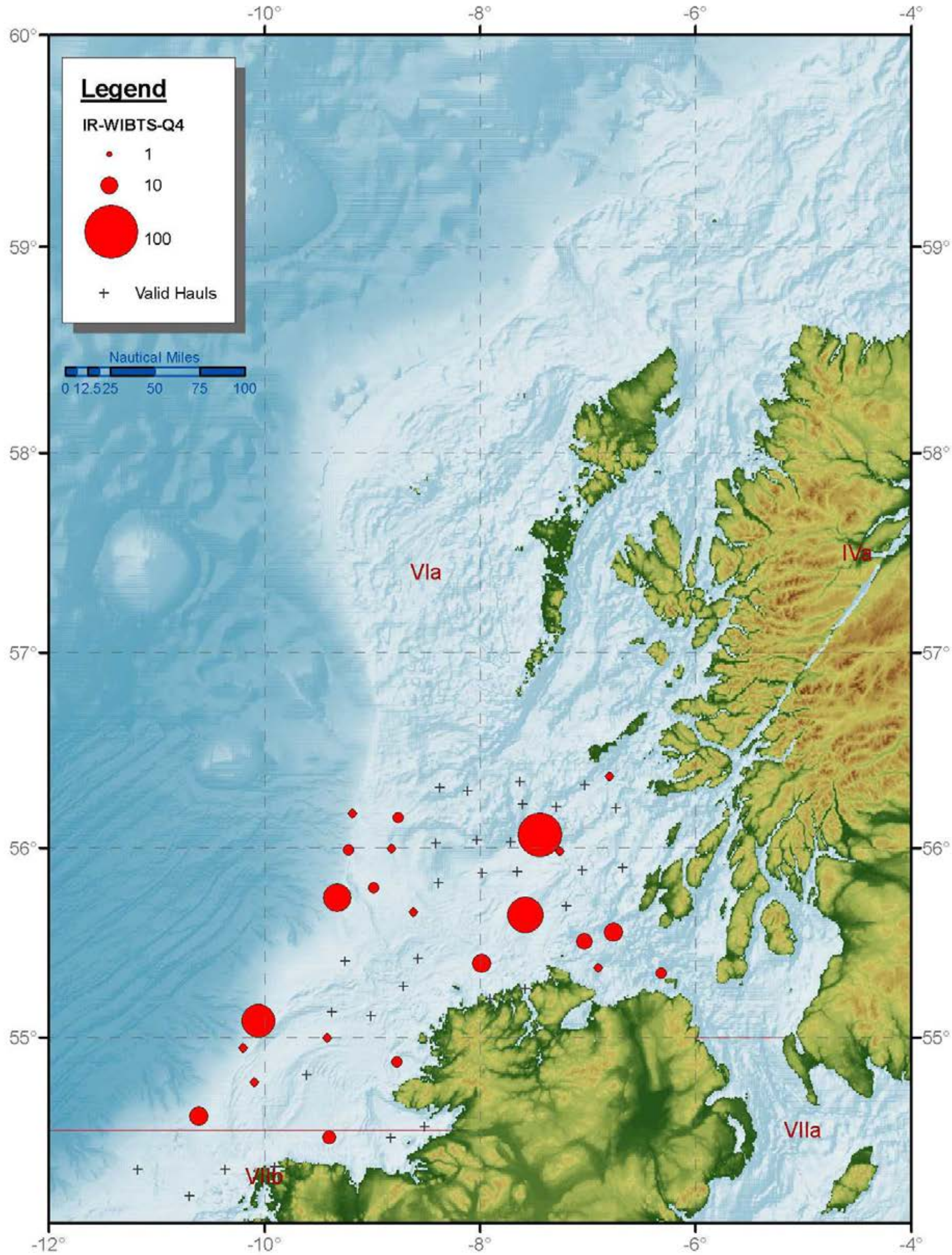



**Figure 3.2.4. Cod in Division VIa. Cpue numbers for fish aged at 1+ by ICES statistical rectangle resulting from quarter four Irish groundfish survey (IRGFS-WIBTS-Q4). Irish Survey values are for fish >23 cm in length (proxy for age 1+) and numbers are standardized to 60 minutes towing. Note that no Scottish quarter four groundfish survey (ScoGFS-WIBTS-Q4) took place in 2010.**

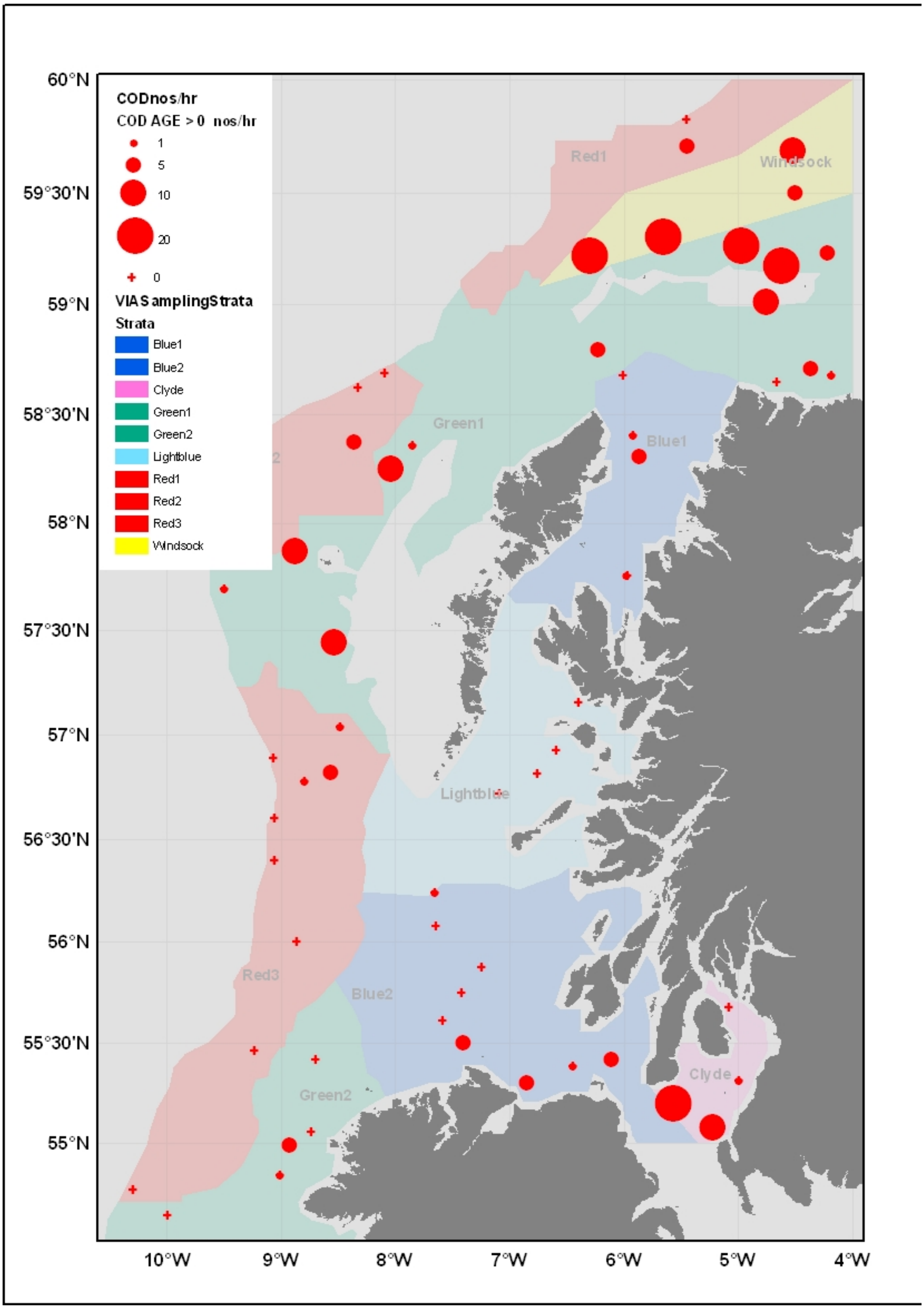



**Figure 3.2.4. Cont. Cod in Division VIa. Cpue numbers for fish aged at 1+ by ICES statistical rectangle resulting from Scottish quarter one survey (ScoGFS-WIBTS-Q1). Numbers are standardized to 60 minutes towing.**

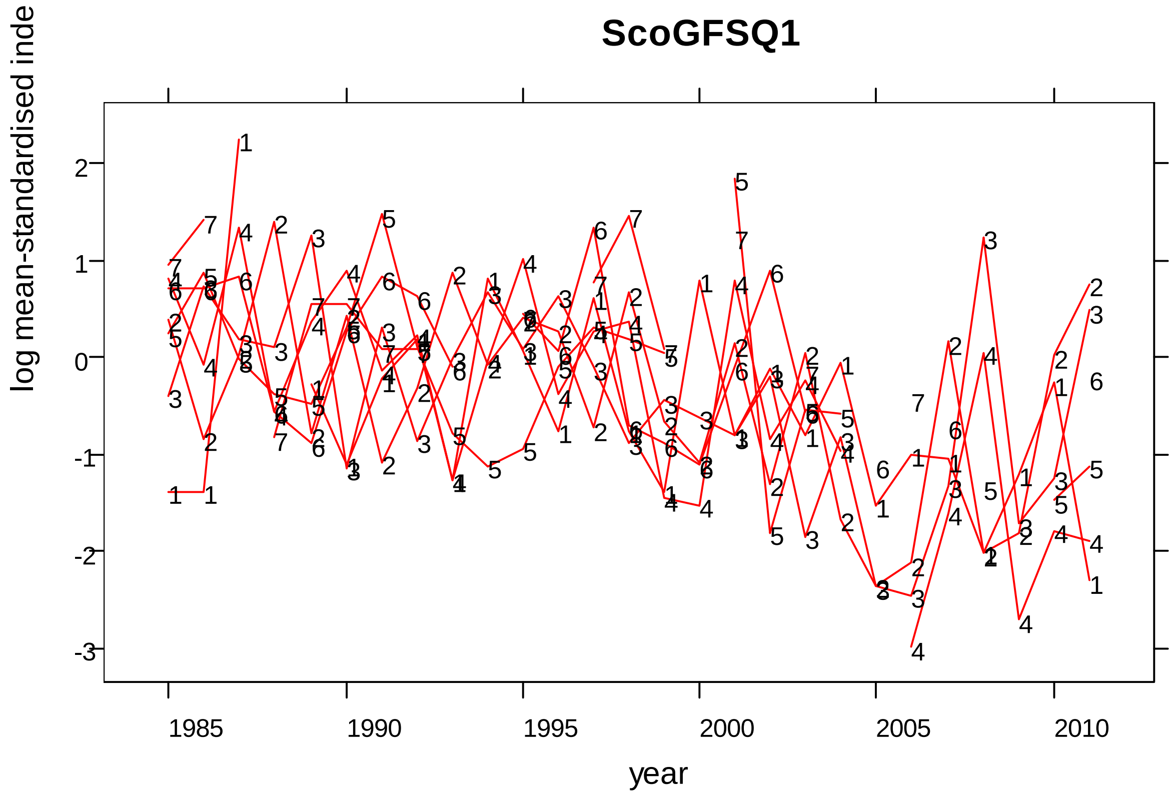



**Figure 3.2.5. Cod in Division VIa. Log mean standardized index values-by year-from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.**

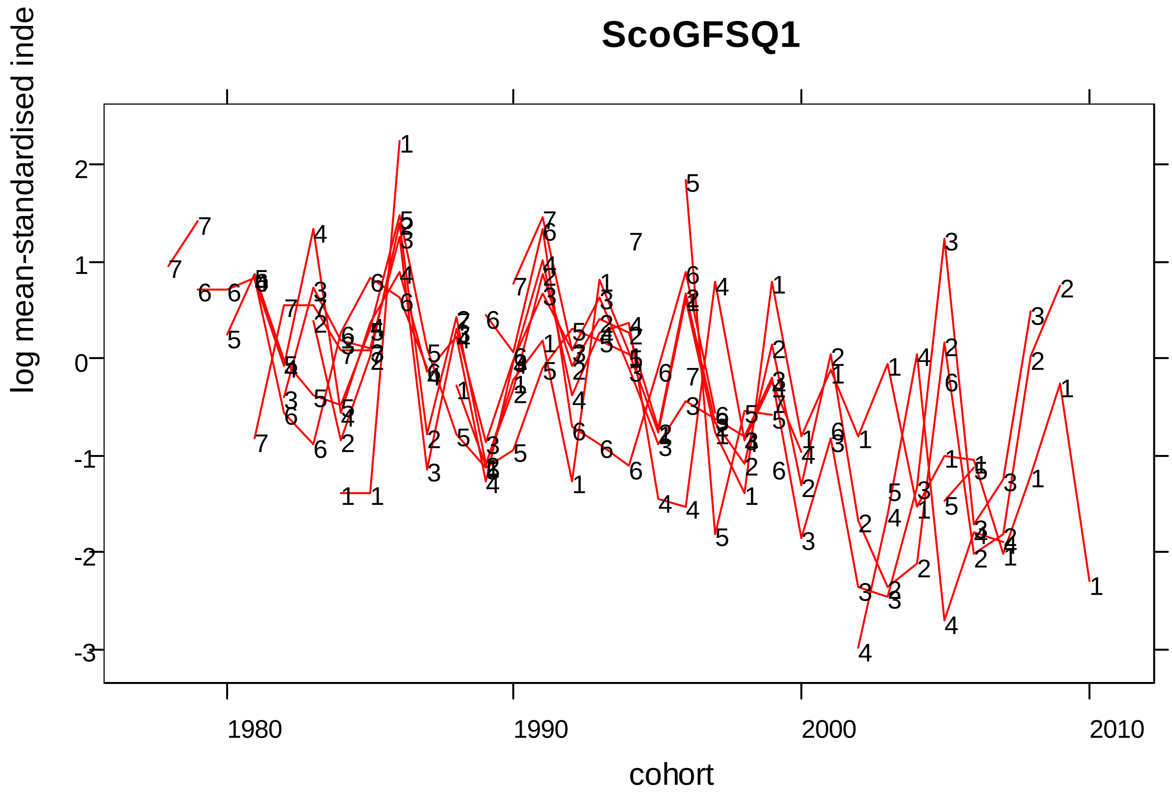



**Figure 3.2.6. Cod in Division VIa. Log mean standardized index values-by cohort-from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.**

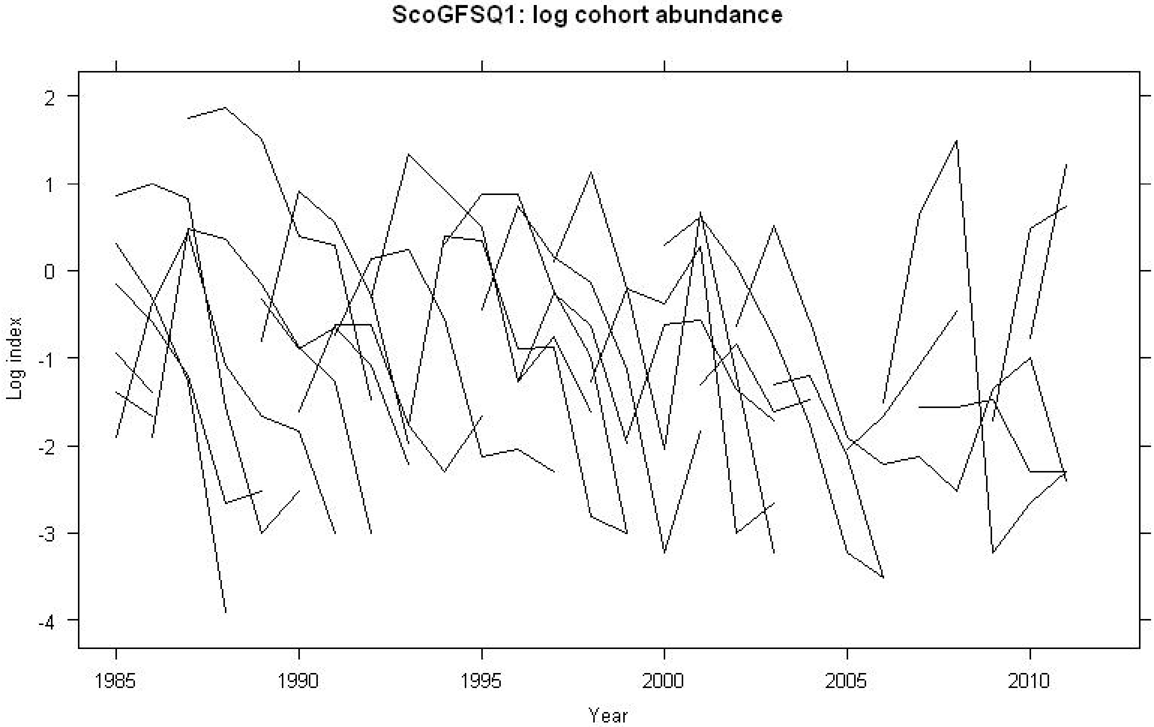



**Figure 3.2.7. Cod in Division VIa. Log catch curves from Scottish quarter one groundfish survey (ScoGFS-WIBTS-Q1); ages 1–6.**

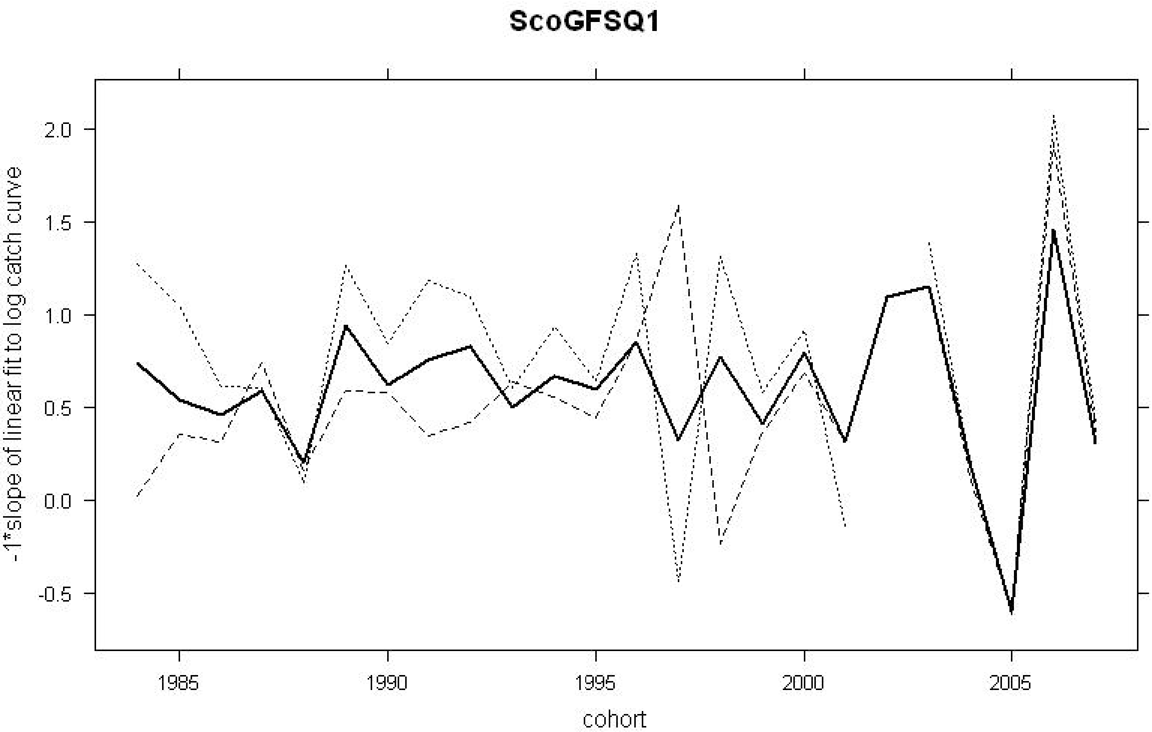



**Figure 3.2.8. Cod in Division VIa. Log catch curve gradient plot using ScoGFS-WIBTS-Q1 index data. Solid line shows time-series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–5. An increasing value indicates increasing mortality.**

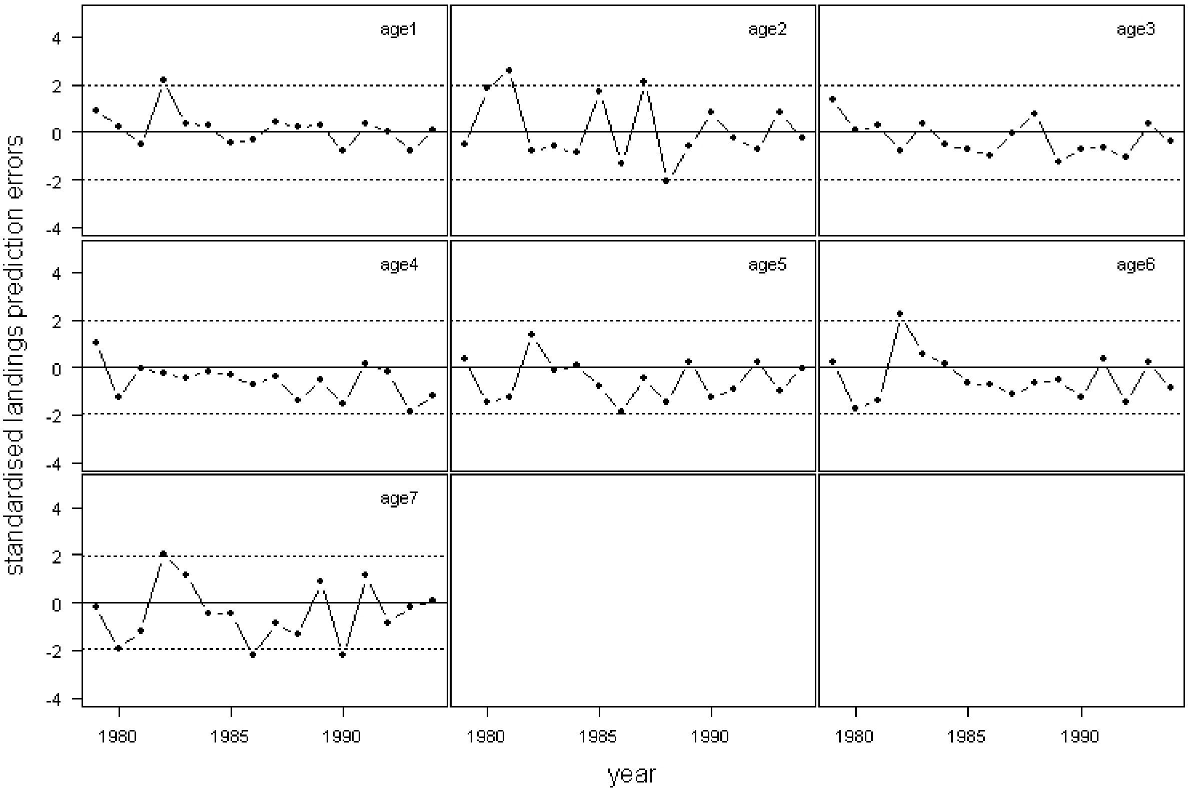



**Figure 3.2.09. Cod in Division VIa. TSA final run. Standardized prediction errors at age plots for landings.**

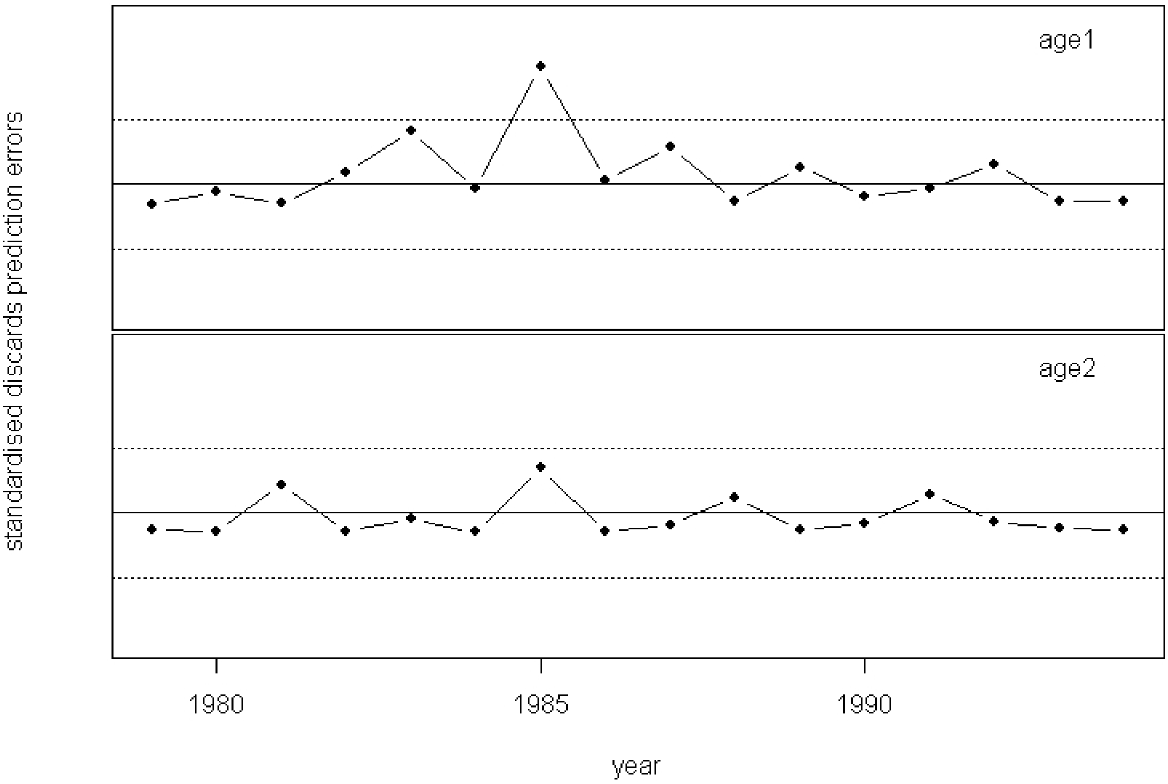



**Figure 3.2.10. Cod in Division VIa. TSA final run. Standardized prediction errors at age plots for discards.**

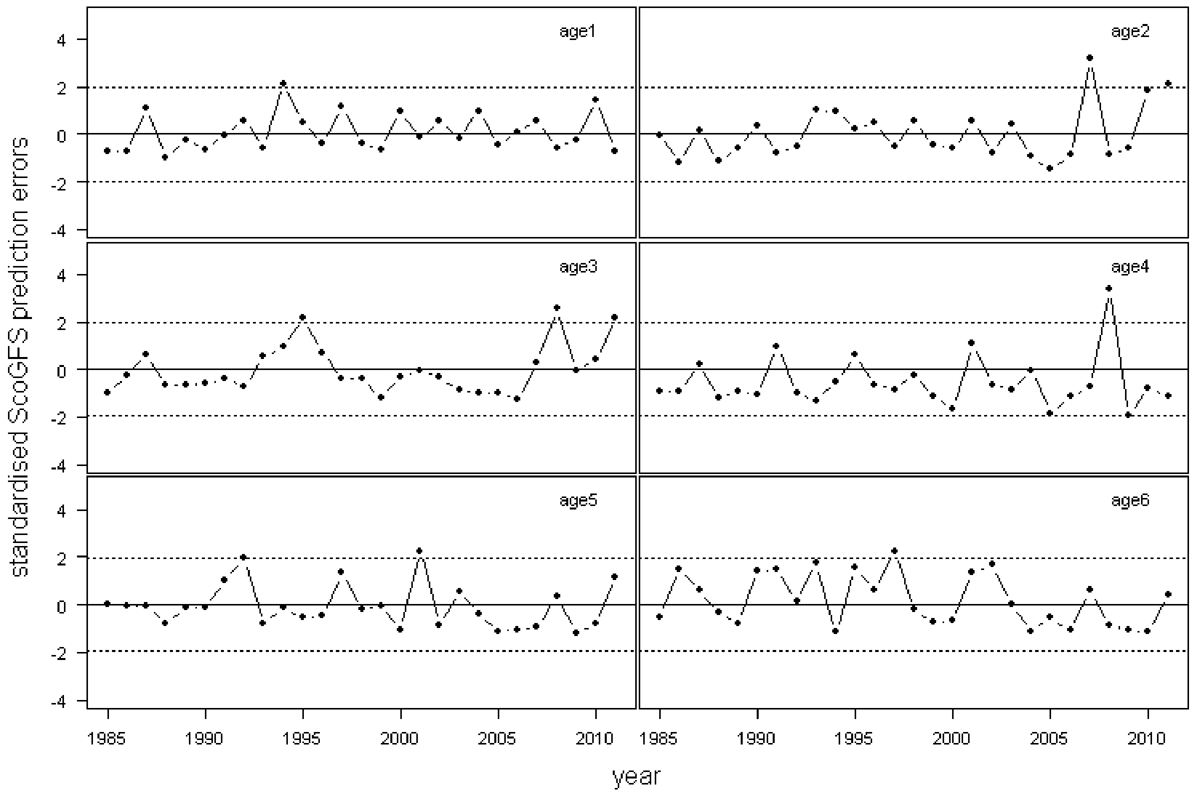



**Figure 3.2.11. Cod in Division VIa. TSA run. Standardized prediction errors at age plots for ScoGFS-WIBTS-Q1.**

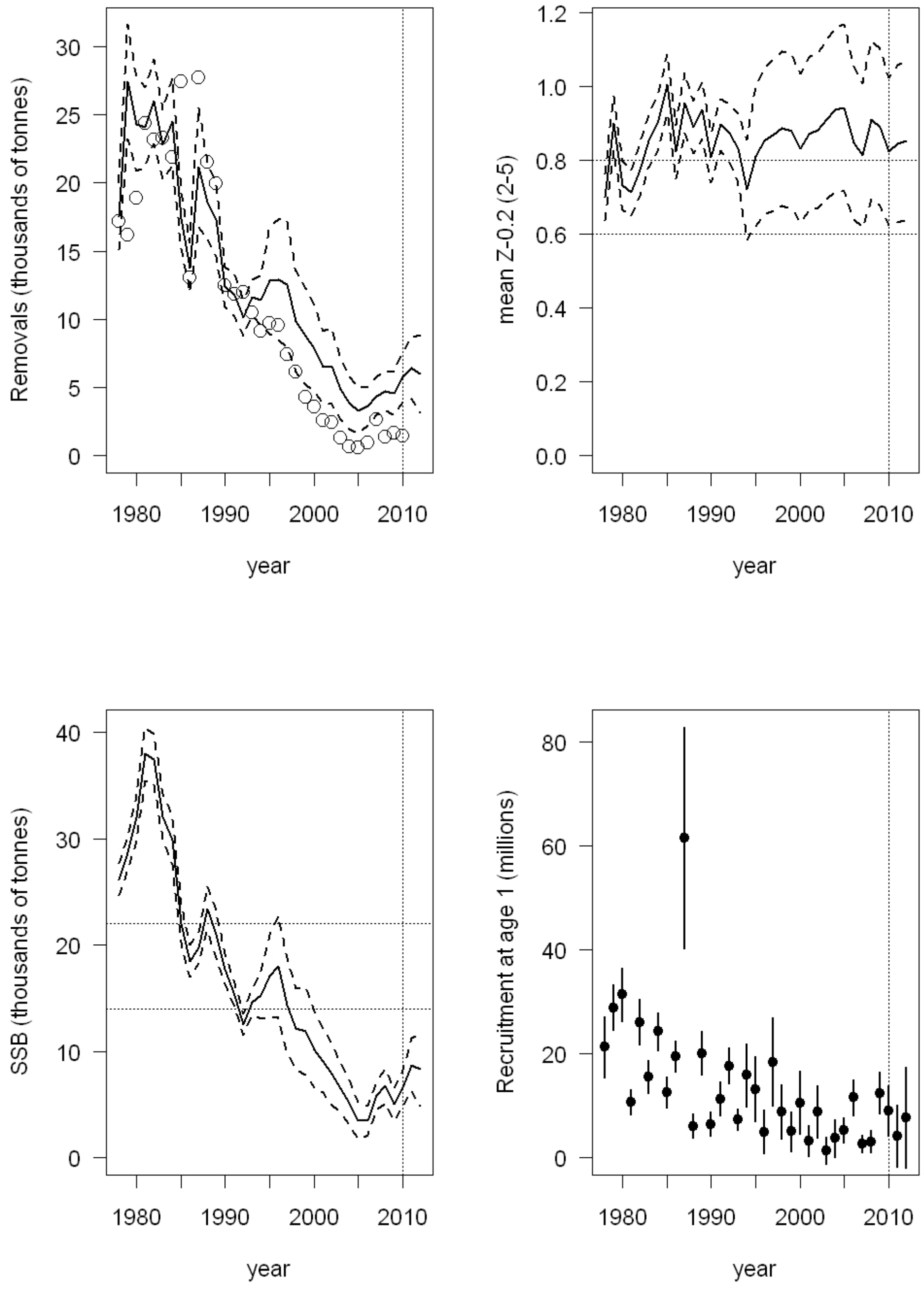



**Figure 3.2.12. Cod in Division VIa. Summary plot of TSA update run. (landings and discard data excluded from 1995 onward). Solid line in top left frame indicates removals resulting from mortality over and above M=0.2; open circles represent reported catch. Solid line in top right frame indicates mortality over and above M=0.2. Dashed lines show ± 2 s.e. (approx 95% confidence interval).**

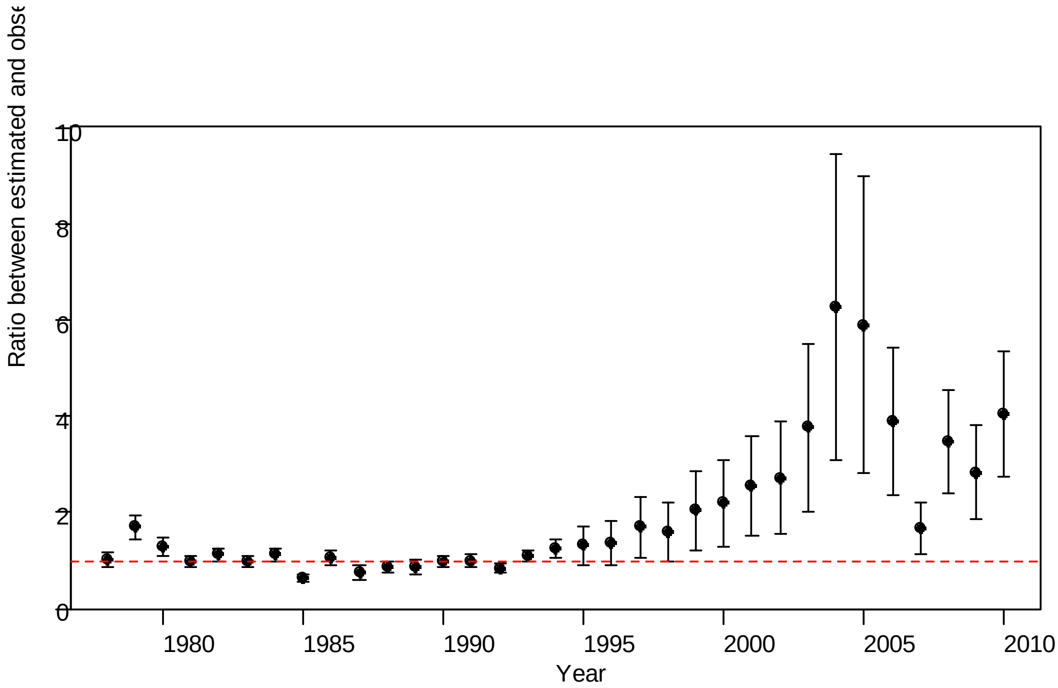



**Figure 3.2.13. Cod in Division VIa. Ratio of estimated to observed catch using TSA. Bars show ± 2 s.e. TSA excludes catch data from 1995 to 2010 inclusive. The 'catch' resulting from TSA is considered removals from both fishing and natural mortality over and above M=0.2.**

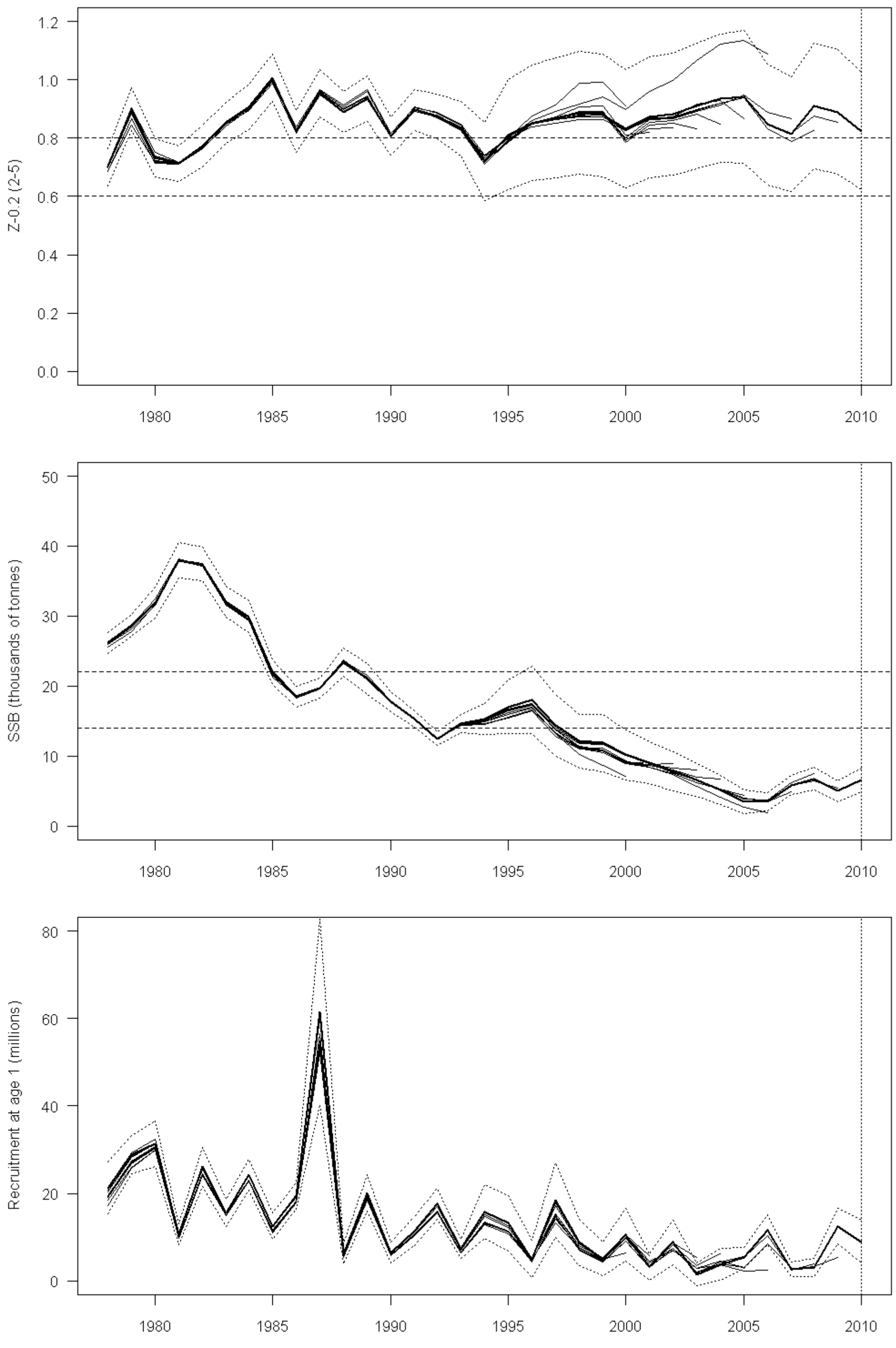



**Figure 3.2.14. Cod in Division VIa. Retrospective plots of TSA run. Biological reference points are given by horizontal dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.**

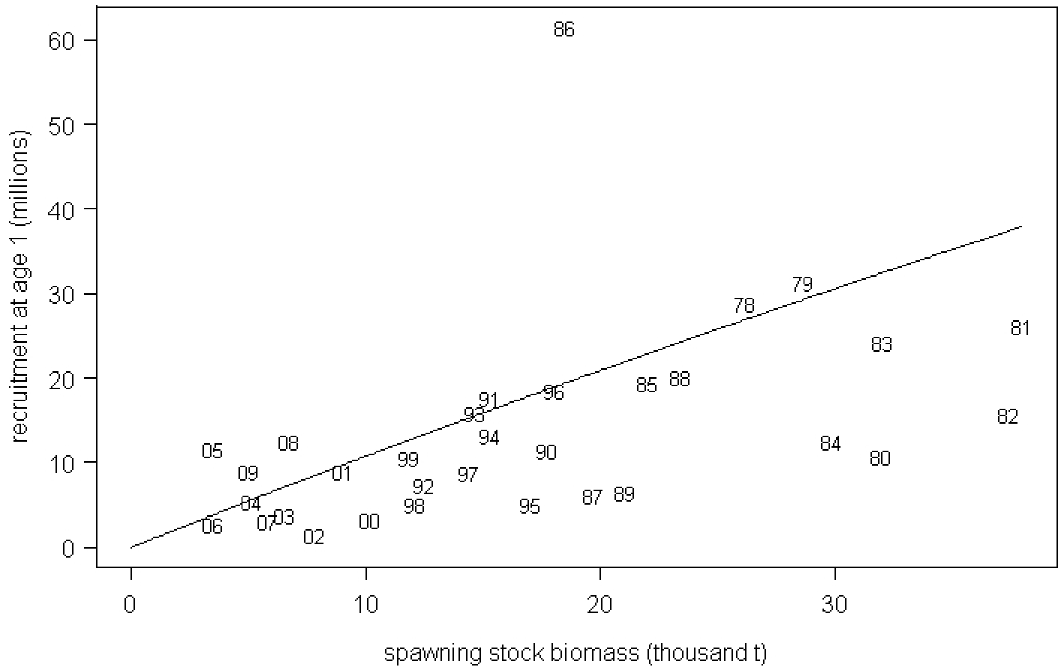



**Figure 3.2.15. Cod in Division VIa. TSA final run. Stock–recruit relationship. Numbers indicate year class.**

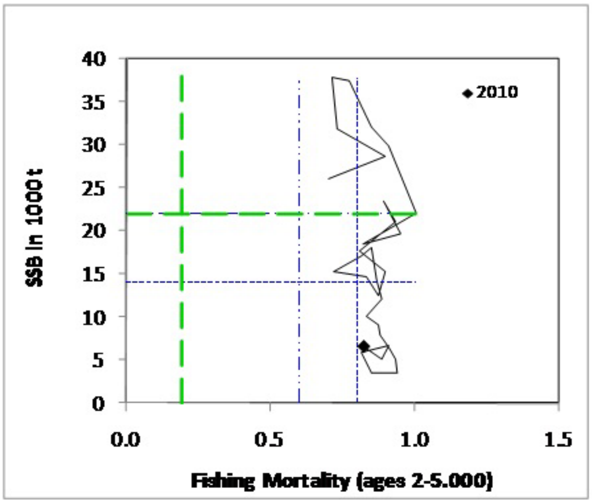



**Figure 3.2.16. Cod in Division VIa. Precautionary approach plot. Mortality is all mortality over and above the fixed natural mortality value of 0.2 (referred to as 'Z-0.2').**

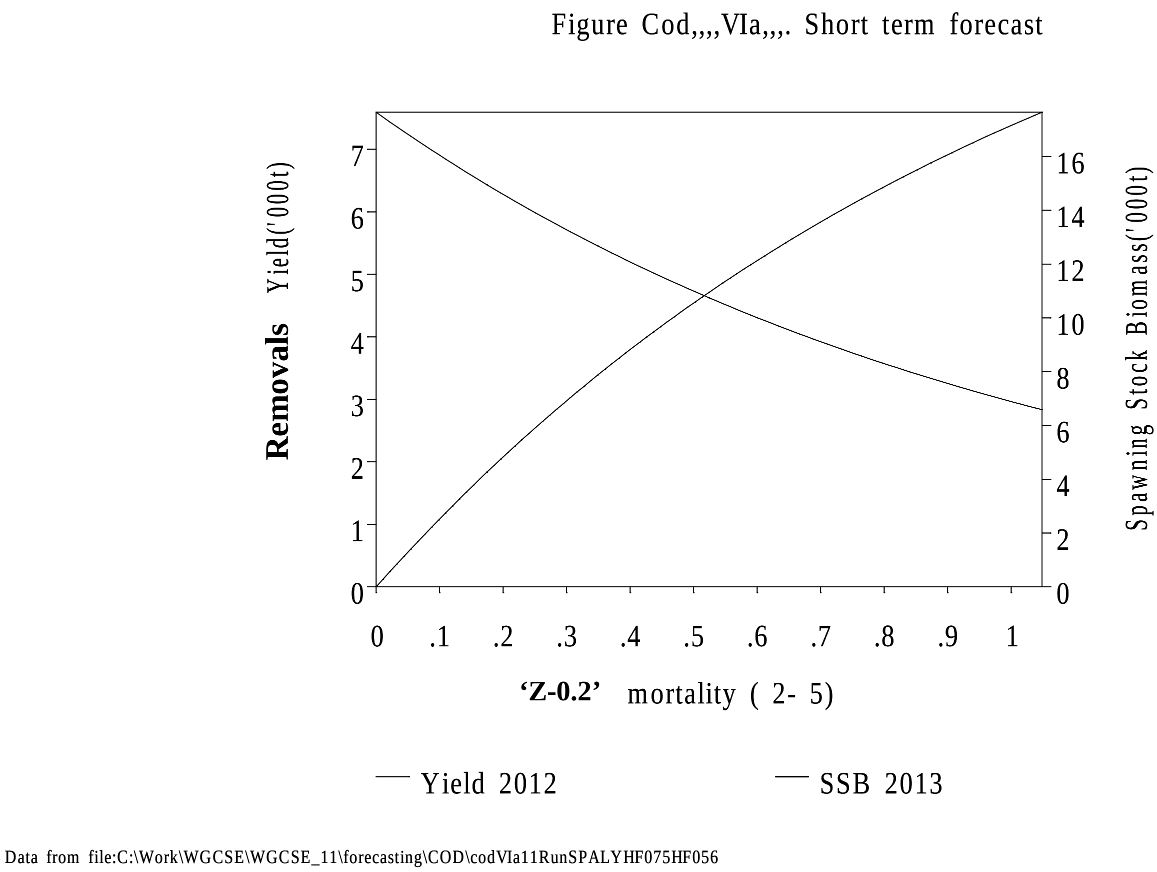



**Figure 3.2.17. Cod in Division VIa. Short-term forecast. Figure shows mortality from all sources that is over and above M=0.2 and associated removals.**

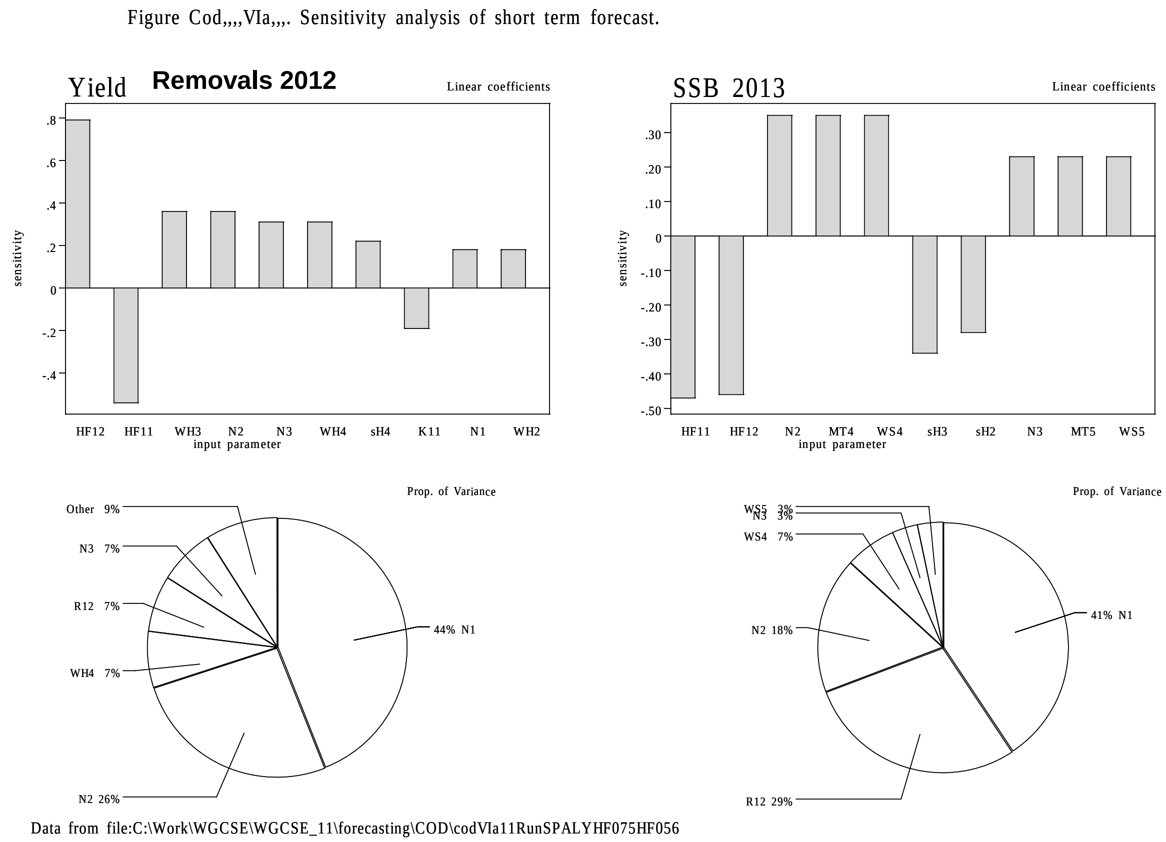



**Figure 3.2.18. Cod in Division VIa. Sensitivity analysis of short-term forecast. Removals are associated with mortality from all sources over and above M=0.2.**

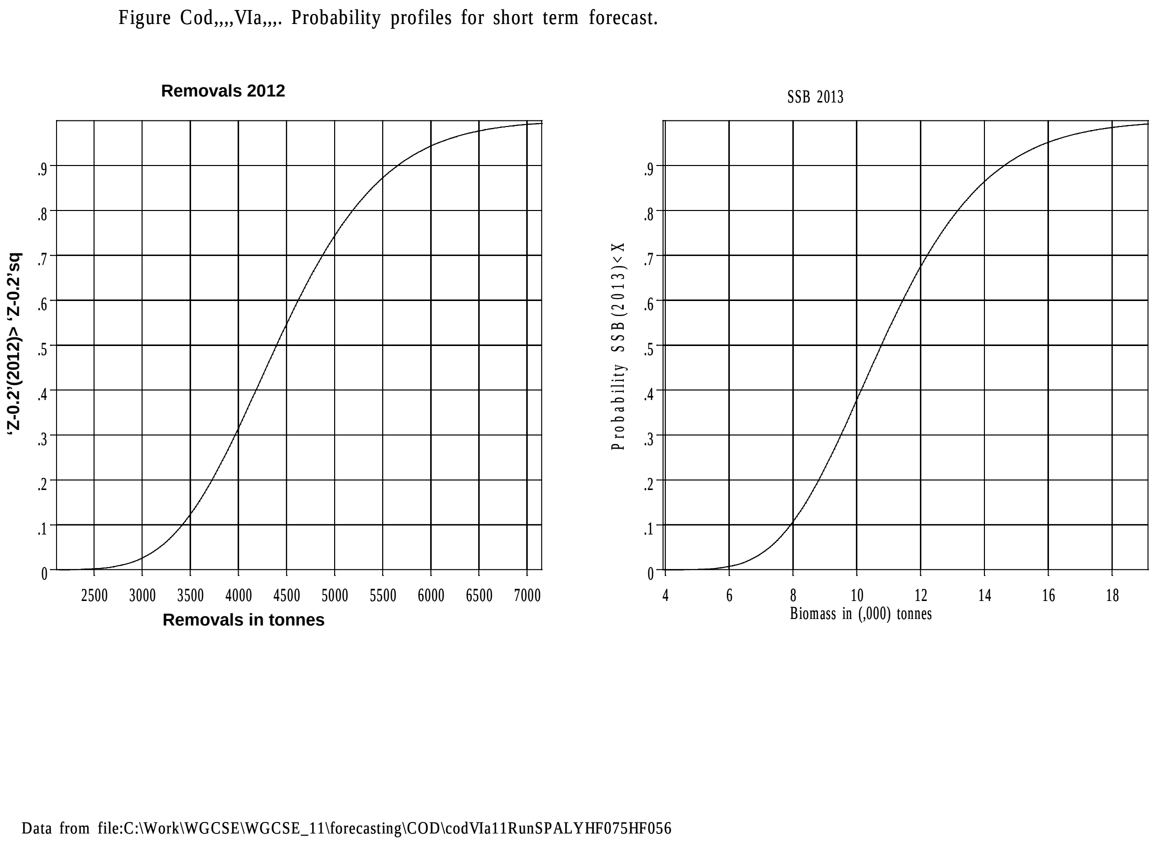



**Figure 3.2.19. Cod in Division VIa. Probability profiles for short-term forecast. Removals are associated with mortality from all sources over and above M=0.2.**

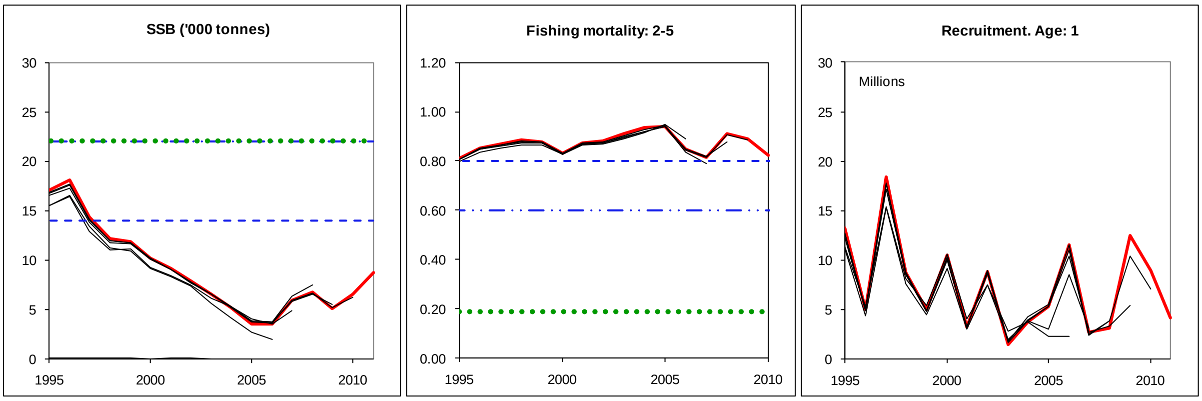



**Figure 3.2.20. Cod in Division VIa. Comparison of SSB, mean F (2–5) estimates and recruitment-at-age one produced by final run assessments between this year's assessment and assessments going back to 2001.**

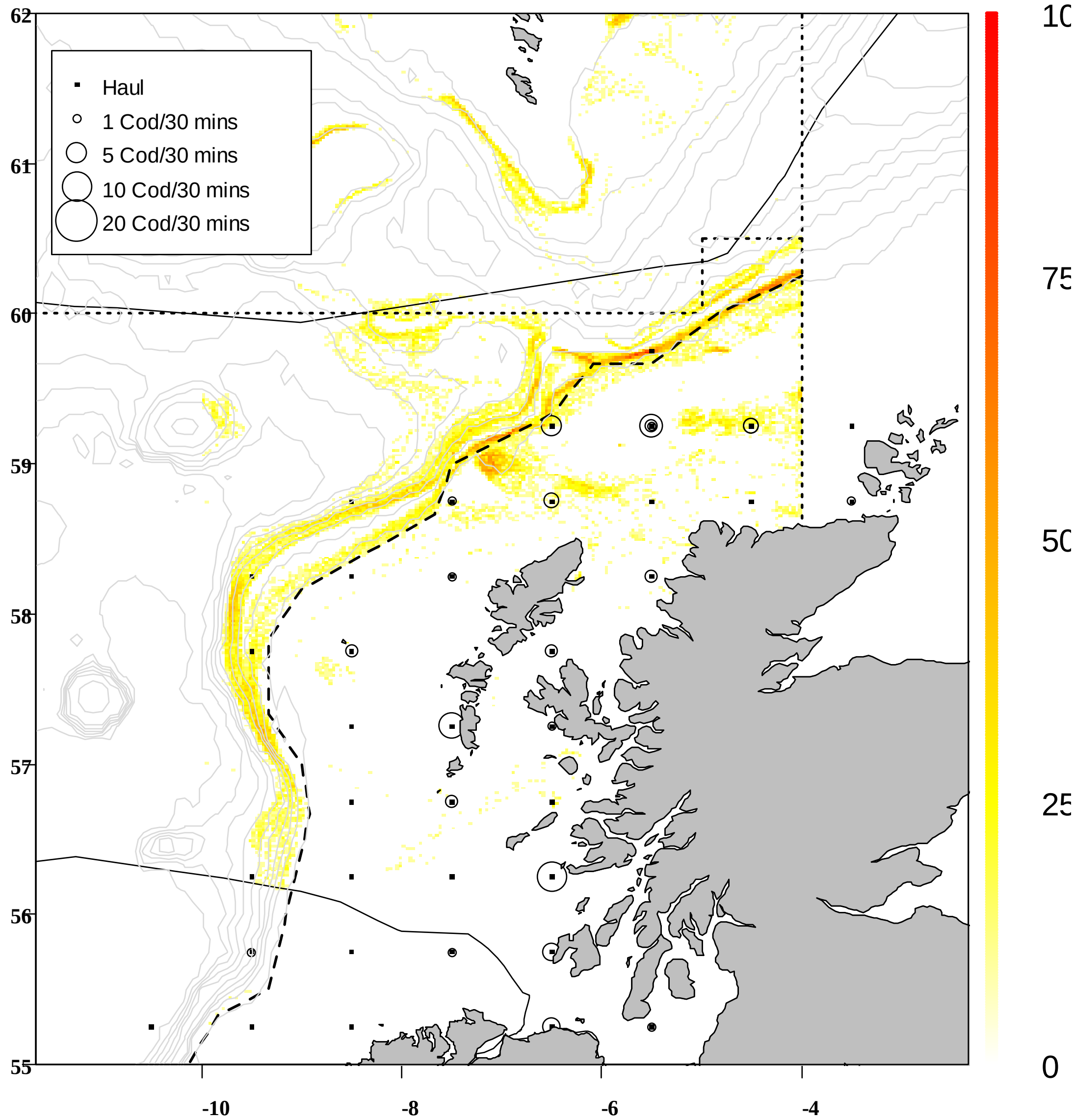



**Figure 3.2.21. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.**

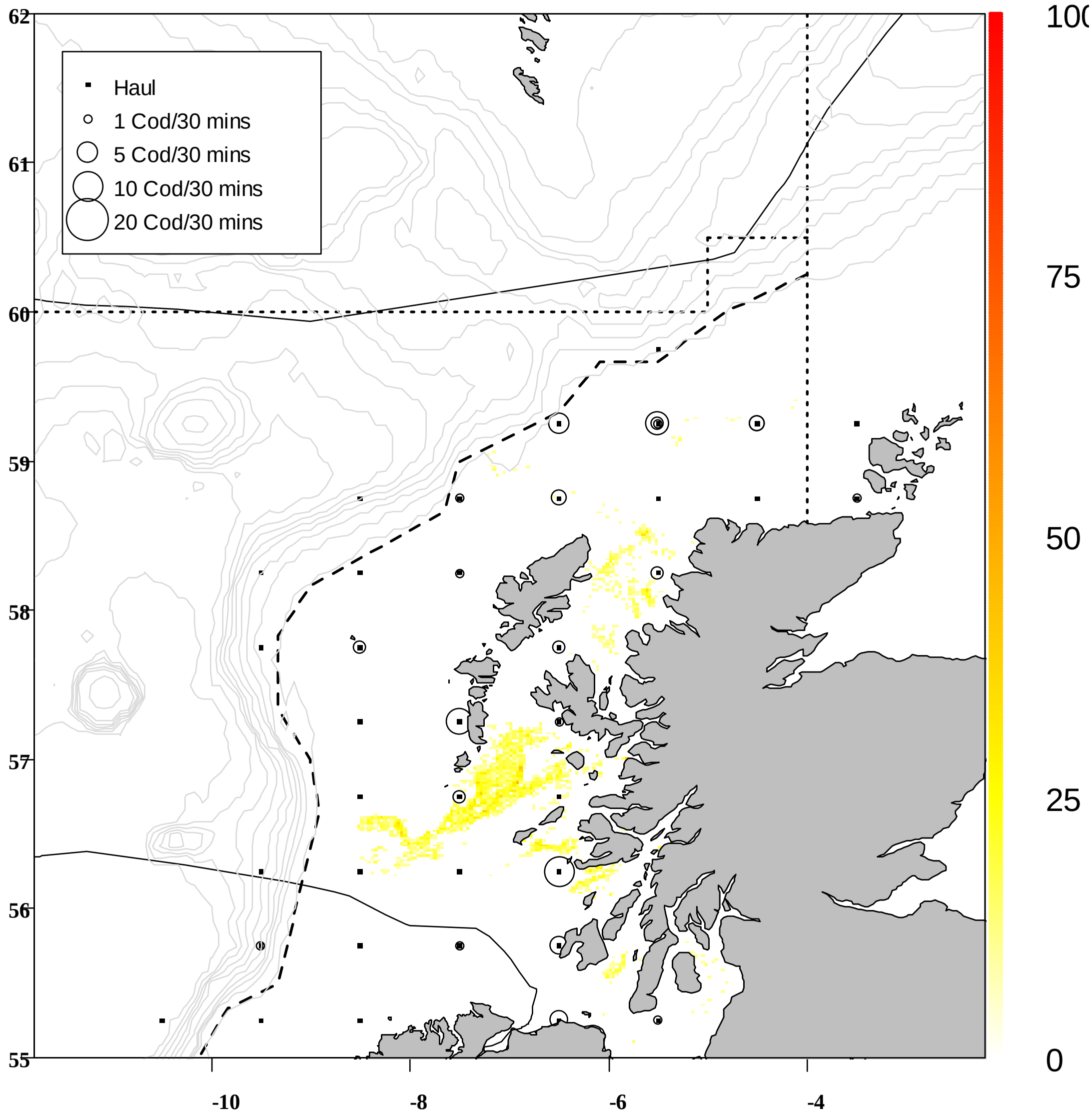



**Figure 3.2.22. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR2 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.**

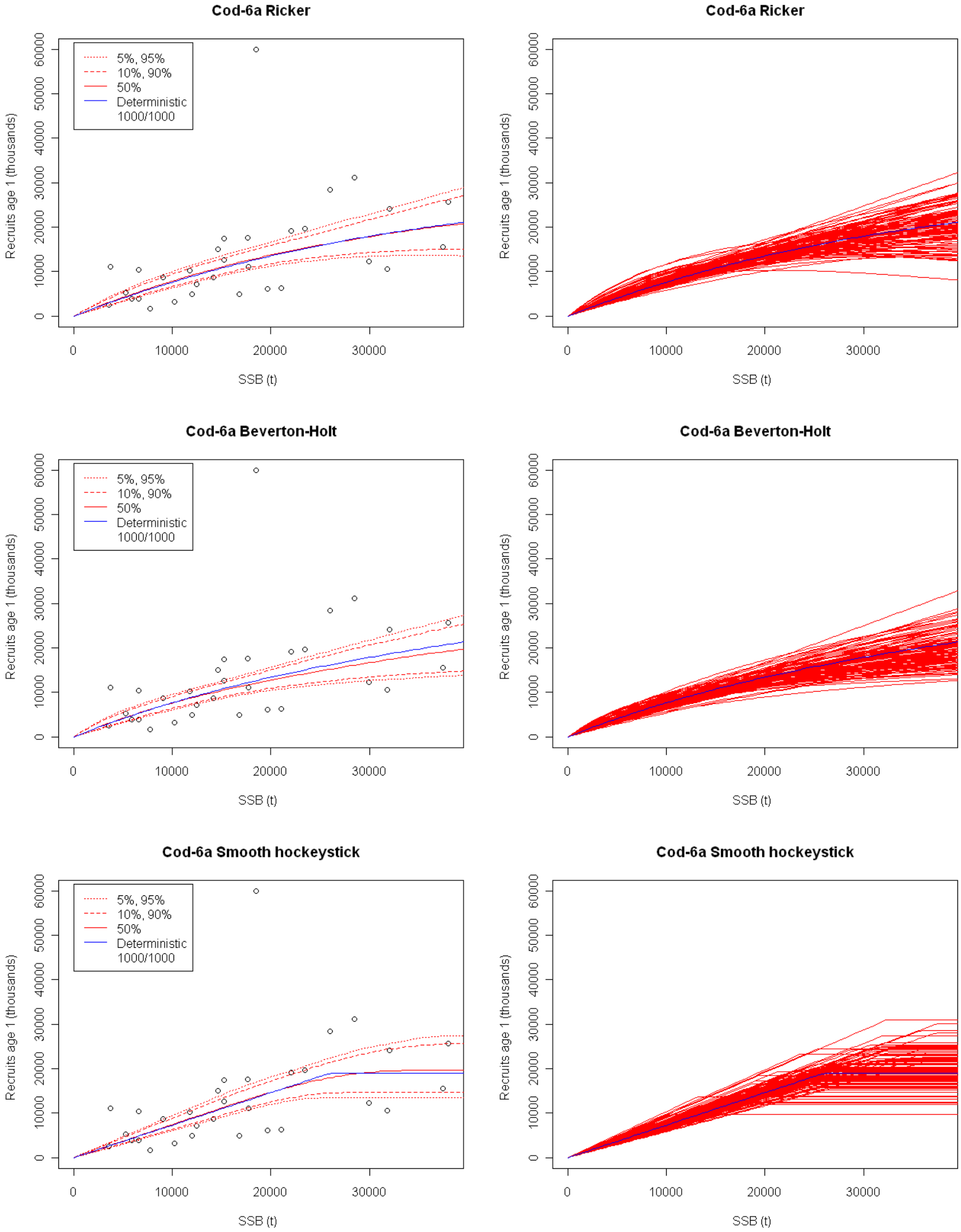



**Figure 3.2.23. Cod in Division VIa. Stock–recruit relationships fitted by srmsymc package. Models were fitted using 1000 MCMC resamples. Left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. The legends for each recruitment model show it was possible to converge on a value of $F_{MSY}$ and $F_{crash}$ for all 1000 iterations in each case.**

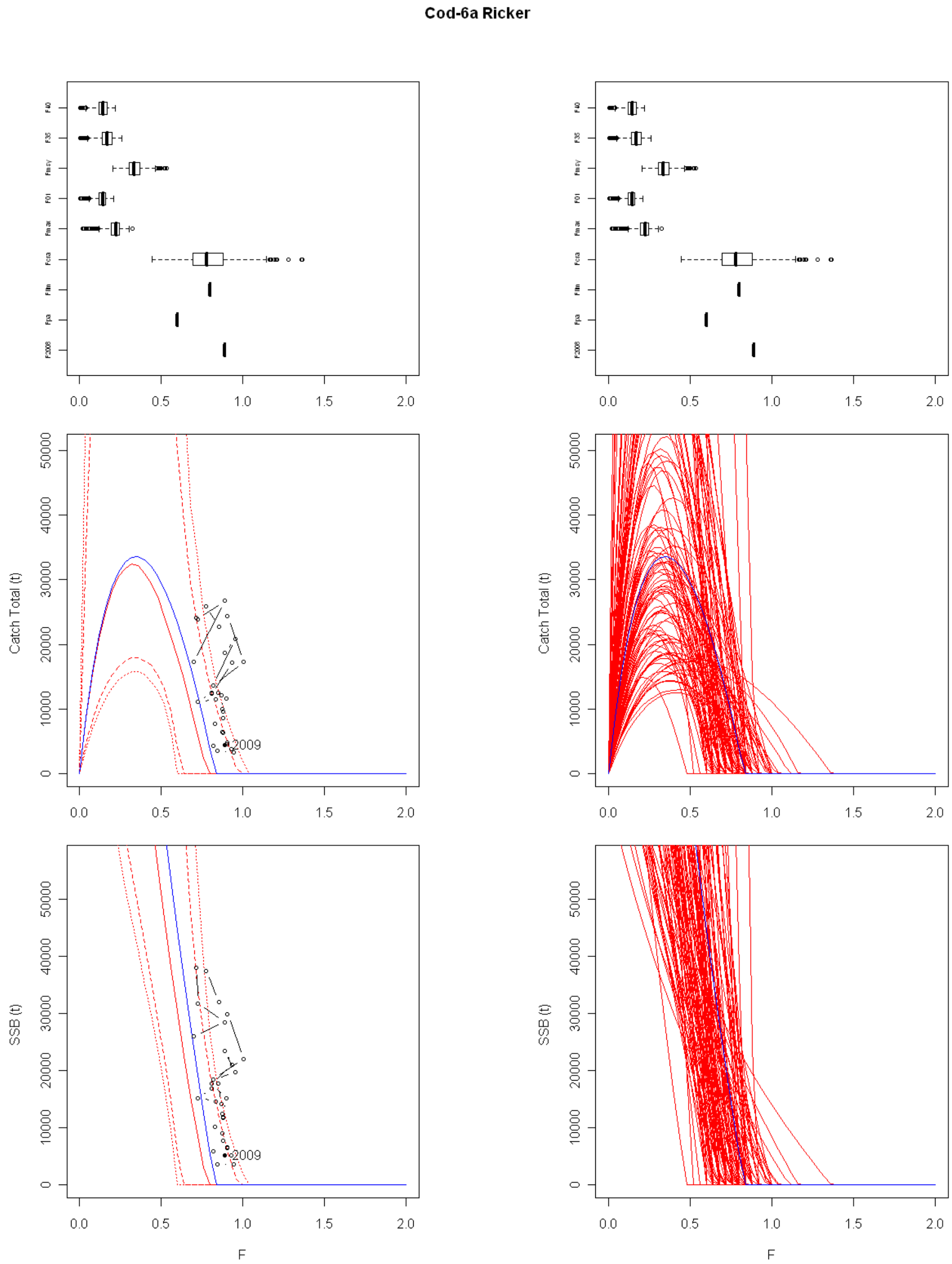



**Figure 3.2.24. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Ricker recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

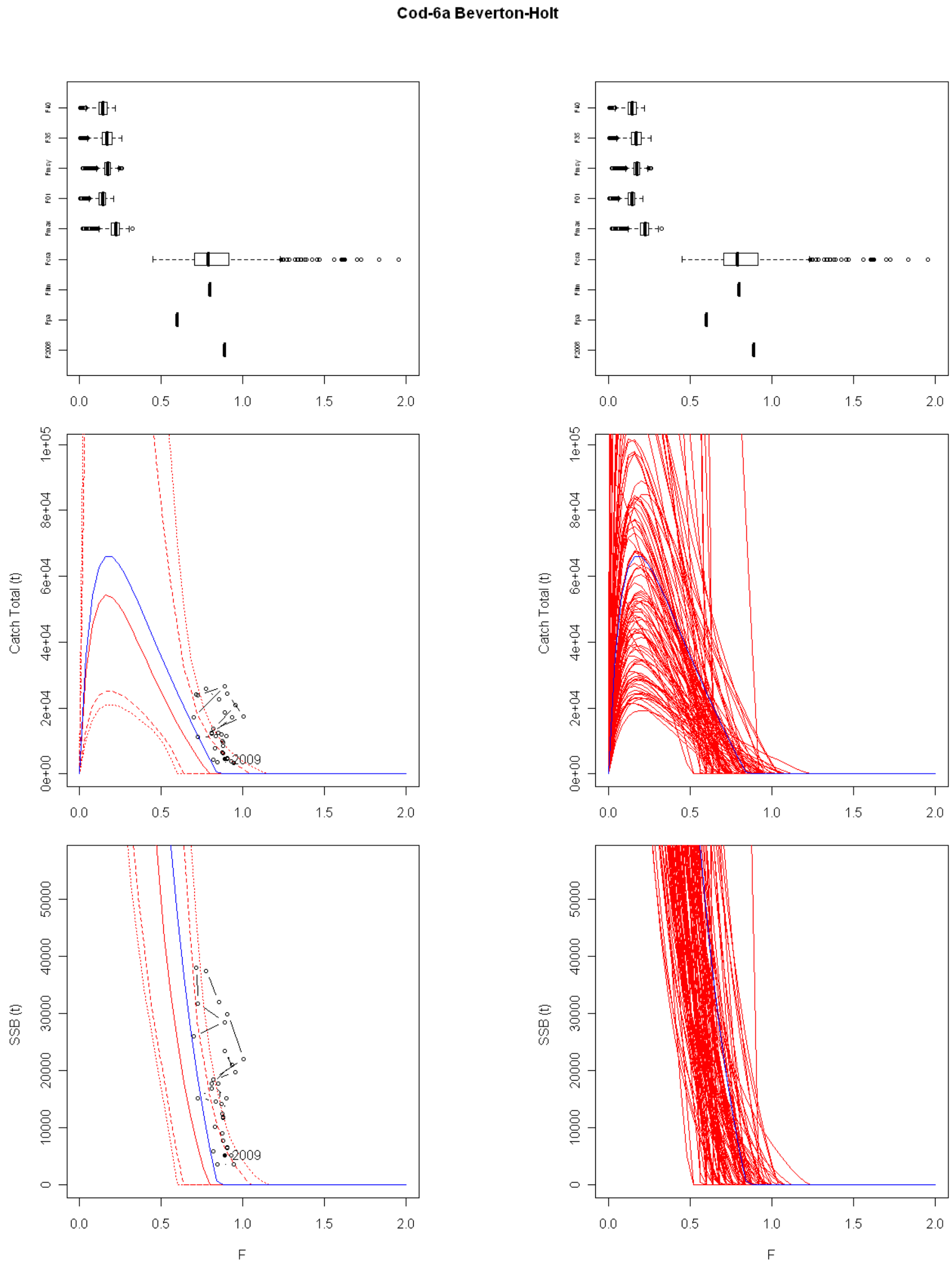



**Figure 3.2.25. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Beverton–Holt recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

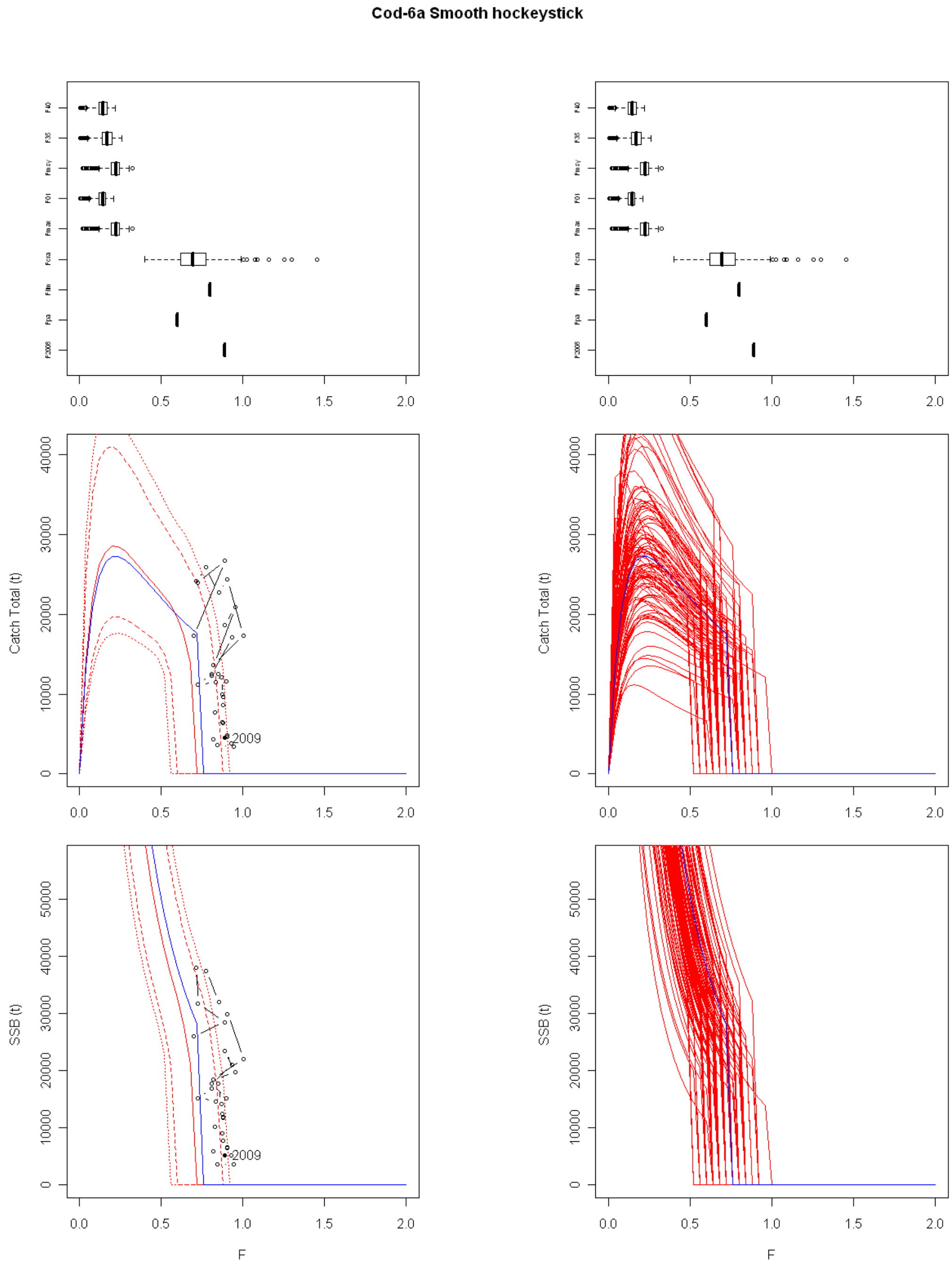



**Figure 3.2.26. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using smooth hockey-stick recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

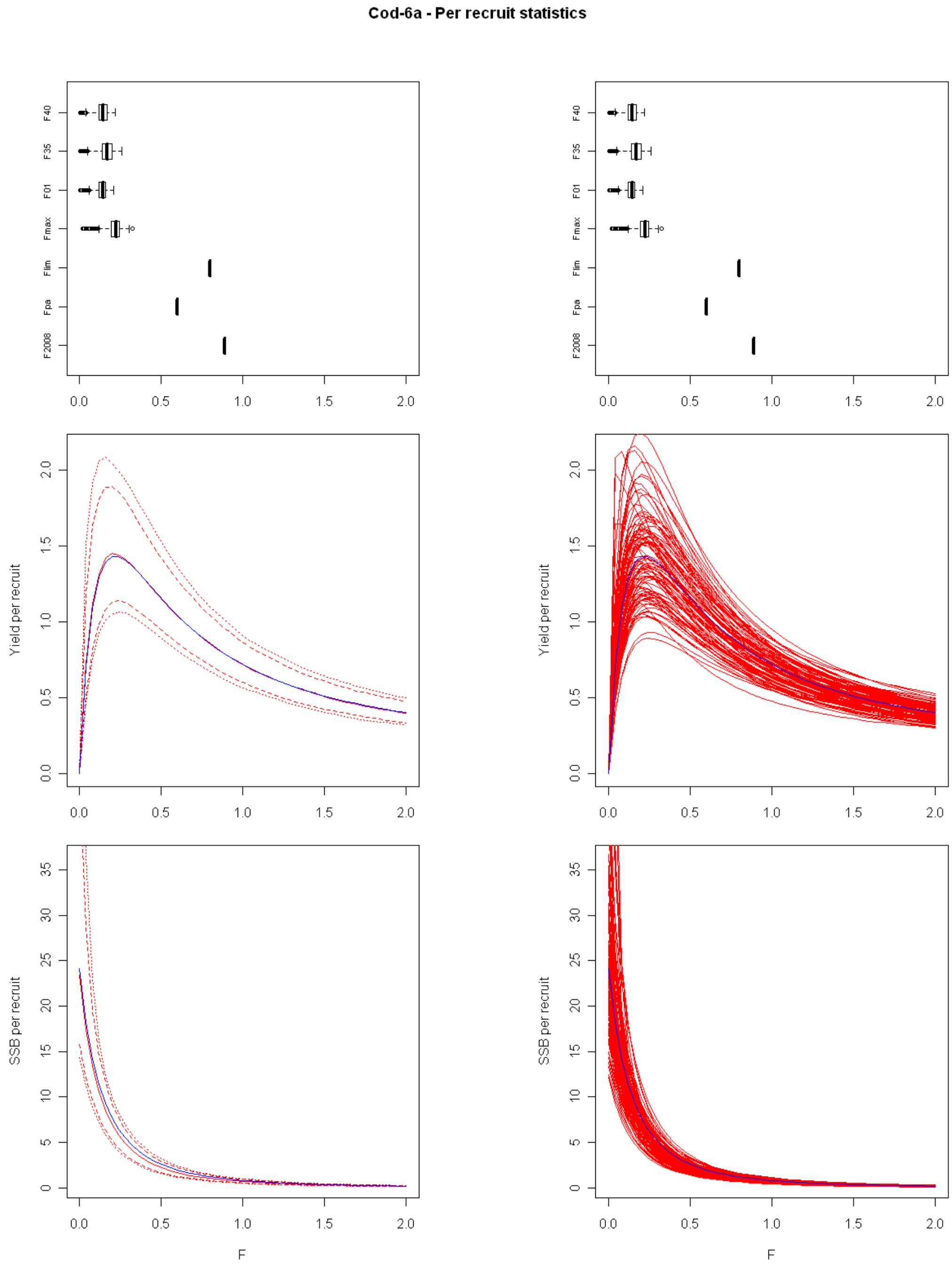



**Figure 3.2.27. Cod in Division VIa. srmsymc package. F reference points and yield-per-recruit and SSB per recruit against mortality. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

## 3.3 Haddock in Division VIa

### Type of assessment in 2011

The stock assessment of VIa haddock in 2011 is an update of last year's assessment with the TSA model, using catch data up to 1994 and tuning data from two Scottish groundfish surveys In 2011 the ScoGFS-WIBTS Q1 was undertaken using a new survey stratification, survey trawl groundgear and adjusted sweep lengths in waters >80 m. In this year's assessment catch data were also included for the period 2006–2010 as these were thought to be recent years where sufficiently reliable catch data were available. See Section 3.3.2 for further explanation.

### ICES advice applicable to 2010

The advice relating to the single-species exploitation boundary for 2010 was:

*"Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects:*

*The current fishing mortality (2009) is estimated to be 0.30, which is the rate expected to lead to high long-term yields and low risk of stock depletion.*

***MSY approach***

*Following the ICES MSY framework implies fishing mortality to be reduced to 0.14, resulting in human consumption landings of less than 1300 t in 2010. This is expected to lead to an SSB of 24 100 t in 2012.*

***EC MSY transition approach***

*Following the EC MSY transition implies fishing mortality to be increased to 0.36, resulting in human consumption landings of less than 3100 t in 2010. This is expected to lead to an SSB of 20 200 t in 2012.*

***Policy paper approach***

*Following the Policy Paper implies fishing mortality to be maintained at 0.30, resulting in human consumption landings of less than 2600 t in 2010. This is expected to lead to an SSB of 21 200 t in 2012.*

Exploitation boundaries in relation to precautionary limits:

*In the absence of fishing, the stock is expected to be rebuilt close to $B_{pa}$ in the short term."*

Following a request to evaluate a management plan for haddock in VIa:

*"ICES advises that a harvest rule with a target fishing mortality of 0.3 and a TAC constraint of ±15% is consistent with the precautionary approach (high probability of SSB being above $B_{lim}$ by 2015 and beyond). In addition, simulations suggest that this harvest rule has the best chance, among those tested, of producing a combination of low risk to biomass and high cumulative yield, thus it conforms with the goal of achieving long-term maximum sustainable yield from the stock.*

*The harvest rule was tested for several combinations of target fishing mortality (0.2, 0.3, 0.4) and interannual variation in TAC (±15%, ±20%, ±25%)."*

Note that the statement above refers to a management plan where, when SSB is below $B_{lim}$, the fishing mortality should be 0.1. Subsequent evaluations are being carried out for a management plan where the TAC constraint is ±25% whether above or below $B_{lim}$.

### ICES advice applicable to 2011

#### *MSY approach*

*Following the ICES MSY framework implies fishing mortality to be increased to 0.3, resulting in human consumption landings of less than 13 300 t in 2011. This is expected to lead to an SSB of 52 300 t in 2013.*

## 3.3.1 General

### Stock description and management units

A TAC relating to this stock is in place for EU and international waters of ICES management Areas Vb and VIa and the assessment is carried out using data from VIa. The basis for the stock assessment area is described in the Stock Annex.

The agreed minimum landing size for haddock in Division VIa is 30 cm. There is no formal management plan currently in place. Further regulations implemented for the west of Scotland, include technical measures associated with the cod recovery plan (EC regulation 1342/2008), emergency measures introduced with EC regulation 43/2009, The EU Registration of Buyers and Sellers regulation has reduced bias in commercial landings data The regulations are described in the overview section for this management area (Section 3.1).

The following table summarizes EC TACs applied for haddock in Division VIa during 2010.

| **Species:** | Haddock<br>*Melanogrammus aeglefinus* | **Zone:** | EU and international waters of Vb and VIa<br>(HAD/5BC6A.) |
|---|---|---|---|
| Belgium | 3 | | |
| Germany | 4 | | |
| France | 147 | | |
| Ireland | 438 | | |
| United Kingdom | 2 081 | | |
| EU | 2 673 | | |
| TAC | 2 673 | | Analytical TAC |

**Values are tonnes.**

The following table summarizes EC TACs applied for haddock in Division VIa during 2011.

| **Species:** Haddock *Melanogrammus aeglefinus* | | **Zone:** EU and international waters of Vb and VIa (HAD/5BC6A.) |
|---|---|---|
| Belgium | 2 | |
| Germany | 3 | |
| France | 111 | |
| Ireland | 328 | |
| United Kingdom | 1 561 | |
| EU | 2 005 | |
| TAC | 2 005 | Analytical TAC |

**Values are tonnes.**

#### Fishery in 2010

Official (reported) landings for each country participating in the fishery are given in Table 3.3.1. Vessels operating in the fishery are mainly Scottish and Irish and the amount of quota allocated to different countries reflects this.

Uptake of quota is given here and is calculated from the official landings as a proportion of the EC allocated quota for each country. The UK surpassed their allocated quota by ~16% in 2010, increasing the overall uptake in relation to 2009. Uptake of quota has generally been low in recent years (e.g. ~73% in 2006; ~51% in 2007; ~45% in 2008 and ~79% in 2009) but in 2010 there was an increase to ~109%. Discards data that are reported are dealt with in the following section.

| Country | TAC 2010 | Official landings* | % uptake of quota |
|---|---|---|---|
| Belgium | 3 | 0 | 0% |
| Germany | 4 | 1 | 25% |
| France | 147 | 88 | 60% |
| Ireland | 438 | 396 | 90% |
| UK | 2081 | 2414 | 116% |
| EC | 2673 | 2911 | 109% |

**Values of TAC (Total Allowable Catch) and landings are in tonnes.**

*** The official landings provided to the WG for 2010 are preliminary at time of writing in 2011.**

### 3.3.2 Data

An overview of the data that have been provided to the WG is given in Section 2, including sampling levels by country for this stock. The reliability of catch data for this stock was a concern for several years, due to issues such as misreporting or underreporting and associated unaccounted discarding. It became impossible to quantify the extent of unallocated removals, leading to the use at the 2006 meeting of a modified TSA assessment method which did not use catch data after 1994.

Recent changes in regulations and fleet behaviour have improved the quality of catch data, which is now thought to be more representative of the true catch. The UK Registration of Buyers and Sellers Regulations are likely to have reduced or largely eliminated underreported landings. Information from the Compliance section of Marine

Scotland suggests that approximately 435 tonnes of haddock were suspected of misreported out of Area VIa in 2010 (~18% of the officially reported UK(Scotland) landings). At the same time 246 tonnes were suspected of misreported in to Area VIa (~10% of the officially reported UK (Scotland) landings). The TAC in recent years was not restrictive; however this has not been the case in 2010.

Official landings as reported to ICES and estimated by the WG are provided in Table 3.3.1.

#### Catch-at-age data

Total catch-at-age data (landings and discards) are given in Table 3.3.2., while catch-at-age data and mean weights-at-age for each catch component (landings and discards) are given in Tables 3.3.3–3.3.7. The full available year and age range are given for completeness: however, it should be noted that commercial catch data before 1978 are not used in the assessment. As that was the initial year of the discard observer programme. The data collected from that year onwards is reliable allowing the split of total catch into landings and discards.

#### Discards

WG estimates of discards are based on data collected in the Scottish and Irish discard programmes; raised by weighted average to the level of the total international discards (Table 3.3.4.). Discards data from Scotland were raised from ten sampled trips in 2010, spread across the year. And the Irish were raised from nine trips.

#### Biological

##### *Weights-at-age*

The estimated weights-at-age for the total catch in Division VIa are given in Table 3.3.5. These are calculated as weighted averages of the corresponding weights-at-age in landings and discards: the latter are given in Tables 3.3.6.and 3.3.7. Weights-at-age in the stock are assumed to be equal to the weights-at-age in the total catch, in the absence of a sufficiently long time-series of survey-based weight measurements. The weights-at-age time-series are also plotted in Figures 3.3.1–3.3.3. These show that weights-at-age in landings (and, by extension, catch and stock) for fish aged 4 and older have declined considerably over the last ~20 years. The weights-at-age of younger fish (age 1 and 2) have decreased in 2010. Weights-at-age in discards are relatively constant but with a decrease in weight in 2010. The supplied data for fish weights-at-age 1 in 2010 in Irish landings was 365 g. This is far from the 2009 value (460 g) but again it is higher than the Scottish 2010 value (245 g). According to Dickey-Collas *et al*., 2003, haddock tends to grow faster in the southern area of Division VIa, where the mean temperature is higher than the west of Scotland(1°C less than the Irish Sea and 2°C less than Celtic Sea) being these the areas were the Irish fishing vessels are most likely to operate.

##### *Natural mortality and maturity*

Natural mortality was assumed to be 0.2 for all ages and years, and maturity was assumed to be as follows:

| Age | 1 | 2 | 3+ |
|---|---|---|---|
| Proportion mature | 0.00 | 0.57 | 1.0 |

Proportions of *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

#### Surveys

##### *Research vessel surveys*

Four research-vessel survey-series are available for the assessment of haddock in Division VIa as given in the following table:

| Survey | Years available | Ages available | Ages used |
|---|---|---|---|
| ScoGFS-WIBTS Q1 | 1985–2011 | 1–8 | 1–7 |
| ScoGFS-WIBTS Q4 | 1996–2009 | 0–7 | 1–7 |
| IGFS-WIBTS-Q4 | 1993–2002 | 0–8 | - |
| New IGFS-WIBTS-Q4 | 2003–2010 | 0–10 | - |

The reports of the 2006 meeting of the WG (WGNSDS 2006) and the 2007 meeting of the IBTS WG (IBTSWG 2007) explored available survey data in detail. Both ScoGFS-WIBTS-Q1 and Q4 were first accepted for use in the 2006 assessment, and this practice has been continued in subsequent years. The IGFS-WIBTS-Q4 series was not considered further due to problems with internal consistency (ICES-WGNSDS 2006). The new IGFS-WIBTS-Q4 series has eight years of data and can be considered for tuning purposes at the next benchmark assessment.

All survey series available for tuning the assessment are given in Table 3.3.8, with the data that were used in the final assessment indicated in bold type. Plots of the spatial distribution of the ScoGFS-WIBTS-Q1 and Q4 survey mean catch rates per ICES statistical rectangle by age class are given in the Stock Annex. Commercial cpue.

##### *Commercial catch-effort series*

The available commercial effort and lpue data for this stock are indicated in the Stock Annex.

### 3.3.3 Historical stock development

The model used for this assessment is the state space model TSA, with data from two research vessel surveys (1985–2011) and with catch data included 1978–1994 and 2006–2010, corresponding to the time periods when catch data are thought to be reliable. The model is run using R. Outputs from the TSA assessment are shown in Figures 3.3.4–3.3.10 and Tables 3.3.10–3.3.14.

The reliability of landings data for haddock was a concern for several years, and because it was not possible to quantify the extent of unallocated removals, this lead, at the 2006 meeting, to the use of a modified TSA assessment method which did not use catch data after 1994. This remained the accepted assessment method for the 2007–2009 meetings. In 2010, measurable improvements in the reliability of catch data (Section 3.3.2) led the WG to question the continued discrepancy between the prediction of landings by the model and the reported catches after 2005. Furthermore, while the assessment was primarily survey based, the uncertainty around estimates of F was appreciable, and the estimate was not coming down in years when evidence of reduced effort indicated a probable reduction in F.

The re-inclusion of catch data has been implemented with TSA in other assessments for which this model is used. For example, catch data were re-included in the assessment of VIa cod at the 1997 meeting of the Working Group for the Assessment of Northern Shelf Demersal Stocks (WGNSDS, 1997). The catch data for cod were re-included in following assessments, but were removed again subsequently because of more recent concerns over reported landings for that stock. See Section 3.2.

#### Final update assessment

The assessment in 2011 was an update, including data indicated in the table below, which summarizes the data ranges used in recent assessments.

| Data | 2006 assessment | 2007 assessment | 2008 assessment | 2009 assessment | 2010 assessment | 2011 assessment |
|---|---|---|---|---|---|---|
| Catch data | Years: 1978–1994 Ages: 1–8+ | Years: 1978–1994 Ages: 1–8+ | Years: 1978–1994 Ages: 1–8+ | Years: 1978–1994 Ages: 1–8+ | Years: 1978–1994 and 2006-2009 Ages: 1–8+ | Years: 1978–1994 and 2006-2010 Ages: 1–8+ |
| Survey: ScoGFS Q1 | Years: 1985–2006 Ages: 1–7 | Years: 1985–2007 Ages 1–7 | Years: 1985–2008 Ages 1–7 | Years: 1985–2009 Ages 1–7 | Years: 1985–2010 Ages 1–7 | Years: 1985–2011 Ages 1–7 |
| Survey: ScoGFS Q4 | Years: 1996–2005 Ages: 1–5 | Years: 1996–2006 Ages 1–7 | Years: 1996–2007 Ages 1–7 | Years: 1996–2008 Ages 1–7 | Years: 1996–2009 Ages 1–7 | Years: 1996–2009 Ages 1–7 |
| Survey: IGFS | Not used | Not used | Not used | Not used | Not used | Not used |

Table 3.3.9 shows the evolution of the corresponding TSA parameter estimates since 2003.

Standardized prediction errors from the assessment model are shown in Figures 3.3.5 (landings), 3.3.6 (discards), 3.3.7 (ScoGFS-WIBTS-Q1) and 3.3.8 (ScoGFS-WIBTS Q4). TSA is a state space model, and these prediction errors are an analogous (but not completely equivalent) diagnostic tool to residuals of fits from other stock assessment models. The small, negative prediction errors for the landings and discards in the period 2006–2010 at various ages show that the model is predicting landings and discards to be slightly higher than observed data. Generally the prediction errors do not show a pattern persisting for longer than five years. The only cases where this occurs are for age 1 of the ScoGFS-WIBTS-Q1 index (Figure 3.3.7). The magnitude of these (age 1 ScoGFS) prediction errors is relatively small (ranging from -0.9 to -1.6). A similar, inconsequential, pattern is seen in the fit to the ScoGFS-WIBTS-Q4 index (Figure 3.3.8). None of the prediction errors are of a magnitude or show a pattern which would invalidate the model fit. Negative prediction errors in the survey indices at age 1 indicate lower than expected recruitments in recent years.

Previous assessments have applied a down-weighting to certain data points, based on the TSA prediction errors. These are described here. A notable prediction error occurred in the ScoGFS-WIBTS Q1 in 2011 at age 6 This was due to a large index value in this survey year at that the model setting, $q_{catch}(age=6, year=2011)$ was altered (multiplied by 3.0 in the appropriate model settings) in order to decrease the influence of this extreme value (an adjustment recommended in Fryer, 2001 which has been applied previously to several age/year data points). A prediction error from the ScoGFS-WIBTS Q1 in 2009 (age 4) was also down weighted according to the same procedure. Three other points were down-weighted from the ScoGFS-WIBTS Q1 for the assessment 2011. 1993 age 2, 1995 age 7, 2002 age 3 (all of them were multiplied by 3.0).

There is a poor relationship between stock size (SSB) and recruitment for this stock, with large values for recruitment possible at small stock sizes and small recruitments possible at large stock sizes (Figure 3.3.9). The TSA stock–recruit plot is shown in Figure 3.3.9.

Estimated and observed discard rates (proportions-at-age) are shown in Figure 3.3.10. The discard model fits are good for the years when catch data are included (1978–1994 and 2006–2010) and also most other years. The observed proportions deviate slightly in 2003–2005.

TSA estimates a discard ogive for every year. However, when there are no catch data, the estimated ogive will simply be some weighted average of the discard ogives in neighbouring years. So, when several years of catch data are omitted, the estimated discard ogives in this period will hardly change at all because there are no new data included from which to produce a new estimate. From 2006, when the catch data are re-included, the model is able to much better estimate the discard ogive (Figure 3.3.10).

#### Retrospective analysis

Most retrospective bias in this stock assessment (see Figure 3.3.11) is thought to be caused by mismatch between catch and survey data (WGMG 2007), and as only survey data are used in the TSA model between 1995 and 2005 the retrospective pattern observed in F is not surprising.

Comparison with previous year's assessment

There was a minor revision of the discard and landings data for 2009 due to an update of the French data This resulted in an overall difference of an additional 8 tonnes in discards and 12 tonnes in landings.

The 2010 VIa haddock assessment estimated F in 2009 at 0.30 and SSB (January 1st 2009) at 16 818 tonnes. The current assessment has revised these figures, to a fishing mortality of 0.22 in 2009 and an SSB (January 2009) as 22 302 tonnes (33% increase). Recruitment in 2009 has been revised from 7.9 million to 21.9 million (~177% increase).

The estimate of SSB in January 2010 from this assessment is 19 004 tonnes with a standard error of 2009 tonnes (~11%). Last year's assessment put this figure at 13 377 tonnes.

The current assessment's estimate of SSB (for January 2011) is 29 508 tonnes. The short-term forecast from last year's assessment predicted SSB in 2011 to be at 13 600 tonnes. This is a difference of 15 908 tonnes (~117% increase in the estimate).

#### State of the stock

The state of the stock is summarized in Figure 3.3.4 and Table 3.3.14.

The final estimates for the stock in 2010 are:

$F_{(2\text{-}6)}$ = 0.23

SSB = 19 004 t

Based on the most recent estimates of SSB in 2011 (29 508 tonnes, >$B_{lim,}$ ) ICES classifies the stock as being at full reproductive capacity.

Based on the most recent estimate of fishing mortality in 2010 (0.23, <$F_{pa}$) ICES classifies the stock as being harvested sustainably.

Based on fishing mortality being estimated to be less that $F_{MSYHCR}$ and SSB greater than MSY $B_{trigger}$; ICES in relation to the MSY reference, classifies the stock as being appropriate.

Summaries from the final assessment, including, total removals, landings, discards, recruitment, mean F and SSB are given in Figure 3.3.4, while corresponding estimates and standard errors are presented in Tables 3.3.10 and 3.3.11 (population abundance), Tables 3.3.12 and 3.3.13 (fishing mortality), and Table 3.3.14 (stock summary). Mean $F_{2\text{-}6}$ is estimated to have risen to just above $F_{pa}$ (0.5) during 2003–2007, subsequently falling below 0.5 in 2008, and remaining below $F_{pa}$ since. A sequence of low recruitments led to a fall in SSB from the peak in 2003. The assessment estimates that SSB has been below $B_{pa}$ since 2005. The most recent estimate of recruitment, from the 2011 Quarter 1 Scottish Groundfish survey (the 2009 year class) is highest in the last nine years and above the long-term average.

Uncertainty in fitted and observed catches increases from 1995–2005 (Figure 3.3.4), which is the period when the landings and discards are excluded from the model and the survey data are used for estimation. Catch data tend to have more precision than survey data and although both survey used in the assessment have been seen to track year-class strength well, the survey data are more "noisy" (show greater variability) than the catch data. Therefore, when the catch is included in the later part of the time-series (2006–2010) the confidence intervals of the estimates are seen to reduce.

The difference between observed and predicted catch represents unaccounted removals, amounting to about 10% of the landings by 2006–2010. The reported catch in 2010 is within the bounds of error of the estimated catch. This is thought to reflect beneficial effects of management regulations and changes in fleet behaviour since 2006, and is supported by anecdotal information from the fishing industry. For example, there has been great effort reduction by the whitefish otter trawler fleet in Division VIa and the TAC does not appear to be restrictive for this fishery, diminishing the incentive to underreport landings. Information from the Compliance section of Marine Scotland put estimates of misreporting out and in of VIa at approximately 680 tonnes in 2010 (table below). The misreporting seems to occur mainly between Areas VIa and Iva but with the contribution of other areas as well.

| Recorded in | IVa (EU) | VIa (EU) | VIa (EU) | VIa (EU) | VIa (EU) | VIa (EU) | VIb (EU) | VIIa (EU) |
|---|---|---|---|---|---|---|---|---|
| Suspected of | VIa (EU) | IVa (EU) | IVa (NEZ) | IVb (EU) | Vb (FEZ) | VIb (EU) | VIa (EU) | VIa (EU) |
| Tonnes | 219.3 | 239.8 | 12.8 | 66.0 | 89.8 | 26.1 | 23.0 | 3.7 |

### 3.3.4 Short-term projections

#### Recruitment estimates

The TSA assessment model provides estimates of recruitment for the forecast years 2011 and 2012. The value for 2010 (that is, the 2010 year class at age 1) is based largely on the ScoGFS –WIBTS-Q1 datum for 2011 (along with a degree of time-series smoothing), and as it is based on observations it is appropriate to use it in the forecast. The value for 2012 (that is, the 2011 year class at age 1) is not generated directly by data, but rather the underlying Ricker stock–recruit model that is included by TSA (Figure 3.3.9) as part of the overall model fit. As with the assessment of last year, a long-term (1978–2010) geometric mean is used for subsequent years (2013). The recruitment values used in the forecast are given in the following table:

| Year | TSA | GM (78-10) |
|---|---|---|
| 2011 | 5532 (~ ScoGFS) | |
| 2012 | 116 300 (Ricker) | |
| 2013 | - | 83 400 |

There is agreement in trends between the TSA-generated recruitment estimates, and the indices from the survey (see Figure 3.3.12).

TSA produces short-term forecasts as part of every standard model run. The model will also forecast fishing mortality rates. It does so by iterating forward the time-series model that had been fitted to historical data. These forecast mortalities therefore retain the time-series characteristics of the preceding data. Although the TSA estimates are likely to follow a pattern of damped oscillation towards an eventual steady state, the WG preferred to use standard tools (i.e. MFDP) as the basis for the forecast. The procedure used instead of TSA's built in procedure is described below.

The time-series at age of fishing mortality estimate is shown in Figure 3.3.13, along with the mean F over ages 2–6. As with last year's assessment, a three-year mean fishing mortality selection pattern was used in the forecast. Figure 3.3.14 compares a simple three-year mean, the most recent estimate (2010), and TSA-generated selection patterns.

The forecasts presented in this Section have been given as forecasts of total removals, split subsequently into removals due to landings, discards and unallocated removals (other than those assumed to be due to current estimates of natural mortality) respectively. As highlighted previously, the assessment is survey-based from 1995 to 2005 and can only estimate total removals during this period. The difference between reported and estimated catches represents unallocated removals, reflecting our uncertainty in natural mortality and a certain amount of likely area-misreporting. In the period when the assessment is survey based only the estimated amount of unallocated removals is appreciable. The 1999 year class of haddock was strong, and survey estimates of that year class would have contributed to high model estimates of predicted catch between 2002 and 2005 (Figure 3.3.4).

The WG considered that the most appropriate level of discarding to use in the forecast was a mean of the last three years. It is not possible to know what discarding practices will be in the immediate future, although since the incoming of the 2009 year class has been estimated to be at appreciable numbers by the Scottish and Irish groundfish surveys in Q4 2009 and by the Scottish groundfish survey in Q1 2010 led to an increase in discard numbers going from ~1.8 thousand to ~2.8 thousand tonnes in 2010. The discard behaviour in the last three years changed in largely due to the 2009 large year class which made haddock more abundant and part due to the poor selectivity in the fleet component fishing for *Nephrops* (TR2). The total catch for haddock is estimated to be 5830 tonnes; of these 51% are discards. Splitting discards by fleet shows that TR2 vessels are responsible for ~88% of all discards while landing only 21 tonnes, less than 1% of total landings (2882 tonnes).

Nevertheless, taking a 3-year mean is still the most unbiased approach. For the short-term forecast, the assumption is that this input F remains constant.

The final key issue for the forecast is that of weights-at-age, and in particular, the slow growth observed in recent year classes. Figure 3.3.15 demonstrates this with linear models fitted to cohort-based mean weights-at-age data. A number of recent year classes appear to be growing more slowly than has been the case in the more distant past. As with last year, linear models were used as the basis for predictions for those cohorts with sufficient data (Table 3.3.15), with the small change that the models were fit using data from age 0–8+, as this slightly improved precision (Jaworski, WD12).

Short-term projections are presented here for reference only; they are not considered reliable because recruitment of haddock is characterized by sporadic events, therefore the use of geometric mean recruitment (1978–2010) for 2011–2013 provides a very uncertain estimate of future recruitment.

Short-term projections were performed using MFDP1a software.

Results of the forecast at *status quo F* are summarized in the following table:

| Year | Removals (000 t) | SSB (000 t) |
|---|---|---|
| 2011 | 5.83 | 29.5 |
| 2012 | 3.7 | 37.3 |
| 2013 | - | 46.9 |

At the *status quo* rate of removals, and given assumptions about growth and recruitment, the most recent estimate of SSB (2011) is greater than $B_{lim}$ and is forecast to increase in 2012 and 2013, primarily due to the most recent estimate of recruitment in 2010 being relatively high compared to the last nine years.

### 3.3.5 MSY evaluations

No estimates of MSY reference points were presented at the WG this year.

#### Biological reference points

ICES has defined the following reference points for this stock.

| Reference point | Technical basis |
|---|---|
| $B_{pa}$ = 30 000 t | $B_{lim}$*1.4 |
| $B_{lim}$ = 22 000 t | Lowest observed SSB when reference point was establised (1998) |
| $F_{pa}$ = 0.5 | High probablity of avoiding SSB falling below $B_{pa}$ in the long term |
| $F_{lim}$ | Not defined |

### 3.3.6 Management plans

There is no management plan currently in place for this stock. ICES has evaluated a proposed management plan, the details of which can be found at:

http://www.ices.dk/committe/acom/comwork/report/2010/Special%20Requests/EC%20haddock%20management%20plan.pdf

### 3.3.7 Uncertainties and bias in assessment and forecast

**Quality of the assessment**

*Landings and discards*

Quotas for haddock in Division VIa appear to have started to become restrictive in or around 1995. Anecdotal evidence suggests that these and other restrictive management measures led to increasing unreliability of landings data from the commercial fleets prosecuting the fishery from 1995 to 2005. The approach taken by this WG from 2006 onwards was to assess the stock using a modified TSA model which did not include catch data from 1995 onwards, and which thus modelled removals rather than catches. During the period when the catch is not included (1994–2005) the discard ogives estimated by the model are weighted averages of those of neighbouring years. This results in little change in the estimated discard ogive in the years when the catch is excluded and an observable discrepancy between the model's discard ogive and the reported discards proportions in 2003–2005.

*Effort*

Currently commercial cpue or lpue data cannot be used in the assessment with any confidence. The assessment is therefore primarily survey-based, with landings and discards data used prior to 1995.

*Surveys*

A survey-based assessment can only be as good as the surveys on which it is based. The Scottish groundfish survey-series appear to have good internal consistency and to track cohorts reasonably well, with the exception of a period during the mid-1990s. Concerns remain over the apparent differences in catchability of young fish between the Scottish and Irish components of IBTS (ICES-IBTSWG 2007). These concerns will extend in the to the GFS WCIBTS Q1 as this survey adopted the same gear and design as the Irish. Any survey is likely to become less reliable when stock abundance declines, and this issue needs to be revisited in the near future for haddock and many other stocks.

This assessment is survey based for the years 1995–2005. Re-including catch data for 2006–2010 has resulted in narrower confidence intervals for estimates of F, SSB, and catch components (landings, discards and total removals). Some uncertainty remains over the unallocated component of removals and how this could be divided between removals caused by natural mortality and removals related to fishing (for example, escape mortality and area misreporting).

For 2011 the rig and sampling design of the ScoGFS-WIBTS-Q1 survey was changed. A new groundgear capable of tackling challenging terrain was introduced broadly modelled around the rig used by Ireland for the IGFS-WIBTS-Q4. The move to a more robust groundgear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4) as the previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year was considered a bias prone method for surveying. It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland. New survey strata were designed using cluster analysis on aggregated data from the previous ScoGFS-WIBTS-Q1 data (1999–2010) as well as the data collected from a dedicated gadoid survey which took place during quarter 1 of 2010. Species considered were cod, haddock, whiting, saithe and hake. Cluster analysis yielded four specific clusters. Two additional strata were added; the Clyde area and the 'windsock' which is an area that has been designated as a recovery zone since 2002 and has therefore experienced no mobile gear exploitation during this time. Each individual polygon was treated as a separate stratum and the number of survey stations for each was allocated according to polygon size and the variability of indices within each stratum. Strata were weighted by surface area to build the final indices. Also, The ScoGFS-WIBTS-Q4 did not take place in 2010. However, due to the introduction of catch-at-age data this has less affect on the quality of the assessment than previously when the recent catch was excluded.

*Weights-at-age*

In this assessment, simple linear growth models have been fitted to cohort weights-at-age data and used to generate weights-at-age in the forecast. These models fit reasonably well, but this approach is quite simplistic and may be missing important growth characteristics such as variable growth within a cohort. This may lead to greater uncertainty in the forecast.

*Model formulation*

Models such as the modified TSA used this year, based largely on survey data, are becoming the *de facto* standard in several ICES assessments for which problems have existed with commercial catch data (see this report, and also WGNSSK 2006). Other examples include BADAPT and SURBA. While these types of models are essential in order to address data problems, it needs to be borne in mind that there are two main problems with such approaches. Firstly, survey data are based on far fewer samples, and are therefore more variable than catch data. It is therefore likely that precision is sacrificed to reduce bias. Secondly, a survey-based assessment estimates removals from the stock and total mortality, rather than landings and fishing mortality, and is therefore more difficult to use as the basis of quota advice than corresponding catch-based approaches. It is therefore thought to be appropriate to re-include catch data when they become more reliable, and investigations have indicated that this has been the case in the years 2006–2010.

*Stock connectivity*

There is uncertainty concerning the stock definition and hence the degree of connectivity between the VIa haddock stock and the North Sea haddock stock. Since these stocks are currently assessed separately, it is possible that the two stock assessments are both affected by uncertainties in catch data relating to area misreporting.

### 3.3.8 Recommendations for next benchmark

Some ways of addressing these issues are proposed here. All aspects are considered important and the proposed time frame would be to work on these in order to prepare for the next benchmark. Continuing the work on management plan development is also important.

*Landings and discards*

There should be a full analysis of the precision and bias of catch-at-age data. Although catch data between 2006–2010 are thought to represent a large proportion of the true catch, further analysis would help to put a clearer estimate on the uncertainty of this. Measures such as the UK Registration of Buyers and Sellers legislation seem to have greatly improved the reliability of commercial landings data for the last three years. Also, the landings misreporting; in, out and within Area VIa should be addressed in the next benchmark and assess their impact in the assessment.

#### *Effort*

A VMS-based analysis of lpue could help to address the concern that currently commercial cpue or lpue data cannot be used in the assessment. With the increased requirement for vessels to operate with VMS it is likely that the quality of effort data will improve. This will lead to an improved time-series of effort data in future but still leaves the uncertainties regarding the earlier years in the time-series.

#### *Surveys*

There are now seven years of data from the IGFS-WIBTS-Q4 and should be evaluated at the next benchmark for this stock Despite of not being currently used in the assessment, this survey was used as an index to corroborate the strength of the 2009 year class. Also due to the lack of the ScoGFS-WIBTS Q4 2010 survey it would assume a great importance the introduction of the IGFS survey into the assessment. Figure 3.1.16 shows the indices of all three surveys in a comparison plot. These seem to agree but further investigation is necessary before its introduction in the assessment.

#### *Weights-at-age*

The growth characteristics of this haddock stock are very variable, and seem to be strongly driven by cohort effects rather than year effects: that is, early life-history events determine the subsequent growth potential of each cohort. Work is underway at Marine Scotland (Aberdeen) and elsewhere to develop improved models of growth, and it is hoped that these will improve stock forecasts in future. Consideration of using stock weights from the survey, instead of the estimated weights-at-age could also be addressed at a benchmark assessment.

#### *Other modelling*

Growth modelling could help with forecasts of mean weights-at-age. It may also be of interest to use bioeconomic models to address questions to do with feedbacks between quota, uptake of quota and strong drivers of quota uptake and fishers' behaviour, for example, fuel price.

Other assessment models could be considered where information from the age structure of the catch data could be incorporated in the assessment for the years where the catch data are currently excluded (1995–2005).

### 3.3.9 Management considerations

This stock is at a low level of biomass, but a good recruitment (age 1) in 2010 is moving into the population and is estimated to elevate the biomass to more safe levels. An agreed long-term management plan, which takes into account the recruitment characteristics of this stock, has been evaluated by ICES and at this point is waiting to be signed off.

Discard rates, in recent years have been high, and in 2010 they represented 51% of the total catch. The majority of these discards ~88% (2592 tonnes) happen in the *Nephrops* fishery landing only 21 tonnes, which shows having a poor selectivity for young haddock. Any measure to reduce discarding and to improve the fishing pattern should be actively encouraged. Such measures should include the adoption of a sorting grid as well as appropriately located square mesh panels.

The expansion of the Catch Quota scheme in the North Sea from 17 vessels in 2010 to 25 vessels in 2011 and still with potential to grow might during the year "force" some vessels to redirect their effort to VIa or VIb. Vessels within this scheme are not allowed to fish in the North Sea if they reach the annual cod quota, but as an alternative they can fish west of the 4 degree line.

**Table 3.3.1. Haddock in Division VIa. Nominal landings[2], as officially reported to ICES and estimated by the WG.**

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 9 | - | 9 | 1 | 7 | 1 | - | 1 | 3 | 2 | 2 | 1 |
| Denmark | + | + | + | + | 1 | - | 1 | 1 | - | - | - | - |
| Faroe Islands | 13 | - | 1 | - | - | - | - | - | - | - | - | - |
| France | 1335 | 863 | 761 | 762 | 1132 | 753 | 671 | 455 | 270 | 394 | - | 282 |
| Germany | - | - | 1 | 2 | 9 | 19 | 14 | 2 | 1 | 1 | 2 | 1 |
| Germany | 4 | 15 | - | - | - | - | - | - | - | - | - | - |
| Ireland | 2171 | 773 | 710 | 700 | 911 | 746 | 1406 | 1399 | 1447 | 1352 | 1054 | 677 |
| Netherlands | - | - | - | - | - | - | - | - | - | - | - | - |
| Norway | 74 | 46 | 12 | 72 | 40 | 7 | 13 | 16 | 21 | 28 | 18 | 70 |
| Spain | - | - | - | - | - | - | 1 | - | - | 2 | 4 | + |
| UK – (E&W)3 | 235 | 164 | 137 | 132 | 155 | 254 | 322 | 448 | 493 | 458 | 315 | 199 |
| UK - England & Wales | - | - | - | - | - | - | - | - | - | - | - | - |
| UK – (Total) | - | - | - | - | - | - | - | - | - | - | - | - |
| UK - Scotland | 19 940 | 10 964 | 8434 | 5263 | 10 423 | 7421 | 10 367 | 10 790 | 10 352 | 12 125 | 8630 | 5933 |
| Un. Sov. Soc. Rep. | - | - | 59 | - | - | - | - | - | - | - | - | - |
| Total reported | 23 781 | 12 825 | 10 124 | 6932 | 12 678 | 9201 | 12 795 | 13 112 | 12 587 | 14 362 | 10 025 | 7163 |
| WG estimates | 16 691 | 10 141 | 10 557 | 11 351 | 19 068 | 14 272 | 12 368 | 13 466 | 12 883 | 14 401 | 10 464 | 6958 |

**1) Preliminary.**

**2) Includes Divisions Vb(EC) and VIb.**

**3) 1989–2005 N. Ireland included with England and Wales.**

**WG estimates refer to the sum-of-products of landings and weights-at-age provided to the WG, rather than the estimated removals produced in the final assessment.**

**Table 3.3.1. Continued. Haddock in Division VIa. Nominal landings[2], as officially reported to ICES and estimated by the WG.**

| Country | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 20101 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 2 | - | - | + | - | - | - | - | - | - |
| Denmark | - | - | + | + | - | - | - | - | - | - |
| Faroe Islands | - | - | - | 4 | - | 1 | 2 | + | - | 0 |
| France | 160 | 151 | 183 | 173 | 273 | 291 | 211 | 151 | 139 | 88 |
| Germany | 1 | - | - | - | 1 | 7 | - | 1 | - | - |
| Germany | - | - | - | - | - | - | - | - | - | 1 |
| Ireland | 744 | 672 | 497 | 194 | 152 | 526 | 759 | 879 | 297 | 396 |
| Netherlands | - | - | - | 1 | - | - | - | - | - | |
| Norway | 32 | 30 | 23 | 4 | 21 | 17 | 16 | 28 | 18 | 11 |
| Spain | 4 | 4 | 5 | - | 47 | 44 | 5 | 10 | 21 | - |
| UK – (E&W)3 | 201 | 237 | 107 | 93 | 42 | 19 | 193 | 32 | 14 | - |
| UK - England & Wales | - | - | - | - | - | - | - | - | - | - |
| UK – (Total) | - | - | - | - | - | - | - | - | - | - |
| UK - Scotland | 5886 | 5988 | 4582 | 2909 | 2025 | 4928 | 2587 | 1744 | 2366 | 2414 |
| Un. Sov. Soc. Rep. | - | - | - | - | - | - | - | - | - | - |
| Total reported | 7030 | 7082 | 5397 | 3378 | 2561 | 5833 | 3773 | 2845 | 2855 | 2911 |
| WG estimates | 6762 | 7115 | 5337 | 3874 | 3792 | 6266 | 3777 | 2848 | 2851 | 3016 |

**1) Preliminary.**

**2) Includes Divisions Vb(EC) and VIb.**

**3) 1989–2005 N. Ireland included with England and Wales.**

**WG estimates refer to the sum-of-products of landings and weights-at-age provided to the WG, rather than the estimated removals produced in the final assessment.**

**Table 3.3.2. Haddock in Division VIa. Total catch-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 451 | 1059 | 1341 | 72461 | 6816 | 294 | 274 | 174 | 11 |
| 1966 | 5953 | 1595 | 529 | 1113 | 47431 | 1926 | 64 | 32 | 57 |
| 1967 | 40122 | 19185 | 19332 | 951 | 265 | 24979 | 400 | 9 | 14 |
| 1968 | 27 | 129418 | 38393 | 3079 | 356 | 681 | 14063 | 727 | 43 |
| 1969 | 2742 | 84 | 160706 | 10260 | 1434 | 268 | 379 | 4576 | 191 |
| 1970 | 17189 | 6317 | 519 | 95114 | 2770 | 173 | 89 | 145 | 585 |
| 1971 | 6604 | 71481 | 3915 | 3328 | 79966 | 545 | 127 | 7 | 20 |
| 1972 | 14215 | 20713 | 85141 | 2718 | 2336 | 53823 | 504 | 50 | 19 |
| 1973 | 19589 | 47387 | 16907 | 19477 | 258 | 1222 | 33193 | 150 | 32 |
| 1974 | 63698 | 68837 | 11562 | 10757 | 6317 | 83 | 447 | 11463 | 104 |
| 1975 | 6849 | 179349 | 34957 | 3339 | 3350 | 1882 | 95 | 98 | 3454 |
| 1976 | 4227 | 24337 | 72330 | 15224 | 1588 | 1491 | 868 | 21 | 7 |
| 1977 | 4552 | 13109 | 3468 | 35948 | 5705 | 680 | 495 | 308 | 28 |
| 1978 | 57 | 15942 | 2095 | 971 | 24357 | 2938 | 351 | 247 | 338 |
| 1979 | 5697 | 70070 | 17282 | 1865 | 470 | 9863 | 833 | 114 | 145 |
| 1980 | 13 | 22729 | 21927 | 5636 | 922 | 143 | 3082 | 229 | 22 |
| 1981 | 764 | 251 | 83911 | 20697 | 1768 | 194 | 39 | 822 | 39 |
| 1982 | 136 | 15492 | 5019 | 73676 | 8167 | 898 | 108 | 272 | 288 |
| 1983 | 2084 | 14524 | 20233 | 6040 | 36122 | 3398 | 597 | 41 | 194 |
| 1984 | 269 | 98976 | 8626 | 12910 | 6242 | 22790 | 2449 | 371 | 43 |
| 1985 | 155 | 22820 | 78922 | 4667 | 4184 | 1789 | 11189 | 964 | 84 |
| 1986 | 2979 | 8127 | 11235 | 45367 | 1823 | 916 | 449 | 2611 | 344 |
| 1987 | 1498 | 89021 | 16824 | 10150 | 23857 | 1452 | 1116 | 642 | 1818 |
| 1988 | 7582 | 10007 | 58414 | 7598 | 4185 | 9255 | 428 | 235 | 177 |
| 1989 | 3773 | 5010 | 3420 | 25724 | 2755 | 1556 | 3634 | 255 | 84 |
| 1990 | 437 | 37247 | 5856 | 1884 | 12158 | 871 | 279 | 519 | 48 |
| 1991 | 8921 | 36924 | 21991 | 1259 | 834 | 5132 | 412 | 283 | 410 |
| 1992 | 4332 | 51840 | 18971 | 11331 | 565 | 236 | 1577 | 157 | 37 |
| 1993 | 2196 | 43659 | 60785 | 20763 | 4669 | 306 | 219 | 915 | 70 |
| 1994 | 2843 | 19484 | 32638 | 21527 | 5671 | 1579 | 76 | 175 | 237 |
| 1995 | 7692 | 17580 | 15759 | 23599 | 6865 | 1472 | 387 | 34 | 111 |
| 1996 | 10249 | 33344 | 39812 | 6641 | 10225 | 3663 | 1007 | 324 | 23 |
| 1997 | 2984 | 23843 | 10507 | 21550 | 2178 | 2668 | 870 | 259 | 59 |
| 1998 | 2058 | 11421 | 18001 | 8032 | 15116 | 1352 | 1036 | 377 | 124 |
| 1999 | 6898 | 6179 | 18055 | 11569 | 3004 | 4919 | 579 | 452 | 96 |
| 2000 | 5709 | 50142 | 6642 | 8596 | 4213 | 1055 | 1104 | 205 | 133 |
| 2001 | 11818 | 11023 | 33496 | 2432 | 3666 | 1521 | 533 | 314 | 65 |
| 2002 | 1362 | 16427 | 12394 | 32248 | 833 | 714 | 549 | 238 | 144 |
| 2003 | 3861 | 6972 | 5592 | 6848 | 12830 | 222 | 209 | 70 | 34 |
| 2004 | 2727 | 15159 | 6506 | 2384 | 3839 | 6706 | 286 | 101 | 26 |
| 2005 | 3965 | 7190 | 6202 | 3700 | 2116 | 2669 | 2704 | 57 | 42 |
| 2006 | 817 | 16031 | 4831 | 3844 | 3801 | 3109 | 2731 | 2750 | 33 |
| 2007 | 257 | 1777 | 15850 | 2897 | 1725 | 2428 | 811 | 904 | 478 |
| 2008 | 1840 | 2409 | 2330 | 4421 | 587 | 609 | 868 | 255 | 185 |
| 2009 | 2021 | 4999 | 434 | 429 | 6681 | 512 | 335 | 254 | 79 |
| 1373 | 37370 | 1936 | 422 | 580 | 4633 | 258 | 158 | 1373 | 64 |

**Table 3.3.2. Continued. Haddock in Division VIa. Total catch-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 24 |
| 1966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 |
| 1967 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| 1968 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 52 |
| 1969 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 200 |
| 1970 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 600 |
| 1971 | 175 | 16 | 0 | 0 | 0 | 0 | 0 | 212 |
| 1972 | 0 | 67 | 0 | 0 | 0 | 0 | 0 | 86 |
| 1973 | 6 | 125 | 0 | 0 | 0 | 0 | 0 | 163 |
| 1974 | 34 | 31 | 0 | 1 | 4 | 0 | 0 | 174 |
| 1975 | 72 | 8 | 0 | 0 | 0 | 0 | 0 | 3534 |
| 1976 | 1103 | 4 | 0 | 5 | 0 | 0 | 0 | 1119 |
| 1977 | 11 | 259 | 5 | 0 | 0 | 0 | 0 | 304 |
| 1978 | 7 | 17 | 211 | 3 | 0 | 0 | 0 | 575 |
| 1979 | 28 | 3 | 1 | 42 | 1 | 0 | 0 | 221 |
| 1980 | 5 | 21 | 3 | 0 | 4 | 0 | 0 | 54 |
| 1981 | 14 | 2 | 2 | 1 | 0 | 1 | 0 | 60 |
| 1982 | 31 | 12 | 1 | 0 | 0 | 0 | 0 | 332 |
| 1983 | 195 | 40 | 15 | 0 | 0 | 0 | 0 | 444 |
| 1984 | 44 | 73 | 3 | 0 | 0 | 0 | 0 | 162 |
| 1985 | 4 | 8 | 56 | 4 | 0 | 0 | 1 | 157 |
| 1986 | 38 | 7 | 15 | 1 | 3 | 0 | 0 | 409 |
| 1987 | 326 | 20 | 15 | 9 | 3 | 12 | 0 | 2203 |
| 1988 | 935 | 45 | 3 | 1 | 3 | 2 | 0 | 1167 |
| 1989 | 87 | 437 | 56 | 1 | 1 | 0 | 0 | 666 |
| 1990 | 22 | 12 | 2 | 0 | 0 | 0 | 0 | 85 |
| 1991 | 24 | 11 | 5 | 6 | 0 | 0 | 1 | 457 |
| 1992 | 108 | 25 | 0 | 0 | 0 | 0 | 0 | 169 |
| 1993 | 107 | 44 | 25 | 1 | 2 | 0 | 0 | 250 |
| 1994 | 17 | 16 | 9 | 1 | 0 | 0 | 0 | 279 |
| 1995 | 90 | 2 | 0 | 0 | 0 | 0 | 0 | 203 |
| 1996 | 40 | 12 | 4 | 0 | 0 | 0 | 0 | 80 |
| 1997 | 1 | 7 | 1 | 0 | 0 | 0 | 0 | 67 |
| 1998 | 45 | 2 | 4 | 1 | 0 | 0 | 0 | 175 |
| 1999 | 12 | 2 | 1 | 2 | 1 | 0 | 0 | 115 |
| 2000 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 156 |
| 2001 | 25 | 11 | 0 | 3 | 0 | 0 | 0 | 104 |
| 2002 | 18 | 9 | 0 | 0 | 0 | 0 | 0 | 172 |
| 2003 | 12 | 10 | 0 | 0 | 0 | 0 | 0 | 56 |
| 2004 | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 37 |
| 2005 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 48 |
| 2006 | 26 | 5 | 0 | 0 | 1 | 0 | 0 | 65 |
| 2007 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 485 |
| 2008 | 122 | 0 | 0 | 0 | 0 | 0 | 0 | 307 |
| 2009 | 41 | 32 | 0 | 0 | 0 | 0 | 0 | 152 |
| 2010 | 39 | 26 | 24 | 0 | 0 | 0 | 0 | 153 |

**Table 3.3.3. Haddock in Division VIa. Landings-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 0 | 33 | 463 | 60967 | 6753 | 294 | 274 | 174 | 11 |
| 1966 | 0 | 58 | 175 | 1082 | 46902 | 1926 | 64 | 32 | 57 |
| 1967 | 0 | 595 | 6136 | 782 | 262 | 24979 | 400 | 9 | 14 |
| 1968 | 0 | 3665 | 12439 | 2573 | 354 | 681 | 14063 | 727 | 43 |
| 1969 | 0 | 3 | 45819 | 8766 | 1423 | 268 | 379 | 4576 | 191 |
| 1970 | 0 | 169 | 170 | 78402 | 2747 | 173 | 89 | 145 | 585 |
| 1971 | 0 | 1925 | 1149 | 2665 | 78909 | 545 | 127 | 7 | 20 |
| 1972 | 0 | 576 | 26700 | 2225 | 2312 | 53823 | 504 | 50 | 19 |
| 1973 | 0 | 1252 | 5301 | 16109 | 256 | 1222 | 33193 | 150 | 32 |
| 1974 | 0 | 1706 | 3318 | 8625 | 6261 | 83 | 447 | 11463 | 104 |
| 1975 | 0 | 4629 | 10534 | 2735 | 3315 | 1882 | 95 | 98 | 3454 |
| 1976 | 0 | 745 | 22563 | 12358 | 1571 | 1491 | 868 | 21 | 7 |
| 1977 | 0 | 451 | 1317 | 29456 | 5645 | 680 | 495 | 308 | 28 |
| 1978 | 0 | 1030 | 1006 | 813 | 23620 | 2912 | 344 | 247 | 338 |
| 1979 | 0 | 2068 | 10448 | 1761 | 468 | 9810 | 833 | 114 | 145 |
| 1980 | 0 | 2505 | 12871 | 5341 | 915 | 143 | 3082 | 229 | 22 |
| 1981 | 0 | 200 | 20553 | 15695 | 1768 | 194 | 39 | 822 | 39 |
| 1982 | 0 | 250 | 1342 | 46283 | 8004 | 898 | 108 | 272 | 288 |
| 1983 | 0 | 568 | 4917 | 4585 | 34659 | 3387 | 597 | 41 | 194 |
| 1984 | 0 | 3341 | 4386 | 10754 | 5959 | 20352 | 2449 | 371 | 43 |
| 1985 | 0 | 939 | 19434 | 4437 | 4112 | 1782 | 11031 | 964 | 84 |
| 1986 | 0 | 603 | 4812 | 26770 | 1823 | 916 | 449 | 2611 | 344 |
| 1987 | 0 | 4254 | 7388 | 9206 | 23551 | 1452 | 1116 | 642 | 1818 |
| 1988 | 0 | 847 | 20687 | 6873 | 4091 | 9205 | 428 | 235 | 177 |
| 1989 | 0 | 927 | 1414 | 18417 | 2744 | 1556 | 3633 | 255 | 84 |
| 1990 | 0 | 787 | 3198 | 1342 | 9450 | 848 | 279 | 519 | 48 |
| 1991 | 0 | 2145 | 10578 | 1217 | 834 | 5131 | 412 | 283 | 410 |
| 1992 | 0 | 691 | 10194 | 10010 | 553 | 236 | 1575 | 157 | 37 |
| 1993 | 0 | 745 | 15008 | 15975 | 4594 | 290 | 219 | 910 | 70 |
| 1994 | 0 | 1017 | 6326 | 15037 | 5240 | 1484 | 76 | 175 | 237 |
| 1995 | 0 | 540 | 3669 | 12774 | 6483 | 1472 | 387 | 34 | 111 |
| 1996 | 0 | 437 | 9457 | 4968 | 8626 | 3622 | 1007 | 324 | 23 |
| 1997 | 0 | 883 | 2831 | 16921 | 2125 | 2638 | 870 | 259 | 59 |
| 1998 | 0 | 1345 | 7129 | 5675 | 13387 | 1352 | 1036 | 377 | 124 |
| 1999 | 0 | 346 | 5501 | 7159 | 2960 | 4864 | 493 | 452 | 96 |
| 2000 | 0 | 759 | 2507 | 5864 | 3841 | 1054 | 1090 | 205 | 133 |
| 2001 | 0 | 245 | 8535 | 1822 | 3523 | 1393 | 533 | 314 | 65 |
| 2002 | 0 | 177 | 1227 | 13557 | 691 | 707 | 549 | 199 | 144 |
| 2003 | 0 | 21 | 1029 | 2150 | 8809 | 221 | 206 | 69 | 34 |
| 2004 | 0 | 14 | 245 | 804 | 1819 | 4071 | 286 | 100 | 26 |
| 2005 | 0 | 7 | 287 | 792 | 1252 | 1212 | 2018 | 57 | 42 |
| 2006 | 0 | 67 | 567 | 1513 | 2300 | 2504 | 2259 | 2192 | 33 |
| 2007 | 0 | 34 | 842 | 1121 | 1429 | 2394 | 778 | 855 | 478 |
| 2008 | 0 | 21 | 297 | 2718 | 546 | 584 | 752 | 254 | 161 |
| 2009 | 0 | 4 | 57 | 188 | 3929 | 487 | 287 | 208 | 79 |
| 2010 | 0 | 44 | 260 | 377 | 453 | 4250 | 234 | 158 | 52 |

**Table 3.3.3. Continued. Haddock in Division VIa. Landings-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 24 |
| 1966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 |
| 1967 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| 1968 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 52 |
| 1969 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 200 |
| 1970 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 600 |
| 1971 | 175 | 16 | 0 | 0 | 0 | 0 | 0 | 212 |
| 1972 | 0 | 67 | 0 | 0 | 0 | 0 | 0 | 86 |
| 1973 | 6 | 125 | 0 | 0 | 0 | 0 | 0 | 163 |
| 1974 | 34 | 31 | 0 | 1 | 4 | 0 | 0 | 174 |
| 1975 | 72 | 8 | 0 | 0 | 0 | 0 | 0 | 3534 |
| 1976 | 1103 | 4 | 0 | 5 | 0 | 0 | 0 | 1119 |
| 1977 | 11 | 259 | 5 | 0 | 0 | 0 | 0 | 304 |
| 1978 | 7 | 17 | 211 | 3 | 0 | 0 | 0 | 575 |
| 1979 | 28 | 3 | 1 | 42 | 1 | 0 | 0 | 221 |
| 1980 | 5 | 21 | 3 | 0 | 4 | 0 | 0 | 54 |
| 1981 | 14 | 2 | 2 | 1 | 0 | 1 | 0 | 60 |
| 1982 | 31 | 12 | 1 | 0 | 0 | 0 | 0 | 332 |
| 1983 | 195 | 40 | 15 | 0 | 0 | 0 | 0 | 444 |
| 1984 | 44 | 73 | 3 | 0 | 0 | 0 | 0 | 162 |
| 1985 | 4 | 8 | 56 | 4 | 0 | 0 | 1 | 157 |
| 1986 | 38 | 7 | 15 | 1 | 3 | 0 | 0 | 409 |
| 1987 | 326 | 20 | 15 | 9 | 3 | 12 | 0 | 2203 |
| 1988 | 935 | 45 | 3 | 1 | 3 | 2 | 0 | 1167 |
| 1989 | 87 | 437 | 56 | 1 | 1 | 0 | 0 | 666 |
| 1990 | 22 | 12 | 2 | 0 | 0 | 0 | 0 | 85 |
| 1991 | 24 | 11 | 5 | 6 | 0 | 0 | 1 | 457 |
| 1992 | 108 | 25 | 0 | 0 | 0 | 0 | 0 | 169 |
| 1993 | 107 | 44 | 25 | 1 | 2 | 0 | 0 | 250 |
| 1994 | 17 | 16 | 9 | 1 | 0 | 0 | 0 | 279 |
| 1995 | 90 | 2 | 0 | 0 | 0 | 0 | 0 | 203 |
| 1996 | 40 | 12 | 4 | 0 | 0 | 0 | 0 | 80 |
| 1997 | 1 | 7 | 1 | 0 | 0 | 0 | 0 | 67 |
| 1998 | 45 | 2 | 4 | 1 | 0 | 0 | 0 | 175 |
| 1999 | 12 | 2 | 1 | 2 | 1 | 0 | 0 | 115 |
| 2000 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 156 |
| 2001 | 25 | 11 | 0 | 3 | 0 | 0 | 0 | 104 |
| 2002 | 18 | 9 | 0 | 0 | 0 | 0 | 0 | 172 |
| 2003 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 55 |
| 2004 | 6 | 2 | 2 | 0 | 0 | 0 | 0 | 37 |
| 2005 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 48 |
| 2006 | 26 | 5 | 0 | 0 | 1 | 0 | 0 | 65 |
| 2007 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 485 |
| 2008 | 122 | 0 | 0 | 0 | 0 | 0 | 0 | 283 |
| 2009 | 41 | 32 | 0 | 0 | 0 | 0 | 0 | 152 |
| 2010 | 39 | 26 | 24 | 0 | 0 | 0 | 0 | 140 |

**Table 3.3.4. Haddock in Division VIa. Discards-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 451 | 1026 | 877 | 11494 | 63 | 0 | 0 | 0 | 0 |
| 1966 | 5953 | 1537 | 354 | 31 | 529 | 0 | 0 | 0 | 0 |
| 1967 | 40122 | 18590 | 13196 | 169 | 3 | 0 | 0 | 0 | 0 |
| 1968 | 27 | 125753 | 25954 | 506 | 3 | 0 | 0 | 0 | 0 |
| 1969 | 2742 | 81 | 114887 | 1493 | 11 | 0 | 0 | 0 | 0 |
| 1970 | 17189 | 6148 | 348 | 16712 | 23 | 0 | 0 | 0 | 0 |
| 1971 | 6604 | 69556 | 2766 | 663 | 1057 | 0 | 0 | 0 | 0 |
| 1972 | 14215 | 20137 | 58442 | 494 | 24 | 0 | 0 | 0 | 0 |
| 1973 | 19589 | 46135 | 11607 | 3368 | 2 | 0 | 0 | 0 | 0 |
| 1974 | 63698 | 67131 | 8244 | 2132 | 56 | 0 | 0 | 0 | 0 |
| 1975 | 6849 | 174721 | 24423 | 604 | 35 | 0 | 0 | 0 | 0 |
| 1976 | 4227 | 23593 | 49767 | 2866 | 17 | 0 | 0 | 0 | 0 |
| 1977 | 4552 | 12658 | 2152 | 6492 | 59 | 0 | 0 | 0 | 0 |
| 1978 | 55 | 14911 | 1090 | 157 | 738 | 27 | 7 | 0 | 0 |
| 1979 | 5697 | 68002 | 6833 | 104 | 2 | 53 | 0 | 0 | 0 |
| 1980 | 13 | 20224 | 9057 | 295 | 7 | 0 | 0 | 0 | 0 |
| 1981 | 764 | 51 | 63359 | 5002 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 136 | 15241 | 3678 | 27393 | 163 | 0 | 0 | 0 | 0 |
| 1983 | 2084 | 13957 | 15316 | 1456 | 1464 | 12 | 0 | 0 | 0 |
| 1984 | 269 | 95634 | 4240 | 2156 | 284 | 2438 | 0 | 0 | 0 |
| 1985 | 155 | 21882 | 59488 | 231 | 71 | 6 | 159 | 0 | 0 |
| 1986 | 2979 | 7524 | 6423 | 18597 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 1498 | 84767 | 9436 | 944 | 306 | 0 | 0 | 0 | 0 |
| 1988 | 7582 | 9160 | 37727 | 725 | 95 | 49 | 0 | 0 | 0 |
| 1989 | 3773 | 4083 | 2007 | 7308 | 11 | 0 | 1 | 0 | 0 |
| 1990 | 437 | 36460 | 2658 | 542 | 2708 | 23 | 0 | 0 | 0 |
| 1991 | 8921 | 34779 | 11413 | 42 | 0 | 1 | 0 | 0 | 0 |
| 1992 | 4331 | 51148 | 8776 | 1322 | 12 | 0 | 2 | 0 | 0 |
| 1993 | 2196 | 42914 | 45777 | 4787 | 74 | 16 | 0 | 5 | 0 |
| 1994 | 2843 | 18467 | 26312 | 6490 | 432 | 94 | 0 | 0 | 0 |
| 1995 | 7692 | 17040 | 12090 | 10825 | 382 | 0 | 0 | 0 | 0 |
| 1996 | 10249 | 32907 | 30354 | 1674 | 1599 | 41 | 0 | 0 | 0 |
| 1997 | 2984 | 22961 | 7676 | 4629 | 53 | 30 | 0 | 0 | 0 |
| 1998 | 2058 | 10075 | 10872 | 2357 | 1728 | 0 | 0 | 0 | 0 |
| 1999 | 6898 | 5834 | 12554 | 4410 | 44 | 54 | 86 | 0 | 0 |
| 2000 | 5709 | 49383 | 4136 | 2731 | 372 | 1 | 14 | 0 | 0 |
| 2001 | 11818 | 10778 | 24961 | 611 | 143 | 128 | 0 | 0 | 0 |
| 2002 | 1362 | 16250 | 11168 | 18692 | 142 | 8 | 0 | 39 | 0 |
| 2003 | 3861 | 6951 | 4564 | 4697 | 4021 | 2 | 2 | 1 | 0 |
| 2004 | 2727 | 15146 | 6261 | 1580 | 2021 | 2635 | 0 | 1 | 0 |
| 2005 | 3965 | 7184 | 5915 | 2908 | 864 | 1457 | 686 | 0 | 1 |
| 2006 | 817 | 15964 | 4263 | 2331 | 1501 | 605 | 471 | 557 | 0 |
| 2007 | 257 | 1743 | 15008 | 1775 | 296 | 34 | 33 | 48 | 0 |
| 2008 | 1840 | 2388 | 2033 | 1703 | 41 | 25 | 116 | 1 | 24 |
| 2009 | 2021 | 4994 | 378 | 240 | 2752 | 25 | 48 | 46 | 0 |
| 2010 | 1373 | 37326 | 1676 | 45 | 127 | 382 | 24 | 0 | 13 |

**Table 3.3.4. Continued. Haddock in Division VIa. Discards-at-age numbers (000s). Values used in the final assessment are boxed.**

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1967 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1969 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1970 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1971 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 |
| 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |

**Table 3.3.5. Haddock in Division VIa. Weights-at-age (kg) in total catch. Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 0.04 | 0.16 | 0.242 | 0.412 | 0.692 | 0.916 | 1.041 | 1.249 | 1.517 |
| 1966 | 0.04 | 0.162 | 0.251 | 0.555 | 0.572 | 1.041 | 1.125 | 1.325 | 1.522 |
| 1967 | 0.04 | 0.16 | 0.266 | 0.569 | 0.573 | 0.667 | 1.177 | 1.844 | 1.611 |
| 1968 | 0.04 | 0.159 | 0.264 | 0.567 | 0.823 | 0.731 | 0.811 | 1.43 | 1.903 |
| 1969 | 0.04 | 0.158 | 0.243 | 0.526 | 0.916 | 1.042 | 1.024 | 0.999 | 1.569 |
| 1970 | 0.04 | 0.161 | 0.23 | 0.368 | 0.812 | 1.283 | 1.262 | 1.043 | 1.342 |
| 1971 | 0.04 | 0.16 | 0.248 | 0.341 | 0.546 | 1.04 | 1.313 | 1.651 | 1.426 |
| 1972 | 0.04 | 0.16 | 0.249 | 0.38 | 0.53 | 0.546 | 0.984 | 1.499 | 1.538 |
| 1973 | 0.04 | 0.159 | 0.251 | 0.384 | 0.597 | 0.512 | 0.571 | 1.185 | 1.706 |
| 1974 | 0.04 | 0.159 | 0.248 | 0.368 | 0.527 | 0.764 | 0.685 | 0.798 | 1.142 |
| 1975 | 0.04 | 0.159 | 0.26 | 0.428 | 0.581 | 0.832 | 1.027 | 1.001 | 1.009 |
| 1976 | 0.04 | 0.159 | 0.256 | 0.459 | 0.592 | 0.831 | 1.095 | 1.585 | 1.084 |
| 1977 | 0.04 | 0.161 | 0.274 | 0.406 | 0.684 | 0.8 | 1.128 | 1.337 | 1.117 |
| 1978 | 0.068 | 0.134 | 0.278 | 0.388 | 0.516 | 0.827 | 1.045 | 1.152 | 1.399 |
| 1979 | 0.032 | 0.182 | 0.325 | 0.457 | 0.73 | 0.777 | 1.04 | 1.491 | 1.944 |
| 1980 | 0.077 | 0.134 | 0.319 | 0.572 | 0.719 | 0.998 | 0.985 | 1.143 | 1.565 |
| 1981 | 0.082 | 0.252 | 0.245 | 0.467 | 0.887 | 0.975 | 1.376 | 1.294 | 1.347 |
| 1982 | 0.038 | 0.157 | 0.273 | 0.376 | 0.746 | 1.126 | 1.539 | 1.549 | 1.514 |
| 1983 | 0.05 | 0.178 | 0.282 | 0.461 | 0.557 | 1.002 | 1.37 | 1.716 | 1.558 |
| 1984 | 0.059 | 0.149 | 0.319 | 0.456 | 0.688 | 0.667 | 1.087 | 1.392 | 2.075 |
| 1985 | 0.019 | 0.138 | 0.268 | 0.486 | 0.636 | 0.802 | 0.868 | 1.272 | 1.277 |
| 1986 | 0.064 | 0.182 | 0.27 | 0.362 | 0.637 | 0.903 | 1.115 | 1.043 | 1.418 |
| 1987 | 0.028 | 0.168 | 0.27 | 0.418 | 0.566 | 0.88 | 1.105 | 1.25 | 1.147 |
| 1988 | 0.085 | 0.17 | 0.254 | 0.444 | 0.562 | 0.704 | 1.027 | 1.28 | 1.279 |
| 1989 | 0.052 | 0.226 | 0.301 | 0.402 | 0.625 | 0.749 | 0.894 | 1.115 | 1.465 |
| 1990 | 0.073 | 0.112 | 0.355 | 0.445 | 0.534 | 0.891 | 1.108 | 1.28 | 1.823 |
| 1991 | 0.058 | 0.184 | 0.297 | 0.547 | 0.618 | 0.678 | 0.931 | 1.053 | 1.091 |
| 1992 | 0.05 | 0.133 | 0.321 | 0.437 | 0.766 | 0.892 | 0.932 | 1.407 | 1.493 |
| 1993 | 0.037 | 0.108 | 0.277 | 0.458 | 0.65 | 0.861 | 0.898 | 1.022 | 1.514 |
| 1994 | 0.031 | 0.169 | 0.253 | 0.405 | 0.611 | 0.698 | 0.929 | 0.959 | 0.909 |
| 1995 | 0.03 | 0.149 | 0.274 | 0.354 | 0.553 | 0.833 | 0.978 | 1.322 | 1.059 |
| 1996 | 0.047 | 0.128 | 0.243 | 0.404 | 0.462 | 0.645 | 0.75 | 0.754 | 1.122 |
| 1997 | 0.048 | 0.153 | 0.263 | 0.394 | 0.614 | 0.73 | 0.925 | 1.057 | 0.921 |
| 1998 | 0.089 | 0.164 | 0.283 | 0.382 | 0.502 | 0.689 | 0.802 | 0.951 | 1.006 |
| 1999 | 0.035 | 0.172 | 0.255 | 0.365 | 0.494 | 0.611 | 0.729 | 0.84 | 1.067 |
| 2000 | 0.053 | 0.127 | 0.27 | 0.361 | 0.447 | 0.572 | 0.719 | 0.84 | 0.749 |
| 2001 | 0.05 | 0.112 | 0.242 | 0.403 | 0.432 | 0.514 | 0.657 | 0.808 | 1.029 |
| 2002 | 0.048 | 0.118 | 0.208 | 0.307 | 0.521 | 0.606 | 0.632 | 0.636 | 0.81 |
| 2003 | 0.036 | 0.124 | 0.239 | 0.282 | 0.382 | 0.652 | 0.648 | 0.908 | 0.945 |
| 2004 | 0.033 | 0.112 | 0.189 | 0.29 | 0.313 | 0.373 | 0.541 | 0.715 | 0.782 |
| 2005 | 0.053 | 0.103 | 0.198 | 0.295 | 0.451 | 0.429 | 0.525 | 1.163 | 0.916 |
| 2006 | 0.024 | 0.155 | 0.254 | 0.326 | 0.388 | 0.471 | 0.496 | 0.563 | 1.242 |
| 2007 | 0.060 | 0.115 | 0.219 | 0.331 | 0.404 | 0.456 | 0.550 | 0.593 | 0.682 |
| 2008 | 0.022 | 0.113 | 0.245 | 0.367 | 0.492 | 0.570 | 0.619 | 0.708 | 0.770 |
| 2009 | 0.048 | 0.135 | 0.266 | 0.357 | 0.410 | 0.570 | 0.633 | 0.630 | 0.897 |
| 2010 | 0.043 | 0.067 | 0.180 | 0.388 | 0.409 | 0.459 | 0.725 | 0.755 | 0.852 |

**Table 3.3.5. Continued. Haddock in Division VIa. Weights-at-age (kg) in total catch. Values used in the final assessment are boxed.**

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 1.92 | 1.833 | 0 | 0 | 0 | 0 | 0 | 1.713 |
| 1966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.522 |
| 1967 | 2.355 | 0 | 0 | 0 | 0 | 0 | 0 | 1.786 |
| 1968 | 2.516 | 0 | 0 | 0 | 0 | 0 | 0 | 2.005 |
| 1969 | 2.065 | 0 | 0 | 0 | 0 | 0 | 0 | 1.590 |
| 1970 | 1.791 | 1.213 | 0 | 0 | 0 | 0 | 0 | 1.352 |
| 1971 | 1.466 | 2.042 | 0 | 0 | 0 | 0 | 0 | 1.506 |
| 1972 | 0 | 1.551 | 0 | 0 | 0 | 0 | 0 | 1.548 |
| 1973 | 2.202 | 1.52 | 0 | 0 | 0 | 0 | 0 | 1.581 |
| 1974 | 1.319 | 1.229 | 0 | 0.833 | 0.89 | 0 | 0 | 1.183 |
| 1975 | 1.19 | 2.523 | 0 | 0 | 0 | 0 | 0 | 1.016 |
| 1976 | 1.243 | 1.806 | 0 | 1.679 | 0 | 0 | 0 | 1.246 |
| 1977 | 1.394 | 1.339 | 1.593 | 0 | 0 | 0 | 0 | 1.325 |
| 1978 | 2.126 | 1.376 | 1.208 | 1.627 | 0 | 0 | 0 | 1.338 |
| 1979 | 1.735 | 1.569 | 1.781 | 1.119 | 1.59 | 0 | 0 | 1.754 |
| 1980 | 1.632 | 1.879 | 2.862 | 0 | 1.482 | 0 | 0 | 1.747 |
| 1981 | 1.366 | 1.314 | 1.785 | 1.587 | 0 | 1.677 | 0 | 1.379 |
| 1982 | 1.738 | 2.068 | 1.543 | 0 | 0 | 0 | 0 | 1.555 |
| 1983 | 1.556 | 1.555 | 1.999 | 0 | 0 | 0 | 0 | 1.572 |
| 1984 | 1.882 | 1.417 | 1.864 | 0 | 0 | 0 | 0 | 1.724 |
| 1985 | 1.695 | 2.014 | 2.152 | 2.741 | 0 | 0 | 4.141 | 1.694 |
| 1986 | 1.517 | 1.832 | 1.925 | 1.504 | 2.635 | 0 | 0 | 1.463 |
| 1987 | 1.149 | 1.851 | 2.774 | 3.04 | 2.828 | 2.664 | 0 | 1.182 |
| 1988 | 0.879 | 1.618 | 0.99 | 3.424 | 3.994 | 4.15 | 0 | 0.984 |
| 1989 | 1.357 | 0.949 | 1.388 | 2.807 | 3.008 | 0 | 0.429 | 1.110 |
| 1990 | 1.682 | 2.288 | 1.964 | 2.506 | 0 | 0 | 0 | 1.860 |
| 1991 | 1.755 | 3.29 | 2.17 | 1.343 | 0 | 0 | 2.869 | 1.201 |
| 1992 | 1.564 | 2.18 | 0 | 0 | 0 | 0 | 0 | 1.639 |
| 1993 | 1.21 | 1.578 | 2.304 | 1.8 | 2.405 | 0 | 0 | 1.483 |
| 1994 | 1.243 | 1.319 | 1.961 | 2.43 | 0 | 0 | 0 | 0.992 |
| 1995 | 0.94 | 1.953 | 1.996 | 2.492 | 0 | 0 | 0 | 1.020 |
| 1996 | 1.163 | 1.046 | 1.141 | 0 | 3.167 | 0 | 0 | 1.137 |
| 1997 | 2.024 | 1.63 | 2.252 | 0 | 3.033 | 0 | 0 | 1.020 |
| 1998 | 1.064 | 2.488 | 2.585 | 3.322 | 2.591 | 0 | 0 | 1.077 |
| 1999 | 1.465 | 1.465 | 3.246 | 1.993 | 2.954 | 2.829 | 0 | 1.172 |
| 2000 | 1.186 | 1.262 | 0 | 2.168 | 0 | 0 | 0 | 0.813 |
| 2001 | 0.975 | 1.089 | 3.361 | 0.597 | 0 | 0 | 0 | 1.015 |
| 2002 | 1.995 | 0.916 | 0 | 2.698 | 0 | 0 | 0 | 0.939 |
| 2003 | 1.232 | 1.393 | 2.682 | 0 | 0 | 0 | 0 | 1.086 |
| 2004 | 0.853 | 1.396 | 3.976 | 0 | 0 | 0 | 0 | 0.988 |
| 2005 | 1.467 | 2.084 | 3.491 | 2.275 | 0 | 0 | 0 | 1.018 |
| 2006 | 1.182 | 1.682 | 2.675 | 0 | 3.889 | 5.471 | 0 | 1.294 |
| 2007 | 0.825 | 2.160 | 2.270 | 0 | 0 | 0 | 0 | 0.685 |
| 2008 | 0.911 | 2.494 | 2.109 | 0 | 0 | 0 | 0 | 0.827 |
| 2009 | 1.042 | 1.233 | 1.874 | 0.000 | 0.000 | 0.000 | 0.000 | 1.008 |
| 2010 | 0.852 | 0.734 | 1.141 | 0.000 | 0.000 | 0.000 | 0.000 | 0.877 |

**Table 3.3.6. Haddock in Division VIa. Weights-at-age (kg) in landings. Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 0.000 | 0.273 | 0.295 | 0.440 | 0.695 | 0.916 | 1.041 | 1.249 | 1.517 |
| 1966 | 0.000 | 0.315 | 0.324 | 0.563 | 0.575 | 1.041 | 1.125 | 1.325 | 1.522 |
| 1967 | 0.000 | 0.285 | 0.374 | 0.635 | 0.576 | 0.667 | 1.177 | 1.844 | 1.611 |
| 1968 | 0.000 | 0.259 | 0.367 | 0.627 | 0.827 | 0.731 | 0.811 | 1.430 | 1.903 |
| 1969 | 0.000 | 0.199 | 0.314 | 0.570 | 0.921 | 1.042 | 1.024 | 0.999 | 1.569 |
| 1970 | 0.000 | 0.348 | 0.261 | 0.389 | 0.817 | 1.283 | 1.262 | 1.043 | 1.342 |
| 1971 | 0.000 | 0.295 | 0.328 | 0.360 | 0.549 | 1.040 | 1.313 | 1.651 | 1.426 |
| 1972 | 0.000 | 0.285 | 0.325 | 0.406 | 0.532 | 0.546 | 0.984 | 1.499 | 1.538 |
| 1973 | 0.000 | 0.259 | 0.329 | 0.408 | 0.599 | 0.512 | 0.571 | 1.185 | 1.706 |
| 1974 | 0.000 | 0.264 | 0.328 | 0.393 | 0.530 | 0.764 | 0.685 | 0.798 | 1.142 |
| 1975 | 0.000 | 0.277 | 0.365 | 0.465 | 0.585 | 0.832 | 1.027 | 1.001 | 1.009 |
| 1976 | 0.000 | 0.251 | 0.345 | 0.504 | 0.596 | 0.831 | 1.095 | 1.585 | 1.084 |
| 1977 | 0.000 | 0.307 | 0.370 | 0.437 | 0.689 | 0.800 | 1.128 | 1.337 | 1.117 |
| 1978 | 0.000 | 0.257 | 0.353 | 0.419 | 0.524 | 0.832 | 1.060 | 1.152 | 1.399 |
| 1979 | 0.000 | 0.269 | 0.386 | 0.467 | 0.732 | 0.779 | 1.040 | 1.491 | 1.944 |
| 1980 | 0.000 | 0.251 | 0.373 | 0.587 | 0.722 | 0.998 | 0.985 | 1.143 | 1.565 |
| 1981 | 0.000 | 0.289 | 0.357 | 0.502 | 0.887 | 0.975 | 1.376 | 1.294 | 1.347 |
| 1982 | 0.000 | 0.285 | 0.369 | 0.452 | 0.754 | 1.126 | 1.539 | 1.549 | 1.514 |
| 1983 | 0.000 | 0.479 | 0.424 | 0.518 | 0.568 | 1.004 | 1.370 | 1.716 | 1.558 |
| 1984 | 0.000 | 0.273 | 0.388 | 0.486 | 0.705 | 0.713 | 1.087 | 1.392 | 2.075 |
| 1985 | 0.000 | 0.283 | 0.346 | 0.494 | 0.641 | 0.803 | 0.875 | 1.272 | 1.277 |
| 1986 | 0.000 | 0.294 | 0.373 | 0.440 | 0.637 | 0.903 | 1.115 | 1.043 | 1.418 |
| 1987 | 0.000 | 0.276 | 0.337 | 0.435 | 0.570 | 0.880 | 1.105 | 1.250 | 1.147 |
| 1988 | 0.000 | 0.310 | 0.338 | 0.462 | 0.567 | 0.706 | 1.027 | 1.280 | 1.279 |
| 1989 | 0.000 | 0.372 | 0.406 | 0.468 | 0.625 | 0.749 | 0.894 | 1.115 | 1.462 |
| 1990 | 0.000 | 0.335 | 0.443 | 0.532 | 0.618 | 0.908 | 1.108 | 1.280 | 1.823 |
| 1991 | 0.000 | 0.287 | 0.382 | 0.556 | 0.618 | 0.678 | 0.931 | 1.053 | 1.091 |
| 1992 | 0.000 | 0.310 | 0.384 | 0.461 | 0.777 | 0.892 | 0.932 | 1.407 | 1.493 |
| 1993 | 0.000 | 0.313 | 0.395 | 0.509 | 0.655 | 0.889 | 0.898 | 1.026 | 1.514 |
| 1994 | 0.000 | 0.280 | 0.352 | 0.454 | 0.633 | 0.723 | 0.929 | 0.959 | 0.909 |
| 1995 | 0.000 | 0.293 | 0.375 | 0.415 | 0.567 | 0.833 | 0.978 | 1.322 | 1.059 |
| 1996 | 0.000 | 0.285 | 0.363 | 0.445 | 0.492 | 0.649 | 0.750 | 0.754 | 1.122 |
| 1997 | 0.000 | 0.275 | 0.365 | 0.425 | 0.621 | 0.735 | 0.925 | 1.057 | 0.921 |
| 1998 | 0.000 | 0.265 | 0.331 | 0.416 | 0.524 | 0.689 | 0.802 | 0.951 | 1.006 |
| 1999 | 0.000 | 0.313 | 0.353 | 0.420 | 0.496 | 0.614 | 0.820 | 0.840 | 1.067 |
| 2000 | 0.000 | 0.265 | 0.347 | 0.410 | 0.465 | 0.572 | 0.724 | 0.840 | 0.749 |
| 2001 | 0.000 | 0.243 | 0.332 | 0.457 | 0.439 | 0.538 | 0.657 | 0.808 | 1.029 |
| 2002 | 0.000 | 0.254 | 0.321 | 0.383 | 0.566 | 0.608 | 0.632 | 0.691 | 0.810 |
| 2003 | 0.000 | 0.240 | 0.311 | 0.389 | 0.428 | 0.654 | 0.651 | 0.917 | 0.946 |
| 2004 | 0.000 | 0.253 | 0.329 | 0.394 | 0.391 | 0.448 | 0.541 | 0.718 | 0.782 |
| 2005 | 0.000 | 0.270 | 0.358 | 0.415 | 0.542 | 0.596 | 0.594 | 1.167 | 0.921 |
| 2006 | 0.000 | 0.291 | 0.348 | 0.392 | 0.437 | 0.508 | 0.527 | 0.621 | 1.242 |
| 2007 | 0.000 | 0.248 | 0.357 | 0.398 | 0.423 | 0.458 | 0.558 | 0.605 | 0.682 |
| 2008 | 0.000 | 0.275 | 0.378 | 0.418 | 0.505 | 0.578 | 0.666 | 0.709 | 0.823 |
| 2009 | 0.000 | 0.344 | 0.469 | 0.467 | 0.488 | 0.581 | 0.687 | 0.691 | 0.897 |
| 2010 | 0.000 | 0.280 | 0.338 | 0.406 | 0.438 | 0.471 | 0.764 | 0.755 | 0.990 |

**Table 3.3.6. Continued. Haddock in Division VIa. Weights-at-age (kg) in landings. Values used in the final assessment are boxed.**

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 1.920 | 1.833 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.713 |
| 1966 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.522 |
| 1967 | 2.355 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.786 |
| 1968 | 2.516 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.005 |
| 1969 | 2.065 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.590 |
| 1970 | 1.791 | 1.213 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.352 |
| 1971 | 1.466 | 2.042 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.506 |
| 1972 | 0.000 | 1.551 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.548 |
| 1973 | 2.202 | 1.520 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.581 |
| 1974 | 1.319 | 1.229 | 0.000 | 0.833 | 0.890 | 0.000 | 0.000 | 1.183 |
| 1975 | 1.190 | 2.523 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.016 |
| 1976 | 1.243 | 1.806 | 0.000 | 1.679 | 0.000 | 0.000 | 0.000 | 1.246 |
| 1977 | 1.394 | 1.339 | 1.593 | 0.000 | 0.000 | 0.000 | 0.000 | 1.325 |
| 1978 | 2.126 | 1.376 | 1.208 | 1.627 | 0.000 | 0.000 | 0.000 | 1.338 |
| 1979 | 1.735 | 1.569 | 1.781 | 1.119 | 1.590 | 0.000 | 0.000 | 1.754 |
| 1980 | 1.632 | 1.879 | 2.862 | 0.000 | 1.482 | 0.000 | 0.000 | 1.747 |
| 1981 | 1.366 | 1.314 | 1.785 | 1.587 | 0.000 | 1.677 | 0.000 | 1.379 |
| 1982 | 1.738 | 2.068 | 1.543 | 0.000 | 0.000 | 0.000 | 0.000 | 1.555 |
| 1983 | 1.556 | 1.555 | 1.999 | 0.000 | 0.000 | 0.000 | 0.000 | 1.572 |
| 1984 | 1.882 | 1.417 | 1.864 | 0.000 | 0.000 | 0.000 | 0.000 | 1.724 |
| 1985 | 1.695 | 2.014 | 2.152 | 2.741 | 0.000 | 0.000 | 4.141 | 1.694 |
| 1986 | 1.517 | 1.832 | 1.925 | 1.504 | 2.635 | 0.000 | 0.000 | 1.463 |
| 1987 | 1.149 | 1.851 | 2.774 | 3.040 | 2.828 | 2.664 | 0.000 | 1.182 |
| 1988 | 0.879 | 1.618 | 0.990 | 3.424 | 3.994 | 4.150 | 0.000 | 0.984 |
| 1989 | 1.357 | 0.948 | 1.388 | 2.807 | 3.008 | 0.000 | 0.429 | 1.109 |
| 1990 | 1.682 | 2.288 | 1.964 | 2.506 | 0.000 | 0.000 | 0.000 | 1.860 |
| 1991 | 1.755 | 3.290 | 2.170 | 1.343 | 0.000 | 0.000 | 2.869 | 1.201 |
| 1992 | 1.564 | 2.180 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.639 |
| 1993 | 1.210 | 1.578 | 2.304 | 1.800 | 2.405 | 0.000 | 0.000 | 1.483 |
| 1994 | 1.243 | 1.319 | 1.961 | 2.430 | 0.000 | 0.000 | 0.000 | 0.992 |
| 1995 | 0.940 | 1.953 | 1.996 | 2.492 | 0.000 | 0.000 | 0.000 | 1.020 |
| 1996 | 1.163 | 1.046 | 1.141 | 0.000 | 3.167 | 0.000 | 0.000 | 1.137 |
| 1997 | 2.024 | 1.630 | 2.252 | 0.000 | 3.033 | 0.000 | 0.000 | 1.020 |
| 1998 | 1.064 | 2.488 | 2.585 | 3.322 | 2.591 | 0.000 | 0.000 | 1.077 |
| 1999 | 1.465 | 1.465 | 3.246 | 1.993 | 2.954 | 2.829 | 0.000 | 1.172 |
| 2000 | 1.186 | 1.262 | 0.000 | 2.168 | 0.000 | 0.000 | 0.000 | 0.813 |
| 2001 | 0.975 | 1.089 | 3.361 | 0.597 | 0.000 | 0.000 | 0.000 | 1.015 |
| 2002 | 1.995 | 0.916 | 0.000 | 2.698 | 0.000 | 0.000 | 0.000 | 0.939 |
| 2003 | 1.253 | 1.395 | 2.682 | 0.000 | 0.000 | 0.000 | 0.000 | 1.091 |
| 2004 | 0.853 | 1.396 | 3.976 | 0.000 | 0.000 | 0.000 | 0.000 | 0.988 |
| 2005 | 1.467 | 2.084 | 3.491 | 2.275 | 0.000 | 0.000 | 0.000 | 1.023 |
| 2006 | 1.182 | 1.682 | 2.675 | 0.000 | 3.889 | 5.471 | 0.000 | 1.294 |
| 2007 | 0.825 | 2.160 | 2.270 | 0.000 | 0.000 | 0.000 | 0.000 | 0.685 |
| 2008 | 0.911 | 2.494 | 2.109 | 2.966 | 0.000 | 0.000 | 0.000 | 0.862 |
| 2009 | 1.042 | 1.233 | 1.874 | 0.000 | 3.002 | 0.000 | 0.000 | 1.011 |
| 2010 | 0.852 | 0.734 | 1.141 | 0.000 | 0.000 | 0.000 | 0.000 | 0.930 |

**Table 3.3.7. Haddock in Division VIa. Weights-at-age (kg) in discards. Values used in the final assessment are boxed.**

| Year | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1965 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1966 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1967 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1968 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1969 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1970 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1971 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1972 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1973 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1974 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1975 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1976 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1977 | 0.040 | 0.156 | 0.215 | 0.265 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1978 | 0.059 | 0.125 | 0.208 | 0.231 | 0.259 | 0.265 | 0.308 | 0.000 | 0.000 |
| 1979 | 0.032 | 0.180 | 0.230 | 0.272 | 0.266 | 0.303 | 0.000 | 0.000 | 0.000 |
| 1980 | 0.077 | 0.120 | 0.243 | 0.287 | 0.334 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1981 | 0.082 | 0.106 | 0.209 | 0.360 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1982 | 0.038 | 0.155 | 0.238 | 0.247 | 0.363 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1983 | 0.050 | 0.165 | 0.237 | 0.283 | 0.298 | 0.536 | 0.000 | 0.000 | 0.000 |
| 1984 | 0.059 | 0.145 | 0.248 | 0.303 | 0.331 | 0.278 | 0.000 | 0.000 | 0.000 |
| 1985 | 0.019 | 0.132 | 0.242 | 0.326 | 0.362 | 0.423 | 0.353 | 0.000 | 0.000 |
| 1986 | 0.064 | 0.173 | 0.193 | 0.248 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1987 | 0.028 | 0.163 | 0.218 | 0.247 | 0.281 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1988 | 0.085 | 0.157 | 0.208 | 0.279 | 0.331 | 0.341 | 0.000 | 0.000 | 0.000 |
| 1989 | 0.052 | 0.193 | 0.226 | 0.237 | 0.491 | 0.961 | 1.423 | 0.000 | 2.572 |
| 1990 | 0.073 | 0.108 | 0.250 | 0.228 | 0.242 | 0.268 | 0.000 | 0.000 | 0.000 |
| 1991 | 0.058 | 0.178 | 0.218 | 0.278 | 0.000 | 0.263 | 0.000 | 0.000 | 0.000 |
| 1992 | 0.050 | 0.130 | 0.247 | 0.258 | 0.242 | 0.000 | 0.947 | 0.000 | 0.000 |
| 1993 | 0.037 | 0.105 | 0.238 | 0.287 | 0.382 | 0.348 | 0.000 | 0.430 | 0.000 |
| 1994 | 0.031 | 0.163 | 0.229 | 0.291 | 0.337 | 0.304 | 0.000 | 0.000 | 0.000 |
| 1995 | 0.030 | 0.144 | 0.243 | 0.281 | 0.310 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | 0.047 | 0.126 | 0.206 | 0.282 | 0.300 | 0.317 | 0.000 | 0.000 | 0.000 |
| 1997 | 0.048 | 0.148 | 0.226 | 0.283 | 0.340 | 0.317 | 0.000 | 0.000 | 0.000 |
| 1998 | 0.089 | 0.151 | 0.251 | 0.298 | 0.337 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1999 | 0.035 | 0.163 | 0.213 | 0.276 | 0.318 | 0.311 | 0.206 | 0.000 | 0.000 |
| 2000 | 0.053 | 0.125 | 0.223 | 0.257 | 0.259 | 0.625 | 0.337 | 0.000 | 0.000 |
| 2001 | 0.050 | 0.109 | 0.211 | 0.243 | 0.254 | 0.245 | 0.000 | 0.000 | 0.000 |
| 2002 | 0.048 | 0.117 | 0.196 | 0.253 | 0.305 | 0.456 | 0.000 | 0.358 | 0.000 |
| 2003 | 0.036 | 0.123 | 0.223 | 0.233 | 0.282 | 0.462 | 0.439 | 0.496 | 0.591 |
| 2004 | 0.033 | 0.112 | 0.183 | 0.237 | 0.242 | 0.256 | 0.000 | 0.411 | 0.000 |
| 2005 | 0.053 | 0.103 | 0.190 | 0.262 | 0.320 | 0.290 | 0.322 | 0.416 | 0.493 |
| 2006 | 0.024 | 0.154 | 0.241 | 0.284 | 0.313 | 0.318 | 0.348 | 0.336 | 0.000 |
| 2007 | 0.060 | 0.113 | 0.211 | 0.288 | 0.314 | 0.336 | 0.368 | 0.373 | 0.000 |
| 2008 | 0.022 | 0.112 | 0.226 | 0.287 | 0.322 | 0.389 | 0.312 | 0.458 | 0.419 |
| 2009 | 0.048 | 0.134 | 0.235 | 0.271 | 0.298 | 0.362 | 0.309 | 0.356 | 0.000 |
| 2010 | 0.000 | 0.067 | 0.156 | 0.240 | 0.307 | 0.320 | 0.345 | 0.000 | 0.279 |

**Table 3.3.7. Continued. Haddock in Division VIa. Weights-at-age (kg) in discards. Values used in the final assessment are boxed.**

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 10 | 11 | 12 | 13 | 14 | 15+ | 8+ |
| 1965 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1966 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1967 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1968 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1969 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1970 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1971 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1972 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1973 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1974 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1975 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1976 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1977 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1978 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1979 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1980 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1981 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1982 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1983 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1984 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1985 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1986 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1987 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1988 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1989 | 0.000 | 3.048 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.810 |
| 1990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1991 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1992 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1993 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1994 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1995 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1996 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1997 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1998 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1999 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2003 | 0.432 | 0.689 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.493 |
| 2004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2005 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.493 |
| 2006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2007 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.419 |
| 2009 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2010 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.279 |

**Table 3.3.8. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.**

| ScoGFS Q1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Age | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
| 1985 | 1104 | 4085 | 68 | 80 | 141 | 388 | 27 | 1 | 5893 |
| 1986 | 753 | 1669 | 1877 | 17 | 14 | 47 | 90 | 5 | 4467 |
| 1987 | 5518 | 446 | 460 | 690 | 25 | 34 | 25 | 67 | 7198 |
| 1988 | 571 | 3610 | 303 | 112 | 246 | 10 | 4 | 8 | 4856 |
| 1989 | 178 | 488 | 1701 | 98 | 49 | 69 | 5 | 1 | 2588 |
| 1990 | 2577 | 87 | 54 | 296 | 26 | 6 | 36 | 3 | 3082 |
| 1991 | 1591 | 1763 | 92 | 25 | 184 | 9 | 4 | 15 | 3668 |
| 1992 | 3618 | 1193 | 321 | 12 | 13 | 28 | 6 | 1 | 5191 |
| 1993 | 5371 | 5922 | 675 | 167 | 0 | 2 | 18 | 2 | 12 155 |
| 1994 | 1151 | 2300 | 787 | 126 | 39 | 3 | 1 | 8 | 4407 |
| 1995 | 7112 | 1074 | 1697 | 485 | 65 | 30 | 10 | 4 | 10 473 |
| 1996 | 4401 | 3742 | 315 | 456 | 125 | 20 | 11 | 3 | 9070 |
| 1997 | 4262 | 2018 | 1915 | 147 | 151 | 53 | 2 | 1 | 8548 |
| 1998 | 5034 | 2720 | 616 | 562 | 40 | 64 | 19 | 7 | 9055 |
| 1999 | 941 | 2989 | 687 | 168 | 128 | 15 | 11 | 2 | 4939 |
| 2000 | 7936 | 553 | 440 | 97 | 13 | 20 | 1 | 3 | 9060 |
| 2001 | 3421 | 5762 | 143 | 146 | 34 | 16 | 6 | 1 | 9528 |
| 2002 | 2339 | 3246 | 5293 | 56 | 70 | 24 | 9 | 3 | 11 037 |
| 2003 | 2650 | 1696 | 1449 | 1874 | 23 | 34 | 18 | 4 | 7744 |
| 2004 | 1397 | 2765 | 869 | 1199 | 609 | 11 | 3 | 5 | 6853 |
| 2005 | 573 | 633 | 1402 | 351 | 512 | 402 | 5 | 3 | 3878 |
| 2006 | 633 | 892 | 539 | 397 | 156 | 170 | 51 | 2 | 2838 |
| 2007 | 99 | 2019 | 296 | 121 | 192 | 82 | 89 | 65 | 2898 |
| 2008 | 86 | 113 | 1094 | 98 | 84 | 71 | 13 | 15 | 1558 |
| 2009 | 42 | 113 | 147 | 1445 | 29 | 43 | 63 | 7 | 1882 |
| 2010 | 706 | 111 | 26 | 71 | 452 | 23 | 4 | 9 | 1393 |
| 2011 | 23 | 3759 | 310 | 98 | 109 | 828 | 12 | 10 | 5139 |

**Table 3.3.8. Continued. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.**

**ScoGFS Q4**

| | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
| 1996 | 2907 | 761 | 656 | 70 | 137 | 57 | 24 | 6 | 1711 |
| 1997 | 3713 | 1359 | 282 | 151 | 25 | 26 | 14 | 4 | 1861 |
| 1998 | 399 | 1640 | 486 | 148 | 137 | 17 | 33 | 5 | 2466 |
| 1999 | 4670 | 366 | 574 | 267 | 92 | 68 | 11 | 18 | 1396 |
| 2000 | 2959 | 4231 | 147 | 191 | 59 | 25 | 5 | 3 | 4661 |
| 2001 | 3083 | 2219 | 3563 | 48 | 138 | 22 | 12 | 2 | 6004 |
| 2002 | 2943 | 1709 | 1770 | 2841 | 34 | 50 | 24 | 8 | 6436 |
| 2003 | 293 | 2023 | 965 | 1470 | 639 | 28 | 17 | 3 | 5145 |
| 2004 | 542 | 574 | 1068 | 410 | 649 | 524 | 5 | 9 | 3239 |
| 2005 | 286 | 419 | 409 | 410 | 223 | 309 | 87 | 1 | 1858 |
| 2006 | 19 | 543 | 233 | 162 | 281 | 79 | 100 | 40 | 1438 |
| 2007 | 125 | 69 | 1392 | 109 | 128 | 90 | 48 | 45 | 1881 |
| 2008 | 14 | 117 | 78 | 835 | 74 | 94 | 63 | 29 | 1290 |
| 2009 | 335 | 68 | 161 | 343 | 551 | 44 | 35 | 26 | 1228 |

IreGFS

| | Effort | Age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | (hours) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
| 1993 | 2130 | 143 | 2493 | 5691 | 1606 | 693 | 29 | 112 | 56 | 35 | 10 715 |
| 1994 | 1865 | 76 | 1237 | 3538 | 3303 | 367 | 187 | 13 | 18 | 66 | 8729 |
| 1995 | 2026 | 967 | 3104 | 1149 | 4152 | 1663 | 187 | 149 | 29 | 14 | 10 447 |
| 1996 | 2008 | 192 | 2536 | 3688 | 2155 | 627 | 254 | 126 | 45 | 24 | 9455 |
| 1997 | 1879 | 2900 | 8289 | 636 | 532 | 375 | 294 | 45 | 8 | 3 | 10 182 |
| 1998 | 1936 | 96 | 1098 | 1538 | 1353 | 192 | 84 | 75 | 15 | 49 | 4404 |
| 1999 | 1914 | 7985 | 1028 | 1967 | 1530 | 679 | 237 | 118 | 25 | 34 | 5618 |
| 2000 | 1878 | 1454 | 8865 | 569 | 691 | 484 | 183 | 32 | 30 | 0 | 10 854 |
| 2001 | 965 | 1951 | 2728 | 3548 | 136 | 187 | 151 | 36 | 4 | 0 | 6790 |
| 2002 | 796 | 6618 | 2541 | 2768 | 1788 | 67 | 90 | 32 | 5 | 2 | 7293 |

**Table 3.3.8. Continued. Haddock in Division VIa. Available research-vessels survey data. Values used in the final assessment are boxed.**

| IRGFS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | | | | | | |
| Year | (hours) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
| 2003 | 1127 | 207 | 7588 | 2382 | 839 | 355 | 22 | 30 | 7 | 0 | 3 | 2 | 11 228 |
| 2004 | 1200 | 86 | 2163 | 3322 | 1281 | 941 | 957 | 60 | 10 | 21 | 0 | 0 | 8755 |
| 2005 | 960 | 233 | 1160 | 767 | 778 | 315 | 87 | 3 | 0 | 0 | 1 | 0 | 3111 |
| 2006 | 1510 | 313 | 207 | 1027 | 381 | 1337 | 543 | 130 | 59 | 0 | 0 | 0 | 3684 |
| 2007 | 1173 | 320 | 979 | 1049 | 346 | 689 | 101 | 64 | 69 | 1 | 0 | 0 | 3298 |
| 2008 | 1135 | 76 | 2052 | 562 | 645 | 74 | 196 | 169 | 31 | 14 | 0 | 0 | 3742 |
| 2009 | 1378 | 744 | 535 | 919 | 309 | 328 | 76 | 187 | 61 | 6 | 0 | 0 | 2422 |
| 2010 | 1291 | 66 | 2997 | 213 | 348 | 123 | 237 | 48 | 70 | 57 | 0 | 3 | 4095 |

**Table 3.3.9. Haddock in Division VIa. TSA parameter estimates from this year's assessment, along with those from previous assessments for comparison. * = fixed parameter.**

| Parameter | Notation | Description | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial fishing mortality | F (1, 1978) | Fishing mortality-at-age a in year y | 0.42 | 0.28 | 0.26 | 0.23 | 0.25 | 0.40 | 0.40 | 0.43 | 0.4105 |
| | F (2, 1978) | | 0.67 | 0.5 | 0.51 | 0.50 | 0.56 | 0.71 | 0.70 | 0.81 | 0.6707 |
| | F (4, 1978) | | 0.53 | 0.51 | 0.51 | 0.51 | 0.52 | 0.56 | 0.57 | 0.59 | 0.5971 |
| Survey selectivities | □(1) | | 3.99 | 2.25 | 2.35 | 2.49 | 2.58 | 2.60 | 2.58 | 3.11 | 2.50 |
| ScoGFS Q1 | □(2) | ScoGFS Q1 survey selectivity-at-age a | 4.84 | 2.71 | 2.45 | 2.55 | 3.01 | 3.07 | 3.01 | 3.34 | 2.86 |
| | □(4) | | 2.1 | 1.51 | 2.11 | 2.19 | 2.04 | 1.92 | 1.94 | 2.24 | 1.93 |
| Survey selectivities | □(1) | | - | - | - | 1.99 | 1.62 | 1.77 | 1.75 | 2.24 | 2.09 |
| ScoGFS Q4 | □(2) | ScoGFS Q4 survey selectivity-at-age a | - | - | - | 1.99 | 1.76 | 1.88 | 1.84 | 2.22 | 2.10 |
| | □(4) | | - | - | - | 2.25 | 2.39 | 2.61 | 2.64 | 3.44 | 2.76 |
| Fishing mortality standard deviations | □F | Transitory changes in overall F | 0.00 | 0.11 | 0.10 | 0.10 | 0.12 | 0.20 | 0.20 | 0.19 | 0.076 |
| | □U | Persistent changes in selection (age effect in F) | 0.05 | 0.04 | 0.01 | 0.00 | 0.09 | 0.03 | 0.03 | 0.05 | 0.08 |
| | □V | Transitory changes in the year effect in F | 0.27 | 0.23 | 0.22 | 0.23 | 0.23 | 0.33 | 0.35 | 0.26 | 0.25 |
| | □Y | Persistent changes in the year effect in F | 0.00 | 0.14 | 0.09 | 0.09 | 0.07 | 0.00 | 0.00 | 0.15 | 0.17 |
| Survey catchability standard deviations | □□□□ | Transitory changes in ScoGFS Q1 catchability | 0.00 | 0.08 | 0.18 | 0.30 | 0.19 | 0.12 | 0.12 | 0.27 | 0.23 |
| | □□□□ | Persistent changes in ScoGFS Q1 catchability | 0.14 | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00 | 0 |
| | □□□□ | Transitory changes in ScoGFS Q4 catchability | - | - | - | | 0.16 | 0.20 | 0.19 | 0.21 | 0.17 |
| | □□□□ | Persistent changes in ScoGFS Q4 catchability | - | - | - | | 0.00* | 0.00* | 0.00* | 0.00 | 0.00 |
| Measurement coefficients of variation | cv landings | Coefficent of variation of landings-at-age data | 0.22 | 0.25 | 0.23 | 0.20 | 0.20 | 0.24 | 0.25 | 0.28 | 0.24 |
| | cv discards | Coefficent of variation of discards-at-age data | 0.51 | 0.43 | 0.45 | 0.42 | 0.41 | 0.54 | 0.54 | 0.59 | 0.51 |
| | cv survey | Coefficent of variation of ScoGFS Q1 survey data | 0.40 | 0.34 | 0.53 | 0.57 | 0.33 | 0.35 | 0.36 | 0.41 | 0.37 |
| | cv survey | Coefficent of variation of ScoGFS Q4 survey data | - | - | - | 0.57 | 0.22 | 0.34 | 0.35 | 0.51 | 0.41 |

**Table 3.3.9. Continued. Haddock in Division VIa. TSA parameter estimates from this year's assessment, along with those from previous assessments for comparison. * = fixed parameter.**

| Parameter | Notation | Description | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Discard curve parameters | □P | Transitory changes in overall discard proportion | 0.50 | 0.19 | 0.20 | 0.19 | 0.18 | 0.20 | 0.20 | 0.00 | 0.30 |
| | □□ 1 | Transitory changes in discard-ogive intercept | 0.00 | 0.15 | 0.02 | 0.00 | 0.14 | 0.00 | 0.00 | 0.01 | 0.00 |
| | □□ 1 | Persistent changes in discard-ogive intercept | 0.26 | 0.21 | 0.22 | 0.21 | 0.32 | 0.26 | 0.25 | 0.29 | 0.28 |
| | □□ 2 | Transitory changes in discard-ogive slope | 0.34 | 0.01 | 0.03 | 0.21 | 0.23 | 0.22 | 0.23 | 0.40 | 0.36 |
| | □□ 2 | Persistent changes in discard-ogive slope | 0.02 | 0.61 | 0.43 | 0.23 | 0.002 | 0.000 | 0.000 | 0.00 | 0.0 |
| Trend parameters | □□ 1 | Trend parameter for discard-ogive intercept | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00 |
| | □□ 2 | Trend parameter for discard-ogive slope | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00 |
| Recruitment | □1 | Ricker parameter (slope at the origin) | 9.10 | 9.63 | 9.71 | 9.73 | 9.06 | 11.35 | 11.08 | 9.62 | 10.84 |
| | □2 | Ricker parameter (curve dome occurs at $1/\eta^2$) | 0.33 | 0.29 | 0.31 | 0.29 | 0.30 | 0.35 | 0.35 | 0.39 | 0.36 |
| | cv rec | Coefficent of variation of recruitment curve | 0.52 | 0.89 | 0.89 | 0.90 | 0.62 | 0.60 | 0.61 | 0.69 | 0.55 |

**Table 3.3.10. Haddock in Division VIa. Estimates of population abundance (in thousands) from the final TSA run.**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| 1978 | 69076 | 8047 | 2435 | 59099 | 4412 | 610 | 479 | 1045 |
| 1979 | 155068 | 41185 | 3905 | 1057 | 22713 | 1509 | 220 | 561 |
| 1980 | 501887 | 87106 | 17587 | 1513 | 371 | 7548 | 448 | 241 |
| 1981 | 63026 | 322440 | 44882 | 7215 | 593 | 151 | 2985 | 254 |
| 1982 | 71169 | 41985 | 191820 | 22592 | 3459 | 290 | 75 | 1565 |
| 1983 | 44787 | 47495 | 24885 | 103340 | 11666 | 1798 | 150 | 853 |
| 1984 | 336806 | 28409 | 25639 | 10930 | 47148 | 5308 | 805 | 469 |
| 1985 | 73355 | 200978 | 12036 | 9748 | 4633 | 19894 | 2214 | 530 |
| 1986 | 59617 | 42544 | 94867 | 5011 | 4044 | 2001 | 8342 | 1170 |
| 1987 | 270616 | 38677 | 23127 | 48080 | 2564 | 2086 | 1039 | 4891 |
| 1988 | 22295 | 146689 | 14890 | 8018 | 16477 | 860 | 696 | 2021 |
| 1989 | 16216 | 11586 | 61178 | 5493 | 2844 | 5867 | 311 | 976 |
| 1990 | 98947 | 7993 | 4413 | 22949 | 1916 | 958 | 1983 | 437 |
| 1991 | 126295 | 58734 | 3319 | 1837 | 9526 | 792 | 398 | 999 |
| 1992 | 180215 | 71060 | 24172 | 1183 | 701 | 3573 | 300 | 526 |
| 1993 | 184579 | 111886 | 33850 | 10182 | 524 | 308 | 1555 | 359 |
| 1994 | 57675 | 103697 | 42158 | 9632 | 3023 | 147 | 87 | 555 |
| 1995 | 207798 | 33973 | 49726 | 16691 | 3742 | 1205 | 59 | 254 |
| 1996 | 113294 | 121442 | 15410 | 19826 | 6401 | 1447 | 471 | 122 |
| 1997 | 132049 | 62616 | 51198 | 5507 | 7326 | 2303 | 529 | 217 |
| 1998 | 146197 | 73795 | 25618 | 17836 | 1993 | 2644 | 826 | 269 |
| 1999 | 31542 | 80334 | 29209 | 8781 | 6199 | 714 | 964 | 385 |
| 2000 | 508661 | 16945 | 31033 | 9730 | 3142 | 2058 | 251 | 472 |
| 2001 | 199368 | 262441 | 6103 | 8984 | 2887 | 960 | 584 | 213 |
| 2002 | 97823 | 120660 | 128097 | 2633 | 3583 | 1142 | 386 | 316 |
| 2003 | 115446 | 65154 | 70712 | 71262 | 1306 | 1769 | 574 | 351 |
| 2004 | 46052 | 74446 | 36248 | 37658 | 32041 | 590 | 797 | 420 |
| 2005 | 29476 | 28859 | 39761 | 18464 | 17194 | 14204 | 259 | 539 |
| 2006 | 104721 | 16680 | 13506 | 16610 | 6718 | 6367 | 5010 | 286 |
| 2007 | 23103 | 67262 | 8389 | 6844 | 7402 | 2959 | 2826 | 2317 |
| 2008 | 13972 | 14864 | 40984 | 4871 | 3609 | 3843 | 1550 | 2688 |
| 2009 | 24596 | 9341 | 9475 | 26729 | 2896 | 2163 | 2284 | 2528 |
| 2010 | 134971 | 17346 | 6198 | 6541 | 17191 | 1854 | 1388 | 3089 |
| | | | | | | | | |
| 2011 | 17382 | 94357 | 11441 | 4224 | 4270 | 11096 | 1206 | 2913 |
| 2012 | 109794 | 12098 | 61313 | 7693 | 2671 | 2700 | 7017 | 2604 |

***Estimates for 2011 and 2012 are TSA forecasts.**

**Table 3.3.11. Haddock in Division VIa. Standard errors of estimates of population abundance (in thousands) from the final TSA run.**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| 1978 | 7680.7581 | 713.66067 | 282.89319 | 375.24692 | 1044.4071 | 186.34319 | 107.50876 | 285.40186 |
| 1979 | 15059.291 | 3980.6091 | 329.16963 | 133.86536 | 1721.3997 | 495.44174 | 94.586488 | 156.12112 |
| 1980 | 41490.823 | 8085.3057 | 2033.4584 | 165.66072 | 61.472679 | 1012.6672 | 233.73317 | 92.155607 |
| 1981 | 6654.6378 | 26490.176 | 4773.8027 | 1034.1256 | 91.605527 | 34.758886 | 579.40641 | 138.96673 |
| 1982 | 7879.5052 | 4493.1513 | 16596.352 | 2553.1159 | 541.78473 | 54.524069 | 20.756808 | 376.11037 |
| 1983 | 5930.2272 | 5301.4998 | 2719.1761 | 8783.4684 | 1272.9889 | 288.97068 | 31.157739 | 207.21062 |
| 1984 | 35541.225 | 3333.0356 | 2553.07 | 1119.787 | 3432.92 | 496.84632 | 115.2341 | 85.335489 |
| 1985 | 8170.0062 | 19845.891 | 1475.278 | 1217.3977 | 448.42292 | 1938.8053 | 292.31023 | 79.392071 |
| 1986 | 6425.4495 | 4464.2209 | 9170.227 | 575.77142 | 513.51126 | 252.55782 | 1162.8688 | 189.29034 |
| 1987 | 34147.264 | 3923.4529 | 2477.3898 | 4627.164 | 284.87577 | 269.57087 | 146.39853 | 718.51068 |
| 1988 | 4091.8135 | 15764.112 | 1455.735 | 909.1432 | 1736.3719 | 118.58138 | 124.6594 | 346.98751 |
| 1989 | 3684.6073 | 1517.0202 | 6374.9505 | 586.22854 | 342.8845 | 739.44152 | 54.471433 | 180.00044 |
| 1990 | 12002.917 | 1558.2411 | 544.19818 | 2718.3574 | 234.10389 | 156.06351 | 365.28894 | 99.563423 |
| 1991 | 13233.463 | 6768.8043 | 493.36272 | 200.67548 | 1012.8211 | 94.94132 | 66.811831 | 174.00583 |
| 1992 | 18430.666 | 6662.2247 | 2595.0451 | 163.30142 | 70.478959 | 429.60654 | 43.529415 | 85.957254 |
| 1993 | 20082.854 | 10929.535 | 2855.6964 | 1066.1101 | 54.97695 | 29.71376 | 192.01416 | 47.441912 |
| 1994 | 11308.729 | 11640.395 | 4196.0058 | 953.25349 | 274.18639 | 13.249435 | 10.510903 | 66.540817 |
| 1995 | 28308.588 | 6841.1845 | 7213.707 | 2722.0073 | 598.45578 | 188.21762 | 9.7276637 | 44.685884 |
| 1996 | 19973.849 | 19181.761 | 3403.0847 | 3652.4585 | 1243.8714 | 281.86356 | 93.58631 | 25.939739 |
| 1997 | 22400.347 | 11183.5 | 9382.6976 | 1087.9189 | 1225.9712 | 440.08745 | 108.10771 | 45.902796 |
| 1998 | 22859.317 | 11750.603 | 4405.5472 | 3062.1764 | 299.74394 | 357.06128 | 138.46706 | 47.450485 |
| 1999 | 9731.3542 | 12759.485 | 4974.0646 | 1385.9393 | 1027.9695 | 105.3525 | 145.12154 | 66.07159 |
| 2000 | 101502.11 | 5353.7406 | 6147.4025 | 1853.1624 | 535.52209 | 441.13812 | 50.149917 | 96.534405 |
| 2001 | 24270.173 | 47902.459 | 1632.5661 | 1748.7471 | 522.07933 | 165.85059 | 151.5133 | 52.754375 |
| 2002 | 14415.294 | 13500.63 | 20620.75 | 432.27296 | 543.75467 | 162.96822 | 58.445121 | 65.533372 |
| 2003 | 14442.976 | 9398.3911 | 8198.4331 | 10455.959 | 205.25986 | 273.0398 | 88.064524 | 60.491915 |
| 2004 | 6197.1757 | 9480.1881 | 5206.3832 | 4636.9955 | 4607.3458 | 99.647874 | 141.42527 | 74.684069 |
| 2005 | 4278.4364 | 3762.3073 | 5591.0329 | 2527.6238 | 2137.7359 | 2188.6836 | 48.473927 | 99.688369 |
| 2006 | 8370.2525 | 2267.4624 | 1444.7327 | 1822.0121 | 739.54094 | 749.92949 | 831.71256 | 54.016837 |
| 2007 | 2836.5048 | 5320.5852 | 1211.0334 | 725.31779 | 867.9712 | 390.21218 | 425.6539 | 453.03156 |
| 2008 | 2908.9791 | 1712.4127 | 3552.5262 | 624.64609 | 417.67572 | 521.90423 | 245.46834 | 460.10377 |
| 2009 | 5609.6048 | 1944.9403 | 1091.4156 | 2404.2826 | 411.57506 | 289.39346 | 360.00954 | 423.10283 |
| 2010 | 23852.56 | 4054.1239 | 1346.5629 | 839.58052 | 1801.0605 | 296.73358 | 212.11782 | 491.31837 |
| | | | | | | | | |
| 2011 | 33812.363 | 17505.255 | 2756.9394 | 941.67446 | 611.38282 | 1406.5954 | 217.02947 | 470.14959 |
| 2012 | 60768.184 | 23571.761 | 13097.995 | 1998.5183 | 665.02937 | 506.02365 | 1250.4611 | 527.52466 |

***Estimates for 2011 and 2012 are TSA forecasts.**

**Table 3.3.12. Haddock in Division VIa. Estimates of fishing mortality from the final TSA run.**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| 1978 | 0.2988685 | 0.4458873 | 0.6341248 | 0.7636918 | 0.766471 | 0.7579773 | 0.7517134 | 0.7548334 |
| 1979 | 0.3766399 | 0.6299629 | 0.7454233 | 0.8538543 | 0.870116 | 0.8615486 | 0.8666279 | 0.8656776 |
| 1980 | 0.2585282 | 0.4612172 | 0.6134899 | 0.6947724 | 0.6636843 | 0.6779775 | 0.6760237 | 0.6718661 |
| 1981 | 0.2104816 | 0.3372768 | 0.4697196 | 0.4964646 | 0.4968406 | 0.489848 | 0.4990518 | 0.4964275 |
| 1982 | 0.20192 | 0.3207524 | 0.4063326 | 0.4619612 | 0.4562779 | 0.4618071 | 0.4637395 | 0.4575135 |
| 1983 | 0.2807623 | 0.423583 | 0.4373751 | 0.4741334 | 0.4815324 | 0.4863003 | 0.4856971 | 0.4943724 |
| 1984 | 0.325025 | 0.6037283 | 0.7282339 | 0.6584988 | 0.6543647 | 0.6706382 | 0.6718816 | 0.6655837 |
| 1985 | 0.3448145 | 0.5516437 | 0.6637909 | 0.663027 | 0.6379627 | 0.6667289 | 0.6507081 | 0.6465875 |
| 1986 | 0.2262162 | 0.4109287 | 0.476569 | 0.4648742 | 0.4579504 | 0.4512355 | 0.4625107 | 0.4632209 |
| 1987 | 0.4123337 | 0.7496722 | 0.8586961 | 0.871231 | 0.8926179 | 0.8953901 | 0.884557 | 0.8746061 |
| 1988 | 0.4053304 | 0.6757967 | 0.7965007 | 0.8336872 | 0.8323018 | 0.8160659 | 0.8197768 | 0.8261099 |
| 1989 | 0.4050814 | 0.6965645 | 0.7719975 | 0.8363724 | 0.8563897 | 0.8603704 | 0.8556128 | 0.854311 |
| 1990 | 0.3227772 | 0.6446311 | 0.6784371 | 0.672039 | 0.6741911 | 0.662637 | 0.6730879 | 0.6717257 |
| 1991 | 0.3631173 | 0.6880489 | 0.8045591 | 0.752443 | 0.7807398 | 0.7642939 | 0.7762774 | 0.7671235 |
| 1992 | 0.252216 | 0.4849945 | 0.6528354 | 0.6089101 | 0.5748144 | 0.5977391 | 0.5942593 | 0.5887749 |
| 1993 | 0.3665189 | 0.7350086 | 0.9936309 | 0.9284949 | 0.9214506 | 0.9595969 | 0.939885 | 0.9427282 |
| 1994 | 0.3421254 | 0.5169411 | 0.7146191 | 0.7401114 | 0.7076728 | 0.7083775 | 0.7221441 | 0.7156858 |
| 1995 | 0.3378486 | 0.5825792 | 0.7197008 | 0.7548053 | 0.7489767 | 0.7384421 | 0.7438222 | 0.7442031 |
| 1996 | 0.3925833 | 0.6648649 | 0.82824 | 0.7955944 | 0.8210597 | 0.8059715 | 0.8034656 | 0.8076895 |
| 1997 | 0.3935855 | 0.6963258 | 0.8603952 | 0.8080388 | 0.7805034 | 0.824308 | 0.8095365 | 0.8083949 |
| 1998 | 0.4024028 | 0.7274882 | 0.8651421 | 0.8631002 | 0.8185784 | 0.8040871 | 0.843675 | 0.8323807 |
| 1999 | 0.408201 | 0.7477899 | 0.8984973 | 0.8454646 | 0.8818322 | 0.842924 | 0.8378588 | 0.8554247 |
| 2000 | 0.4587839 | 0.8504375 | 1.0375051 | 1.0214988 | 0.9912442 | 1.0516206 | 1.0153849 | 1.0209357 |
| 2001 | 0.287581 | 0.5308291 | 0.6919276 | 0.7230524 | 0.7072814 | 0.6951046 | 0.7263344 | 0.7135568 |
| 2002 | 0.2064314 | 0.3315148 | 0.4166309 | 0.50201 | 0.5029943 | 0.4858028 | 0.4842632 | 0.4935976 |
| 2003 | 0.2392339 | 0.3920784 | 0.4214175 | 0.5952535 | 0.5972565 | 0.5997924 | 0.5961619 | 0.5903967 |
| 2004 | 0.2656114 | 0.4251686 | 0.4776931 | 0.5839767 | 0.6134374 | 0.6227742 | 0.6143708 | 0.6112762 |
| 2005 | 0.3644565 | 0.5679953 | 0.6589535 | 0.8106179 | 0.7937831 | 0.8318731 | 0.823936 | 0.8180149 |
| 2006 | 0.262802 | 0.4498199 | 0.4765107 | 0.6003383 | 0.6153198 | 0.6082807 | 0.619521 | 0.6059282 |
| 2007 | 0.2320079 | 0.2966227 | 0.3594623 | 0.4394955 | 0.451298 | 0.4434752 | 0.4453908 | 0.4437779 |
| 2008 | 0.1782784 | 0.2480998 | 0.2213478 | 0.3175094 | 0.3110835 | 0.3187046 | 0.3149822 | 0.3148026 |
| 2009 | 0.1460121 | 0.2079865 | 0.1701751 | 0.2403887 | 0.2464547 | 0.2437485 | 0.2444435 | 0.2423229 |
| 2010 | 0.1507412 | 0.2088229 | 0.1765188 | 0.224757 | 0.23692 | 0.2296376 | 0.2304808 | 0.2292399 |
| | | | | | | | | |
| 2011 | 0.1623416 | 0.2310901 | 0.1969336 | 0.2583396 | 0.2583097 | 0.258259 | 0.2584656 | 0.2583959 |
| 2012 | 0.1639251 | 0.2338546 | 0.1991835 | 0.2613319 | 0.2613319 | 0.2613319 | 0.2613319 | 0.2613319 |

***Estimates for 2011 and 2012 are TSA forecasts.**

**Table 3.3.13. Haddock in Division VIa. Standard errors of estimates of log fishing mortality from the final TSA run.**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| 1978 | 0.206453 | 0.148727 | 0.150504 | 0.108707 | 0.115775 | 0.122662 | 0.125273 | 0.12418 |
| 1979 | 0.190304 | 0.136666 | 0.126038 | 0.112172 | 0.106457 | 0.116014 | 0.12161 | 0.120787 |
| 1980 | 0.208158 | 0.148104 | 0.145012 | 0.119063 | 0.12446 | 0.120835 | 0.129743 | 0.130305 |
| 1981 | 0.209366 | 0.161555 | 0.143026 | 0.128513 | 0.131389 | 0.135432 | 0.135355 | 0.138316 |
| 1982 | 0.201553 | 0.153463 | 0.140118 | 0.12315 | 0.125167 | 0.129327 | 0.134997 | 0.131419 |
| 1983 | 0.184809 | 0.1416 | 0.149031 | 0.116512 | 0.11937 | 0.123065 | 0.128858 | 0.12718 |
| 1984 | 0.21629 | 0.141486 | 0.125516 | 0.122116 | 0.117068 | 0.126711 | 0.130847 | 0.131687 |
| 1985 | 0.190243 | 0.141482 | 0.137154 | 0.117076 | 0.119771 | 0.121926 | 0.128573 | 0.129561 |
| 1986 | 0.203079 | 0.148184 | 0.138435 | 0.125298 | 0.126471 | 0.129743 | 0.132856 | 0.134561 |
| 1987 | 0.19178 | 0.12471 | 0.121978 | 0.100229 | 0.104401 | 0.111435 | 0.11682 | 0.114219 |
| 1988 | 0.198018 | 0.136202 | 0.12154 | 0.106595 | 0.107466 | 0.115629 | 0.120396 | 0.119079 |
| 1989 | 0.202943 | 0.146291 | 0.131197 | 0.108204 | 0.110479 | 0.113555 | 0.121968 | 0.120986 |
| 1990 | 0.194262 | 0.144491 | 0.143296 | 0.118571 | 0.119718 | 0.123929 | 0.127724 | 0.129457 |
| 1991 | 0.190284 | 0.136179 | 0.138359 | 0.110111 | 0.110501 | 0.118149 | 0.123135 | 0.121775 |
| 1992 | 0.196615 | 0.140633 | 0.133626 | 0.118286 | 0.118913 | 0.123312 | 0.128944 | 0.128488 |
| 1993 | 0.191276 | 0.127054 | 0.109989 | 0.101333 | 0.102957 | 0.116037 | 0.116956 | 0.119794 |
| 1994 | 0.235951 | 0.198522 | 0.186487 | 0.164914 | 0.167563 | 0.173068 | 0.174508 | 0.174294 |
| 1995 | 0.313633 | 0.26698 | 0.251585 | 0.229771 | 0.230826 | 0.232599 | 0.234215 | 0.234215 |
| 1996 | 0.309893 | 0.25826 | 0.253674 | 0.228216 | 0.227918 | 0.229333 | 0.230655 | 0.231699 |
| 1997 | 0.294442 | 0.238737 | 0.219479 | 0.200516 | 0.200392 | 0.201758 | 0.204296 | 0.205411 |
| 1998 | 0.300334 | 0.238714 | 0.229005 | 0.198704 | 0.199751 | 0.201172 | 0.203111 | 0.204586 |
| 1999 | 0.312079 | 0.249444 | 0.237881 | 0.215584 | 0.214342 | 0.215604 | 0.216602 | 0.218279 |
| 2000 | 0.312464 | 0.247619 | 0.224117 | 0.207523 | 0.206965 | 0.207899 | 0.210009 | 0.211204 |
| 2001 | 0.317023 | 0.253042 | 0.241566 | 0.214318 | 0.215251 | 0.215485 | 0.216871 | 0.218404 |
| 2002 | 0.326674 | 0.265213 | 0.256829 | 0.228131 | 0.227145 | 0.227669 | 0.227915 | 0.229972 |
| 2003 | 0.325278 | 0.266759 | 0.250366 | 0.226513 | 0.225861 | 0.226795 | 0.228187 | 0.229242 |
| 2004 | 0.327999 | 0.265352 | 0.250926 | 0.230496 | 0.230195 | 0.231583 | 0.232418 | 0.233467 |
| 2005 | 0.298893 | 0.23372 | 0.204967 | 0.183508 | 0.183724 | 0.18671 | 0.189898 | 0.189999 |
| 2006 | 0.232325 | 0.169921 | 0.154264 | 0.121719 | 0.122623 | 0.125637 | 0.130809 | 0.133124 |
| 2007 | 0.237761 | 0.179961 | 0.172191 | 0.132762 | 0.13316 | 0.135659 | 0.140711 | 0.14191 |
| 2008 | 0.243622 | 0.196434 | 0.195269 | 0.145507 | 0.146524 | 0.147506 | 0.152729 | 0.153586 |
| 2009 | 0.252796 | 0.21284 | 0.215753 | 0.159105 | 0.159074 | 0.160202 | 0.16481 | 0.16558 |
| 2010 | 0.279207 | 0.243262 | 0.251027 | 0.176641 | 0.17748 | 0.178924 | 0.183039 | 0.18314 |
| | | | | | | | | |
| 2011 | 0.445671 | 0.410543 | 0.412679 | 0.383666 | 0.383651 | 0.383678 | 0.383668 | 0.383683 |
| 2012 | 0.483273 | 0.451159 | 0.453215 | 0.426662 | 0.426662 | 0.426662 | 0.426662 | 0.426662 |

***Estimates for 2011 and 2012 are TSA forecasts.**

**Table 3.3.14. Haddock in Division VIa. Stock summary from final TSA run. "Obs." denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield. "Pred." are TSA estimates, and "SE" denotes standard errors. *Estimates for 2011 and 2012 are TSA projections.**

| Year | Landings (tonnes) | | | Discards (tonnes) | | | Total catches (tonnes) | | | Mean F(2–6) | | SSB (tonnes) | | Recruitment (000s at age 1) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Pred. | SE | Obs. | Pred. | SE | Obs. | Pred. | SE | Estimate | SE | Estimate | SE | Estimate | SE |
| 1978 | 17187 | 18892 | 1439 | 2318 | 2438 | 525 | 19505 | 21308 | 1620 | 0.674 | 0.059 | 38947 | 1020 | 69076 | 7681 |
| 1979 | 14837 | 16285 | 1451 | 13841 | 9592 | 1947 | 28678 | 26042 | 2713 | 0.792 | 0.064 | 30683 | 1909 | 155068 | 15059 |
| 1980 | 12759 | 13928 | 1564 | 4715 | 16397 | 3177 | 17474 | 32034 | 4237 | 0.622 | 0.058 | 35728 | 2437 | 501887 | 41491 |
| 1981 | 18233 | 18946 | 2584 | 15048 | 14754 | 3133 | 33281 | 34640 | 4515 | 0.458 | 0.047 | 77463 | 4683 | 63026 | 6655 |
| 1982 | 29635 | 28616 | 4115 | 10063 | 7430 | 1625 | 39698 | 34693 | 4132 | 0.421 | 0.041 | 102365 | 6732 | 71169 | 7880 |
| 1983 | 29411 | 29903 | 3332 | 6781 | 5230 | 1008 | 36192 | 35084 | 3573 | 0.461 | 0.042 | 92449 | 5473 | 44787 | 5930 |
| 1984 | 30689 | 27519 | 2409 | 15666 | 14735 | 3264 | 46355 | 42614 | 4639 | 0.663 | 0.059 | 63486 | 3085 | 336806 | 35541 |
| 1985 | 24451 | 23728 | 2329 | 17385 | 16310 | 3270 | 41837 | 39833 | 4571 | 0.637 | 0.057 | 67393 | 4069 | 73355 | 8170 |
| 1986 | 19561 | 19966 | 2399 | 7153 | 5082 | 1038 | 26714 | 23972 | 2745 | 0.452 | 0.044 | 60311 | 4027 | 59617 | 6425 |
| 1987 | 27012 | 29271 | 2613 | 16193 | 15710 | 3530 | 43205 | 45066 | 4887 | 0.854 | 0.064 | 54488 | 3381 | 270616 | 34147 |
| 1988 | 21153 | 21302 | 2217 | 9519 | 10188 | 2268 | 30672 | 31567 | 3685 | 0.791 | 0.064 | 47728 | 3103 | 22295 | 4092 |
| 1989 | 16691 | 18809 | 2335 | 2979 | 3028 | 767 | 19669 | 21320 | 2546 | 0.804 | 0.068 | 38836 | 2939 | 16216 | 3685 |
| 1990 | 10141 | 10854 | 1374 | 5381 | 3205 | 709 | 15522 | 13169 | 1630 | 0.666 | 0.062 | 21962 | 1800 | 98947 | 12003 |
| 1991 | 10557 | 10080 | 1037 | 8691 | 9624 | 1823 | 19248 | 20258 | 2485 | 0.758 | 0.064 | 21702 | 1531 | 126295 | 13233 |
| 1992 | 11351 | 10105 | 1120 | 9161 | 9192 | 1542 | 20513 | 20008 | 2217 | 0.584 | 0.053 | 29703 | 1901 | 180215 | 18431 |
| 1993 | 19068 | 18345 | 1767 | 16803 | 16303 | 2365 | 35871 | 34667 | 3028 | 0.908 | 0.069 | 42622 | 2545 | 184579 | 20083 |
| 1994 | 14272 | 12130 | 1530 | 11070 | 11903 | 2173 | 25342 | 24406 | 2840 | 0.678 | 0.101 | 40773 | 2981 | 57675 | 11309 |
| 1995 | 12368 | 14613 | 3824 | 8552 | 12543 | 3458 | 20920 | 26819 | 6216 | 0.709 | 0.154 | 36738 | 4682 | 207798 | 28309 |

**Continued on next page.**

**Table 3.3.14. Continued. Haddock in Division VIa. Stock summary from final TSA run. "Obs." denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield. "Pred." are TSA estimates, and "SE" denotes standard errors. *Estimates for 2011 and 2012 are TSA projections.**

| Year | Landings (tonnes) | | | Discards (tonnes) | | | Total catches (tonnes) | | | Mean F(2-6) | | SSB (tonnes) | | Recruitment (000s at age 1) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obs. | Pred. | SE | Obs. | Pred. | SE | Obs. | Pred. | SE | Estimate | SE | Estimate | SE | Estimate | SE |
| 1996 | 13466 | 13691 | 4037 | 11351 | 14178 | 3841 | 24817 | 28210 | 6944 | 0.783 | 0.166 | 37934 | 5269 | 113294 | 19974 |
| 1997 | 12883 | 15163 | 4268 | 6461 | 13925 | 3674 | 19344 | 30163 | 6622 | 0.794 | 0.145 | 41243 | 5718 | 132049 | 22400 |
| 1998 | 14401 | 12529 | 3324 | 5535 | 15715 | 3941 | 19936 | 29464 | 6326 | 0.816 | 0.150 | 35194 | 4326 | 146197 | 22859 |
| 1999 | 10464 | 11114 | 3198 | 4856 | 10498 | 2884 | 15321 | 22636 | 5058 | 0.843 | 0.166 | 32270 | 4012 | 31542 | 9731 |
| 2000 | 6958 | 10288 | 3020 | 7893 | 24856 | 8530 | 14851 | 35652 | 10146 | 0.990 | 0.185 | 22040 | 3526 | 508661 | 101502 |
| 2001 | 6762 | 7957 | 3182 | 6626 | 23531 | 6854 | 13389 | 33244 | 9199 | 0.670 | 0.132 | 45318 | 7411 | 199368 | 24270 |
| 2002 | 7115 | 10999 | 4264 | 8862 | 12067 | 3531 | 15977 | 22412 | 5553 | 0.448 | 0.094 | 58550 | 7275 | 97823 | 14415 |
| 2003 | 5337 | 17543 | 4783 | 4101 | 9935 | 2814 | 9438 | 26005 | 5610 | 0.521 | 0.109 | 58965 | 5908 | 115446 | 14443 |
| 2004 | 3874 | 14060 | 3588 | 3705 | 6905 | 1919 | 7579 | 19504 | 4388 | 0.545 | 0.116 | 43522 | 4352 | 46052 | 6197 |
| 2005 | 3792 | 16289 | 3733 | 2902 | 5645 | 1601 | 6694 | 20560 | 4187 | 0.733 | 0.121 | 38990 | 4037 | 29476 | 4278 |
| 2006 | 6266 | 7374 | 908 | 4618 | 5792 | 1062 | 10884 | 12991 | 1479 | 0.550 | 0.053 | 22781 | 1461 | 104721 | 8370 |
| 2007 | 3777 | 4250 | 471 | 3968 | 4094 | 720 | 7745 | 8327 | 1000 | 0.398 | 0.044 | 22194 | 1342 | 23103 | 2837 |
| 2008 | 2848 | 3802 | 436 | 1229 | 2155 | 485 | 4077 | 6189 | 808 | 0.283 | 0.036 | 27295 | 1850 | 13972 | 2909 |
| 2009 | 2851 | 3269 | 484 | 1643 | 1558 | 356 | 4494 | 4824 | 560 | 0.222 | 0.031 | 22766 | 1706 | 24596 | 5610 |
| 2010 | 3016 | 3174 | 362 | 2812 | 1748 | 388 | 5828 | 5000 | 622 | 0.215 | 0.035 | 19852 | 1850 | 134971 | 23853 |
| | | | | | | | | | | | | | | | |
| 2011* | NA | 3780 | 1234 | NA | 4025 | 1628 | NA | 8110 | 2760 | 0.241 | 0.088 | 31551 | 3696 | 17382 | 33812 |
| 2012* | NA | 4488 | 1680 | NA | 3797 | 1921 | NA | 8741 | 3287 | 0.243 | 0.098 | 38156 | 7512 | 109794 | 60768 |
| Min | 2848 | 3174 | | 1229 | 1558 | | 4077 | 4824 | | 0.215 | | 19852 | | 13972 | |
| GM | 10776 | 12940 | | 6398 | 8138 | | 17683 | 22238 | | 0.592 | | 39477 | | 86793 | |
| AM | 13430 | 14994 | | 7815 | 10190 | | 21245 | 25233 | | 0.629 | | 43403 | | 129112 | |
| Max | 30689 | 29903 | | 17385 | 24856 | | 46355 | 45066 | | 0.990 | | 102365 | | 508661 | |

**Table 3.3.15. Haddock in Division VIa. Mean weights-at-age in total catches (or stock) and forecasted weights-at-age in 2011. Forecasts in this table are based on either of simple three year means or linear model projections: those that were used in the forecasts are shaded and boxed: simple three year means were used for the younger ages (1–4) and linear model projections for the older ages (5–8+). The weights for the 2000 year class are highlighted in red.**

| | | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| | 1999 | 0.172 | 0.255 | 0.365 | 0.494 | 0.611 | 0.729 | 0.840 | 1.172 |
| | 2000 | 0.127 | 0.270 | 0.361 | 0.447 | 0.572 | 0.719 | 0.840 | 0.813 |
| | 2001 | 0.112 | 0.242 | 0.403 | 0.432 | 0.514 | 0.657 | 0.808 | 1.015 |
| | 2002 | 0.118 | 0.208 | 0.307 | 0.521 | 0.606 | 0.632 | 0.636 | 0.939 |
| | 2003 | 0.124 | 0.239 | 0.282 | 0.382 | 0.652 | 0.648 | 0.908 | 1.086 |
| | 2004 | 0.112 | 0.189 | 0.290 | 0.313 | 0.373 | 0.541 | 0.715 | 0.988 |
| | 2005 | 0.103 | 0.198 | 0.295 | 0.451 | 0.429 | 0.525 | 1.163 | 1.018 |
| | 2006 | 0.155 | 0.254 | 0.326 | 0.388 | 0.471 | 0.496 | 0.563 | 1.294 |
| | 2007 | 0.115 | 0.219 | 0.331 | 0.404 | 0.456 | 0.550 | 0.593 | 0.685 |
| | 2008 | 0.113 | 0.245 | 0.367 | 0.492 | 0.570 | 0.619 | 0.708 | 0.827 |
| | 2009 | 0.135 | 0.266 | 0.357 | 0.410 | 0.570 | 0.633 | 0.630 | 1.008 |
| | 2010 | 0.067 | 0.180 | 0.388 | 0.409 | 0.459 | 0.725 | 0.755 | 0.877 |
| | | | | | | | | | |
| arithmetic mean | 2011 | 0.105 | 0.230 | 0.371 | 0.437 | 0.533 | 0.659 | 0.698 | 0.904 |
| linear model | 2011 | | | | | 0.530 | 0.561 | 0.834 | 0.991 |
| | year class in 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 |
| | | | | | | | | | |
| | CV | 0.327 | 0.193 | 0.043 | 0.109 | 0.121 | 0.088 | 0.091 | 0.104 |

**Table 3.3.16. Haddock in Division VIa. Inputs to short-term forecasts.**

| Label | Value | CV | Label | Value | CV |
|---|---|---|---|---|---|
| **Number-at-age** | | | **Stock weight** | | |
| N1 | 17381.77 | 1.95 | WS1 | 0.105 | 0.33 |
| N2 | 94356.51 | 0.19 | WS2 | 0.230 | 0.19 |
| N3 | 11440.96 | 0.24 | WS3 | 0.371 | 0.04 |
| N4 | 4223.859 | 0.22 | WS4 | 0.437 | 0.11 |
| N5 | 4270.216 | 0.14 | WS5 | 0.530 | 0.12 |
| N6 | 11095.72 | 0.13 | WS6 | 0.561 | 0.09 |
| N7 | 1205.718 | 0.18 | WS7 | 0.834 | 0.09 |
| N8 | 2912.888 | 0.16 | WS8 | 0.991 | 0.10 |
| **Removals selectivity** | | | **Removals weights** | | |
| sH1 | 0.158 | 0.11 | WH1 | 0.105 | 0.33 |
| sH2 | 0.222 | 0.10 | WH2 | 0.230 | 0.19 |
| sH3 | 0.189 | 0.15 | WH3 | 0.371 | 0.04 |
| sH4 | 0.261 | 0.19 | WH4 | 0.437 | 0.11 |
| sH5 | 0.265 | 0.15 | WH5 | 0.530 | 0.12 |
| sH6 | 0.264 | 0.18 | WH6 | 0.561 | 0.09 |
| sH7 | 0.263 | 0.17 | WH7 | 0.834 | 0.09 |
| sH8 | 0.262 | 0.18 | WH8 | 0.991 | 0.10 |
| **Natural mortality** | | | **Prop.mature.** | | |
| M1 | 0.2 | 0.1 | MT1 | 0 | 0.1 |
| M2 | 0.2 | 0.1 | MT2 | 0.57 | 0.1 |
| M3 | 0.2 | 0.1 | MT3 | 1 | 0.1 |
| M4 | 0.2 | 0.1 | MT4 | 1 | 0 |
| M5 | 0.2 | 0.1 | MT5 | 1 | 0 |
| M6 | 0.2 | 0.1 | MT6 | 1 | 0 |
| M7 | 0.2 | 0.1 | MT7 | 1 | 0 |
| M8 | 0.2 | 0.1 | MT8 | 1 | 0 |
| **Relative effort** | | | **Year effect for M** | | |
| 'HF10' | 1 | 0.08 | 'K10' | 1 | 0.1 |
| 'HF11' | 1 | 0.08 | 'K11' | 1 | 0.1 |
| 'HF12' | 1 | 0.08 | 'K12' | 1 | 0.1 |
| **Recruitment** | | | | | |
| 'R12' | 109794 | 0.606 | | | |
| 'R13' | 86793 | 1.42 | | | |
| Prop. F before spawning | 0 | | | | |
| Prop. M before spawning | 0 | | | | |

**Stock numbers in 2011 are TSA survivors.**

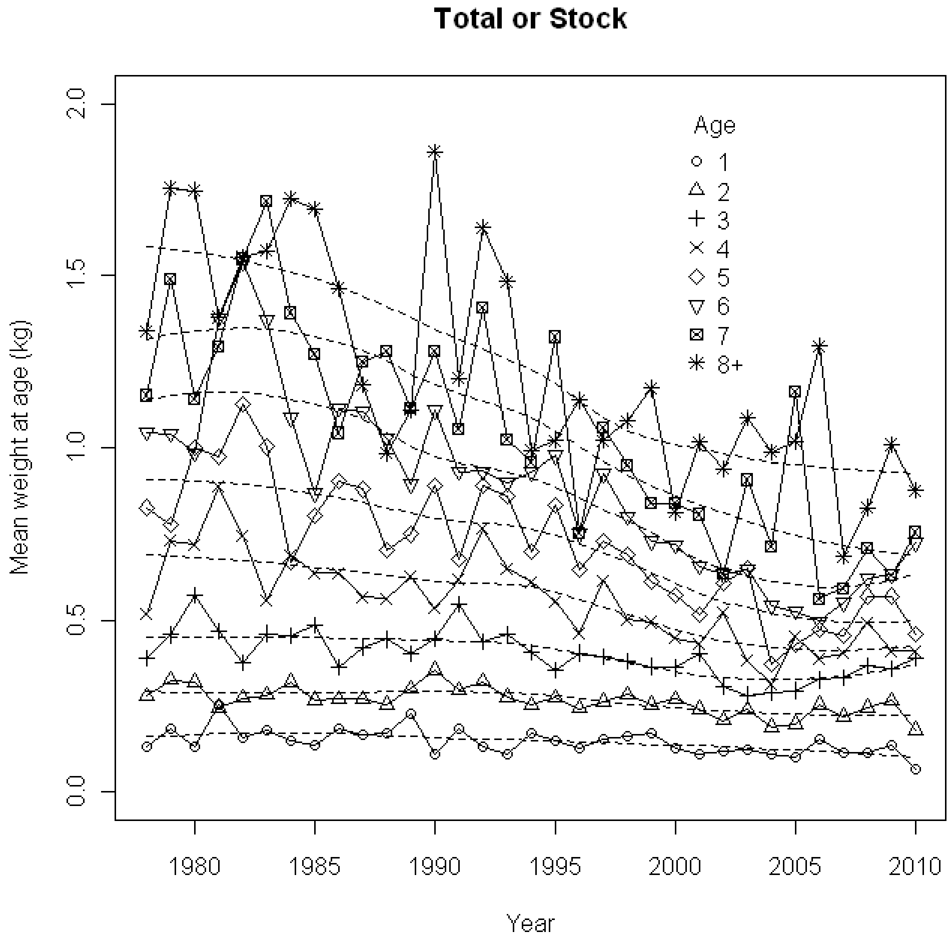



**Figure 3.3.1. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (also used for stock weights). Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.**

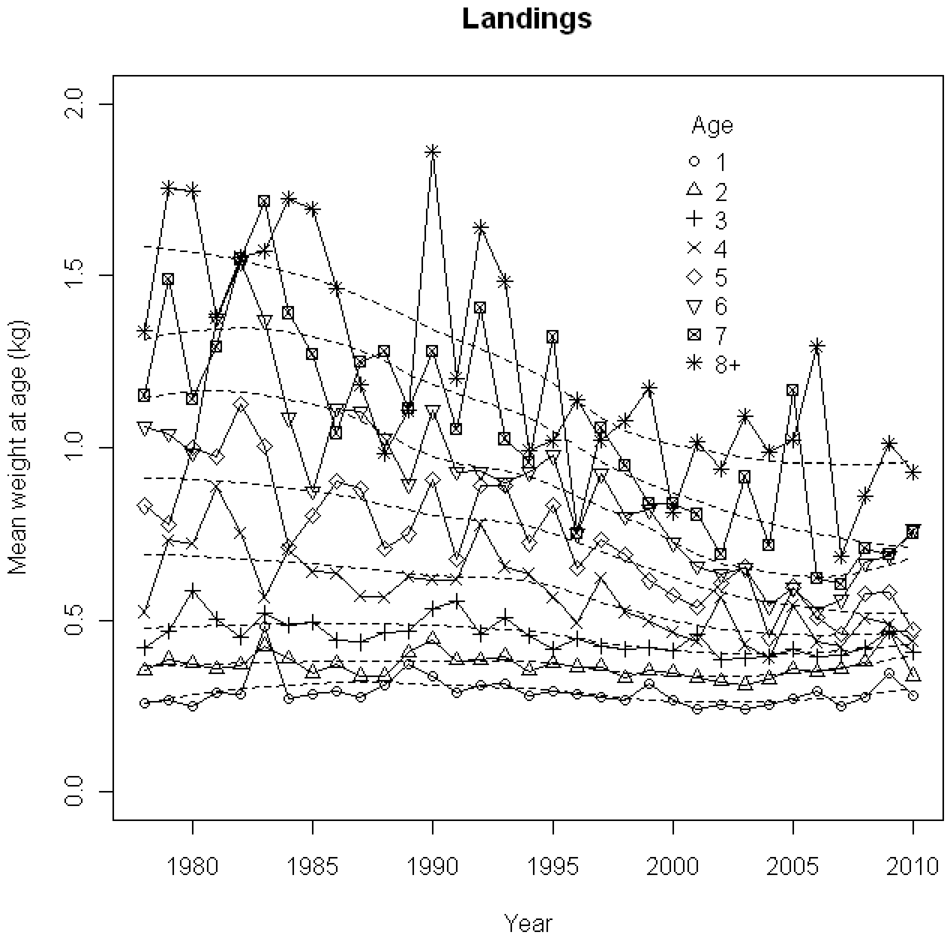



**Figure 3.3.2. Haddock in Division VIa. Mean weights-at-age (kg) in landings. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.**

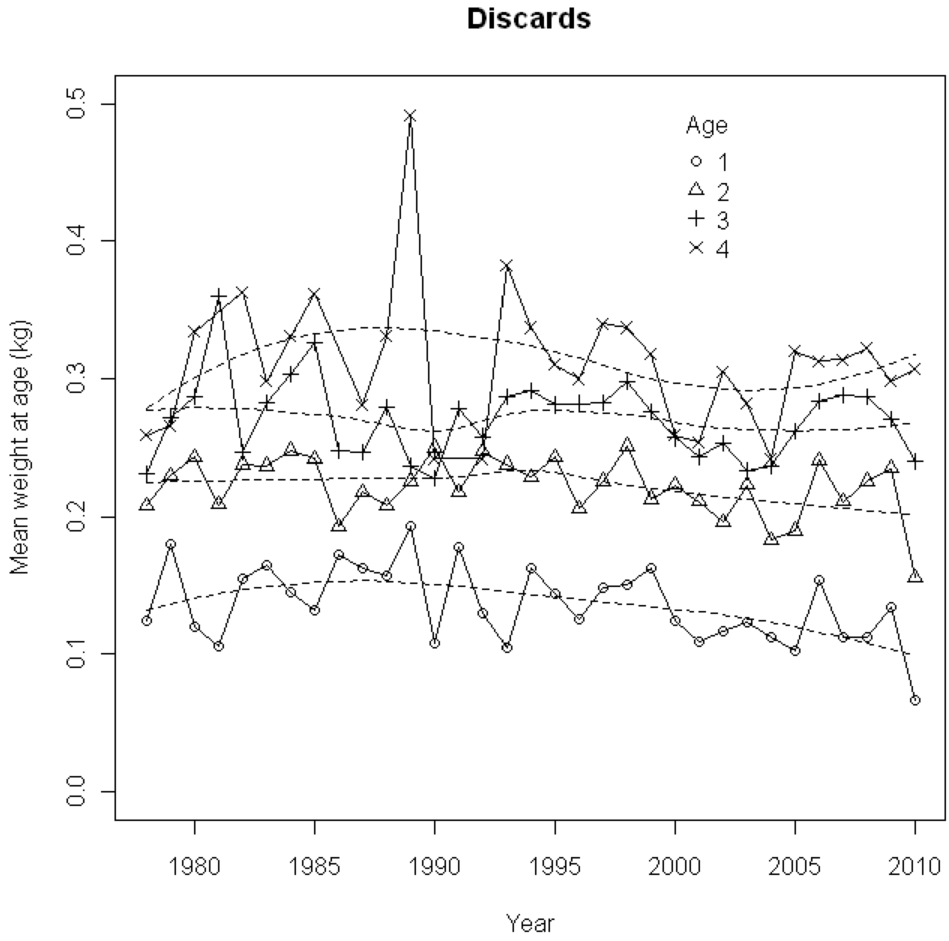



**Figure 3.3.3. Haddock in Division VIa. Mean weights-at-age (kg) in discards. Dotted lines show Loess smoothers fitted through each time-series at age. For clarity, only ages 1–4 are shown here.**

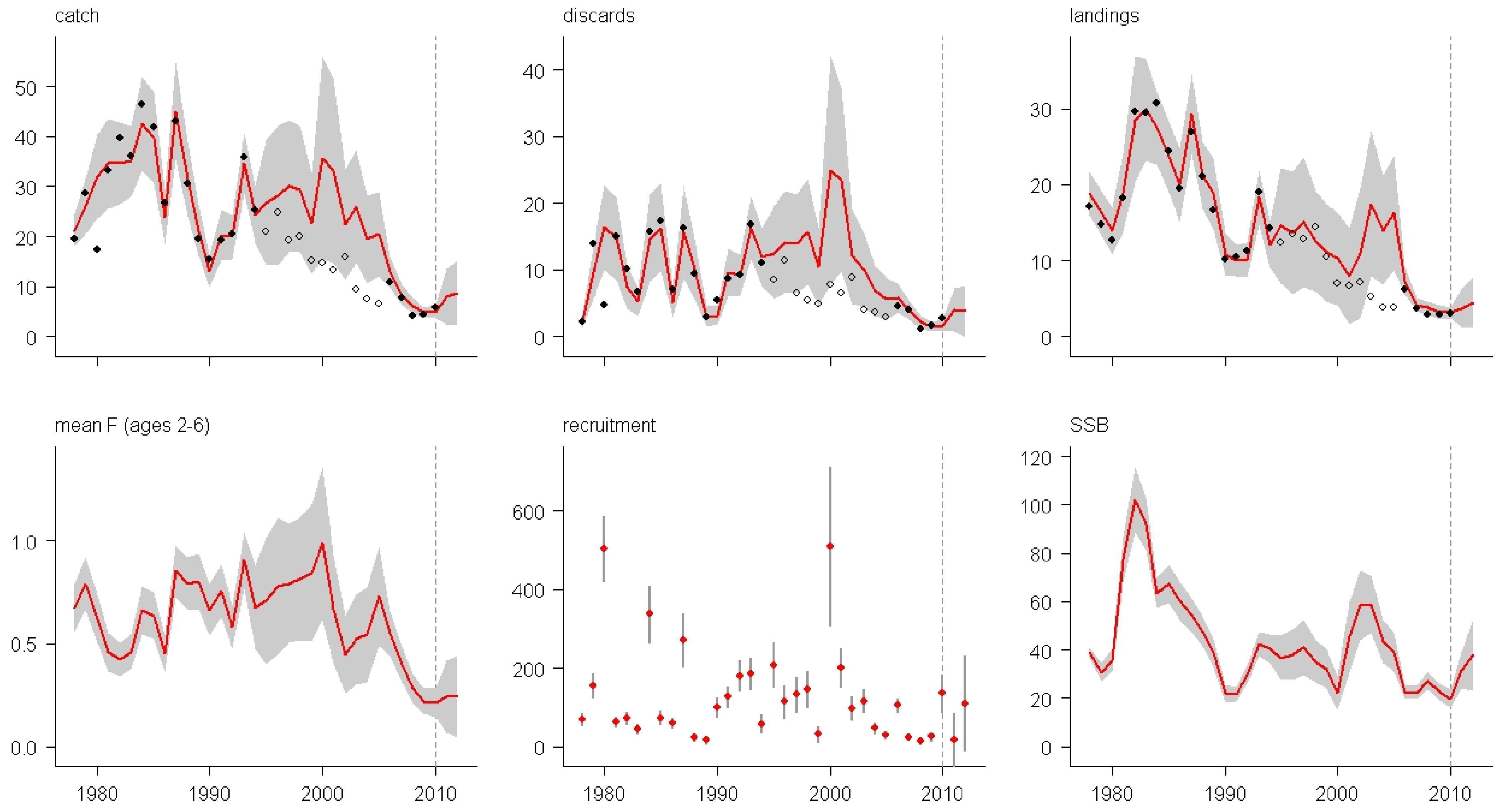



**Figure 3.3.4. Haddock in Division VIa. TSA stock summaries from the final run with catch data included 1978–1994 and 2006–2010. Estimates are plotted with approximate point-wise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. Values to the right of the vertical dashed line are forecasted by the model.**

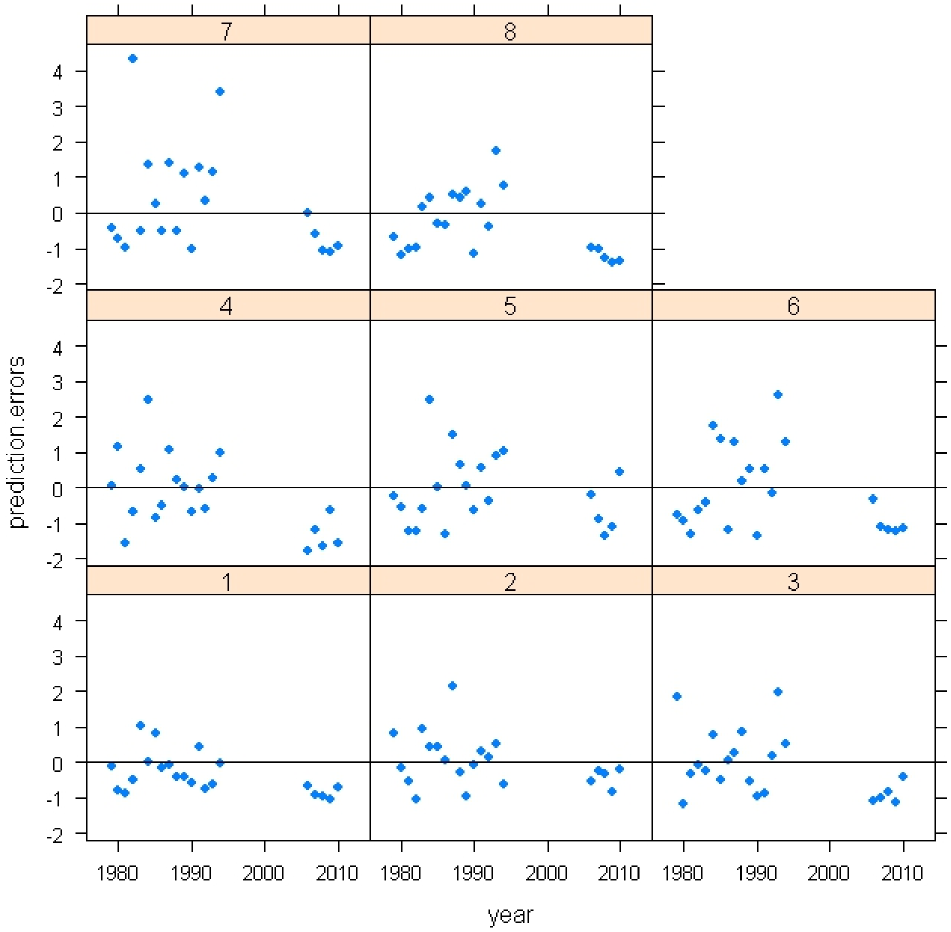



**Figure 3.3.5. Haddock in Division VIa. Standardized landings prediction errors from the final TSA run.**

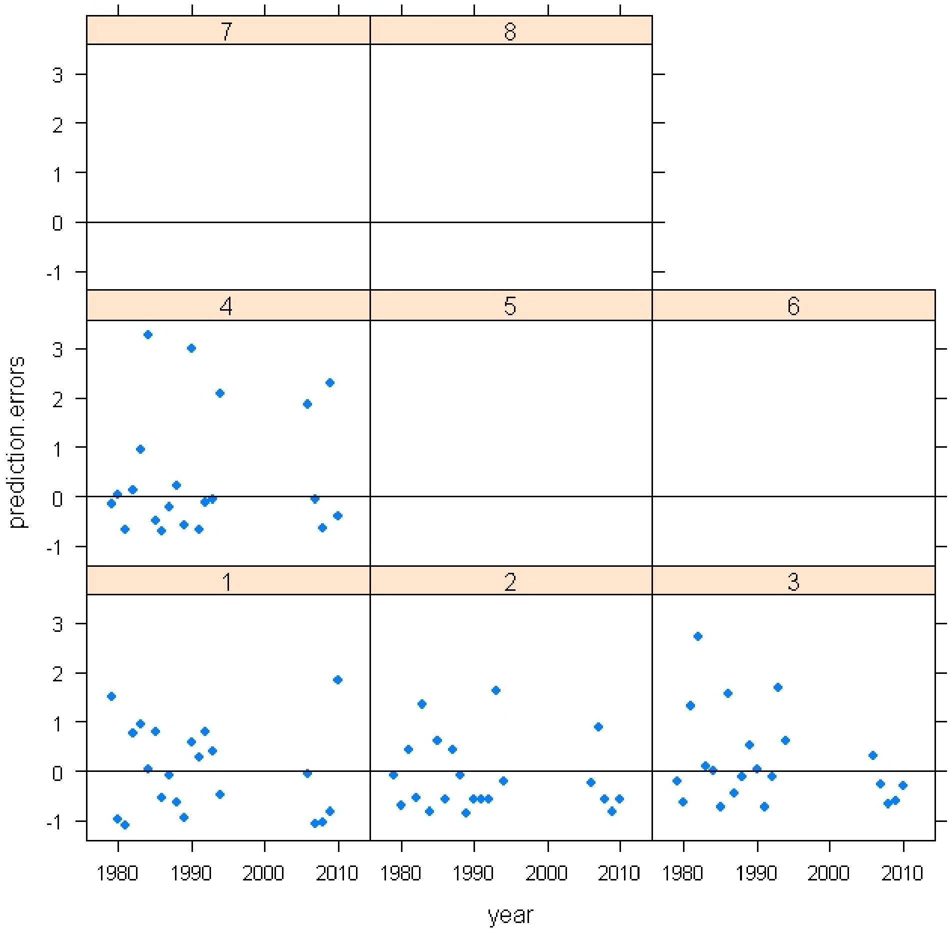



**Figure 3.3.6. Haddock in Division VIa. Standardized discards prediction errors from the final TSA run.**

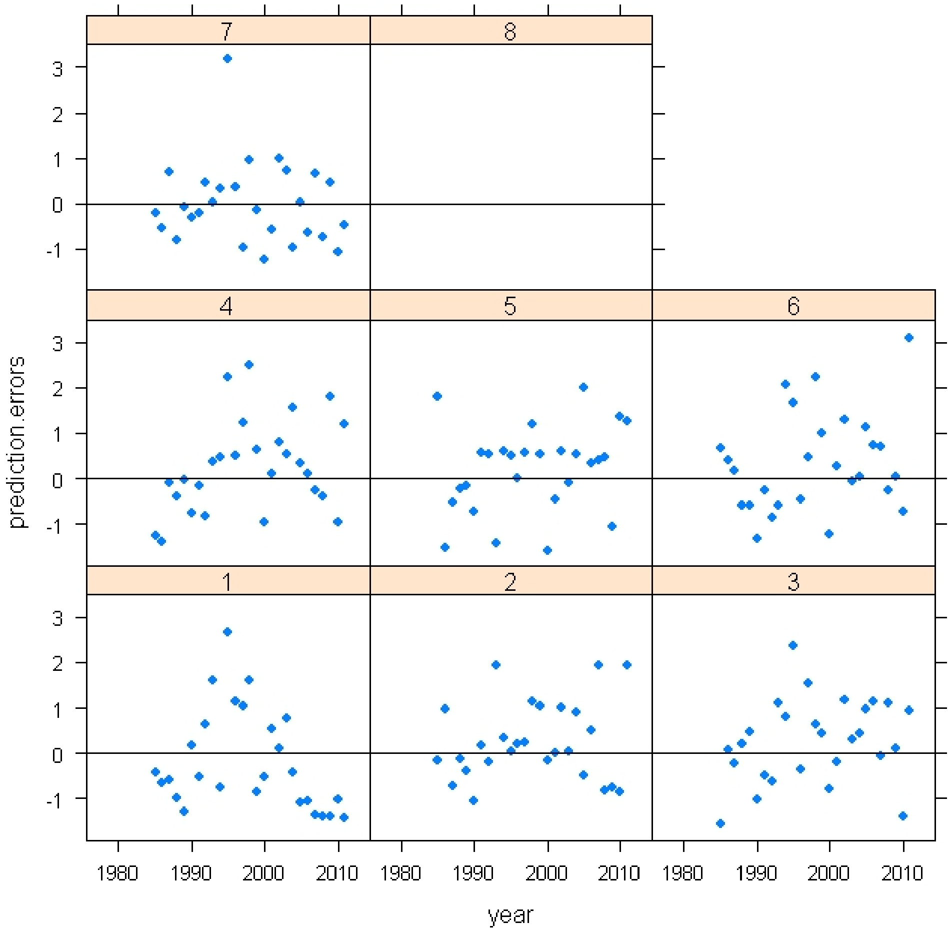



**Figure 3.3.7. Haddock in Division VIa. Standardized ScoGFS Q1 prediction errors from the final TSA run.**

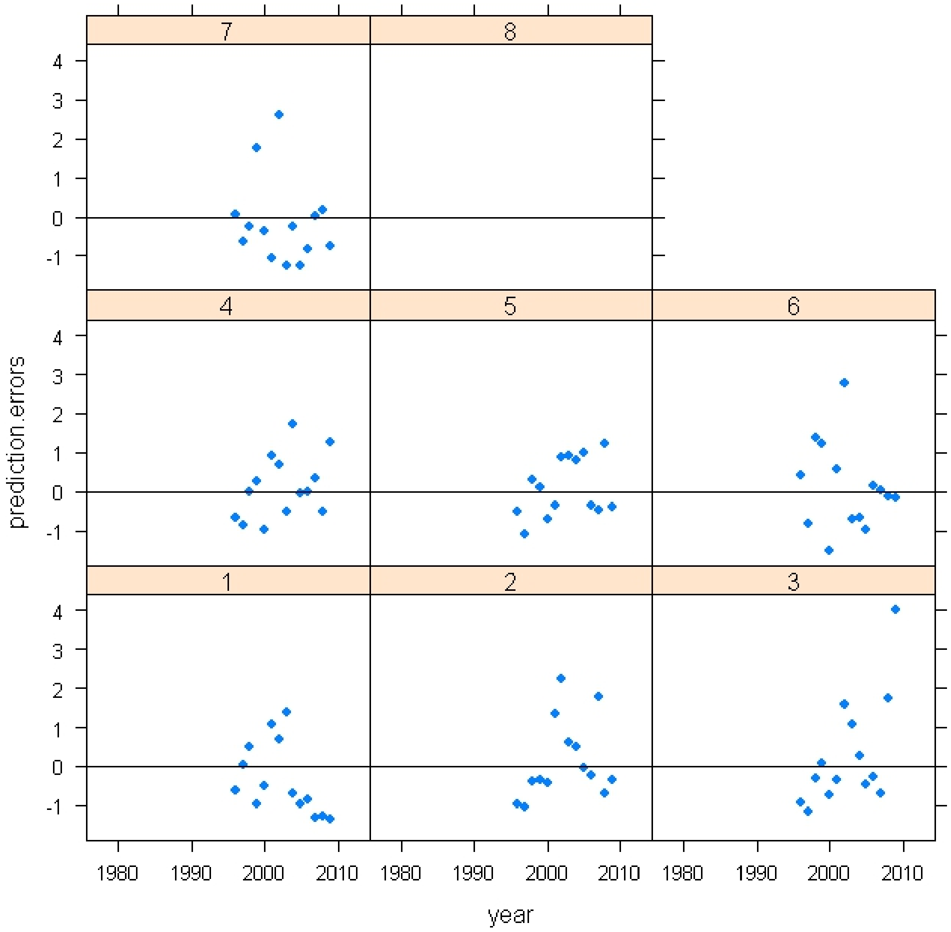



**Figure 3.3.8. Haddock in Division VIa. Standardized ScoGFS Q4 prediction errors from the final TSA run.**

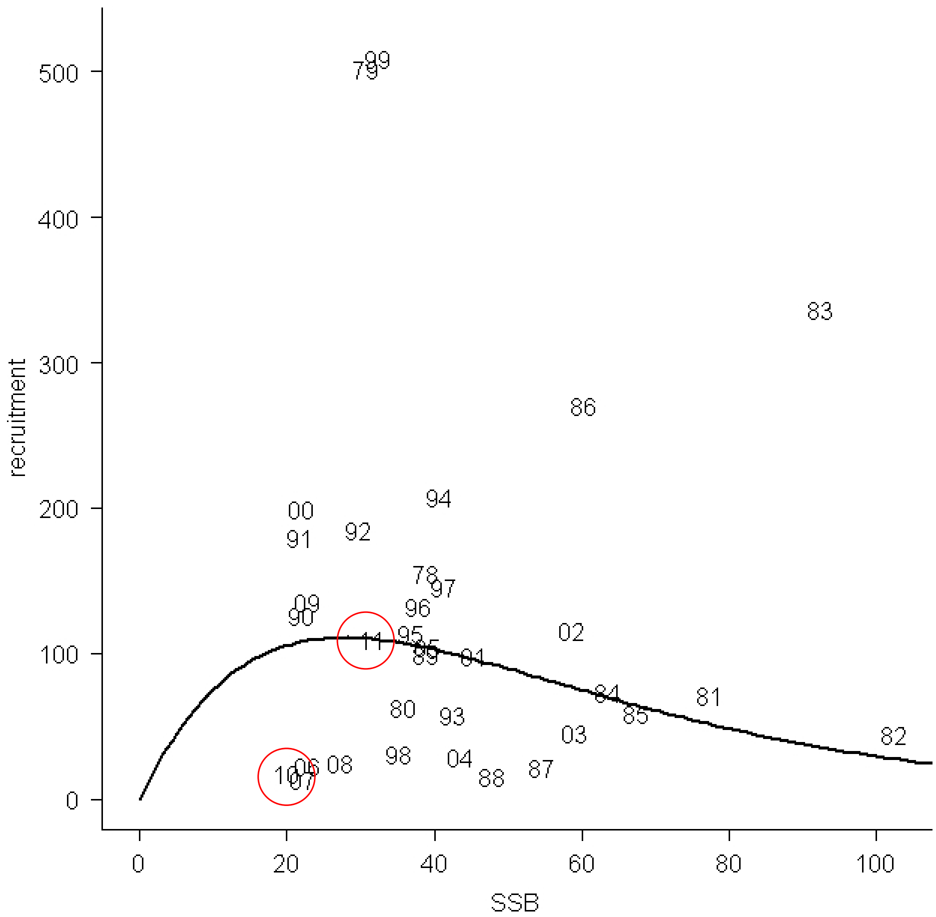



**Figure 3.3.9. Haddock in Division VIa. Stock–recruit plot from the final TSA run, points labelled as year classes. Predicted recruitments are circled: for the 2009 year-class recruiting in 2010 (using ScoGFS Q1 data); and the 2010 year-class recruiting in 2011 (based on the underlying Ricker model).**

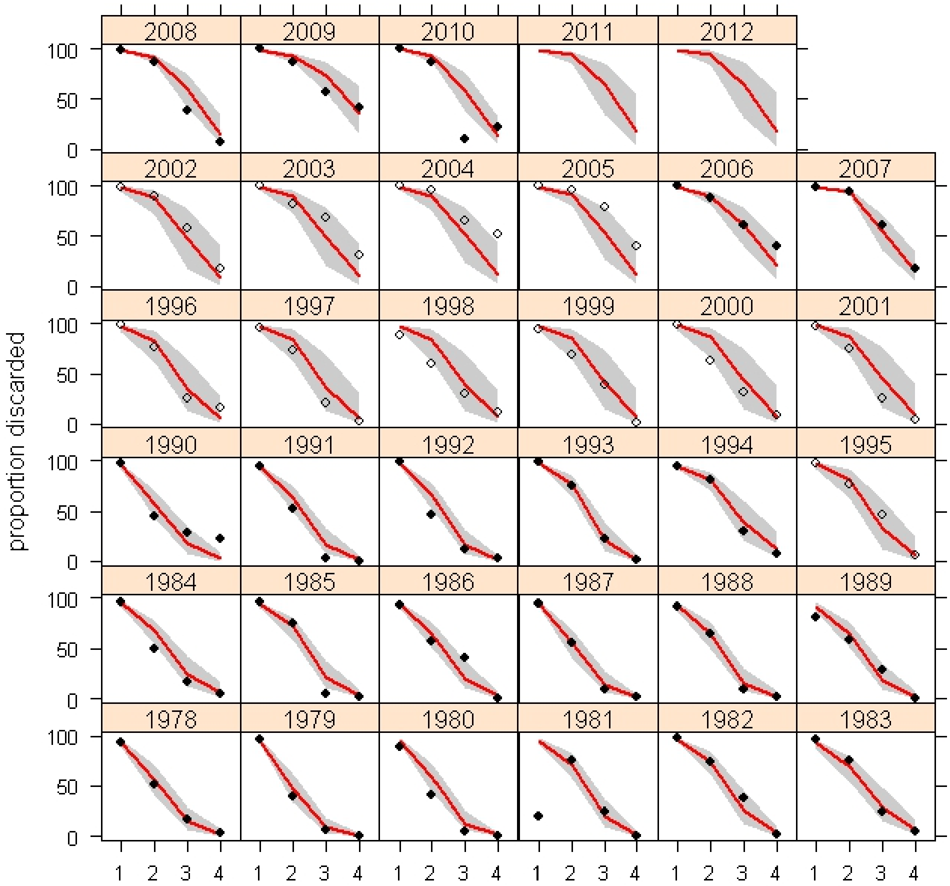



**Figure 3.3.10. Haddock in Division VIa. Fitted (lines) and observed (dots) discard proportions-at-age from the final TSA run.**

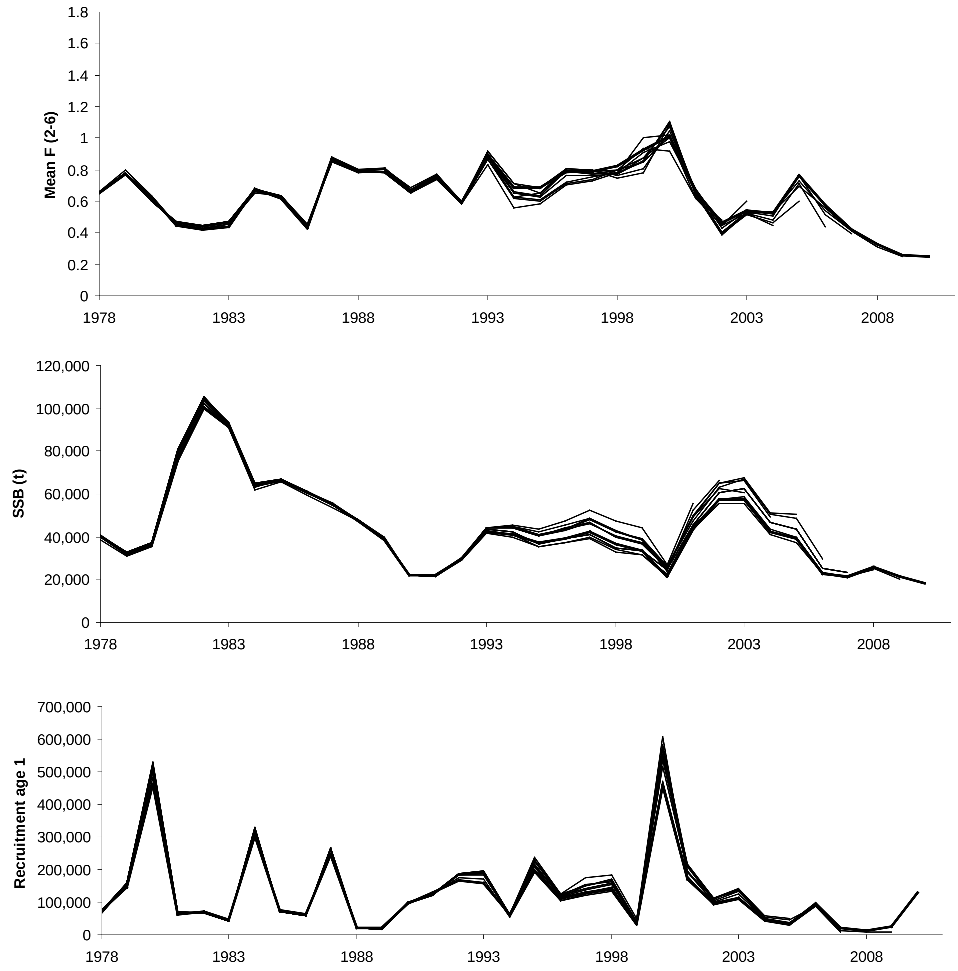



**Figure 3.3.11. Haddock in Division VIa. Estimates of Mean $F_{2-6}$, SSB and recruitment from retrospective TSA runs.**

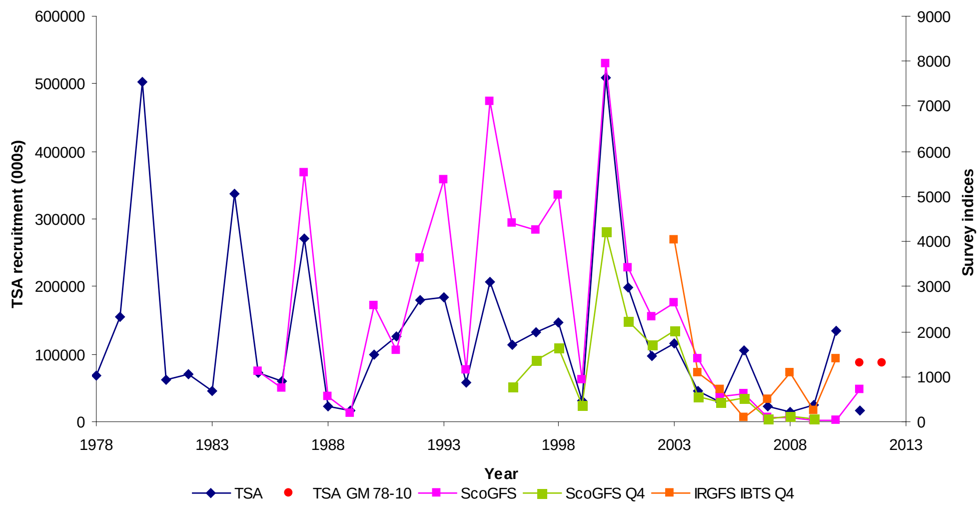



**Figure 3.3.12. Haddock in Division VIa. Time-series of recruitment-at-age 1 from the final TSA assessment, along with the long-term (1978–20010) geometric mean and the age-1 indices from the Q1 and Q4 ScoGFS survey-series.**

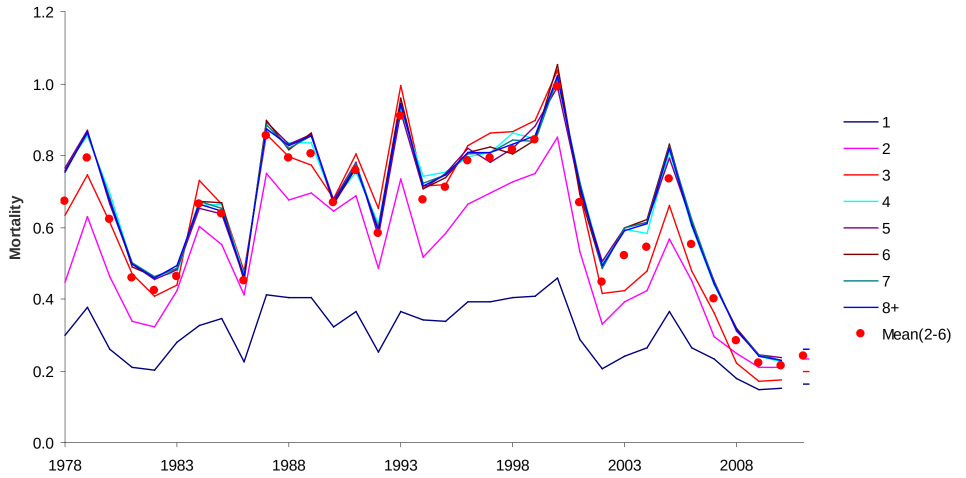



**Figure 3.3.13. Haddock in Division VIa. Time-series of estimated fishing mortality-at-age, along with the mean over ages 2–6.**

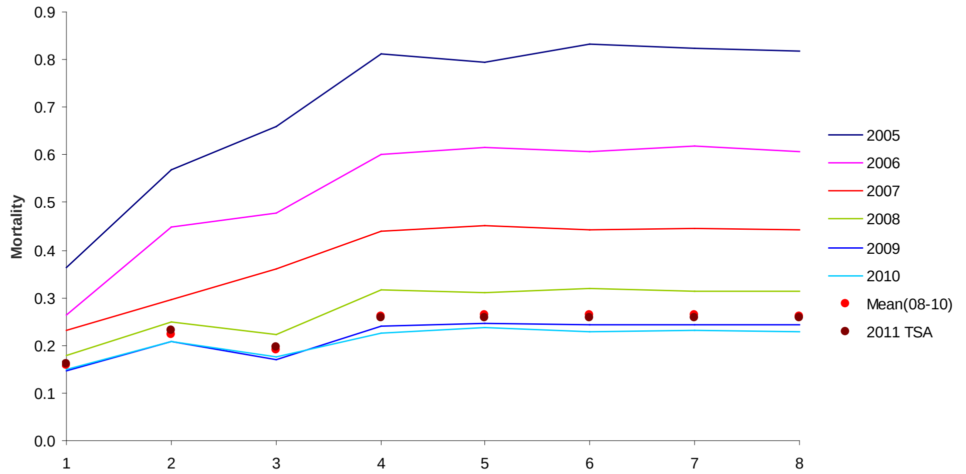



**Figure 3.3.14. Haddock in Division VIa. Candidates for fishing mortality-at-age in short-term forecasts. Lines labelled 2005, 2006, 2007, 2008, 2009, 2010 indicate the TSA estimates for those years. Points marked 2010 TSA and 2011 TSA show the TSA-generated forecast values from the final assessment.**


**Figure 3.3.15. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (or stock), tracked by year class with a linear model fit. Predicted weights in 2011 based on linear model fits indicated with the dotted lines.**

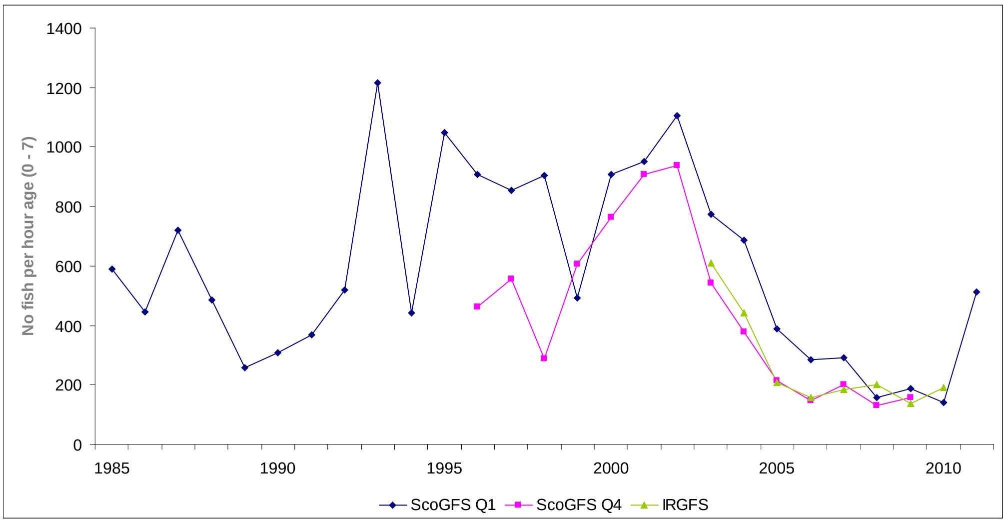



**Figure 3.3.16. Survey indices for Haddock in VIa. Total number of fish ages (0–7) caught per hour. ScoGFS Q1 time-series (1985–2011), ScoGFS Q4 time-series (1996–2009), IRGFS time-series (2003–2010).**

### 3.3.10 Other issues

After the conclusion of the stock assessment and after the review group gave its comments on the assessment; other run was made. This run as requested by the review group excluding the ScoGFS WCIBTS Q1 (2011) from the assessment due to changes both in gear and design.

The resulting figures and tables from this run are showed in the stock annex.

### 3.3.11 References

Fryer R.J. 2001. TSA: is it the way? Annex of Report of the Working Group on Methods of Fish Stock Assessment, 2001.

Dickey-Collas, M., Armstrong, M.J., Officer, R.A., Wright, P.J., Brown, J., Dunn, M.R., Young, E.F. 2003. Growth and expansion of haddock (*Melanogrammus aeglefinus* L.) stocks to the west of the British Isles in the 1990s. ICES Journal of Marine Science, (In-Press).

## 3.4 Whiting in Subarea VIa

### Type of assessment in 2011

As agreed at the 2010 meeting of ACOM, the assessment for whiting in Division VIa is being updated this year; in 2008 and 2009 no advice was provided. Earlier, ACFM review groups (RGNSDS) highlighted the various data problems associated with this stock; including noisy survey data and discard data which need to be reworked. Their conclusion in 2006 was that:

> Until revised Scottish discards are available and Irish discards included, a formal analytic assessment is not possible for this stock.

Scottish discard data are available (although not completely revised), and Irish discards from 2010 were made available. The assessment presented by the WG this year is, therefore, based on survey data which is the same approach as that adopted in the 2010 assessment, as well as an exploratory analytical assessment with the Time-Series Analysis (TSA) model using data from the catch and the Q1 survey.

### ICES advice applicable to 2010 and 2011

In 2006, ICES Advice for 2007 in terms of single-stock exploitation boundaries was as follows:

> *Exploitation boundaries in relation to precautionary limits*

"*Given that SSB is estimated at the lowest observed level and total mortality at the highest level over the time period, catches in 2007 should be reduced to the lowest possible level.*"

The Advice given since then has been the same (see Table with ICES Advice given in the years 2001–2011 below). Detailed advice given in 2011 taking into account MSY, PA and EU policy paper considerations was as follows:

#### *MSY considerations*

Biomass has declined to record low level in recent years. Exploitation status is unknown with regards to MSY levels. To allow the stock to rebuild, catches (half of which are discarded) should be reduced to the lowest possible level in 2011.

There are strong indications that TAC management control is not effective in limiting the catch.

#### *PA considerations*

Given that SSB is estimated at the lowest observed level, recent recruitment (with the exception of the 2009 year class) has been weak catches in 2011 should be reduced to the lowest possible level.

#### *Policy paper*

In the light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 10 (as catches should be reduced to the lowest possible level). This implies a 25% TAC decrease. The resulting TAC would be 323 t.

### 3.4.1 General

**Stock description**

General information is now located in the Stock Annex.

**Management applicable to 2010 and 2011**

The TAC for whiting is set for ICES Subareas VI, XII and XIV and EU and international waters of ICES Subdivision Vb, and for 2011 was as shown below:

| Species: Whiting *Merlangius merlangus* | | Zone: VI; EU and international waters of Vb; international waters of XII and XIV (WHG/561214) |
|---|---|---|
| Germany | 2 | |
| France | 39 | |
| Ireland | 97 | |
| United Kingdom | 185 | |
| EU | 323 | |
| TAC | 323 | Analytical TAC |

The following table summarizes ICES advice and actual management applicable for whiting in Division VIa during 2001–2011:

| Year | Single-species exploitation (tonnes) | Basis for single species | TAC for Vb, VI, XII, XIV (tonnes) | % change in F associated with TAC[1] |
|---|---|---|---|---|
| 2001 | < 4200 | Reduce F below $F_{pa}$ | 4000 | -40% |
| 2002 | < 2000 | SSB > $B_{pa}$ in short term | 3500 | -40% |
| 2003 | - | SSB > $B_{pa}$ in short term | 2000 | -60% |
| 2004 | - | SSB > $B_{pa}$ in 2005 | 1600 | (no assessment) |
| 2005 | - | - | 1600 | (assessment in relative trends only) |
| 2006 | - | - | 1360 | (assessment in relative trends only) |
| 2007 | 0 | Reduce catches to lowest possible level | 1020 | (assessment in relative trends only) |
| 2008 | 0 | Reduce catches to lowest possible level | 765 | (no assessment) |
| 2009 | 0 | Reduce catches to lowest possible level | 574 | (no assessment) |
| 2010 | 0 | Reduce catches to lowest possible level | 431 | (assessment in relative trends only) |
| 2011 | See scenarios | Reduce catches to lowest possible level | 323 | (assessment in relative trends only) |

[1] **Based on F-multipliers from forecast tables.**

The minimum landing size for whiting in Division VIa is 27 cm.

**Fishery in 2010**

A description of the fisheries on the west of Scotland is given in Section 3.1.

Tables and figures of total effort to 2006 by the fleets operating in Division VIa can be found in Section 16 of the Report of WGNSDS 2007.

Anecdotal information from the fishing industry suggests that the number of vessels targeting whiting continues to be very low. However, the recent low TACs combined with increased interest in bigger whiting (driven by good prices) has resulted in an increasing uptake of the whiting quota. Quota uptake for UK vessels in 2009 and 2010 were 96.7% and 87% respectively, with post regulation quota swaps taken into account. Total landings in 2010 were 349 t, down considerably from 2009 (Table 3.4.1). These are above the lowest recorded landings of 2005, but continue to be far below the long-term average.

The total estimated international catch of ages 1–7+ in 2010 was 1193 t of which approximately 886 t were discards (Table 3.4.2): of these 150 t were discarded by the TR1 fleet and 736 t were discarded by the TR2 (*Nephrops*) fleet. A very small amount (<1 t) of 0-gp fish were also estimated to be discarded.

Mandatory introduction of larger square mesh panels for the TR2 (*Nephrops*) fleet in 2008 does not seem to have had much of an effect on the discards of whiting in Division VIa in 2010. In the TR1 fleet, discarding is expected to decline in subsequent years following the mandatory increase in mesh size to 120 mm in 2009. Although the discards in 2010 were higher than those in 2007, 2008 and 2009, they are still the fourth lowest in the respective time-series. However, in terms of discard rate (discards as a proportion of catch) they represent the 2nd highest in the time-series.

### 3.4.2 Data

#### Landings

Total landings, as officially reported to ICES in 1965–2010, are shown in Figure 3.4.1. There have been concerns that the quality of landings data are deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS-WIBTS-Q1) in recent years (see Section 5.1.6.1.3 in the 2005 WG Re-port). Improved compliance measures and the introduction of UK and Irish legislation requiring registration of all fish buyers and sellers may mean that the reported landings from 2006 onwards are more representative of actual landings.

Details on nations which supply data and sampling levels are given in Table 2.1. Age distributions were estimated from market samples. Annual numbers-at-age in the landings are given in Table 3.4.3. Annual mean weights-at-age in the landings are given in Table 3.4.6 and shown in Figure 3.4.2. These have been variable in recent years due to the variability associated with low sample sizes. Efforts to increase sampling in these fisheries are being pursued.

#### Discards

Annual numbers-at-age in the discards are given in Table 3.4.4. Annual mean weights-at-age in the discards are given in Table 3.4.7 and shown in Figure 3.4.2.

This year, WG estimates of discards are based on data collected in the Irish and Scottish discard programme (raised by weighted average to the level of the total international discards). Discard age compositions from Scottish and Irish samples have been applied to unsampled fleets. Work is underway to revise the time-series of Scottish discard estimates with an aim to reduce bias and increase precision. Such revisions are particularly important for the estimation of total catch for this stock which has very high discards across a wide age range. A working document set out the methodology of this work at the 2004 meeting of WGNSDS (Fryer and Millar, 2004) and these methods have been developed further (Fernandes *et al.*, in press).

#### Biological

Annual numbers-at-age in the total catch are given in Table 3.4.5. Annual mean weights-at-age in the total catch are given in Table 3.4.8. As in previous meetings, the catch mean weights-at-age were also used as stock mean weights-at-age (see Stock Annex).

Values for natural mortality (0.2 for all ages and years) and the proportion of fish mature-at-age (knife-edged at age 2 for all years) are unchanged from the last assessment. Also as in the 2007 assessment, the proportion mature before spawning and the proportion fished before spawning are both set to be zero.

#### Surveys

Four research survey indices for whiting in VIa were also available:

- Scottish west coast groundfish survey (ScoGFS-WIBTS-Q1): ages 1–7, years 1985–2011.
- Irish west coast groundfish survey (IreGFS): ages 0–5, year 1993–2002.
- Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4): ages 0–8, years 1996–2009.
- Irish groundfish survey (IRGFS-WIBTS-Q4): ages 0–6; years 2003–2010.

The Scottish fourth-quarter west coast groundfish survey (ScoGFS-WIBTS-Q4) was not carried out in 2010 due to an engine break down of the research vessel.

For the Scottish surveys, a new vessel and gear were used from 1999. The catch rates as presented are corrected for the change in vessel and gear. The basis for the correction is comparative trawl haul data (Zuur *et al.*, 2001). The Irish quarter four survey was discontinued in 2003 and has been replaced by a new survey. The replacement survey (IRGFS-WIBTS-Q4) has been running for seven years. The Scottish quarter four survey was presented for the first time to WGNSDS 2005.

The Scottish survey has been modified and presented at IBTSWG2011 and WGCSE2011. No correction applied as yet.

For 2011 the rig and sampling design of the ScoGFS-WIBTS-Q1 survey was changed. A new groundgear capable of tackling challenging terrain was introduced broadly modelled around the rig used by Ireland for the IRGFS-WIBTS-Q4. The move to a more robust groundgear also allowed a move to a random stratified survey (which is again consistent with the IRGFS-WIBTS-Q4) as the previous repeat station survey format consisting of the same series of survey trawl positions being sampled at approximately the same temporal period every year was considered a bias prone method for surveying. It is hoped the greater compatibility between Scottish and Irish surveys will facilitate both being used to assess gadoids west of Scotland. New survey strata were designed using cluster analysis on aggregated data from the previous ScoGFS-WIBTS-Q1 data (1999–2010) as well as the data collected from a dedicated gadoid survey which took place during quarter 1 of 2010. Species considered were cod, haddock, whiting, saithe and hake. Cluster analysis yielded four specific clusters. Two additional strata were added; the Clyde area and the ‘windsock’ which is an area that has been designated as a recovery zone since 2002 and has therefore experienced no mobile gear exploitation during this time. Each individual polygon was treated as a separate stratum and the number of survey stations for each was allocated according to polygon size and the variability of indices within each stratum. Strata were weighted by surface area to build the final indices. Comparison trials have been conducted between the previous and new survey groundgears. The analysis from these trails was not available for this meeting but will be available in preparation for the VIa whiting benchmark scheduled for 2012.

The survey-series are described in the Report of the 2009 IBTSWG and also in the Stock Annex. For all survey-series, the oldest age given represents a true age, rather than a plus group. The survey indices are shown in Table 3.4.9 with data used in the final assessment highlighted in bold. Summing over ages 1–7, the Scottish first-quarter west coast groundfish survey indices were the 21st in the 27 year time-series. The spatial distribution of cpue from the two Scottish surveys in 2009 and 2010 have been provided in the Stock Annex.

#### Commercial cpue

Four commercial catch-effort dataseries were available to the WG including:

- Scottish light trawlers (ScoLTR): ages 1–7, years 1965–2005;
- Scottish seiners (ScoSEI): ages 1–6, years 1965–2005;
- Scottish *Nephrops* trawlers (ScoNTR): ages 1–6, years 1965–2005;
- Irish Otter Trawlers (IreOTB); ages 1–7, years 1995–2005.

Given the problems with non-mandatory effort reporting in the UK (described further in the report of WGNSSK for 2000, ICES CM 2001/ACFM:07), these cpue series have not been used for a number of years and are not presented in the Report. They are retained in the Stock Annex.

### 3.4.3 Historical stock development

Two exploratory assessments have been carried out: one based only on survey data conducted using SURBA, and one based on catch data and survey data using the Time-Series Analysis (TSA) model (Fryer, 2001) which is a state space model which allows for years with missing catch and/or survey data.

#### Data screening and exploratory runs

Software used: SURBA 3.0

Model Options chosen: one or two tuning series used in one run

Input data types and characteristics:

- ScoGFS-WIBTS-Q1: lambda=1, equal catchabilities at age, ages 1–6, all available years, mean Z range 2–4.

Due to a ship's engine breakdown, there was no Scottish Groundfish Survey in Quarter 4 in 2010. The results of a SURBA analysis from last year are therefore repeated here for reference.

Software used: TSA for R

Input data types and characteristics:

- Catch data, ages 1–7+, years 1965–1994 and 2006–2010;
- ScoGFS-WIBTS-Q1

Of the four survey-series available, only the two Scottish surveys were considered here.

The Irish west coast groundfish survey (IreGFS) has been discontinued and doubts about its consistency mean it is not used in stock assessments. To date the replacement IRGFS-WIBTS-Q4 has been considered too short a series to be considered. It now has seven years of data and will be considered in the VIa whiting benchmark process.

A comparison of scaled (standardized to z-scores) survey indices (from ScoGFS-WIBTS-Q1 & ScoGFS-WIBTS-Q4) at age show similar trends for most ages (up to age 5, Figure 3.4.3).

Log mean-standardized survey indices by year class and by year and scatterplots of indices within year classes are shown in Figures 3.4.4, 3.4.5 and 3.4.6. The year-class plots for both surveys are quite noisy and the ability of these surveys to reliably track year-class strength is generally poor. In addition, some of the correlations for the older ages in the ScoGFS-WIBTS-Q1 scatterplot are negative, while the equivalent plots of the ScoGFS-WIBTS-Q4 survey show very scattered data points. Age 0 in ScoGFS-WIBTS-Q4 appears to be a particularly poor measure of year-class strength (little evidence of positive correlation) and is therefore excluded in further analysis of this survey. There are no marked year effects. The log catch curves for these surveys along with those for the catch are shown in Figure 3.4.7. The curves for both ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4 are relatively linear and not very noisy, and show a fairly steep and consistent drop in abundance.

The trawl survey data (ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4) for West of Scotland whiting were extensively analysed at WGNSDS 2005–2007 using both SURBA 2.2 and SURBA 3.0 to look at consistency of output using a variety of age ranges, smoothing parameter values, relative catchabilities and weighting factors. Initial single fleet SURBA runs this year therefore used the model settings that were chosen in 2007 with the extension of the age range for ScoGFS-WIBTS-Q4 to 1–6 (as compared to ages 1–5 in the 2007 runs). This year only SURBA (version 3.0) was used to carry out the survey-based analysis; FLSURBA could not be run due to incompatibility of its available versions with the recent R versions (in 2007, both SURBA and FLSURBA were run).

The summary output of mean Z (2–4), recruitment and biomass from the SURBA run for ScoGFS-WIBTS-Q1 is shown in Figure 3.4.8 and Table 3.4.10; with the residuals illustrated in Figure 3.4.9. Model residuals are large for some age classes in some years, but with the exception of age 1, do not show any particular trends or non-randomness. Little systematic retrospective bias is apparent in the stock trends although the estimates for recruitment show some variability (Figure 3.4.10). The mean Z (2–4) estimates from this run show large fluctuations over the examined period. Choosing larger values for the smoothing parameter (lambda) smoothed out the fluctuations in mean Z, but the runs showed much worse retrospective patterns (not shown).

The SURBA analyses of the ScoGFS-WIBTS-Q4 survey from last year's WG are presented here for comparison: they do not include data from 2010 because the survey did not take place. The summary output is shown in Figure 3.4.11 and the residuals in Figure 3.4.12. Some trends are similar to those obtained with the ScoGFS-WIBTS-Q1 data. For total mortality, the trends are similar during 1996–2006 and after 2006, the trends are different. Model residuals are noisy, but show no particular trends or non-randomness. No retrospective plots could be produced as some values were extremely high. The ScoGFS-WIBTS-Q4 survey is a relatively short time-series (in comparison to ScoGFS-WIBTS-Q1), without particularly good internal consistency or strong year-class signals and this may be the reason for the poor retrospective performance.

In addition to SURBA runs, an analytical assessment using the TSA model was carried out with the ScoGFS-WIBTS-Q1 survey. Despite the lack of independent discard estimates for the pre-1978 period, catch data from a time period considered to be reliable (1965–1994 and 2006–2010) was used in the TSA run. Natural mortality was assumed to be 0.2 for all ages. The proportion mature was knife-edge at age 2 (i.e. 0 at age 1, 1 at age 2 and above). Table 3.4.11 shows the corresponding TSA parameter estimates.

Standardized prediction errors are given in Figures 3.4.13 (catch) and 3.4.14 (ScoGFS-WIBTS-Q1). None of these are large enough to invalidate the model fit and there are no obvious time-trends in recent years. Summary plots from the final assessment are given in Figure 3.4.15, while corresponding summary estimates are presented in Table 3.4.12. The TSA stock–recruit plot is presented in Figure 3.4.16 and shows a rather good relationship partly because the stock was driven to very low levels of SSB in the last decade. TSA also estimated a large increase in catchability: this is plotted as the percentage change compared to the catchability at the start of the survey in Figure 3.4.17. The estimates are uncertain, with wide confidence intervals, but an increase of at least 200% is indicated by this model. This will require further investigation at the benchmark.

The output from TSA was compared with the SURBA run (for ScoGFS-WIBTS-Q1) outputs, both being mean-standardized over the period 1995–2011 (Figure 3.4.18). There are some differences between the two estimates of SSB in the early period (from the mid-1980s to the early 1990s), but there is more agreement between them from the mid-1990s onwards. Both models indicate a decline in mortality to low levels from 2007 to around the lowest in the time-series.

#### Final assessment

In the absence of a benchmark and an official assessment to update, the TSA run using ScoGFS-WIBTS-Q1 is presented as the final assessment run given that it provides an analytical assessment. The final estimates for the stock are:

$F_{(2\text{-}4)}$ in 2010 = 0.35

SSB in 2011 = 6237 t

Mean $F_{2\text{-}4}$ is estimated to have declined below $F_{pa}$ (0.6) since 2008, but a sequence of low recruitments led to a fall in SSB in recent years. The 2009 year class is estimated as the strongest since 2004 and contributes towards a slight increase in SSB in 2011. Estimated and observed catches diverged considerably in the period where catches are thought to be unreliable due to black landings (1995–2005). Recent estimates of catch are almost the same as observed values. This could indicate a beneficial effect of management regulations and changes in fleet behaviour since 2006, and is supported by anecdotal information from the fishing industry.

### 3.4.4 Short-term projections

No short-term predictions were made by this WG.

### 3.4.5 Medium-term projections

Stochastic medium-term predictions were not made at this WG because the assessment is considered only to be indicative of stock trends.

### 3.4.6 MSY explorations

No estimates of MSY reference points were presented at the WG this year. The general lack of consensus concerning the assessment approach prevents using the final run output as the basis for advice.

### 3.4.7 Biological reference points

ICES considers that $B_{lim}$ is 16 000 t and $B_{pa}$ be set at 22 000 t. ICES proposes that $F_{lim}$ is 1.0 and $F_{pa}$ be set at 0.6.

The Working Group attempted a yield-per-recruit analysis with the output from the final TSA run (Figure 3.4.19). $F_{0.1}$ was estimated at around 0.2 and $F_{max}$ at around 0.3, but it is unclear how stable these estimates are in the long term. The WG considers that yield-per-recruit F reference points are not applicable due to the uncertainty in historical stock trends.

### 3.4.8 Management plans

There are no specific management objectives or a management plan for this stock, but a plan is under development.

### 3.4.9 Uncertainties and bias in the assessment and forecast

The most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings (species and quantity) is known to occur and directly affects the perception of the stock. TSA is explicitly designed to allow for omission in the catch data during this period which is why it was used here as the exploratory and final assessment.

The survey data and commercial catch data contain different signals concerning the stock. The data since the mid-1990s are sufficiently consistent to conduct a catch-at-age analysis tuned with survey data. However, due to the discrepancy present in the earlier period, the Working Group considers that it is not possible to evaluate the current state of the stock with reference to precautionary reference points. A similar problem has been present in the North Sea whiting stock (as reported by WGNSSK 2010). Three potential sources of this discrepancy were identified for the North Sea stock, and they may apply to whiting in VIa as well: bias in catch estimates, changes in survey catchability or changes in natural mortality due to predation or regime shift (WGNSSK 2010).

Jump in SSB predicted by SURBA based on a single modified survey may have some catchability bias and benefit from a swept-area correction. Anecdotally however the trend in survey catches, particularly a significant drop in recruits, is reflected in the overlapping Irish time-series.

Long-term information on the historical yield and catch composition indicates that the present stock size is low. The current assessment indicates (as the assessment carried out in 2007 did) that the stock is historically at a very low level. Total mortality has been declining over the past few years. The sum of the Scottish west coast groundfish survey indices (both in quarter one and quarter four) is also low, but shows an increase from 2008 onwards. The persistence of this trend should be verified in subsequent assessments.

### 3.4.10 Recommendation for next benchmark

A landings and discards disaggregated assessment may potentially be a reliable basis for determining the status of the whiting stock in VIa. Currently, the main problem is the discrepancy between survey and catch data prior to 1995. Unless this discrepancy can be resolved, truncating the catch data from 1995 may be an option, which proved satisfactory in previous exploratory XSA runs carried out at this working group. Given the new legislation on reporting landings, the quality of landings data is likely to continue to improve.

The potential for improvement in the quality of survey data needs to be investigated. The issue of changes in survey catchability needs to be addressed. The location of sampling stations may be reconsidered to better match the distribution of commercial landings and maximize coordinated survey effort in the area.

### 3.4.11 Management considerations

Recruitment during the 1990s appears to have been high while more recently, it has been below average. There are many indications that the 2009 year class is relatively strong, following historically low recruitment of 2006 to 2008 year classes.

Recent estimates of SSB to remain at a low level, but the latest estimate for 2011 indicates a potential upturn, driven by the large 2009 year class. Fishing mortality also remains low. The perception of the state of this stock (as estimated from this assessment) appears not to have changed much, except for recruitment, from last year.

Whiting are caught in mixed fisheries with cod and haddock in VIa. Management of whiting will be strongly linked to that for cod for which there is an ongoing recovery plan (Council Regulation (EC) 1342/2008). There have also been several technical conservation measures introduced in the VIa gadoid fishery in recent years including the mandatory increases in mesh size to 120 mm.

Whiting are caught mainly as a bycatch species and there are no targeted fisheries for this stock, making direct management difficult. Whiting are caught and heavily discarded in small-meshed fisheries for *Nephrops*: in 2010 this fleet discarded the majority of the catch of this species: 736 t, of the total catch of 1193 t (62%), were estimated to have been discarded by the *Nephrops* fleet. Any management measures which may result in a shift of vessels to these smaller mesh sizes will therefore result in a worse exploitation pattern and higher discards. Measures to improve the selectivity of these fisheries, such as sorting grids and appropriately placed square mesh panels should be introduced if these discards are to be avoided.

#### References

Fryer, R. 2001. TSA: is it the way? Working document for the Working Group on Methods of Fish Stock Assessment 2001.

## 3.4b Whiting in Subarea VIb

Officially reported landings are given in Table 3.4b.

**Table 3.4.1. Nominal landings (t) of WHITING in Division VIa, 1989–2010, as officially reported to ICES.**

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 1 | - | + | - | + | + | + | - | 1 | 1 | + | - | - | - | - | + | - | - | - | - | - | - |
| Denmark | 1 | + | 3 | 1 | 1 | + | + | + | + | - | - | - | - | - | + | + | - | - | - | - | - | - |
| Faroe Islands | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | + | - | + |
| France | 1991,2 | 180 | 3521,2 | 105 | 149 | 191 | 362 | 202 | 108 | 82 | 300 | 48 | 52 | 21 | 11 | 6 | 9 | 7 | 1 | 3 | 1 | 3 |
| Germany | + | + | + | 1 | 1 | + | - | + | - | - | + | - | - | - | - | - | - | + | 1 | - | - | - |
| Ireland | 1,315 | 977 | 1,200 | 1,377 | 1,192 | 1,213 | 1,448 | 1,182 | 977 | 952 | 1,121 | 793 | 764 | 577 | 568 | 356 | 172 | 196 | 56 | 69 | 125 | 99 |
| Netherlands | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - |
| Spain | - | - | - | - | - | - | 1 | - | 1 | 2 | + | - | 2 | - | - | - | - | - | - | - | - | - |
| UK (E, W & NI) | 44 | 50 | 218 | 196 | 184 | 233 | 204 | 237 | 453 | 251 | 210 | 104 | 71 | 73 | 35 | 13 | 5 | 2 | 1 | - | - | - |
| UK (Scot.) | 6,109 | 4,819 | 5,135 | 4,330 | 5,224 | 4,149 | 4,263 | 5,021 | 4,638 | 3,369 | 3,046 | 2,258 | 1,654 | 1,064 | 751 | 444 | 103 | 178 | 424 | - | - | - |
| UK (total) | | | | | | | | | | | | | | | | | | | | 369 | 354 | 247 |
| Total landings | 7,669 | 6,026 | 6,908 | 6,010 | 6,751 | 5,786 | 6278 | 6642 | 6178 | 4657 | 4677 | 3203 | 2543 | 1735 | 1365 | 819 | 289 | 383 | 484 | 441 | 482 | 349 |

*** Preliminary.**

**1989–2009 N. Ireland included with England and Wales.**

**Table 3.4.2. Whiting in Division VIa. Annual weight and numbers caught, years 1978–2010.**

| Year | Weight (tonnes) | | | Numbers (thousands) | | |
|---|---|---|---|---|---|---|
| | Total | Human consumption | Discards | Total | Human consumption | Discards |
| 1978 | 20452 | 14677 | 5775 | 93932 | 54369 | 39563 |
| 1979 | 20163 | 17081 | 3082 | 77794 | 61393 | 16401 |
| 1980 | 15108 | 12816 | 2292 | 57131 | 44562 | 12569 |
| 1981 | 16439 | 12203 | 4236 | 72113 | 46067 | 26046 |
| 1982 | 20064 | 13871 | 6193 | 87481 | 47883 | 39598 |
| 1983 | 21980 | 15970 | 6010 | 79114 | 49359 | 29755 |
| 1984 | 24118 | 16458 | 7660 | 125708 | 50218 | 75490 |
| 1985 | 23560 | 12893 | 10667 | 124683 | 43166 | 81517 |
| 1986 | 13413 | 8454 | 4959 | 64495 | 31273 | 33222 |
| 1987 | 18666 | 11544 | 7122 | 103485 | 41221 | 62264 |
| 1988 | 23136 | 11352 | 11784 | 141314 | 40681 | 100633 |
| 1989 | 11599 | 7531 | 4068 | 54633 | 26876 | 27757 |
| 1990 | 10036 | 5643 | 4393 | 42927 | 19201 | 23726 |
| 1991 | 12006 | 6660 | 5346 | 63112 | 25103 | 38009 |
| 1992 | 15396 | 6004 | 9392 | 86903 | 22266 | 64637 |
| 1993 | 15373 | 6872 | 8501 | 68351 | 23246 | 45105 |
| 1994 | 14771 | 5901 | 8870 | 87881 | 20060 | 67821 |
| 1995 | 13657 | 6076 | 7581 | 77932 | 18763 | 59169 |
| 1996 | 14058 | 7156 | 6902 | 71396 | 22329 | 49067 |
| 1997 | 11192 | 6285 | 4907 | 50459 | 19250 | 31209 |
| 1998 | 10476 | 4631 | 5845 | 56583 | 14387 | 42196 |
| 1999 | 7734 | 4613 | 3121 | 38260 | 15970 | 22290 |
| 2000 | 9715 | 3010 | 6705 | 78815 | 10118 | 68697 |
| 2001 | 4850 | 2438 | 2412 | 20802 | 8477 | 12325 |
| 2002 | 3829 | 1709 | 2120 | 25179 | 5765 | 19414 |
| 2003 | 2936 | 1356 | 1580 | 15403 | 4124 | 11279 |
| 2004 | 3437 | 811 | 2626 | 21749 | 2571 | 19178 |
| 2005 | 1239 | 341 | 898 | 6154 | 1051 | 5103 |
| 2006 | 1326 | 380 | 946 | 12988 | 1049 | 11939 |
| 2007 | 849 | 484 | 365 | 4879 | 1145 | 3734 |
| 2008 | 617 | 443 | 174 | 3085 | 1232 | 1853 |
| 2009 | 905 | 488 | 417 | 18038 | 1115 | 16923 |
| 2010 | 1193 | 307 | 886 | 18391 | 601 | 17790 |
| Min | 617 | 306.843349 | 174 | 3085 | 601.205845 | 1853 |
| GM | 7741 | 3946 | 3342 | 42993 | 12677 | 26166 |
| AM | 11645 | 6862 | 4783 | 59126 | 23482 | 35645 |
| Max | 24118 | 17081 | 11784 | 141314 | 61393 | 100633 |

**Table 3.4.3. Whiting in Division VIa. Landings-at-age (thousands).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 6938 | 6085 | 43530 | 4803 | 388 | 103 | 22 |
| 1966 | 1685 | 10544 | 2229 | 28185 | 1861 | 186 | 52 |
| 1967 | 5169 | 26023 | 10619 | 697 | 14574 | 789 | 143 |
| 1968 | 7265 | 16484 | 9239 | 3656 | 324 | 5036 | 368 |
| 1969 | 873 | 25174 | 8644 | 2566 | 1206 | 118 | 2333 |
| 1970 | 730 | 6423 | 28065 | 3241 | 670 | 214 | 550 |
| 1971 | 2387 | 8617 | 4122 | 34784 | 1338 | 240 | 223 |
| 1972 | 16777 | 12028 | 4013 | 1363 | 14796 | 793 | 148 |
| 1973 | 14078 | 36142 | 5592 | 1461 | 357 | 4292 | 310 |
| 1974 | 9083 | 51036 | 10049 | 1166 | 180 | 52 | 849 |
| 1975 | 14917 | 16778 | 36318 | 2819 | 281 | 57 | 245 |
| 1976 | 8500 | 46421 | 15757 | 17423 | 1508 | 66 | 57 |
| 1977 | 16120 | 13376 | 25144 | 3127 | 4719 | 292 | 24 |
| 1978 | 17670 | 18175 | 6682 | 9400 | 941 | 1433 | 68 |
| 1979 | 6334 | 34221 | 13282 | 3407 | 3488 | 276 | 384 |
| 1980 | 11650 | 11378 | 14860 | 4155 | 1244 | 1085 | 190 |
| 1981 | 3593 | 24395 | 11297 | 4611 | 1518 | 452 | 201 |
| 1982 | 2991 | 5783 | 29094 | 6821 | 2043 | 803 | 348 |
| 1983 | 3418 | 7094 | 8040 | 22757 | 6070 | 1439 | 540 |
| 1984 | 7209 | 12765 | 8221 | 4387 | 14825 | 1953 | 858 |
| 1985 | 4139 | 19520 | 8574 | 3351 | 1997 | 4764 | 822 |
| 1986 | 2674 | 14824 | 9770 | 2653 | 532 | 291 | 529 |
| 1987 | 6430 | 13935 | 13988 | 5442 | 837 | 330 | 259 |
| 1988 | 1842 | 20587 | 9638 | 6168 | 1949 | 290 | 207 |
| 1989 | 2529 | 5887 | 11889 | 4767 | 1266 | 468 | 71 |
| 1990 | 3203 | 8028 | 2393 | 4009 | 1326 | 204 | 37 |
| 1991 | 3294 | 8826 | 10046 | 1208 | 1391 | 286 | 51 |
| 1992 | 2695 | 9440 | 4473 | 4782 | 396 | 373 | 106 |
| 1993 | 1051 | 10179 | 6293 | 2673 | 2738 | 163 | 147 |
| 1994 | 909 | 4889 | 9158 | 3607 | 712 | 715 | 69 |
| 1995 | 215 | 4322 | 6516 | 5654 | 1397 | 376 | 282 |
| 1996 | 990 | 5410 | 7675 | 5052 | 2461 | 583 | 157 |
| 1997 | 877 | 3658 | 8514 | 4316 | 1441 | 338 | 106 |
| 1998 | 840 | 3504 | 4277 | 3698 | 1442 | 338 | 288 |
| 1999 | 1013 | 6131 | 4546 | 2040 | 1774 | 355 | 112 |
| 2000 | 484 | 2952 | 4211 | 1570 | 485 | 328 | 89 |
| 2001 | 461 | 3271 | 2630 | 1567 | 401 | 131 | 16 |
| 2002 | 62 | 1624 | 3018 | 799 | 227 | 23 | 13 |
| 2003 | 170 | 710 | 1111 | 1673 | 347 | 111 | 2 |
| 2004 | 54 | 724 | 543 | 521 | 622 | 78 | 29 |
| 2005 | 28 | 276 | 455 | 140 | 99 | 45 | 7 |
| 2006 | 82 | 139 | 369 | 260 | 61 | 113 | 24 |
| 2007 | 187 | 168 | 255 | 326 | 132 | 27 | 50 |
| 2008 | 6 | 265 | 394 | 336 | 152 | 55 | 24 |
| 2009 | 59 | 216 | 254 | 430 | 100 | 44 | 13 |
| 2010 | 53 | 94 | 153 | 119 | 126 | 24 | 31 |

**Table 3.4.4. Whiting in Division VIa. Discards-at-age (thousands).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 17205 | 4968 | 11437 | 531 | 14 | 2 | 0 |
| 1966 | 4322 | 8946 | 515 | 3317 | 79 | 3 | 0 |
| 1967 | 12237 | 20791 | 2674 | 84 | 629 | 12 | 1 |
| 1968 | 16394 | 12612 | 2137 | 377 | 13 | 82 | 3 |
| 1969 | 1983 | 20494 | 2093 | 292 | 51 | 2 | 26 |
| 1970 | 1776 | 6704 | 7494 | 382 | 33 | 4 | 0 |
| 1971 | 5505 | 6719 | 969 | 3906 | 57 | 4 | 1 |
| 1972 | 39192 | 8930 | 850 | 152 | 610 | 14 | 1 |
| 1973 | 30521 | 26995 | 1225 | 147 | 14 | 77 | 2 |
| 1974 | 23101 | 40590 | 2362 | 123 | 7 | 1 | 7 |
| 1975 | 37295 | 13541 | 8485 | 310 | 12 | 1 | 0 |
| 1976 | 24891 | 35812 | 3360 | 1940 | 63 | 1 | 0 |
| 1977 | 48148 | 8675 | 5432 | 301 | 212 | 5 | 0 |
| 1978 | 27942 | 10505 | 889 | 206 | 1 | 20 | 0 |
| 1979 | 3450 | 10722 | 1619 | 533 | 76 | 0 | 0 |
| 1980 | 2376 | 6172 | 3206 | 651 | 156 | 9 | 0 |
| 1981 | 1017 | 22014 | 2763 | 148 | 101 | 4 | 0 |
| 1982 | 17837 | 4577 | 15938 | 1189 | 55 | 1 | 0 |
| 1983 | 15069 | 8173 | 1964 | 4271 | 176 | 102 | 0 |
| 1984 | 68241 | 3951 | 1085 | 572 | 1577 | 59 | 4 |
| 1985 | 59783 | 17426 | 3134 | 663 | 61 | 446 | 3 |
| 1986 | 10459 | 20085 | 2491 | 117 | 6 | 2 | 61 |
| 1987 | 46876 | 13689 | 1518 | 180 | 1 | 0 | 0 |
| 1988 | 46421 | 51395 | 2472 | 292 | 54 | 0 | 0 |
| 1989 | 17778 | 3660 | 5796 | 401 | 111 | 11 | 0 |
| 1990 | 16406 | 5791 | 860 | 571 | 95 | 3 | 0 |
| 1991 | 30355 | 2874 | 4432 | 173 | 140 | 36 | 0 |
| 1992 | 46463 | 15041 | 2224 | 908 | 0 | 0 | 0 |
| 1993 | 14618 | 22281 | 5966 | 921 | 1317 | 0 | 2 |
| 1994 | 39697 | 18403 | 7775 | 1634 | 183 | 125 | 4 |
| 1995 | 28557 | 20921 | 8483 | 961 | 246 | 0 | 0 |
| 1996 | 28620 | 14617 | 4398 | 1395 | 18 | 1 | 18 |
| 1997 | 18182 | 9037 | 3431 | 466 | 93 | 0 | 0 |
| 1998 | 31183 | 7304 | 2418 | 991 | 184 | 51 | 64 |
| 1999 | 13623 | 7256 | 933 | 369 | 79 | 29 | 0 |
| 2000 | 63789 | 3556 | 1206 | 117 | 15 | 14 | 0 |
| 2001 | 5514 | 5861 | 738 | 208 | 4 | 0 | 0 |
| 2002 | 14166 | 3235 | 1749 | 130 | 124 | 8 | 1 |
| 2003 | 9331 | 1107 | 427 | 371 | 34 | 7 | 2 |
| 2004 | 14667 | 3557 | 536 | 305 | 107 | 4 | 2 |
| 2005 | 2923 | 1578 | 534 | 37 | 19 | 7 | 4 |
| 2006 | 9784 | 852 | 1000 | 256 | 36 | 11 | 2 |
| 2007 | 995 | 1077 | 308 | 64 | 4 | 3 | 0 |
| 2008 | 806 | 638 | 142 | 162 | 51 | 41 | 0 |
| 2009 | 6926 | 112 | 72 | 49 | 16 | 3 | 0 |
| 2010 | 16005 | 1427 | 245 | 42 | 61 | 6 | 1 |

**Table 3.4.5. Whiting in Division VIa. Total catch-at-age (thousands).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 24143 | 11054 | 54967 | 5334 | 402 | 105 | 22 |
| 1966 | 6007 | 19490 | 2744 | 31502 | 1940 | 189 | 53 |
| 1967 | 17406 | 46814 | 13293 | 781 | 15204 | 801 | 144 |
| 1968 | 23659 | 29096 | 11376 | 4034 | 337 | 5118 | 372 |
| 1969 | 2856 | 45668 | 10737 | 2858 | 1257 | 120 | 2358 |
| 1970 | 2506 | 13128 | 35559 | 3623 | 703 | 218 | 550 |
| 1971 | 7891 | 15336 | 5090 | 38690 | 1395 | 245 | 224 |
| 1972 | 55969 | 20958 | 4863 | 1514 | 15406 | 807 | 149 |
| 1973 | 44599 | 63137 | 6817 | 1608 | 371 | 4369 | 313 |
| 1974 | 32185 | 91625 | 12412 | 1289 | 188 | 53 | 856 |
| 1975 | 52213 | 30319 | 44804 | 3129 | 293 | 58 | 245 |
| 1976 | 33392 | 82233 | 19117 | 19363 | 1571 | 67 | 57 |
| 1977 | 64268 | 22051 | 30576 | 3428 | 4931 | 297 | 24 |
| 1978 | 45612 | 28680 | 7571 | 9606 | 942 | 1452 | 68 |
| 1979 | 9784 | 44943 | 14901 | 3940 | 3565 | 276 | 384 |
| 1980 | 14026 | 17551 | 18065 | 4806 | 1400 | 1093 | 190 |
| 1981 | 4610 | 46409 | 14060 | 4758 | 1618 | 456 | 201 |
| 1982 | 20829 | 10360 | 45032 | 8010 | 2098 | 804 | 348 |
| 1983 | 18487 | 15266 | 10004 | 27029 | 6246 | 1541 | 540 |
| 1984 | 75450 | 16716 | 9306 | 4959 | 16403 | 2011 | 863 |
| 1985 | 63922 | 36946 | 11708 | 4014 | 2058 | 5210 | 825 |
| 1986 | 13133 | 34909 | 12260 | 2770 | 539 | 293 | 591 |
| 1987 | 53305 | 27624 | 15506 | 5621 | 839 | 330 | 259 |
| 1988 | 48263 | 71982 | 12110 | 6460 | 2002 | 290 | 207 |
| 1989 | 20307 | 9547 | 17685 | 5168 | 1377 | 479 | 71 |
| 1990 | 19609 | 13819 | 3252 | 4580 | 1421 | 208 | 37 |
| 1991 | 33648 | 11700 | 14478 | 1381 | 1531 | 322 | 51 |
| 1992 | 49158 | 24481 | 6697 | 5691 | 396 | 373 | 106 |
| 1993 | 15669 | 32460 | 12259 | 3594 | 4055 | 163 | 149 |
| 1994 | 40606 | 23292 | 16933 | 5241 | 896 | 840 | 73 |
| 1995 | 28772 | 25243 | 14999 | 6615 | 1643 | 377 | 283 |
| 1996 | 29611 | 20027 | 12073 | 6447 | 2479 | 584 | 175 |
| 1997 | 19059 | 12695 | 11946 | 4782 | 1534 | 338 | 106 |
| 1998 | 32023 | 10808 | 6695 | 4689 | 1626 | 389 | 352 |
| 1999 | 14636 | 13387 | 5479 | 2408 | 1853 | 384 | 112 |
| 2000 | 64273 | 6508 | 5417 | 1687 | 500 | 343 | 89 |
| 2001 | 5975 | 9132 | 3368 | 1775 | 405 | 131 | 17 |
| 2002 | 14228 | 4859 | 4767 | 929 | 351 | 32 | 13 |
| 2003 | 9501 | 1817 | 1538 | 2044 | 381 | 119 | 4 |
| 2004 | 14721 | 4281 | 1079 | 825 | 730 | 82 | 31 |
| 2005 | 2951 | 1854 | 988 | 178 | 118 | 53 | 11 |
| 2006 | 9865 | 991 | 1369 | 516 | 97 | 124 | 26 |
| 2007 | 1182 | 1245 | 563 | 390 | 136 | 29 | 50 |
| 2008 | 812 | 903 | 536 | 498 | 203 | 96 | 24 |
| 2009 | 6985 | 328 | 325 | 478 | 116 | 47 | 13 |
| 2010 | 16058 | 1521 | 399 | 161 | 187 | 30 | 32 |

**Table 3.4.6. Whiting in Division VIa. Landings weights-at-age (kg).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 0.218 | 0.249 | 0.308 | 0.452 | 1.208 | 0.72 | 0.778 |
| 1966 | 0.238 | 0.243 | 0.325 | 0.374 | 0.61 | 0.72 | 0.828 |
| 1967 | 0.204 | 0.24 | 0.319 | 0.424 | 0.412 | 0.639 | 0.821 |
| 1968 | 0.206 | 0.263 | 0.366 | 0.444 | 0.554 | 0.538 | 0.735 |
| 1969 | 0.178 | 0.223 | 0.335 | 0.5 | 0.57 | 0.649 | 0.63 |
| 1970 | 0.205 | 0.203 | 0.274 | 0.382 | 0.519 | 0.619 | 0.683 |
| 1971 | 0.209 | 0.247 | 0.276 | 0.316 | 0.426 | 0.551 | 0.712 |
| 1972 | 0.211 | 0.258 | 0.345 | 0.368 | 0.426 | 0.494 | 0.638 |
| 1973 | 0.196 | 0.235 | 0.362 | 0.479 | 0.485 | 0.532 | 0.666 |
| 1974 | 0.193 | 0.215 | 0.317 | 0.444 | 0.591 | 0.641 | 0.584 |
| 1975 | 0.209 | 0.245 | 0.305 | 0.471 | 0.651 | 0.615 | 0.717 |
| 1976 | 0.201 | 0.242 | 0.309 | 0.361 | 0.497 | 0.687 | 0.856 |
| 1977 | 0.2 | 0.244 | 0.296 | 0.392 | 0.431 | 0.629 | 0.819 |
| 1978 | 0.199 | 0.235 | 0.286 | 0.389 | 0.516 | 0.549 | 0.612 |
| 1979 | 0.218 | 0.232 | 0.306 | 0.404 | 0.536 | 0.678 | 0.693 |
| 1980 | 0.172 | 0.242 | 0.33 | 0.42 | 0.492 | 0.595 | 0.817 |
| 1981 | 0.192 | 0.228 | 0.289 | 0.382 | 0.409 | 0.409 | 0.547 |
| 1982 | 0.184 | 0.22 | 0.276 | 0.352 | 0.505 | 0.513 | 0.526 |
| 1983 | 0.216 | 0.249 | 0.28 | 0.34 | 0.409 | 0.494 | 0.51 |
| 1984 | 0.216 | 0.259 | 0.313 | 0.371 | 0.412 | 0.458 | 0.458 |
| 1985 | 0.185 | 0.238 | 0.306 | 0.402 | 0.43 | 0.461 | 0.538 |
| 1986 | 0.174 | 0.236 | 0.294 | 0.365 | 0.468 | 0.482 | 0.499 |
| 1987 | 0.188 | 0.237 | 0.304 | 0.373 | 0.511 | 0.52 | 0.576 |
| 1988 | 0.176 | 0.215 | 0.301 | 0.4 | 0.483 | 0.567 | 0.6 |
| 1989 | 0.171 | 0.22 | 0.279 | 0.348 | 0.459 | 0.425 | 0.555 |
| 1990 | 0.225 | 0.251 | 0.324 | 0.359 | 0.417 | 0.582 | 0.543 |
| 1991 | 0.199 | 0.22 | 0.291 | 0.354 | 0.391 | 0.442 | 0.761 |
| 1992 | 0.193 | 0.23 | 0.288 | 0.349 | 0.388 | 0.397 | 0.51 |
| 1993 | 0.186 | 0.242 | 0.314 | 0.361 | 0.412 | 0.452 | 0.474 |
| 1994 | 0.161 | 0.217 | 0.29 | 0.371 | 0.451 | 0.482 | 0.483 |
| 1995 | 0.19 | 0.225 | 0.296 | 0.381 | 0.469 | 0.473 | 0.528 |
| 1996 | 0.195 | 0.245 | 0.288 | 0.365 | 0.483 | 0.526 | 0.569 |
| 1997 | 0.198 | 0.245 | 0.297 | 0.384 | 0.522 | 0.629 | 0.661 |
| 1998 | 0.215 | 0.236 | 0.301 | 0.364 | 0.438 | 0.5 | 0.646 |
| 1999 | 0.181 | 0.225 | 0.28 | 0.365 | 0.44 | 0.524 | 0.594 |
| 2000 | 0.205 | 0.241 | 0.298 | 0.336 | 0.419 | 0.488 | 0.617 |
| 2001 | 0.173 | 0.234 | 0.303 | 0.37 | 0.395 | 0.376 | 0.595 |
| 2002 | 0.213 | 0.257 | 0.304 | 0.363 | 0.464 | 0.65 | 0.707 |
| 2003 | 0.228 | 0.264 | 0.309 | 0.362 | 0.374 | 0.436 | 0.717 |
| 2004 | 0.193 | 0.251 | 0.295 | 0.345 | 0.382 | 0.403 | 0.342 |
| 2005 | 0.189 | 0.261 | 0.313 | 0.378 | 0.44 | 0.482 | 0.356 |
| 2006 | 0.221 | 0.292 | 0.319 | 0.394 | 0.455 | 0.528 | 0.567 |
| 2007 | 0.215 | 0.280 | 0.349 | 0.418 | 0.498 | 0.598 | 0.660 |
| 2008 | 0.274 | 0.245 | 0.322 | 0.384 | 0.514 | 0.530 | 0.653 |
| 2009 | 0.328 | 0.347 | 0.437 | 0.479 | 0.470 | 0.519 | 0.595 |
| 2010 | 0.288 | 0.402 | 0.456 | 0.567 | 0.652 | 0.619 | 0.613 |

**Table 3.4.7. Whiting in Division VIa. Discard weights-at-age (kg).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 0.122 | 0.177 | 0.213 | 0.249 | 0.287 | 0.303 | 0.287 |
| 1966 | 0.122 | 0.178 | 0.212 | 0.248 | 0.29 | 0.297 | 0.286 |
| 1967 | 0.122 | 0.178 | 0.213 | 0.248 | 0.29 | 0.295 | 0.289 |
| 1968 | 0.128 | 0.179 | 0.213 | 0.249 | 0.291 | 0.298 | 0.287 |
| 1969 | 0.121 | 0.178 | 0.214 | 0.249 | 0.29 | 0.295 | 0.285 |
| 1970 | 0.121 | 0.175 | 0.213 | 0.249 | 0.29 | 0.299 | 0.284 |
| 1971 | 0.12 | 0.177 | 0.211 | 0.248 | 0.29 | 0.299 | 0.284 |
| 1972 | 0.121 | 0.177 | 0.213 | 0.248 | 0.289 | 0.301 | 0.281 |
| 1973 | 0.123 | 0.176 | 0.215 | 0.252 | 0.288 | 0.301 | 0.285 |
| 1974 | 0.119 | 0.177 | 0.214 | 0.25 | 0.285 | 0.299 | 0.288 |
| 1975 | 0.119 | 0.176 | 0.213 | 0.25 | 0.286 | 0.301 | 0.278 |
| 1976 | 0.116 | 0.177 | 0.213 | 0.249 | 0.288 | 0.3 | 0.28 |
| 1977 | 0.118 | 0.177 | 0.214 | 0.249 | 0.289 | 0.299 | 0.282 |
| 1978 | 0.135 | 0.167 | 0.199 | 0.288 | 0.32 | 0.238 | 0 |
| 1979 | 0.173 | 0.188 | 0.208 | 0.215 | 0.281 | 0 | 0 |
| 1980 | 0.14 | 0.179 | 0.208 | 0.22 | 0.271 | 0.386 | 0 |
| 1981 | 0.108 | 0.16 | 0.195 | 0.298 | 0.286 | 0.295 | 0 |
| 1982 | 0.096 | 0.18 | 0.209 | 0.243 | 0.283 | 0.44 | 0 |
| 1983 | 0.141 | 0.186 | 0.228 | 0.237 | 0.267 | 0.267 | 0 |
| 1984 | 0.087 | 0.199 | 0.246 | 0.26 | 0.259 | 0.303 | 0.227 |
| 1985 | 0.102 | 0.191 | 0.237 | 0.286 | 0.326 | 0.312 | 0.316 |
| 1986 | 0.092 | 0.17 | 0.196 | 0.245 | 0.258 | 0.33 | 0.263 |
| 1987 | 0.085 | 0.182 | 0.233 | 0.249 | 0.225 | 0 | 0 |
| 1988 | 0.076 | 0.143 | 0.203 | 0.227 | 0.262 | 0 | 0 |
| 1989 | 0.099 | 0.177 | 0.205 | 0.209 | 0.294 | 0.305 | 0 |
| 1990 | 0.124 | 0.171 | 0.214 | 0.219 | 0.237 | 0.264 | 0 |
| 1991 | 0.085 | 0.169 | 0.205 | 0.223 | 0.226 | 0.281 | 0 |
| 1992 | 0.109 | 0.173 | 0.219 | 0.227 | 0 | 0 | 0 |
| 1993 | 0.118 | 0.197 | 0.225 | 0.242 | 0.256 | 0 | 0.436 |
| 1994 | 0.087 | 0.157 | 0.22 | 0.283 | 0.297 | 0.253 | 0.299 |
| 1995 | 0.075 | 0.154 | 0.189 | 0.246 | 0.278 | 0.597 | 0.493 |
| 1996 | 0.095 | 0.18 | 0.203 | 0.229 | 0.302 | 0.421 | 0.26 |
| 1997 | 0.112 | 0.182 | 0.221 | 0.235 | 0.243 | 0.422 | 0.819 |
| 1998 | 0.098 | 0.179 | 0.225 | 0.254 | 0.282 | 0.264 | 0.245 |
| 1999 | 0.077 | 0.168 | 0.217 | 0.205 | 0.266 | 0.268 | 0 |
| 2000 | 0.075 | 0.164 | 0.203 | 0.233 | 0.282 | 0.25 | 0 |
| 2001 | 0.094 | 0.154 | 0.196 | 0.203 | 0.381 | 0 | 0 |
| 2002 | 0.073 | 0.162 | 0.212 | 0.245 | 0.24 | 0.295 | 0.276 |
| 2003 | 0.077 | 0.177 | 0.231 | 0.242 | 0.213 | 0.3 | 0.278 |
| 2004 | 0.086 | 0.186 | 0.236 | 0.246 | 0.304 | 0.349 | 0.314 |
| 2005 | 0.088 | 0.149 | 0.223 | 0.214 | 0.315 | 0.292 | 0.373 |
| 2006 | 0.046 | 0.197 | 0.235 | 0.295 | 0.322 | 0.518 | 0.362 |
| 2007 | 0.059 | 0.159 | 0.225 | 0.226 | 0.334 | 0.794 | 0.266 |
| 2008 | 0.075 | 0.211 | 0.286 | 0.301 | 0.397 | 0.222 | 0.304 |
| 2009 | 0.051 | 0.288 | 0.227 | 0.262 | 0.248 | 0.253 | 0.000 |
| 2010 | 0.038 | 0.124 | 0.269 | 0.375 | 0.376 | 0.401 | 0.964 |

**Table 3.4.8. Whiting in Division VIa. Total catch weights-at-age (kg).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| 1965 | 0.122 | 0.177 | 0.213 | 0.249 | 0.287 | 0.303 | 0.287 |
| 1966 | 0.122 | 0.178 | 0.212 | 0.248 | 0.29 | 0.297 | 0.286 |
| 1967 | 0.122 | 0.178 | 0.213 | 0.248 | 0.29 | 0.295 | 0.289 |
| 1968 | 0.128 | 0.179 | 0.213 | 0.249 | 0.291 | 0.298 | 0.287 |
| 1969 | 0.121 | 0.178 | 0.214 | 0.249 | 0.29 | 0.295 | 0.285 |
| 1970 | 0.121 | 0.175 | 0.213 | 0.249 | 0.29 | 0.299 | 0.284 |
| 1971 | 0.12 | 0.177 | 0.211 | 0.248 | 0.29 | 0.299 | 0.284 |
| 1972 | 0.121 | 0.177 | 0.213 | 0.248 | 0.289 | 0.301 | 0.281 |
| 1973 | 0.123 | 0.176 | 0.215 | 0.252 | 0.288 | 0.301 | 0.285 |
| 1974 | 0.119 | 0.177 | 0.214 | 0.25 | 0.285 | 0.299 | 0.288 |
| 1975 | 0.119 | 0.176 | 0.213 | 0.25 | 0.286 | 0.301 | 0.278 |
| 1976 | 0.116 | 0.177 | 0.213 | 0.249 | 0.288 | 0.3 | 0.28 |
| 1977 | 0.118 | 0.177 | 0.214 | 0.249 | 0.289 | 0.299 | 0.282 |
| 1978 | 0.135 | 0.167 | 0.199 | 0.288 | 0.32 | 0.238 | 0 |
| 1979 | 0.173 | 0.188 | 0.208 | 0.215 | 0.281 | 0 | 0 |
| 1980 | 0.14 | 0.179 | 0.208 | 0.22 | 0.271 | 0.386 | 0 |
| 1981 | 0.108 | 0.16 | 0.195 | 0.298 | 0.286 | 0.295 | 0 |
| 1982 | 0.096 | 0.18 | 0.209 | 0.243 | 0.283 | 0.44 | 0 |
| 1983 | 0.141 | 0.186 | 0.228 | 0.237 | 0.267 | 0.267 | 0 |
| 1984 | 0.087 | 0.199 | 0.246 | 0.26 | 0.259 | 0.303 | 0.227 |
| 1985 | 0.102 | 0.191 | 0.237 | 0.286 | 0.326 | 0.312 | 0.316 |
| 1986 | 0.092 | 0.17 | 0.196 | 0.245 | 0.258 | 0.33 | 0.263 |
| 1987 | 0.085 | 0.182 | 0.233 | 0.249 | 0.225 | 0 | 0 |
| 1988 | 0.076 | 0.143 | 0.203 | 0.227 | 0.262 | 0 | 0 |
| 1989 | 0.099 | 0.177 | 0.205 | 0.209 | 0.294 | 0.305 | 0 |
| 1990 | 0.124 | 0.171 | 0.214 | 0.219 | 0.237 | 0.264 | 0 |
| 1991 | 0.085 | 0.169 | 0.205 | 0.223 | 0.226 | 0.281 | 0 |
| 1992 | 0.109 | 0.173 | 0.219 | 0.227 | 0 | 0 | 0 |
| 1993 | 0.118 | 0.197 | 0.225 | 0.242 | 0.256 | 0 | 0.436 |
| 1994 | 0.087 | 0.157 | 0.22 | 0.283 | 0.297 | 0.253 | 0.299 |
| 1995 | 0.075 | 0.154 | 0.189 | 0.246 | 0.278 | 0.597 | 0.493 |
| 1996 | 0.095 | 0.18 | 0.203 | 0.229 | 0.302 | 0.421 | 0.26 |
| 1997 | 0.112 | 0.182 | 0.221 | 0.235 | 0.243 | 0.422 | 0.819 |
| 1998 | 0.098 | 0.179 | 0.225 | 0.254 | 0.282 | 0.264 | 0.245 |
| 1999 | 0.077 | 0.168 | 0.217 | 0.205 | 0.266 | 0.268 | 0 |
| 2000 | 0.075 | 0.164 | 0.203 | 0.233 | 0.282 | 0.25 | 0 |
| 2001 | 0.094 | 0.154 | 0.196 | 0.203 | 0.381 | 0 | 0 |
| 2002 | 0.073 | 0.162 | 0.212 | 0.245 | 0.24 | 0.295 | 0.276 |
| 2003 | 0.077 | 0.177 | 0.231 | 0.242 | 0.213 | 0.3 | 0.278 |
| 2004 | 0.086 | 0.186 | 0.236 | 0.246 | 0.304 | 0.349 | 0.314 |
| 2005 | 0.088 | 0.149 | 0.223 | 0.214 | 0.315 | 0.292 | 0.373 |
| 2006 | 0.046 | 0.197 | 0.235 | 0.295 | 0.322 | 0.518 | 0.362 |
| 2007 | 0.059 | 0.159 | 0.225 | 0.226 | 0.334 | 0.794 | 0.266 |
| 2008 | 0.075 | 0.211 | 0.286 | 0.301 | 0.397 | 0.222 | 0.304 |
| 2009 | 0.051 | 0.288 | 0.227 | 0.262 | 0.248 | 0.253 | 0.000 |
| 2010 | 0.038 | 0.124 | 0.269 | 0.375 | 0.376 | 0.401 | 0.964 |

**Table 3.4.9. Whiting in Division VIa. Available survey tuning-series. Data used in final run are highlighted in bold. For ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.**

| SCOGFS-WIBTS-Q1: Scottish Groundfish Sruvey - Effort in hours - Numbers-at-age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | |
| Year | (hours) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1985 | 10 | 3140 | 1792 | 380 | 85 | 23 | 156 | 18 |
| 1986 | 10 | 1456 | 1526 | 403 | 68 | 10 | 9 | 10 |
| 1987 | 10 | 6938 | 1054 | 584 | 143 | 36 | 2 | 1 |
| 1988 | 10 | 567 | 3469 | 653 | 189 | 42 | 5 | 1 |
| 1989 | 10 | 910 | 505 | 586 | 237 | 48 | 3 | 0 |
| 1990 | 10 | 1818 | 572 | 122 | 216 | 61 | 4 | 1 |
| 1991 | 10 | 3203 | 277 | 298 | 22 | 39 | 9 | 1 |
| 1992 | 10 | 4777 | 1597 | 410 | 517 | 56 | 18 | 0 |
| 1993 | 10 | 5532 | 6829 | 644 | 91 | 30 | 11 | 2 |
| 1994 | 10 | 6614 | 2443 | 1487 | 174 | 56 | 15 | 6 |
| 1995 | 10 | 5598 | 2831 | 1160 | 370 | 70 | 17 | 32 |
| 1996 | 10 | 9384 | 2238 | 635 | 341 | 135 | 30 | 5 |
| 1997 | 10 | 5663 | 2444 | 1531 | 355 | 102 | 17 | 4 |
| 1998 | 10 | 9851 | 1352 | 294 | 195 | 50 | 14 | 1 |
| 1999 | 10 | 6125 | 4952 | 489 | 103 | 16 | 1 | 0.4 |
| 2000 | 10 | 12862 | 471 | 152 | 34 | 10 | 11 | 0 |
| 2001 | 10 | 4653 | 1954 | 242 | 41 | 8 | 1 | 1 |
| 2002 | 10 | 5542 | 1028 | 964 | 86 | 15 | 1 | 1 |
| 2003 | 10 | 6934 | 746 | 436 | 300 | 32 | 2 | 4 |
| 2004 | 10 | 5888 | 1566 | 189 | 131 | 44 | 9 | 1 |
| 2005 | 10 | 1308 | 723 | 183 | 35 | 8 | 11 | 2 |
| 2006 | 10 | 1441 | 466 | 282 | 77 | 0.3 | 3 | 0.6 |
| 2007 | 10 | 614 | 522 | 127 | 75 | 16 | 3 | 2 |
| 2008 | 10 | 593 | 127 | 77 | 26 | 8 | 3 | 0 |
| 2009 | 10 | 906 | 387 | 103 | 105 | 20 | 9 | 7 |
| 2010 | 10 | 3523 | 340 | 108 | 52 | 40 | 4 | 3 |
| 2011 | 10 | 219 | 1767 | 404 | 68 | 32 | 47 | 13 |

| IR-WCGFS : Irish West Coast GFS (VIa) - Effort in minutes - Numbers-at-age | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | |
| Year | (min) | 0 | 1 | 2 | 3 | 4 | 5 |
| 1993 | 2130 | 14403 | 32643 | 11419 | 1464 | 231 | 13 |
| 1994 | 1865 | 264 | 11969 | 4817 | 2812 | 78 | 57 |
| 1995 | 2026 | 34584 | 5609 | 6406 | 734 | 186 | 80 |
| 1996 | 2008 | 376 | 7457 | 3551 | 374 | 232 | 5 |
| 1997 | 1879 | 1550 | 13865 | 8207 | 1022 | 524 | 50 |
| 1998 | 1936 | 1829 | 4077 | 3361 | 663 | 121 | 5 |
| 1999 | 1914 | 3337 | 3059 | 1965 | 322 | 11 | 12 |
| 2000 | 1878 | 682 | 10102 | 2126 | 109 | 109 | 4 |
| 2001 | 965 | 1118 | 5201 | 2903 | 149 | 70 | 3 |
| 2002 | 796 | 594 | 8247 | 9348 | 820 | 280 | 0 |

**Table 3.4.9. (continued).**

| IRGFS-WIBTS-Q4: Irish groundfish survey – Effort in minutes – Numbers-at-age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | |
| Year | (min) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2003 | 1127 | 1101 | 12886 | 2894 | 512 | 290 | 102 | 1 |
| 2004 | 1200 | 6924 | 3114 | 1312 | 104 | 35 | 16 | 1 |
| 2005 | 960 | 910 | 2228 | 1126 | 91 | 5 | 4 | 0 |
| 2006 | 1510 | 99 | 1055 | 921 | 214 | 27 | 3 | 0 |
| 2007 | 1173 | 138 | 1989 | 2380 | 722 | 169 | 251 | 122 |
| 2008 | 1135 | 24 | 4342 | 1328 | 573 | 243 | 123 | 36 |
| 2009 | 1378 | 16906 | 1430 | 989 | 325 | 68 | 21 | 41 |
| 2010 | 1291 | 108 | 9822 | 1510 | 382 | 121 | 64 | 15 |

| ScoGFS-WIBTS-Q4 : Quarter four Scottish groundfish survey – Effort in hours – Numbers-at-age | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | | | |
| Year | (hours) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1996 | 10 | 5154 | 1908 | 1116 | 570 | 188 | 51 | 6 | 1 | 0 |
| 1997 | 10 | 8001 | 2869 | 951 | 323 | 160 | 46 | 12 | 1 | 0 |
| 1998 | 10 | 1852 | 2713 | 1124 | 149 | 100 | 20 | 1 | 0 | + |
| 1999 | 10 | 8203 | 2338 | 582 | 141 | 33 | 24 | 1 | 1 | 0 |
| 2000 | 10 | 4434 | 4055 | 789 | 160 | 9 | 7 | 1 | 0 | 0 |
| 2001 | 10 | 9615 | 1957 | 1420 | 155 | 40 | 12 | 2 | 0 | 0 |
| 2002 | 10 | 14658 | 1591 | 621 | 479 | 30 | 9 | 5 | 0 | 0 |
| 2003 | 10 | 9932 | 3446 | 567 | 338 | 83 | 27 | 4 | 0 | 0 |
| 2004 | 10 | 5923 | 1758 | 940 | 83 | 57 | 62 | 1 | 0 | 0 |
| 2005 | 10 | 2297 | 308 | 318 | 76 | 9 | 4 | 0.9 | 0.7 | 0 |
| 2006 | 10 | 415 | 296 | 140 | 101 | 35 | 8 | 3 | 0.5 | 0 |
| 2007 | 10 | 1894 | 434 | 326 | 99 | 83 | 48 | 0.6 | 0 | 0 |
| 2008 | 10 | 2297 | 208 | 78 | 110 | 28 | 24 | 4 | 0 | + |
| 2009 | 10 | 4833 | 236 | 178 | 50 | 58 | 12 | 6 | 6 | 0 |

**Table 3.4.10. Whiting in Division VIa. Summary of SURBA assessment: Relative estimates of Recruitment, Spawning–Stock Biomass (SSB) and total mortality (Z), based on data from ScoGFS-WIBTS-Q1.**

| Year | Rec | SSB | TSB | Mean Z(2-4) |
|---|---|---|---|---|
| 1985 | 4.729 | 0.494 | 1 | 1.472 |
| 1986 | 3.79 | 0.399 | 0.812 | 1.048 |
| 1987 | 6.006 | 0.543 | 1.132 | 1.257 |
| 1988 | 1.095 | 0.557 | 0.645 | 1.297 |
| 1989 | 1.776 | 0.332 | 0.524 | 1.212 |
| 1990 | 1.495 | 0.262 | 0.472 | 1.27 |
| 1991 | 2.034 | 0.192 | 0.389 | 0.298 |
| 1992 | 6.869 | 0.481 | 1.257 | 0.96 |
| 1993 | 6.499 | 0.879 | 1.672 | 0.956 |
| 1994 | 5.462 | 0.959 | 1.445 | 1.082 |
| 1995 | 9.715 | 0.847 | 1.585 | 1.068 |
| 1996 | 7.061 | 1.171 | 1.863 | 1.261 |
| 1997 | 6.933 | 1.012 | 1.816 | 1.691 |
| 1998 | 8.415 | 0.582 | 1.432 | 1.853 |
| 1999 | 6.85 | 0.449 | 1.031 | 1.888 |
| 2000 | 13.996 | 0.374 | 1.437 | 1.846 |
| 2001 | 4.223 | 0.577 | 0.999 | 1.261 |
| 2002 | 1.914 | 0.575 | 0.716 | 1.11 |
| 2003 | 5.539 | 0.445 | 0.888 | 1.314 |
| 2004 | 5.927 | 0.471 | 0.98 | 1.987 |
| 2005 | 1.706 | 0.286 | 0.438 | 1.925 |
| 2006 | 1.33 | 0.146 | 0.208 | 1.038 |
| 2007 | 0.607 | 0.17 | 0.221 | 1.492 |
| 2008 | 0.431 | 0.108 | 0.141 | 0.64 |
| 2009 | 0.808 | 0.168 | 0.211 | 0.691 |
| 2010 | 2.838 | 0.161 | 0.269 | 0.385 |
| 2011 | 0.212 | 0.641 | 0.653 | 0.572 |

**Table 3.4.11. Whiting in Division VIa. TSA parameter estimates from this year's assessment. * = fixed parameter.**

| Parameter | Notation | Description | 2010 |
|---|---|---|---|
| | F (1, 1965) | | 0.37 |
| Initial fishing mortality | F (2, 1965) | Fishing mortality-at-age a in year y | 0.49 |
| | F (4, 1965) | | 0.75 |
| Survey selectivities | □(1) | | 2.68 |
| ScoGFS-WIBTS-Q1 | □(2) | | 2.10 |
| | □(3) | ScoGFS-WIBTS-Q1 survey selectivity-at-age a | 1.88 |
| | □(4) | | 1.56 |
| | □(5) | | 1.53 |
| | □(6) | | 1.43 |
| | □F | Transitory changes in overall F | 0.15 |
| Fishing mortality standard deviations | □U | Persistent changes in selection (age effect in F) | 0.07 |
| | □V | Transitory changes in the year effect in F | 0.17 |
| | □Y | Persistent changes in the year effect in F | 0.19 |
| Survey catchability standard deviations | □□□□ | Transitory changes in ScoGFS-WIBTS-Q1 catchability | 0.13 |
| | □□□□ | Persistent changes in ScoGFS-WIBTS-Q1 catchability | 0.13 |
| | cv landings | Coefficent of variation of catch-at-age data | 0.20 |
| Measurement coefficients of variation | cv discards | | 0.51 |
| | cv survey | Coefficent of variation of ScoGFS-WIBTS-Q1 survey data | 0.40 |
| | □1 | Ricker parameter (slope at the origin) | 9.80 |
| Recruitment | □2 | Ricker parameter (curve dome occurs at 1/η2) | 0.32 |
| | cv rec | Coefficent of variation of recruitment curve | 0.40 |

**Table 3.4.12. Whiting in Division VIa. Summary of TSA assessment: estimated catch, Recruitment-at-age 1, Spawning–Stock Biomass (SSB) and total mortality (Z).**

| Year | Catch (t) | Recruits ('000s) | SSB (t) | Mean F(2-4) |
|---|---|---|---|---|
| 1965 | 21223 | 82872 | 45681 | 0.68 |
| 1966 | 18291 | 118799 | 36957 | 0.63 |
| 1967 | 25018 | 95711 | 36467 | 1.03 |
| 1968 | 27146 | 413152 | 28124 | 0.91 |
| 1969 | 28926 | 37614 | 66602 | 0.72 |
| 1970 | 14832 | 33877 | 40866 | 0.58 |
| 1971 | 16292 | 45645 | 28549 | 0.79 |
| 1972 | 17037 | 153512 | 18861 | 0.92 |
| 1973 | 28376 | 363043 | 25757 | 1.13 |
| 1974 | 29126 | 125248 | 51917 | 0.87 |
| 1975 | 28490 | 226113 | 44627 | 0.81 |
| 1976 | 31467 | 89783 | 49651 | 1.05 |
| 1977 | 23054 | 137714 | 29940 | 0.91 |
| 1978 | 17413 | 144644 | 26080 | 0.66 |
| 1979 | 20774 | 116370 | 33635 | 0.75 |
| 1980 | 24323 | 339470 | 33932 | 0.62 |
| 1981 | 20167 | 59543 | 61008 | 0.46 |
| 1982 | 19609 | 64840 | 50367 | 0.47 |
| 1983 | 21985 | 69660 | 39317 | 0.69 |
| 1984 | 19634 | 138964 | 28359 | 0.80 |
| 1985 | 22299 | 160087 | 26553 | 1.02 |
| 1986 | 14385 | 101937 | 24124 | 0.81 |
| 1987 | 18486 | 193617 | 26049 | 0.86 |
| 1988 | 20761 | 56966 | 30573 | 1.11 |
| 1989 | 12272 | 95503 | 15527 | 0.99 |
| 1990 | 9558 | 60190 | 16975 | 0.73 |
| 1991 | 10291 | 103266 | 15256 | 0.75 |
| 1992 | 12172 | 137539 | 17750 | 0.68 |
| 1993 | 15457 | 104861 | 26225 | 0.79 |
| 1994 | 15060 | 120409 | 23464 | 0.78 |
| 1995 | 15056 | 130556 | 22215 | 0.84 |

**Table 3.4.12. contd. Whiting in Division VIa. Summary of TSA assessment: estimated catch, Recruitment-at-age 1, Spawning–Stock Biomass (SSB) and total mortality (Z).**

| Year | Catch (t) | Recruits ('000s) | SSB (t) | Mean F(2-4) |
|---|---|---|---|---|
| 1996 | 18357 | 126311 | 23986 | 0.89 |
| 1997 | 18326 | 85773 | 21452 | 1.12 |
| 1998 | 15175 | 151051 | 10968 | 1.13 |
| 1999 | 14305 | 91151 | 13132 | 1.51 |
| 2000 | 11514 | 151577 | 6618 | 1.35 |
| 2001 | 8470 | 67427 | 9273 | 0.95 |
| 2002 | 7788 | 56477 | 9760 | 0.92 |
| 2003 | 7915 | 69463 | 6661 | 1.14 |
| 2004 | 5252 | 50833 | 3589 | 1.06 |
| 2005 | 2188 | 21618 | 1777 | 0.96 |
| 2006 | 1504 | 16020 | 2147 | 0.82 |
| 2007 | 1134 | 7382 | 1996 | 0.61 |
| 2008 | 1069 | 7966 | 1898 | 0.63 |
| 2009 | 882 | 13767 | 2234 | 0.35 |
| 2010 | 1034 | 33690 | 2422 | 0.31 |
| 2011 | | | 6237 | |

**Table 3.4b. Nominal landings (t) of Whiting in Division VIb, 1989–2009, as officially reported to ICES.**

| Country | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Faroe Islands | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ireland | - | - | - | - | 32 | 10 | 4 | 23 | 3 | 1 | - | - | 10 | | 2 | 3 | 3 | 104 | 16 | 23 | 4 | 2 |
| Spain | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - |
| UK (E.& W, NI) | 16 | 6 | 1 | 5 | 10 | 2 | 5 | 26 | 49 | 20 | + | + | - | - | - | - | - | - | - | - | - | - |
| UK (Scotland) | 18 | 482 | 459 | 283 | 86 | 68 | 53 | 36 | 65 | 23 | 44 | 58 | 4 | 7 | 11 | 1 | 1 | 1 | 1 | … | … | … |
| UK (all) | | | | | | | | | | | | | | | | | | | | 8 | 12 | 17 |
| Total | 34 | 488 | 460 | 288 | 128 | 80 | 62 | 85 | 117 | 44 | 44 | 58 | 14 | 7 | 13 | 4 | 4 | 105 | 17 | 31 | 16 | 19 |

*** Preliminary.**

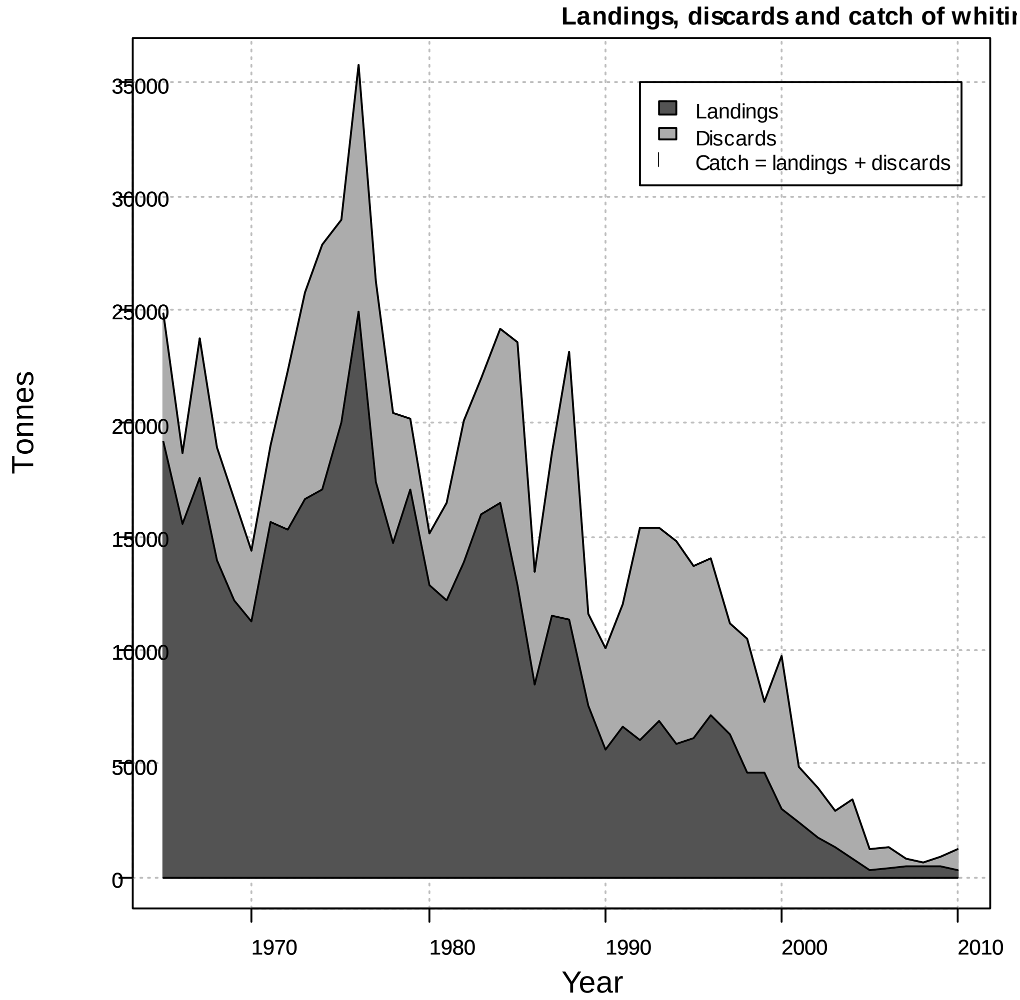
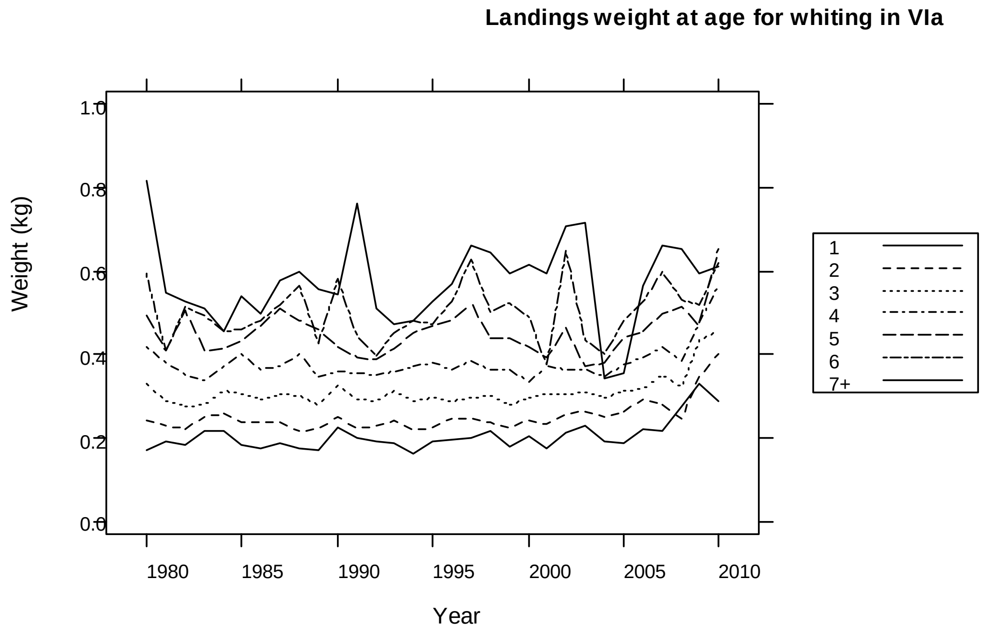



**Figure 3.4.1. Landings, discards and catch (in tonnes) of whiting in Division VIa, as officially reported to ICES.**



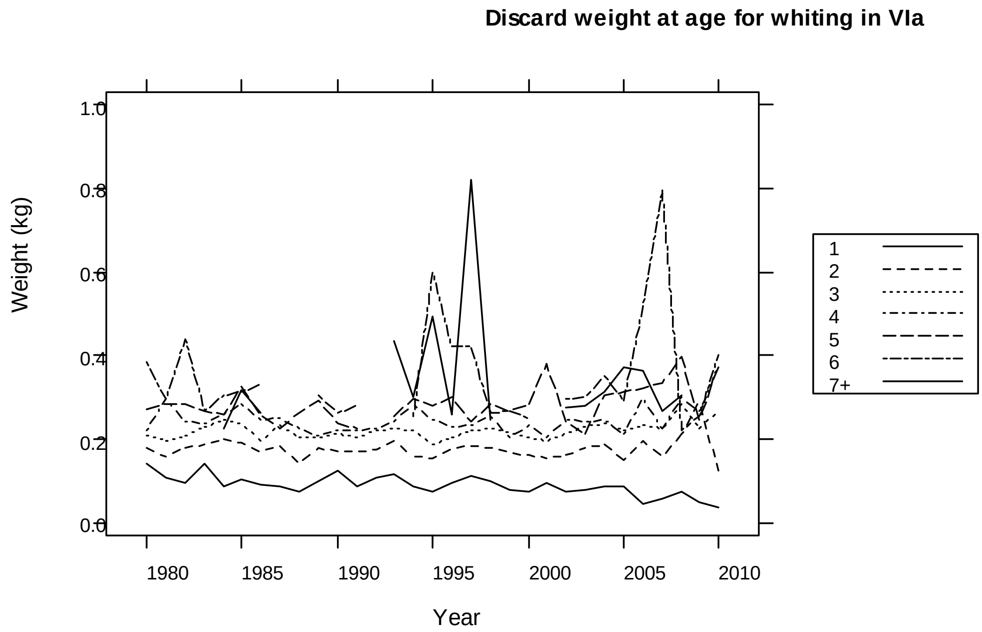




**Figure 3.4.2. Whiting in Division VIa. Mean weights-at-age in the landings (upper panel) and discards (lower panel).**

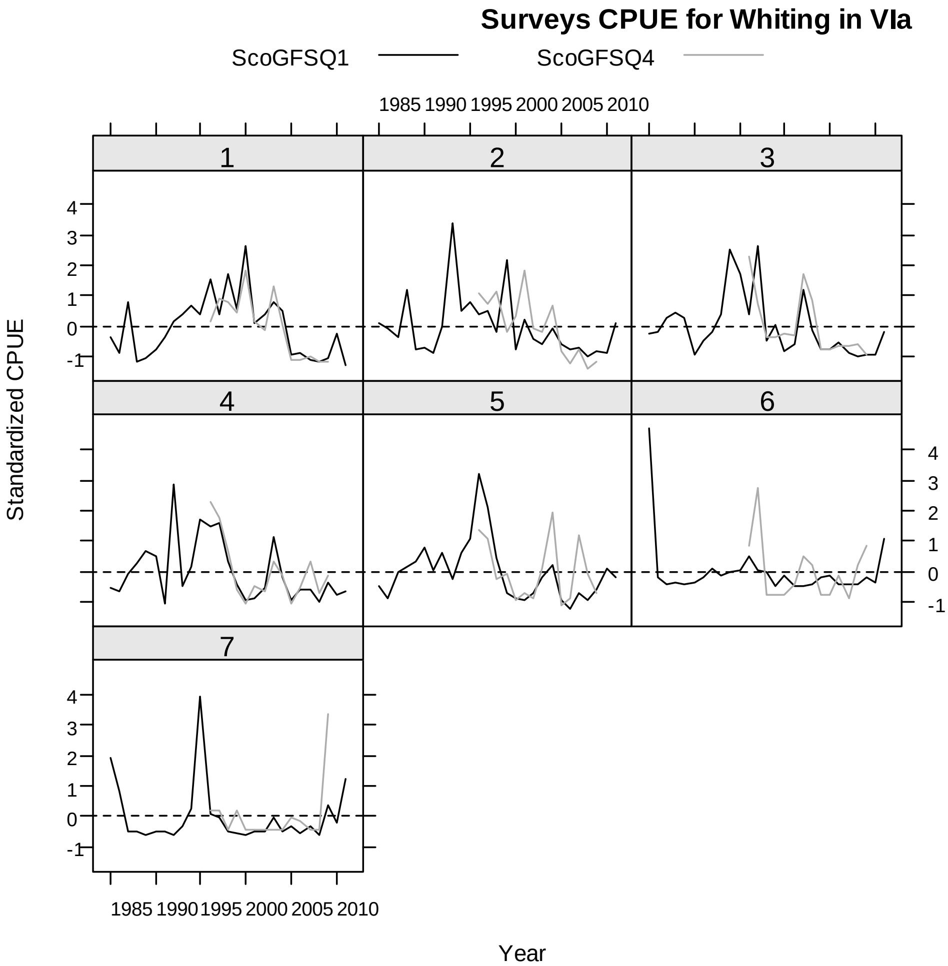



**Figure 3.4.3. Whiting in Division VIa. Comparison of scaled survey indices from ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4.**

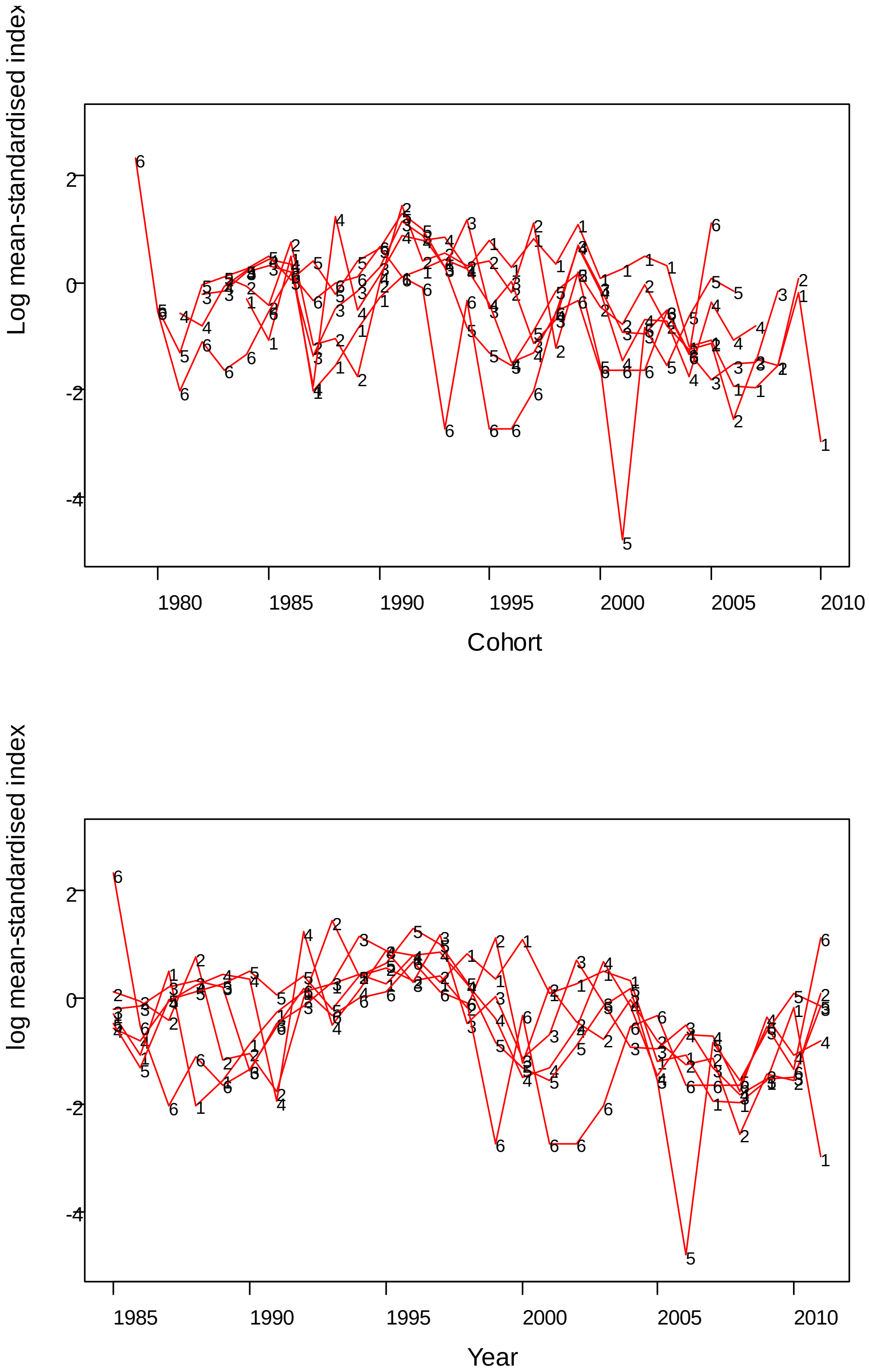



**Figure 3.4.4. Whiting in Division VIa. Log mean standardized survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q1.**

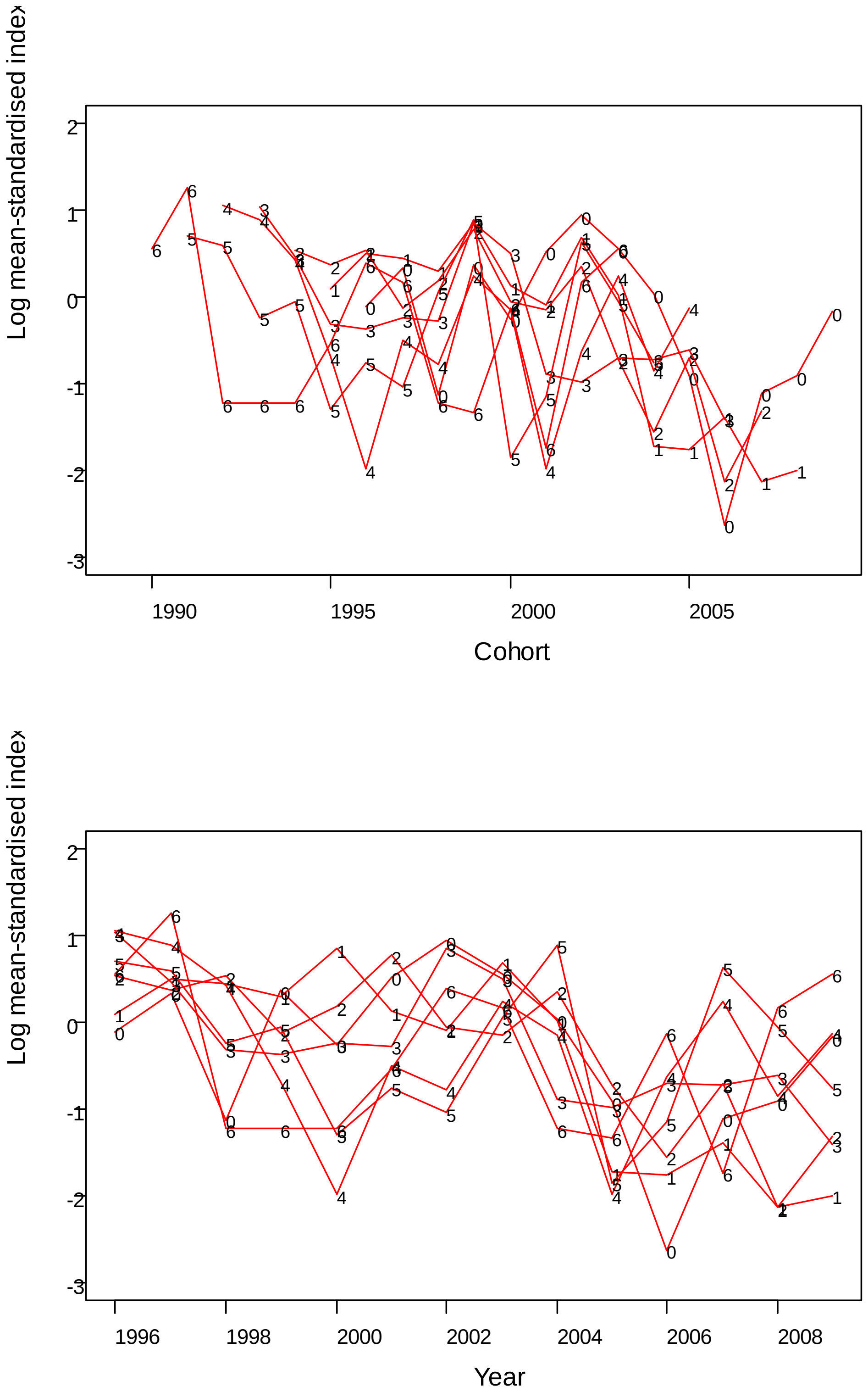
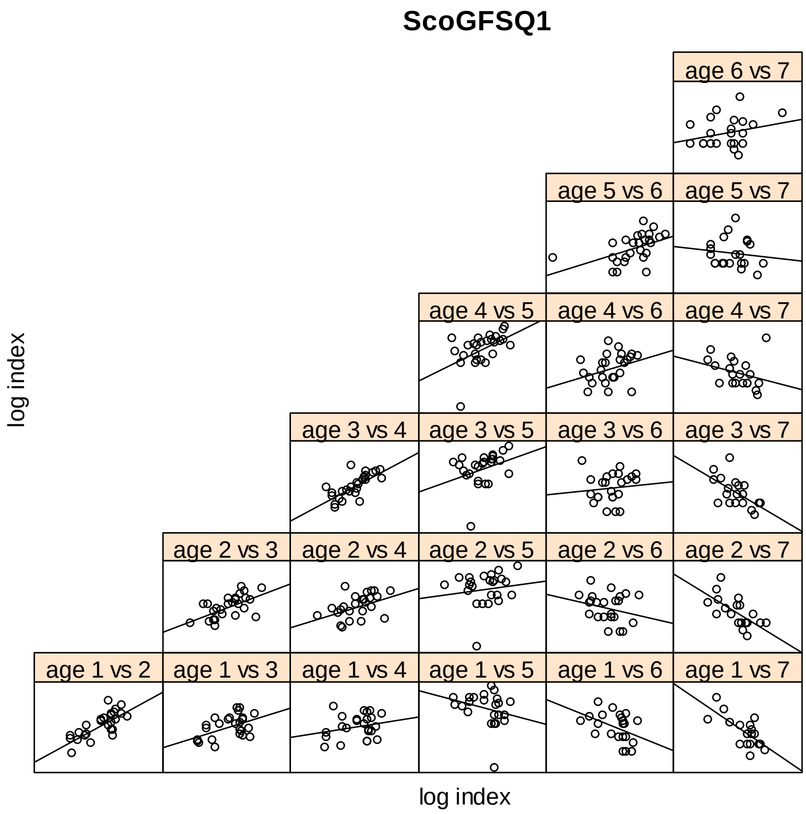



**Figure 3.4.5. Whiting in Division VIa. Log mean standardized survey index for each age by cohort (upper panel) and year (lower panel) in ScoGFS-WIBTS-Q4.**



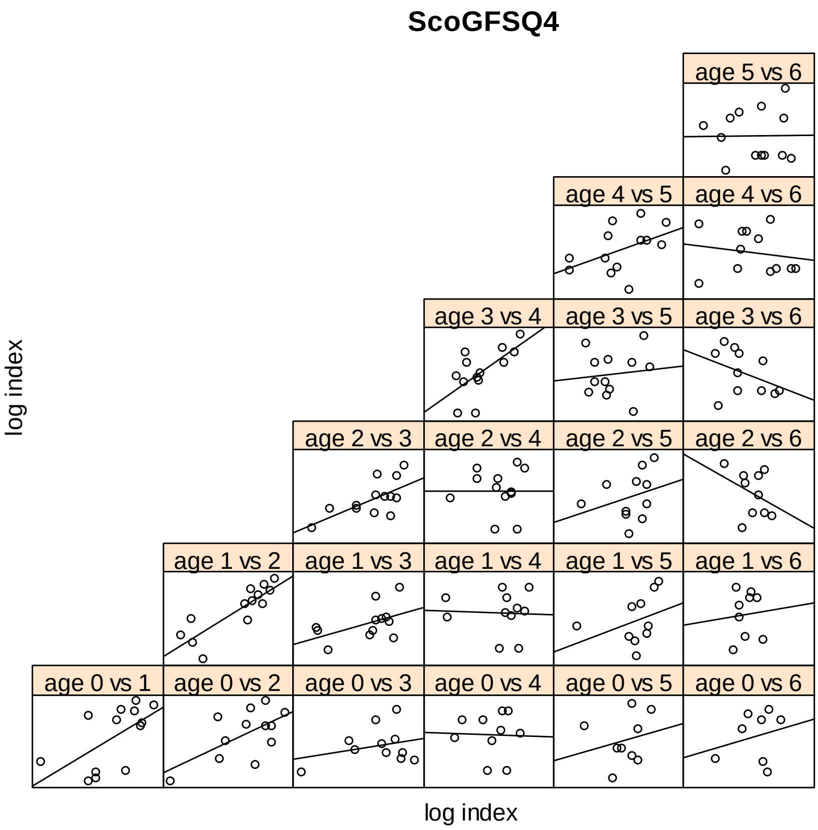




**Figure 3.4.6. Whiting in Division VIa. Comparative scatterplots-at-age for Scottish groundfish surveys, ScoGFS-WIBTS-Q1 and ScoGFS-WIBTS-Q4.**

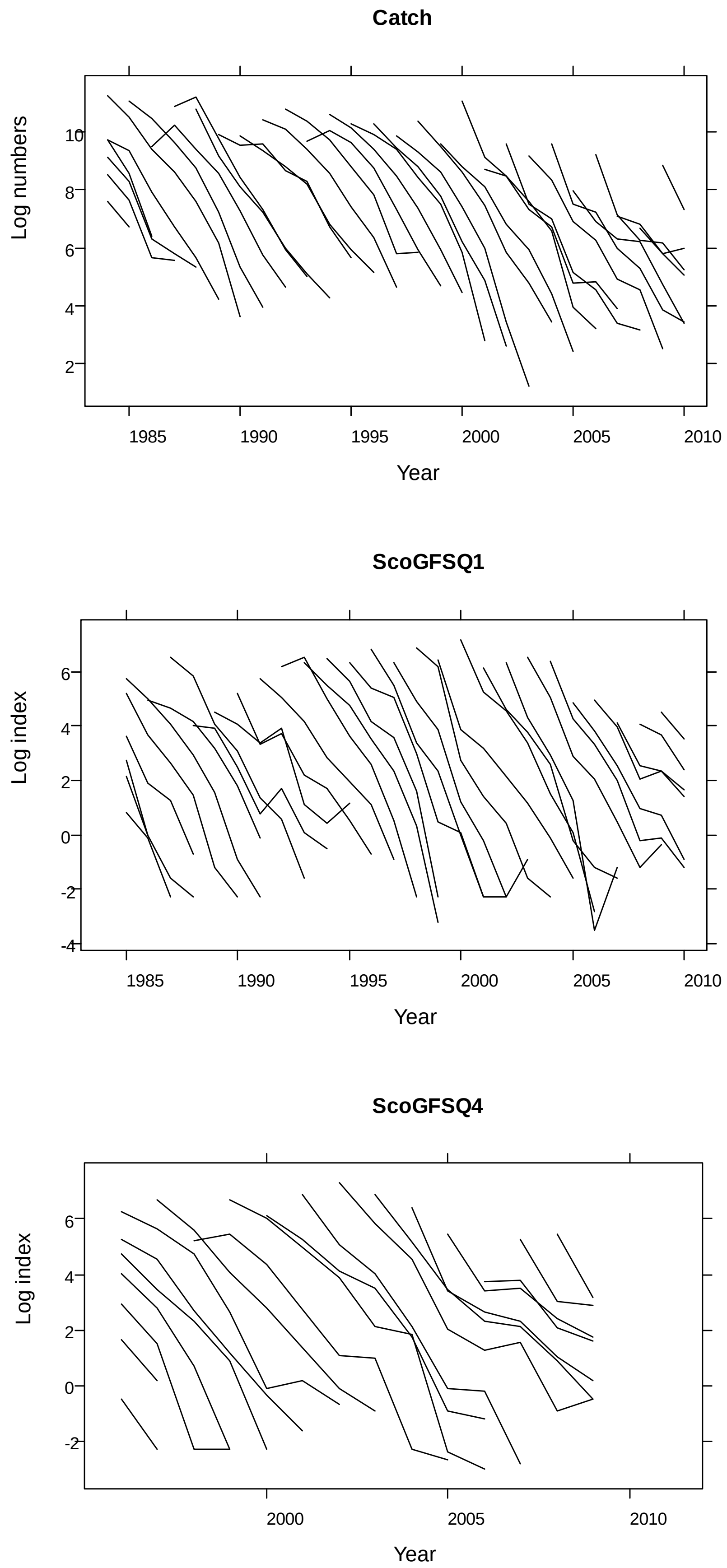



**Figure 3.4.7. Whiting in Division VIa. Log catch curves from the catch (ages 1–7) and the two Scottish groundfish surveys, ScoGFS-WIBTS-Q1 (ages 1–7) and ScoGFS-WIBTS-Q4 (ages 0–7).**

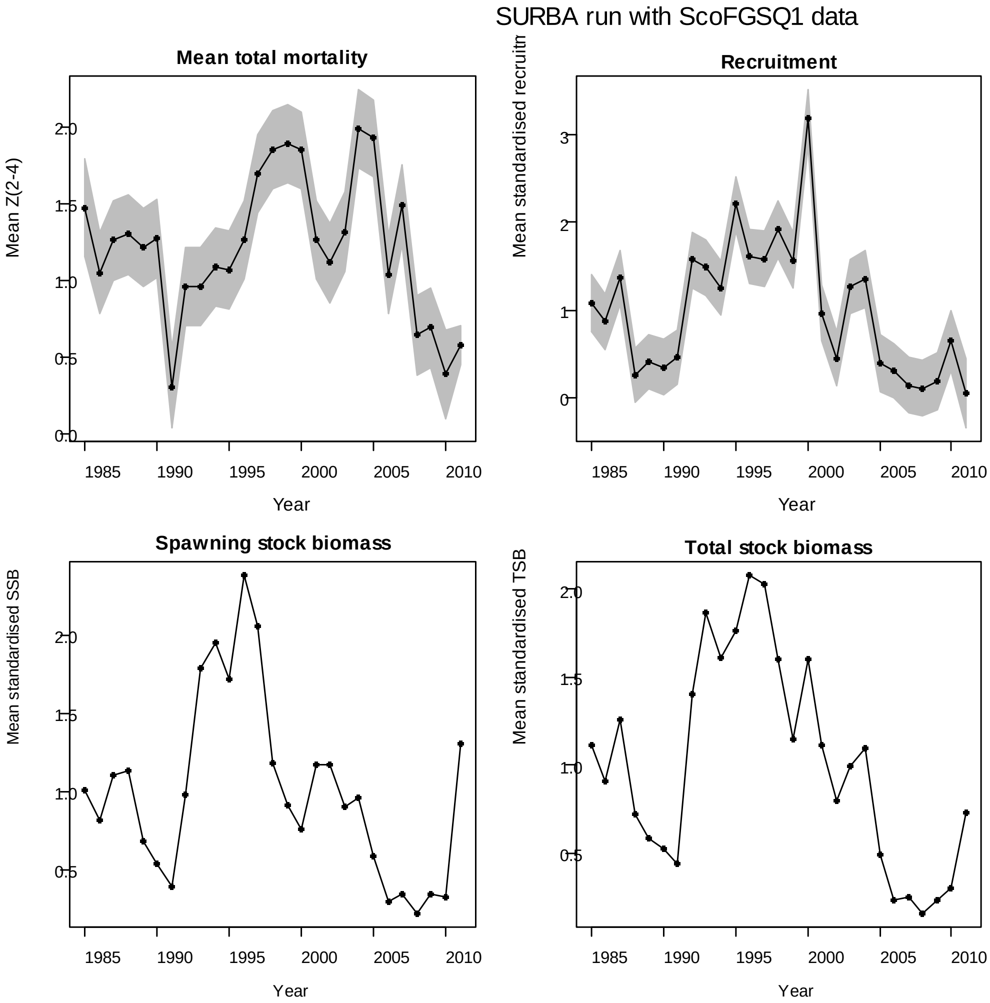



**Figure 3.4.8. Whiting in Division VIa. Results of SURBA run using ScoGFS-WIBTS-Q1 data. Mean total mortality estimates are given as absolute; biomass and recruitment are mean-standardized. Mean total mortality and recruitment are shown with +/- standard errors.**

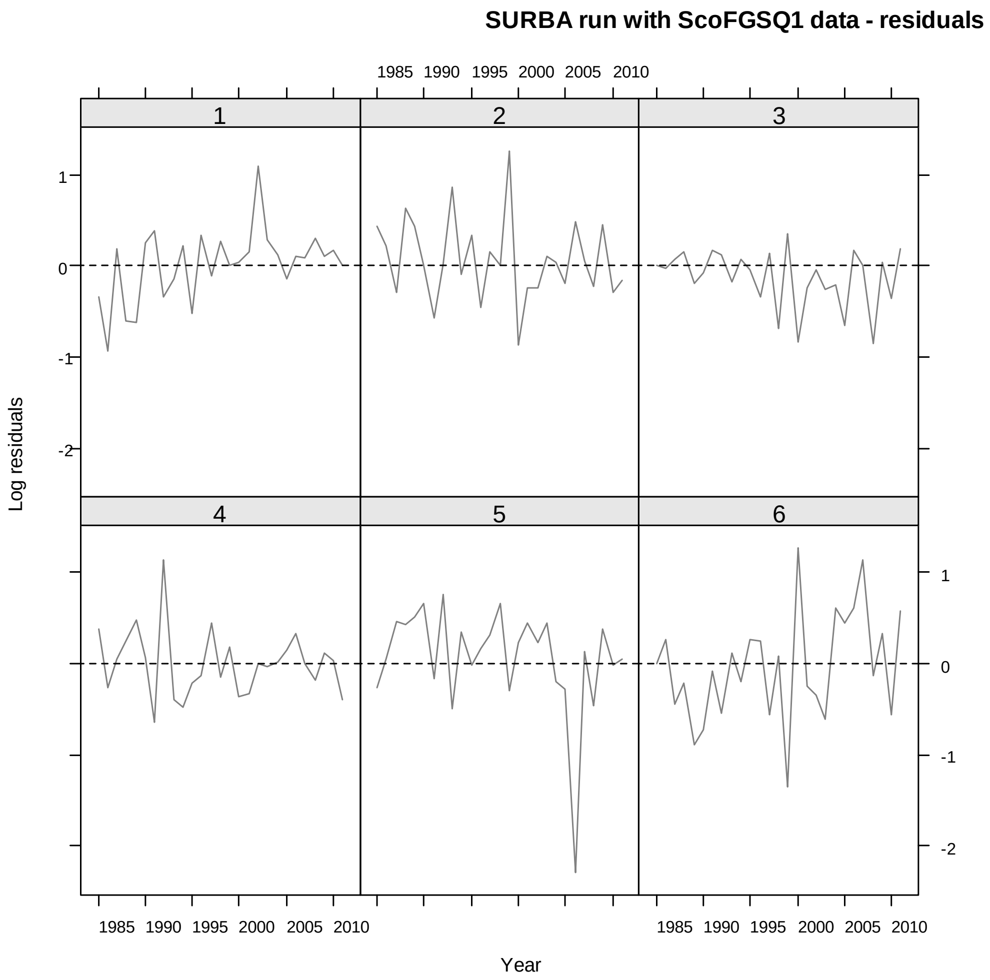



**Figure 3.4.9. Whiting in Division VIa. Residuals by age from SURBA run using ScoGFS-WIBTS-Q1 data.**

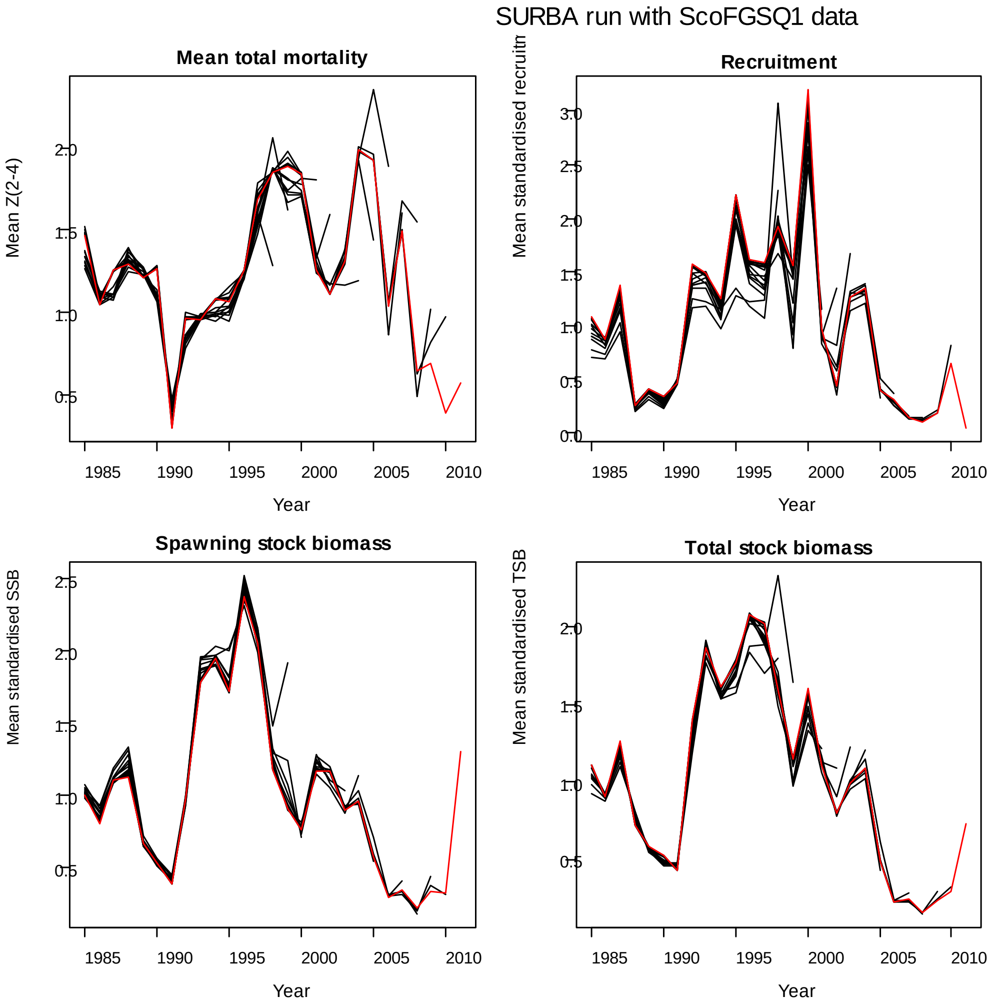



**Figure 3.4.10. Whiting in Division VIa. Retrospective plots of SURBA run using ScoFGS-WIBTS-Q1 data.**

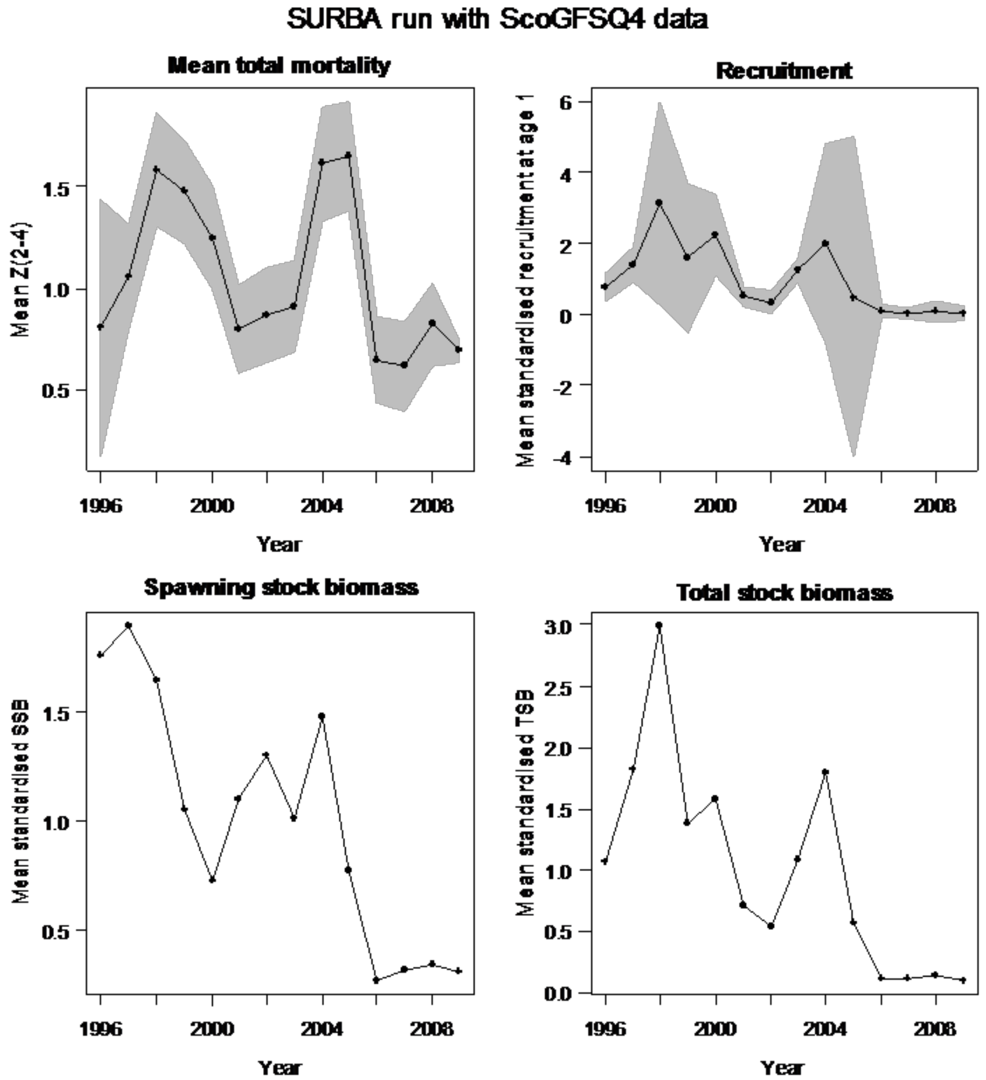



**Figure 3.4.11. Whiting in Division VIa. Results of SURBA run using ScoGFS-WIBTS-Q4 data. Mean total mortality estimates are given as absolute; biomass and recruitment are mean-standardized. Mean total mortality and recruitment are shown with +/- standard errors.**

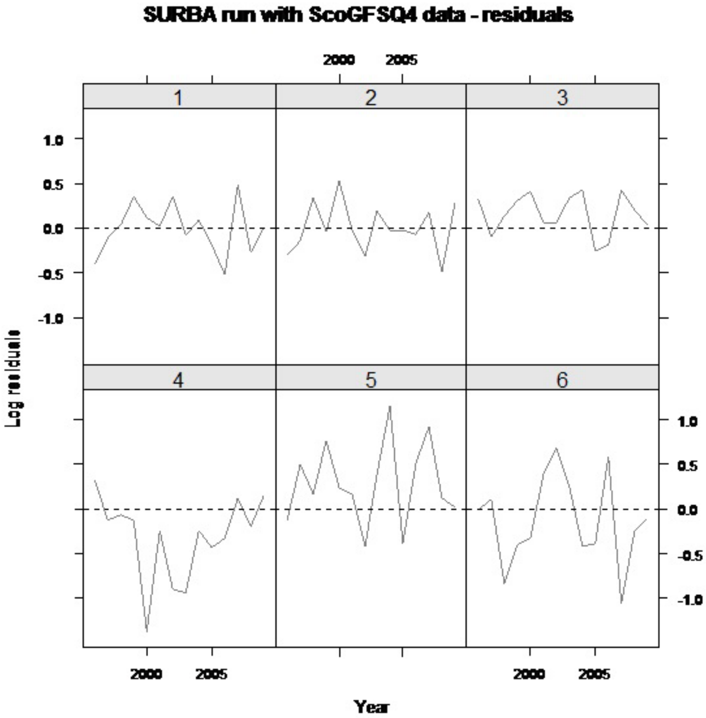



**Figure 3.4.12. Whiting in Division VIa. Residuals by age from SURBA run using ScoGFS-WIBTS-Q4 data.**

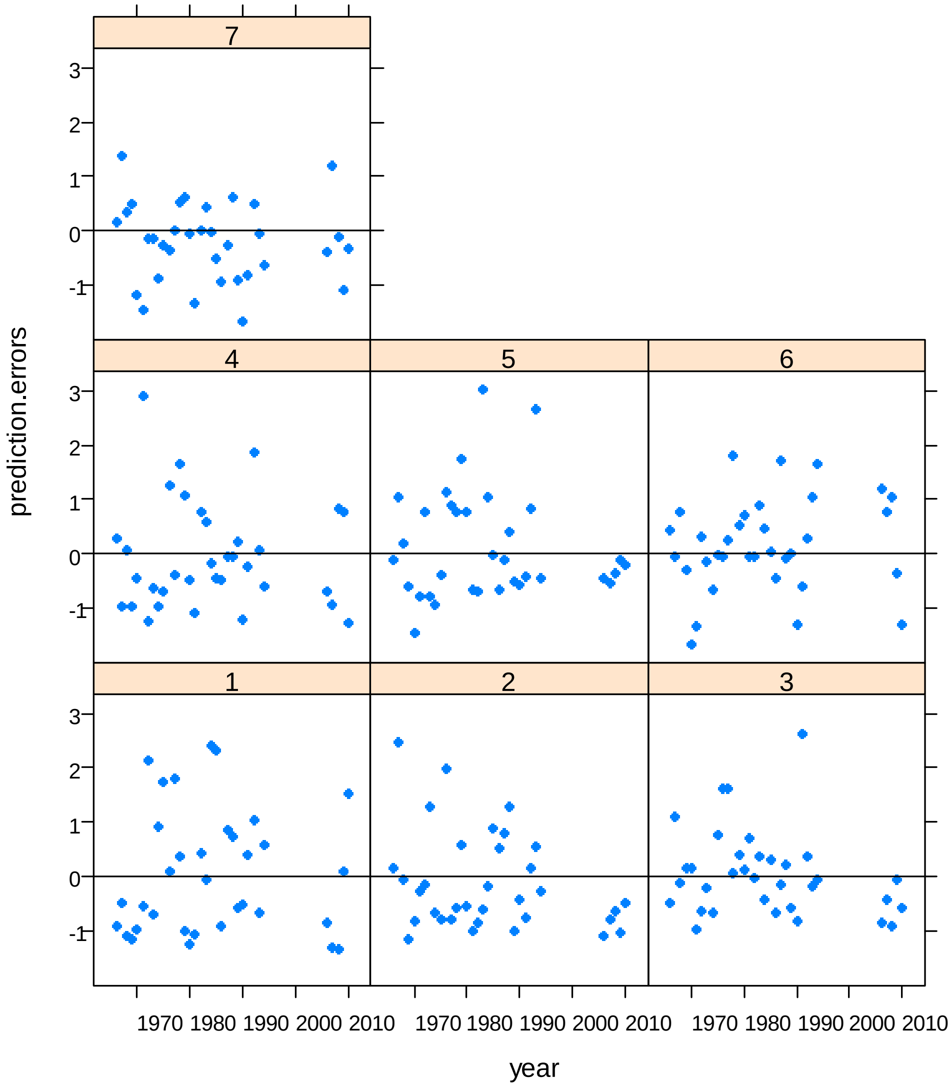



**Figure 3.4.13. Whiting in Division VIa. Standardized catch prediction errors from TSA.**

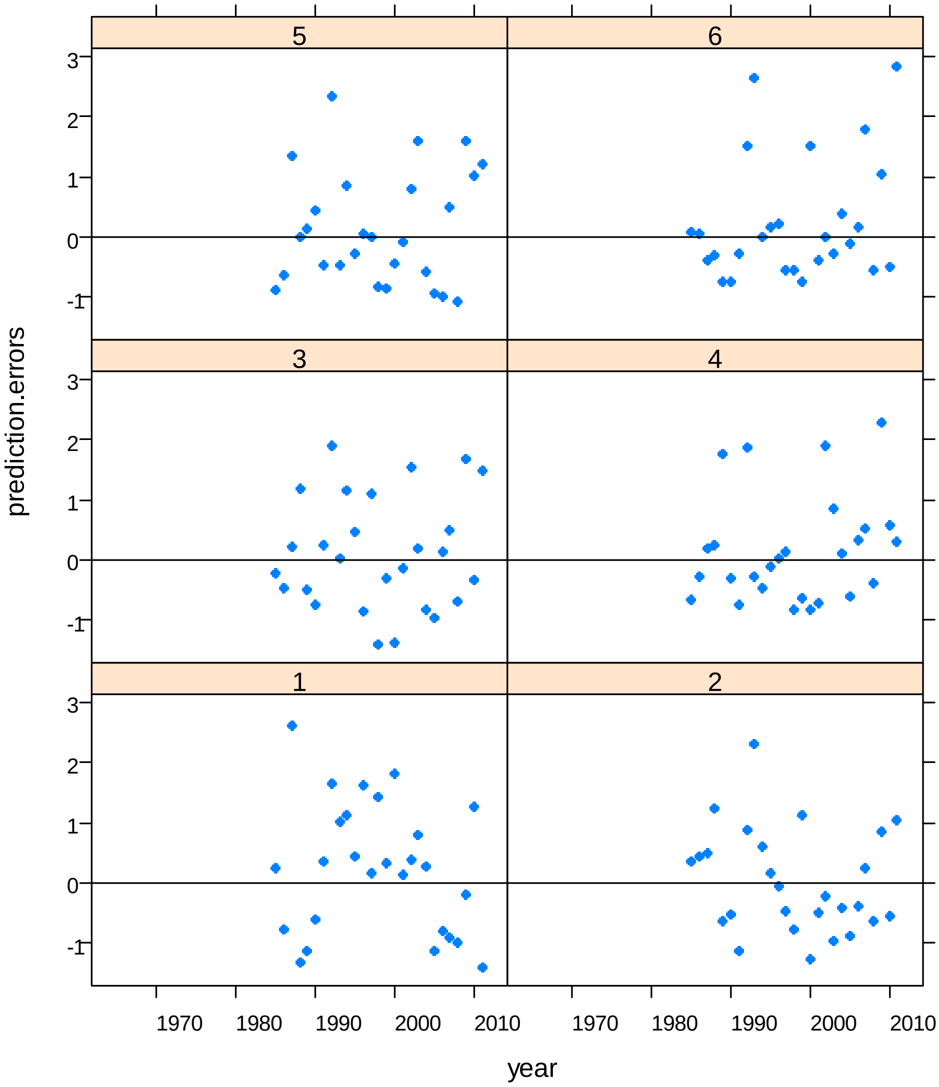



**Figure 3.4.14. Whiting in Division VIa. Standardized survey prediction errors from TSA.**

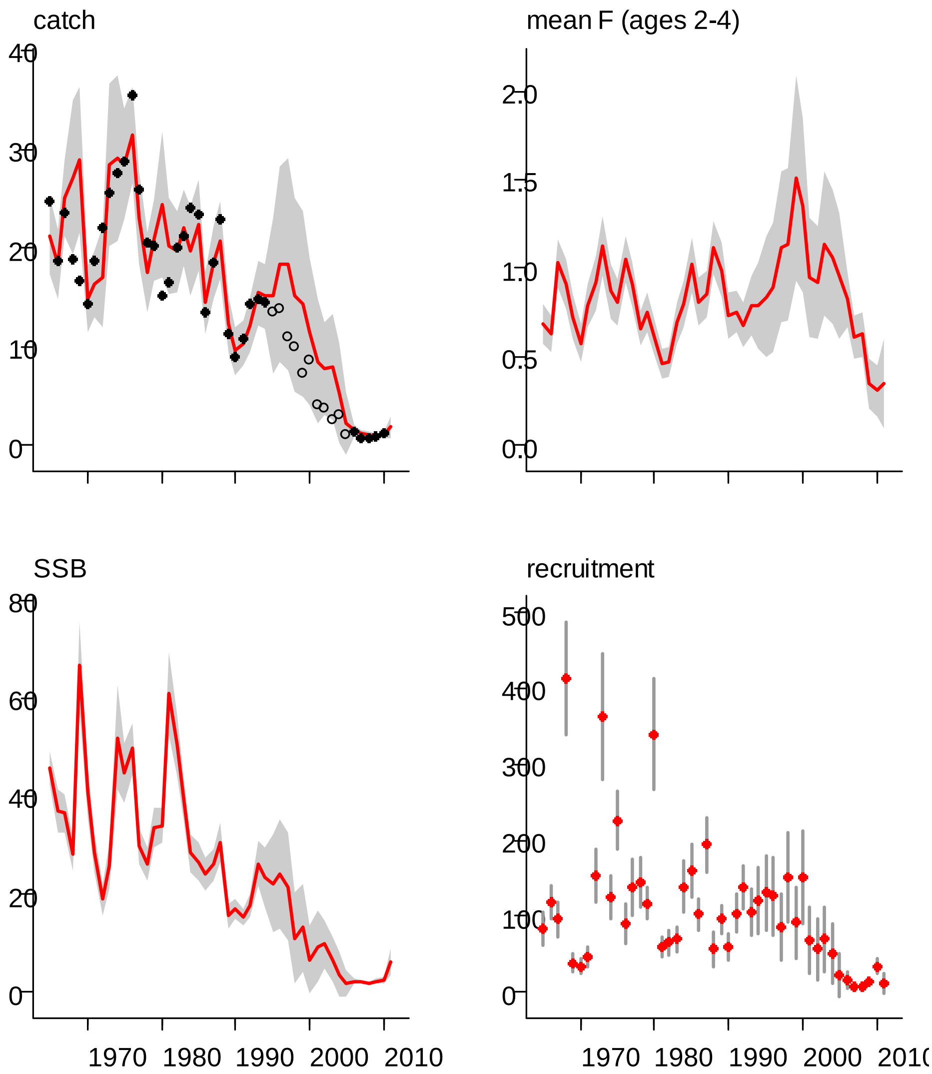



**Figure 3.4.15. Whiting in Division VIa. TSA stock summaries from the TSA run with catch data included 1978–1994 and 2006–2010. Catch and SSB in tonnes, recruitment in thousands. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, with open symbols indicating catch data that were not used in the assessment.**

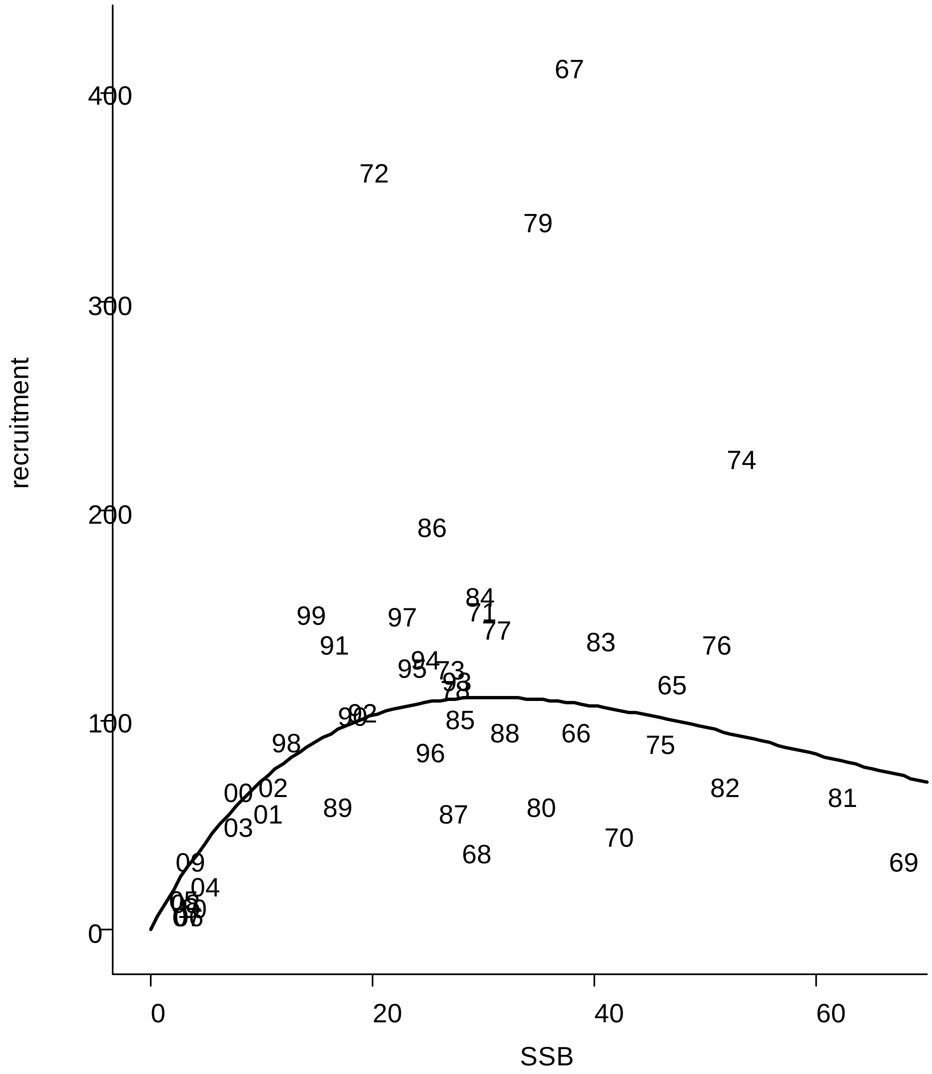



**Figure 3.4.16 Whiting in Division VIa. Stock–recruitment plot from the final TSA run, with points labelled as year classes and fitted Ricker stock–recruitment function (solid line).**

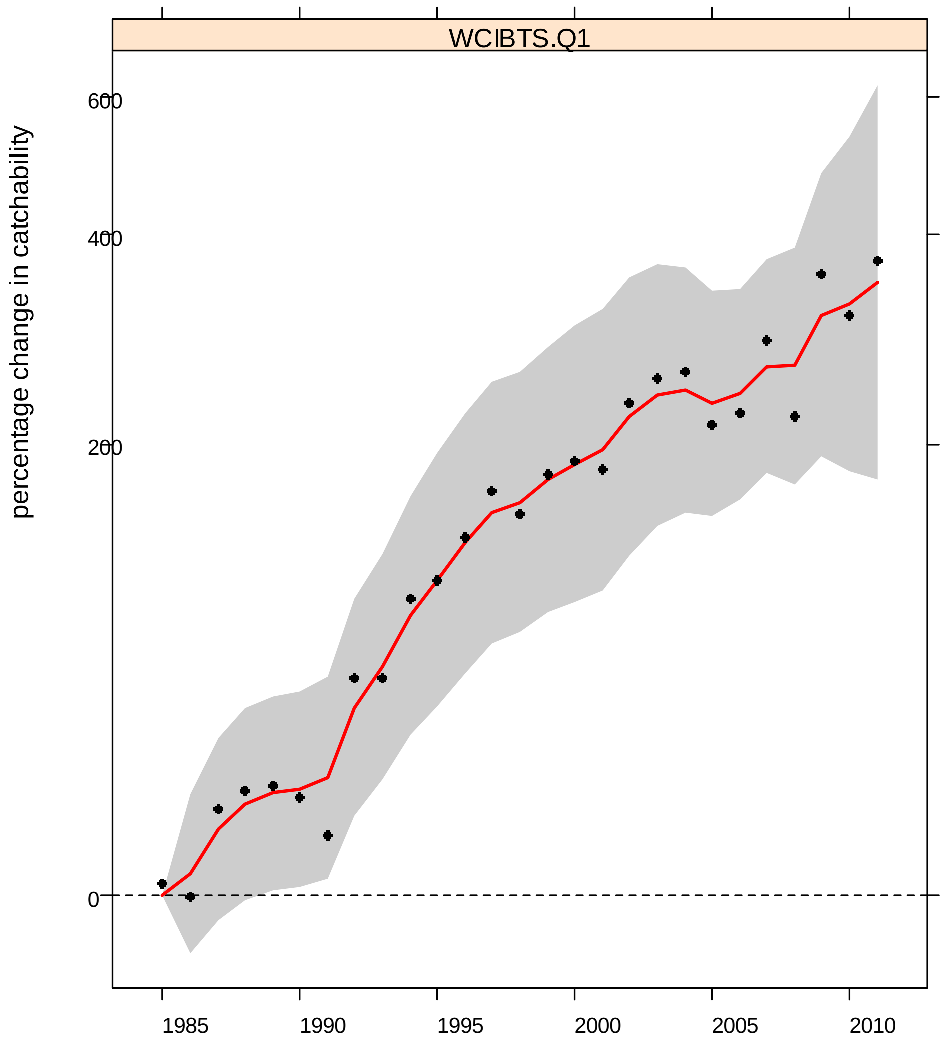



**Figure 3.4.17. Whiting in Division VIa. Percentage change in catchability from the final TSA run. Transient changes are plotted as points and the persistent change is plotted as the solid red line with uncertainty represented by the grey polygon.**

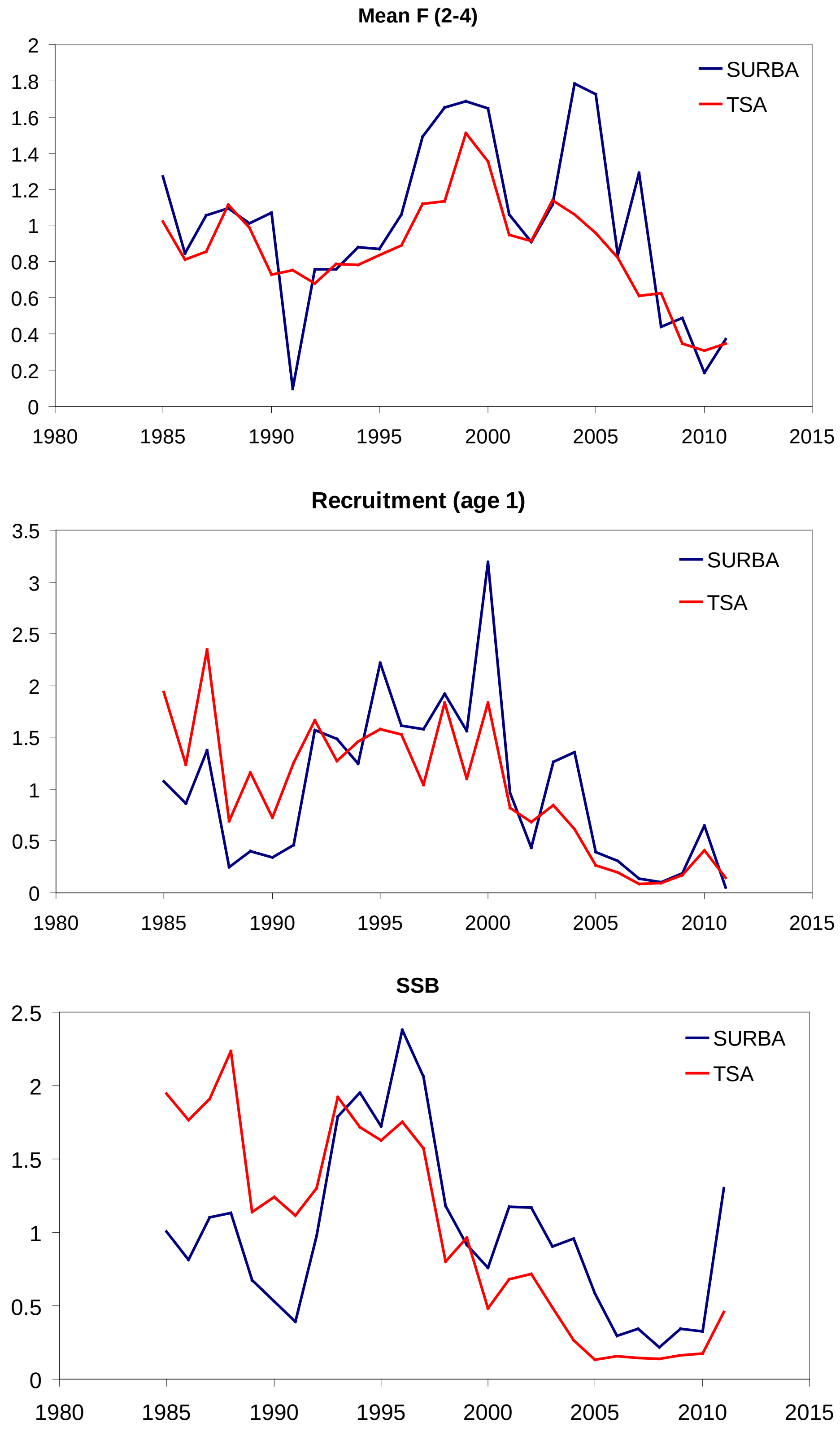



**Figure 3.4.18. Whiting in Division VIa. Comparison of trends based assessment final run outputs (SURBA) with TSA final run assessment estimates. Fishing mortality, recruitment and SSB are mean-standardized over the period 1985–2010 (the length of the tuning-series used in TSA).**

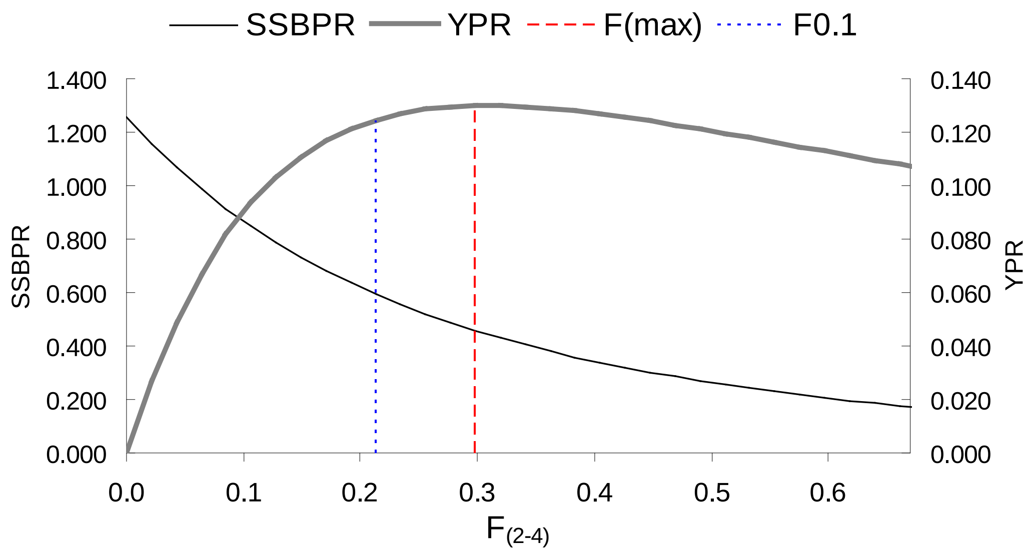



**Figure 3.4.19. Whiting in Division VIa. Yield-per-recruit analysis with the output from the final TSA run.**

## 3.5 North Minch, FU11

*Nephrops* stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 3.5.1 and illustrated in Figure 3.5.1. The Functional Unit is the level at which the WG collects fishery data (quantities landed and discarded, fishing effort, cpues and lpues, etc.) and length distributions, and at which it performs assessments.

There are three Functional Units in Division VIa, the level at which EU management of *Nephrops* currently takes place. Nominal landings as reported to ICES, along with WG estimates of landings are presented in Tables 3.5.2 and 3.5.3 respectively. Landings are also made from outside the Functional Units, from statistical rectangles where small pockets of suitable sediment exist, these are generally small amounts. There are no Functional Units in Division VIb and only very small quantities of *Nephrops* are landed.

#### Type of assessment in 2011

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WKNEPH, 2009) and described in Section 2.2.

### 3.5.1 Ecosystem aspects

The North Minch Functional Unit 11 at the northern end of the west coast of Scotland (Figure 3.5.1).

Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the North Minch Functional Unit these substrata are distributed according to prevailing hydrographic and bathymetric conditions. The area is characterized by numerous islands of varying size and sea lochs occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. The North Minch exhibits the most patchy ground among west coast FUs. Very soft sediments are found in the southeast while coarser sandy muds prevail to the north and west. Figure 3.5.7 shows the distribution of sediment in the area.

### 3.5.2 The fishery in 2010

Information on developments in the fishery was provided by Marine Scotland staff including fishery officers and scientists sampling in the ports and on board vessels; some comments were also received from industry representatives. The fishery in 2010 was described as being slightly better than in 2009 but generally similar to previous years with a fleet of mainly smaller trawlers working 1–4 day trips from the main ports of Lochinver, Ullapool, Stornoway and Gairloch. The largest part of the North Minch fleets continued to be based at Stornoway, made up of mostly smaller vessels, currently six single rigged trawlers and six muti-rigged trawlers, all but one are around 15 m length. The Barra fleet is more nomadic as the fishing grounds are more exposed which forces the fleet to find shelter on the east side of the North Minch. The Barra vessels are generally bigger than the Stornoway fleet, being all over 15 m in length. Although several vessels have been sold or left the fleet in recent years, the remainder have continued to fish the same pattern as always, most trawlers landing daily or every second day. During May 2010, several boats shifted from Lochinver, Ullapool and Gairloch towards Skye and Mallaig where the fishery was described as being better. As a consequence of bad fishing and/or poor weather, a few local boats left the North Minch to fish in the Moray Firth squid fishery. Trawlers are still fishing with 80 mm mesh. In 2009, under the west coast emergency measures a square meshed panel of 120 mm was also required (Council Reg. (EU) 43/2009). Little if any marketable fish bycatch was reported by the boats fishing in the North Minch, this was confirmed during *Nephrops* discard trips on board North Minch boats. There are a number of creel vessels from Kylesku down to Gairloch which reported good catches during 2010.

Further general information on the fishery can be found in the stock annex.

### 3.5.3 ICES advice for 2010 and 2011

#### ICES advice for *2010*

Exploitation boundaries in relation to precautionary considerations was as follows:

"ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should be less than $F_{0.1}$. This corresponds to landings less than 972 t for the North Minch stock."

#### ICES conclusions in 2010

"The evidence from the TV survey suggests that the population is stable over the last three years, but at a lower level than that evident from 2003–2006. The calculated harvest ratio in 2009 (dead removals/UWTV abundance) is above the values associated with high long-term yield and low risk depletion.

For this FU, the absolute density observed on the UWTV survey is medium (~0.55 $m^2$) suggesting the stock may have a medium productivity capability. Historical harvest ratios in this FU have been above that equivalent to fishing at $F_{max}$ and landings have been relatively stable in the last thirty years. $F_{35\%SpR}$ (combined between sexes) is expected to deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for $F_{MSY}$."

#### ICES advice for 2011

MSY approach was as follows:

"Following the ICES MSY framework implies the harvest ratio to be reduced to $F_{MSY}$ 12.5 %, resulting in landings of 1900 t in 2011. Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced to 20.1% (0.8 x harvest ratio($F_{2010}$ 22%) + 0.2 x harvest ratio($F_{MSY}$ 12.5%) resulting in landings of 3100 t in 2011."

### 3.5.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.5.

### 3.5.5 Assessment

Conclusions of the Review of the 2010 assessment:

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice. The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES Division level. The RG agrees with the WG that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by the WGCSE for choosing Fmsy proxies for *Nephrops*. If ICES is to use UWTV abundance estimates as absolute, then biases due to incomplete coverage of *Nephrops* habitat need to be evaluated. The RG agrees that the relationship between fishing area (VMS) and survey area need further exploration.

The RG report contained a number of technical comments and attempts have been made to address these.

### Approach in 2011

The assessment in 2011 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the North Minch.

The assessment of *Nephrops* and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WKNEPH 2009) and is described in Section 2.2. The provision of advice in 2011 follows the process defined by the benchmark WG and described in Section 3.5 and attempts to incorporate decisions taken at WKFRAME for the provision of MSY advice by ICES in 2010 (see Section 2.2). The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE.

Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. Creel fishing is an important component of the North Minch fishery and landings from creel vessels have risen since the mid 1990s having been at a stable level since then. Given that creels operate across similar areas to those of the trawl fishery, the assessments from 2010 onwards were performed using combined length compositions from trawl and creels.

The accuracy of the currently used boundaries of what is considered *Nephrops* suitable habitat has been considered a source of uncertainty particularly in highly heterogeneous grounds such those on the west coast of Scotland and particularly in the North Minch where differences between fished area and surveyed area are likely to exist. Marine Scotland Science recent access to Vessel Monitoring System data (VMS) makes it possible to link geographical information on the positioning of vessels to landings data resulting in more detailed information on the spatial distribution of fishing effort in the *Nephrops* trawl fishery. In the 2011 assessment a VMS area (rather than the British Geological Survey sediment area estimate) was used for the first time to raise the burrow counts and produce an overall abundance estimate. Further details are described in the Research Vessel Data section.

### Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

#### *Commercial catch and effort data*

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2; these relate to the whole of VI of which the North Minch is a part. Landings by gear category for FU 11 provided through national laboratories are presented in Table 3.5.5. Landings from this fishery are only reported from Scotland. A variety of gear types make landings of *Nephrops*. Total reported landings in 2010 were 2263 tonnes, consisting of 1717 tonnes landed by *Nephrops* trawlers and 540 tonnes landed by creel vessels.

Given the concerns about the previously (prior to 2010) presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG. Reported effort by all Scottish *Nephrops* trawlers has shown a decreasing trend since 2002 (Figures 3.5.3 and 3.5.4).

The introduction of the "buyers and sellers" regulations in the UK in 2006 however, have led to increased reliability in the reported landings. Combined together, the increase in lpue in 2005 is probably reflecting the increase in reported landings rather than a change in stock abundance.

Males consistently make the largest contribution to the landings, although the sex ratio does seem to vary (75% males in 2010) (Figure 3.5.4). This is likely to be due to the varying seasonal pattern in the fishery and associated relative catchability (due to different burrow emergence behaviour) of male and female *Nephrops.* This occurs because males are available throughout the year and the fishery is also prosecuted in all quarters. Females on the other hand are mainly taken in summer when they emerge after egg hatching.

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates in this FU average around 16% by number in the last five years (Table 3.5.10). It is likely that some *Nephrops* survive the discarding process, an estimate of 25% (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard rate adjusted for survivorship which is used in the provision of landings options for 2012 was 11.2% based on a three year average.

#### *Length compositions*

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards-at-length data were available from Scotland and these sampling levels are shown in Table 3.5.4. Although assessments based on detailed catch analysis are not currently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.5.5 shows a series of annual length frequency distributions for the period 1979 to 2010. Catch (removals) length compositions are shown for each sex along with the mean size for both. In both sexes the mean sizes have been fairly stable over time although in 2010 there is some evidence of a slight increase in the mean lengths. Examination of the tails of the distributions above 35mm (the length beyond which the effects of recruitment pulses and discarding are considered to be negligible) shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings (trawl only) shown in Figures 3.5.3 and Table 3.5.6. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also quite stable through time.

Mean weight in the landings (Figure 3.5.6 and Table 3.5.9) show no systematic changes over the time-series although there is a slight increase in 2010.

#### Natural mortality, maturity-at-age and other biological parameters

Biological parameter values are included in the Stock Annex.

#### *Research vessel data*

Underwater TV surveys using a stratified random approach are available for this stock since 1994 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow numbers and distributions, reduce the problems associated with traditional trawl surveys that arise from variability of burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. Traditionally, because of the uncertainty in the sediment distribution in the North Minch, the area surveyed has been divided in four arbitrary rectangles roughly corresponding to discrete patches of mud and the burrow densities in the four rectangles raised to the total sediment area in the FU. The sediment distribution around UK is given by the British Geological Survey (BGS) and the estimated area for the North Minch is 1775 km$^2$. VMS plots (Figure 3.5.9) have shown fishing effort for trawlers (length >15 m) clearly extends outside the present survey area for FU 11, which would imply an underestimate of the stock area. In the 2008 and 2009 TV surveys, a number of exploratory stations were surveyed on the basis of the newly available VMS data and burrows were identified confirming the presence of *Nephrops* outside the BGS sediment grounds. To account for this, the VMS area was used to generate the sampling stations for the 2010 survey and the burrow densities were raised accordingly. The VMS area to which counts were raised was calculated as the average VMS area of the last three years (2506 km$^2$). The numbers of valid stations used in the final analysis are shown in Table 3.5.8.

#### Data analyses

##### *Exploratory analyses of survey data*

A re-working of the UWTV survey abundances for Division VIa were presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 11 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.5.7 shows the basic analysis for the three most recent TV surveys conducted in FU 11. The table includes estimates of abundance and variability of each of the strata adopted in the stratified random approach. For 2010 a single strata based on VMS was applied do calculate the overall abundance. The area calculation method is based in the alpha convex-hull method to define and characterize the overall shape of a set of points and is described in the 2010 SGNEPS report (ICES, 2010). Figure 3.5.7 shows the distribution of stations in recent TV surveys (2004–2010), with the size of the symbols reflecting the *Nephrops* burrow density. Table 3.5.7 and Figure 3.5.8 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. A correction ratio calculated as 1.41 (VMS area/Sediment area) was applied to the previous sediment abundance estimates to get a rough measure of the abundance raised to the VMS area (Table 3.5.8 and Figure 3.5.8).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for FU11 was 1.33 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 33%.

#### Final Assessment

The underwater TV survey is presented as the best available information on the North Minch *Nephrops* stock. The surveys provide a fishery-independent estimate of *Nephrops* abundance. The details of the 2010 survey is shown in Table 3.5.7 with the 2008 and 2009 outcomes. At present it is not possible to extract any length or age structure information from the survey and it therefore only provides information on abundance over the area of the survey. The VMS calculated abundance for 2010 presented at this meeting is not directly comparable with the previous 2009 estimate used for the advice. When compared with the back-calculated VMS series, the abundance in 2010 shows a slight increase (9%) in relation to the 2009 figure.

The TV survey results reported here do not cover the sea loch areas adjacent to the main North Minch grounds and should therefore be considered underestimates of the overall biomass. The sea lochs support a significant but unknown percentage of the creel fishery. This issue is discussed further under quality of assessment.

### 3.5.6 Historical stock trends

The TV survey estimates of abundance for *Nephrops* in the North Minch suggest that historically the population increased until 2003 at which time it has fluctuated around the maximum value until 2006 when it declined for two years before a slight increase in 2009. The recently observed decrease (2006–2008) has left stocks at a similar abundance to those seen in 2002 but not as low as previous to this. The bias adjusted abundance estimates from 1999–2010 (the period over which the survey estimates have been revised) are shown in Table 3.5.10. A new series with the VMS calculated abundance estimated for previous years was added to the table. In 2010, the stock is estimated to now be at 1115 million individuals (bias adjusted values). Table 3.5.10 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) also shows the estimated harvest ratios over this period. It is likely that prior to 2006, the estimated harvest ratios may not be representative of actual harvest ratios due to underreporting of landings).

### 3.5.7 MSY considerations

A number of potential $F_{msy}$ proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and an exploitation and discard ogive for trawl and creel caught *Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit $F_{msy}$ proxies is given in the text table below and the process for choosing an appropriate $F_{msy}$ proxy is described in Section 2.2. All $F_{msy}$ proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For this FU, the absolute density observed on the UWTV survey is intermediate (based on the guideline categories suggested in Section 2.2) with an average of just over 0.59 $m^{-2}$ suggesting the stock may have a medium productivity capability. Historical harvest ratios in this FU have been above that equivalent to fishing at $F_{max}$ and landings have been relatively stable in the last thirty years. $F_{35\%SpR}$ (combined between sexes) is also estimated to be at $F_{max}$. For these reasons, the working group considered that **F35%SpR (combined between sexes) deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for $F_{msy}$.**

| | | $F_{bar}$(20–40 mm) | | | | SPR (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | $F_{mult}$ | M | F | HR (%) | M | F | T |
| F0.1 | M | 0.20 | 0.14 | 0.05 | 7.4 | 39.7 | 69.2 | 50.6 |
| | F | 0.65 | 0.44 | 0.15 | 19.8 | 13.0 | 38.0 | 22.2 |
| | T | 0.24 | 0.16 | 0.06 | 8.7 | 34.6 | 65.0 | 45.8 |
| Fmax | M | 0.36 | 0.24 | 0.08 | 12.2 | 24.3 | 54.4 | 35.4 |
| | F | 1.49 | 1.01 | 0.34 | 37.2 | 4.7 | 18.2 | 9.6 |
| | T | 0.52 | 0.35 | 0.12 | 16.6 | 16.7 | 44.2 | 26.8 |
| F35%SpR | M | 0.24 | 0.16 | 0.06 | 8.7 | 34.6 | 65.0 | 45.8 |
| | F | 0.73 | 0.49 | 0.17 | 21.7 | 11.4 | 34.9 | 20.0 |
| | T | 0.37 | 0.25 | 0.09 | 12.5 | 23.6 | 53.7 | 34.7 |

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 330 million individuals.

### 3.5.8 Landings forecasts

A prediction of landings in 2012 based on principles established at the Benchmark Workshop WKNEPH (ICES 2009) and using the revised approach based on various proxies for $F_{MSY}$ (Dobby, 2009) outlined in the introductory Section 2.2 was made for the North Minch. The landings prediction for 2012 at the $F_{msy}$ proxy harvest ratio is 3236 tonnes. There is no transition stage since the current harvest rate is below the $F_{msy}$ proxy. The inputs to the landings forecast were as follows:

Mean weight in landings (08–10) = 26.16 g

Dead discard rate (08–10) = 11.2 %

Survey bias = 1.33

| | Harvest rate | Survey Index (adjusted) | Implied fishery<br>Retained number | <br>Landings (tonnes) |
|---|---|---|---|---|
| $F_{msy}$ | 12.5% | 1115 | 124 | 3236 |
| $F_{0.1(M)}$ | 7.4% | 1115 | 73 | 1916 |
| $F_{2010}$ | 7.6% | 1115 | 75 | 1968 |
| $F_{0.1(T)}$ / $F_{35\%SpR(M)}$ | 8.7% | 1115 | 86 | 2253 |
| $F_{max\ (M)}$ | 12.2% | 1115 | 121 | 3159 |
| $F_{35\%SpR(T)}$ | 12.5% | 1115 | 124 | 3236 |
| $F_{max\ (T)}$ | 16.6% | 1115 | 164 | 4298 |

**Note: No $F_{msy}$ transition as $F_{2010}$ is below $F_{msy}$.**

$F_{0.1(M,T)}$: Harvest ratio equivalent to fishing at a level associated with 10% of the slope at the origin on the male or combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male or combined SPR equal to 35% of the unfished level.

$F_{max\ (M,\ T)}$: Harvest ratio equivalent to fishing at a rate which maximizes the male or combined YPR.

A discussion of $F_{msy}$ reference points for *Nephrops* is provided in Section 2.2.

### 3.5.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks.

### 3.5.10 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately. However, in 2010 discard trips in quarters one and two have not been completed and as such, fill-ins from quarters four and two were applied respectively. In this assessment (as in 2010) combined trawl and creel length compositions are used to account for the fact that the creel fishery accounts for over 24% of the landings, increasingly operates over similar areas to trawling, and exhibits a length composition composed of larger animals.

There were concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers was introduced and the reliability began to improve. Because of this the final assessment adopted is independent of official statistics. Harvest ratios since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions has also improved estimates of harvest ratios.

Underwater TV surveys have been conducted for this stock since 1994, with a continual annual series available since 1998. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are quite small for this functional unit. There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realized harvest rates has not been investigated.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2008–2010) of discard rate (adjusted to account for some survival of discarded animals) have been used in the calculation of catch options. The recent observed discard rate shows a marked decline in 2010.

The cumulative bias estimates for FU 11 are largely based on expert opinion (See Annex). The precision of these bias corrections cannot yet be characterized.

The stock are has been increased by WGCSE 2011 using integrated VMS-logbook data to more accurately estimate the spatial extent of *Nephrops* catches. Two other factors however, are likely to increase the fished area further. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substratum and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilize these data to improve estimates of mud area and *Nephrops* abundance. The current stock area can be therefore considered a minimum estimate.

### 3.5.11 Status of the stock

The evidence from the TV survey suggests that the population is stable, but at a lower level than that observed between 2003–2006. In 2010 an increase in abundance was observed (9% when compared with the VMS area based estimated for 2009). The calculated harvest ratio in 2010 (dead removals/TV abundance) is now below the values associated with high long-term yield and low risk depletion.

### 3.5.12 Management considerations

The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Creel fishing takes place in this area but overall effort by this fleet in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the North Minch and STECF estimates that discards of whiting and haddock are high in VIa generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod under the Scottish Conservation Credits scheme and west coast emergency measures include the implementation of larger meshed square meshed panels (120 mm) and real-time closures to avoid cod.

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

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**Table 3.5.1.** ***Nephrops*** **Functional Units and descriptions by statistical rectangle.**

| Functional Unit | Stock | Division | ICES Rectangles |
|---|---|---|---|
| 11 | North Minch | VIa | 44–46 E3–E4 |
| 12 | South Minch | VIa | 41–43 E2–E4 |
| 13 | Clyde | VIa | 39–40 E4–E5 |
| 14 | Irish Sea East | VIIa | 35–38E6; 38E5 |
| 15 | Irish Sea West | VIIa | 36E3; 35–37 E4–E5; 38E4 |

**Table 3.5.2. Nominal catch (tonnes) of *Nephrops* in Division VIa and VIb, 1980–2010, as officially reported to ICES. There are no Functional Units in ICES Division VIb but occasional small landings are made.**

**VIa Official Landings**

| | France | Ireland | Spain | UK–(Engl+Wales+N.Irl) | UK–Scotland | UK | TOTAL |
|---|---|---|---|---|---|---|---|
| 1980 | 5 | 1 | - | - | 7,422 | - | 7,428 |
| 1981 | 5 | 26 | - | - | 9,519 | - | 9,550 |
| 1982 | 1 | 1 | - | 1 | 9,000 | - | 9,003 |
| 1983 | 1 | 1 | - | 11 | 10,706 | - | 10,719 |
| 1984 | 3 | 6 | - | 12 | 11,778 | - | 11,799 |
| 1985 | 1 | 1 | 28 | 9 | 12,449 | - | 12,488 |
| 1986 | 8 | 20 | 5 | 13 | 11,283 | - | 11,329 |
| 1987 | 6 | 128 | 11 | 15 | 11,203 | - | 11,363 |
| 1988 | 1 | 11 | 7 | 62 | 12,649 | - | 12,730 |
| 1989 | - | 9 | 2 | 25 | 10,949 | - | 10,985 |
| 1990 | - | 10 | 4 | 35 | 10,042 | - | 10,091 |
| 1991 | - | 1 | - | 37 | 10,458 | - | 10,496 |
| 1992 | - | 10 | - | 56 | 10,783 | - | 10,849 |
| 1993 | - | 7 | - | 191 | 11,178 | - | 11,376 |
| 1994 | 3 | 6 | - | 290 | 11,047 | - | 11,346 |
| 1995 | 4 | 9 | 3 | 346 | 12,527 | - | 12,889 |
| 1996 | - | 8 | 1 | 176 | 10,929 | - | 11,114 |
| 1997 | - | 5 | 15 | 133 | 11,104 | - | 11,257 |
| 1998 | - | 25 | 18 | 202 | 10,949 | - | 11,194 |
| 1999 | - | 136 | 40 | 256 | 11,078 | - | 11,510 |
| 2000 | 1 | 130 | 69 | 137 | 10,667 | - | 11,004 |
| 2001 | 9 | 115 | 30 | 139 | 10,568 | - | 10,861 |
| 2002 | - | 117 | 18 | 152 | 10,225 | - | 10,512 |
| 2003 | - | 145 | 12 | 81 | 10,450 | - | 10,688 |
| 2004 | - | 150 | 6 | 267 | 9,941 | - | 10,364 |
| 2005 | - | 153 | 17 | 153 | 7,616 | - | 7,939 |
| 2006 | - | 133 | 1 | 255 | 13,419 | - | 13,808 |
| 2007 | - | 155 | - | 2,088 | 14,120 | - | 16,363 |
| 2008 | - | 56 | 1 | 419 | 14,795 | - | 15,271 |
| 2009 | - | 53 | - | 1226 | 11,462 | - | 12741 |
| 2010* | - | 45 | - | - | - | 12,199 | 12244 |

*** figures are provisional.**

**VIb Official Landings**

| | France | Germany | Ireland | Spain | UK-(Engl+Wales+N.Irl) | UK-Scotland | TOTAL |
|---|---|---|---|---|---|---|---|
| 1980 | - | - | - | - | - | - | 0 |
| 1981 | - | - | - | - | - | - | 0 |
| 1982 | - | - | - | - | - | - | 0 |
| 1983 | - | - | - | - | - | - | 0 |
| 1984 | - | - | - | - | - | - | 0 |
| 1985 | - | - | - | - | - | - | 0 |
| 1986 | - | - | - | 8 | - | - | 8 |
| 1987 | - | - | - | 18 | 11 | - | 29 |
| 1988 | - | - | - | 27 | 4 | - | 31 |
| 1989 | - | - | - | 14 | - | - | 14 |
| 1990 | - | - | - | 10 | 1 | - | 11 |
| 1991 | - | - | - | 30 | - | - | 30 |
| 1992 | - | - | - | 2 | 4 | 1 | 7 |
| 1993 | - | - | - | 2 | 6 | 9 | 17 |
| 1994 | - | - | - | 5 | 16 | 5 | 26 |
| 1995 | 1 | - | - | 2 | 26 | 1 | 30 |
| 1996 | - | 6 | - | 5 | 65 | 5 | 81 |
| 1997 | - | - | 1 | 3 | 88 | 23 | 115 |
| 1998 | - | - | 1 | 6 | 46 | 7 | 60 |
| 1999 | - | - | - | 5 | 2 | 5 | 12 |
| 2000 | 2 | - | 8 | 3 | 4 | 4 | 21 |
| 2001 | 1 | - | 1 | 14 | 2 | 7 | 25 |
| 2002 | 1 | - | - | 7 | 3 | 7 | 18 |
| 2003 | - | - | 1 | 5 | 6 | 18 | 30 |
| 2004 | - | - | - | 2 | 7 | 13 | 22 |
| 2005 | 3 | - | 1 | 1 | 5 | 7 | 17 |
| 2006 | - | - | - | - | 1 | 3 | 4 |
| 2007 | - | - | - | 2 | 3 | - | 5 |
| 2008 | - | - | - | - | - | - | 0 |
| 2009 | - | - | - | - | - | - | 0 |
| 2010* | - | - | - | - | - | - | 0 |

*** figures are provisional.**

**Table 3.5.3.** ***Nephrops*****, Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2010.**

| Year | FU11 | FU12 | FU13 | Other | Total |
|---|---|---|---|---|---|
| 1981 | 2861 | 3651 | 2968 | 39 | 9519 |
| 1982 | 2799 | 3552 | 2623 | 27 | 9001 |
| 1983 | 3196 | 3412 | 4077 | 34 | 10719 |
| 1984 | 4144 | 4300 | 3310 | 36 | 11790 |
| 1985 | 4061 | 4008 | 4285 | 104 | 12458 |
| 1986 | 3382 | 3484 | 4341 | 89 | 11296 |
| 1987 | 4083 | 3891 | 3007 | 257 | 11238 |
| 1988 | 4035 | 4473 | 3665 | 529 | 12702 |
| 1989 | 3205 | 4745 | 2812 | 212 | 10974 |
| 1990 | 2544 | 4430 | 2912 | 182 | 10068 |
| 1991 | 2792 | 4442 | 3038 | 255 | 10527 |
| 1992 | 3560 | 4237 | 2805 | 248 | 10849 |
| 1993 | 3192 | 4455 | 3342 | 344 | 11332 |
| 1994 | 3616 | 4415 | 2629 | 441 | 11101 |
| 1995 | 3656 | 4680 | 3989 | 460 | 12785 |
| 1996 | 2871 | 3995 | 4060 | 239 | 11165 |
| 1997 | 3046 | 4345 | 3618 | 243 | 11252 |
| 1998 | 2441 | 3730 | 4843 | 157 | 11171 |
| 1999 | 3257 | 4051 | 3752 | 438 | 11498 |
| 2000 | 3246 | 3952 | 3419 | 421 | 11038 |
| 2001 | 3259 | 3992 | 3182 | 420 | 10853 |
| 2002 | 3440 | 3305 | 3383 | 397 | 10525 |
| 2003 | 3268 | 3879 | 3171 | 433 | 10751 |
| 2004 | 3135 | 3868 | 3025 | 403 | 10431 |
| 2005 | 2984 | 3841 | 3423 | 254 | 10502 |
| 2006 | 4160 | 4554 | 4778 | 241 | 13733 |
| 2007 | 3968 | 5451 | 6495 | 420 | 16334 |
| 2008 | 3799 | 5347 | 5997 | 128 | 15271 |
| 2009 | 3497 | 4282 | 4777 | 185 | 12741 |
| 2010* | 2263 | 3725 | 5701 | 555 | 12244 |

*** provisional.**

**Table 3.5.4. *Nephrops*. Sampling levels all FUs in VIa.**

| IMS data only | 2007 | 2008 | 2009* | 2010* |
|---|---|---|---|---|
| | | | | |
| No. *Nephrops* Samples | 126 | 119 | 133 | 83 |
| No. *Nephrops* measured | 119 962 | 68 309 | 74 261 | 57 388 |
| | | | | |
| Discard data only | 2007 | 2008 | 2009* | 2010* |
| | | | | |
| No. *Nephrops* Samples | 22 | 24 | 25 | 22 |
| No. Marketable *Nephrops* measured | NA | 45 251 | 46 223 | 31 315 |
| No. Discards Measured | 14 630 | 15 975 | 13 549 | 8941 |

*** 2009 and 2010 are not directly comparable with previous years given that sampling levels shown are aggregated for all gears while sampling numbers for 2007 and 2008 include only *Nephrops* trawl and Creel fishing.**

**Table 3.5.5.** ***Nephrops*****, North Minch (FU11), Nominal Landings of** ***Nephrops*****, 1981–2010.**

| Year | UK Scotland | | | |
|---|---|---|---|---|
| | *Nephrops* trawl | Other trawl | Creel | Total** |
| 1981 | 2320 | 170 | 371 | 2861 |
| 1982 | 2323 | 105 | 371 | 2799 |
| 1983 | 2784 | 95 | 317 | 3196 |
| 1984 | 3449 | 161 | 534 | 4144 |
| 1985 | 3236 | 117 | 708 | 4061 |
| 1986 | 2642 | 203 | 537 | 3382 |
| 1987 | 3458 | 143 | 482 | 4083 |
| 1988 | 3449 | 149 | 437 | 4035 |
| 1989 | 2603 | 112 | 490 | 3205 |
| 1990 | 1941 | 134 | 469 | 2544 |
| 1991 | 2228 | 125 | 439 | 2792 |
| 1992 | 2978 | 150 | 432 | 3560 |
| 1993 | 2699 | 85 | 408 | 3192 |
| 1994 | 2916 | 246 | 454 | 3616 |
| 1995 | 2940 | 184 | 532 | 3656 |
| 1996 | 2355 | 147 | 369 | 2871 |
| 1997 | 2553 | 102 | 391 | 3046 |
| 1998 | 2023 | 67 | 351 | 2441 |
| 1999 | 2791 | 56 | 410 | 3257 |
| 2000 | 2695 | 28 | 523 | 3246 |
| 2001 | 2651 | 41 | 567 | 3259 |
| 2002 | 2775 | 79 | 586 | 3440 |
| 2003 | 2607 | 44 | 617 | 3268 |
| 2004 | 2400 | 25 | 710 | 3135 |
| 2005 | 2267 | 18 | 699 | 2984 |
| 2006 | 3446 | 17 | 697 | 4160 |
| 2007 | 3362 | 16 | 590 | 3968 |
| 2008 | 3230 | 12 | 557 | 3799 |
| 2009 | 2858 | 26 | 613 | 3497 |
| 2010* | 1717 | 6 | 540 | 2263 |

*** provisional   na = not available.**

**** There are no landings by other countries from this FU**

**Table 3.5.6. *Nephrops*, North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2010.**

| | Catches | | Landings | | | |
|---|---|---|---|---|---|---|
| | < 35 mm CL | | < 35 mm CL | | > 35 mm CL | |
| Year | Males | Females | Males | Females | Males | Females |
| 1981 | 30.2 | 29.3 | 30.6 | 30.2 | 39.2 | 37.6 |
| 1982 | 29.8 | 28.6 | 30.1 | 29.0 | 39.8 | 37.4 |
| 1983 | 29.0 | 27.6 | 29.1 | 27.5 | 40.0 | 37.8 |
| 1984 | 28.5 | 28.0 | 28.5 | 28.1 | 39.2 | 37.4 |
| 1985 | 27.9 | 27.5 | 27.9 | 27.5 | 40.0 | 37.5 |
| 1986 | 29.5 | 28.4 | 29.7 | 28.6 | 39.1 | 37.6 |
| 1987 | 29.6 | 29.0 | 29.9 | 29.6 | 39.8 | 37.9 |
| 1988 | 29.9 | 29.5 | 30.3 | 30.1 | 38.9 | 38.0 |
| 1989 | 29.0 | 29.0 | 29.2 | 29.2 | 40.1 | 38.9 |
| 1990 | 29.3 | 28.6 | 29.8 | 28.9 | 39.1 | 38.1 |
| 1991 | 30.3 | 29.1 | 30.6 | 29.5 | 39.4 | 39.1 |
| 1992 | 29.3 | 28.0 | 29.7 | 28.3 | 39.6 | 38.3 |
| 1993 | 29.4 | 27.9 | 29.5 | 28.0 | 38.7 | 38.3 |
| 1994 | 28.1 | 27.0 | 29.4 | 28.3 | 39.5 | 38.8 |
| 1995 | 27.7 | 27.7 | 28.6 | 29.0 | 40.0 | 38.2 |
| 1996 | 29.5 | 29.4 | 30.2 | 30.2 | 40.0 | 38.7 |
| 1997 | 29.1 | 28.4 | 29.9 | 28.8 | 39.4 | 38.0 |
| 1998 | 29.8 | 28.8 | 30.6 | 29.3 | 39.6 | 38.4 |
| 1999 | 28.9 | 28.2 | 30.1 | 29.1 | 39.4 | 37.5 |
| 2000 | 29.9 | 28.6 | 30.4 | 29.0 | 39.4 | 37.8 |
| 2001 | 29.4 | 28.1 | 30.3 | 28.8 | 39.8 | 38.2 |
| 2002 | 29.2 | 28.4 | 30.4 | 29.5 | 39.7 | 38.3 |
| 2003 | 29.0 | 28.3 | 30.3 | 29.6 | 39.2 | 37.8 |
| 2004 | 29.6 | 28.9 | 30.4 | 29.5 | 40.3 | 38.8 |
| 2005 | 28.4 | 27.8 | 30.1 | 30.0 | 39.4 | 37.8 |
| 2006 | 29.0 | 27.4 | 30.5 | 28.9 | 39.1 | 38.2 |
| 2007 | 30.0 | 28.3 | 30.0 | 28.2 | 40.3 | 38.7 |
| 2008 | 29.6 | 28.3 | 30.1 | 28.8 | 40.0 | 38.5 |
| 2009 | 28.6 | 27.0 | 29.9 | 28.0 | 40.8 | 39.3 |
| 2010* | 30.2 | 28.8 | 31.2 | 29.5 | 40.7 | 39.8 |

*** provisional   na = not available.**

**Table 3.5.7. *Nephrops*, North Minch (FU 11): Results by stratum of the 2008–2010 TV surveys. Note that stratification was based on a series of arbitrary rectangles (U, V, W, X).**

| Stratum | Area (km²) | Number of Stations | Mean burrow density (no./m²) | Observed variance | Abundance (millions) | Stratum variance | Proportion of total variance |
|---|---|---|---|---|---|---|---|
| | | | 2008 TV survey | | | | |
| U | 656 | 13 | 0.36 | 0.05 | 233 | 1511 | 0.255 |
| V | 425 | 10 | 0.59 | 0.05 | 250 | 827 | 0.140 |
| W | 563 | 13 | 0.40 | 0.14 | 225 | 3511 | 0.592 |
| X | 131 | 5 | 1.07 | 0.02 | 140 | 78 | 0.013 |
| Total | 1775 | 41 | | | 848* | 5927 | 1 |
| | | | 2009 TV survey | | | | |
| U | 656 | 9 | 0.39 | 0.03 | 255 | 1476 | 0.174 |
| V | 425 | 6 | 0.60 | 0.08 | 255 | 2251 | 0.266 |
| W | 563 | 8 | 0.54 | 0.12 | 306 | 4644 | 0.549 |
| X | 131 | 3 | 1.17 | 0.02 | 153 | 93 | 0.011 |
| Total | 1775 | 26 | | | 969 | 8464 | 1 |
| | | | 2010 TV survey** | | | | |
| VMS | 2506 | 37 | 0.592 | 0.103 | 1483 | 17 494 | 1 |
| Total | 2506 | 37 | | | 1483 | 17 494 | 1 |

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown on Table 3.5.8 are small.**

**Table 3.5.8. *Nephrops*, North Minch (FU 11): Results of the 1994–2010 TV surveys (not adjusted for bias).**

| Year | Number of valid stations | Mean density | Abundance (Sediment) | 95% confidence interval (sediment) | Abundance (VMS) | 95% confidence interval (VMS) |
|---|---|---|---|---|---|---|
| | | burrows/m² | millions | millions | millions | millions |
| 1994 | 41 | 0.38 | 665 | 99 | 938 | - |
| 1995 | No survey | | | | | |
| 1996 | 38 | 0.25 | 439 | 62 | 619 | - |
| 1997 | No survey | | | | | |
| 1998 | 38 | 0.41 | 728 | 103 | 1026 | - |
| 1999 | 36 | 0.36 | 644 | 119 | 908 | - |
| 2000 | 39 | 0.53 | 946 | 109 | 1334 | - |
| 2001 | 56 | 0.50 | 886 | 108 | 1249 | - |
| 2002 | 37 | 0.61 | 1084 | 121 | 1528 | - |
| 2003 | 41 | 0.80 | 1420 | 171 | 2002 | - |
| 2004 | 38 | 0.80 | 1420 | 142 | 2002 | - |
| 2005 | 41 | 0.70 | 1249 | 133 | 1761 | - |
| 2006 | 30 | 0.81 | 1429 | 134 | 2015 | - |
| 2007 | 36 | 0.55 | 978 | 122 | 1379 | - |
| 2008 | 41 | 0.48 | 848 | 127 | 1196 | - |
| 2009 | 26 | 0.55 | 969 | 184 | 1366 | - |
| 2010 | 37 | 0.59 | - | - | 1483 | 265 |

**Table 3.5.9. *Nephrops* mean weight in the landings (FU 11–13).**

| Year | FU 11 | FU 12 | FU13 Firth of Clyde | FU13 Sound of Jura |
|---|---|---|---|---|
| 1990 | 21.31 | 19.90 | 24.21 | |
| 1991 | 25.28 | 21.65 | 20.57 | |
| 1992 | 21.58 | 24.01 | 25.08 | |
| 1993 | 20.70 | 21.16 | 29.40 | |
| 1994 | 23.38 | 24.88 | 25.22 | |
| 1995 | 22.16 | 21.87 | 19.14 | |
| 1996 | 26.63 | 23.02 | 21.60 | |
| 1997 | 21.62 | 23.28 | 24.14 | |
| 1998 | 23.57 | 22.09 | 18.04 | |
| 1999 | 21.49 | 23.60 | 16.74 | |
| 2000 | 22.77 | 24.81 | 19.54 | |
| 2001 | 23.15 | 21.44 | 19.06 | |
| 2002 | 23.03 | 23.60 | 15.82 | |
| 2003 | 22.86 | 24.48 | 18.59 | |
| 2004 | 21.45 | 24.02 | 18.31 | 16.90 |
| 2005 | 23.62 | 23.53 | 17.46 | 15.47 |
| 2006 | 21.97 | 23.15 | 18.66 | 15.05 |
| 2007 | 21.68 | 21.43 | 18.53 | 19.02 |
| 2008* | 23.81 | 23.84 | 16.42 | 21.60 |
| 2009 | 25.34 | 23.79 | 18.09 | 25.58 |
| 2010 | 29.33 | 25.79 | 21.16 | 17.13 |
| Mean (08-10) | 26.16 | 24.47 | 18.56 | 21.44 |

*** From 2008 onwards mean weights are shown for trawl and creels combined.**

**Table 3.5.10.** ***Nephrops*, North Minch (FU 11): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

| Year | Landings in number (millions) | Discards in number (millions) | Removals in number (millions) | Adjusted survey (sediment) | Adjusted survey (VMS) | Harvest ratio (VMS) | Harvest ratio (sediment) | Landings (tonnes) | Discard (tonnes) | Discard rate | Dead discard rate |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | 145 | 28 | 164 | 484 | 683 | 24.0 | 33.8 | 3257 | 275 | 16.4 | 12.8 |
| 2000 | 133 | 10 | 141 | 711 | 1003 | 14.1 | 19.9 | 3246 | 98 | 6.9 | 5.2 |
| 2001 | 130 | 17 | 141 | 666 | 939 | 15.0 | 21.2 | 3259 | 161 | 11.7 | 9.1 |
| 2002 | 132 | 28 | 153 | 815 | 1149 | 13.3 | 18.7 | 3440 | 276 | 17.6 | 13.8 |
| 2003 | 127 | 30 | 148 | 1068 | 1505 | 9.8 | 13.8 | 3268 | 303 | 19.2 | 15.2 |
| 2004 | 123 | 18 | 136 | 1068 | 1505 | 9.0 | 12.7 | 3135 | 203 | 13.0 | 10.1 |
| 2005 | 108 | 51 | 144 | 939 | 1324 | 10.9 | 15.3 | 2984 | 514 | 32.0 | 26.1 |
| 2006 | 171 | 74 | 223 | 1074 | 1515 | 14.7 | 20.7 | 4160 | 762 | 30.3 | 24.6 |
| 2007 | 170 | 12 | 177 | 735 | 1037 | 17.1 | 24.1 | 3968 | 216 | 6.5 | 5.0 |
| 2008 | 162 | 19 | 173 | 638 | 900 | 19.2 | 27.1 | 3799 | 198 | 10.5 | 8.1 |
| 2009 | 145 | 37 | 164 | 729 | 1027 | 16.0 | 22.5 | 3497 | 344 | 20.3 | 16.0 |
| 2010 | 77 | 11 | 85 | - | 1115 | 7.6 | - | 2263 | 121 | 12.4 | 9.6 |
| Average 08–10 | | | | | | | | | | | 11.2 |

***harvest rates previous to 2006 are unreliable.**

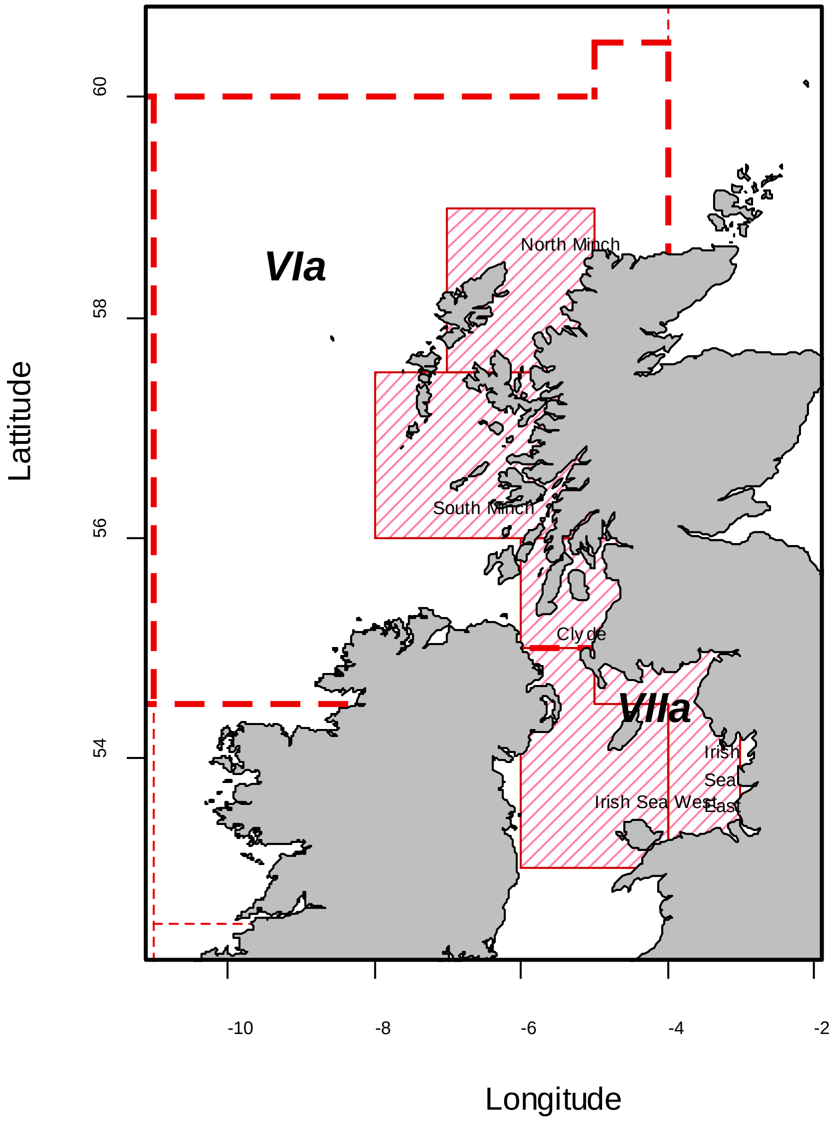


**Figure 3.5.1.** ***Nephrops*** **Functional Units in VIa and VIIa. North Minch (FU11), South Minch (FU12), Clyde (FU13), Irish Sea East (FU14) and Irish Sea West (FU15).**

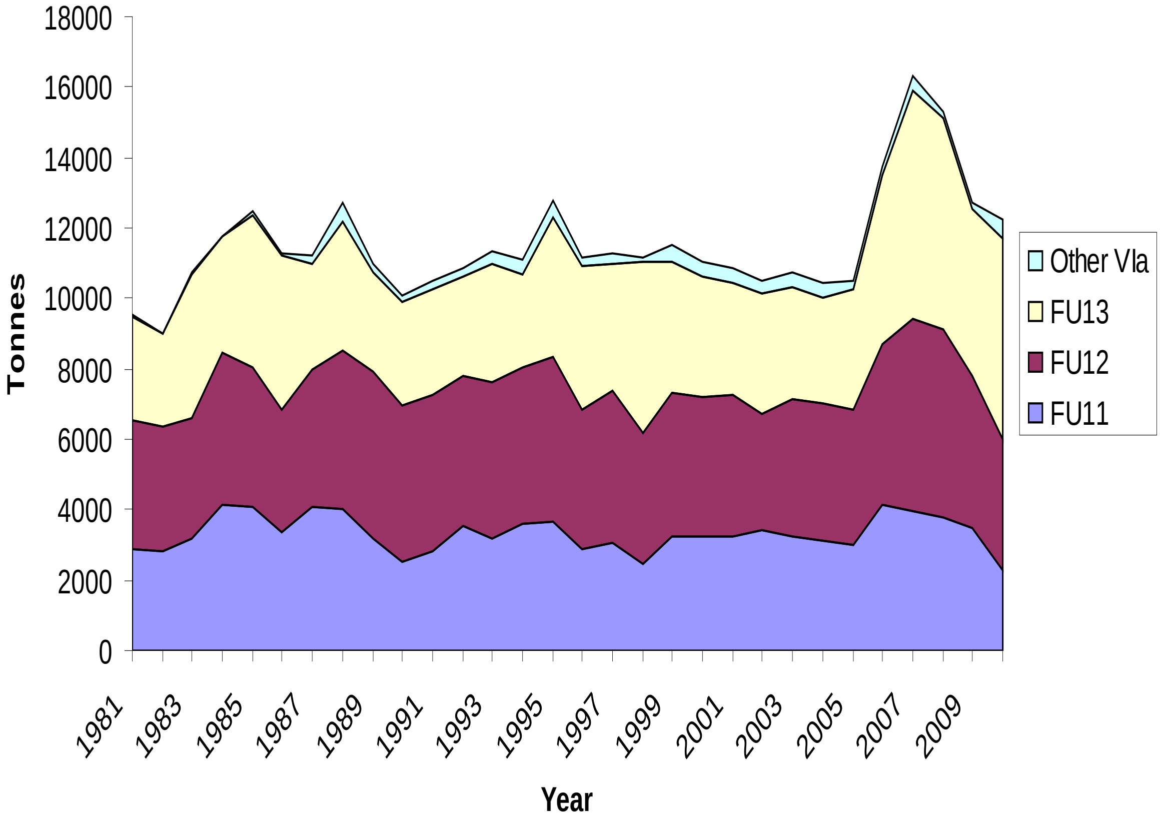


**Figure 3.5.2.** ***Nephrops*** **in Division VIa. Landing (thousands tonnes) by FU and Other rectangles.**

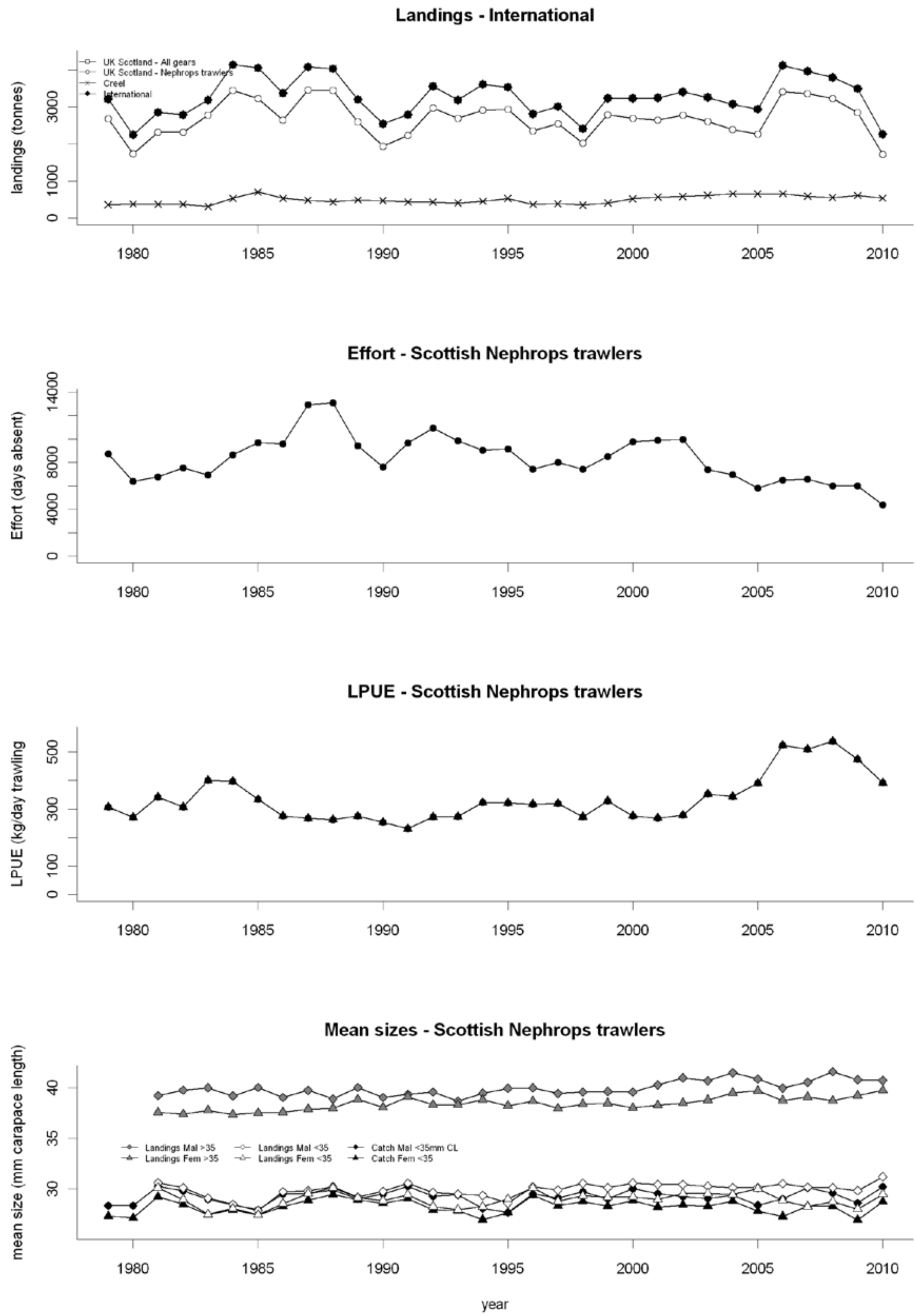


**Figure 3.5.3.** ***Nephrops*****, North Minch (FU11), Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

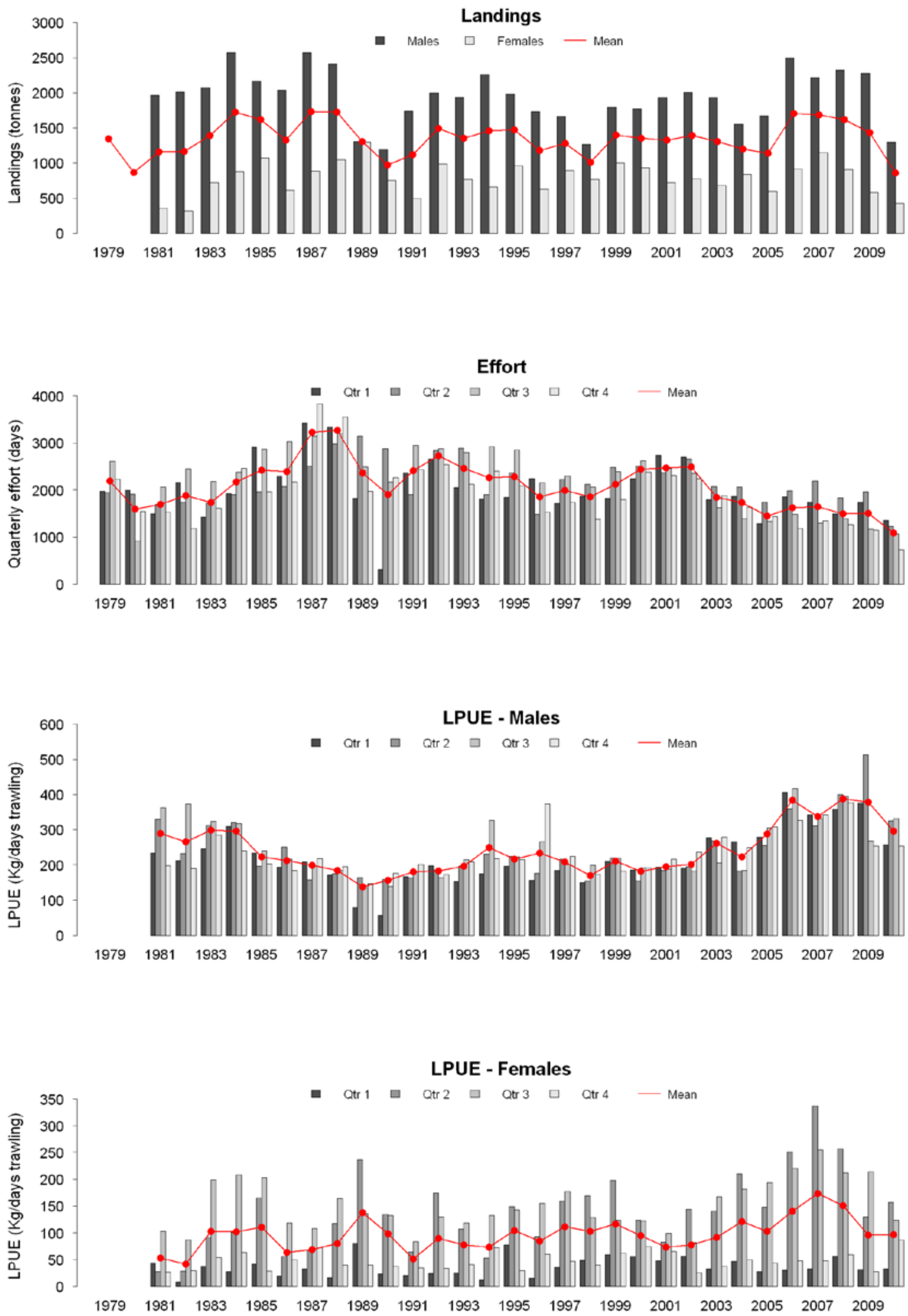


**Figure 3.5.4.** ***Nephrops*, North Minch (FU11), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

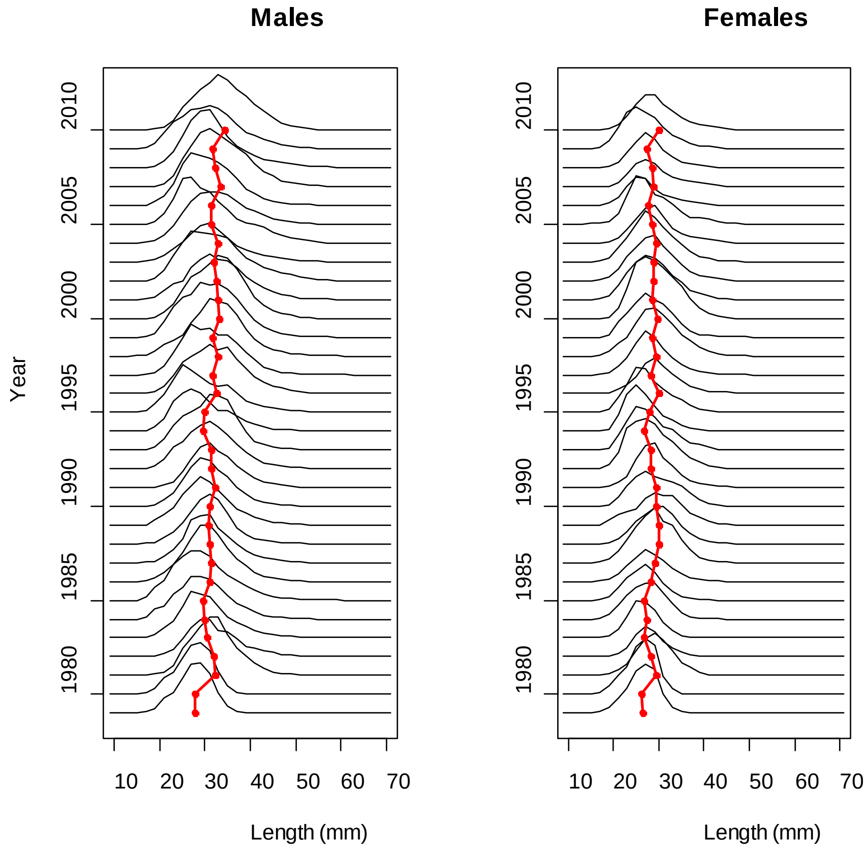


**Figure 3.5.5.** ***Nephrops*****, North Minch (FU11), Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the North Minch, 1979–2010.**

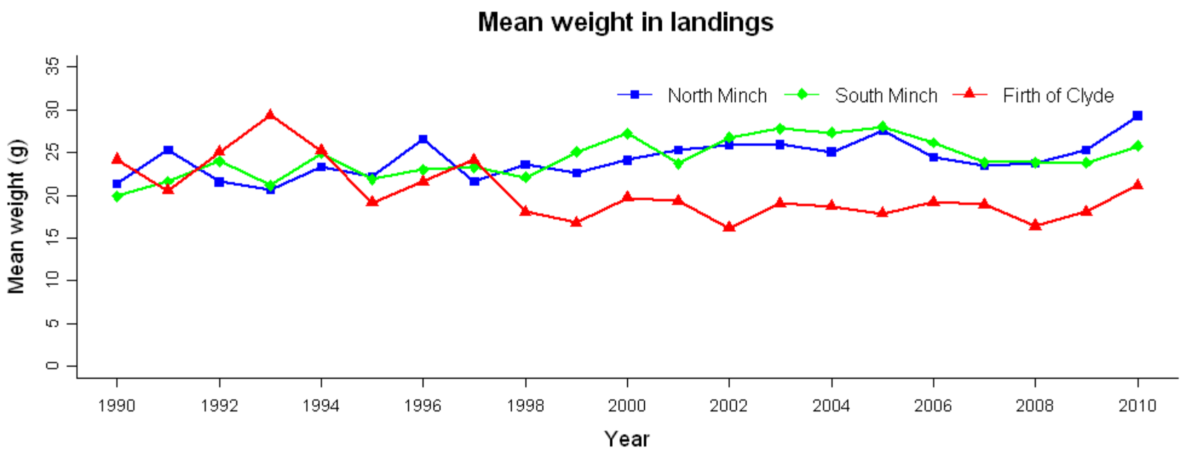


**Figure 3.5.6.** ***Nephrops*****, (FUs 11–13), individual mean weight in the landings from 1990–2010 (from Scottish market sampling data).**

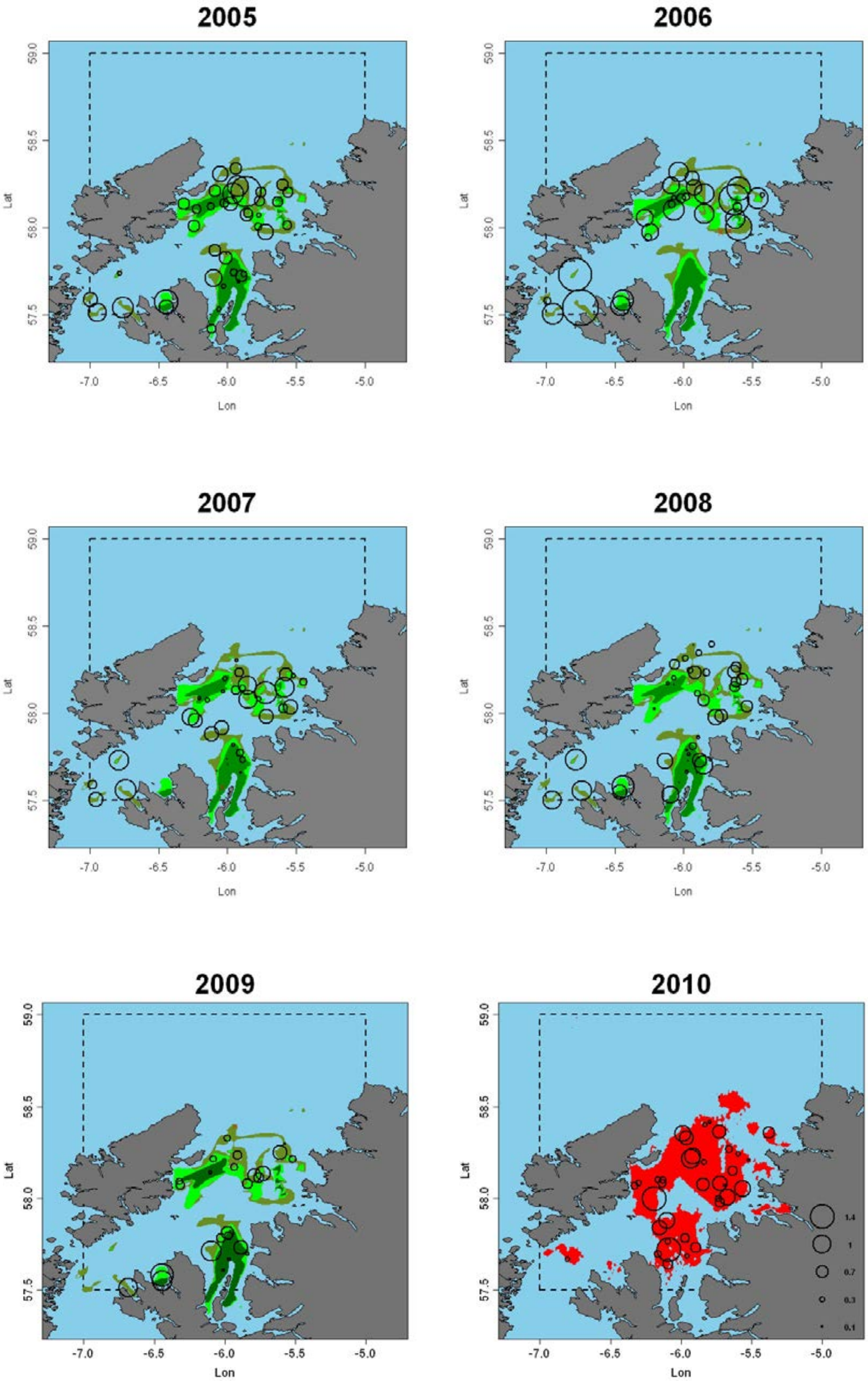


**Figure 3.5.7** ***Nephrops*****, North Minch (FU11), TV survey station distribution and relative density (burrows/m²), 2005–2010. Shaded green and brown areas represent areas of suitable sediment for** ***Nephrops*****. Bubbles in these figures are all scaled the same. Crosses represent zero observations.**

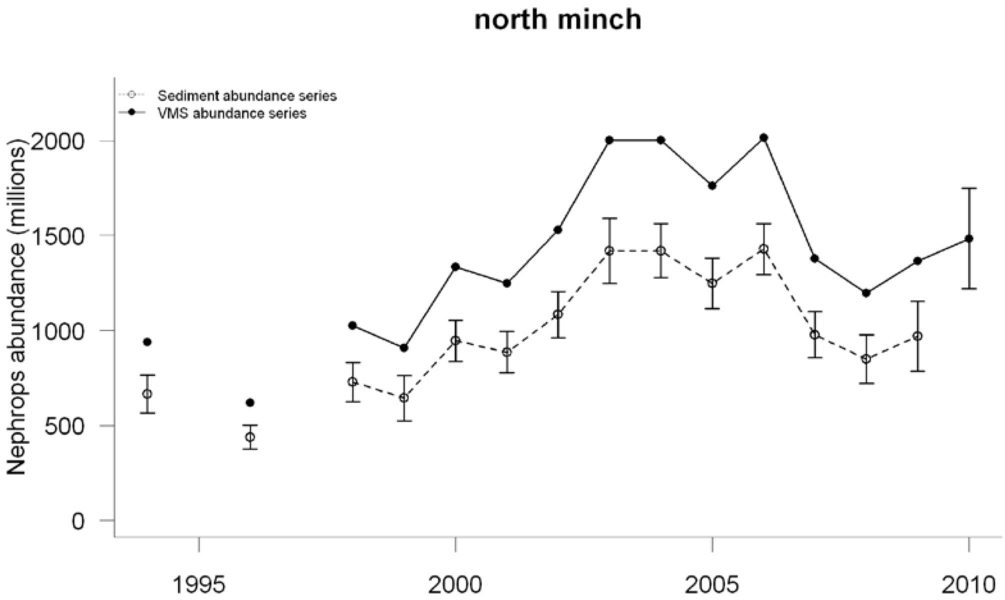


**Figure 3.5.8.** ***Nephrops*****, North Minch (FU11), time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1994–2010 (no survey in 1995 and 1997). The dashed and solid lines are the abundance estimated raised to the sediment area and VMS area, respectively.**

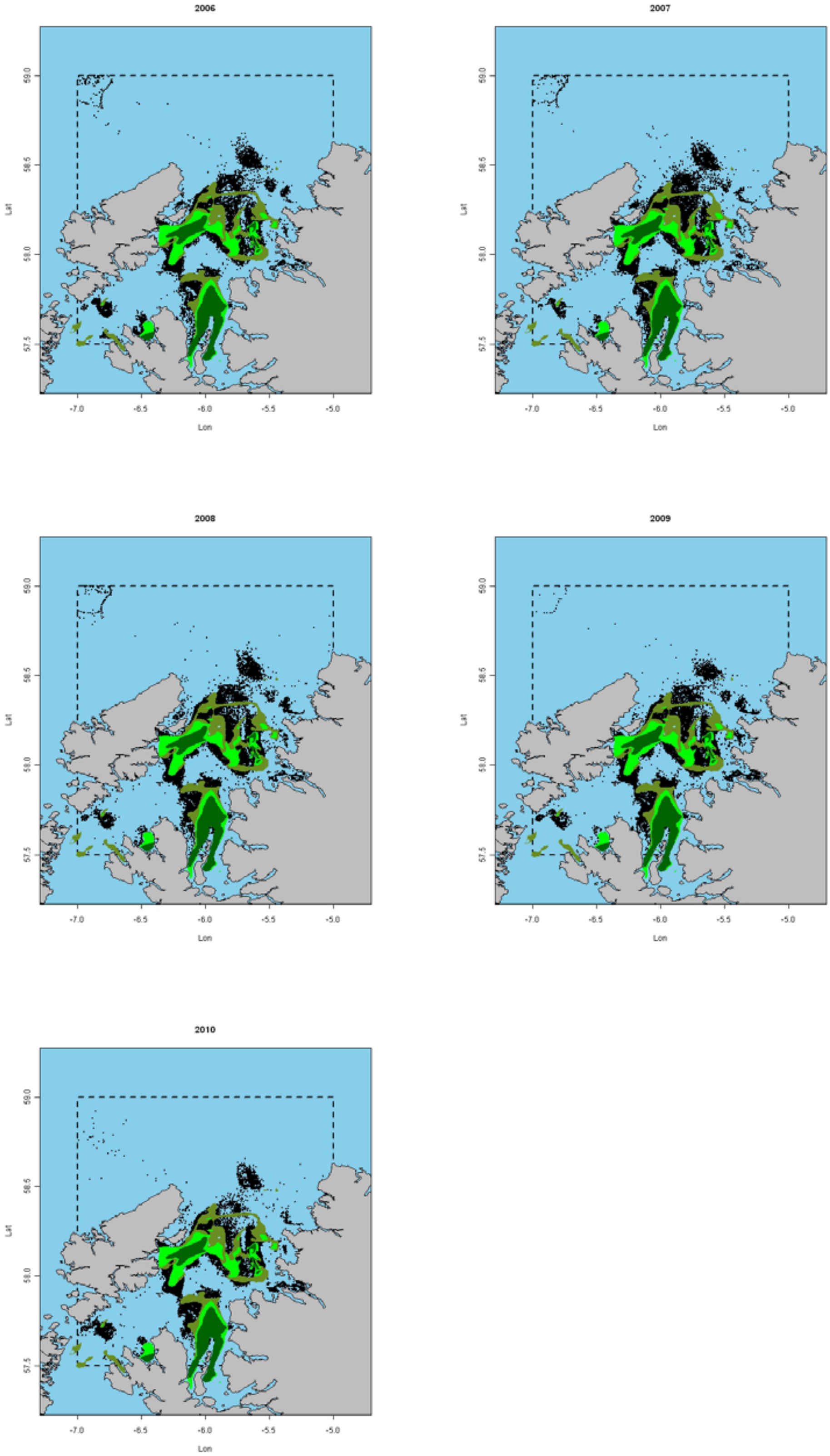


**Figure 3.5.9.** ***Nephrops*, North Minch (FU11), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006-2010. VMS data filtered to exclude vessel speeds>4.5 knots.**

## 3.6 South Minch, FU12

### Type of assessment in 2011

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WKNEPH, 2009) and described in Section 2.2.

### 3.6.1 Ecosystem aspects

The South Minch Functional Unit 12 is located mid way down the west coast of Scotland (Figure 3.5.1).

Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the South Minch Functional Unit these substrates are distributed according to prevailing hydrographic and bathymetric conditions. The area is characterized by numerous islands of varying size and sea lochs occur along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of soft sediments. A more continuous extensive area of sediment suitable for *Nephrops* occurs further offshore to the southwest. Figure 3.6.4 shows the distribution of sediment in the area.

### 3.6.2 The fishery in 2010

Information on developments in the fishery was provided by Marine Scotland staff including fishery officers and scientists sampling in the ports and on board vessels; some comments were also received from industry representatives. Two distinct fleets continued to operate in the South Minch during 2010, landing into the two main ports of Oban and Mallaig. Inshore, a fleet of smaller vessels including creel boats operated throughout the year, while some larger twin riggers fish further afield with the distance offshore increasing in 2010. 90% of boats are thought to fish for *Nephrops* at some time. The Mallaig local fleet has declined in recent years and several more vessels were decommissioned in 2010, 14 were resident during November. Traditionally east coast vessels (mainly twin riggers from Fraserburgh) visit Mallaig in March or April, but in the last few years there has been a significant reduction in effort from visiting east coast vessels, this pattern continued in 2010 as a result of high fuel prices. During May 2010, a number of vessels typically fishing the North Minch moved into the South Minch as a result of poor fishing on their regular fishing grounds.

Owing to high fuel costs and relatively poor prices for *Nephrops*, fishing practices progressively changed in 2010. Many of the boats worked longer days during slack tide periods but during stronger tides remained in harbour. Most boats landed once or twice per week. There are very few vessels (2-3) that landed on a daily basis. During winter, fishing activity is severely reduced in the South Minch due to the weather and small boats are often restricted to trawling in the sheltered sea-lochs. There is increasing overlap of the areas exploited by trawl and creel fishing and this has led to some gear conflict issues. (This is described further in the quality of assessment section to illustrate the extent of trawling by some vessels). Boats on the west coast of Scotland are operating in accordance with the Scottish Conservation Credits Scheme and from 2009 have been required to fit 120 mm square meshed panels in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Twin rig vessels tend to use a 200 mm square mesh panel (with a 100 mm codend), some of them slightly bigger than that. This means that they do not catch bulk quantities and this leads to prawns of better average size and quality suitable for storage using 'individual tubing'. This marketing technique (previously developed in the creel fishery) was more prevalent in 2010.

There is very little fish bycatch landed, only 2–3 vessels do so owing to the restrictions on cod, haddock and whiting under the emergency measures. Estimates of discard rates of haddock and whiting remain high however. In 2010, boats were catching small quantities of squid as bycatch with their prawns. This led to some fishermen wanting to target squid, but the ban on 40 mm mesh within west coast emergency zone meant, they were unable to do so. In November/December 2010, four smaller *Nephrops* boats diverted to pair trawling for sprats and herring.

### 3.6.3 ICES advice in 2010 and 2011

#### ICES advice for *2010*

Exploitation boundaries in relation to precautionary considerations was as follows:

"ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should not exceed $F_{2008}$. This corresponds to landings of no more than 4126 t for the South Minch stock."

#### ICES advice for *2011*

"The stable mean sizes in the length compositions of catches (of individuals >35 mm CL) and recent fall in estimated harvest ratios (dead removals/TV abundance) to the equivalent of the $F_{MSY}$ proxy suggests that the stock is now being exploited sustainably. For this FU, the absolute density observed on the UWTV survey is medium (~0.44/m$^2$) suggesting the stock has moderate productivity. The fishery in this area has been in existence since the 1960s and the population has been studied numerous times. Historical harvest ratios in this FU have been variable but generally around the $F_{35\%SpR}$. $F_{35\%SpR}$ (combined between sexes) is expected to deliver high long-term yield with a low probability of recruitment overfishing and therefore is chosen as a proxy for $F_{MSY}$."

ICES advice for 2011 based on MSY approach was as follows:

"Following the ICES MSY framework implies the harvest ratio to be reduced to 12.3%, resulting in landings of 3800 t in 2011. Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced to 12.9% (0.8 x harvest ratio($F_{2010}$ 13.0%) + 0.2 x harvest ratio($F_{MSY}$ 12.3%) resulting in landings of 4000 t in 2011."

### 3.6.4 Management applicable in 2009 and 2010

Management applicable to this stock is included in management for Division VIa as a whole, and is described in 3.5.1.

### 3.6.5 Assessment

The 2010 RG concluded that the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, The RG agreed with the WG that management of this stock should be applied at a local FU level rather than at the ICES Division level. The RG agrees that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by WGCSE for choosing $F_{msy}$ proxies for *Nephrops*. The RG recommended that if ICES is to use UWTV abundance estimates as absolute, then biases due to incomplete coverage of *Nephrops* habitat need to be evaluated. The RG agreed that the relationship between fishing area (VMS) and survey area need further exploration. An improvement suggested by the 2010 WG and endorsed by RG is improving the coverage and timing of the UWTV survey and correlating it with VMS data for best adjustment to the harvest area.

The RG report contained a number of technical comments and attempts have been made to address these.

### Approach in 2011

As last year the assessment in 2011 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the South Minch FU 12. The assessment of *Nephrops* through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in the stock annex.

The provision of advice in 2010 develops the process defined by the benchmark WG. Section 2.2 outlines the WG approach to integrate WKFRAME recommendations in the provision of $F_{MSY}$ proxies for *Nephrops*. The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE. Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. Creel fishing is important in the South Minch and increasingly operates across similar areas to the trawl fishery. For this reason the assessment is performed using combined length compositions from these fisheries.

### Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

#### *Commercial catch and effort data*

Official catch statistics (landings) reported to ICES are shown in Table 3.5.2. These relate to the whole of VIa of which the South Minch is a part. Landings for FU 12 provided through national laboratories are presented in Table 3.6.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, with low levels reported from the rest of the UK in the mid 1990s, and low levels more recently reported for Ireland. Total international reported landings in 2010 were 3725 tonnes, consisting of 2814 tonnes landed by Scottish trawlers and 889 tonnes landed by Scottish creel vessels. These estimates for total landings show a reduction from the high values in 2006 to 2008 to landings more typical of the late 1980s. The high landings of 2006–2008 are thought to have arisen through a combination of good recruitment in the mid 2000s recruiting to the fished population, increased catching opportunities and to the introduction of the "buyers and sellers" regulations in the UK in 2006 which have increased the reliability of landings information. Landings from creel vessels have remained relatively stable over the last four years, at close to 1000 tonnes, the highest level in the time-series.

Reported effort (given in days fished rather than hours since this is thought to be more reliable).by all Scottish *Nephrops* trawlers has fluctuated gently throughout the time-series reaching a peak in the early 1990s and showing a gradual decline since then (Figures 3.6.1 and 3.6.2).

Sex ratio in the South Minch shows some variation but males consistently make the largest contribution to the annual landings (63% in 2010). This occurs because males are available throughout the year whereas females on the other hand are mainly taken in summer when they emerge after egg hatching (Figure 3.6.2).

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates average around 16% by number in this FU over the most recent five years (Table 3.6.5).

Studies (Charuau *et al.*, 1982; Sangster *et al.*, 1997; Wileman *et al.*, 1999) suggest that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard rate adjusted to account for some survival was estimated by taking a three year average 2008–2010 and amounts to 11.8%. According to the agreed benchmark protocol this 'dead discard' value is used in the provision of landings options for 2012.

#### *Length compositions*

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards-at-length data were available from Scotland and these sampling levels are shown in Table 3.5.4. Length compositions for the creel fishery are for landings only since the small numbers of discards survive well and are not considered to be removed from the population. Although assessments based on detailed catch analysis are not currently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.6.3 shows a series of annual length frequency distributions for the period 1979 to 2010. Catch (removals) length compositions are shown for each sex along with the mean size for both. In both sexes the mean sizes have been fairly stable over time although there is some evidence of slight increases in the most recent years. Examination of the tails of the distributions above 35 mm (the length beyond which the effects of recruitment pulses and discarding are considered to be negligible) shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.6.1 and Table 3.6.2. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also quite stable through time.

Mean weight in the landings is shown in Figure 3.5.6 and Table 3.5.9 and this also shows no systematic changes over the time-series although there is a slight increase in 2010.

#### *Natural mortality, maturity-at-age and other biological parameters*

Biological parameter values are included in the Stock Annex.

### Research vessel data

Underwater TV surveys using a stratified random approach are available for this stock since 1995. Underwater television surveys of *Nephrops* burrow number and distribution reduce the problems associated with traditional trawl surveys that arise from variability of burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.6.4. On average, 34 stations have been considered valid each year, then raised to a stock area of 5072 km$^2$. In 2010 station numbers were at the average number.

### Data analyses

#### *Exploratory analyses of survey data*

Full details of the UWTV approach can be found in the stock Annex and the report of (WKNEPH) in 2009 (ICES, 2009).

A re-working of the UWTV survey abundance series for Division VIa was presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 12 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.6.3 shows the basic analysis for the three most recent TV surveys conducted in FU 12. The table includes estimates of abundance and variability of each of the strata adopted in the stratified random approach. Due to the fact only one station was surveyed in the mud sediment type in 2008, it was not possible to calculate a sample variance for this area in the usual way. Instead an average of the three previous years was taken. Results in 2010 were typical of previous years.

Figure 3.6.4 shows the distribution of stations in recent TV surveys (2005–2010), with the size of the symbol reflecting the *Nephrops* burrow density. The most recent survey suggests continued higher density in the southeast part of the functional unit and an area of high density around the island of Rhum. Densities were generally lower in the western parts of the area towards the Outer Hebrides. Table 3.6.4 and Figure 3.6.5 show the time-series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates; confidence intervals, while relatively wide, have been fairly stable in recent years.

The review of the use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

#### Final assessment

The underwater TV survey is presented as the best available information on the South Minch (FU 12) *Nephrops* stock. This survey provides a fishery-independent estimate of *Nephrops* abundance. The details of the 2010 survey is shown in Table 3.6.3 and compared with the 2008 and 2009 outcomes. At present it is not possible to extract any length or age structure information from the survey and it therefore only provides information on abundance over the area of the survey.

The 2010 TV survey data presented at this meeting shows that the abundance has increased to a value significantly above the 2007 low point and is in line with values recorded in 2000 to 2006.

The TV survey results reported here do not cover the sea loch areas adjacent to the main South Minch grounds and should therefore be considered underestimates of the overall abundance. The sea lochs support an unknown but significant part of both the trawl and creel fishery. This issue is discussed further under quality of assessment.

### 3.6.6 Historical stock trends

The TV survey estimates of abundance for *Nephrops* in the South Minch show that the population has fluctuated without obvious trend over the period of the survey. The recently observed upturn gives an abundance of 2740 which is well above the long-term average (2130 million animals) Table 3.6.4. The bias adjusted abundance estimates from 1999–2010 are shown in Table 3.6.5. Table 3.6.5 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) also shows the estimated harvest ratios over this period. Harvest rates have ranged from about 7 to 27% since 1999. The current value is relatively low at 7.4%. (It is likely that prior to 2006, the harvest ratios are underestimates of the actual harvest ratios due to underreporting of landings).

### 3.6.7 MSY considerations

A number of potential $F_{msy}$ proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and a recent exploitation pattern and discard ogive for trawl and creel caught

*Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit $F_{msy}$ proxies is given in the table below and the process for choosing an appropriate $F_{msy}$ proxy is described in Section 2.2. Note that all $F_{msy}$ proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For this FU, the absolute density observed in the UWTV survey series is intermediate (average of just over 0.42 $m^{-2}$) suggesting the stock has moderate productivity. In addition, the fishery in this area has been in existence since the 1960s and the population has been studied numerous times (Afonso-Dias, 1998; Howard and Hall, 1983). Historical harvest ratios in this FU have been variable but generally around the $F_{35\%SpR}$.. **The WG concluded that combined sex $F_{35\%SpR}$ is an appropriate $F_{proxy}$ for South Minch FU 12 *Nephrops*.** This is slightly below $F_{max}$ in males and is predicted to result in about 27% SPR for males; in excess of the 20% considered precautionary lower bound outlined in Section 2.2.

| | | $F_{bar}$(20-40 mm) | | | | SPR (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | $F_{mult}$ | M | F | HR (%) | M | F | T |
| $F_{0.1}$ | M | 0.22 | 0.13 | 0.06 | 7.8 | 40.9 | 60.8 | 48.5 |
| | F | 0.44 | 0.27 | 0.12 | 13.8 | 23.8 | 43.7 | 31.4 |
| | T | 0.25 | 0.15 | 0.07 | 8.7 | 37.4 | 57.7 | 45.2 |
| $F_{max}$ | M | 0.42 | 0.25 | 0.12 | 13.3 | 24.8 | 44.8 | 32.5 |
| | F | 1.1 | 0.67 | 0.31 | 26.8 | 9.9 | 23.6 | 15.2 |
| | T | 0.54 | 0.33 | 0.15 | 16.1 | 19.8 | 38.7 | 27.1 |
| $F_{35\%SpR}$ | M | 0.28 | 0.17 | 0.08 | 9.6 | 34.5 | 54.9 | 42.3 |
| | F | 0.64 | 0.39 | 0.18 | 18.3 | 16.9 | 34.8 | 23.8 |
| | T | 0.38 | 0.23 | 0.11 | 12.3 | 27.0 | 47.3 | 34.8 |

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 1016 million individuals.

### 3.6.8 Landings forecasts

A landings prediction for 2012 was made for the South Minch (FU12) using the approach agreed at the Benchmark Workshop and outlined in the Section 2.2. The text table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2010 using input parameters agreed at WKNEPH (ICES 2009) and mean weight in landings and discard rate from the average of 2008–2010 . The landings prediction for 2012 at the $F_{msy}$ proxy harvest ratio considered appropriate to the South Minch (i.e. 12.3%) is 5514 tonnes. Since current harvest rate is below the $F_{msy}$ proxy, the ICES MSY framework applies and would result in a landings estimate of 5514 tonnes for 2012.

The inputs to the landings forecast were as follows:

Mean weight in landings (08–10) = 24.47 g

Discard rate by number (08–10)) = 11.8%

Survey bias = 1.32

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Survey Index (adjusted) | Retained number | Landings (tonnes) |
| $F_{msy}$ | 12.3% | 2076 | 225 | 5514 |
| $F_{2010}$ | 7.4% | 2076 | 136 | 3317 |
| $F_{0.1(M)}$ | 7.8% | 2076 | 143 | 3497 |
| $F_{0.1(T)}$ | 8.7% | 2076 | 159 | 3900 |
| $F_{35\%SpR(M)}$ | 9.6% | 2076 | 176 | 4304 |
| $F_{35\%SpR(T)}$ | 12.3% | 2076 | 225 | 5514 |
| $F_{max\ (M)}$ | 13.3% | 2076 | 244 | 5962 |
| $F_{0.1(F)}$ | 13.8% | 2076 | 253 | 6186 |
| $F_{max\ (T)}$ | 16.1% | 2076 | 295 | 7217 |

**Note: No $F_{msy}$ transition as $F_{2010}$ is below $F_{msy}$.**

$F_{0.1(M,T)}$: Harvest ratio equivalent to fishing at a level associated with 10% of the slope at the origin on the male or combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male or combined SPR equal to 35% of the unfished level.

$F_{max\ (M,\ T)}$: Harvest ratio equivalent to fishing at a rate which maximizes the male or combined YPR.

A discussion of $F_{msy}$ reference points for *Nephrops* is provided in Section 2.2.

### 3.6.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks.

### 3.6.10 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the trawl fishery adequately. Since 2010 this assessment combined trawl and creel length compositions. The creel fishery accounts for over 20% of the landings and increasingly operates over similar areas to trawling. The creel fishery exhibits a length composition composed of larger animals.

There are concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers was introduced and the reliability began to improve. Because of this the final assessment adopted is independent of official statistics.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are on average greater during the most recent years, when abundance estimates have been slightly higher. The overlap of confidence intervals makes it difficult to determine which population changes are significant, although the recent increase from 2007 to 2010 is considered to be significant. Results suggest that overall the population has fluctuated without trend.

There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is impossible to test and is probably rarely the case. The effect of this assumption on realized harvest rates has not been investigated.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2008–2010) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options. The recent observed discard rate shows a decline in 2010.

The cumulative bias estimates for FU 12 are largely based on expert opinion (See Annex). The precision of these bias corrections cannot yet be characterized.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation although the problem is less severe than in the North Minch. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest some differences between areas fished and the mud sediment maps Figure 3.6.6 overlays the British Geological Survey based sediment distributions on the VMS based activity of >15 m trawlers. On the one hand there is some evidence of *Nephrops* fishing activity outside the contoured areas, but on the other hand, some of the sediment areas are apparently not fished. On average the area estimates for the sediment maps exceed those estimated for the VMS by a factor of about 1.1 (ICES, 2010) Two other factors however, are likely to increase the estimate of ground area available for *Nephrops* and *Nephrops* directed fishing . Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilize these data to improve estimates of mud area and *Nephrops* abundance.

### 3.6.11 Status of the stock

The UWTV survey indicates that the population declined from a record high in 2004 to record low in 2007 but has increased to a level significantly above this again in 2010.and is now well above the long-term average. The slightly increasing mean sizes in the length compositions of catches (of individuals >35 mm CL) and recent fall in estimated harvest ratios (removals/TV abundance) to below the $F_{MSY}$ proxy suggests that the stock is slightly underexploited and that the population is sustainable.

### 3.6.12 Management considerations

The ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could confer controls to ensure effort and catch were in line with resources available.

Creel fishing takes place in this area but overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the South Minch and STECF continues to estimate that discards of whiting and haddock are high in VIa generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod under the Scottish Conservation Credits scheme and the West of Scotland emergency measures (Council Reg. (EU) 43/2009), include the implementation of larger meshed square meshed panels (120 mm) and real-time closures to avoid cod.

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

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**Table 3.6.1. *Nephrops*, South Minch (FU12), Nominal Landings of *Nephrops*, 1981–2010, as officially reported.**

| Year | UK Scotland | | | | Other UK | Ireland | Total |
|---|---|---|---|---|---|---|---|
| | *Nephrops* trawl | Other trawl | Creel | Sub-total | | | |
| 1981 | 2965 | 254 | 432 | 3651 | 0 | 0 | 3651 |
| 1982 | 2925 | 207 | 420 | 3552 | 0 | 0 | 3552 |
| 1983 | 2595 | 361 | 456 | 3412 | 0 | 0 | 3412 |
| 1984 | 3228 | 478 | 594 | 4300 | 0 | 0 | 4300 |
| 1985 | 3096 | 424 | 488 | 4008 | 0 | 0 | 4008 |
| 1986 | 2694 | 288 | 502 | 3484 | 0 | 0 | 3484 |
| 1987 | 2927 | 418 | 546 | 3891 | 0 | 0 | 3891 |
| 1988 | 3544 | 364 | 555 | 4463 | 10 | 0 | 4473 |
| 1989 | 3846 | 338 | 561 | 4745 | 0 | 0 | 4745 |
| 1990 | 3732 | 262 | 436 | 4430 | 0 | 0 | 4430 |
| 1991 | 3597 | 341 | 503 | 4441 | 1 | 0 | 4442 |
| 1992 | 3479 | 208 | 549 | 4236 | 1 | 0 | 4237 |
| 1993 | 3608 | 193 | 649 | 4450 | 5 | 0 | 4455 |
| 1994 | 3743 | 265 | 404 | 4412 | 3 | 0 | 4415 |
| 1995 | 3442 | 716 | 508 | 4666 | 14 | 0 | 4680 |
| 1996 | 3107 | 419 | 468 | 3994 | 1 | 0 | 3995 |
| 1997 | 3519 | 331 | 492 | 4342 | 3 | 1 | 4345 |
| 1998 | 2851 | 340 | 538 | 3729 | 0 | 0 | 3730 |
| 1999 | 3165 | 359 | 513 | 4037 | 0 | 14 | 4051 |
| 2000 | 2939 | 312 | 699 | 3950 | 0 | 2 | 3952 |
| 2001 | 2823 | 393 | 767 | 3983 | 0 | 9 | 3992 |
| 2002 | 2234 | 315 | 742 | 3291 | 0 | 14 | 3305 |
| 2003 | 2812 | 203 | 858 | 3873 | 0 | 6 | 3879 |
| 2004 | 2865 | 104 | 880 | 3849 | 0 | 19 | 3868 |
| 2005 | 2810 | 46 | 953 | 3809 | 1 | 31 | 3841 |
| 2006 | 3569 | 19 | 922 | 4510 | 9 | 35 | 4554 |
| 2007 | 4436 | 8 | 958 | 5402 | 19 | 30 | 5451 |
| 2008 | 4432 | 5 | 895 | 5332 | 2 | 13 | 5347 |
| 2009 | 3347 | 20 | 900 | 4267 | 4 | 11 | 4282 |
| 2010* | 2801 | 13 | 889 | 3703 | 16 | 6 | 3725 |

*** provisional**

**na = not available.**

**Table 3.6.2. *Nephrops*, South Minch (FU 12): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2010.**

| | Catches | | Landings | | | |
|---|---|---|---|---|---|---|
| | < 35 mm CL | | < 35 mm CL | | > 35 mm CL | |
| Year | Males | Females | Males | Females | Males | Females |
| 1981 | 28.2 | 26.4 | 29.6 | 27.5 | 41.5 | 38.0 |
| 1982 | 27.8 | 27.1 | 28.7 | 28.8 | 41.7 | 41.3 |
| 1983 | 28.6 | 26.5 | 29.3 | 27.6 | 39.5 | 37.6 |
| 1984 | 27.9 | 26.3 | 28.4 | 27.0 | 39.8 | 38.0 |
| 1985 | 27.9 | 27.5 | 28.6 | 28.5 | 40.0 | 37.6 |
| 1986 | 28.4 | 27.9 | 29.3 | 28.9 | 39.5 | 37.3 |
| 1987 | 28.3 | 26.6 | 29.2 | 28.1 | 39.8 | 37.6 |
| 1988 | 29.3 | 27.7 | 30.4 | 29.7 | 39.5 | 38.6 |
| 1989 | 28.6 | 28.1 | 29.8 | 29.4 | 39.5 | 38.4 |
| 1990 | 28.0 | 27.5 | 29.3 | 29.0 | 39.4 | 38.5 |
| 1991 | 29.4 | 27.5 | 29.9 | 27.9 | 39.0 | 38.5 |
| 1992 | 29.6 | 28.6 | 31.0 | 29.8 | 39.5 | 38.0 |
| 1993 | 29.0 | 27.8 | 30.0 | 28.5 | 39.5 | 38.0 |
| 1994 | 29.8 | 28.0 | 30.8 | 29.2 | 39.3 | 38.1 |
| 1995 | 29.5 | 28.2 | 30.0 | 28.4 | 39.4 | 38.0 |
| 1996 | 28.9 | 28.5 | 30.4 | 29.8 | 39.9 | 38.1 |
| 1997 | 29.3 | 28.7 | 30.6 | 29.6 | 39.8 | 37.8 |
| 1998 | 28.6 | 27.6 | 30.4 | 28.7 | 39.1 | 38.0 |
| 1999 | 28.6 | 27.7 | 30.0 | 29.5 | 39.4 | 38.3 |
| 2000 | 28.9 | 28.3 | 30.9 | 30.0 | 39.7 | 38.5 |
| 2001 | 27.7 | 27.3 | 29.7 | 28.8 | 39.6 | 38.1 |
| 2002 | 29.1 | 27.8 | 30.4 | 29.0 | 39.5 | 38.8 |
| 2003 | 29.0 | 28.1 | 30.4 | 29.5 | 39.8 | 38.4 |
| 2004 | 28.8 | 28.1 | 30.1 | 29.8 | 39.5 | 38.8 |
| 2005 | 28.1 | 27.8 | 30.4 | 29.5 | 39.8 | 38.6 |
| 2006 | 29.2 | 28.0 | 30.5 | 28.8 | 39.5 | 38.1 |
| 2007 | 29.7 | 28.2 | 29.9 | 28.2 | 40.0 | 38.3 |
| 2008 | 28.6 | 27.5 | 29.4 | 28.5 | 39.6 | 38.1 |
| 2009 | 28.9 | 27.9 | 29.9 | 28.7 | 40.8 | 38.8 |
| 2010* | 29.4 | 28.7 | 30.1 | 29.0 | 41.9 | 39.6 |

*** provisional**

**na = not available**

**Table 3.6.3. *Nephrops* South Minch (FU12). Results by stratum of the 2008–2010 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

| Stratum | Area (km²) | Number of Stations | Mean burrow density (no./m²) | Observed variance | Abundance (millions) | Stratum variance | Proportion of total variance |
|---|---|---|---|---|---|---|---|
| | | | **2008 TV Survey** | | | | |
| M | 303 | 1 | 0.58 | 0.05 | 176 | 4593 | 0.037 |
| SM | 2741 | 18 | 0.45 | 0.19 | 1227 | 78 145 | 0.636 |
| MS | 2028 | 14 | 0.36 | 0.14 | 718 | 40 157 | 0.327 |
| Total | 5072 | 33 | | | 2123* | 122 895 | 1 |
| | | | **2009 TV Survey** | | | | |
| M | 303 | 2 | 0.135 | 0.004 | 41 | 186 | 0.001 |
| SM | 2741 | 13 | 0.447 | 0.207 | 1088 | 109 660 | 0.626 |
| MS | 2028 | 10 | 0.397 | 0.146 | 906 | 65 406 | 0.373 |
| Total | 5072 | 25 | | | 2035 | 175 252 | 1 |
| | | | **2010 TV Survey** | | | | |
| M | 303 | 5 | 0.512 | 0.255 | 155 | 4682 | 0.024 |
| SM | 2741 | 13 | 0.615 | 0.251 | 1687 | 144 966 | 0.753 |
| MS | 2028 | 16 | 0.443 | 0.167 | 898 | 42 875 | 0.223 |
| Total | 5072 | 34 | | | 2740 | 192 523 | 1 |

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown on Table 3.6.4 are small.**

**Table 3.6.4.** ***Nephrops*****, South Minch (FU 12): Results of the 1995–2010 TV surveys. (not adjusted for bias).**

| Year | Stations | Mean density | Abundance | 95% confidence interval |
|---|---|---|---|---|
| | | burrows/m² | millions | millions |
| 1995 | 33 | 0.30 | 1520 | 331 |
| 1996 | 21 | 0.38 | 1945 | 700 |
| 1997 | 36 | 0.28 | 1434 | 244 |
| 1998 | 38 | 0.38 | 1916 | 306 |
| 1999 | 37 | 0.28 | 1433 | 343 |
| 2000 | 41 | 0.48 | 2447 | 460 |
| 2001 | 47 | 0.53 | 2689 | 606 |
| 2002 | 31 | 0.49 | 2507 | 749 |
| 2003 | 25 | 0.56 | 2847 | 998 |
| 2004 | 38 | 0.67 | 3377 | 625 |
| 2005 | 33 | 0.57 | 2914 | 977 |
| 2006 | 36 | 0.48 | 2436 | 789 |
| 2007 | 39 | 0.26 | 1341 | 205 |
| 2008 | 33 | 0.42 | 2123 | 548 |
| 2009 | 25 | 0.40 | 2035 | 837 |
| 2010 | 34 | 0.54 | 2740 | 878 |

**Table 3.6.5.** ***Nephrops*****, South Minch (FU 12): Adjusted TV survey abundance, landings, discard rate proportion by number) and estimated harvest rate.**

| Year | Landings in number (millions) | Discards in number (millions) | Removals in number (millions) | Adjusted survey | Harvest ratio | Landings (tonnes) | Discard (tonnes) | Discard rate | Dead discard rate |
|---|---|---|---|---|---|---|---|---|---|
| 1999 | 154 | 28 | 178 | 1086 | 16.4 | 4051 | 196 | 15.4 | 12.0 |
| 2000 | 140 | 32 | 168 | 1854 | 9.0 | 3952 | 275 | 18.7 | 14.7 |
| 2001 | 160 | 62 | 215 | 2037 | 10.6 | 3992 | 562 | 27.9 | 22.5 |
| 2002 | 119 | 25 | 142 | 1899 | 7.5 | 3305 | 239 | 17.6 | 13.8 |
| 2003 | 139 | 38 | 167 | 2157 | 7.7 | 3879 | 380 | 21.3 | 16.9 |
| 2004 | 138 | 43 | 173 | 2558 | 6.8 | 3868 | 443 | 23.8 | 19.0 |
| 2005 | 135 | 49 | 173 | 2208 | 7.8 | 3841 | 447 | 26.5 | 21.2 |
| 2006 | 174 | 29 | 196 | 1845 | 10.6 | 4554 | 320 | 14.3 | 11.1 |
| 2007 | 227 | 65 | 277 | 1016 | 27.2 | 5451 | 896 | 22.4 | 17.8 |
| 2008 | 224 | 74 | 279 | 1608 | 17.3 | 5347 | 605 | 24.7 | 19.8 |
| 2009 | 179 | 25 | 199 | 1542 | 12.9 | 4282 | 215 | 12.5 | 9.6 |
| 2010 | 142 | 12 | 153 | 2076 | 7.4 | 3725 | 127 | 7.7 | 5.9 |
| Average 08–10 | | | | | | | | | 11.8 |

***harvest rates previous to 2006 are unreliable.**

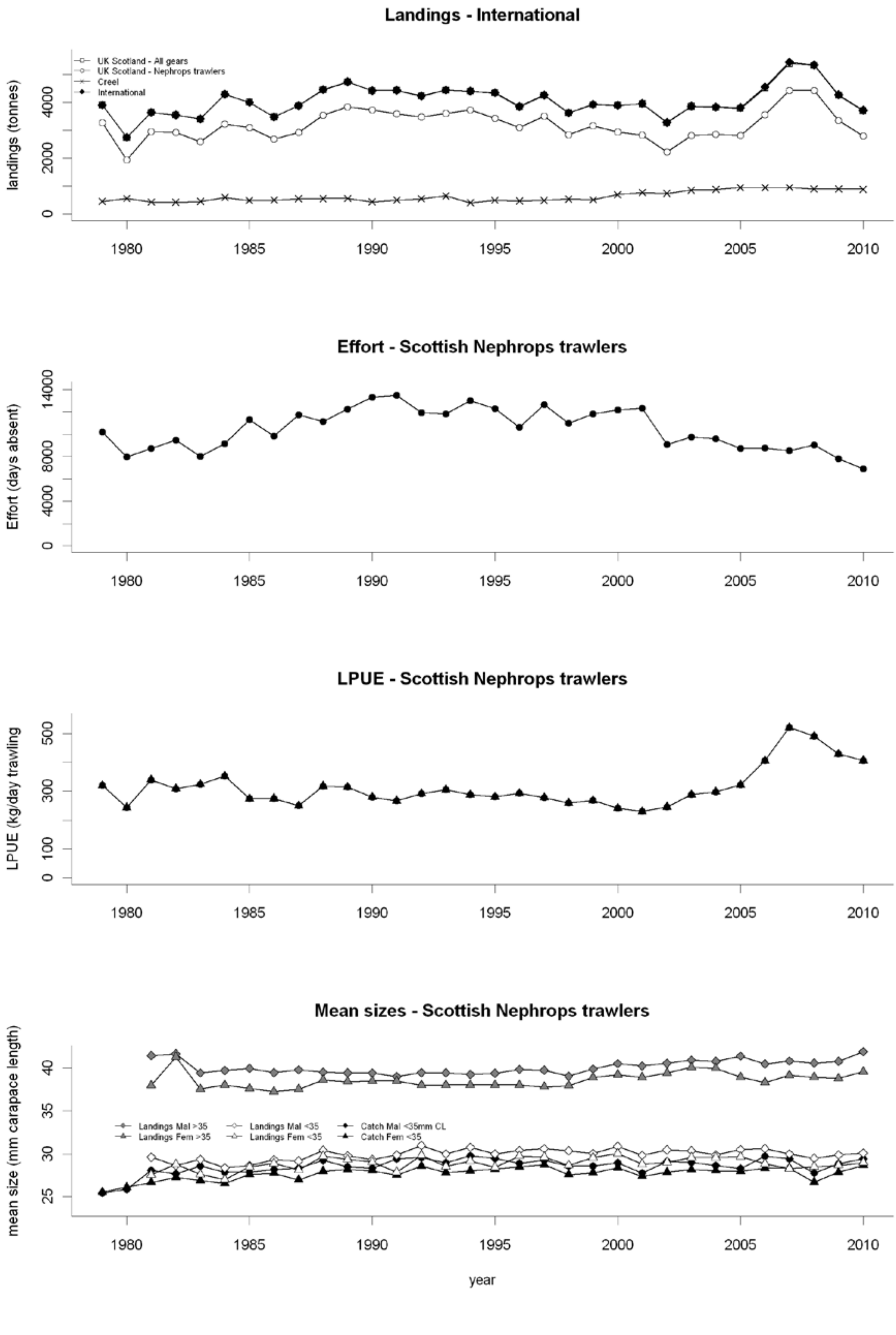


**Figure 3.6.1.** ***Nephrops*****, South Minch (FU12), Long-term landings, effort, lpue and mean sizes. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

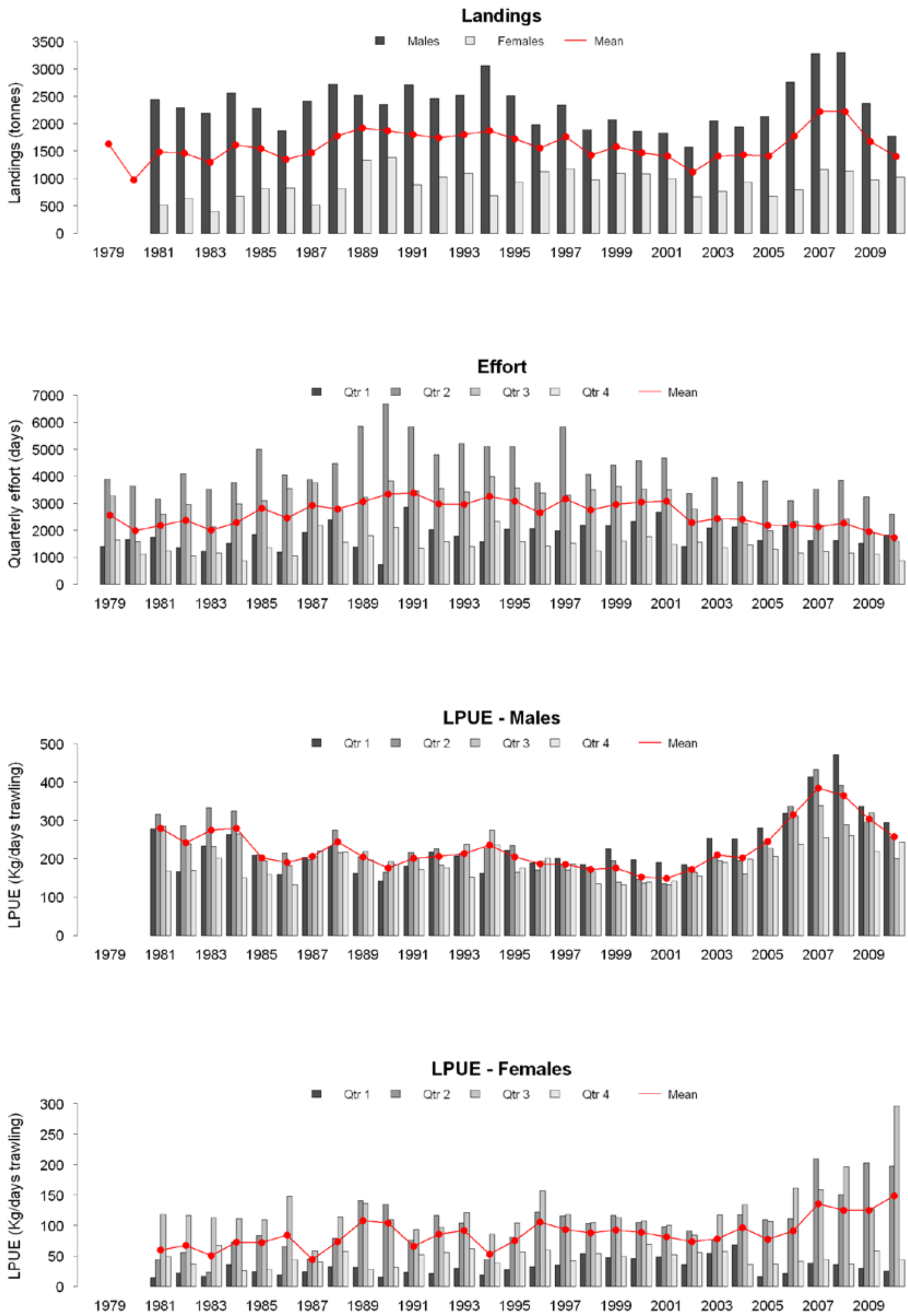


**Figure 3.6.2.** ***Nephrops*, South Minch (FU12), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers. The interpretation of the lpue series is likely to be affected by the introduction of the "buyers and sellers" regulations in 2006.**

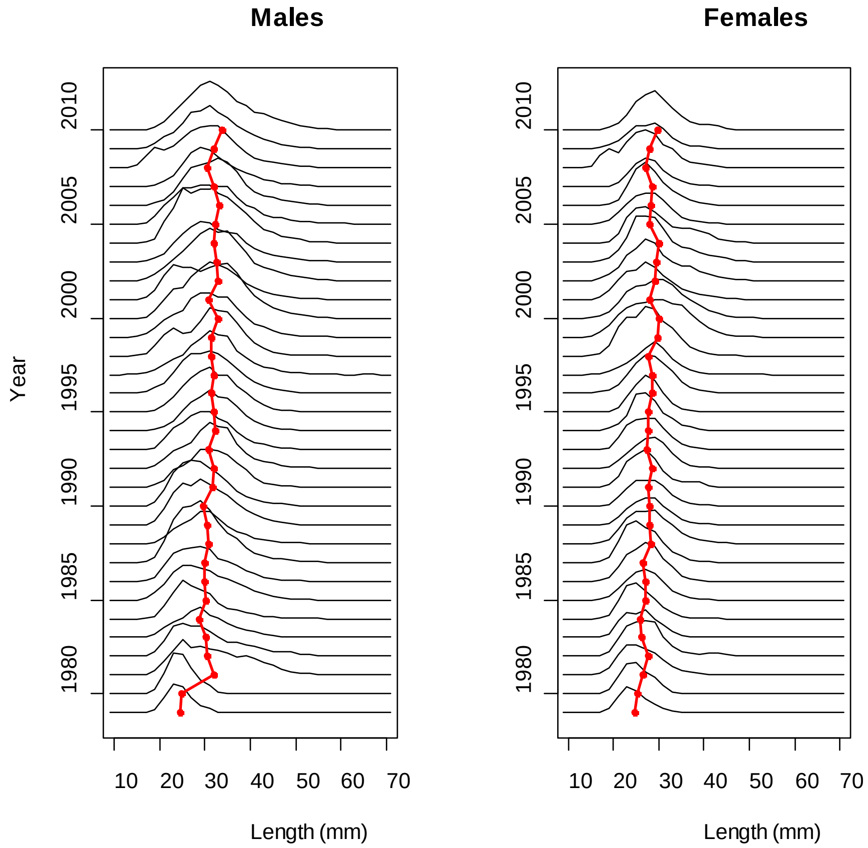


**Figure 3.6.3.** ***Nephrops.*** **South Minch (FU12). Catch length frequency distribution and mean sizes (red line) for *Nephrops* in the South Minch, 1979–2010.**

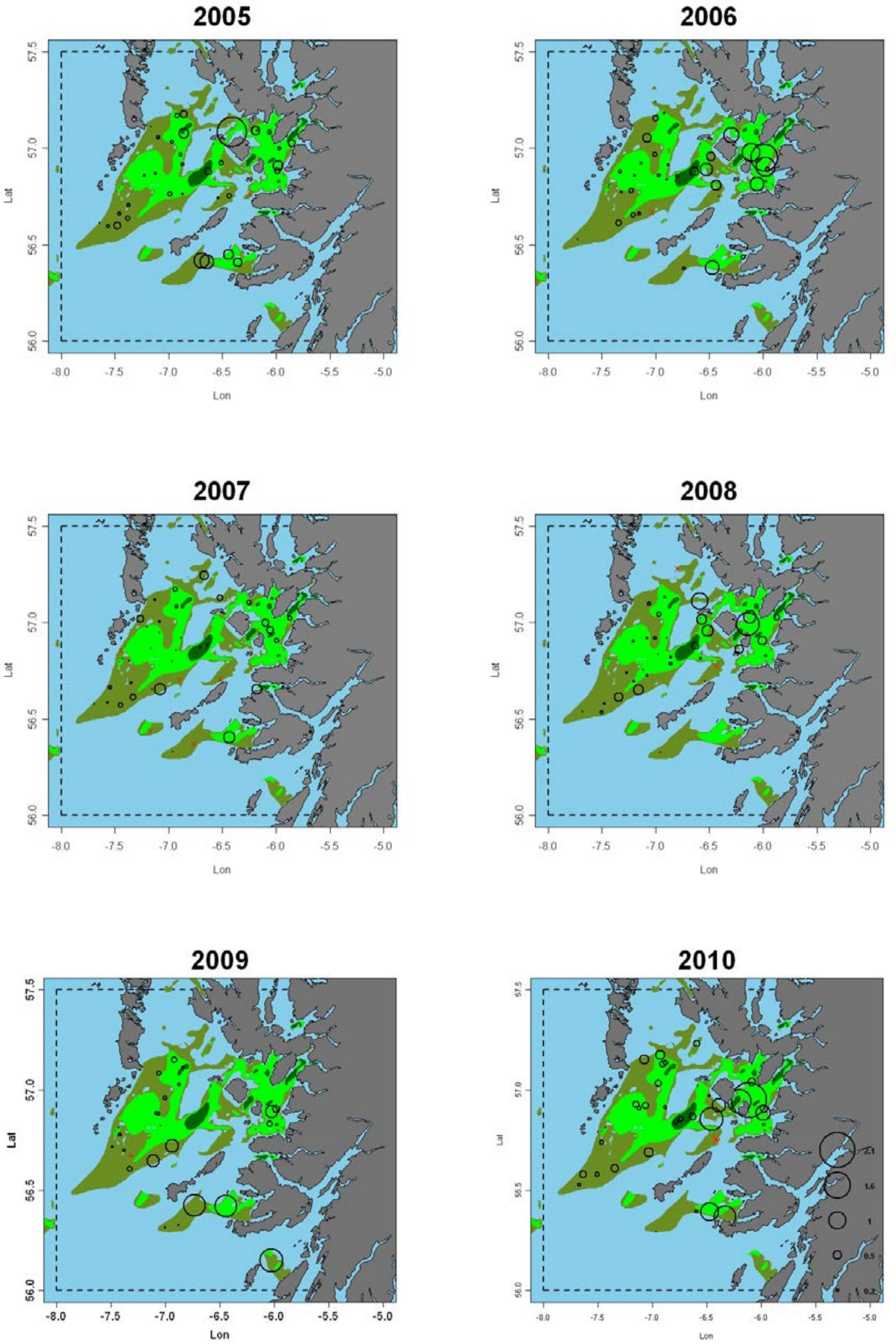


**Figure 3.6.4. *Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2005–2010. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.**

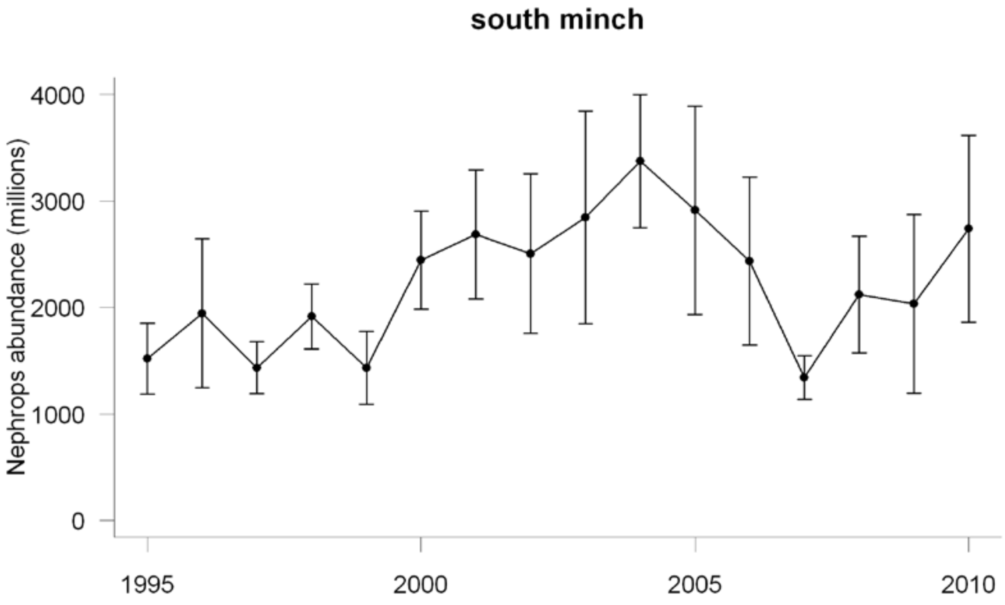


**Figure 3.6.5.** ***Nephrops*****, South Minch (FU12), Time-series of revised TV survey abundance estimate (not adjusted for bias), with 95% confidence intervals, 1995–2010.**

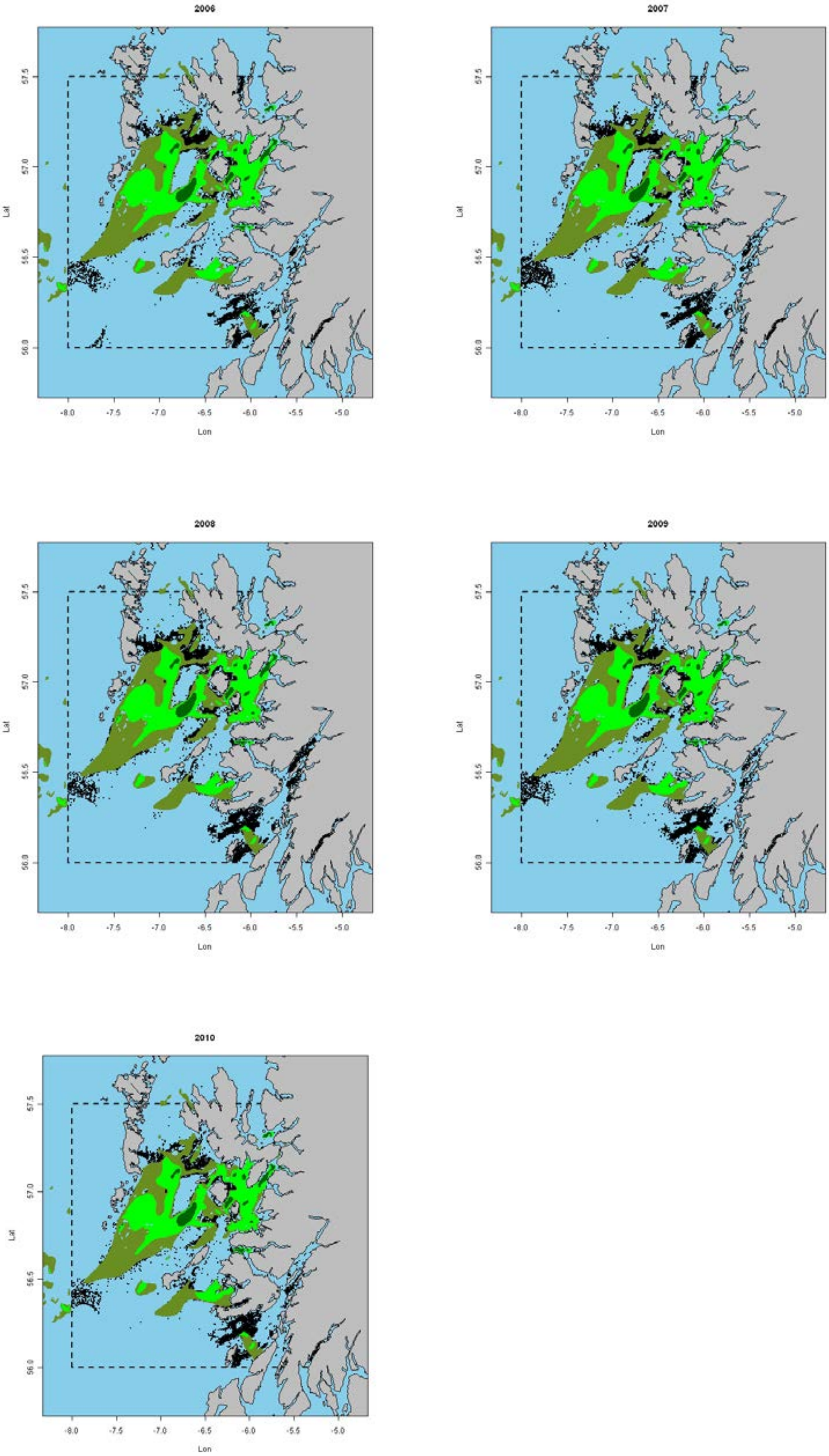


**Figure 3.6.6. *Nephrops*, South Minch (FU12), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2010. VMS data filtered to exclude vessel speeds >4.5 knots.**

## 3.7 Clyde, FU13

Type of assessment in 2011.

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WKNEPH, 2009) and described in Section 2.2.

### 3.7.1 Ecosystem aspects

The Clyde FU comprises two distinct patches in the Firth of Clyde and the Sound of Jura, to the east and west of the Mull of Kintyre respectively. The hydrography of the two subareas differs with the Sound of Jura characterized by stronger tidal currents and the Firth of Clyde exhibiting features of a lower energy environment with a shallow entrance sill.

Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of mud, sandy mud and muddy sand. Within the two patches these substrata are distributed according to prevailing hydrographic and bathymetric conditions. The available area of suitable sediment is smaller in the Sound of Jura, occupying only the deepest parts of the Sound, while in the Firth of Clyde these sediments predominate.

### 3.7.2 The fishery in 2010

Information on developments in the fishery was provided by Marine Scotland staff including fishery officers and scientists sampling in the ports and on board vessels; some comments were also received from industry representatives. Around 35 trawlers ranging from 9.9 to 20 m operated in the Clyde during 2010. The number of vessels has not really changed from that of 2009. Some have left the fleet through decommissioning or personal reasons but they have however, been replaced by others meaning that, on the whole, the number has remained similar. Vessels were all using 80 mm codends with 120 mm minimum square mesh panels, in line with west coast emergency measures conditions (Council Reg. (EU) 43/2009). The most significant landings were made at the main Clyde landing ports of Troon, Girvan, Largs on the east side of the Clyde and Campbelltown, Tarbert, and Carradale on the west side of the Clyde. Almost all of the Clyde *Nephrops* fleet fish daily trips. Vessels in the Clyde tend to stick the same gear type but traditionally some will swap between *Nephrops* and scallop gear during the year.

There is not much movement of the regular vessels into other areas although in 2010 a couple of boats went to North Shields. Some went to fish to Oban and to the Irish Sea. The boats that fish in the latter two areas tend to still land into their local processor. A few Northern Irish boats fish the Clyde at varying times of the year according to weather and catch rates. In 2010, the Northern Irish fleet moved up to Clyde at the end of October for six weeks. These boats fish mainly for tails, landing into Campbeltown or Troon.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length. An increasing number of creel boats operate in the Clyde. Creeling activity now takes place quite widely in the northern parts of the Firth operating on some of the same grounds but often taking place during the weekend trawling ban. Only about a third of creelers operated throughout the year, the rest prosecuted a summer fishery.

Because of the high fuel prices, poor prices for *Nephrops* and the new legislation regarding cheap labour, many of the boats have had a difficult year financially. This has lead to 3–4 vessels diversifying into queenie and scallop fisheries; which they have been fishing for the entire year. Some of the trawlers are now tubing their prawns in order to maximize profits. The vessels that are tubing are not landing tails which means that they do not catch bulk quantities and this leads to *Nephrops* of better average size and quality suitable for storage using 'individual tubing'. This marketing technique (previously developed in the creel fishery) was more prevalent in 2010. Vessels which are landing tails are required, by the local buyers, not to land small tails (~96–100 tails per kilo). This has resulted in a larger overall size of tail being landed.

During the weekends, some of the larger boats went to fish in the Sound of Jura. There is reportedly a good fishing there however, the price of fuel means that it is not always worth the trip up for a weekend.

### 3.7.3 ICES advice in 2010 and 2011

#### ICES advice for *2010*

Based on Exploitation boundaries in relation to precautionary considerations was as follows:

*"ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed* $F_{max}$*. This corresponds to landings of no more than 3855 t for the Firth of Clyde stock."*

#### ICES conclusions in 2010

*"Harvest rates for Nephrops in the Firth of Clyde have been at or above the proposed* $F_{MSY}$ *proxy in recent years. UWTV abundance remains well above the preliminary* $B_{trigger}$*. Harvest rates for Nephrops in the Sound of Jura have been well below the proposed* $F_{MSY}$ *proxy in recent years. UWTV abundance remains higher than observed at the start of the series but the series is too short and patchy to propose a preliminary* $B_{trigger}$ *level."*

#### ICES advice for 2011

Based on MSY approach was as follows:

*"Following the ICES MSY framework implies the harvest ratio for the Firth of Clyde subarea to be reduced to 16.4%, resulting in landings of 2800 t in 2011. Following the ICES MSY framework implies the harvest ratio for the Sound of Jura Subarea to be 14.5 %, resulting in landings of 520 t in 2011.*

*Following the transition scheme towards the ICES MSY framework implies the harvest ratio for the Firth of Clyde should be reduced to 24.1% (0.8 x harvest ratio(*$F_{2010}$*) + 0.2 x harvest ratio(*$F_{MSY}$*)), resulting in landings of 4100 t in 2011. For the Sound of Jura no transition is needed as the harvest rate is already below the* $F_{MSY}$ *proxy".*

### 3.7.4 Management applicable to 2009 and 2010

Management is at the ICES subarea level as described at the beginning of Section 3.5. In 2009, ICES again reiterated its advice that *Nephrops* stocks should be managed at the FU level.

### 3.7.5 Assessment

The RGCSE 2010 concluded as follows:

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, but is concerned about the possible overestimate of landings in the forecast due to the use of a discard rate well below the recent average. The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level. The RG agrees that $F_{max}$ (harvest ratio 16.5% combined between sexes) is consistent with the approach adopted by WGCSE for choosing $F_{msy}$ proxies for *Nephrops*. This is predicted to deliver an $F_{35\%spr}$ of about 20% for males. The use of the low UWTV estimates from the mid 1990s to give a $B_{trigger}$ of 579 million individuals is appropriate as a first estimate but has no basis other than being a low point in a relatively short time-series. The WG was not able to conduct a yield-per-recruit for the Sound of Jura population and has adopted the Clyde $F_{MSY}$ calculations as an interim approach (combined sex $F_{35\%SpR}$ HR of 13%, based on low burrow density). The RG notes that the discard rates appear to be negligible which means that the $F_{MSY}$ estimates for the Clyde (where an 18.6% discard rate was adopted) may have an additional bias. The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) has not been defined but is expected to be below 200 million individuals. RG agrees on this provisional figure as the approach is consistent with the other VIa FUs.

#### Approach in 2011

The assessment in 2011 is based on a combination of examining trends in fishery indicators and underwater TV using an extensive dataseries for the Firth of Clyde component of FU 13. Following last year's approach, the more limited UWTV data available for the Sound of Jura subarea was also used.

The assessment of *Nephrops* through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in Section 2.2.

The provision of advice in 2011 develops the process defined by the benchmark WG and described in Section 2.2 and attempts to incorporate decisions taken at WKFRAME for the provision of MSY advice by ICES in 2010. The approach was developed based on intersessional work carried out by participants of the benchmark and involving collaboration between WGNSSK and WGCSE.

Previous TV based assessments have derived predicted landings by applying a harvest rate approach to populations described in terms of length compositions from the trawl component of the fishery. In recent years, creel fishing has become more important in the Firth of Clyde and operates across similar areas to the trawl fishery. For this reason the assessment is performed using combined length compositions.

### Data available

An overview of the data provided and used by the WG is shown in Table 2.1.

#### Commercial catch and effort data

Official catch statistics (landings) reported to ICES are shown in Table and Figure 3.7.1. These relate to the whole of VIa of which the Clyde FU is a part. Landings statistics for FU 13 provided through national laboratories are presented in Table 3.7.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although the remainder of the UK also contributed about 8% in 2010; landings from Northern Ireland form the main part of this. Total international reported landings increased by 19% in 2010 and consisted of 5050 tonnes landed by Scottish trawlers and 186 tonnes landed by Scottish creel vessels. Creel landings have increased in the most recent years but remain at a low level compared to other methods and to the creel fisheries elsewhere on the west coast of Scotland.

Table 3.7.2 show the split in landings between the two subareas comprising FU13. Most of the landings are currently taken from the Firth of Clyde subarea with only about 1% from the Sound of Jura. Earlier in the time-series the Sound of Jura contributed as much a 20%. The decline has occurred through a progressive reduction in fishing activity in the area. The main reason for this is probably related to the size composition in the population which is characterized by small *Nephrops* (Bailey and Chapman, 1983) whereas the market has increasingly favoured larger whole animals.

The introduction of the "buyers and sellers" regulation in the UK in 2006 has led to increased reliability in the reported landings.

Uncertainties over the accuracy of the effort data emerged recently. In an effort to improve reliability, effort was extracted and expressed in terms of days fished (because the logbook field for hours is not mandatory). Preliminary examination of the new effort series showed a marked discontinuity around 1995 with a large and inexplicable drop in effort in days. Further investigation revealed that at this time the process of recording days effort in the split rectangle region of the Clyde changed. This will require some additional work to establish if a reliable series can be reinstated. For the present, long-term trends in effort and lpue/cpue are not reported here. It is not thought however, that the change has affected the intra-annual, quarterly patterns of effort and lpue and these have been included.

Sex ratio in the Firth of Clyde shows some variation but males consistently make the largest contribution to the annual landings (62% in 2010). This occurs because males are available throughout the year and the fishery is also prosecuted in all quarters. Females on the other hand are mainly taken in summer when they emerge after egg hatching (Figure 3.7.2).

Discarding of undersized and unwanted *Nephrops* occurs in the Firth of Clyde fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates are high in this FU and average around 33% by number in this FU since 1999. In 2010, discard rates were estimated to be lower than average at 17% by number (Table 3.7.8).

Studies (Charuau *et al*., 1982; Sangster *et al*., 1997; Wileman *et al*., 1999) suggest that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard rate adjusted to account for some survival was estimated to be 25.3% (taking a three year average 2008–2010) and according to the agreed benchmark protocol this value is used in the provision of landings options for 2011.

#### Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Quarterly landings and discards at length data were available for the Firth of Clyde from Scotland and these sampling levels are shown in Table 3.5.4. . Length compositions for the creel fishery are of landings only since the small numbers of discards survive well and are not considered to be removed from the population. Sampling of length compositions in the Sound of Jura is more infrequent and only limited data are available. Although assessments based on detailed catch analysis are not currently considered advisable, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.7.3 shows a series of annual Firth of Clyde length frequency distributions for the period 1979 to 2010. Catch (removals) length compositions are shown for each sex along with the mean size for both. In both sexes the mean sizes have been fairly stable over time although in 2010 there is some evidence of a slight increase in the mean lengths. Examination of the tails of the distributions above 35 mm (the length beyond which the effects of recruitment pulses and discarding are considered to be negligible) shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.7.1 and Table 3.7.3. This parameter might be expected to reduce in size if overexploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also stable through time, although in the most recent year the mean size of individuals in the landings and catch below 35 mm has increased quite markedly, which is in line with what is described in Section 3.7.2 about trawlers tubing larger *Nephrops* and not landing as many small tails as before.

Mean weight in the Firth of Clyde landings is shown in Figure 3.5.6 and Table 3.5.9 and this also shows no systematic changes over the time-series although there is a slight increase in 2010.

#### Natural mortality, maturity-at-age and other biological parameters

Biological parameter values are included in the Stock Annex.

#### Research vessel data

Underwater TV surveys are available for both subareas since 1995 although the Sound of Jura has been sampled more infrequently. Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability of burrow emergence of *Nephrops*. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows.

The UWTV in the Firth of Clyde subarea is carried out using a stratified random approach. The numbers of valid stations used in the final analysis in each year are shown in Table 3.7.4. On average, 37 stations have been considered valid each year, then raised to the estimated area of the ground available for *Nephrops*; 2080 km$^2$ based on contoured superficial sediment information (British Geological Surveys).

The number of valid stations in the Sound of Jura is shown in Table 3.7.6.

### Data analyses

#### Exploratory analyses of survey data

Full details of the UWTV approach can be found in the Stock Annex and the report of (WKNEPH) in 2009 (ICES, 2009). A re-working of the UWTV survey abundance series for Division VIa was presented to the *Nephrops* benchmark workshop (WKNEPH) in 2009 (ICES, 2009) and further details of the technical changes to the camera can be found in the report of that workshop. The revised abundance estimates for FU 13 from 1999 onwards were presented for the first time at WGCSE 2009 and are slightly higher than the previous values due to the field of view being smaller than previously calculated.

Table 3.7.4 shows the basic analysis for the most recent TV surveys conducted in the Firth of Clyde. The table includes estimates of abundance and variability of each of the strata adopted in the stratified random approach. The areas of all sediment types (mud, muddy sand and sandy mud) in this region are very similar and as such the number of stations surveyed in each sediment type are similar also. Basic analysis for the Sound of Jura is shown in Table 3.7.6.

Figure 3.7.4 shows the distribution of stations in recent TV surveys (2005–2010) across FU13 (the two distinct subareas can be clearly seen), with the size of the symbols reflecting the *Nephrops* burrow density. Table 3.7.5 and Figure 3.7.5 show the time-series estimated abundance for the TV surveys in the Firth of Clyde, with 95% confidence intervals on annual estimates. Similar information for the Sound of Jura is shown in Table 3.7.7 and Figure 3.7.6. The most recent survey suggests continued higher density in the south part of the functional unit.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative bias correction factor estimated for the Firth of Clyde was 1.19 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 19%. A review of the Sound of Jura biases has not so far been carried out; biases are here assumed to be similar to the Firth of Clyde.

#### Final Assessment

The underwater TV surveys are presented as the best available information on the stocks of *Nephrops* in the two subareas of FU13. The surveys provide fishery-independent estimates of *Nephrops* abundance. The details of the 2010 Firth of Clyde survey are shown in Table 3.7.4 and compared with the 2008 and 2009 outcomes. The details of the 2009 Sound of Jura survey are shown in Table 3.7.6. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on abundance over the area of the survey.

The 2010 TV survey data presented at this meeting shows that the abundance in the Firth of Clyde has increased compared to 2009 and is in line with values recorded before the abundance drop in 2007 remaining at the upper end of the values observed throughout the time-series. The 2010 TV survey data presented at this meeting shows that the abundance in the Sound of Jura increased markedly and is around 50% higher than the previous 2009 estimate.

The TV survey results reported here do not cover the sea loch areas adjacent to the main Firth of Clyde and Sound of Jura areas and should therefore be considered underestimates of the overall biomass. This issue is discussed further under quality of assessment.

### 3.7.6 Historical stock trends

The TV survey estimates of abundance for *Nephrops* in the Firth of Clyde suggests that the population increased until the mid 2000s implying a sustained period of increased recruitment. Following this, abundance has declined and fluctuated around the values previously observed in the early 2000s just prior to the maximum. The bias adjusted abundance estimates from 1999–2010 (the period over which the survey estimates have been revised) is shown in Table 3.7.8. The latest bias adjusted stock estimate is 1750 million individuals.

Table 3.7.8 (now including comparable information to that included in the Celtic Seas WG report sections for other FUs) also shows the estimated harvest ratios over this period. These range from 12–50 % over this period. (It is unlikely that prior to 2006, the estimated harvest ratios are representative of actual harvest ratios due to under-reporting of landings).

Results for the Sound Jura are sparser and are associated with large confidence intervals particularly in 2002 and 2006. Table 3.7.9 summarizes the bias adjusted estimates of abundance and harvest rates where available.

### 3.7.7 MSY considerations

A number of potential $F_{msy}$ proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2.2 of this report. The analysis assumes the same input biological parameters as used at the benchmark meeting in 2009 and an exploitation and discard ogive for trawl and creel caught *Nephrops* generated in 2010 for the years 2008–2009. The complete range of the per-recruit $F_{msy}$ proxies for the Firth of Clyde subarea is given in the table below and the process for choosing an appropriate $F_{msy}$ proxy is described in Section 2.2. Note that all $F_{msy}$ proxy harvest rate values remain preliminary and may be modified following further data exploration and analysis.

For the Firth of Clyde subarea of this FU, the absolute density observed on the UWTV survey is generally high (average of over 0.8 $m^{-2}$ for entire series and around 1.0 $m^{-2}$ for the last five years suggesting the stock has relatively high productivity. In addition, the fishery in this area has been in existence since the 1960s and the population and biological parameters have been studied numerous times (Bailey and Chapman, 1983; Tuck *et al*., 1997; Tuck *et al*., 1999). Historical harvest ratios in this FU have been generally high at or above $F_{max}$.. **An appropriate $F_{msy}$ proxy is considered therefore to be the total population $F_{max}$ which is predicted to deliver an $F_{35\%SpR}$ of about 22% for males**; considered precautionary for this species (See Section 2.2).

| | | | Fbar(20–40 mm) | | | SPR (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | Fmult | M | F | HR (%) | M | F | T |
| F0.1 | M | 0.17 | 0.15 | 0.06 | 8.7 | 40.2 | 66.8 | 49.1 |
| | F | 0.43 | 0.37 | 0.14 | 21.1 | 16.2 | 40.7 | 24.4 |
| | T | 0.19 | 0.16 | 0.06 | 9.7 | 36.9 | 64.0 | 45.9 |
| Fmax | M | 0.27 | 0.23 | 0.09 | 13.6 | 27.0 | 54.4 | 36.2 |
| | F | 0.71 | 0.61 | 0.24 | 34.0 | 8.3 | 26.5 | 14.3 |
| | T | 0.33 | 0.28 | 0.11 | 16.4 | 21.9 | 48.6 | 30.8 |
| F35%SpR | M | 0.21 | 0.18 | 0.07 | 10.7 | 34.0 | 61.4 | 43.1 |
| | F | 0.53 | 0.46 | 0.18 | 25.7 | 12.4 | 34.6 | 19.8 |
| | T | 0.29 | 0.25 | 0.10 | 14.5 | 25.1 | 52.4 | 34.2 |

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 579 million individuals.

Yield-per-recruit analysis is not yet available for the Sound of Jura subarea of this FU and so proxies from the Firth of Clyde (shown in the table above) are used. The absolute density observed on the UWTV survey is generally high (average of about 0.8 $m^{-2}$ over the time-series and around 1 $m^{-2}$ over the last five years) suggesting the stock has relatively high productivity. A number of studies have investigated biology and the area is acknowledged as having high abundance for many years. However, the time-series of TV data is more fragmented and sampling is at a relatively low level; confidence intervals are larger. The fishery in this area has been in existence since the

1960s but in recent times has operated at a low level and harvest ratios in this FU have been low. **An appropriate $F_{msy}$ proxy is considered therefore to be the total population $F_{35\%SpR}$ which is predicted to deliver an $F_{35\%SpR}$ of about 25% for males**; above the level considered precautionary for this species (See Section 2.2).

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) has not been defined but is expected to be below 200 million individuals.

### 3.7.8 Landings forecasts

Landings prediction for 2011 were made for the Firth of Clyde and Sound of Jura subareas of the Clyde FU13 using the approach agreed at WKNEPH 2009 and outlined in the Section 2.2. The tables below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2010 using the input parameters agreed at WKNEPH (ICES 2009). The landings prediction for 2012 at the $F_{msy}$ proxy harvest ratio considered appropriate to the Firth of Clyde (i.e. 16.4%) is 3980 tonnes. There is a transition stage (HR 17.1%) as the current harvest ratio is above the $F_{msy}$ proxy in 2012 this gives landings of 4150 t.

For the Sound of Jura subarea, the landings prediction for 2012 at the $F_{msy}$ proxy harvest ratio of 14.5% is 873 t. There is no transition stage since the current position is below the $F_{msy}$ proxy.

The inputs to the landings forecast for the Firth of Clyde and Sound of Jura were as follows:

Mean weight in landings in Firth of Clyde (08-10) = 18.56 g

Mean weight in landings in Sound of Jura (08-10) = 21.44 g

Discard rate (by number) = 25.3%

Survey bias = 1.19 (as calculated at WKNEPH 2009).

**Firth of Clyde**

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Survey Index (adjusted) | Retained number | Landings (tonnes) |
| $F_{msy}$ | 16.4% | 1750 | 214 | 3980 |
| $F_{msy\ transition}$ | 17.1% | 1750 | 224 | 4150 |
| $F_{0.1(M)}$ | 8.7% | 1750 | 114 | 2111 |
| $F_{0.1(T)}$ | 9.7% | 1750 | 127 | 2354 |
| $F_{35\%SpR(M)}$ | 10.7% | 1750 | 140 | 2597 |
| $F_{max\ (M)}$ | 13.6% | 1750 | 178 | 3301 |
| $F_{35\%SpR(T)}$ | 14.5% | 1750 | 190 | 3519 |
| $F_{max\ (T)}$ | 16.4% | 1750 | 214 | 3980 |
| $F_{2010}$ | 17.5% | 1750 | 229 | 4247 |

**Sound of Jura**

| | Harvest rate | Survey Index (adjusted) | Implied fishery Retained number | Implied fishery Landings (tonnes) |
|---|---|---|---|---|
| $F_{msy}$ | 14.5% | 376 | 41 | 873 |
| $F_{2010}$ | 1.1% | 376 | 3 | 66 |
| $F_{0.1(M)}$ | 8.7% | 376 | 24 | 524 |
| $F_{0.1(T)}$ | 9.7% | 376 | 27 | 584 |
| $F_{35\%SpR(M)}$ | 10.7% | 376 | 30 | 645 |
| $F_{max\ (M)}$ | 13.6% | 376 | 38 | 819 |
| $F_{35\%SpR(T)}$ | 14.5% | 376 | 41 | 873 |
| $F_{max\ (T)}$ | 16.4% | 376 | 46 | 988 |

**Note: No $F_{msy}$ transition as $F_{2011}$ is below $F_{msy}$.**

$F_{0.1(M,T)}$: Harvest ratio equivalent to fishing at a level associated with 10% of the slope at the origin on the male or combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male or combined SPR equal to 35% of the unfished level.

$F_{max\ (M,\ T)}$: Harvest ratio equivalent to fishing at a rate which maximizes the male or combined YPR.

A discussion of $F_{msy}$ reference points for *Nephrops* is provided in Section 2.2.

### 3.7.9 Biological reference points

Precautionary approach biological reference points have not been determined for *Nephrops* stocks.

### 3.7.10 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in the Firth of Clyde subarea fishery since 1990, and is considered to represent the fishery adequately. Sampling in the Sound of Jura is sparser.

There are concerns over the accuracy of historical landings and effort data and because of this the final assessment adopted is independent of official statistics.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals around the abundance estimates are stable throughout the series and relatively low compared with other FUs in VIa. There is a gap of 18 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realized harvest rates has not been investigated.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. A three year average (2008–2010) of discard rate (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options. Discard rates have fluctuated over the time-series but have been stable in the last two years and there have been a significant decrease in 2010. These uncertainties are not taken into account in the forecast.

The cumulative bias estimates for FU 13 Clyde and Jura component is largely based on expert opinion (See Annex). The precision of these bias corrections cannot yet be characterized.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation. VMS data, recently made available and linked to landings (from queries of the Scottish FIN database) suggest some discrepancy between areas fished and the mud sediment maps. Figure 3.7.7 overlays the British Geological Survey based sediment distributions on the VMS based activity of >15 m trawlers. On the one hand there is some evidence of *Nephrops* fishing activity outside the contoured areas, but on the other hand, some of the sediment areas are apparently not fished. Overall the area estimates for the sediment maps exceed those estimated for the VMS by a factor of 1.2. The inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations while in the Clyde the unestimated sea loch areas are relatively small.

### 3.7.11 Status of the stock

The perception of the state of the stock in the Firth of Clyde has not changed substantially since the assessment in 2008. The evidence from the TV survey suggests that the population is stable and the 17% increase observed in 2010 is within the confidence limits for the past two years. The calculated harvest ratio in 2010 (dead removals/TV abundance) is slightly above the values associated with high long-term yield and low risk depletion.

### 3.7.12 Management considerations

The ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could confer controls to ensure effort and catch were in line with resources available. In this FU the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the landings advice. There is a need to reduce discards in this FU.

Creel fishing takes place in part of this area although the relative scale of the fishery is smaller than in the Minches. Overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the Firth of Clyde and STECF estimates that discards of whiting and haddock are high in VIa generally. It is important that efforts are made to ensure that unwanted bycatch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted bycatches of cod under the Scottish Conservation credits scheme and west coast emergency measures, include the implementation of larger meshed square meshed panels (120 mm). A seasonal closure (early spring) in the southwest part of the Firth of Clyde is in place to protect spawning cod although *Nephrops* vessels are derogated to fish in those parts where mud sediments are distributed.

The implementation of buyers and sellers legislation in the UK in 2006 has improved the reliability of fishery statistics but the transition period was accompanied in some cases by large changes in landings which produce significant changes in the lpue and cpue series that cannot be completely attributed to changes in stock. Until a sufficient time-series of reliable data has built up, use of fishery catch and effort data in the assessment process should be avoided.

### 3.7.13 Other *Nephrops* populations within Division VIa

*Nephrops* fisheries also take place outside the Functional Units in Subdivision VIa, although they represent a small proportion of the reported landings (Table 3.5.3). Over the time-series, average landings have been just over 250 t and in recent ten years, just over 300 t. An allowance for this activity is required in the final landings advice for 2012. The main areas of activity are the Stanton Bank (to the west of the South Minch) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides.

### 3.7.14 Stanton Bank

Underwater TV surveys were not conducted in Stanton Bank in 2010.

### 3.7.15 Shelf edge west of Scotland

Marine Scotland Science has taken the opportunity of using the Scotia deep-water surveys conducted in 2000, 2002 and 2004 to conduct preliminary underwater TV work on the *Nephrops* populations along the shelf edge. These TV runs are carried out during the night (when the vessel is not required for fishing). It is hoped that this can continue as an annual survey.

To date, successful survey runs have been conducted to a depth of 635 m, observing *Nephrops* burrows at a range of locations along the shelf edge and slope. Observed densities have been very low (average 0.04 $m^{-2}$) compared to shelf stocks on the west coast and in the North Sea (typically 0.2–0.9 $m^{-2}$), although the animals on the shelf edge are considerably larger than those found on the shelf. Forecasts of landings based on TV surveys were not attempted for this area.

### 3.7.16 References

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**Table 3.7.1. *Nephrops*, Clyde (FU13), Nominal Landings of *Nephrops*, 1981–2010, as officially reported.**

| Year | UK Scotland | | | | Other UK | Total |
|---|---|---|---|---|---|---|
| | *Nephrops* trawl | Other trawl | Creel | Sub-total | | |
| 1981 | 2498 | 404 | 66 | 2968 | 0 | 2968 |
| 1982 | 2373 | 171 | 79 | 2623 | 0 | 2623 |
| 1983 | 3890 | 120 | 53 | 4063 | 14 | 4077 |
| 1984 | 3069 | 154 | 77 | 3300 | 10 | 3310 |
| 1985 | 3921 | 293 | 64 | 4278 | 7 | 4285 |
| 1986 | 4074 | 175 | 79 | 4328 | 13 | 4341 |
| 1987 | 2859 | 80 | 65 | 3004 | 3 | 3007 |
| 1988 | 3507 | 108 | 43 | 3658 | 7 | 3665 |
| 1989 | 2577 | 184 | 35 | 2796 | 16 | 2812 |
| 1990 | 2732 | 122 | 24 | 2878 | 34 | 2912 |
| 1991 | 2845 | 145 | 25 | 3015 | 23 | 3038 |
| 1992 | 2532 | 246 | 10 | 2788 | 17 | 2805 |
| 1993 | 3199 | 110 | 5 | 3314 | 28 | 3342 |
| 1994 | 2503 | 49 | 28 | 2580 | 49 | 2629 |
| 1995 | 3767 | 132 | 26 | 3925 | 64 | 3989 |
| 1996 | 3880 | 111 | 27 | 4018 | 42 | 4060 |
| 1997 | 3486 | 44 | 25 | 3555 | 63 | 3618 |
| 1998 | 4539 | 81 | 40 | 4660 | 183 | 4843 |
| 1999 | 3475 | 29 | 38 | 3542 | 210 | 3752 |
| 2000 | 3143 | 63 | 76 | 3282 | 137 | 3419 |
| 2001 | 2889 | 67 | 94 | 3050 | 132 | 3182 |
| 2002 | 3074 | 53 | 105 | 3232 | 151 | 3383 |
| 2003 | 2954 | 20 | 117 | 3091 | 80 | 3171 |
| 2004 | 2659 | 18 | 90 | 2767 | 258 | 3025 |
| 2005 | 3166 | 14 | 95 | 3275 | 148 | 3423 |
| 2006 | 4446 | 0 | 0 | 4534 | 244 | 4778 |
| 2007 | 6129 | 0 | 0 | 6129 | 366 | 6495 |
| 2008 | 5382 | 2 | 197 | 5581 | 416 | 5997 |
| 2009 | 4305 | 0 | 189 | 4494 | 283 | 4777 |
| 2010* | 5050 | 0 | 186 | 5236 | 465 | 5701 |

*** provisional.**

**** Total also includes Rep. of Ireland.**

**Table 3.7.2.** ***Nephrops*****, Clyde (FU13), Nominal Landings of** ***Nephrops*****, in each of the subareas (Firth of Clyde and Sound of Jura 1981–2010, as officially reported.**

| | UK | | |
|---|---|---|---|
| Year | Firth of Clyde | Sound of Jura | All subareas |
| 1981 | | | 2968 |
| 1982 | | | 2623 |
| 1983 | | | 4077 |
| 1984 | | | 3310 |
| 1985 | | | 4285 |
| 1986 | | | 4341 |
| 1987 | | | 3007 |
| 1988 | | | 3665 |
| 1989 | | | 2812 |
| 1990 | | | 2912 |
| 1991 | | | 3038 |
| 1992 | | | 2805 |
| 1993 | 2766 | 576 | 3342 |
| 1994 | 2094 | 535 | 2629 |
| 1995 | 3690 | 299 | 3989 |
| 1996 | 3673 | 387 | 4060 |
| 1997 | 3132 | 486 | 3618 |
| 1998 | 4372 | 471 | 4843 |
| 1999 | 3424 | 328 | 3752 |
| 2000 | 3230 | 189 | 3419 |
| 2001 | 2980 | 202 | 3182 |
| 2002 | 3349 | 34 | 3383 |
| 2003 | 3153 | 18 | 3171 |
| 2004 | 2975 | 50 | 3025 |
| 2005 | 3387 | 36 | 3423 |
| 2006 | 4717 | 61 | 4778 |
| 2007 | 6397 | 98 | 6495 |
| 2008 | 5919 | 78 | 5997 |
| 2009 | 4686 | 91 | 4777 |
| 2010* | 5643 | 58 | 5701 |

*** provisional.**

**na = not available.**

**Table 3.7.3. *Nephrops*, Clyde (FU 13): Firth of Clyde subarea. Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish trawl catches and landings, 1981–2010.**

| | Catches | | Landings | | | |
|---|---|---|---|---|---|---|
| | < 35 mm CL | | < 35 mm CL | | > 35 mm CL | |
| Year | Males | Females | Males | Females | Males | Females |
| 1981 | 28.4 | 27.3 | 30.2 | 29.3 | 40.3 | 39.3 |
| 1982 | 28.2 | 26.4 | 29.9 | 29.0 | 39.9 | 40.1 |
| 1983 | 27.9 | 26.7 | 29.3 | 28.5 | 40.8 | 39.5 |
| 1984 | 27.0 | 25.9 | 28.0 | 26.8 | 40.9 | 39.6 |
| 1985 | 27.1 | 26.1 | 28.1 | 27.2 | 39.8 | 39.3 |
| 1986 | 27.1 | 26.0 | 27.9 | 27.1 | 40.5 | 39.0 |
| 1987 | 28.5 | 26.5 | 29.6 | 28.3 | 39.4 | 40.0 |
| 1988 | 28.1 | 27.0 | 30.6 | 29.5 | 41.2 | 40.1 |
| 1989 | 26.9 | 26.9 | 30.2 | 30.0 | 41.6 | 39.8 |
| 1990 | 27.4 | 26.2 | 30.4 | 29.5 | 40.1 | 39.8 |
| 1991 | 28.6 | 27.1 | 29.2 | 28.2 | 39.3 | 40.3 |
| 1992 | 29.6 | 28.8 | 30.1 | 29.2 | 39.9 | 41.1 |
| 1993 | 29.6 | 29.7 | 31.4 | 30.9 | 40.4 | 39.9 |
| 1994 | 26.4 | 27.0 | 29.4 | 29.4 | 40.8 | 39.2 |
| 1995 | 27.2 | 25.8 | 28.7 | 27.6 | 40.3 | 39.8 |
| 1996 | 28.8 | 28.0 | 30.0 | 29.1 | 38.6 | 40.4 |
| 1997 | 27.9 | 26.9 | 30.0 | 29.2 | 40.0 | 40.3 |
| 1998 | 25.9 | 25.2 | 28.4 | 27.9 | 38.9 | 39.1 |
| 1999 | 26.5 | 25.3 | 28.5 | 27.3 | 39.0 | 39.5 |
| 2000 | 28.3 | 27.7 | 29.3 | 28.6 | 38.7 | 39.1 |
| 2001 | 27.4 | 26.8 | 29.5 | 28.7 | 39.0 | 39.6 |
| 2002 | 27.5 | 25.6 | 28.4 | 26.4 | 39.0 | 39.4 |
| 2003 | 27.2 | 25.9 | 29.1 | 27.9 | 39.2 | 38.6 |
| 2004 | 27.1 | 26.5 | 28.4 | 27.6 | 39.2 | 39.5 |
| 2005 | 28.0 | 26.7 | 29.2 | 27.9 | 38.7 | 38.1 |
| 2006 | 28.7 | 27.1 | 29.0 | 27.3 | 40.0 | 38.7 |
| 2007 | 27.0 | 26.7 | 29.1 | 29.2 | 39.1 | 38.6 |
| 2008 | 27.2 | 25.2 | 28.6 | 26.6 | 39.1 | 38.2 |
| 2009 | 26.9 | 25.3 | 29.3 | 26.4 | 39.4 | 39.0 |
| 2010* | 29.0 | 27.9 | 29.8 | 28.7 | 39.9 | 38.2 |

*** provisional.**

**na = not available**

**Table 3.7.4.** ***Nephrops*****, Clyde (FU 13): Firth of Clyde subarea. Results by stratum of the 2008–2010 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).**

| Stratum | Area (km²) | Number of Stations | Mean burrow density (no./m²) | Observed variance | Abundance (millions) | Stratum variance | Proportion of total variance |
|---|---|---|---|---|---|---|---|
| | | | | **2008 TV survey** | | | |
| M | 717 | 15 | 0.88 | 0.21 | 629 | 7345 | 0.173 |
| SM | 699 | 11 | 0.90 | 0.55 | 628 | 24 502 | 0.575 |
| MS | 665 | 12 | 1.28 | 0.29 | 848 | 10 732 | 0.252 |
| Total | 2081 | 38 | | | 2105* | 42 579 | 1 |
| | | | | **2009 TV survey** | | | |
| M | 717 | 16 | 0.741 | 0.049 | 531 | 1583 | 0.102 |
| SM | 699 | 11 | 0.705 | 0.178 | 469 | 7150 | 0.459 |
| MS | 665 | 12 | 1.122 | 0.168 | 784 | 6842 | 0.439 |
| Total | 2081 | 39 | | | 1784 | 15 575 | 1 |
| | | | | **2010 TV survey** | | | |
| M | 717 | 13 | 1.106 | 0.22 | 793 | 8712 | 0.23 |
| SM | 699 | 15 | 1.23 | 0.516 | 859 | 16 800 | 0.444 |
| MS | 665 | 9 | 0.648 | 0.251 | 431 | 12 324 | 0.326 |
| Total | 2081 | 37 | | | 2083 | 37 836 | 1 |

***Note: abundance estimates for these years based on figures prior to the 2009 revision of the dataseries. Differences between these figures and the revised figures shown in Table 3.7.5 are small.**

**Table 3.7.5.** ***Nephrops*, Clyde (FU 13): Firth of Clyde subarea. Results of the 1995–2010 TV surveys. (not adjusted for bias).**

| Year | Stations | Mean density | Abundance | 95% confidence interval |
|---|---|---|---|---|
| | | burrows/m² | millions | millions |
| 1995 | 29 | 0.33 | 689 | 210 |
| 1996 | 38 | 0.54 | 1113 | 288 |
| 1997 | 31 | 0.68 | 1426 | 312 |
| 1998 | 38 | 0.720 | 1502 | 254 |
| 1999 | 39 | 0.532 | 1107 | 344 |
| 2000 | 40 | 0.807 | 1679 | 293 |
| 2001 | 39 | 0.850 | 1768 | 319 |
| 2002 | 36 | 0.899 | 1870 | 343 |
| 2003 | 37 | 1.039 | 2162 | 347 |
| 2004 | 32 | 1.127 | 2344 | 437 |
| 2005 | 44 | 1.121 | 2331 | 342 |
| 2006 | 43 | 1.050 | 2203 | 306 |
| 2007 | 40 | 0.705 | 1467 | 260 |
| 2008 | 38 | 1.012 | 2105 | 346 |
| 2009 | 39 | 0.86 | 1784 | 250 |
| 2010 | 37 | 1.001 | 2083 | 389 |

**Table 3.7.6.** ***Nephrops*, Clyde (FU 13): Sound of Jura subarea. Results by stratum of the 2009–2010 TV surveys. Note that stratification was based on a series of sediment strata.**

| Stratum | Area (km²) | Number of Stations | Mean burrow density (no./m²) | Observed variance | Abundance (millions) | Stratum variance | Proportion of total variance |
|---|---|---|---|---|---|---|---|
| **2009 TV survey** | | | | | | | |
| M | 90 | 2 | 0.62 | 0.02 | 56 | 66 | 0.040 |
| SM | 150 | 5 | 0.50 | 0.10 | 75 | 463 | 0.279 |
| MS | 142 | 5 | 1.18 | 0.28 | 168 | 1127 | 0.681 |
| Total | 382 | 12 | | | 299 | 1656 | 1 |
| **2010 TV survey** | | | | | | | |
| M | 90 | 2 | 1.305 | <0.01 | 117 | 0.2 | <0.01 |
| SM | 150 | 5 | 1.066 | 0.039 | 160 | 173 | 0.332 |
| MS | 142 | 5 | 1.202 | 0.086 | 171 | 349 | 0.668 |
| Total | 382 | 12 | | | 448 | 522 | 1 |

**Table 3.7.7. *Nephrops*, Clyde (FU 13): Sound of Jura subarea. Results of the 1995–2010 TV surveys. (not adjusted for bias).**

| Year | Stations | Mean density | Abundance | 95% confidence interval |
|---|---|---|---|---|
| | | burrows/m² | millions | millions |
| 1995 | 7 | 0.50 | 190 | 69 |
| 1996 | 10 | 0.53 | 204 | 31 |
| 1997 | | | | |
| 1998 | | no surveys | | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | 13 | 0.85 | 324 | 90 |
| 2002 | 9 | 1.24 | 474 | 199 |
| 2003 | 12 | 0.81 | 309 | 81 |
| 2004 | | no survey | | |
| 2005 | 11 | 0.94 | 360 | 100 |
| 2006 | 10 | 1.34 | 512 | 160 |
| 2007 | 10 | 0.80 | 304 | 69 |
| 2008 | | no survey | | |
| 2009 | 12 | 0.78 | 299 | 81 |
| 2010 | 12 | 1.173 | 448 | 46 |

**Table 3.7.8. *Nephrops*, Clyde (FU 13): Firth of Clyde subarea. Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

| Year | Landings in number (millions) | Discards in number (millions) | Removals in number (millions) | Adjusted survey | Harvest ratio | Landings (tonnes) | Discard (tonnes) | Discard rate | Dead discard rate |
|---|---|---|---|---|---|---|---|---|---|
| 1999 | 189 | 79 | 267 | 930 | 28.7 | 3424 | 481 | 29.6 | 24.0 |
| 2000 | 154 | 43 | 197 | 1411 | 14.0 | 3230 | 418 | 21.8 | 17.3 |
| 2001 | 141 | 71 | 211 | 1486 | 14.2 | 2980 | 584 | 33.5 | 27.4 |
| 2002 | 193 | 47 | 243 | 1571 | 15.4 | 3349 | 379 | 19.4 | 15.3 |
| 2003 | 161 | 130 | 264 | 1817 | 14.5 | 3153 | 1209 | 44.7 | 37.8 |
| 2004 | 143 | 152 | 284 | 1970 | 14.4 | 2975 | 1298 | 51.5 | 44.4 |
| 2005 | 179 | 66 | 240 | 1959 | 12.3 | 3387 | 580 | 26.9 | 21.6 |
| 2006 | 234 | 52 | 286 | 1851 | 15.4 | 4717 | 487 | 18.3 | 14.3 |
| 2007 | 323 | 357 | 614 | 1233 | 49.8 | 6397 | 2372 | 52.5 | 45.3 |
| 2008 | 332 | 192 | 513 | 1769 | 29.0 | 5919 | 1329 | 36.6 | 30.2 |
| 2009 | 236 | 152 | 382 | 1499 | 25.5 | 4686 | 1248 | 39.1 | 32.5 |
| 2010 | 236 | 48 | 306 | 1750 | 17.5 | 5643 | 460 | 16.8 | 13.1 |
| Average 08–10 | | | | | | | | | 25.3 |

***harvest rates previous to 2006 are unreliable.**

**Table 3.7.9. *Nephrops*, Clyde (FU 13): Sound of Jura subarea. Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest rate.**

| Year | Landings in number (millions) | Removals in number (millions) | Adjusted survey | Harvest ratio | Landings (tonnes) | Discard Rate* | Dead discard Rate* |
|---|---|---|---|---|---|---|---|
| 2005 | 0.8 | 3.2 | 303 | 1.1 | 36 | 26.9 | 21.6 |
| 2006 | 2 | 5 | 430 | 1.2 | 61 | 18.3 | 14.3 |
| 2007 | 2.1 | 10.8 | 255 | 4.3 | 98 | 52.5 | 45.3 |
| 2008 | 1.7 | 5.7 | NA | NA | 78 | 36.6 | 30.2 |
| 2009 | 0.8 | 5.8 | 251 | 2.3 | 91 | 39.1 | 32.5 |
| 2010 | 0.4 | 4.1 | 376 | 1.1 | 58 | 16.8 | 13.1 |
| Average 08–10 | | | | | | | 25.3 |

***Discard rates assumed to be the same as in the Firth of Clyde.**

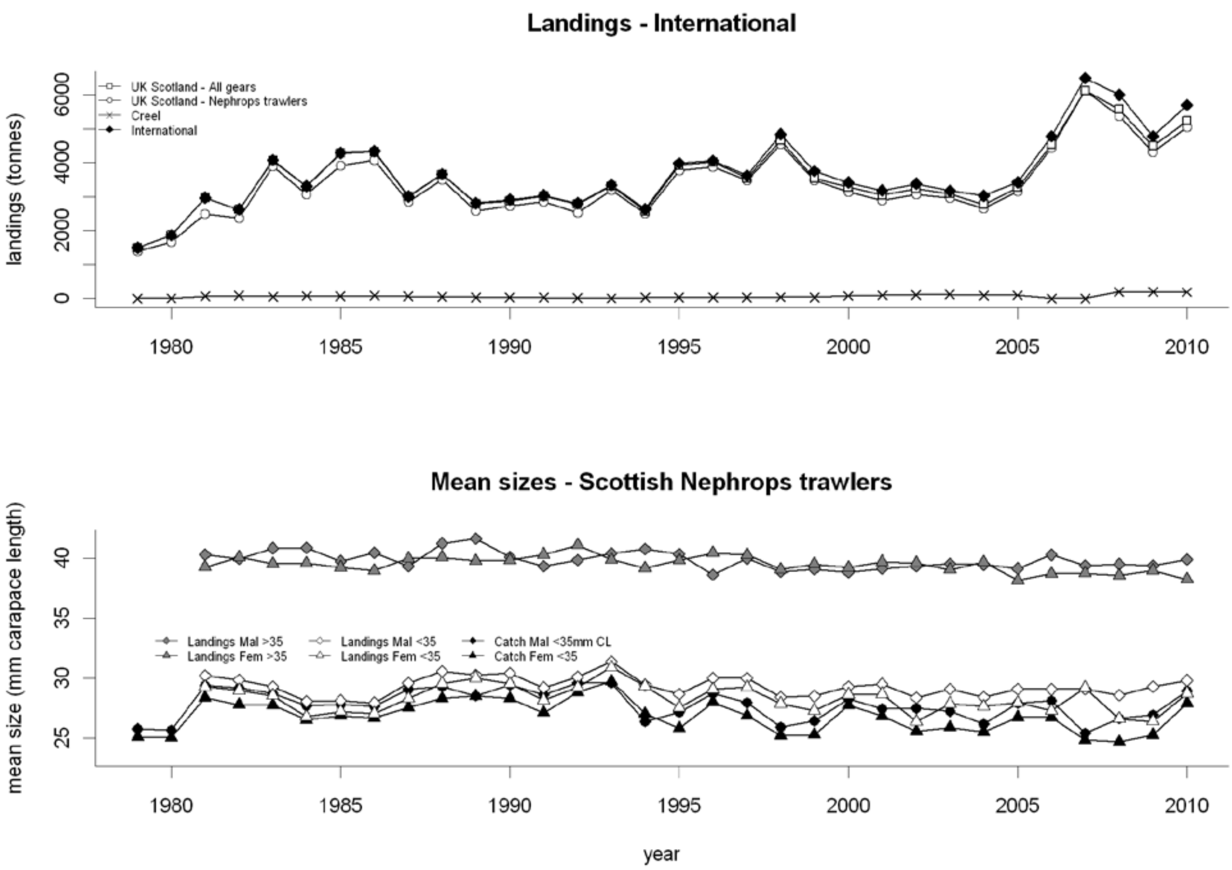


**Figure 3.7.1.** ***Nephrops*, Clyde (FU13): Long-term landings, and mean sizes (Firth of Clyde subarea only).**

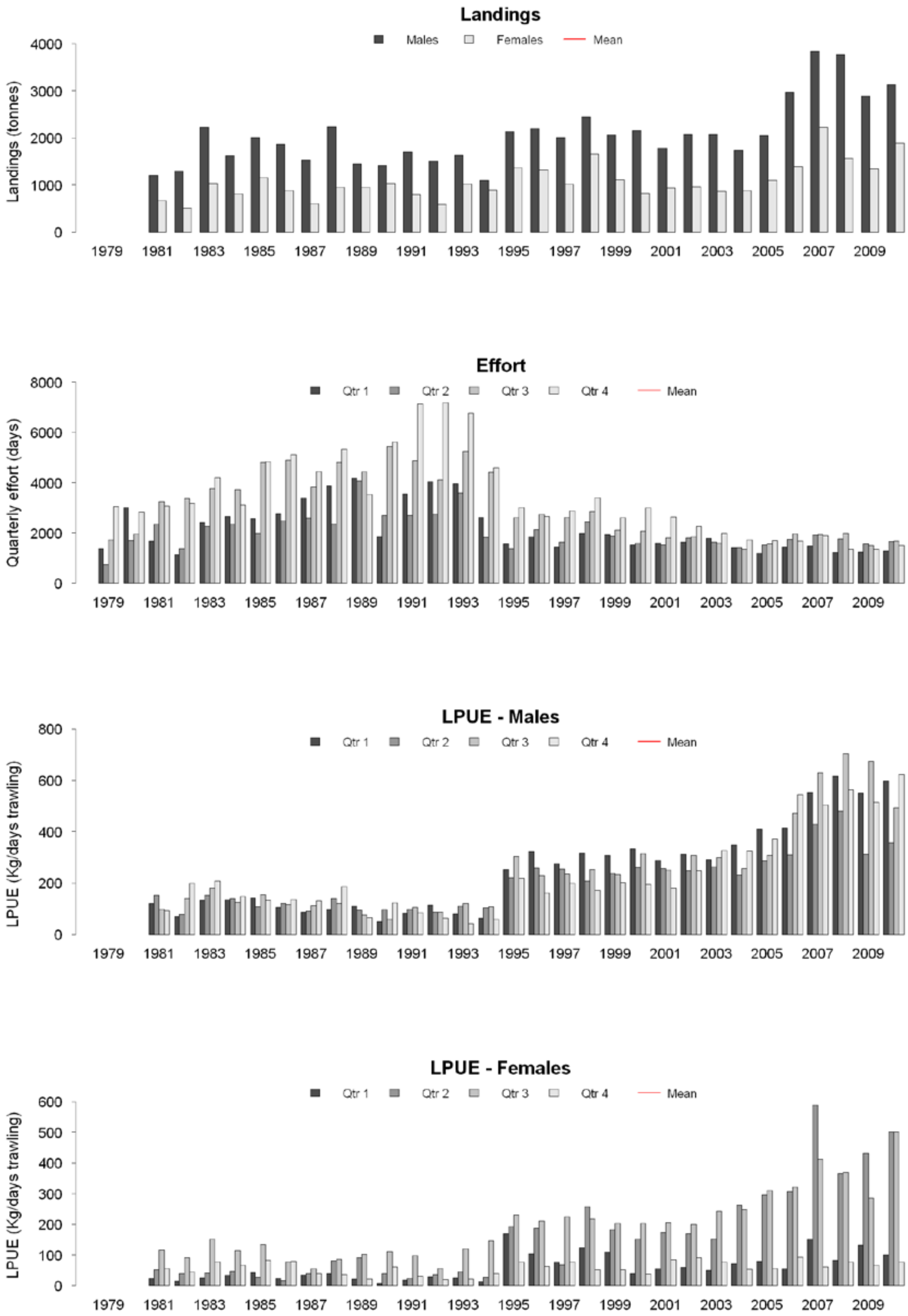


**Figure 3.7.2.** ***Nephrops*, Clyde (FU13), Firth of Clyde subarea, Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers. The marked discontinuity in effort around 1995 is related with the process of recording days effort in the split rectangle region of the Clyde which changed at that time.**

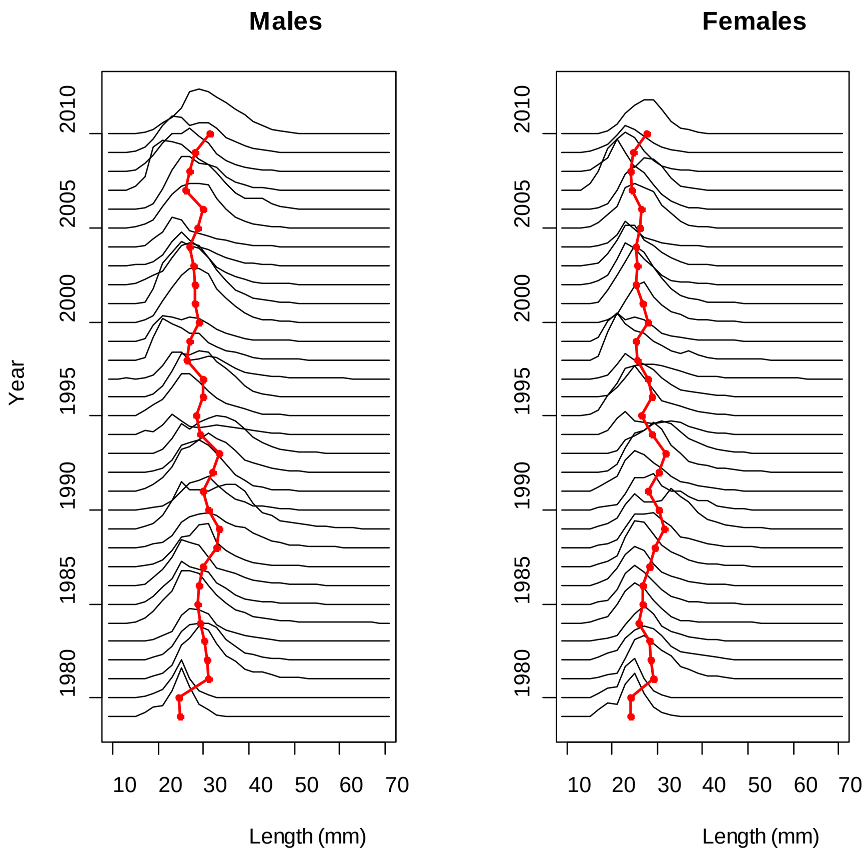


**Figure 3.7.3.** ***Nephrops,*** **Clyde (FU13), Catch length frequency distribution and mean sizes (red line) for** ***Nephrops*** **in the Firth of Clyde, 1979–2010.**

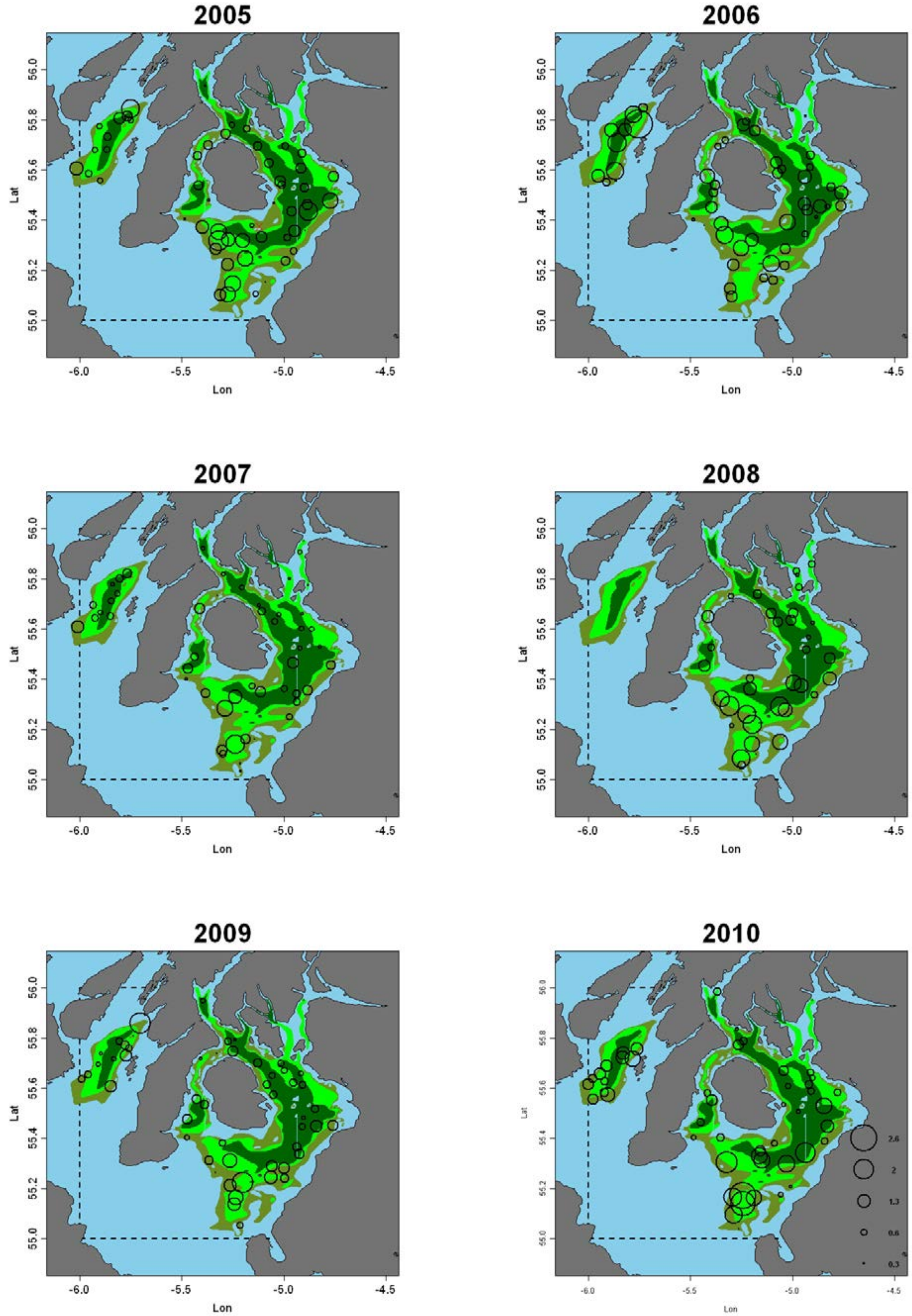


**Figure 3.7.4.** ***Nephrops*****, Clyde (FU13), TV survey station distribution and relative density (burrows/m$^2$) for Firth of Clyde and Sound of Jura subareas, 2005–2010. Sound of Jura located to the east. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same. Red crosses represent zero observations.**

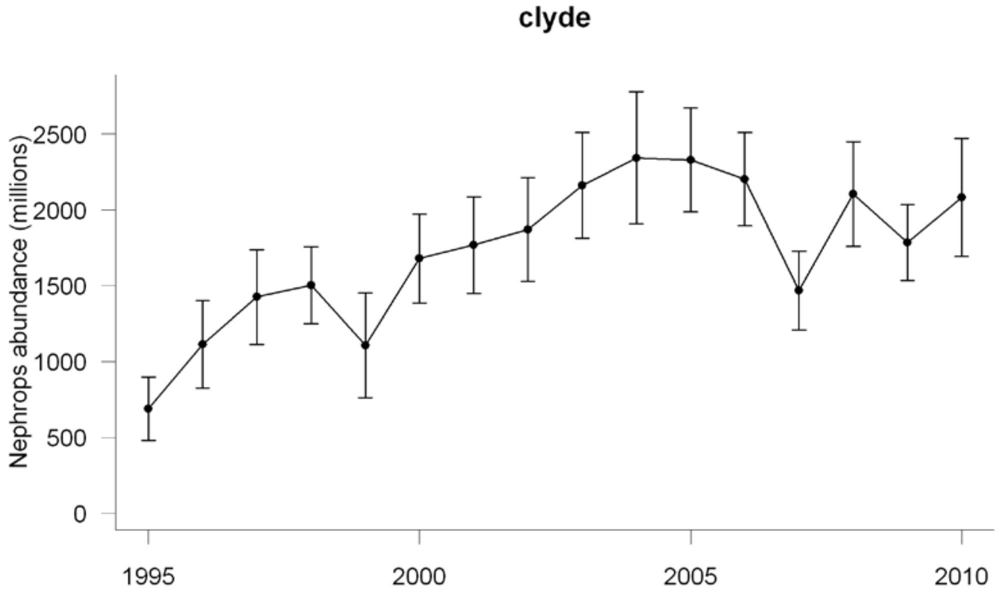


**Figure 3.7.5.** ***Nephrops*, Clyde (FU13): Firth of Clyde subarea. Time-series of revised TV survey abundance estimates (not adjusted for bias), with 95% confidence intervals, 1995–2010.**

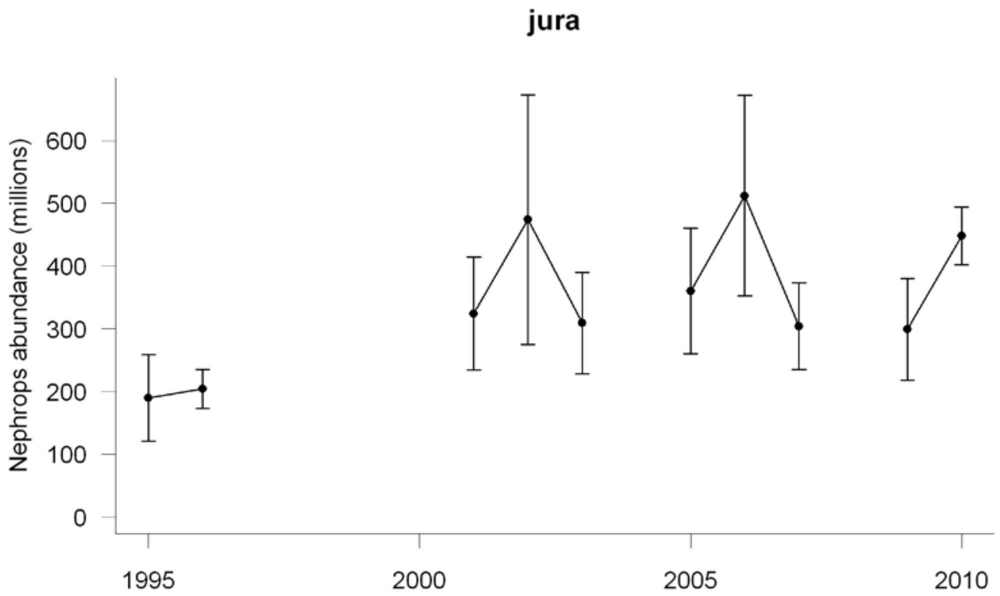


**Figure 3.7.6.** ***Nephrops*, Clyde (FU13): Sound of Jura subarea, Time-series of TV survey abundance estimates with 95% confidence intervals, 1995–2010.**

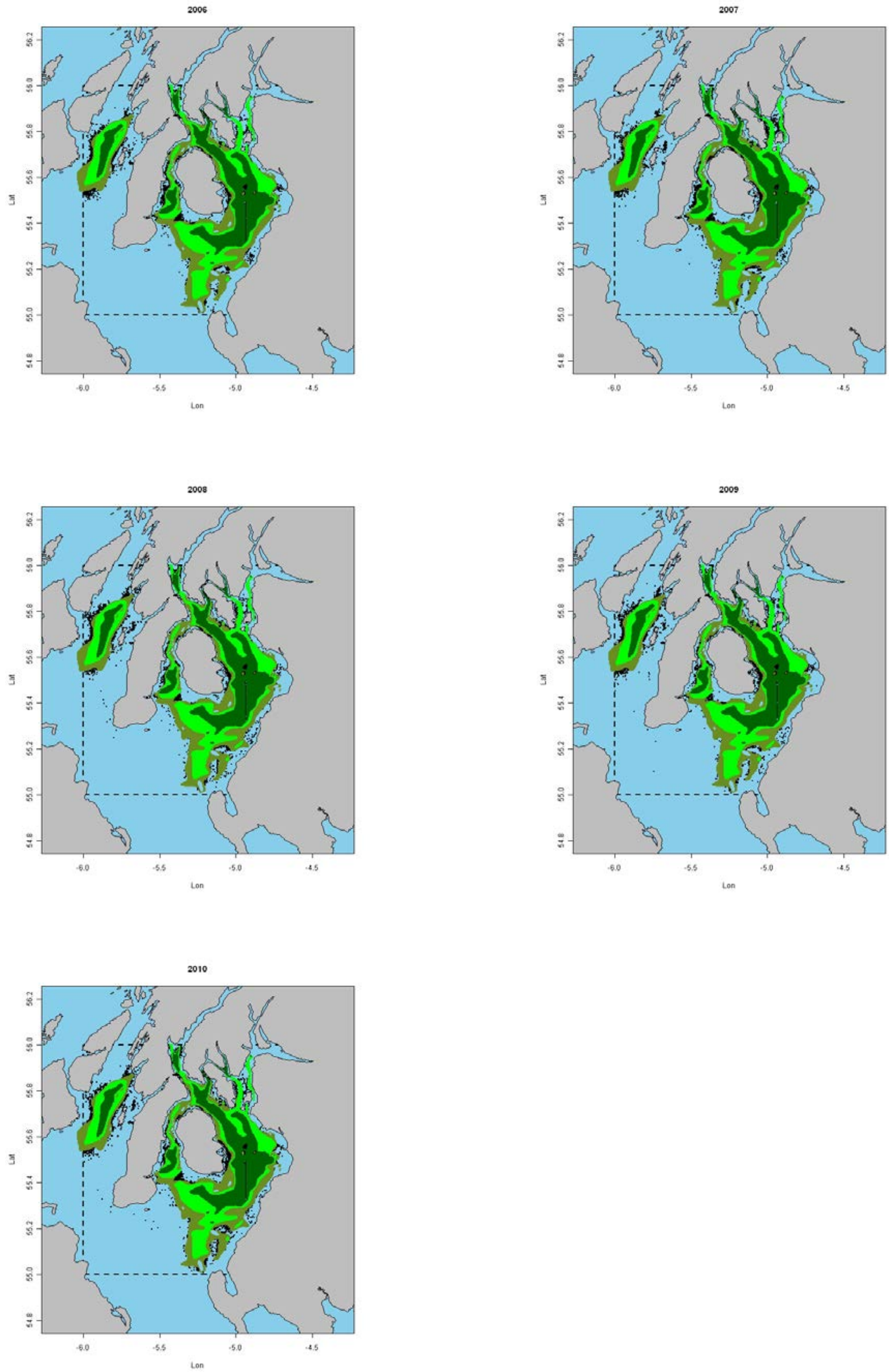


**Figure 3.7.7.** ***Nephrops*, Clyde (FU13), comparison of area of *Nephrops* ground defined by BGS sediment distribution (green shaded overlay) and by distribution of VMS pings (shown by black dots, underlay) recorded from *Nephrops* trawlers >15 m length for 2006–2010. VMS data filtered to exclude vessel speeds >4.5 knots.**

## 4.2 Cod in Division VIb

Officially reported catches are shown in Table 4.2.1 and Figure 4.2.1. Lpue results from the Irish and Scottish otter trawl fleet are presented in Figures 4.2.2 and 4.2.3. Figure 4.2.2 shows a large decline in lpue between 1995 and 2003 followed by relatively stable values at a level much lower than at the start of the time-series. Scottish hours fished data is not mandatory and incomplete. Scottish otter trawl fleet data is therefore in units of kg/kWday. The Scottish series is too short to draw firm conclusions about trends. However, both series show a fall in lpue in 2010 relative to previous years. No analytical assessment of this stock has been carried out.

**Table 4.2.1. Cod in Division VIb (Rockall). Official catch statistics.**

| Country | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Faroe Islands | 18 | - | 1 | - | 31 | 5 | - | - | - | 1 | - | - |
| France | 9 | 17 | 5 | 7 | 2 | - | - | - | - | - | - | - |
| Germany | - | 3 | - | - | 3 | - | - | 126 | 2 | - | - | - |
| Ireland | - | - | - | - | - | - | 400 | 236 | 235 | 472 | 280 | 477 |
| Norway | 373 | 202 | 95 | 130 | 195 | 148 | 119 | 312 | 199 | 199 | 120 | 92 |
| Portugal | - | - | - | - | - | - | - | - | - | - | - | - |
| Russia | - | - | - | - | - | - | - | - | - | - | - | - |
| Spain | 241 | 1200 | 1219 | 808 | 1345 | - | 64 | 70 | - | - | - | 2 |
| UK (E. & W. & N.I.) | 161 | 114 | 93 | 69 | 56 | 131 | 8 | 23 | 26 | 103 | 25 | 90 |
| UK (Scotland) | 221 | 437 | 187 | 284 | 254 | 265 | 758 | 829 | 714 | 322 | 236 | 370 |
| Total | 1,023 | 1,973 | 1,600 | 1,298 | 1,886 | 549 | 1,349 | 1,596 | 1,176 | 1,097 | 661 | 1,031 |

| Country | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Faroe Islands | - | - | - | - | n/a | n/a | n/a | | | | |
| France | - | - | - | - | + | +* | 1 | | | 0.08 | |
| Germany | 10 | 22 | 3 | 11 | 1 | - | - | | | | |
| Ireland | 436 | 153 | 227 | 148 | 119 | 40 | 18 | 11 | 7 | 12 | 22.7 |
| Norway | 91 | 55* | 51* | 85* | 152* | 89 | 28 | 25 | 23 | 7 | 7 |
| Portugal | - | 5 | - | - | - | - | - | | | | |
| Russia | - | - | - | - | 7 | 26 | - | | | | |
| Spain | 5 | 1 | 6 | 4 | 3 | 1 | | 6 | | | |
| UK (E. & W. & N.I.) | 23 | 20 | 32 | 22 | 4 | 2 | 2 | 3 | | | |
| UK (Scotland) | 210 | 706 | 341 | 389 | 286 | 176 | 67 | 57 | 45 | 43 | |
| UK | | | | | | | | | | | 28.7 |
| Total | 775 | 962 | 660 | 659 | 572 | 334 | 115 | 102 | 75 | 62 | 58.4 |

| Country | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|
| Faroe Islands | - | | 3 | 4.9 |
| France | - | | | 0 |
| Germany | - | | | |
| Ireland | 24 | 40.7 | 20.4 | 6.4 |
| Norway | 12 | 14 | 25 | 27.2 |
| Portugal | - | | | |
| Russia | - | | 1 | |
| Spain | - | | | |
| UK (E. & W. & N.I.) | | | | |
| UK (Scotland) | 26 | 41.3 | 47.8 | |
| UK | | | | 22.7 |
| Total | 62 | 96.0 | 97.2 | 61.2 |

*** Preliminary**

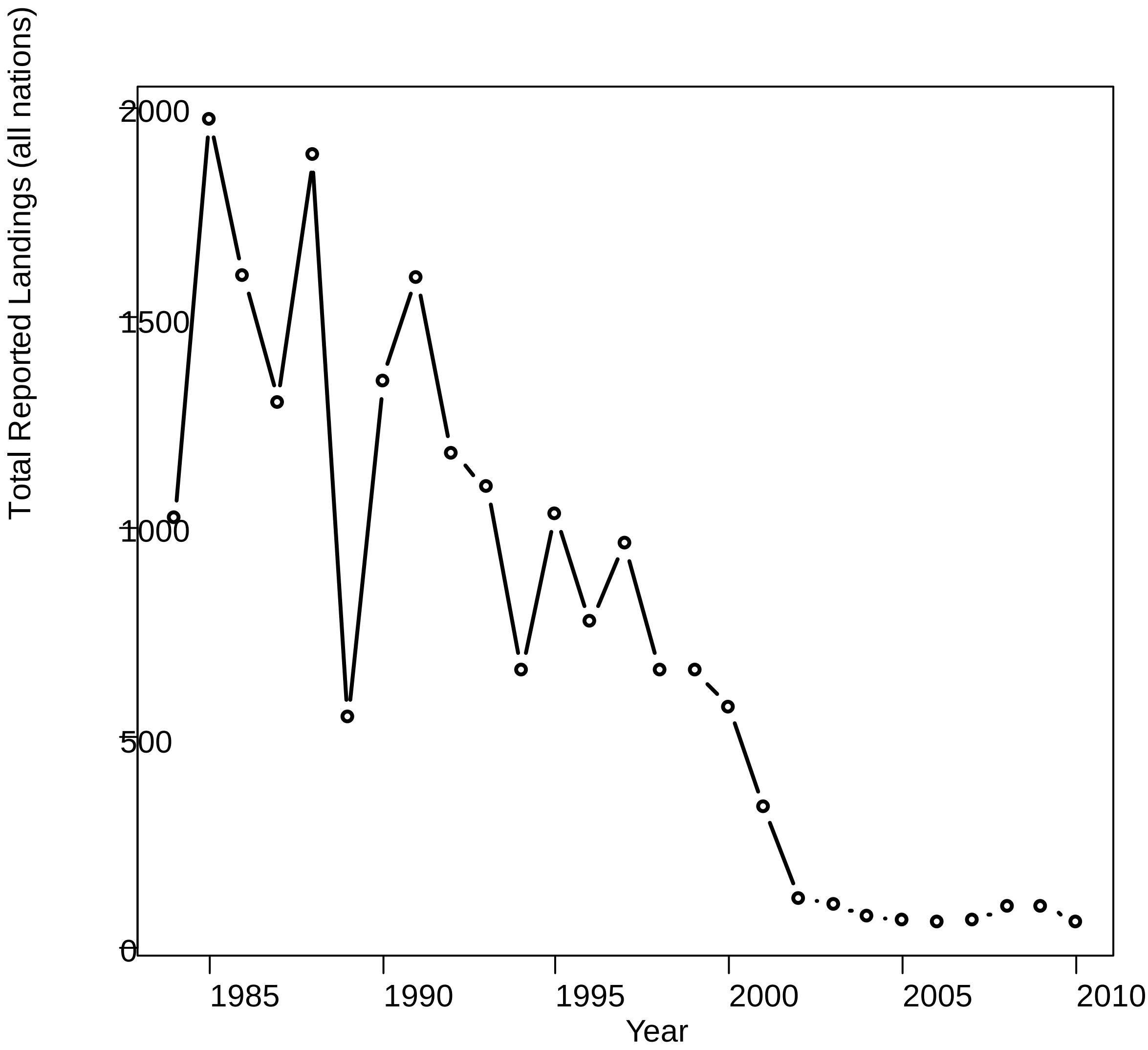


**Figure 4.2.1. Cod in Division VIb. Total of official catch (all nations combined), 1984–2010. Values for 2010 are provisional.**

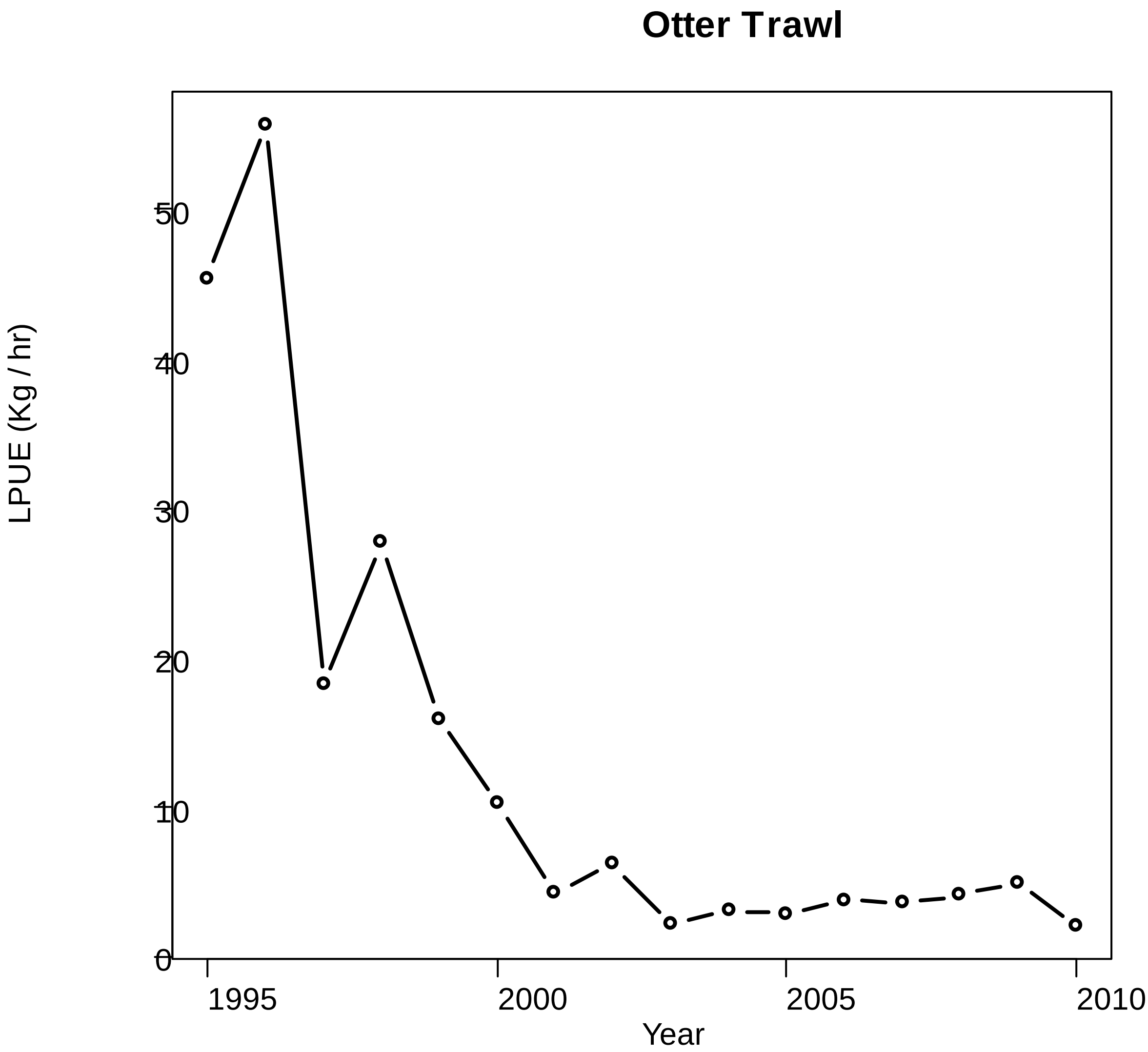


**Figure 4.2.2. Cod in Division VIb. Lpue (kg/hr) from Irish Otter trawl fleet, 1995–2010.**

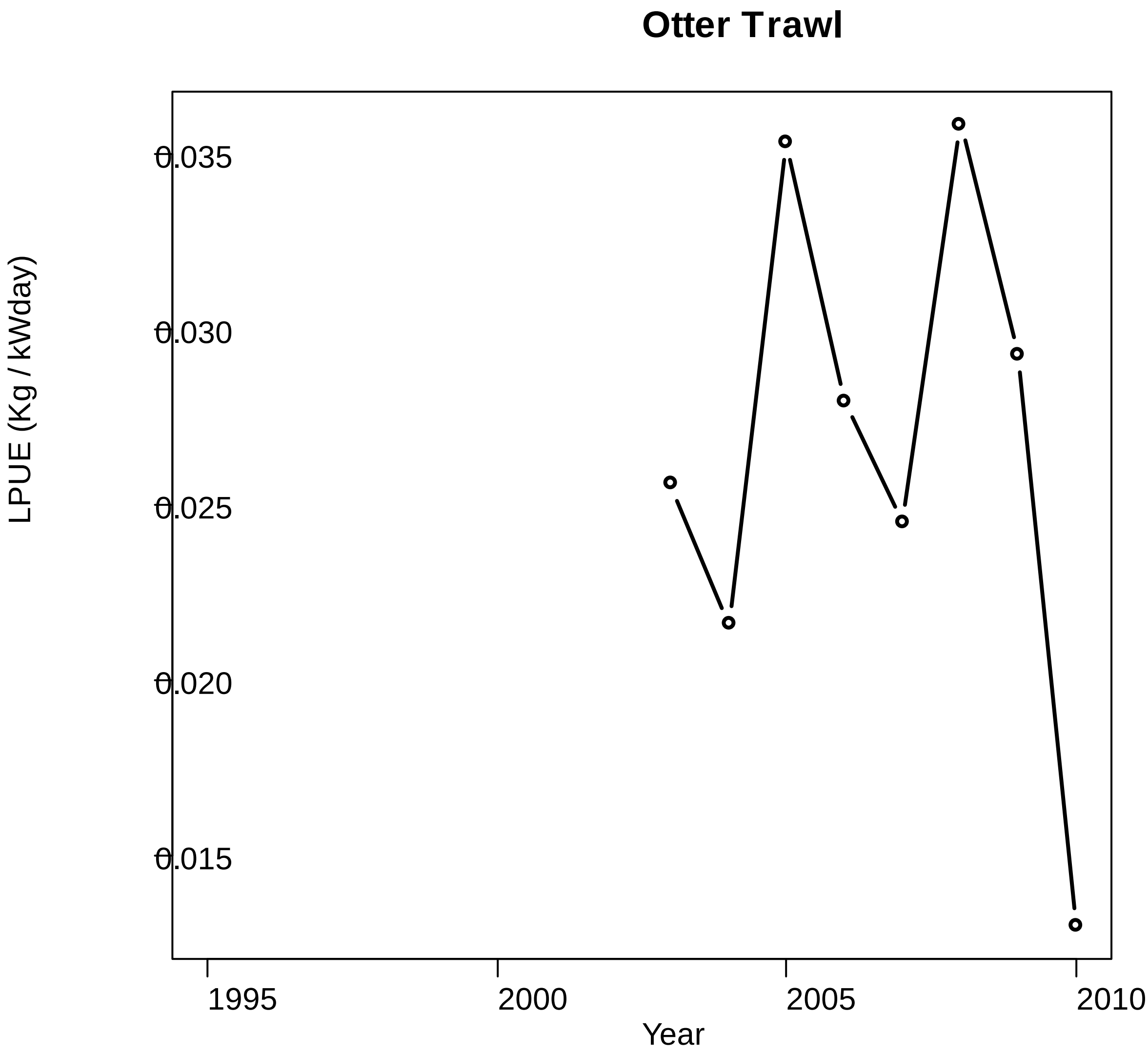


**Figure 4.2.3. Cod in Division VIb. Lpue (Kg/kWday) from Scottish Otter trawl fleet, 2003–2010.**

## 4.3 Haddock in Division VIb (Rockall)

### Type of assessment in 2011: Update assessment

The assessment of the haddock stock in Division VIb is based on catch-at-age and one survey index (Scottish Rock-IBTS-Q3) and conducted using the XSA method. Discarding occurs in part of the fishery. Discards have been estimated and used in the assessment. In 2005, WGNSDS, on the recommendation of RGNSDS, adopted a new assessment approach, which allows modelling of the total catch (including discards) of the Irish, Scottish and Russian fleets (for details see Stock Annex). The same approach has been used in the annual assessment since 2005. The current assessment is an update of the last year assessment.

### ICES advice applicable to 2010

The ICES advice for 2010 in terms of single-stock exploitation boundaries was as follows:

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects.

*"Fishing mortality around $F_{0.1}$ (0.18) can be considered as a candidate target reference point consistent with taking high long-term yields and achieving a low risk of depleting the productive potential (<5%). The present fishing mortality (0.23) is above the candidate reference point and below $F_{pa}$."*

Exploitation boundaries in relation to precautionary limits.

*"Fishing mortality should be less than $F_{pa}$, corresponding to total catches less than 7090 t in 2010. Assuming that current discarding practices will be continued, landings should be less than 5480 t in 2010."*

*Considering the option below ICES advises that there is little gain on the long-term yield by increasing fishing mortality above current levels. ICES therefore recommends limiting catches and landings in 2010 to 4280 t and 3330 t, respectively.*

### ICES advice applicable to 2011

The ICES advice for 2011 in terms of exploitation boundaries was as follows:

#### *"MSY approach*

*Following the ICES MSY framework implies fishing mortality to be reduced to 0.3 (= $F_{MSY}$), resulting in landings of less than 2700 t in 2011. This is expected to lead to an SSB of 8540 t in 2012.*

*Because F in 2010 is very close to $F_{MSY}$, no transition scheme is necessary.*

*Further management measures should be introduced to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB.*

#### *PA approach*

*A 26% reduction in F is needed to keep SSB to above $B_{pa}$ in 2012. This corresponds to landings of 2350 t in 2011."*

### 4.3.1 General

#### Stock description and management units

The haddock stock at Rockall is an entirely separate stock from that on the continental shelf of the British Isles. Since 2004, the EU TAC for haddock in VIb has been included with Divisions XII and XIV. For details of the earlier management units see Stock Annex.

#### Management applicable to 2010 and 2011

The EU TAC for 2010 was set at 4997 t (a 15% reduction compared to TAC for 2009) and is shown below:

| Species: | Haddock *Melanogrammus aeglefinus* | Zone: | EU and international waters VIb, XII and XIV (HAD/6B1214) |
|---|---|---|---|
| Belgium | 11 | | |
| Germany | 13 | | |
| France | 551 | | |
| Ireland | 393 | | |
| United Kingdom | 4 029 | | |
| EU | 4 997 | | |
| TAC | 4 997 | | Analytical TAC |

The EU TAC for VIb, XII and XIV was set at 3748 t in 2011 (a 25% reduction compared to TAC for 2010).

The ICES advice, agreed TAC for EU waters, and WG estimates of landings during 2002–2011 are summarized below. All values are in tonnes.

| YEAR | CATCHES CORRESPONDING TO ICES ADVICE (VIB) | BASIS | AGREED TAC | WG LANDINGS |
|---|---|---|---|---|
| 2002 | < 1300 | Reduce F below 0.2 | 1300[a] | 3336 |
| 2003 | - | Lowest possible F | 702[a] | 6242 |
| 2004 | - | Lowest possible F | 702[b] | 6445 |
| 2005 | - | Lowest possible F | 702[b] | 5179 |
| 2006 | - | Lowest possible F | 597[b] | 2765 |
| 2007 | <7100 | Reduce F below $F_{pa}$ | 4615[b] | 3349 |
| 2008 | <10 640[c] | Keep F below $F_{pa}$ | 6916[b] | 4221 |
| 2009 | <4300[d] | No long-term gains in increasing F | 5879[b] | 3814 |
| 2010 | <3300[d] | Little gain on the long-term yield by increasing F | 4997 | 3405 |
| 2011 | <2700[d] | Reduction in F is needed to keep SSB to above $B_{pa}$ in 2012 | 3748 | |

**[a] TAC was set for Divisions VIa and VIb (plus Vb1, XII and XIV) combined with restrictions on quantity that can be taken in Vb and VIa. The quantity shown here is the total area TAC minus the maximum amount which is allowed to be taken from Vb and VIa.**

**[b] In 2004, the EU TAC for Division VI was split and the VIb TAC for haddock was included with XII and XIV. This value is the TAC for VIb, XII and XIV.**

**[c] Total catch, including landings and discards.**

**[d] Only landings.**

The minimum landing size of haddock taken by EU vessels at Rockall is 30 cm. There is no minimum landing size for haddock taken by non-EU vessels in international waters.

In order to protect the prerecruit stock, the International Waters component of the statistical rectangle 42D5 has been closed for fishing since 2001 and its EU component, since 2002 (see Stock Annex). The protected area (the whole rectangle) is referred to as Rockall Haddock Box. In order to protect cold-water corals, three further areas (Northwest Rockall, Logachev Mounds and West Rockall Mounds) were closed since January 2007 (see Stock Annex). A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007.

### Fishery in 2010

Nominal landings for 2010 and previous years as reported to ICES are given in Table 4.3.1.

#### *Russian fishery in 2010*

In 2010, Russian haddock fishery on the Rockall Bank was conducted by one Russian trawler. The vessel operated in March–April during six fishing days (Table 4.3.2) (WD15, WGCSE 2011). The total Russian catch at the bottom fishery amounted to 201 t, including 198 t of haddock.

#### *Scottish fishery in 2010*

The number of Scottish vessels fishing for haddock and the number of trips made to Rockall declined substantially from 2000 onwards (WD6, WGNSDS 2004). The declining trend was reversed in 2007. The number of vessels in increased from 22 in 2007 to 28 in 2008, and 37 in 2009.

Total Scottish demersal landings in VIb in 2009 are estimated to be 4585 t, of which 2951 t were haddock. The landings of haddock in 2010 amounted to 2931 t (Tables 4.3.1, 4.3.3). Other important target species included anglerfish (*Lophius* spp.), saithe, ling and megrim.

The UK landings and effort data included only Scottish vessels in 2010.

#### *Irish fishery in 2010*

Landings totalling 169 t were reported from Irish otter trawlers in 2010 (over a twofold decrease from 721 t in 2008; Table 4.3.1).

#### *Norwegian fishery in 2010*

In 2010 the Norwegian demersal fleet fishing on the Rockall Bank consisted mainly of longliners and targeted mainly ling and tusk. Total Norwegian landings of haddock at Rockall in 2010 were 65 t. All catch of haddock was taken in March and May–November.

In 2009, Norwegian landings of haddock amounted to 71 t which was a twofold increase compared to 2008, and was within the catch range for the periods 2001–2005 and 2007–2009 (32–84 t).

### 4.3.2 Data

#### Landings

Nominal landings as reported to ICES are given in Table 4.3.1, along with Working Group estimates of total estimated landings. Reported international landings of Rockall haddock in 1991–2005 varied between 4000 and 6000 t, except for 2001–2002, when they decreased down to about 2300–3000 t. In 2006, they were also low at 2760 t, but increased to 3348 t in 2007 and 4221 t in 2008. In 2010, international landings decreased to 3405 t.

Revisions to official catch statistics for previous years are also shown in Table 4.3.1.

Anecdotal evidence suggests that misreporting of haddock from Rockall have occurred historically (which may have led to discrepancies in assessment), but a quantitative estimation of the degree of misreporting is not possible.

Age composition and mean weight-at-age of Scottish and Irish landings were obtained from port sampling.

Age composition and mean weight-at-age of Russian landings were obtained by observers on board commercial fishing vessels. In 2002 and 2009, there was no sampling of the Russian catch and therefore the length composition for that year had to be estimated (for estimation details, see Stock Annex). The age composition in the Russian catch in 2009 was assumed to be the same as in the Scottish catches including discards.

Observer data from commercial vessels are also available for Norwegian landings for 2006–2010.

#### Discards

Discarding by EC fleets is significant and therefore the assessment of the stock is done based on the total catch (landings+discards). On Russian vessels, the whole catch of haddock is kept on board and therefore, total catch is equivalent to landings.

Haddock discards on board Scottish and Irish vessels were in some years determined directly, while in other years, indirect estimates of discards were done (for details of the estimation of discards see Stock Annex).

The analysis of the discard data collected by Scottish scientists in 1999 and 2001 indicated that only a relatively small proportion of fish taken aboard is landed (Figure 4.3.1). The direct estimates from the Scottish trawlers in 1985, 1999 and 2001 showed a larger proportion of discards of small haddock: from 12 to 75% by weight (Table 4.3.4) and up to 80–90% of catch abundance. Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels is variable with a mean rate of 30% (Table 4.3.5).

Discard data were also obtained by Irish scientists from discard trips in 2007–2009. They showed that 52, 87 and 63% of the catch in numbers, respectively, was discarded. The range of discarded sizes was 19–43 cm (mean 30 cm) (Table 4.3.6). It should be noted that these estimates are based on very few trips (one, two and three for 2007, 2008 and 2009 respectively) and should therefore be treated with caution.

The proportion of fish discarded from Scottish and Irish catches at different sizes may be determined and modelled using a logistic curve. Calculations where the discard curve was applied agree well with the results of size composition measurements from

Scottish vessels in 1999 and 2001 and from the combined 1995–2002 Irish discard trips (see Stock Annex).

Russian vessels retain all haddock and therefore there is no need to calculate discards (see Stock Annex).

For estimation of the discards in 2010, no on-board observations for Scottish and Irish fleets were available, and it was not possible to use the logistic selectivity curve to the haddock stock length composition obtained from the survey (see stock annex), since no survey was carried out in 2010. The discards were therefore estimated using the mean proportion of discards/landings at age over the period 1999–2009. As the recent recruitments are weak and the landings mainly composed of age 5, the resulting overall discards rate is estimated to be one of the lowest in the time-series.

#### Biological

There was no change in biological parameters compared to the 2010 assessment (see Stock Annex).

#### Surveys

There is only one abundance index available for VPA assessment of this stock from the Scottish survey (Figure 4.3.2). The survey is conducted in about 40 standard trawl stations. However, the survey area varied along with the number of stations in different years and survey covers only part of the currently known distribution area of haddock (see Stock Annex).

The distribution of sampling stations has slightly varied over time. (Figure 4.3.2). The stations located in the southwest were not sampled every year and area that was covered by survey considerably differed in same years. Survey data were standardized for exploratory runs in 2009–2010. The stations which were located in the southwest were excluded from calculation. VPA in 2011 was run with the non-standardized indices, i.e. same indices as last year for final run (Table 4.3.7). The indices for 2010 are missing, since the Scottish survey did not occur in 2010 due to a technical problem on the vessel.

The Russian trawl-acoustic survey conducted in 2005 provided information on the stock size and biomass of the haddock stock, both in the EU zone and in international waters. The acoustic survey yielded a biomass estimate of 60 000 t and an abundance estimate of 225.9 million (for the details see Stock Annex). No such survey has been conducted in subsequent years. In 2010 the Russian survey covered only small part of Rockall bank.

#### Commercial cpue

Commercial cpue series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in Division VIb. The effort data for these five fleets are shown in Figure 4.3.3 and Table 4.3.8. Commercial cpue series for the different fleets are shown in Figure 4.3.4.

In 2005–2009, the Russian effort in bottom fishery (in hours and number of vessels/days) decreased due to economic reasons (Figure 4.3.4). Haddock catches varied accordingly with the changes in fishing effort. In 2006–2007, cpue in the Russian haddock fishery (mainly with trawlers of tonnage class 10) increased compared to previous years. In 2008–2009, it slightly decreased (with trawlers of class 8 and 9 only). The dynamics of catch per unit of effort for vessels agrees of tonnage class 10 agreed well with year-to-year variations in total biomass of haddock (Figure 4.3.5).

The effort data from the Scottish fleets are known to be unreliable due to changes in the practices of effort recording and non-mandatory effort reporting (see the report of WGNSSK 2000, CM 2001/ACFM:07, for further details). It is unknown what proportion of Scottish and Irish effort was applied directly to the haddock fishery. The apparent effort increase may just be the result of more exact reporting of effort due to VMS, but another suggestion is that it arises from restrictive 'days at sea' in other areas (VIa and IV). Working at Rockall keeps 'days at sea' elsewhere intact (the years in question do correspond to the introduction of the days at sea legislation) and it is possible that vessels are either working extra days in VIb or they are simply reporting extra days from VIb. Despite the uncertainty about the fishing effort, the lpue for the Scottish fleet increased considerably in 2007 and 2008 compared to previous years (Figure 4.3.4). The effort information for 2010 was considered inconsistent with previous years, and thus not presented here.

The Irish otter trawl effort series indicated low values between 2002 and 2005 with the lowest value in 2004. In 2006–2008, the effort increased considerably, but declined in 2009 and 2010 (Figure 4.3.3). The lpue showed an increase in 2007–2009 (Figure 4.3.4).

The WG decided that the commercial cpue and lpue data, which do not include discards and have not been corrected for changes in fishing power despite known changes in vessel size, engine power, fish-finding technology and net design, were unsuitable for catch-at-age tuning.

#### Other relevant data

The Irish Fisheries Board (BIM) and the Marine Institute recently conducted a collaborative series of surveys to assess the length structure of haddock at various locations on the Rockall Bank and tested the selectivity of a number of codend configurations, which are typically used by the Irish fleets.

The selectivity of gears with different mesh sizes was also investigated at Rockall by Russian scientists in 2010.

### 4.3.3 Historical stock development

Model used:

The assessment is based on catch-at-age data and one survey index (Scottish Groundfish Survey) and conducted using the XSA method.

Software used:

The same software was used as in the last year's assessment (XSA from Lowestoft suite of VPA programs).

Model Options chosen:

Settings for the final XSA assessment did not change compared to the previous assessment (see Stock Annex) and were as follows:

Assessment model: XSA

Tuning indices: one survey index (SCOGFS)

Time-series weights: none

Catchability dependent for ages <4

Regression type: C

Q plateau: 5

Shrinkage stand. error: 1.0

Shrinkage age-year: 4 years, 3 ages

Minimum stand. error: 0.3

Plus group: 7+

$F_{bar}$: 2–5

Input data types and characteristics:

There were no changes in data types and characteristics compared to the previous assessment:

Year range: 1991–2010

Age range: 1–7+

For tuning data the following year and age ranges were used:

Year range: 1991–2009

Age range: 1–6

#### Data screening

Figures 4.3.6 and 4.3.7 and Table 4.3.9 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.3.10–4.3.12.

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.3.13–4.3.16. The mean weights-at-age in the stock are assumed to be the same as the catch weights. The temporal dynamics of haddock mean weights-at-age in the total catch (including discards) are shown in Figure 4.3.8. Mean weights-at-age 6 and 7+ in total catch were higher in 2010 compared to 2006–2009 (Figure 4.3.8). This increase was observed in the Scottish landings and in the Russian catches.

Mean weights-at-age 6 and 7+ for 2010 has been recalculated using linear regression by analogy with haddock VIa. The mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.3.9.

There were small landings of haddock aged 1 in 2010 and very few aged 2 to 4 compared to historical values. Discarded fish are, primarily, haddock aged 1–2 (see Tables 4.3.1 and 4.3.2 in Stock Annex). Figures of log catch by age show that these values are much less variable when discards are included (Figures 4.3.10–4.3.15). Data on catches, landings and discards-at-age are given in Tables 4.3.10–4.3.12.

The Scottish trawl survey was the only survey index available to the working group. Plots of log cpue by age, year and year class are shown in Figures 4.3.16–4.3.18.

A SURBA 3.0 run was carried out to analyse the survey data. Previous working groups have concluded that the first three years of the survey should not be used in assessments and that age 0 data were a poor indicator of year-class strength. Here, the runs were actually conducted using the survey data from 1991 onwards to be consistent with the period over which the catch-at-age assessment could be run (the settings: lambda = 1.0, reference age = 3). A summary of the results are shown in

Figure 4.3.19. SSB shows a declining trend from 1995, an increase in 2003–2004 and a general decrease in the subsequent years. The estimates of the temporal component of F are very noisy, but indicate a steep decline since 2000. Retrospective analysis showed consistent estimation of SSB and F (2–5) (Figure 4.3.19a).

Comparative scatterplots of log index at age are shown in Figure 4.3.19b. The survey shows relatively good internal consistency in tracking year-class strength through time.

#### Final update assessment

##### *Final run*

In the final run 2011, not standardized indices were used as last year final run. The diagnostics file of the final XSA run is given in Table 4.3.17. Adjusted survey cpue against XSA population estimates are shown in Figures 4.3.22-4.3.23. The analysis of residuals and retrospective analysis (Figures 4.3.20, 4.3.21, 4.3.24) shows that applying the chosen parameters for XSA (as done in 2005–2009 assessments) improves the residual patterns compared to other exploratory settings. However, there are still same trends apparent in the log-catchability residuals. The results of the retrospective analysis conducted by the Working Group in 2002 and 2003 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. In this year's analysis, only 18 years' data were available for the retrospective analysis, but a good year-to-year consistency was obtained. Dynamics of fishing mortality-at-age are presented in Figure 4.3.25. The final XSA results are given in Tables 4.3.18–4.3.20. The final XSA and SURBA results are compared in Figure 4.3.26. The SURBA estimates are more variable, but there is a good overall consistency between estimates by the two methods.

Summary plots from the final XSA assessment are shown in Figure 4.3.27.

##### *Comparison with previous assessments*

XSA was conducted with the same basic assumptions and setup as last year's assessment. Perceptions of the stock have not changed. Figure 4.3.28 shows, for comparison, SSB, recruitment-at-age 1 and mean F (2–5) estimates in the present assessment and assessments going back to 2001. The estimates from this year's assessment are reasonably consistent with the assessments carried out in previous years (Figure 4.3.28).

##### *State of the stock*

Spawning biomass has generally increased in recent years as a result of the 2001 and 2005 year classes. SSB has been above $B_{pa}$ since 2003. But SSB reduced in 2009–2010. Fishing mortality was above $F_{pa}$ throughout most of the time-series but declined in 2005 and has remained below $F_{pa}$ since then. Recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below $B_{pa}$ in 2013.

##### *Statistical catch-at-age analysis (SCAA)*

For Statistical catch-at-age analysis, StatCam model was used (J. Brodziak, 2005). VPA and SCAA used identical survey and catch data. For StatCam runs two scenarios were used. First scenario, non-parametric model; second, parametric model.

StatCam model shows good conformity between observed and predicted survey index and catch biomass. Log residuals were less 0.4 for total survey index (Figures 4.3.29–4.3.30).

StatCam summary plots are shown in Figure 4.3.31.

Both Statistical catch-at-age analysis and VPA results show a similar tendency for the SSB dynamics. However, the assessment of the stock size depends on the choice of the model. SSB and TSB plots from the XSA and SCAA assessment are compared in Figure 4.3.32.

### 4.3.4 Short-term projections

*Estimating year-class abundance*

The abundance index for age 0 in the 2009 survey was low (Figure 4.3.33) and the recruitment (age 1) in 2010 by VPA was very poor (242 thousands). Given that no survey took place in 2010 and that the information on catches of age 1 in 2010 were quasi absent (Tables 4.3.10, 4.3.11 and 4.3.12), the only information on the **2009 year-class** strength available to the group was the survey estimate at age 0 in 2009. Therefore, the WG, comforted by the good correlation between VPA estimates for age 1 with age 0 indices over most of the time-series (from 1993 onwards, Figure 4.3.34), estimated year class 2009 using RCT3 regression (Shepherd, 1997) relating survey indices to stock abundance. The input and output RCT3 files are presented Tables 4.3.21 and 4.3.22..It was not considered reliable to use RCT3, as stipulated in the stock annex, for estimating the year class 2010, since the survey used in the modelling of the recruitment for the following year was not carried out in 2010. The recruitments in recent years are estimated to be extremely weak and this would not be translated with the use of geometric mean for forecasting recruitment. The recruitment estimates determined by this method would be higher than the actual total number in the stock.

For forecasting recruitment (age 1) in 2011 and thereafter, the WG recommended using the 25th percentile over the whole time-series.

Many definitions of how to compute the percentile may be found in the literature. The WG chose the simple rounding of the result to the nearest integer and taking the value that correspond to that rank of percentile. The rank of percentile was determined by the following equation:

$$n = \frac{P}{100} * N + \frac{1}{2}$$

P being the percentile value (here P=25), and N the length of the time-series (here N=19). The rank of 25-thpercentile for the recruitment is then 5. The 5th lowest value of the time-series corresponds to a value in 2007 (18 353 thousands).

The input data for the short-term forecast can be found in Table 4.3.23. *Status quo* fishing mortality is taken as a 3-year mean of the values over the period 2008–2010. Three year mean values were also used for stock weights and catch weights.

For forecasting discards and landings, the proportion of discards/landings-at-age in 1999–2009 was used, (Tables 4.3.9–4.3.12, Figure 4.3.35). The results obtained from the forecast (including discards) are given in Tables 4.3.23–4.3.25. The short-term forecast is also shown in Figure 4.3.36.

The sensitivity analysis of forecast is shown in Figures 4.3.37. The probability of SSB in 2013 being below $B_{pa}$ is about 50% (Figure 4.3.38).

Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes are shown in Tables 4.3.26.

### 4.3.5 Medium-term projection

Medium-term projections were conducted using the Marlab software. There appears to be little or no relationship between spawning biomass and recruitment levels at age 1 and no attempt to fit a stock–recruitment relationship with these data has been made. Particularly high discard rates result in very poor estimation of both the overall level and the interannual variability of recruitment. Significant year-to-year fluctuations of recruit abundance can be seen, and that the link between adult haddock biomass and abundance of survived fingerlings and yearlings is absent. In the years when biomass is at high levels, poor year classes are often observed. So in 2001, when the stock was low, one of the most abundant year classes appeared. Strong year classes appear on average once every 4–5 years, although the available time-series is relatively short. SSB has been higher than $B_{pa}$ in recent years but recruitment for the last four years has been low which may be a consequence of rising temperature. With $F_{sq} = 0.25$ there is a 60% probability of SSB falling below $B_{pa}$ in the long term (See Figures 4.3.39–4.3.40).

### 4.3.6 Biological reference points

#### Precautionary approach reference points

Biological reference points for this stock are given below:

$B_{lim}$: 6000 t (lowest observed SSB)

$B_{pa}$: 9000 t ($B_{loss}$ × 1.4)

$F_{pa}$: 0.4 (by analogy with other haddock stocks).

Figure 4.3.41 shows the stock in 2009 to be above $B_{pa}$ and below $F_{pa}$.

#### Yield-per-recruit analysis

The stock–recruitment scatterplot is shown in Figure 4.3.42. Yield-per-recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Figure 4.3.43. *Status quo* F (0.25) is approximately 60% lower than $F_{max}$ (0.40) and twice as high as $F_{0.1}$ (0.12).

#### MSY evaluation

MSY estimates were evaluated in 2010 (WGCSE 2010) using the srmsymc ADMB package. The number of stock and recruit pairs for this stock is fairly limited and these also show a relatively wide dynamic range. Given the high CVs on all F parameters the WG concluded that the underlying data did not support the provision of absolute estimates of $F_{MSY}$ but that current F was close to that expected to deliver long-term equilibrium yield.

### 4.3.7 Management plans

There is a need for an internationally agreed management plan. This would require a management strategy evaluation to identify an appropriate $F_{MSY}$ target. Such a plan should involve extensive collaboration between stakeholders, scientists and management authorities in both the design and the monitoring of conservation measures. Management measures in the haddock fishery could be a combined application of TAC and limits of fishing efforts and should include effective control and enforcement measures. It would be beneficial to develop and introduce into fisheries practice measures aimed at minimizing exploitation of juveniles.

In 2008–2009 the Russian Federation and the European Community have had consultations to develop a fisheries management plan. The report of the scientific working group was presented to the Delegations in 2009. It was recognized that the report contained all the relevant available data on the state of the stock and identified the issues, which would require continued cooperation between the Parties both at scientific and management levels.

In 2004, an ICES Expert Group met to deal with a request for advice from the EU and Russia concerning Rockall haddock management plans. They concluded that the lack of alternative assessment approaches precluded the identification of potential alternative limits to exploitation that may be useful to long-term management. In addressing this term of reference the Expert Group considered alternative approaches to management.

A management plan is under development and is currently being evaluated. European Community and Russian Federation have proposed draft plan for harvest control component of a long-term management plan for haddock at Rockall. NEAFC requests ICES to evaluate the proposal for the harvest control component of a long-term management plan for Rockall haddock and in particular to consider whether the plan is consistent with the precautionary approach and will provide for the sustainable harvesting of the stock.

The 2004 Expert Group acknowledged that the Precautionary Approach requires that management be implemented in data poor situations. The Expert Group considered that the principles of the Precautionary Approach may have application to Rockall haddock provided the implementation considers the particular biology of the target species and the way it is exploited. For Rockall haddock the Expert Group considered that the fishing mortality should not be allowed to expand. Adoption of a TAC may actually allow increased fishing mortality if the stock is declining or there is significant unreported catch. Moreover, application of TACs implies that there is a simple relationship between a recorded landing of a species and the effort exerted on that species. Such an assumption is unlikely to be true for Rockall haddock. Furthermore, there are ways of evading TACs including misreporting, highgrading and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. The Expert Group concluded that effort regulation rather than TACs may be a better means of controlling fishing mortality on Rockall haddock in the long term but that TAC regulation could be used in future if more objective and accurate biological and fishery information are routinely provided (ICES CM 2004/ACFM:33). In circumstances where population is dominated by small individuals and differences in length of older and younger age groups are not great, the effectiveness of using selective properties of trawl gear is very low. Comparison of the discard practices of the national fleets operating at Rockall indicate that an increase of minimum mesh size (as was the case in 1991) does not result in considerable reduction of the proportion of small individuals in catches, however catch rates are decreased. ACFM 2007 was unable to forecast discards and include them in TAC, and as a result, there were no recommendations on allowable landings. ACOM 2008 recommended applying TAC to landings only.

Further measures should be introduced to reduce discarding of haddock in VIb.

### 4.3.8 Uncertainties and bias in assessment and forecast

The WG considers that the long-term trends in the XSA assessment and survey biomass estimates/indices are probably indicative of the general stock trends. However, F is considered to be poorly estimated due to the following sources of uncertainty in the current assessment:

1 ) The method of estimating discards from survey data, although considered appropriate, is likely to be the main source of error, especially in 2010 where an average rate had to be used since the survey could not take place.
2 ) There are concerns over the accuracy of landings statistics from Rockall in earlier years.
3 ) Historically, there is poor agreement between survey and XSA estimates of population numbers during some periods. This may be related to potential inaccuracies in the landings statistics.
4 ) In 1999 the gear and tow duration were changed on the Scottish survey. There were no calibrations done to assess possible impacts on catchability for this survey.
5 ) The XSA assessment shows trends in catchability, even if reduced by weak shrinkage.
6 ) The XSA assessment diagnostics give quite large standard errors on survivors' estimates (0.3–0.4) and there are often quite different values given by ScoGFS, F-shrinkage and P-shrinkage.

The WG considers that a longer series of more accurate landings, discards (for non-Russian fleets) and survey data will be necessary to overcome these deficiencies.

The survey covers only part of the currently known distribution area of haddock that raises uncertainty of an assessment.

There are concerns about the ability to forecast future catches and landings given substantial changes in national composition of the fleets operating at Rockall. A substantial change in TAC may lead to big changes in discarding practices. The Working Group previously presented forecast for total catch. However, with increased EU catches with discards, this approach is no longer considered appropriate. The present forecast predicts future catches disaggregated into landings and discard components.

The WG makes the following reservations about the forecast:

1 ) The future fleet composition at Rockall is very uncertain.
2 ) Discard proportion-at-age has varied considerably over time (Figure 4.3.35) but without clear trend since 1999. Therefore, average proportions at age for 1999–2009 were used and it is assumed that these values will also apply for 2010–2012.
3 ) The recent recruitment estimates are among the lowest in the time-series. The chosen 25th percentile for forecasting, although more precautionous than the geometric mean is still three times the average value over the period 2008–2010.

### 4.3.9 Recommendation for next benchmark

The main conclusion of WGCSE is that time-series of improved landings and discard data are needed before progress can be made towards the next benchmark assessment of this stock.

Because the survey covers only part of the currently known distribution area of haddock, it is necessary to use other available survey data for the assessment of this stock.

It is recommended to analyse the opportunity of using new estimation models including Statistical catch-at-age analysis which could improve quality of assessment.

It would be beneficial to develop and introduce standardization methods for reading of age for haddock.

No time frame for the next benchmark could be proposed at this stage.

### 4.3.10 Management considerations

Fishing mortality has declined over time and is now below $F_{MSY}$. Spawning biomass has increased in recent years as a result of the 2001 and 2005 year classes. SSB has been above $B_{pa}$ since 2003. Recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below $B_{pa}$ in 2013.

Fishing mortality levels have historically been high but have decreased since 2005. The fishing mortality has decreased for small individuals (age 1 and 2) since 2001. Survey-based indices of SSB indicate that the stock was at a historical low in 2002, but have increased since.

The forecast predicts future catches disaggregated into landing and discard components. The mean discard ratio at age is around 47% in 1991–2009 and 34% by number in the recent period (1999–2009). In 2010, the discards are significantly reduced as a result of the small number of young haddock in population. Some countries land the whole catch while others discard part of the catch. For countries which discard part of the catch the discard rate in the past was as high as 52–87% by numbers by results of discards trips. It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of haddock. Elaboration of such measures complies with recommendations under the UNGA Resolution 61/105 that urges states to take action to reduce or eliminate fish discards (UNGA Resolution 61/105, 2007, Chapter VIII, item 60).

In 2004–2010, the analytical methods of stock estimation were improved, the new data on biology and distribution were obtained, a trawl acoustic survey was carried out and the biomass of haddock from the Rockall Bank was estimated. The results from these investigations allow us to draw the following conclusions:

1) Due to the appearance of above-average year classes in 2000–2001 and 2005, the haddock stock has increased over the subsequent few years.
2) The recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below $B_{pa}$ in 2013.
3) It would be beneficial to conduct the groundfish/trawl-acoustic survey annually. An annual trawl survey covering the whole of the distributional area may improve the assessment of the stock status.
4) Discarding and the use of small-mesh gear have historically resulted in significant mortality of small haddock.

5 ) Regulation measures applied for haddock fishery encourage discards. Changes in the level of fishing mortality will not improve the situation as it will still be difficult to present forecasts both for discards and landings, and consequently for fishing mortality rates. Furthermore, there are ways of evading recommended fishing mortality including misreporting, high-grading and discarding.

6 ) It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of undersized haddock.

7 ) General management issues aimed at maintaining a healthy stock of Rockall haddock, such as changes in landing size, changes in mesh size, use of square mesh and headline panels, licences to fishing and closed areas, are currently being discussed through ongoing negotiations between EU and the Russian Federation.

### 4.3.11 References

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**Table 4.3.1. Nominal catch (tonnes) of haddock in Division VIb, 1992–2010, as officially reported to ICES.**

| Country | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009[1] | 2010[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Faroe Islands | - | - | - | - | - | - | - | - | n/a | n/a | - | - | - | - | 2 | 2 | 16 | - | 42 |
| France | …[2] | …[2] | …[2] | …[2] | - | - | - | | 5 | 2 | - | 1 | - | - | - | - | - | - | - |
| Iceland | - | - | - | - | - | - | - | 167 | - | - | - | - | - | - | - | - | - | - | - |
| Ireland | 571 | 692 | 956 | 677 | 747 | 895 | 704 | 1,021 | 824 | 357 | 206 | 169 | 19 | 105 | 41 | 338 | 721 | 352 | 169 |
| Norway | 47 | 68 | 75 | 29 | 24 | 24 | 40 | 61 | 152 | 70 | 49 | 60 | 32 | 33 | 123 | 84 | 36 | 71 | 65 |
| Portugal | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - |
| Russian Federation | - | - | - | - | - | - | - | 458 | 2,154 | 630 | 1,630 | 4,237 | 5,844 | 4,708 | 2,154 | 1,282 | 1669 | 55 | 198 |
| Spain | 51 | - | - | 28 | 1 | 22 | 21 | 25 | 47 | 51 | 7 | 19 | - | - | 5 | - | - | - | - |
| UK (E, W & NI) | 74 | 308 | 169 | 318 | 293 | 165 | 561 | 288 | 36 | - | - | 56 | - | - | - | - | - | - | - |
| UK (Scotland) | 3,777 | 3,045 | 2,535 | 4,439 | 5,753 | 4,114 | 3,768 | 3,970 | 2,470 | 1,205 | 1,145[3] | 1,607 | 411[3] | 332[3] | 440[3] | 1,643[3] | 1,779[3] | 2,951[3] | 2,931[3] |
| Total | 4,520 | 4,113 | 3,735 | 5,491 | 6,818 | 5,220 | 5,098 | 5,990 | 5,688 | 2,315 | 3,037 | 6,148 | 6,306 | 5,178 | 2,765 | 3,349 | 4,221 | 3,429 | 3,405 |
| Unallocated catch | 800 | 671 | 1,998 | -379 | -543 | -591 | -599 | -851 | -357 | -279 | 299 | 94 | 139 | 1 | 0 | 0 | 0 | -192 | 0 |
| WG estimate | 5,320 | 4,784 | 5,733 | 5,112 | 6,275 | 4,629 | 4,499 | 5,139 | 5,331[4] | 2,036[4] | 3,336[4] | 6.242[4] | 6,445 | 5,179 | 2,765 | 3,349 | 4,221 | 3,237 | 3,405 |

**[1]Preliminary.**

**[2]Included in Division VIa.**

**[3]Includes Scotland, England, Wales and NI landings.**

**[4]includes the total Russian catch.**

**n/a = not available.**

**Table 4.3.2. Details of Russian fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2010 (preliminary data).**

| Month | Tonnage class | Number of vessel/days | Catch of haddock tonnes |
|---|---|---|---|
| Macrh–April | 9 | 6 | 198 |
| Total | | | 198 |

**Table 4.3.3. Details of UK fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2010 (preliminary data).**

| Month | Country | Gear type | Catch of haddock, tonnes |
|---|---|---|---|
| January–March | Scotland | OTT | 753.1 |
| April–June | Scotland | OTT | 1773.5 |
| July–September | Scotland | OTT | 131.9 |
| October–December | Scotland | OTT | 272.2 |
| Total | | | 2930.7 |

**OTT – otter twin trawl.**

**Table 4.3.4. Details of Scottish discard trips in the Rockall area (Newton *et al.*, 2003).**

| Trip no. | Date | Gear | No. of hauls | Hours fished | % (by weight) haddock landed of catch | % (by weight) discarded of haddock |
|---|---|---|---|---|---|---|
| 1 | May 1985 | Heavy Trawl | 20 | 89.08 | 74 | 17.3 |
| 2 | Jun 1985 | Heavy Trawl | 28 | 127.17 | 74 | 18.6 |
| 3 | Jun 1999 | Heavy Trawl | 21 | 110.83 | 41 | 74.9 |
| 4 | Apr 2001 | Heavy Trawl | 11 | 47.33 | 96 | 12.4 |
| 5 | Jun 2001 | Heavy Trawl | 35 | 163.58 | 58 | 47.5 |
| 6 | Aug 2001 | Heavy Trawl | 26 | 130.08 | 31 | 69.7 |

**Table 4.3.5. Landings and Discards haddock estimates at Rockall from discard observer trips conducted aboard Irish vessels between 1995 and 2001, and from an observer trip aboard the MFV (February–March 2000). (ICES CM 2004/ACFM:33).**

| | FAT/ KBG/ 00/4 | FAT/ KBG/ 01/12 | FAT/ KBG/ 95/1 | FAT/ KBG/ 95/2 | FAT/ KBG/ 97/7 | FAT/ KBG/ 97/8 | FAT/ KBG/ 98/4 | Feb 2000 | Discard rate |
|---|---|---|---|---|---|---|---|---|---|
| Landing | 3021 | 942 | 12727 | 6893 | 14258 | 25866 | 23805 | 4400 | |
| Discards | 1864 | 926 | 1146 | 1893 | 6625 | 17926 | 3687 | 6200 | |
| % discarded | 38.16 | 49.57 | 8.26 | 21.54 | 31.72 | 40.90 | 13.40 | 58.49 | 27% |

**Table 4.3.6. Discards and retained catch haddock (number per trip) by Irish discard trips in the Rockall area in 2007–2009.**

| Year | 2007 | | 2008 | | 2009 | |
|---|---|---|---|---|---|---|
| Length (cm) | Discards | Retained Catch | Discards | Retained Catch | Discards | Retained Catch |
| 19 | 1.3 | | | | | |
| 22 | 1.6 | | 14.8 | | | |
| 23 | 4.6 | | 66.2 | | | |
| 24 | 7.3 | | 183.8 | | | |
| 25 | 22.7 | | 576.9 | | 15.6 | |
| 26 | 54.2 | | 1424.9 | | 30.4 | |
| 27 | 104.6 | | 3024.6 | | 25.2 | |
| 28 | 256.9 | | 6274.7 | | 228.2 | |
| 29 | 386.5 | 7.9 | 7193.3 | | 180.6 | |
| 30 | 533.4 | 17.6 | 7813.5 | 13.9 | 573.2 | 9.9 |
| 31 | 462.6 | 47.2 | 7573.7 | 40.6 | 1338.1 | 9.9 |
| 32 | 298.8 | 88.3 | 4639.0 | 77.8 | 1762.8 | 57.8 |
| 33 | 227.3 | 99.4 | 3664.7 | 126.8 | 2256.5 | 235.9 |
| 34 | 120.8 | 139.2 | 2391.8 | 277.4 | 1496.5 | 397.3 |
| 35 | 78.3 | 118.8 | 1590.1 | 503.6 | 656.6 | 614.8 |
| 36 | 27.4 | 187.0 | 871.7 | 580.5 | 423.5 | 567.1 |
| 37 | 26.1 | 139.8 | 280.3 | 640.9 | 66.9 | 526.8 |
| 38 | 24.3 | 142.7 | 78.3 | 581.9 | 57.4 | 421.4 |
| 39 | 3.4 | 162.5 | 206.6 | 443.0 | 23.1 | 346.9 |
| 40 | 8.7 | 119.4 | 37.5 | 535.6 | | 281.4 |
| 41 | 1.3 | 133.8 | 5.2 | 310.7 | | 197.9 |
| 42 | 4.6 | 133.1 | 5.2 | 334.7 | | 155.7 |
| 43 | 3.2 | 109.3 | | 333.5 | | 195.1 |
| 44 | | 118.6 | | 291.1 | | 201.7 |
| 45 | | 97.9 | | 253.6 | | 149.9 |
| >45 cm | | 574.5 | 0.0 | 1791.2 | 0.0 | 1001.7 |
| Total | 2659.9 | 2436.9 | 47916.8 | 7136.8 | 9134.4 | 5371.3 |
| Discard rate, % | 52.2 | | 87.0 | | 63.0 | |

**Table 4.3.7. Haddock in VIb. Tuning data available from the Scottish groundfish survey conducted in September.**

HADDOCK WGCSE 2011 ROCKALL
101
SCOGFS (Numbers per 10 hours fishing at Rockall)
1991 2010
1 1 0.66 0.75
0 6

| 1 | 14458 | 16398 | 4431 | 683 | 315 | 228 | 37 | 64 | 3 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 20336 | 44912 | 14631 | 3150 | 647 | 127 | 200 | 4 | 32 |
| 1 | 15220 | 37959 | 15689 | 3716 | 1104 | 183 | 38 | 73 | 21 |
| 1 | 23474 | 13287 | 11399 | 4314 | 969 | 203 | 30 | 12 | 4 |
| 1 | 16923 | 16971 | 6648 | 5993 | 1935 | 483 | 200 | 16 | 0 |
| 1 | 33578 | 19420 | 5903 | 1940 | 1317 | 325 | 69 | 6 | 1 |
| 1 | 28897 | 10693 | 2384 | 538 | 292 | 281 | 71 | 9 | 1 |
| -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1 | 10178 | 9969 | 2410 | 708 | 279 | 172 | 90 | 64 | 32 |
| -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1 | 31813 | 7455 | 521 | 284 | 154 | 39 | 14 | 12 | 14 |
| 1 | 11704 | 20925 | 2464 | 173 | 105 | 65 | 20 | 10 | 15 |
| 1 | 2526 | 10114 | 10927 | 1656 | 138 | 97 | 100 | 26 | 6 |
| -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 1 | 24452 | 4082 | 920 | 1506 | 2107 | 231 | 33 | 13 | 7 |
| 1 | 3570 | 18715 | 2562 | 256 | 1402 | 1694 | 349 | 16 | 6 |
| 1 | 558 | 2671 | 6019 | 570 | 254 | 516 | 367 | 28 | 2 |
| 1 | 85 | 560 | 966 | 3813 | 182 | 41 | 282 | 249 | 49 |
| 1 | 132 | 139 | 323 | 488 | 1651 | 40 | 9 | 54 | 17 |
| -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |

**Table 4.3.8. Details of Scottish and Irish effort (in hours) in 1985–2009 (preliminary data).**

| | Scottish fleet | | | Irish fleet |
|---|---|---|---|---|
| Year | SCOTRL* | SCOLTR* | SCOSEI* | IROTB* |
| 1985 | 8421 | 3081 | 1677 | |
| 1986 | 7465 | 4783 | 507 | |
| 1987 | 8786 | 9737 | 402 | |
| 1988 | 12450 | 5521 | 261 | |
| 1989 | 10161 | 11946 | 1411 | |
| 1990 | 3249 | 5335 | 4552 | |
| 1991 | 2995 | 11464 | 6733 | |
| 1992 | 2402 | 9623 | 3948 | |
| 1993 | 1632 | 11540 | 1756 | |
| 1994 | 2305 | 15543 | 399 | |
| 1995 | 1789 | 13517 | 1383 | 9142 |
| 1996 | 1627 | 17324 | 952 | 7219 |
| 1997 | 563 | 16096 | 1061 | 7169 |
| 1998 | 1332 | 12263 | 456 | 7461 |
| 1999 | 11336 | 9424 | 456 | 8680 |
| 2000 | 12951 | 8586 | 80 | 9883 |
| 2001 | 7838 | 1037 | 42 | 7244 |
| 2002 | 8304 | 1100 | 0 | 2626 |
| 2003 | 15000 | 500 | 50 | 4618 |
| 2004 | 15200 | 300 | 50 | 2070 |
| 2005 | 7788 | 32 | 0 | 2693 |
| 2006 | 9990 | 231 | 0 | 5903 |
| 2007 | 4534 | 319 | 44 | 6589 |
| 2008 | 2497 | 1016 | 82 | 9740 |
| 2009 | NA | NA | NA | 4354 |
| 2010 | | | | 3280 |

**SCOTRL* – Scottish Heavy Trawl , SCOLTR* – Scottish Light Trawl , SCOSEI* – Scottish Seine, IROTB* – Irish bottom otter trawl.**

**Table 4.3.9. Haddock in VIb International landings, discards and total catch.**

| | Num (*1000) | | | Weight, tonnes | | |
|---|---|---|---|---|---|---|
| Year | Landings | Discards | Total Catch[1] | Landings | Discards | Total Catch[1] |
| 1991 | 12302 | 65832 | 78134 | 5656 | 13228 | 18884 |
| 1992 | 11418 | 55964 | 67383 | 5321 | 11871 | 17192 |
| 1993 | 8767 | 44656 | 53423 | 4781 | 9853 | 14634 |
| 1994 | 11400 | 46628 | 58028 | 5732 | 11023 | 16755 |
| 1995 | 11784 | 35467 | 47251 | 5587 | 9168 | 14756 |
| 1996 | 14066 | 41506 | 55572 | 7072 | 9356 | 16428 |
| 1997 | 9965 | 26980 | 36945 | 5167 | 5894 | 11061 |
| 1998 | 9034 | 47831 | 56865 | 4986 | 10862 | 15848 |
| 1999 | 12930 | 52881 | 65811 | 5356 | 11062 | 16418 |
| 2000 | 15999 | 26033 | 42031 | 5444 | 6609 | 12053 |
| 2001 | 5361 | 9222 | 14583 | 2123 | 1535 | 3658 |
| 2002 | 11167 | 21899 | 33066 | 3117 | 4152 | 7270 |
| 2003 | 24409 | 25087 | 49496 | 5969 | 5521 | 11490 |
| 2004 | 22705 | 3989 | 26694 | 6437 | 883 | 7321 |
| 2005 | 19505 | 1877 | 21382 | 5191 | 505 | 5696 |
| 2006 | 9605 | 1667 | 11272 | 2756 | 386 | 3142 |
| 2007 | 8936 | 12261 | 21197 | 3348 | 2242 | 5590 |
| 2008 | 10209 | 7603 | 17812 | 4221 | 2100 | 6320 |
| 2009 | 6709 | 4765 | 11474 | 3237 | 1557 | 4794 |
| 2010 | 5265 | 878 | 6144 | 3404 | 306 | 3710 |

[1] **Landings and discards.**

**Table 4.3.10. Haddock in VIb. International catch (landings and discards) numbers (*10³) at age.**

At 05/05/2011 13:00
Terminal Fs derived using XSA (With F shrinkage)
Catch number-at-age (start of year) Numbers*10**-3

| | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| 1 | 21186 | 16084 | 11178 | 8170 | 2749 | 12096 | 9957 | 14224 | 17282 | 8222 |
| 2 | 33847 | 24711 | 19375 | 20623 | 9831 | 18811 | 10535 | 19807 | 21949 | 12581 |
| 3 | 15189 | 18584 | 15494 | 17868 | 21585 | 10911 | 5388 | 10173 | 12203 | 10697 |
| 4 | 5341 | 5361 | 4938 | 8210 | 9756 | 9612 | 4098 | 4763 | 5499 | 4917 |
| 5 | 1704 | 1761 | 1617 | 2449 | 2464 | 3299 | 5002 | 3740 | 3419 | 2050 |
| 6 | 346 | 676 | 461 | 476 | 787 | 751 | 1758 | 2767 | 2684 | 1498 |
| +gp | 522 | 206 | 359 | 233 | 79 | 92 | 207 | 1391 | 2776 | 2066 |
| TOTAL | 78134 | 67383 | 53423 | 58028 | 47251 | 55572 | 36945 | 56865 | 65811 | 42031 |

Catch number-at-age (start of year) Numbers*10**-3

| | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 1 | 7667 | 13364 | 6576 | 932 | 1061 | 2880 | 1491 | 476 | 223 | 0.05 |
| 2 | 1961 | 11119 | 23606 | 4112 | 3723 | 1475 | 9829 | 2207 | 707 | 118 |
| 3 | 1815 | 4536 | 14559 | 10282 | 7420 | 1626 | 3605 | 11437 | 1237 | 264 |
| 4 | 1018 | 2445 | 2063 | 9212 | 8124 | 2414 | 1503 | 1291 | 8046 | 426 |
| 5 | 1038 | 898 | 1285 | 1386 | 753 | 2291 | 2213 | 507 | 495 | 4718 |
| 6 | 484 | 260 | 925 | 296 | 109 | 436 | 1816 | 964 | 263 | 308 |
| +gp | 601 | 444 | 483 | 474 | 193 | 151 | 741 | 930 | 504 | 310 |
| TOTAL | 14583 | 33066 | 49496 | 26694 | 21382 | 11273 | 21198 | 17812 | 11474 | 6144 |

**Table 4.3.11. Haddock in VIb. International landings numbers (*10³) at age.**

At 05/05/2011 13:15
Terminal Fs derived using XSA (With F shrinkage)
Landings number-at-age (start of year) Numbers*10**-3

| | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| 1 | 87 | 86 | 28 | 30 | 1 | 2 | 1 | 4 | 245 | 33 |
| 2 | 6807 | 3642 | 1919 | 1160 | 146 | 5149 | 319 | 392 | 2600 | 3445 |
| 3 | 3011 | 5624 | 4740 | 5299 | 5205 | 1861 | 2102 | 1815 | 2994 | 5081 |
| 4 | 1344 | 964 | 1157 | 3665 | 4791 | 4149 | 2155 | 1340 | 1972 | 3006 |
| 5 | 558 | 580 | 489 | 1040 | 1319 | 2347 | 3658 | 1898 | 1228 | 1295 |
| 6 | 32 | 364 | 144 | 66 | 279 | 473 | 1540 | 2284 | 1600 | 1176 |
| +gp | 464 | 160 | 290 | 141 | 43 | 85 | 192 | 1301 | 2291 | 1963 |
| TOTAL | 12302 | 11418 | 8767 | 11400 | 11784 | 14066 | 9966 | 9034 | 12930 | 15999 |

Landings number-at-age (start of year) Numbers*10**-3

| AGE | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 399 | 657 | 920 | 197 | 887 | 2344 | 31 | 17 | 5 | 0.03 |
| 2 | 941 | 2983 | 8103 | 1765 | 2835 | 768 | 1220 | 749 | 11 | 71 |
| 3 | 1232 | 3998 | 11001 | 9502 | 6866 | 1290 | 2709 | 6191 | 244 | 196 |
| 4 | 752 | 2111 | 1846 | 9119 | 7913 | 2356 | 1074 | 1164 | 5243 | 352 |
| 5 | 988 | 809 | 1188 | 1364 | 725 | 2269 | 1539 | 479 | 460 | 4078 |
| 6 | 470 | 217 | 878 | 286 | 98 | 428 | 1623 | 761 | 261 | 274 |
| +gp | 579 | 392 | 475 | 472 | 182 | 150 | 740 | 848 | 486 | 294 |
| TOTAL | 5361 | 11167 | 24409 | 22705 | 19505 | 9605 | 8936 | 10209 | 6709 | 5265 |

**Table 4.3.12. Haddock in VIb. International discards numbers (*10[3]) at age.**

At 05/05/2011 13:30

Terminal Fs derived using XSA (With F shrinkage)

Discards number-at-age (start of year) Numbers*10**-3

| AGE | 1991 | 1992 | 1993 | 1994 | 1995* | 1996 | 1997* | 1998 | 1999* | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 21099 | 15998 | 11151 | 8140 | 2748 | 12094 | 9957 | 14220 | 17037 | 8189 |
| 2 | 27040 | 21069 | 17456 | 19464 | 9685 | 13662 | 10216 | 19415 | 19349 | 9136 |
| 3 | 12178 | 12961 | 10755 | 12570 | 16379 | 9051 | 3287 | 8357 | 9210 | 5616 |
| 4 | 3998 | 4397 | 3781 | 4545 | 4965 | 5463 | 1944 | 3423 | 3526 | 1912 |
| 5 | 1146 | 1182 | 1128 | 1409 | 1145 | 952 | 1344 | 1842 | 2191 | 755 |
| 6 | 313 | 312 | 317 | 410 | 509 | 278 | 218 | 483 | 1084 | 322 |
| +gp | 58 | 46 | 69 | 91 | 36 | 7 | 15 | 91 | 485 | 103 |
| TOTAL | 65832 | 55964 | 44656 | 46628 | 35467 | 41506 | 26980 | 47831 | 52881 | 26033 |

Discards number-at-age (start of year) Numbers*10**-3

| AGE | 2001* | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7268 | 12706 | 5655 | 736 | 174 | 536 | 1459 | 458 | 218 | 0.02 |
| 2 | 1020 | 8136 | 15503 | 2346 | 888 | 707 | 8610 | 1458 | 696 | 47 |
| 3 | 583 | 539 | 3558 | 781 | 554 | 336 | 896 | 5246 | 993 | 68 |
| 4 | 266 | 334 | 217 | 93 | 210 | 58 | 429 | 128 | 2803 | 74 |
| 5 | 50 | 89 | 97 | 22 | 28 | 22 | 674 | 28 | 36 | 640 |
| 6 | 15 | 43 | 48 | 10 | 11 | 8 | 193 | 203 | 2 | 33 |
| +gp | 21 | 51 | 8 | 2 | 11 | 1 | 1 | 82 | 18 | 16 |
| TOTAL | 9222 | 21899 | 25087 | 3989 | 1877 | 1667 | 12261 | 7603 | 4765 | 878 |

*** data calculated using estimates from discard observer trips.**

**Table 4.3.13. Haddock in VIb. International catch (landings and discards) weights-at-age (kg).**

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1991 | 0.142 | 0.240 | 0.291 | 0.378 | 0.469 | 0.414 | 0.679 |
| 1992 | 0.133 | 0.239 | 0.318 | 0.362 | 0.423 | 0.567 | 0.844 |
| 1993 | 0.137 | 0.238 | 0.334 | 0.400 | 0.493 | 0.503 | 0.874 |
| 1994 | 0.153 | 0.233 | 0.319 | 0.420 | 0.469 | 0.477 | 0.721 |
| 1995 | 0.118 | 0.222 | 0.309 | 0.401 | 0.501 | 0.460 | 0.843 |
| 1996 | 0.136 | 0.278 | 0.314 | 0.395 | 0.553 | 0.575 | 0.763 |
| 1997 | 0.136 | 0.240 | 0.322 | 0.382 | 0.512 | 0.634 | 0.944 |
| 1998 | 0.141 | 0.250 | 0.308 | 0.354 | 0.436 | 0.546 | 0.662 |
| 1999 | 0.138 | 0.208 | 0.272 | 0.334 | 0.379 | 0.483 | 0.618 |
| 2000 | 0.189 | 0.250 | 0.267 | 0.321 | 0.382 | 0.451 | 0.707 |
| 2001 | 0.133 | 0.257 | 0.320 | 0.416 | 0.432 | 0.521 | 0.713 |
| 2002 | 0.135 | 0.239 | 0.237 | 0.325 | 0.509 | 0.580 | 0.753 |
| 2003 | 0.153 | 0.203 | 0.256 | 0.350 | 0.384 | 0.424 | 0.753 |
| 2004 | 0.147 | 0.198 | 0.244 | 0.294 | 0.444 | 0.609 | 0.753 |
| 2005 | 0.114 | 0.197 | 0.234 | 0.311 | 0.458 | 0.599 | 0.806 |
| 2006 | 0.093 | 0.198 | 0.245 | 0.329 | 0.441 | 0.595 | 0.787 |
| 2007 | 0.114 | 0.186 | 0.266 | 0.296 | 0.387 | 0.497 | 0.569 |
| 2008 | 0.199 | 0.241 | 0.291 | 0.437 | 0.571 | 0.669 | 0.932 |
| 2009 | 0.248 | 0.288 | 0.339 | 0.391 | 0.668 | 0.513 | 1.005 |
| 2010 | 0.100 | 0.352 | 0.460 | 0.437 | 0.560 | 0.926 | 1.401 |

**Table 4.3.14. Haddock in VIb. International landings weights-at-age (kg).**

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1991 | 0.302 | 0.402 | 0.444 | 0.592 | 0.724 | 0.963 | 0.704 |
| 1992 | 0.136 | 0.366 | 0.455 | 0.658 | 0.612 | 0.759 | 0.954 |
| 1993 | 0.305 | 0.402 | 0.503 | 0.701 | 0.830 | 0.820 | 0.972 |
| 1994 | 0.314 | 0.356 | 0.452 | 0.558 | 0.638 | 1.224 | 0.890 |
| 1995 | 0.377 | 0.311 | 0.414 | 0.479 | 0.640 | 0.699 | 1.236 |
| 1996 | 0.327 | 0.436 | 0.501 | 0.487 | 0.627 | 0.709 | 0.783 |
| 1997 | 0.000 | 0.315 | 0.401 | 0.444 | 0.564 | 0.661 | 0.973 |
| 1998 | 0.256 | 0.344 | 0.494 | 0.517 | 0.542 | 0.591 | 0.678 |
| 1999 | 0.274 | 0.338 | 0.390 | 0.440 | 0.505 | 0.601 | 0.665 |
| 2000 | 0.272 | 0.404 | 0.379 | 0.407 | 0.473 | 0.513 | 0.740 |
| 2001 | 0.274 | 0.426 | 0.383 | 0.518 | 0.426 | 0.518 | 0.677 |
| 2002 | 0.240 | 0.422 | 0.416 | 0.541 | 0.565 | 0.649 | 0.818 |
| 2003 | 0.100 | 0.164 | 0.246 | 0.351 | 0.388 | 0.423 | 0.758 |
| 2004 | 0.142 | 0.172 | 0.241 | 0.293 | 0.446 | 0.617 | 0.754 |
| 2005 | 0.103 | 0.184 | 0.230 | 0.310 | 0.461 | 0.614 | 0.824 |
| 2006 | 0.084 | 0.167 | 0.223 | 0.327 | 0.440 | 0.598 | 0.789 |
| 2007 | 0.096 | 0.238 | 0.275 | 0.322 | 0.450 | 0.523 | 0.570 |
| 2008 | 0.125 | 0.197 | 0.302 | 0.444 | 0.583 | 0.752 | 0.984 |
| 2009 | 0.300 | 0.346 | 0.420 | 0.416 | 0.692 | 0.512 | 1.020 |
| 2010 | 0.052 | 0.428 | 0.520 | 0.459 | 0.591 | 0.990 | 1.451 |

**Table 4.3.15. Haddock in VIb. International discards weights-at-age (kg).**

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1991 | 0.142 | 0.199 | 0.253 | 0.306 | 0.345 | 0.358 | 0.478 |
| 1992 | 0.133 | 0.217 | 0.258 | 0.298 | 0.330 | 0.342 | 0.464 |
| 1993 | 0.137 | 0.220 | 0.260 | 0.307 | 0.346 | 0.359 | 0.462 |
| 1994 | 0.153 | 0.226 | 0.263 | 0.308 | 0.345 | 0.356 | 0.458 |
| 1995 | 0.118 | 0.220 | 0.276 | 0.325 | 0.341 | 0.329 | 0.379 |
| 1996 | 0.136 | 0.218 | 0.276 | 0.326 | 0.370 | 0.348 | 0.524 |
| 1997 | 0.136 | 0.238 | 0.272 | 0.312 | 0.372 | 0.442 | 0.568 |
| 1998 | 0.141 | 0.248 | 0.267 | 0.291 | 0.327 | 0.336 | 0.436 |
| 1999 | 0.139 | 0.212 | 0.255 | 0.288 | 0.313 | 0.318 | 0.410 |
| 2000 | 0.189 | 0.267 | 0.289 | 0.311 | 0.330 | 0.334 | 0.462 |
| 2001 | 0.135 | 0.247 | 0.294 | 0.344 | 0.412 | 0.440 | 0.495 |
| 2002 | 0.137 | 0.254 | 0.308 | 0.335 | 0.398 | 0.338 | 0.367 |
| 2003 | 0.161 | 0.223 | 0.287 | 0.342 | 0.337 | 0.440 | 0.510 |
| 2004 | 0.148 | 0.218 | 0.282 | 0.343 | 0.324 | 0.371 | 0.469 |
| 2005 | 0.171 | 0.240 | 0.298 | 0.357 | 0.387 | 0.473 | 0.506 |
| 2006 | 0.132 | 0.233 | 0.334 | 0.420 | 0.495 | 0.435 | 0.435 |
| 2007 | 0.115 | 0.179 | 0.239 | 0.232 | 0.244 | 0.280 | 0.406 |
| 2008 | 0.202 | 0.264 | 0.279 | 0.370 | 0.351 | 0.358 | 0.392 |
| 2009 | 0.246 | 0.287 | 0.319 | 0.343 | 0.360 | 0.662 | 0.593 |
| 2010 | 0.161 | 0.239 | 0.289 | 0.335 | 0.359 | 0.404 | 0.458 |

**Table 4.3.16. Haddock VIb. Stock weights-at-age (kg).**

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1991 | 0.302 | 0.402 | 0.444 | 0.592 | 0.724 | 0.963 | 0.704 |
| 1992 | 0.136 | 0.366 | 0.455 | 0.658 | 0.612 | 0.759 | 0.954 |
| 1993 | 0.305 | 0.402 | 0.503 | 0.701 | 0.830 | 0.820 | 0.972 |
| 1994 | 0.314 | 0.356 | 0.452 | 0.558 | 0.638 | 1.224 | 0.890 |
| 1995 | 0.377 | 0.311 | 0.414 | 0.479 | 0.640 | 0.699 | 1.236 |
| 1996 | 0.327 | 0.436 | 0.501 | 0.487 | 0.627 | 0.709 | 0.783 |
| 1997 | 0.000 | 0.315 | 0.401 | 0.444 | 0.564 | 0.661 | 0.973 |
| 1998 | 0.256 | 0.344 | 0.494 | 0.517 | 0.542 | 0.591 | 0.678 |
| 1999 | 0.274 | 0.338 | 0.390 | 0.440 | 0.505 | 0.601 | 0.665 |
| 2000 | 0.272 | 0.404 | 0.379 | 0.407 | 0.473 | 0.513 | 0.740 |
| 2001 | 0.274 | 0.426 | 0.383 | 0.518 | 0.426 | 0.518 | 0.677 |
| 2002 | 0.240 | 0.422 | 0.416 | 0.541 | 0.565 | 0.649 | 0.818 |
| 2003 | 0.100 | 0.164 | 0.246 | 0.351 | 0.388 | 0.423 | 0.758 |
| 2004 | 0.142 | 0.172 | 0.241 | 0.293 | 0.446 | 0.617 | 0.754 |
| 2005 | 0.103 | 0.184 | 0.230 | 0.310 | 0.461 | 0.614 | 0.824 |
| 2006 | 0.084 | 0.167 | 0.223 | 0.327 | 0.440 | 0.598 | 0.789 |
| 2007 | 0.096 | 0.238 | 0.275 | 0.322 | 0.450 | 0.523 | 0.570 |
| 2008 | 0.125 | 0.197 | 0.302 | 0.444 | 0.583 | 0.752 | 0.984 |
| 2009 | 0.300 | 0.346 | 0.420 | 0.416 | 0.692 | 0.512 | 1.020 |
| 2010 | 0.052 | 0.428 | 0.520 | 0.459 | 0.591 | 0.990 | 1.451 |

**Table 4.3.17. XSA diagnostics in assessment of Haddock in VIb. Final run with old survey indices.**

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 20 years. 1991 to 2010. Ages 1 to 7.

| Fleet | Firs year | Last year | First age | Last age | Alpha | Beta |
|---|---|---|---|---|---|---|
| SCOGFS | 1991 | 2010 | 0 | 6 | 0.66 | 0.75 |

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 10 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 4 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 50 iterations

Total absolute residual between iterations
49 and 50 = .00744

Final year F values

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Iteration 49 | 0.0002 | 0.0416 | 0.068 | 0.0771 | 0.4265 | 0.1946 |
| Iteration 50 | 0.0002 | 0.041 | 0.0673 | 0.0763 | 0.4269 | 0.1897 |

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.111 | 0.144 | 0.152 | 0.075 | 0.066 | 0.038 | 0.094 | 0.066 | 0.06 | 0 |
| 2 | 0.147 | 0.232 | 0.408 | 0.134 | 0.474 | 0.124 | 0.177 | 0.196 | 0.133 | 0.041 |
| 3 | 0.267 | 0.593 | 0.542 | 0.312 | 0.38 | 0.391 | 0.5 | 0.322 | 0.161 | 0.067 |
| 4 | 0.226 | 0.698 | 0.597 | 0.81 | 0.436 | 0.203 | 0.777 | 0.333 | 0.395 | 0.076 |
| 5 | 0.95 | 0.32 | 1.045 | 1.109 | 0.133 | 0.209 | 0.291 | 0.662 | 0.205 | 0.427 |
| 6 | 1.129 | 0.665 | 0.642 | 0.732 | 0.217 | 0.106 | 0.254 | 0.198 | 0.904 | 0.19 |

**Table 4.3.17. cont.**

XSA population numbers (Thousands)

| YEAR | AGE 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 2001 | 8.09E+04 | 1.59E+04 | 8.57E+03 | 5.55E+03 | 1.87E+03 | 7.91E+02 |
| 2002 | 1.10E+05 | 5.93E+04 | 1.12E+04 | 5.38E+03 | 3.63E+03 | 5.92E+02 |
| 2003 | 5.15E+04 | 7.79E+04 | 3.85E+04 | 5.07E+03 | 2.19E+03 | 2.16E+03 |
| 2004 | 1.43E+04 | 3.62E+04 | 4.24E+04 | 1.83E+04 | 2.29E+03 | 6.31E+02 |
| 2005 | 1.83E+04 | 1.09E+04 | 2.59E+04 | 2.54E+04 | 6.67E+03 | 6.17E+02 |
| 2006 | 8.49E+04 | 1.40E+04 | 5.55E+03 | 1.45E+04 | 1.34E+04 | 4.78E+03 |
| 2007 | 1.84E+04 | 6.69E+04 | 1.01E+04 | 3.07E+03 | 9.70E+03 | 8.94E+03 |
| 2008 | 8.17E+03 | 1.37E+04 | 4.59E+04 | 5.03E+03 | 1.16E+03 | 5.94E+03 |
| 2009 | 4.20E+03 | 6.26E+03 | 9.20E+03 | 2.72E+04 | 2.95E+03 | 4.88E+02 |
| 2010 | 2.43E+02 | 3.24E+03 | 4.48E+03 | 6.41E+03 | 1.50E+04 | 1.97E+03 |

Estimated population abundance at 1st Jan 2011

| | | | | | |
|---|---|---|---|---|---|
| 0.00E+00 | 2.03E+02 | 2.57E+03 | 3.46E+03 | 4.91E+03 | 8.02E+03 |

Taper weighted geometric mean of the VPA populations:

| | | | | | |
|---|---|---|---|---|---|
| 3.41E+04 | 3.25E+04 | 2.11E+04 | 1.09E+04 | 4.93E+03 | 1.94E+03 |

Standard error of the weighted Log(VPA populations) :

| | | | | | |
|---|---|---|---|---|---|
| 1.4953 | 0.9443 | 0.7457 | 0.6344 | 0.7217 | 0.9039 |

Log catchability residuals.

Fleet : SCOGFS

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.33 | 0.33 | 0.06 | -0.05 | 0.19 | 0.36 | -0.22 | 99.99 | 0.28 | 99.99 |
| 2 | -0.45 | 0.59 | 0.5 | 0.03 | 0.22 | 0.33 | -0.33 | 99.99 | -0.27 | 99.99 |
| 3 | -0.4 | 0.28 | 0.39 | 0.25 | 0.21 | 0.02 | -0.58 | 99.99 | -0.15 | 99.99 |
| 4 | -0.16 | 0.62 | 0.41 | 0.49 | 0.83 | -0.01 | -1.11 | 99.99 | -0.28 | 99.99 |
| 5 | -0.13 | 0.29 | 0.73 | -0.36 | 1.03 | 0.18 | -0.56 | 99.99 | -0.13 | 99.99 |
| 6 | 0.07 | 0.21 | 0 | -0.09 | 0.14 | -0.14 | -0.35 | 99.99 | -0.06 | 99.99 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.61 | -0.2 | 0.07 | 99.99 | 0.45 | -0.07 | 0.18 | -0.08 | -0.36 | 99.99 |
| 2 | -0.69 | -0.75 | 0.23 | 99.99 | 0.31 | 0.66 | -0.21 | -0.03 | -0.14 | 99.99 |
| 3 | -0.07 | -0.52 | -0.27 | 99.99 | -0.01 | 0.35 | 0.33 | 0.01 | 0.17 | 99.99 |
| 4 | -0.78 | -0.8 | -0.54 | 99.99 | 0.47 | 0.45 | 0.7 | -0.44 | 0.12 | 99.99 |
| 5 | -0.29 | -0.89 | 0.53 | 99.99 | -0.36 | 0.98 | 0.18 | 0.04 | -1.25 | 99.99 |
| 6 | -0.33 | -0.01 | 0.29 | 99.99 | 0.13 | 0.37 | -0.1 | 0 | -0.45 | 99.99 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 4 | 5 | 6 |
|---|---|---|---|
| Mean Log q | -2.5064 | -2.7677 | -2.7677 |
| S.E(Log q) | 0.604 | 0.6346 | 0.2279 |

Regression statistics :

Ages with q dependent on year class strength

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Log q |
|---|---|---|---|---|---|---|---|
| 1 | 0.68 | 4.123 | 4.53 | 0.92 | 16 | 0.3 | -1.52 |
| 2 | 0.78 | 1.642 | 3.92 | 0.8 | 16 | 0.45 | -2.05 |
| 3 | 0.67 | 2.836 | 4.99 | 0.84 | 16 | 0.32 | -2.49 |

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 4 | 0.78 | 1.236 | 3.99 | 0.7 | 16 | 0.46 | -2.51 |
| 5 | 0.92 | 0.351 | 3.21 | 0.59 | 16 | 0.6 | -2.77 |
| 6 | 0.93 | 1.186 | 3.12 | 0.95 | 16 | 0.21 | -2.79 |

**Table 4.3.17 cont.**

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2009

| Fleet | I<br>: | Int<br>s.e | Ext<br>s.e | Var<br>Ratio | N | Scaled<br>Weights | Estimated<br>F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| P shrinkage mean | 32472 | 0.94 | | | | 0.529 | 0 |
| F shrinkage mean | 1 | 1 | | | | 0.471 | 0 |

Weighted prediction :

| Survivors<br>at end of year | Int<br>s.e | Ext<br>s.e | N | Var<br>Ratio | F |
|---|---|---|---|---|---|
| 203 | 0.69 | 7.56 | 2 | 11.007 | 0 |

Age 2 Catchability dependent on age and year class strength

Year class = 2008

| Fleet | I<br>: | Int<br>s.e | Ext<br>s.e | Var<br>Ratio | N | Scaled<br>Weights | Estimated<br>F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 1774 | 0.378 | 0 | 0 | 1 | 0.693 | 0.058 |
| P shrinkage mean | 21073 | 0.75 | | | | 0.197 | 0.005 |
| F shrinkage mean | 621 | 1 | | | | 0.11 | 0.158 |

Weighted prediction :

| Survivors<br>at end of year | Int<br>s.e | Ext<br>s.e | N | Var<br>Ratio | F |
|---|---|---|---|---|---|
| 2575 | 0.32 | 0.81 | 3 | 2.548 | 0.041 |

Age 3 Catchability dependent on age and year class strength

Year class = 2007

| Fleet | I<br>: | Int<br>s.e | Ext<br>s.e | Var<br>Ratio | N | Scaled<br>Weights | Estimated<br>F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 3104 | 0.286 | 0.027 | 0.09 | 2 | 0.733 | 0.074 |
| P shrinkage mean | 10860 | 0.63 | | | | 0.191 | 0.022 |
| F shrinkage mean | 579 | 1 | | | | 0.077 | 0.346 |

Weighted prediction :

| Survivors<br>at end of year | Int<br>s.e | Ext<br>s.e | N | Var<br>Ratio | F |
|---|---|---|---|---|---|
| 3464 | 0.25 | 0.41 | 4 | 1.633 | 0.067 |

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

| Fleet | I<br>: | Int<br>s.e | Ext<br>s.e | Var<br>Ratio | N | Scaled<br>Weights | Estimated<br>F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 5562 | 0.211 | 0.056 | 0.27 | 3 | 0.939 | 0.067 |
| F shrinkage mean | 717 | 1 | | | | 0.061 | 0.43 |

**Table 4.3.17. cont.**

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 4908 | 0.21 | 0.3 | 4 | 1.422 | 0.076 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

| Fleet | I<br>: | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 7749 | 0.2 | 0.057 | 0.28 | 4 | 0.885 | 0.439 |
| F shrinkage mean | 10408 | 1 | | | | 0.115 | 0.344 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 8017 | 0.21 | 0.07 | 5 | 0.322 | 0.427 |

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2004

| Fleet | I<br>: | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 1371 | 0.202 | 0.333 | 1.65 | 5 | 0.9 | 0.185 |
| F shrinkage mean | 1324 | 1 | | | | 0.1 | 0.191 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1366 | 0.21 | 0.28 | 6 | 1.363 | 0.19 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

| Fleet | | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 7746 | 0.2 | 0.057 | 0.28 | 4 | 0.884 | 0.439 |
| F shrinkage mean | 10401 | 1 | | | | 0.116 | 0.344 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 8014 | 0.21 | 0.07 | 5 | 0.322 | 0.427 |

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2004

| Fleet | | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| SCOGFS | 1367 | 0.202 | 0.333 | 1.65 | 5 | 0.9 | 0.185 |
| F shrinkage mean | 1323 | 1 | | | | 0.1 | 0.191 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1363 | 0.21 | 0.28 | 6 | 1.362 | 0.19 |

**Table 4.3.18. Haddock in VIb. Final runs with old survey indices. Fishing mortality-at-age.**

Run title : HADDOCK LANDISC 2004 ROCKALL

At 6/06/2011 15:11

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.2379 | 0.1757 | 0.1045 | 0.14 | 0.0507 | 0.2401 | 0.166 | 0.2421 | 0.4956 | 0.3847 |
| 2 | 0.5885 | 0.4824 | 0.3321 | 0.2854 | 0.2495 | 0.5697 | 0.3407 | 0.5778 | 0.7263 | 0.8448 |
| 3 | 0.8874 | 0.7708 | 0.644 | 0.5865 | 0.5487 | 0.4848 | 0.3128 | 0.6514 | 0.8881 | 1.0089 |
| 4 | 0.9065 | 0.957 | 0.4731 | 0.8797 | 0.7593 | 0.5068 | 0.3372 | 0.505 | 0.9319 | 1.2175 |
| 5 | 0.3644 | 0.9022 | 0.8939 | 0.4563 | 0.7277 | 0.634 | 0.5438 | 0.5925 | 0.8579 | 1.2074 |
| 6 | 0.5335 | 0.2394 | 0.6325 | 0.7328 | 0.2575 | 0.5081 | 0.8586 | 0.6699 | 1.2326 | 1.2973 |
| +gp | 0.5335 | 0.2394 | 0.6325 | 0.7328 | 0.2575 | 0.5081 | 0.8586 | 0.6699 | 1.2326 | 1.2973 |
| FBAR 2-5 | 0.6867 | 0.7781 | 0.5858 | 0.552 | 0.5713 | 0.5488 | 0.3836 | 0.5817 | 0.851 | 1.0696 |

Table 8 Fishing mortality (F) at age

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | FBAR **-** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 1 | 0.1106 | 0.1444 | 0.1521 | 0.0746 | 0.0663 | 0.0382 | 0.094 | 0.0665 | 0.0604 | 0.0002 | 0.0424 |
| 2 | 0.1469 | 0.2323 | 0.4081 | 0.1341 | 0.4743 | 0.1238 | 0.1772 | 0.1964 | 0.1334 | 0.041 | 0.1236 |
| 3 | 0.2665 | 0.5929 | 0.5415 | 0.3121 | 0.3802 | 0.3912 | 0.4997 | 0.3222 | 0.1608 | 0.0673 | 0.1834 |
| 4 | 0.2262 | 0.6982 | 0.597 | 0.8105 | 0.4361 | 0.2031 | 0.7774 | 0.3335 | 0.3955 | 0.0763 | 0.2684 |
| 5 | 0.9505 | 0.3196 | 1.0448 | 1.1093 | 0.1331 | 0.2086 | 0.2905 | 0.6622 | 0.205 | 0.4269 | 0.4314 |
| 6 | 1.1287 | 0.6655 | 0.6425 | 0.732 | 0.2171 | 0.1062 | 0.2544 | 0.1977 | 0.9035 | 0.1897 | 0.4303 |
| +gp | 1.1287 | 0.6655 | 0.6425 | 0.732 | 0.2171 | 0.1062 | 0.2544 | 0.1977 | 0.9035 | 0.1897 | |
| FBAR 2-5 | 0.3975 | 0.4607 | 0.6478 | 0.5915 | 0.3559 | 0.2317 | 0.4362 | 0.3786 | 0.2237 | 0.1528 | |

**Table 4.3.19. Haddock in VIb. Final runs with old survey indices. Stock number ($*10^3$) at age.**

Run title : HADDOCK LANDISC 2004 ROCKALL

At 6/06/2011 15:11

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 1 | 110570 | 110317 | 124464 | 69122 | 61508 | 62627 | 71924 | 73106 | 48875 | 28455 | 80889 |
| 2 | 84093 | 71357 | 75766 | 91788 | 49200 | 47870 | 40329 | 49877 | 46984 | 24378 | 15857 |
| 3 | 28535 | 38223 | 36063 | 44501 | 56489 | 31386 | 22172 | 23486 | 22914 | 18607 | 8575 |
| 4 | 9903 | 9619 | 14479 | 15506 | 20266 | 26719 | 15824 | 13277 | 10024 | 7719 | 5555 |
| 5 | 6167 | 3275 | 3024 | 7386 | 5267 | 7765 | 13179 | 9247 | 6561 | 3232 | 1870 |
| 6 | 924 | 3507 | 1088 | 1013 | 3832 | 2083 | 3372 | 6264 | 4187 | 2278 | 791 |
| +gp | 1381 | 1064 | 837 | 488 | 382 | 252 | 390 | 3110 | 4237 | 3072 | 962 |
| TOTAL | 241571 | 237362 | 255722 | 229805 | 196944 | 178703 | 167190 | 178368 | 143782 | 87739 | 114499 |

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | GMST 91-** | AMST 91-** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | |
| 1 | 109870 | 51500 | 14336 | 18278 | 84910 | 18353 | 8170 | 4202 | 243 | 0 | 50470 | 63737 |
| 2 | 59289 | 77862 | 36215 | 10894 | 14005 | 66913 | 13678 | 6259 | 3239 | 203 | 40444 | 48686 |
| 3 | 11209 | 38481 | 42389 | 25930 | 5551 | 10132 | 45889 | 9201 | 4484 | 2575 | 24047 | 28363 |
| 4 | 5378 | 5072 | 18332 | 25401 | 14516 | 3073 | 5033 | 27223 | 6415 | 3464 | 10626 | 12539 |
| 5 | 3627 | 2190 | 2286 | 6674 | 13446 | 9700 | 1156 | 2952 | 15008 | 4908 | 4769 | 5892 |
| 6 | 592 | 2157 | 631 | 617 | 4783 | 8936 | 5940 | 488 | 1969 | 8017 | 2089 | 2944 |
| +gp | 997 | 1112 | 995 | 1087 | 1653 | 3623 | 5703 | 920 | 1972 | 2702 | | |
| TOTAL | 190961 | 178374 | 115183 | 88881 | 138864 | 120730 | 85569 | 51246 | 33330 | 21870 | | |

**Table 4.3.20. Haddock in VIb. Final run with old survey indices. Summary table.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Run title : HADDOCK LANDISC 2004 ROCKALL | | | | | | |
| | | | | | | |
| At 6/06/2011 15:11 | | | | | | |
| | | | | | | |
| Table 16 Summary (without SOP correction) | | | | | | |
| | | | | | | |
| Terminal Fs derived using XSA (With F shrinkage) | | | | | | |
| | | | | | | |
| | RECI | TOTALBI | TOTSPBI | LANDIN | YIELD/SS | FBAR 2- 5 |
| | Age 1 | | | | | |
| 1991 | 110570 | 52142 | 16259 | 5655 | 0.3478 | 0.6867 |
| 1992 | 110317 | 51635 | 19909 | 5320 | 0.2672 | 0.7781 |
| 1993 | 124464 | 55690 | 20607 | 4784 | 0.2321 | 0.5858 |
| 1994 | 69122 | 56970 | 25008 | 5733 | 0.2293 | 0.552 |
| 1995 | 61508 | 48486 | 30305 | 5587 | 0.1844 | 0.5713 |
| 1996 | 62627 | 47919 | 26093 | 7075 | 0.2712 | 0.5488 |
| 1997 | 71924 | 41898 | 22438 | 5166 | 0.2302 | 0.3836 |
| 1998 | 73106 | 44222 | 21444 | 4984 | 0.2324 | 0.5817 |
| 1999 | 48875 | 33225 | 16708 | 5221 | 0.3125 | 0.851 |
| 2000 | 28455 | 23352 | 11879 | 4558 | 0.3837 | 1.0696 |
| 2001 | 80889 | 21794 | 6961 | 1918 | 0.2755 | 0.3975 |
| 2002 | 109870 | 36347 | 7344 | 2571 | 0.3501 | 0.4607 |
| 2003 | 51500 | 37905 | 14220 | 5961 | 0.4192 | 0.6478 |
| 2004 | 14336 | 27159 | 17881 | 6400 | 0.3579 | 0.5915 |
| 2005 | 18278 | 22500 | 18270 | 5191 | 0.2841 | 0.3559 |
| 2006 | 84910 | 26882 | 16212 | 2759 | 0.1702 | 0.2317 |
| 2007 | 18353 | 28399 | 13861 | 3348 | 0.2415 | 0.4362 |
| 2008 | 8170 | 30424 | 25502 | 4205 | 0.1649 | 0.3786 |
| 2009 | 4202 | 19755 | 16911 | 3237 | 0.1914 | 0.2237 |
| 2010 | 243* | 18273 | 17109 | 3404 | 0.199 | 0.1528 |
| | | | | | | |
| Arith. | | | | | | |
| Mean | 57586 | 36249 | 18246 | 4654 | 0.2672 | 0.5243 |
| 0 Units | (Thousar | (Tonnes | (Tonnes | (Tonnes) | | |
| 1 | | | | | | |
| | | | | | | |
| * R is 4674 thousands by RCT3 and the total biomass in 2010 will be 1812C | | | | | | |

**Table 4.3.21. Haddock in VIb. Input RCT3 file.**

| | | |
|---|---|---|
| Had in VIb age 1 | | |
| 1 17 2 | | |
| 'Y-class' 'VPA' 'Scotsr0' | | |
| 1993 | 69122 | 15220 |
| 1994 | 61508 | 23474 |
| 1995 | 62627 | 16923 |
| 1996 | 71924 | 33578 |
| 1997 | 73106 | 28897 |
| 1998 | 48875 | -11 |
| 1999 | 28455 | 10178 |
| 2000 | 80889 | -11 |
| 2001 | 109870 | 31813 |
| 2002 | 51500 | 11704 |
| 2003 | 14336 | 2526 |
| 2004 | 18278 | -11 |
| 2005 | 84910 | 24452 |
| 2006 | 18353 | 3570 |
| 2007 | 8170 | 558 |
| 2008 | 4202 | 85 |
| 2009 | 243 | 132 |

**Table 4.3.22. Haddock in VIb. Results of RCT3 runs.**

| Year Class Predictior | Weighted Average Error | Log WAP Error | Int Std | Ext Std | Var Ratio | VPA VPA | Log |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1995 | No | valid | surveys | | | | |
| 1996 | 63625 | 11.06 | 0.06 | 0.05 | 0.6 | 71924 | 11.18 |
| 1997 | 66531 | 11.11 | 0.07 | 0.03 | 0.18 | 73106 | 11.2 |
| 1998 | No | valid | surveys | | | | |
| 1999 | 60532 | 11.01 | 0.14 | 0.12 | 0.76 | 28455 | 10.26 |
| 2000 | No | valid | surveys | | | | |
| 2001 | 69804 | 11.15 | 0.27 | 0.22 | 0.65 | 109871 | 11.61 |
| 2002 | 48061 | 10.78 | 0.29 | 0.33 | 1.26 | 51501 | 10.85 |
| 2003 | 39987 | 10.6 | 0.33 | 0.86 | 6.76 | 14336 | 9.57 |
| 2004 | No | valid | surveys | | | | |
| 2005 | 69433 | 11.15 | 0.28 | 0.17 | 0.39 | 84910 | 11.35 |
| 2006 | 20469 | 9.93 | 0.3 | 0.46 | 2.35 | 18354 | 9.82 |
| 2007 | 7007 | 8.85 | 0.34 | 1.04 | 9.3 | 8170 | 9.01 |
| 2008 | 3192 | 8.07 | 0.38 | 1.27 | 11.01 | 4202 | 8.34 |
| 2009 | 4674 | 8.45 | 0.37 | 0.72 | 3.83 | 243 | 5.5 |

**Table 4.3.23. Haddock in VIb. Input data to short-term forecast.**

| | | | | | | |
|---|---|---|---|---|---|---|
| MFDP version 1a | | | | | | |
| Run: 20PERC | | | | | | |
| Time and ( | 6 | 2011 | | | | |
| Fbar age range (Total) : 2-5 | | | | | | |
| Fbar age range Fleet 1 : 2-5 | | | | | | |
| | | | | | | |
| 2011 | | | | | | |
| Age | N | M | Mat | PF | PM | SWt |
| 1 | 18353 | 0.2 | 0 | 0 | 0 | 0.182 |
| 2 | 3823 | 0.2 | 0 | 0 | 0 | 0.294 |
| 3 | 2575 | 0.2 | 1 | 0 | 0 | 0.363 |
| 4 | 3464 | 0.2 | 1 | 0 | 0 | 0.422 |
| 5 | 4908 | 0.2 | 1 | 0 | 0 | 0.6 |
| 6 | 8017 | 0.2 | 1 | 0 | 0 | 0.641 |
| 7 | 2702 | 0.2 | 1 | 0 | 0 | 0.946 |
| | | | | | | |
| Catch | | | | | | |
| Age | Sel | CWt | DSel | DCWt | | |
| 1 | 0.0085 | 0.159 | 0.0339 | 0.203 | | |
| 2 | 0.0413 | 0.324 | 0.0823 | 0.263 | | |
| 3 | 0.1195 | 0.414 | 0.0639 | 0.295 | | |
| 4 | 0.2116 | 0.44 | 0.0568 | 0.349 | | |
| 5 | 0.3637 | 0.622 | 0.0677 | 0.357 | | |
| 6 | 0.3779 | 0.641 | 0.0524 | 0.475 | | |
| 7 | 0.4078 | 0.946 | 0.0228 | 0.481 | | |
| | | | | | | |
| 2012 | | | | | | |
| Age | N | M | Mat | PF | PM | SWt |
| 1 | 18353 | 0.2 | 0 | 0 | 0 | 0.182 |
| 2 | . | 0.2 | 0 | 0 | 0 | 0.294 |
| 3 | . | 0.2 | 1 | 0 | 0 | 0.363 |
| 4 | . | 0.2 | 1 | 0 | 0 | 0.422 |
| 5 | . | 0.2 | 1 | 0 | 0 | 0.6 |
| 6 | . | 0.2 | 1 | 0 | 0 | 0.641 |
| 7 | . | 0.2 | 1 | 0 | 0 | 0.946 |
| | | | | | | |
| Catch | | | | | | |
| Age | Sel | CWt | DSel | DCWt | | |
| 1 | 0.0085 | 0.159 | 0.0339 | 0.203 | | |
| 2 | 0.0413 | 0.324 | 0.0823 | 0.263 | | |
| 3 | 0.1195 | 0.414 | 0.0639 | 0.295 | | |
| 4 | 0.2116 | 0.44 | 0.0568 | 0.349 | | |
| 5 | 0.3637 | 0.622 | 0.0677 | 0.357 | | |
| 6 | 0.3779 | 0.641 | 0.0524 | 0.475 | | |
| 7 | 0.4078 | 0.946 | 0.0228 | 0.481 | | |
| | | | | | | |
| 2013 | | | | | | |
| Age | N | M | Mat | PF | PM | SWt |
| 1 | 18353 | 0.2 | 0 | 0 | 0 | 0.182 |
| 2 | . | 0.2 | 0 | 0 | 0 | 0.294 |
| 3 | . | 0.2 | 1 | 0 | 0 | 0.363 |
| 4 | . | 0.2 | 1 | 0 | 0 | 0.422 |
| 5 | . | 0.2 | 1 | 0 | 0 | 0.6 |
| 6 | . | 0.2 | 1 | 0 | 0 | 0.641 |
| 7 | . | 0.2 | 1 | 0 | 0 | 0.946 |
| | | | | | | |
| Catch | | | | | | |
| Age | Sel | CWt | DSel | DCWt | | |
| 1 | 0.0085 | 0.159 | 0.0339 | 0.203 | | |
| 2 | 0.0413 | 0.324 | 0.0823 | 0.263 | | |
| 3 | 0.1195 | 0.414 | 0.0639 | 0.295 | | |
| 4 | 0.2116 | 0.44 | 0.0568 | 0.349 | | |
| 5 | 0.3637 | 0.622 | 0.0677 | 0.357 | | |
| 6 | 0.3779 | 0.641 | 0.0524 | 0.475 | | |
| 7 | 0.4078 | 0.946 | 0.0228 | 0.481 | | |
| | | | | | | |
| Input units are thousands and kg - output in tonnes | | | | | | |

**Table 4.3.24. Haddock in VIb. Short-term forecast.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MFDP version 1a | | | | | | | | |
| Run: 20PERC | | | | | | | | |
| Time and ( | 6 | 2011 | | | | | | |
| Fbar age range (Total) : 2-5 | | | | | | | | |
| Fbar age range Fleet 1 : 2-5 | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 2011 | | | | | | | | |
| | | Catch | Landings | | Discards | | | |
| Biomass | SSB | FMult | FBar | Yield | FBar | Yield | | |
| 17501 | 13036 | 1 | 0.184 | 3466 | 0.0677 | 536 | | |
| | | | | | | | | |
| 2012 | | | | | | | 2013 | |
| | | Catch | Landings | | Discards | | | |
| Biomass | SSB | FMult | FBar | Yield | FBar | Yield | Biomass | SSB |
| 17692 | 10118 | 0 | 0 | 0 | 0 | 0 | 21436 | 13678 |
| . | 10118 | 0.1 | 0.0184 | 342 | 0.0068 | 63 | 21005 | 13266 |
| . | 10118 | 0.2 | 0.0368 | 670 | 0.0135 | 125 | 20589 | 12868 |
| . | 10118 | 0.3 | 0.0552 | 987 | 0.0203 | 186 | 20188 | 12486 |
| . | 10118 | 0.4 | 0.0736 | 1292 | 0.0271 | 246 | 19800 | 12117 |
| . | 10118 | 0.5 | 0.092 | 1585 | 0.0338 | 305 | 19426 | 11761 |
| . | 10118 | 0.6 | 0.1104 | 1867 | 0.0406 | 362 | 19065 | 11418 |
| . | 10118 | 0.7 | 0.1288 | 2139 | 0.0474 | 419 | 18716 | 11088 |
| . | 10118 | 0.8 | 0.1472 | 2401 | 0.0541 | 475 | 18380 | 10769 |
| . | 10118 | 0.9 | 0.1656 | 2653 | 0.0609 | 529 | 18054 | 10461 |
| . | 10118 | 1 | 0.184 | 2896 | 0.0677 | 583 | 17739 | 10165 |
| . | 10118 | 1.1 | 0.2024 | 3131 | 0.0744 | 636 | 17436 | 9879 |
| . | 10118 | 1.2 | 0.2208 | 3356 | 0.0812 | 688 | 17142 | 9603 |
| . | 10118 | 1.3 | 0.2392 | 3574 | 0.088 | 739 | 16858 | 9336 |
| . | 10118 | 1.4 | 0.2576 | 3783 | 0.0947 | 789 | 16583 | 9079 |
| . | 10118 | 1.5 | 0.276 | 3985 | 0.1015 | 838 | 16317 | 8831 |
| . | 10118 | 1.6 | 0.2944 | 4180 | 0.1083 | 887 | 16060 | 8592 |
| . | 10118 | 1.7 | 0.3128 | 4367 | 0.115 | 934 | 15811 | 8360 |
| . | 10118 | 1.8 | 0.3312 | 4548 | 0.1218 | 981 | 15570 | 8137 |
| . | 10118 | 1.9 | 0.3496 | 4723 | 0.1286 | 1028 | 15337 | 7921 |
| . | 10118 | 2 | 0.3681 | 4891 | 0.1354 | 1073 | 15111 | 7713 |
| | | | | | | | | |
| Input units are thousands and kg - output in tonnes | | | | | | | | |

**Table 4.3.25. Haddock in VIb. Detailed short-term forecast output.**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFDP version 1a | | | | | | | | | | | | |
| Run: 20PERC | | | | | | | | | | | | |
| Time and ( | 6 | 2011 | | | | | | | | | | |
| Fbar age range (Total) : 2-5 | | | | | | | | | | | | |
| Fbar age range Fleet 1 : 2-5 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Year: | 2011 | F multiplier | 1 | Fleet1 HCF | 0.184 | Fleet1 DFb | 0.0677 | | | | | |
| | Catch | | | | | | | | | | | |
| Age | F | CatchNos | Yield | DF | DCatchNo | DYield | StockNos | Biomass | SSNos(Jan | SSB(Jan) | SSNos(ST | SSB(ST) |
| 1 | 0.0085 | 139 | 22 | 0.0339 | 553 | 112 | 18353 | 3340 | 0 | 0 | 0 | 0 |
| 2 | 0.0413 | 135 | 44 | 0.0823 | 269 | 71 | 3823 | 1124 | 0 | 0 | 0 | 0 |
| 3 | 0.1195 | 256 | 106 | 0.0639 | 137 | 40 | 2575 | 935 | 2575 | 935 | 2575 | 935 |
| 4 | 0.2116 | 585 | 258 | 0.0568 | 157 | 55 | 3464 | 1462 | 3464 | 1462 | 3464 | 1462 |
| 5 | 0.3637 | 1324 | 823 | 0.0677 | 246 | 88 | 4908 | 2945 | 4908 | 2945 | 4908 | 2945 |
| 6 | 0.3779 | 2247 | 1441 | 0.0524 | 312 | 148 | 8017 | 5139 | 8017 | 5139 | 8017 | 5139 |
| 7 | 0.4078 | 817 | 773 | 0.0228 | 46 | 22 | 2702 | 2556 | 2702 | 2556 | 2702 | 2556 |
| Total | | 5503 | 3466 | | 1719 | 536 | 43842 | 17501 | 21666 | 13036 | 21666 | 13036 |
| | | | | | | | | | | | | |
| Year: | 2012 | F multiplier | 1 | Fleet1 HCF | 0.184 | Fleet1 DFb | 0.0677 | | | | | |
| | Catch | | | | | | | | | | | |
| Age | F | CatchNos | Yield | DF | DCatchNo | DYield | StockNos | Biomass | SSNos(Jan | SSB(Jan) | SSNos(ST | SSB(ST) |
| 1 | 0.0085 | 139 | 22 | 0.0339 | 553 | 112 | 18353 | 3340 | 0 | 0 | 0 | 0 |
| 2 | 0.0413 | 508 | 165 | 0.0823 | 1013 | 266 | 14402 | 4234 | 0 | 0 | 0 | 0 |
| 3 | 0.1195 | 275 | 114 | 0.0639 | 147 | 43 | 2766 | 1004 | 2766 | 1004 | 2766 | 1004 |
| 4 | 0.2116 | 297 | 130 | 0.0568 | 80 | 28 | 1755 | 741 | 1755 | 741 | 1755 | 741 |
| 5 | 0.3637 | 585 | 364 | 0.0677 | 109 | 39 | 2168 | 1301 | 2168 | 1301 | 2168 | 1301 |
| 6 | 0.3779 | 732 | 469 | 0.0524 | 101 | 48 | 2610 | 1673 | 2610 | 1673 | 2610 | 1673 |
| 7 | 0.4078 | 1726 | 1633 | 0.0228 | 97 | 46 | 5707 | 5399 | 5707 | 5399 | 5707 | 5399 |
| Total | | 4260 | 2896 | | 2098 | 583 | 47762 | 17692 | 15007 | 10118 | 15007 | 10118 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Year: | 2013 | F multiplier | 1 | Fleet1 HCF | 0.184 | Fleet1 DFb | 0.0677 | | | | | |
| | Catch | | | | | | | | | | | |
| Age | F | CatchNos | Yield | DF | DCatchNo | DYield | StockNos | Biomass | SSNos(Jan | SSB(Jan) | SSNos(ST | SSB(ST) |
| 1 | 0.0085 | 139 | 22 | 0.0339 | 553 | 112 | 18353 | 3340 | 0 | 0 | 0 | 0 |
| 2 | 0.0413 | 508 | 165 | 0.0823 | 1013 | 266 | 14402 | 4234 | 0 | 0 | 0 | 0 |
| 3 | 0.1195 | 1034 | 428 | 0.0639 | 553 | 163 | 10421 | 3783 | 10421 | 3783 | 10421 | 3783 |
| 4 | 0.2116 | 319 | 140 | 0.0568 | 85 | 30 | 1885 | 796 | 1885 | 796 | 1885 | 796 |
| 5 | 0.3637 | 296 | 184 | 0.0677 | 55 | 20 | 1099 | 659 | 1099 | 659 | 1099 | 659 |
| 6 | 0.3779 | 323 | 207 | 0.0524 | 45 | 21 | 1153 | 739 | 1153 | 739 | 1153 | 739 |
| 7 | 0.4078 | 1339 | 1267 | 0.0228 | 75 | 36 | 4427 | 4188 | 4427 | 4188 | 4427 | 4188 |
| Total | | 3958 | 2413 | | 2379 | 648 | 51741 | 17739 | 18985 | 10165 | 18985 | 10165 |
| | | | | | | | | | | | | |
| Input units are thousands and kg - output in tonnes | | | | | | | | | | | | |

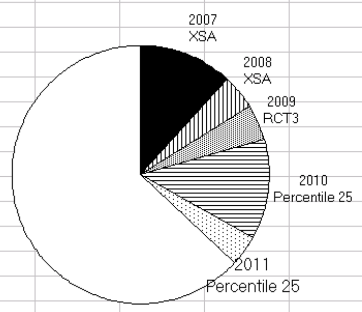
**Table 4.3.26. Haddock VIb. Stock numbers of recruits which were calculated by percentile 25 and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.**

| Year-class | | | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| Stock No. (thousands) | | | 8170 | 4202 | 4674 | 18353 | 18353 |
| of | 1 | year-olds | | | | | |
| Source | | | XSA | XSA | RCT3 | Percentile 25 | Percentile 25 |
| Status Quo F: | | | | | | | |
| % in | 2011 | landings | 7.8 | 3.6 | 2.9 | 3.3 | - |
| % in | 2012 | landings | 11.6 | 4.5 | 4.5 | 12.4 | 3.9 |
| % in | 2011 | SSB | 11.2 | 7.2 | 0.0 | 0.0 | - |
| % in | 2012 | SSB | 12.9 | 7.3 | 9.9 | 0.0 | 0.0 |
| % in | 2013 | SSB | 7.3 | 6.5 | 7.8 | 37.2 | 0.0 |

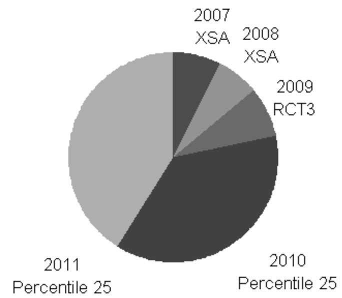
GM : geometric mean recruitment

Haddock VIb : Year-class % contribution to

a ) 2012 landings




b ) 2013 SSB



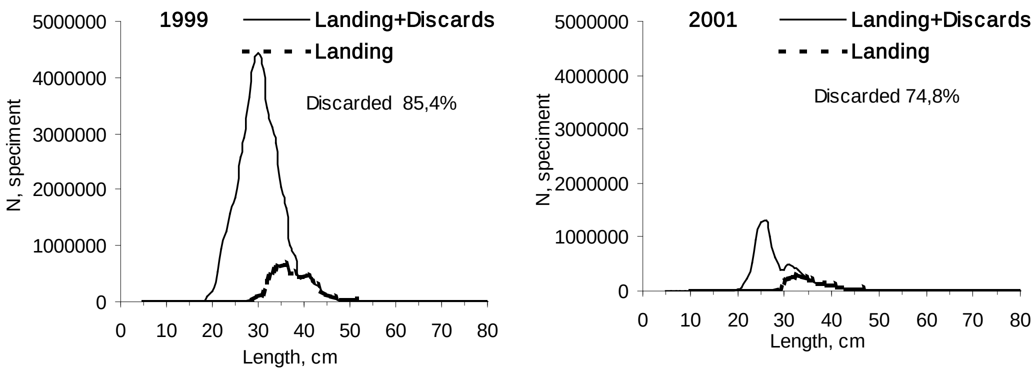



**Figure 4.3.1. Length distribution and quantity of haddock lifted on board and landings by Scottish trawlers in 1999 and 2001 (unpublished data, Newton, 2004).**

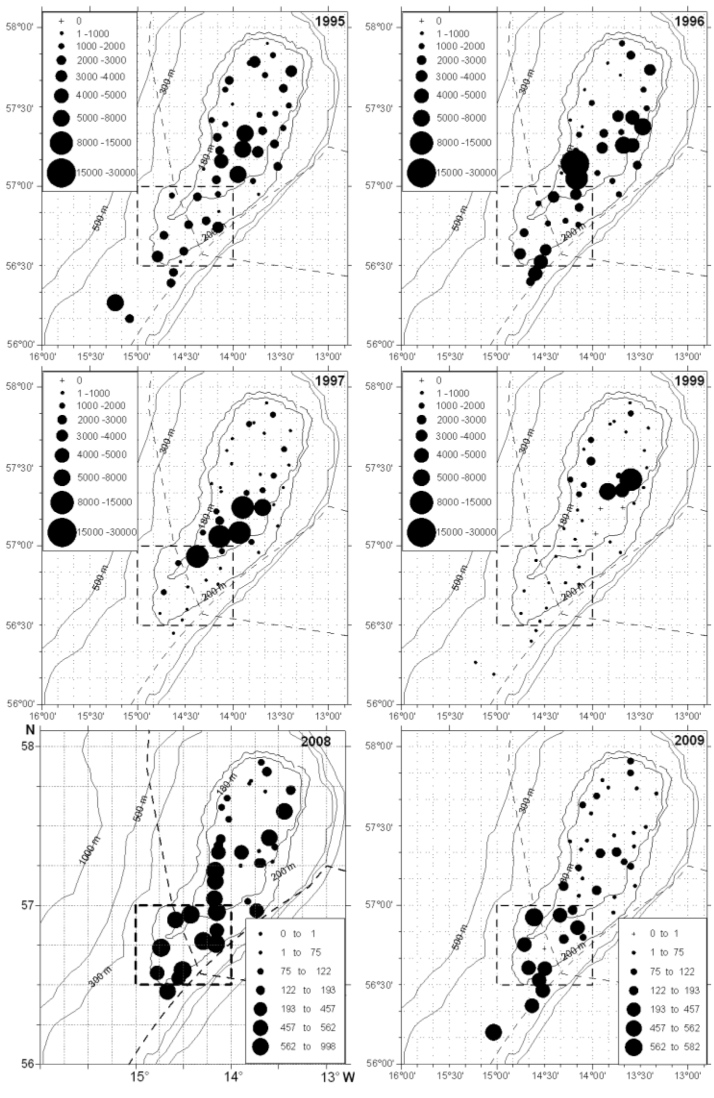



**Figure 4.3.2. Distribution of haddock (catch per 30 minutes) on the Rockall Bank in 1995–1999 and 2008–2009 from the Scottish trawl survey.**

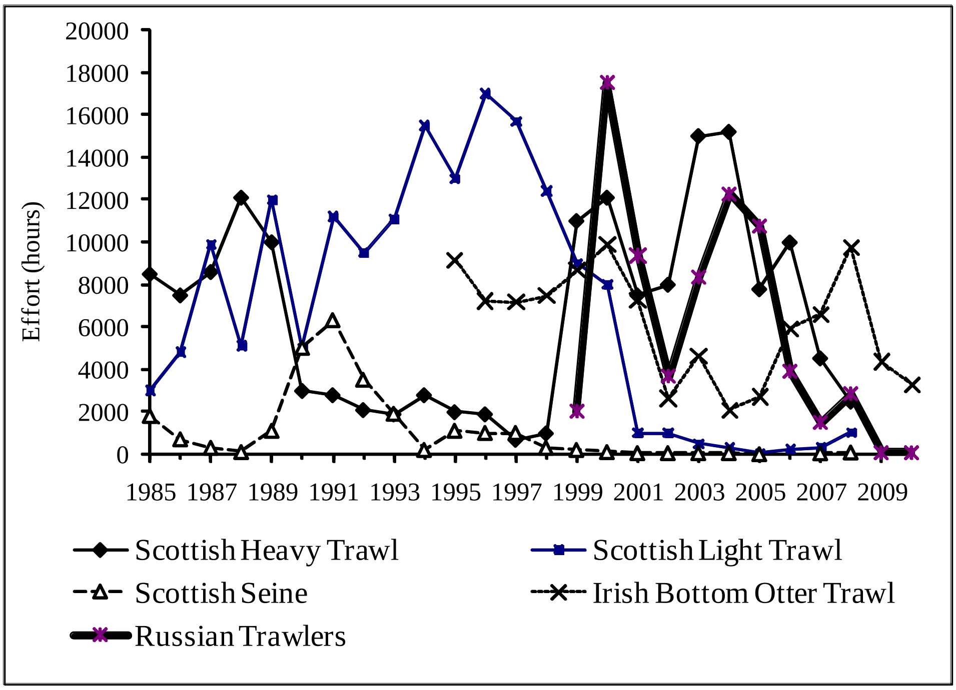



**Figure 4.3.3. Rockall haddock in VIb. Scottish, Irish effort in 1985–2009 and Russian effort in 1999–2010.**

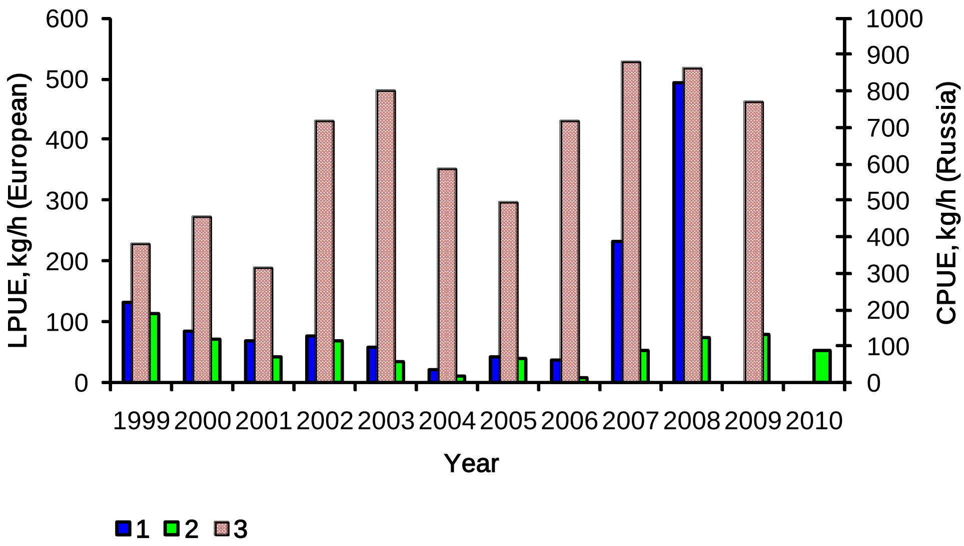



**Figure 4.3.4. Lpue and cpue of the fleets fishing for Rockall haddock in 1999–2009. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.**

**1–Scottish lpue (all gears).**

**2–Irish trawlers lpue.**

**3–Cpue of Russian trawlers (BMRT type, tonnage class 10 in 1999–2007, and tonnage class 9 in 2008–2009).**

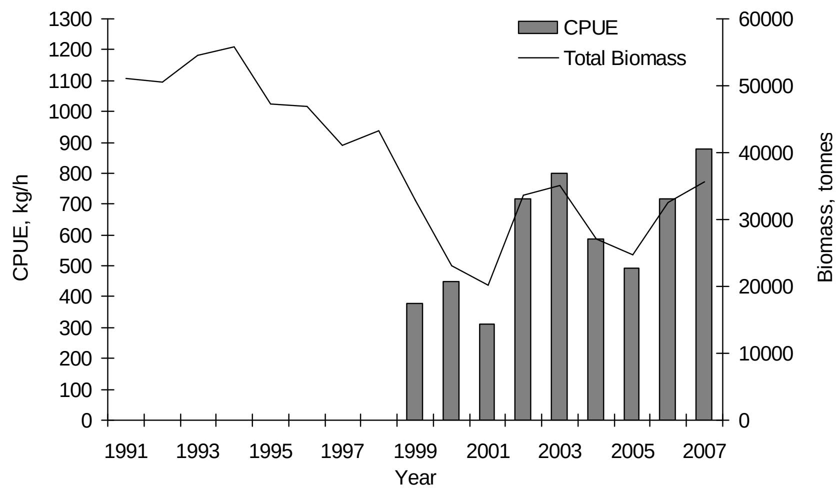



**Figure 4.3.5. Dynamics of haddock total biomass (ICES, 2008a; ICES, 2008b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2007.**

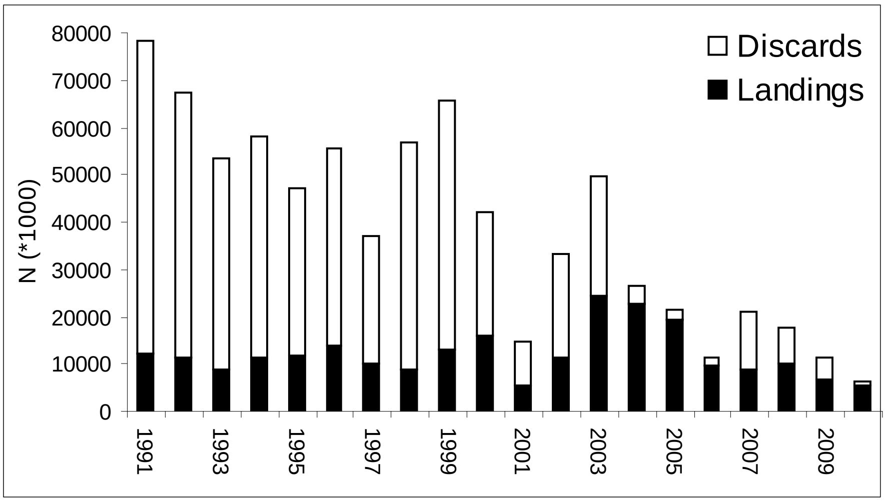



**Figure 4.3.6. Total landings and discards of Rockall haddock ('000 individuals).**

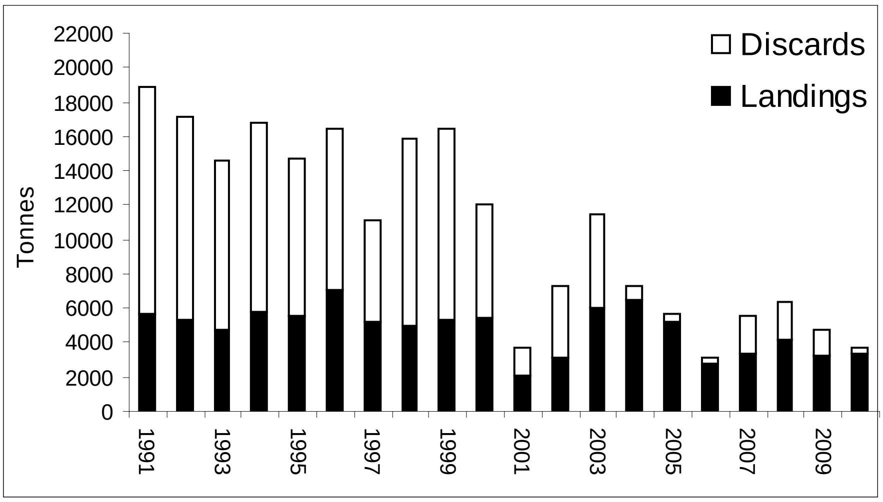



**Figure 4.3.7. Total landings and discards of Rockall haddock (tonnes).**

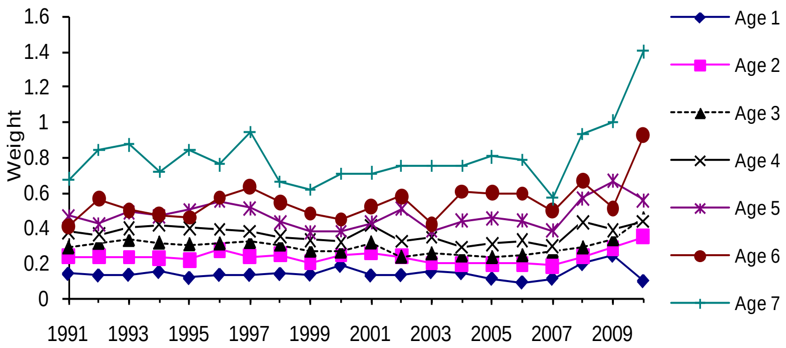
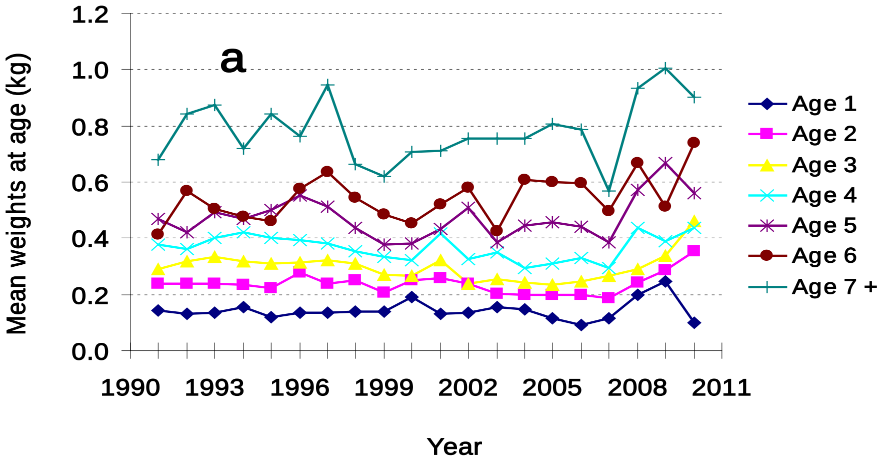



**Figure 4.3.8. Haddock in VIb. Mean weights-at-age in catch by samples data.**



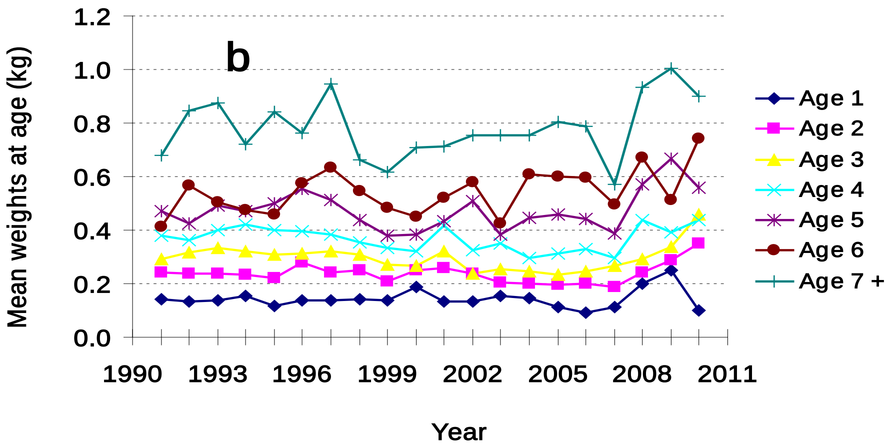




**Figure 4.3.9. Haddock in VIb. Mean weights-at-age a) in catch and b) in stock.**

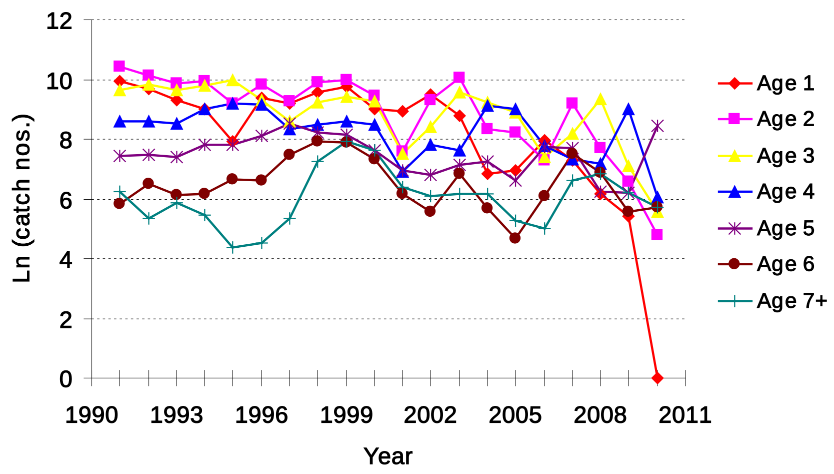



**Figure 4.3.10. Haddock in VIb. Log catch (with discards in numbers) at age by year.**

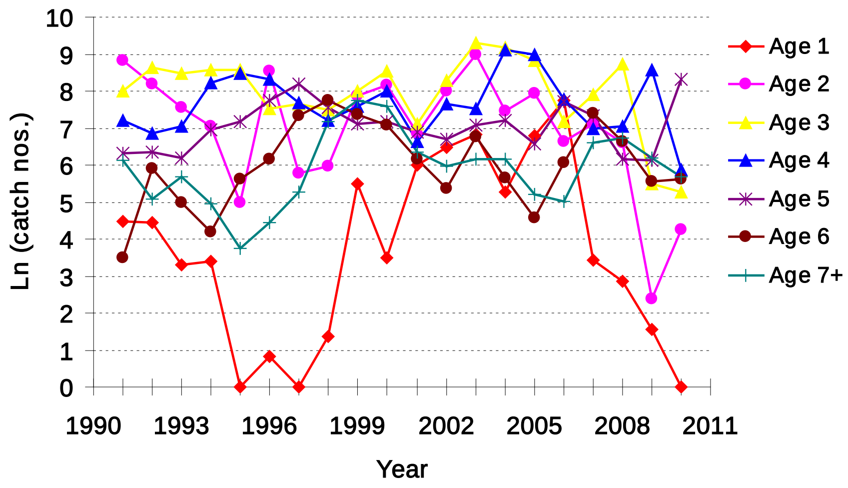



**Figure 4.3.11. Haddock in VIb. Log landings (in numbers) at age by year.**

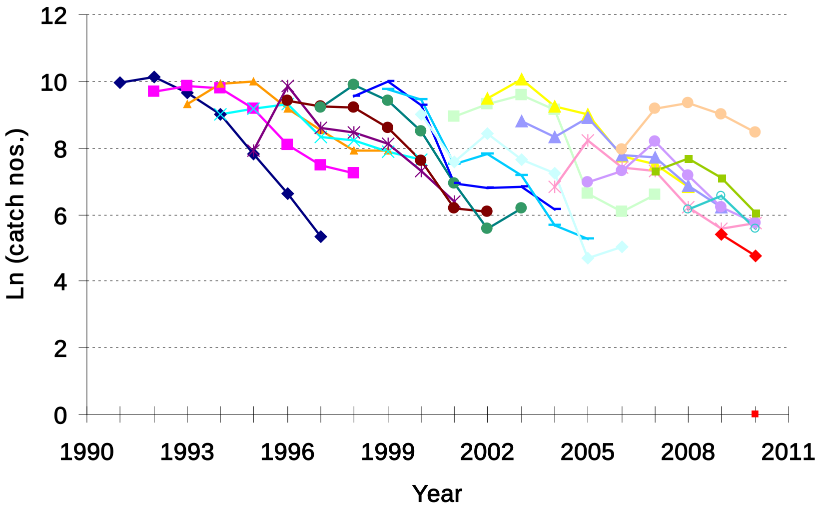



**Figure 4.3.12. Haddock in VIb. Log catch (with discards, in numbers) at age by year class.**

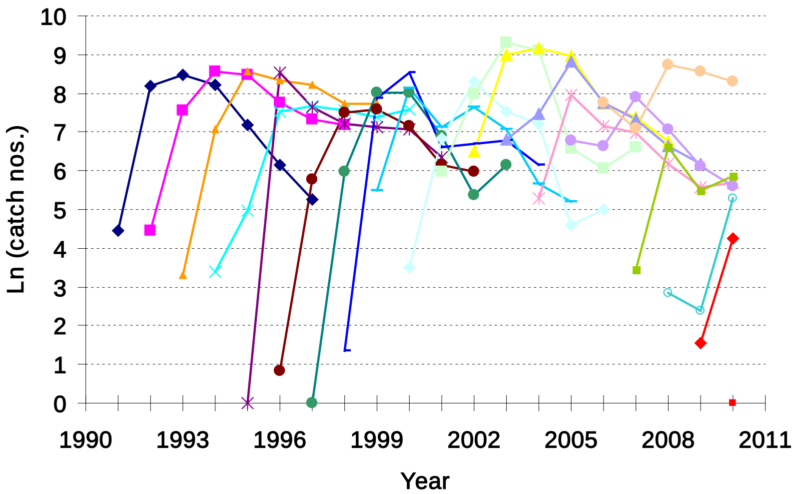



**Figure 4.3.13. Haddock in VIb. Log landings (without registered discards, in numbers) at age by year class.**

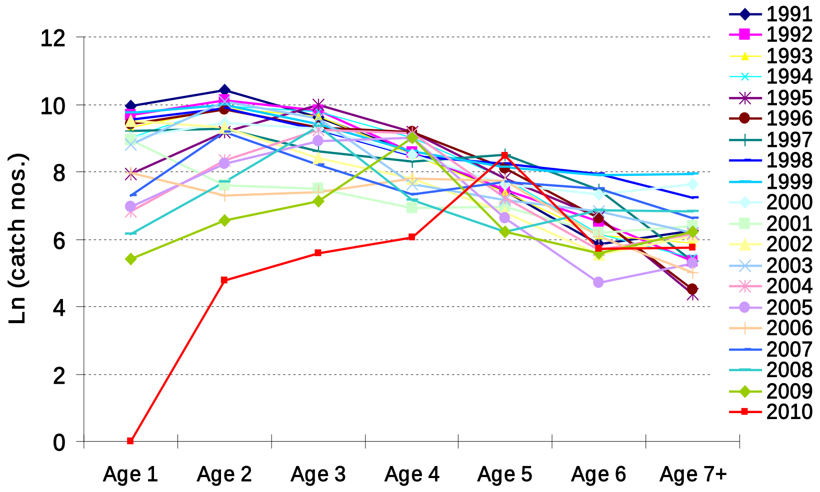



**Figure 4.3.14. Haddock in VIb. Catch curves (with registered discards).**

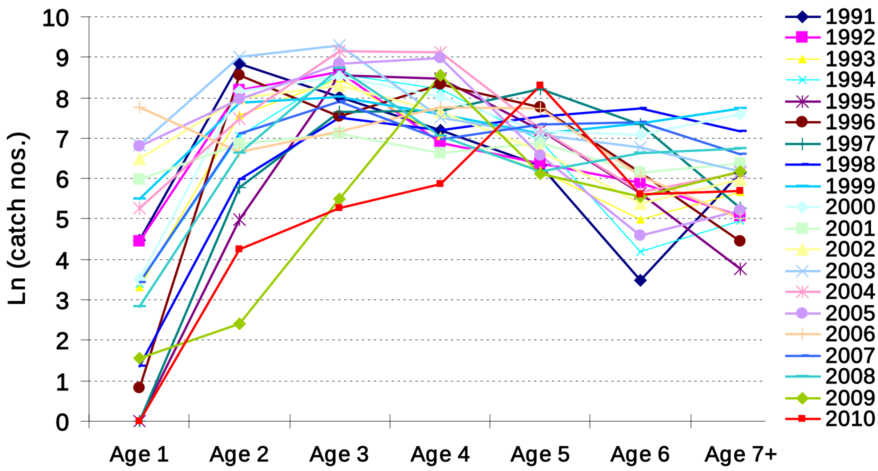



**Figure 4.3.15. Haddock in VIb. Catch curves (landings without registered discards).**

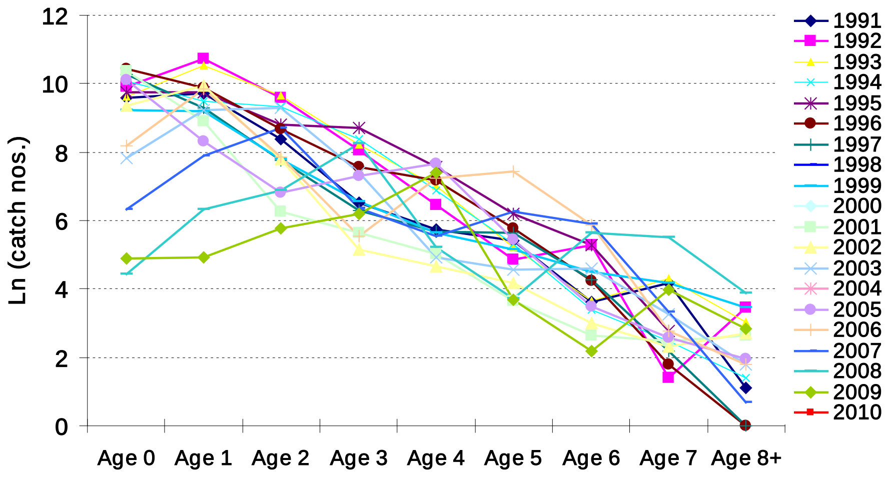



**Figure 4.3.16. Haddock in VIb. Log survey cpue at age by year.**

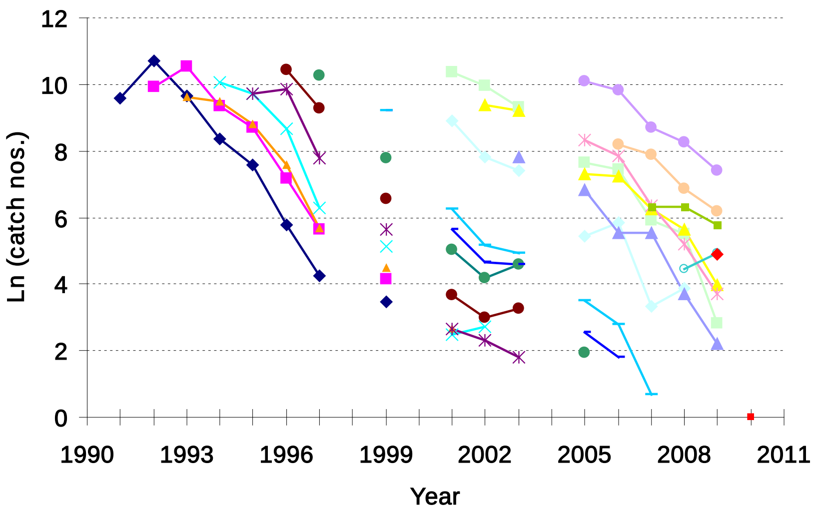



**Figure 4.3.17. Haddock in VIb. Log survey cpue by year class.**

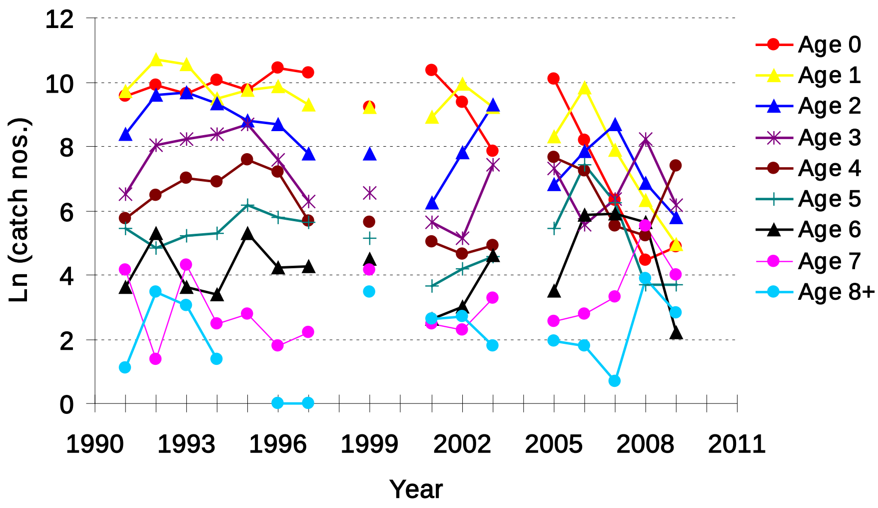



**Figure 4.3.18. Haddock in VIb. Log survey cpue at age.**

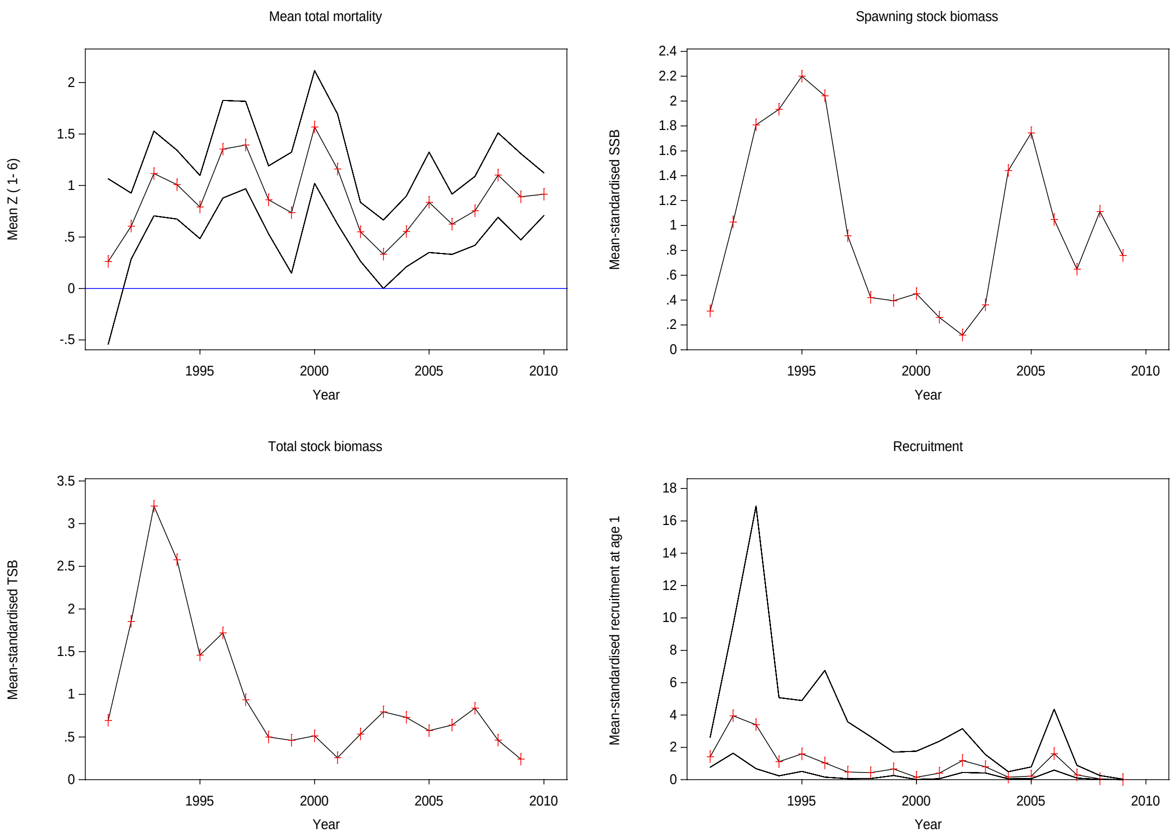



**Figure 4.3.19. SURBA analysis for Rockall haddock.**

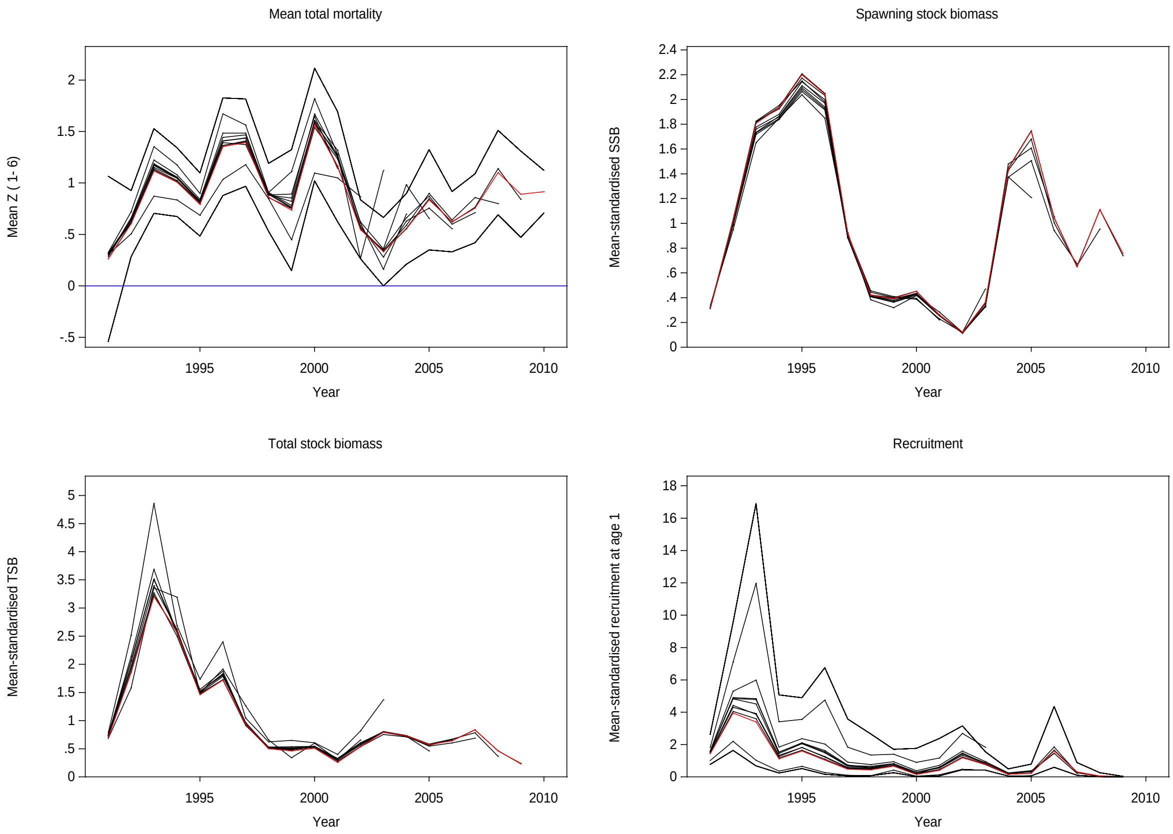



**Figure 4.3.19a. SURBA analysis for Rockall haddock. Retrospective plots.**

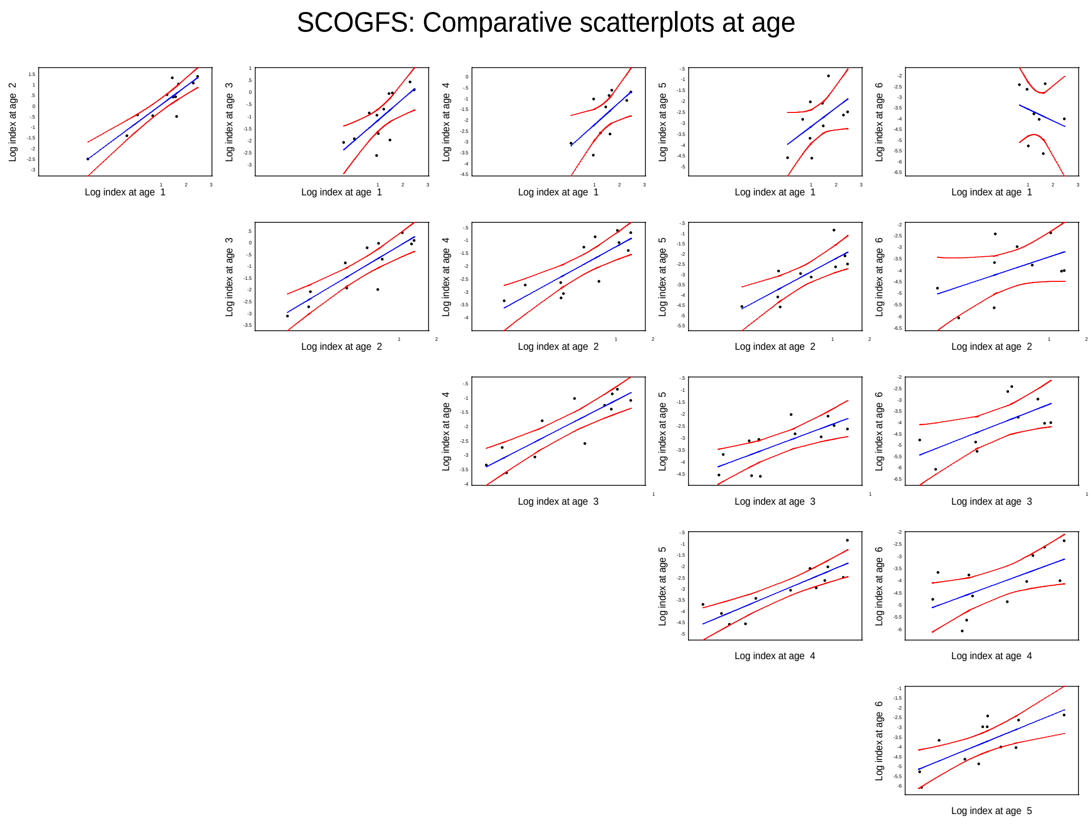



**Figure 4.3.19b. SURBA analysis for Rockall haddock. Pairwise plots of age.**

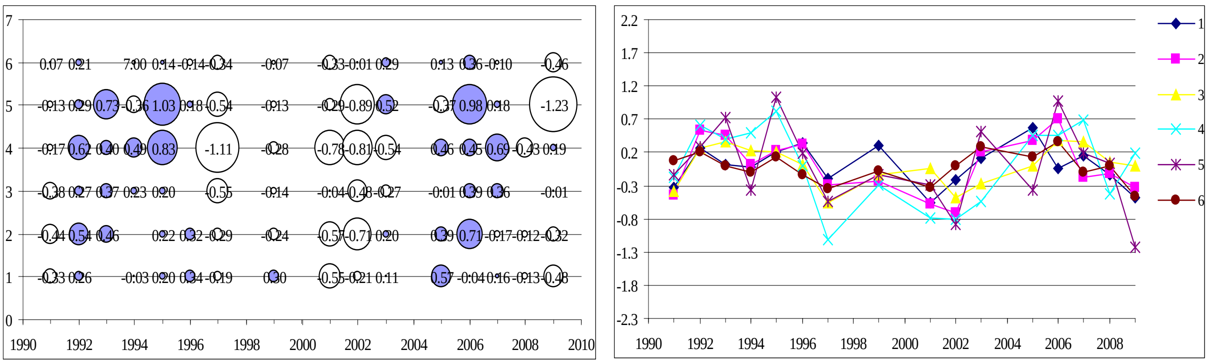


**Figure 4.3.20. Haddock in VIb. Log-catchability residual plots (shrinkage 1.0). XSA run 2009: catchability dependent on stock size at ages <4. Old survey indices data.**

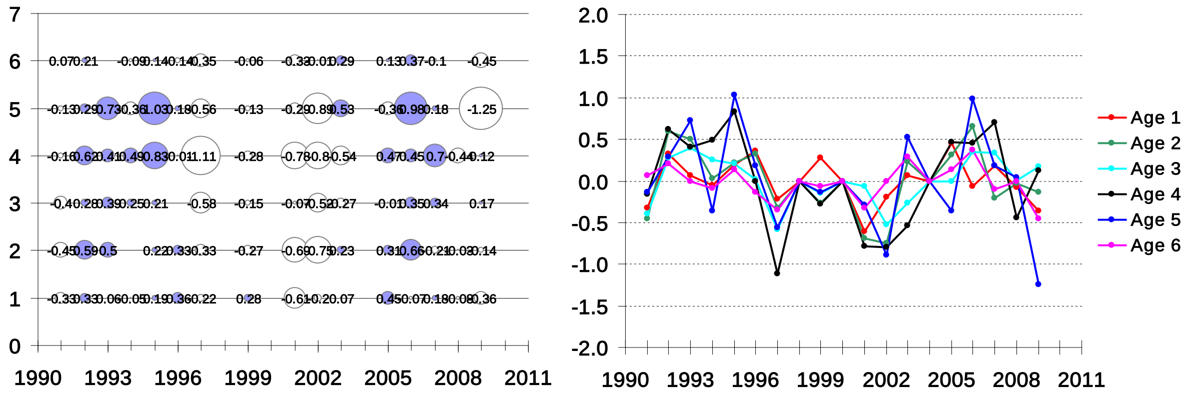



**Figure 4.3.21. Haddock in VIb. Log-catchability residual plots (shrinkage 1.0). Final XSA 2010: catchability dependent on stock size at ages <4. Old survey indices data.**

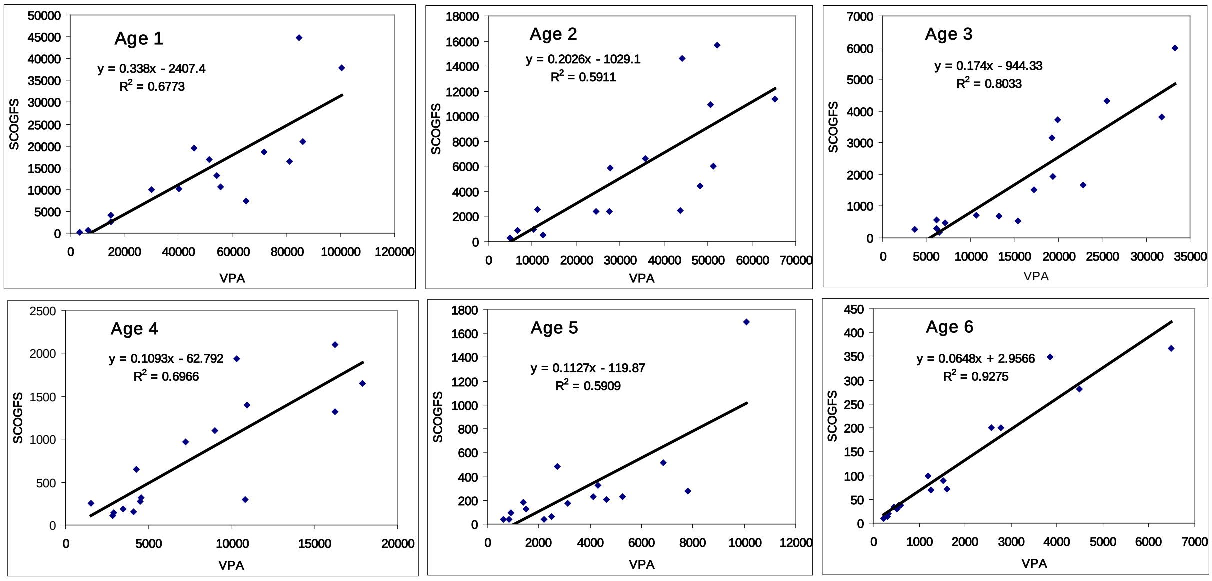



**Figure 4.3.22. Haddock in VIb. Adjusted Scottish groundfish survey cpue from the final XSA run plotted against VPA numbers (shrinkage 1.0) at age. Catchability dependent on stock size at ages <4.**

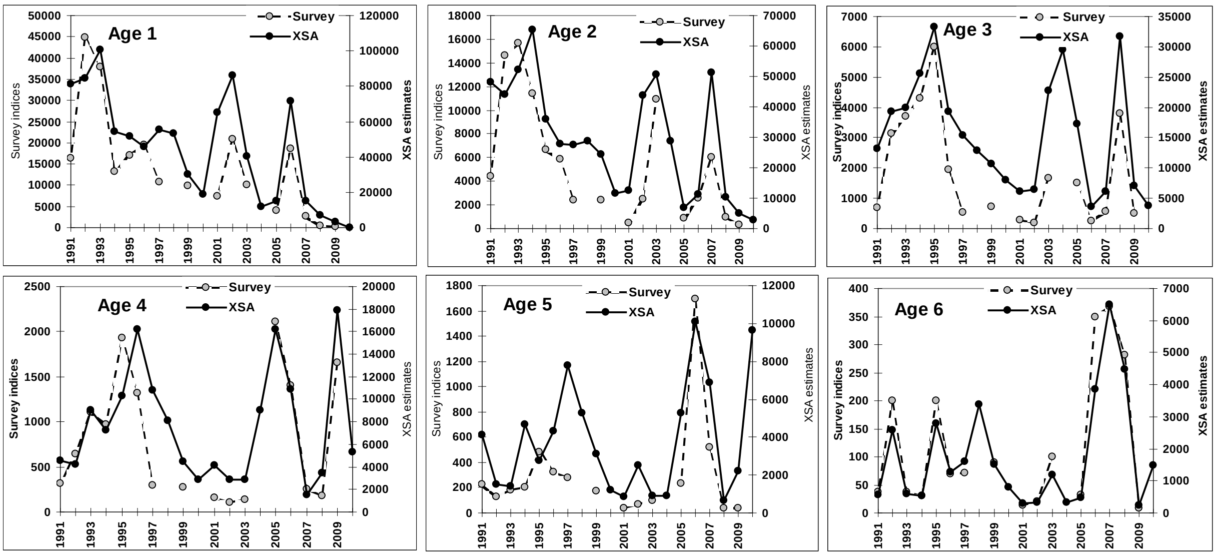



**Figure 4.3.23. Haddock in VIb. Survey indices and XSA estimates (shrinkage 1.0) at age. Final XSA: catchability dependent on stock size at ages <4.**

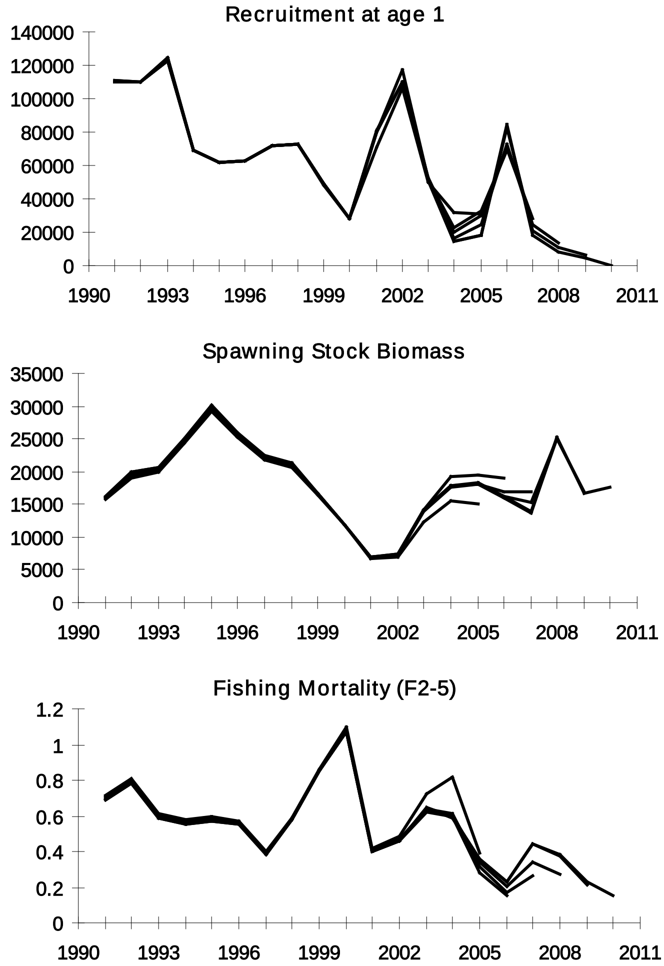



Figure 4.3.24. Haddock in VIb. Retrospective analyses (F shrinkage 1.0).

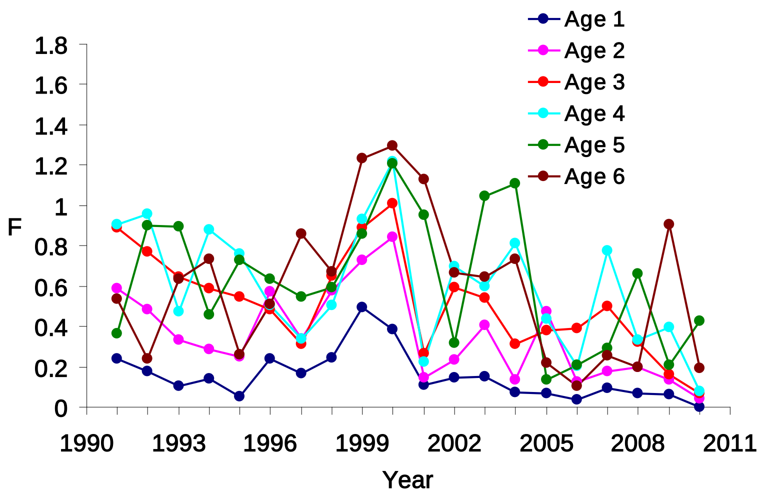



Figure 4.3.25. Haddock in VIb. F at age (F shrinkage 1.0).

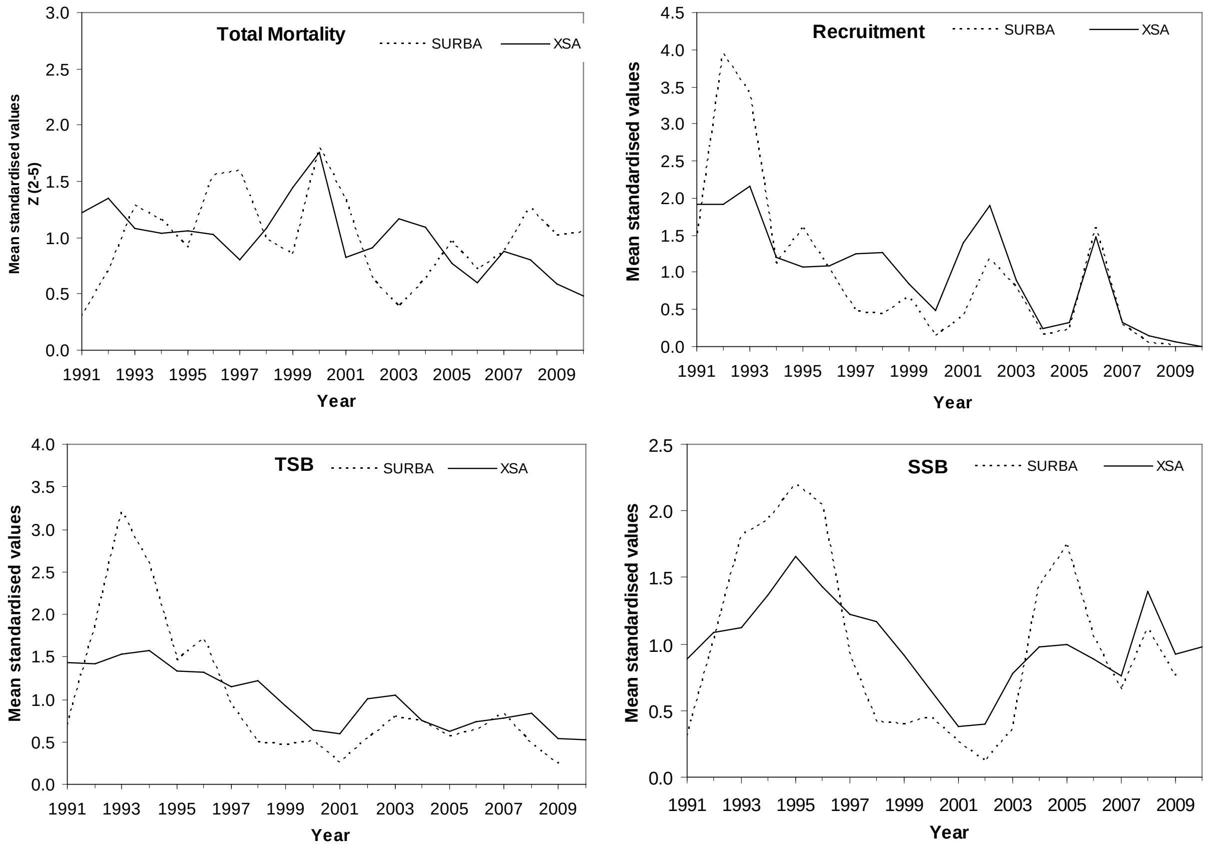



**Figure 4.3.26. Haddock in VIb. XSA and SURBA analyses.**

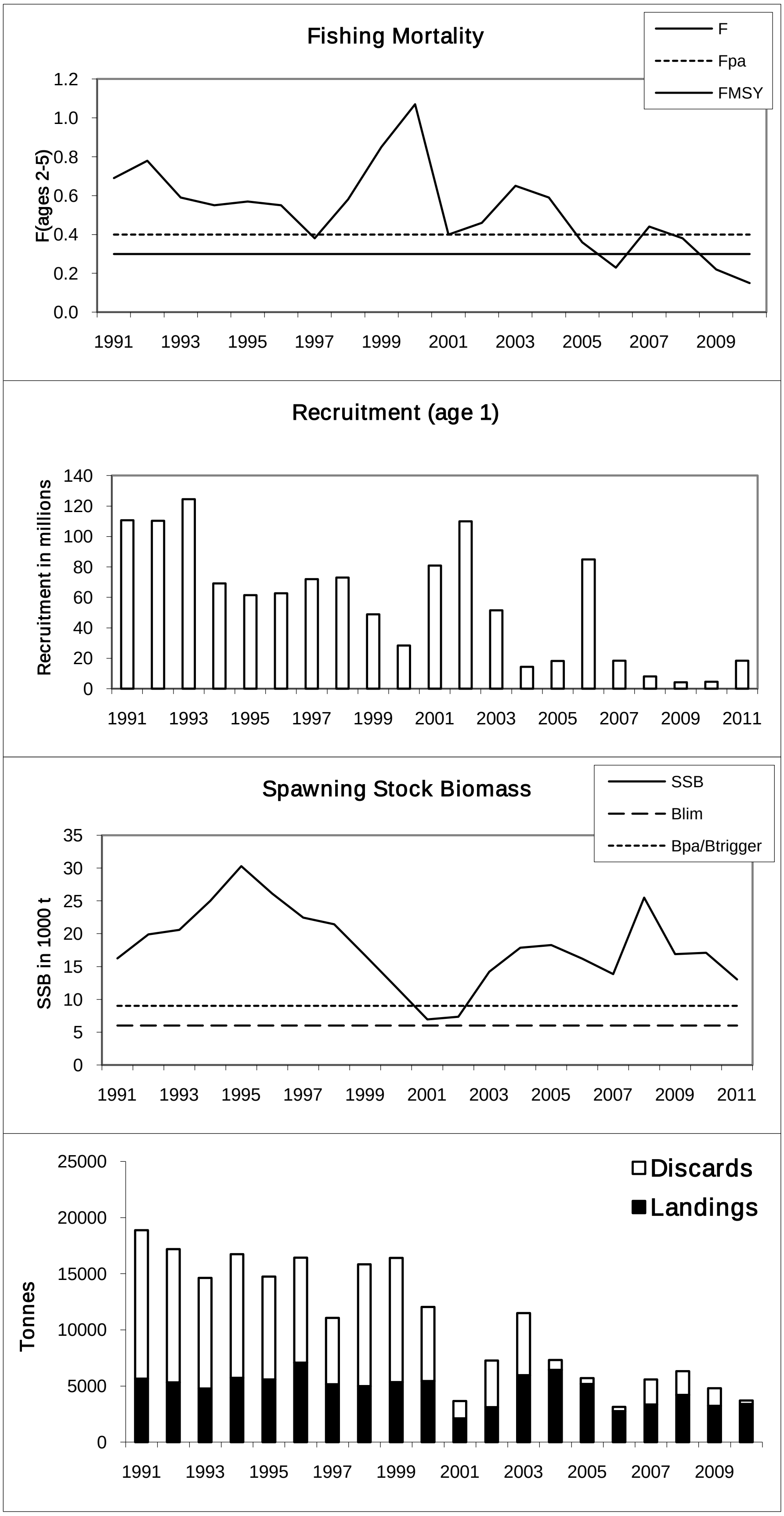



**Figure 4.3.27. Haddock in VIb. Summary plots.**

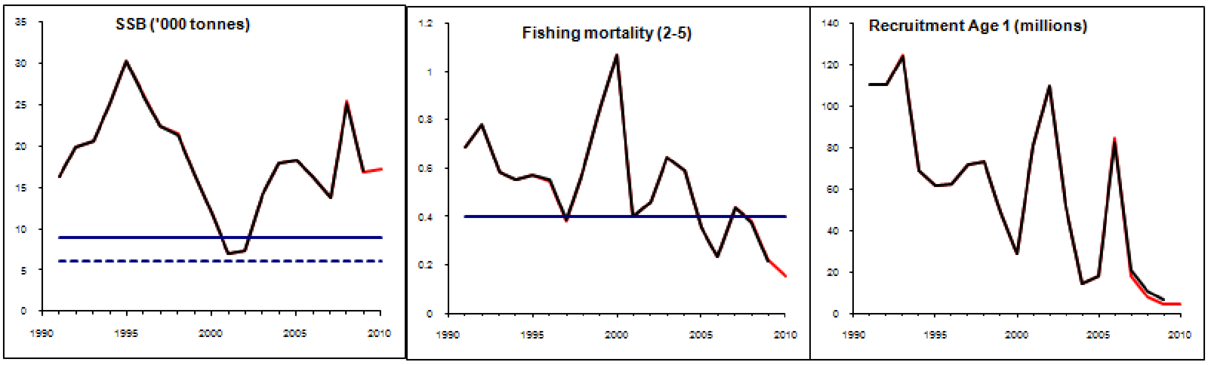



Figure 4.3.28. Haddock in VIb. Comparison of the current assessment (in red) with the previous one (in black).

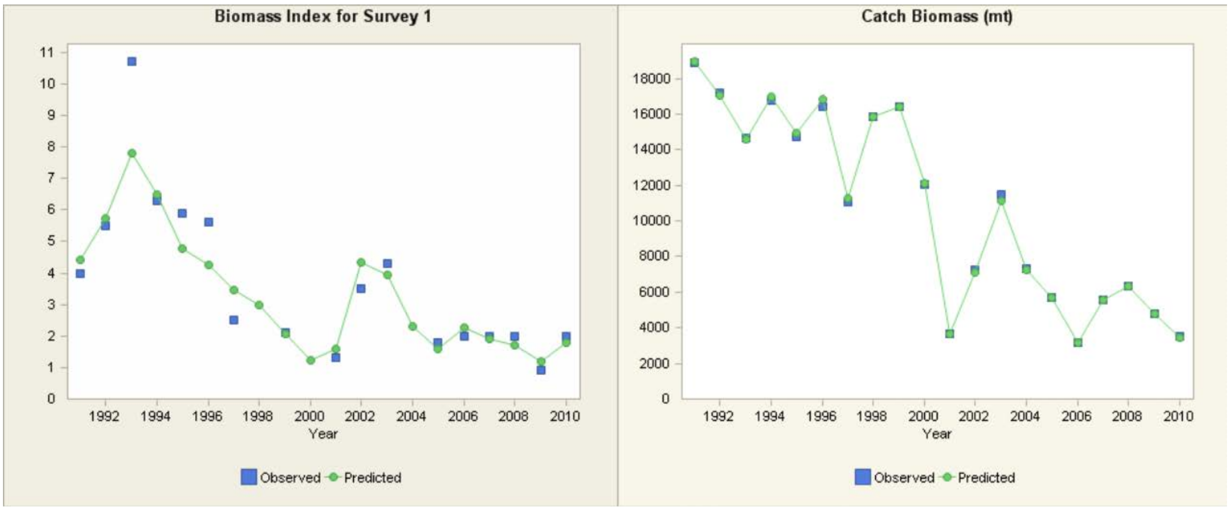



Figure 4.3.29. Haddock in VIb. Comparison observed and predicted by StatCam survey index and catch biomass . Scenario 2.

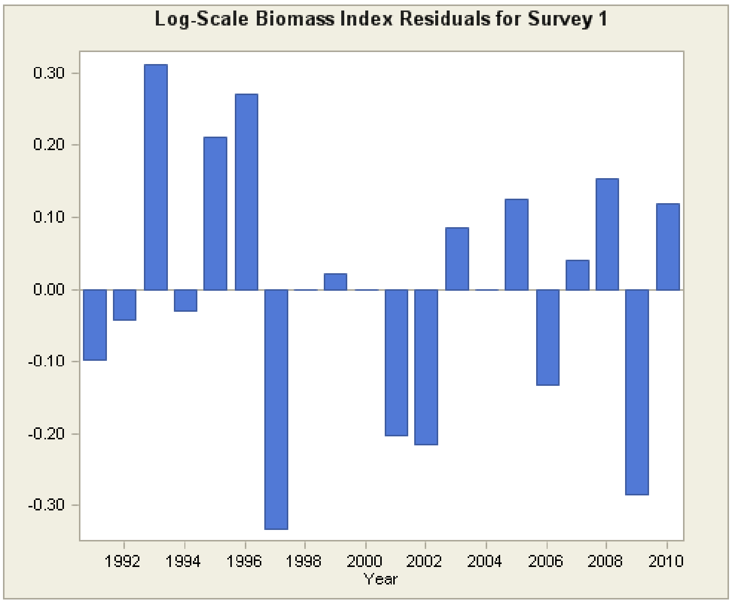



Figure 4.3.30. Haddock in VIb. Log-catchability residuals plot for survey biomass index. Scenario 2 of Statcam run.

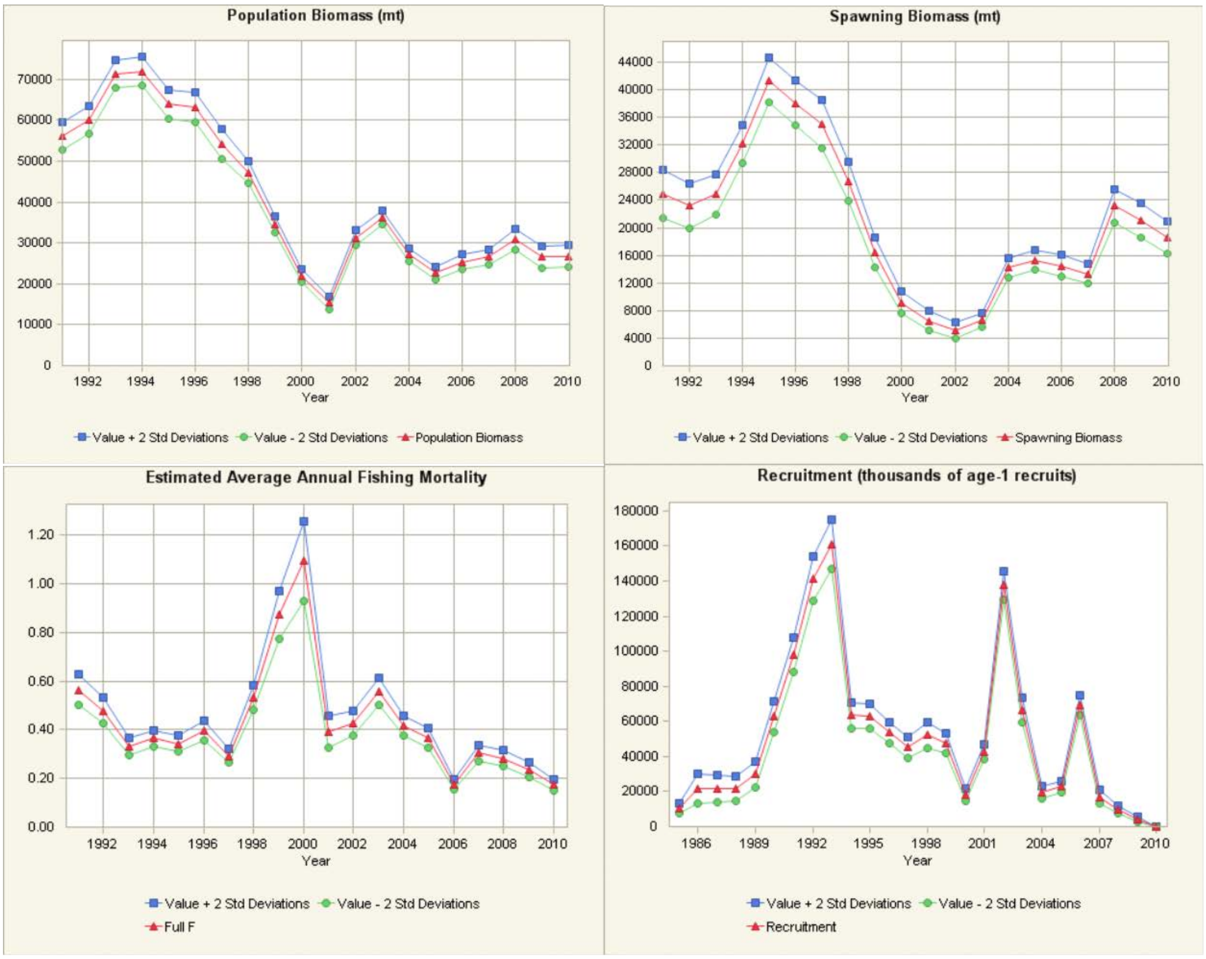



**Figure 4.3.31. Haddock in VIb. Population biomass, SSB, fishin mortality and recruitment by Statcam estimation. Scenario 2.**

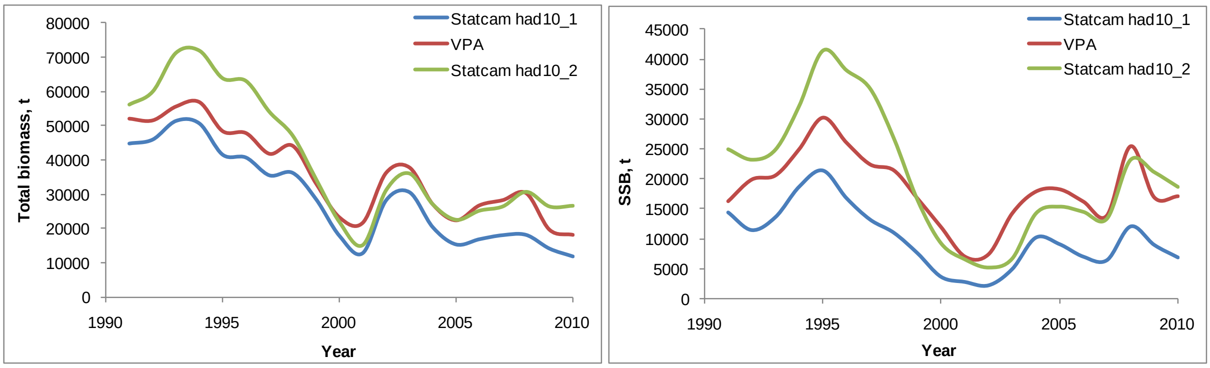



**Figure 4.3.32. Haddock in VIb. Comparison of VPA assessment with the statistical catch-at-age model StatCam assessment.**

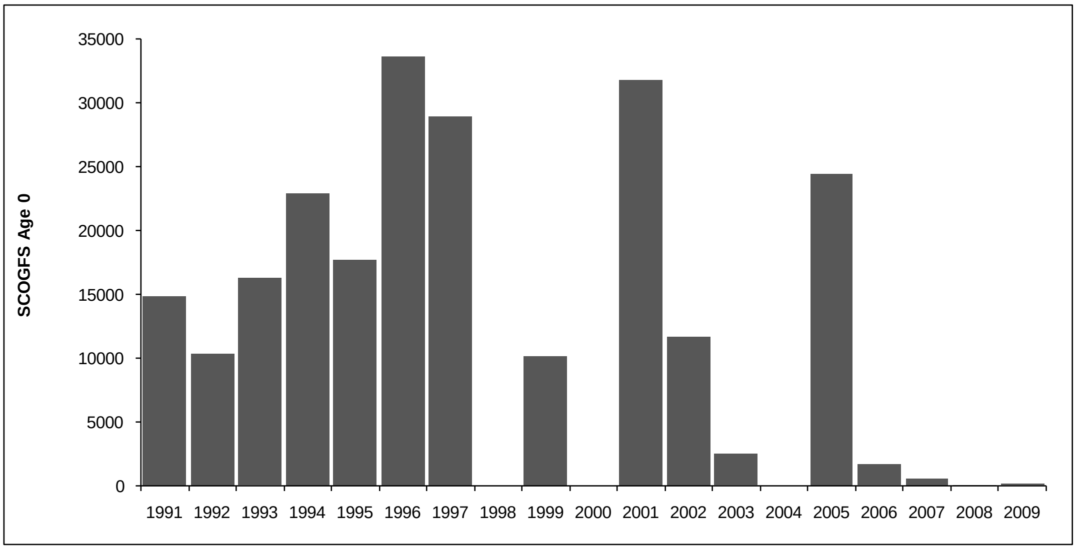



**Figure 4.3.33. Haddock in VIb. Scottish Groundfish survey indices of haddock at age 0.**

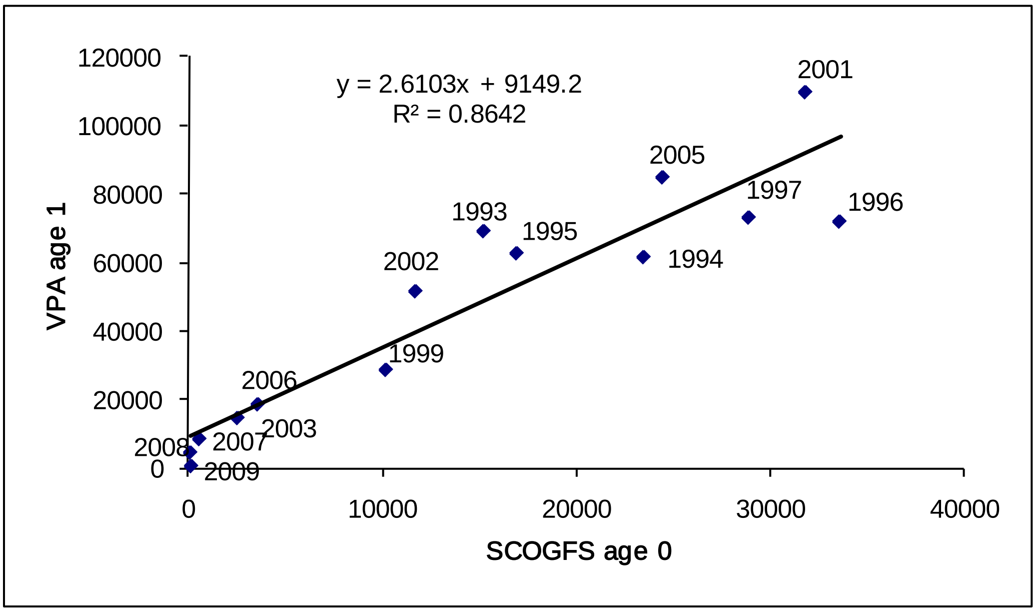



**Figure 4.3.34. Haddock in VIb. VPA numbers-at-age 1 from XSA plotted against Scottish Groundfish survey indices of haddock at age 0.**

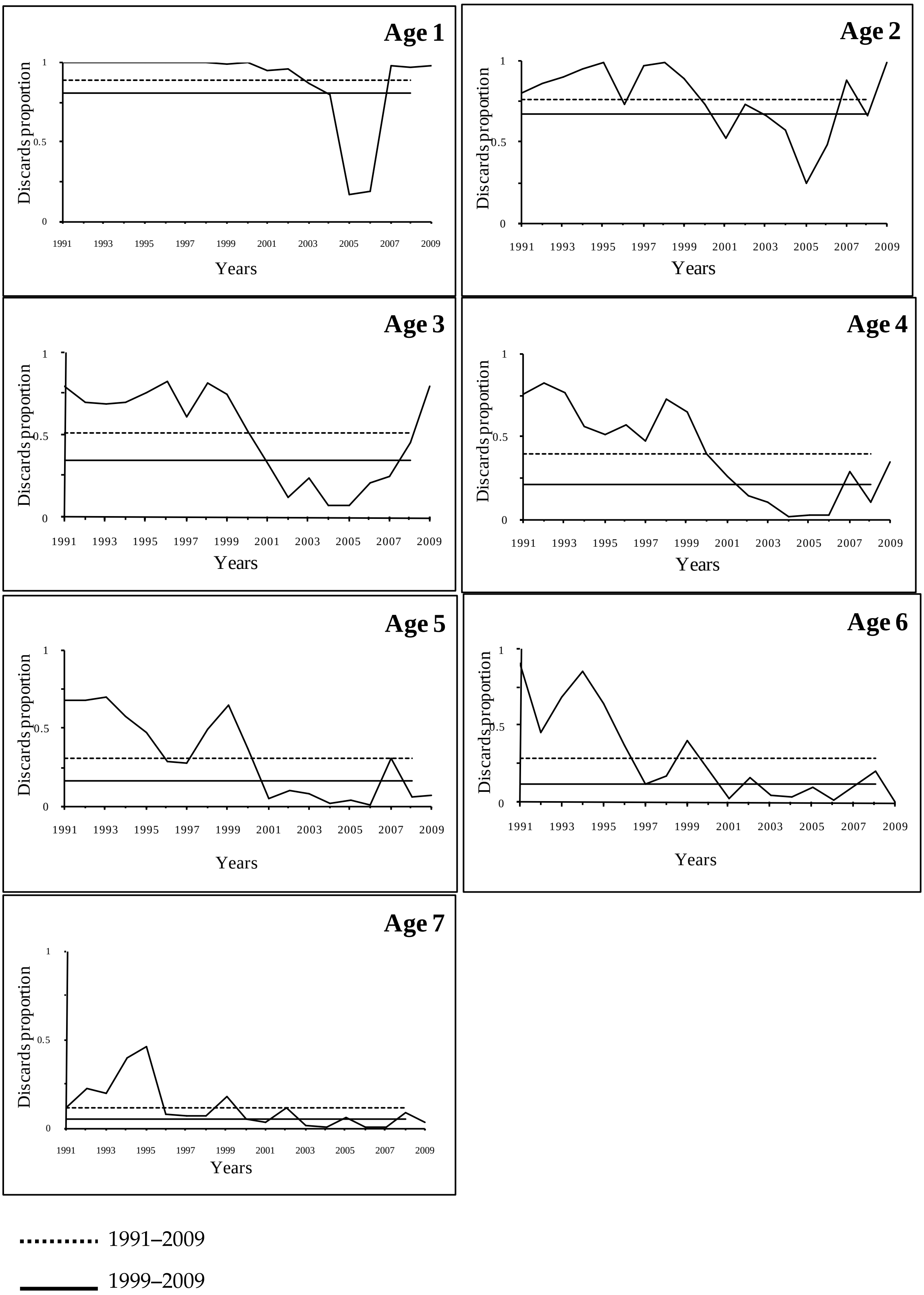



**Figure 4.3.35. Haddock in Division VIb. Discard proportion-at-age by year and mean discard proportion-at-age for two periods, 1991–2009 and 1999–2009.**

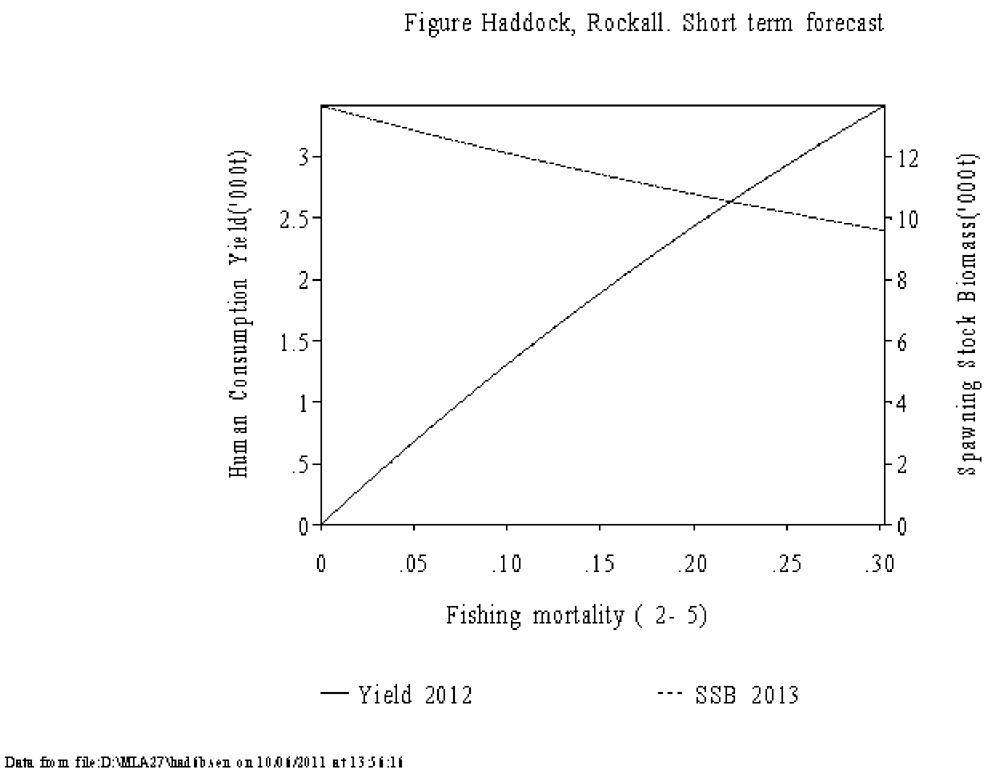



**Figure 4.3.36. Haddock in VIb. Short-term forecast.**

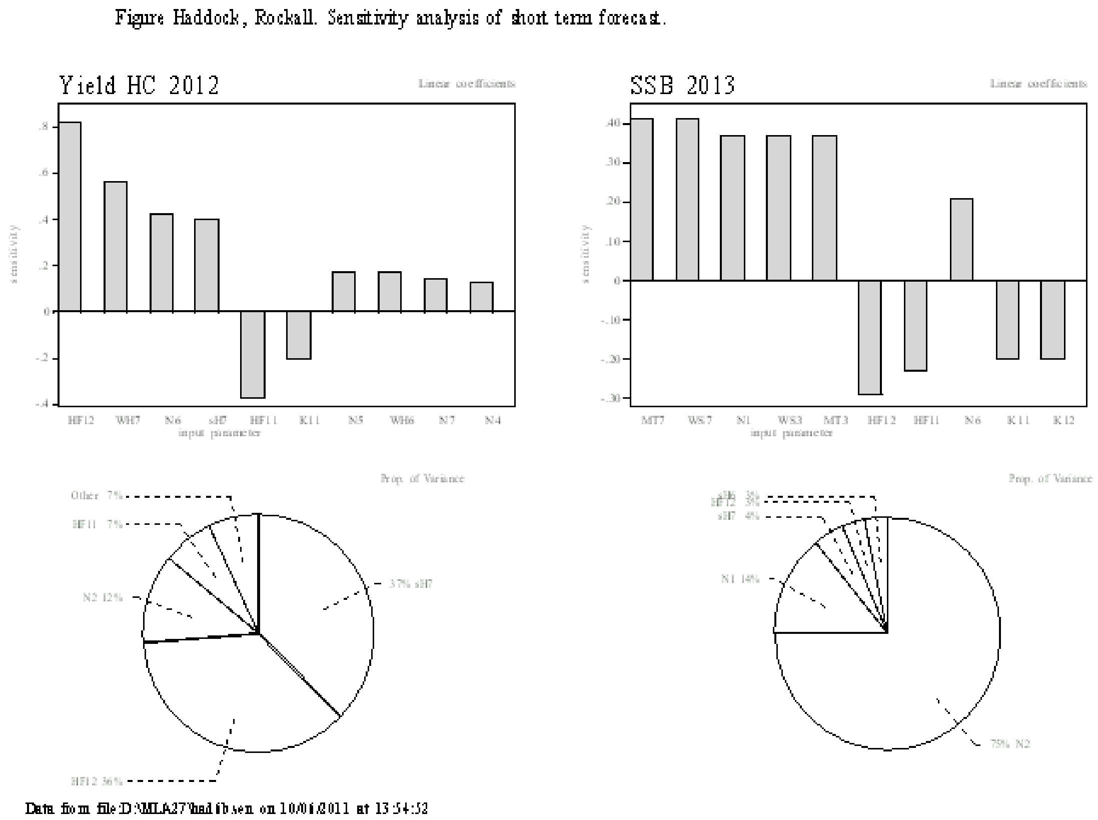



**Figure 4.3.37. Haddock in VIb. Delta plots from sensitivity analysis.**

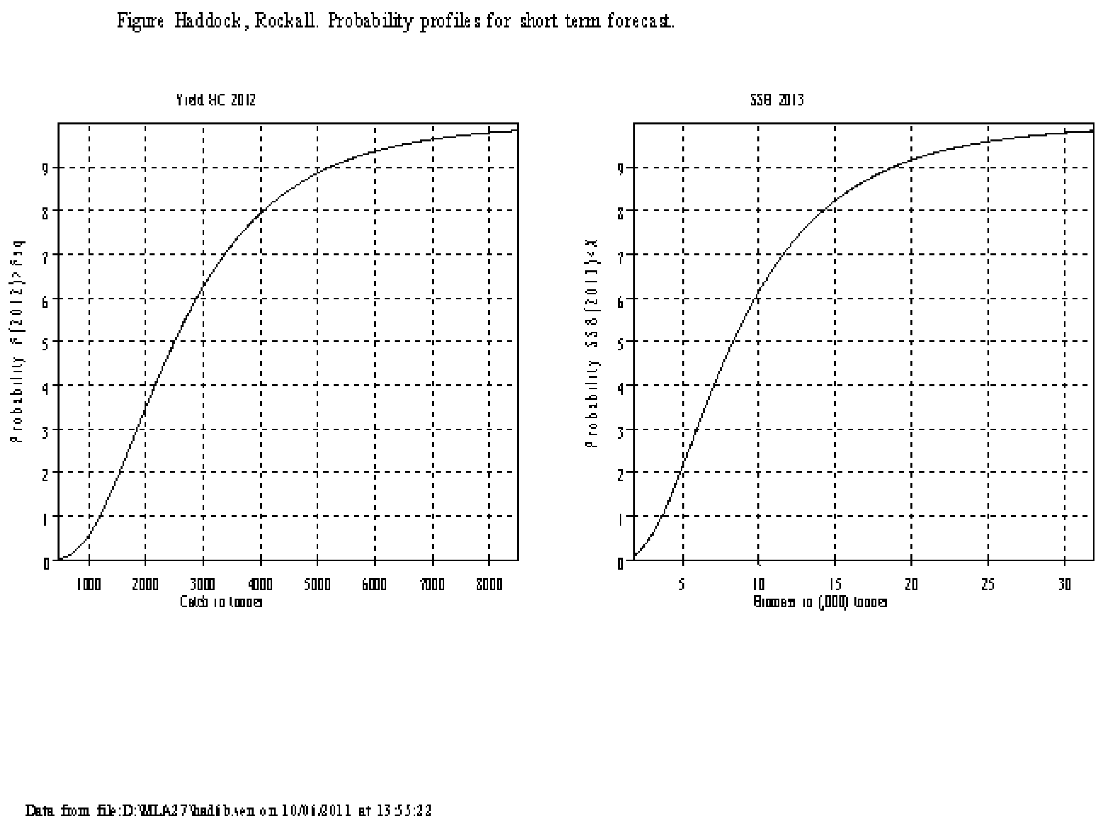



Figure 4.3.38. Haddock in VIb. Probability plots for yield in 2012and SSB in 2013.

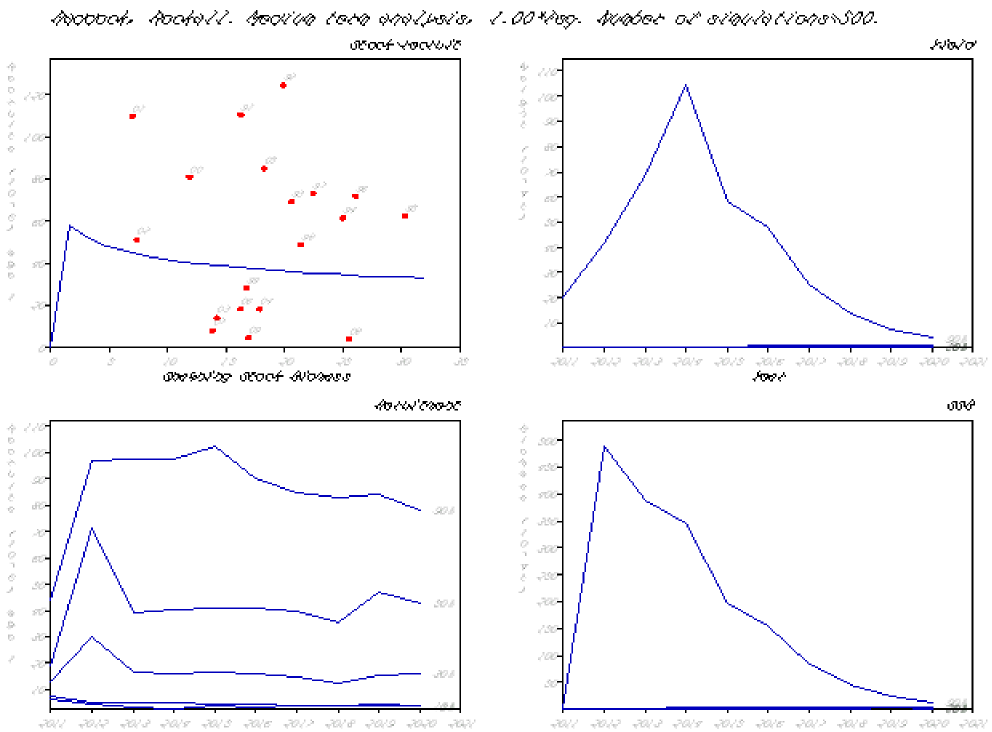


Figure 4.3.39. Haddock VIb. Medium-term analysis.

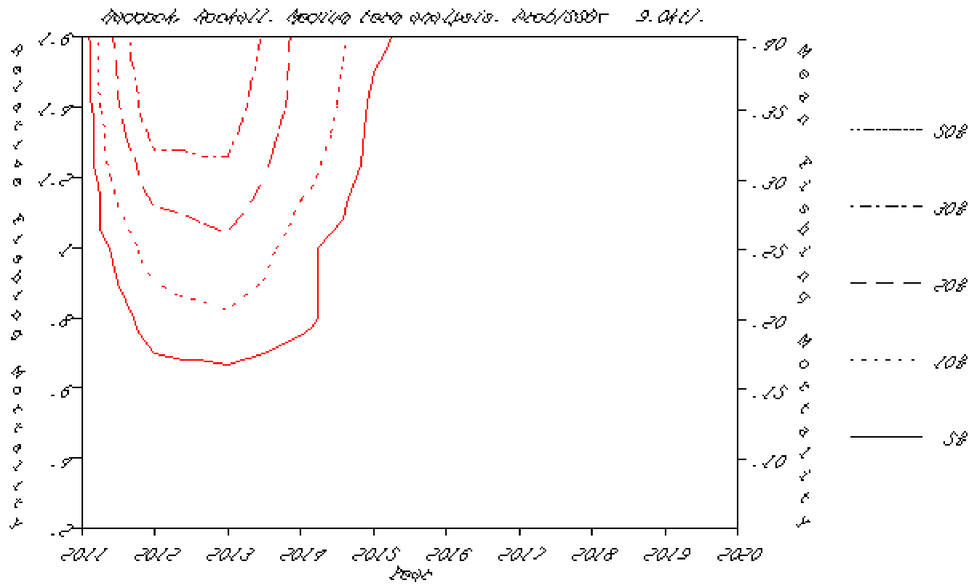


Figure 4.3.40. Haddock VIb. Medium-term analysis.

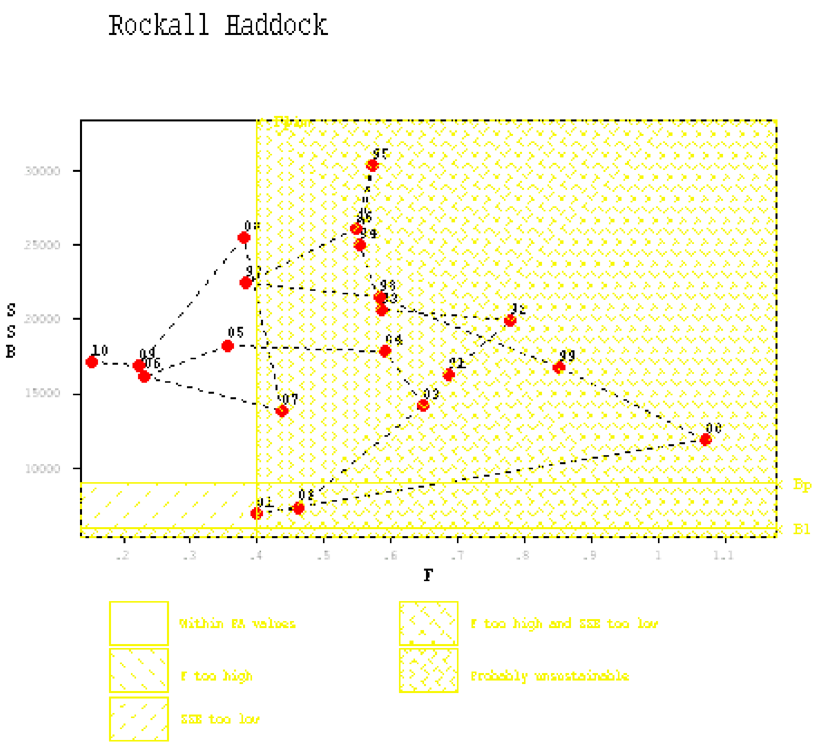



Figure 4.3.41. Haddock in VIb. Biological reference points.

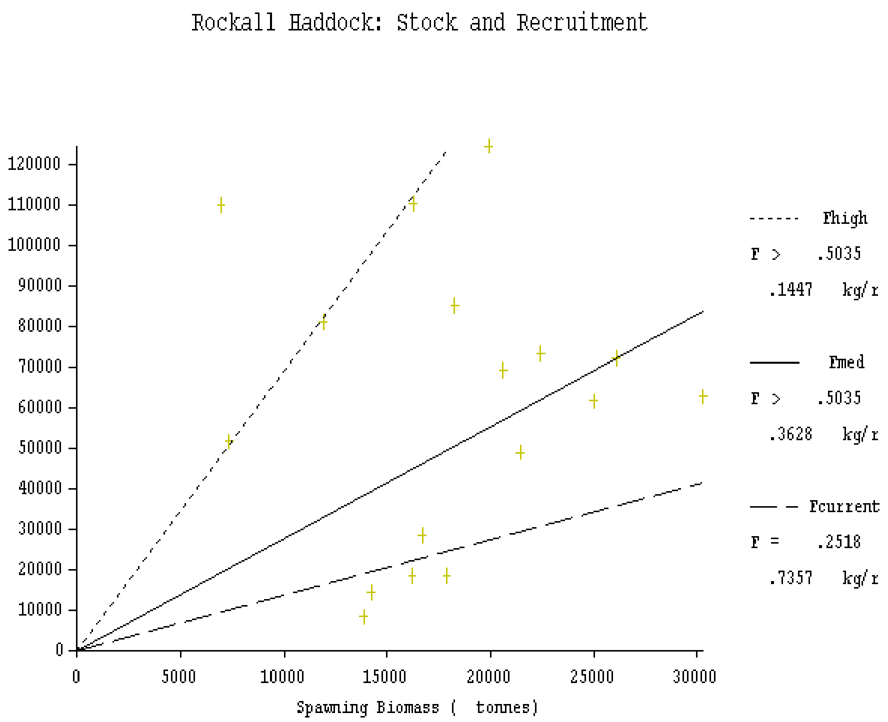



**Figure 4.3.42. Haddock in VIb. SSB and recruitment.**

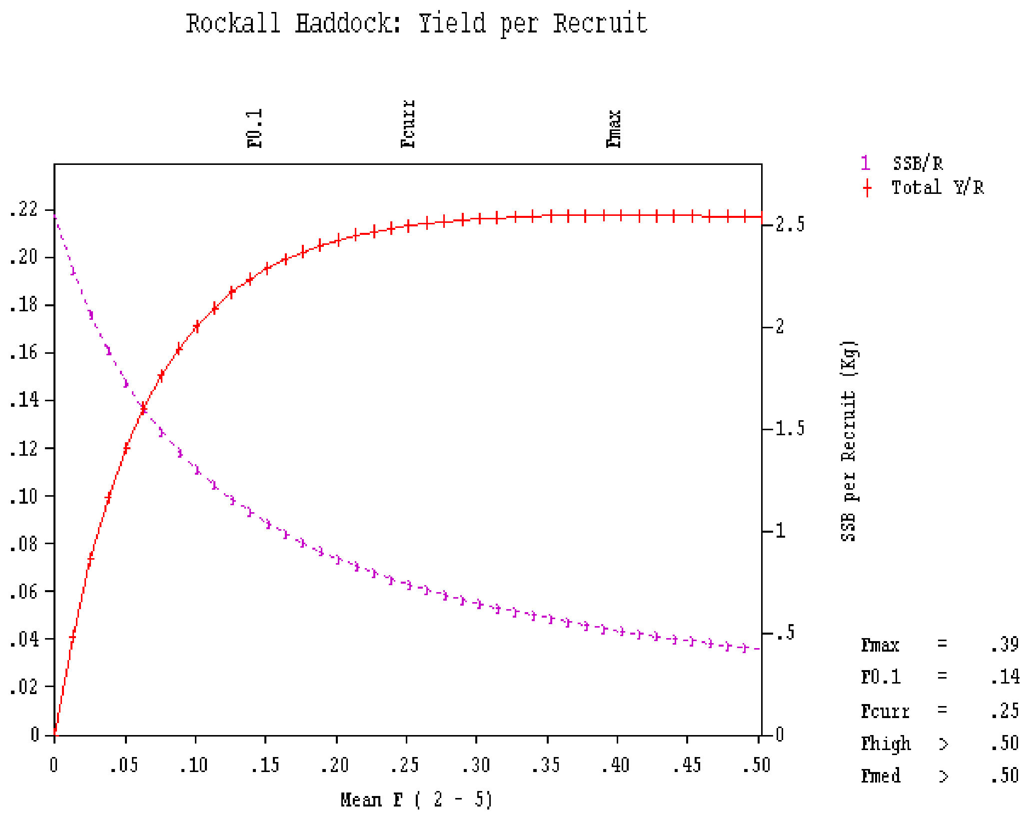



**Figure 4.3.43. Haddock in VIb. Yield-per-recruit.**

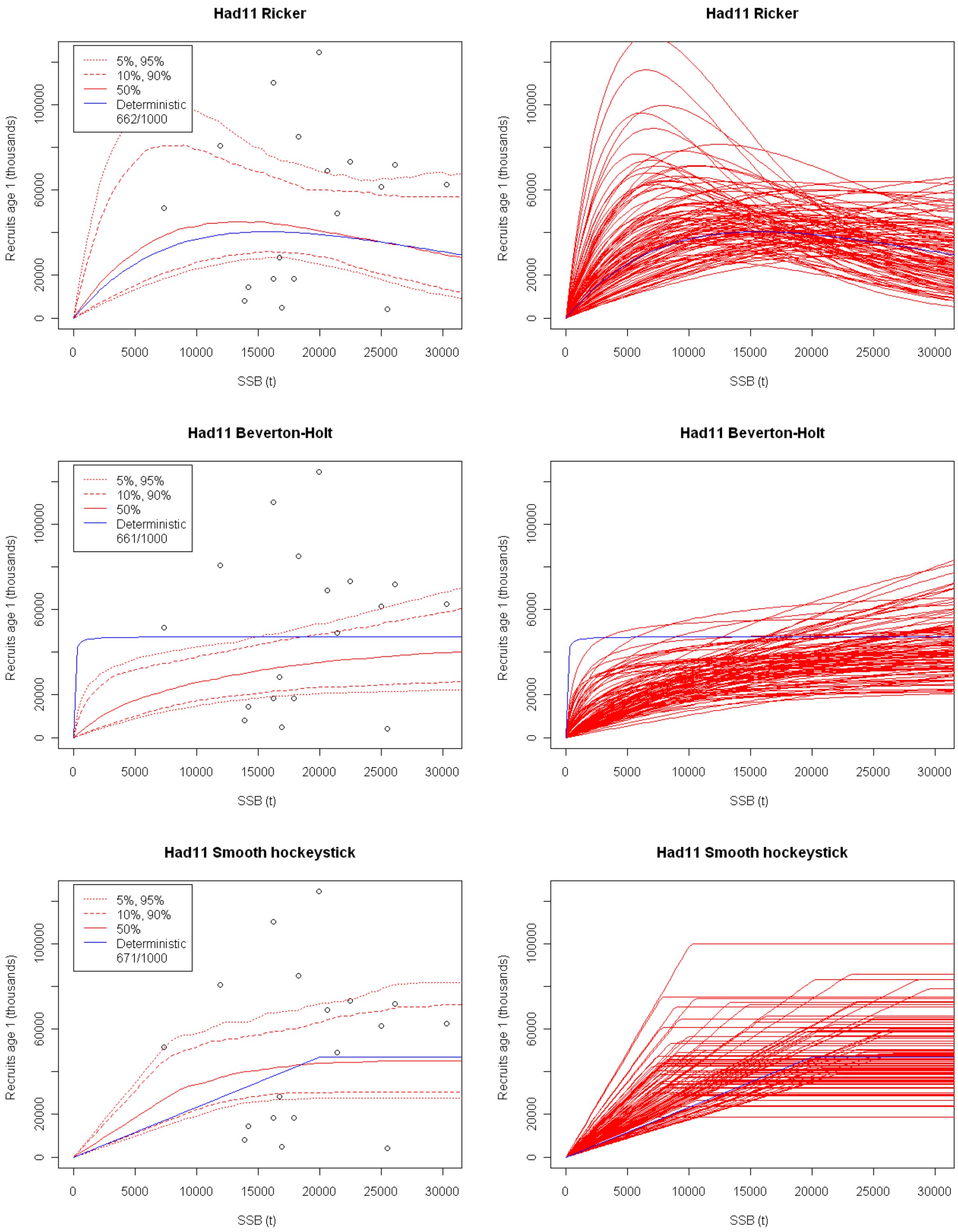



**Figure 4.3.44. Haddock in VIb. Fitted stock–recruit relationships with 1000 MCMC resamples. The left-hand plots show the deterministic fit (blue) as well as the confidence intervals from converged estimates of $F_{MSY}$ (red). Right-hand panels show the fits from the first 100 converged MCMC resamples for illustration. The legends show the number of converged values for $F_{MSY}$ from 1000 resamples.**

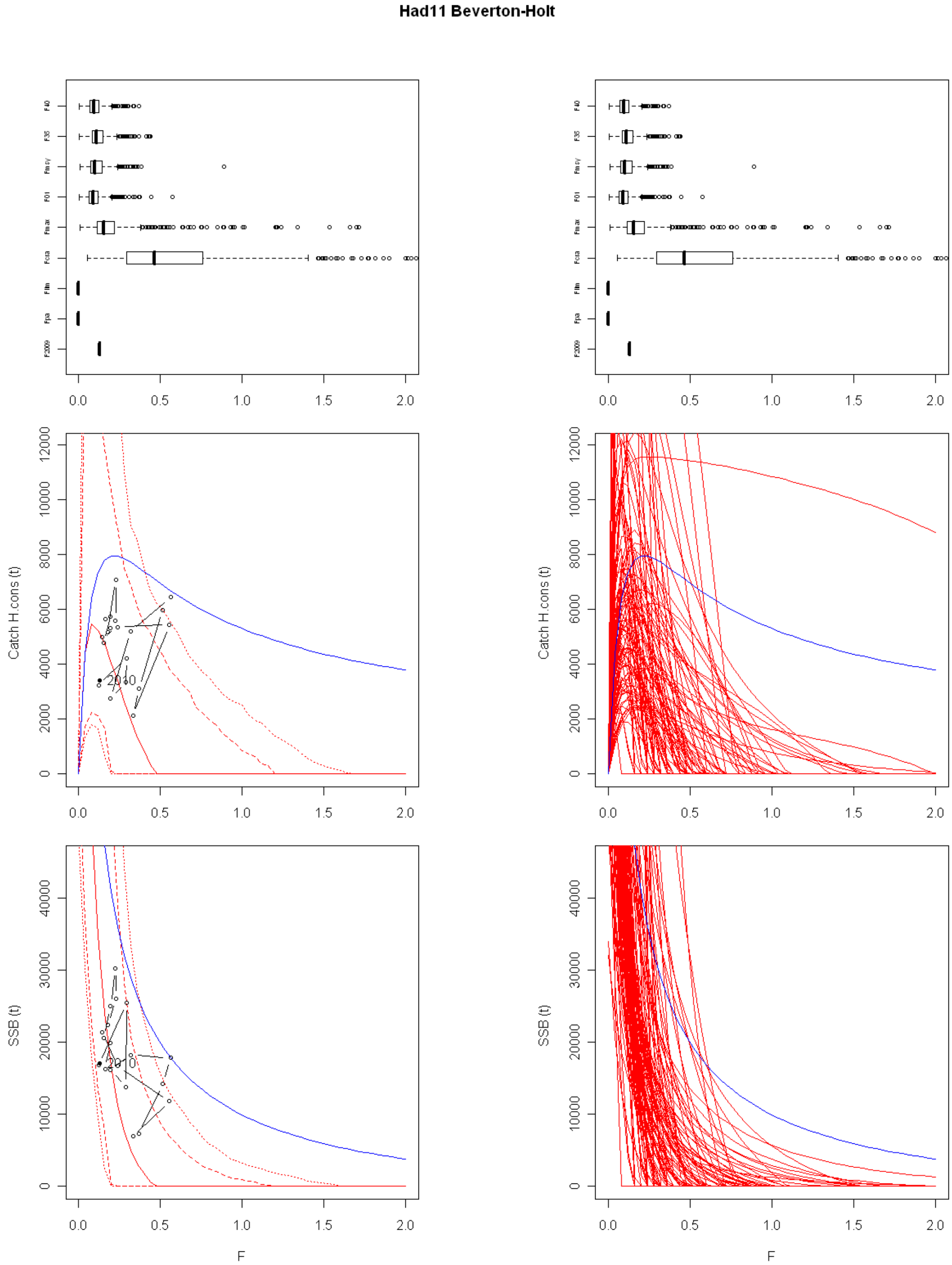



**Figure 4.3.45. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a Beverton and Holt recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.**

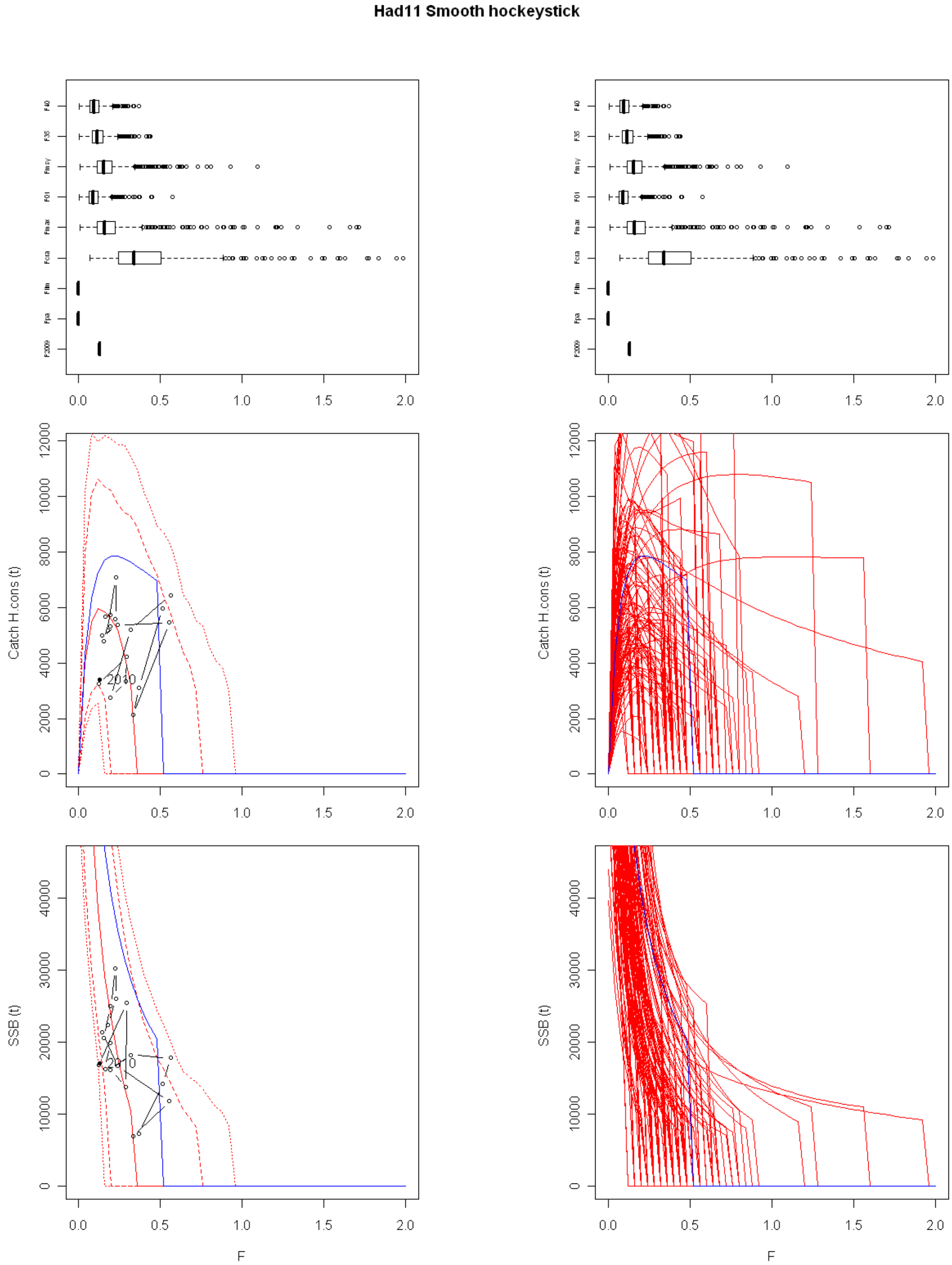



**Figure 4.3.46. Haddock in VIb. Estimates of F reference points and equilibrium yield and SSB against mortality using a hockey-stick recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.**

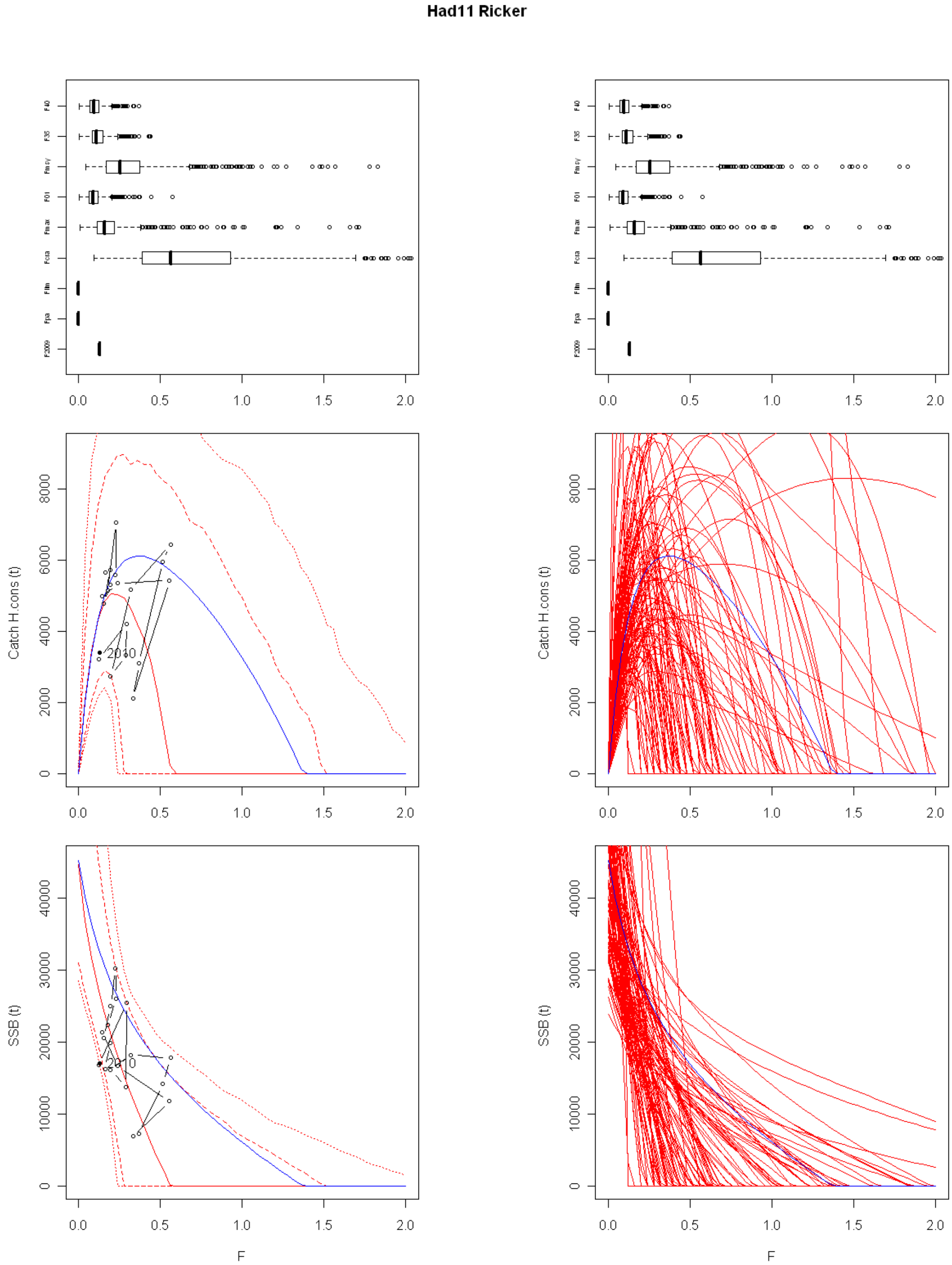



**Figure 4.3.47. Estimates of F reference points and equilibrium yield and SSB against mortality using a Ricker recruitment model. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals of the converged estimates (red) and the right-hand plots show the fit for the first 100 resamples for illustration. The top two plots are identical.**

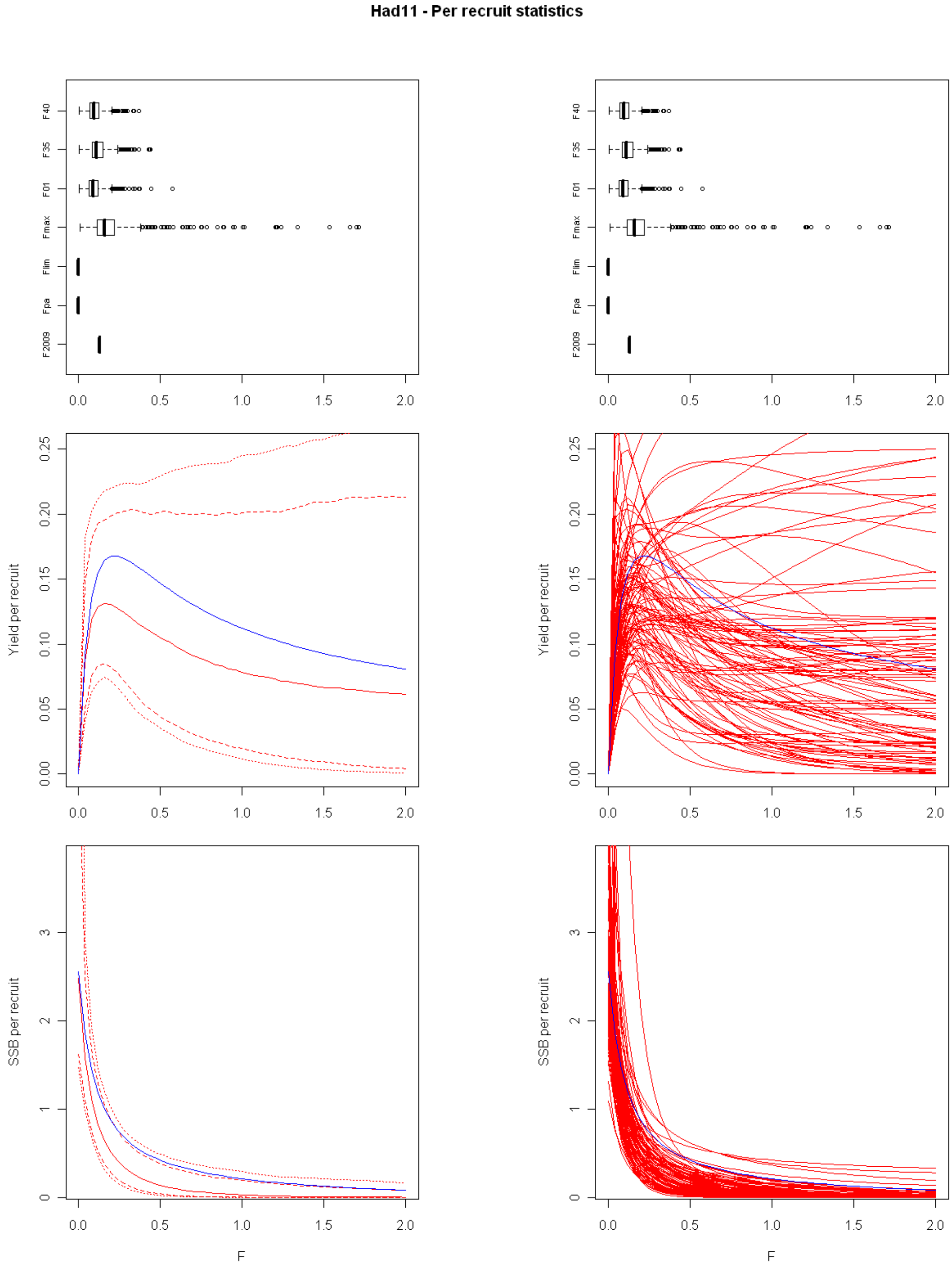



**Figure 4.3.48. Fitted of F reference points and equilibrium yield and SSB. The left-hand plot illustrate the deterministic fit (blue) and confidence intervals (red) and the right-hand plots show the fit for the first 100 iterations. The top two plots are identical.**

## 5.1 Northern Shelf overview

Description of fisheries.

UK (Scottish) vessels account for most of the reported anglerfish landings from the Northern Shelf area. The Danish and Norwegian fleets are the next most important exploiters of this stock in the North Sea while Irish and French vessels take a significant proportion of the landings from the West of Scotland. A description of the fisheries can be found in the Stock Annex.

## 5.2 Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI

The WGNSDS considered the stock structure of anglerfish on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. For the purposes of reporting, anglerfish in IIa is treated in a separate section (5.2.2) from anglerfish on the Northern Shelf (Division IIIa, Subarea IV and VI, Section 5.2.1), but the advice refers to both.

### 5.2.1 Anglerfish in Division IIIa, Subarea IV and VI

There has been no assessment of the anglerfish stock on the Northern Shelf since 2003. Recent ACFM review groups have highlighted the generally poor data for this stock and the need to continue with the recently instigated data collection schemes (both survey and commercial data) in order to obtain time-series of sufficient length. Since 2005, an annual science–industry partnership survey has been conducted by the Scottish, and in some years, Irish institutes: updates to these survey data are presented this year, along with updates to catch and effort data where available.

#### ICES advice applicable to 2010 and 2011

**ICES advice for 2010 (Single-stock Exploitation Boundaries) was as follows:**

*"ICES advises on the basis of precautionary considerations that the effort in fisheries that catch anglerfish should not be allowed to increase."*

**ICES advice for 2011 (Single-stock Exploitation Boundaries) was as follows:**

*MSY approach*

Due to a decrease in survey estimates of stock abundance and biomass and unknown exploitation pattern catches should be reduced at rate greater than the rate of stock decrease. Because the catch levels are not known (only landings) this cannot be quantified. Therefore, effort in fisheries that catch anglerfish should be reduced. The time-series is only five years so the provision of the 2010 survey data will be important for confirming recent trends.

*PA considerations*

The catch should be reduced and effort in fisheries that catch anglerfish should decrease.

*Policy paper*

In the light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 7 (State of the stock is not known precisely and reduction of fishing effort is advised). Under Annex IV.5, applying the indices of biomass from the survey as indicators of stock development, then the average total biomass in the last two years is 2–3% higher than the biomass in the three years previous to that, resulting in an unchanged TAC. Applying the indices of abundance from the survey as indicators of stock development gives a decline of around 27%. This would result in a TAC reduction of 15% for 2011.

#### 5.2.1.1 General

*Stock description and management units*

In this section, the anglerfish stock on the Northern Shelf is considered to occur in Divisions IIa, IIIa (Skagerrak and Kattegat), Subarea IV (the North Sea) and Subarea VI (West of Scotland plus Rockall). Anglerfish in the North Sea and Skagerrak/Kattegat were considered by this Working Group for the first time in 1999. In 2004, the WG was asked to consider the stock structure of anglerfish on a wider Northern European scale and despite a lack of conclusive evidence to indicate a single-stock, anglerfish in IIa was included in the ToR at subsequent WG meetings.

Management of Northern Shelf anglerfish is based on separate TACs for the North Sea area and West of Scotland area. The following table summarizes ICES advice and actual management applicable for Northern Shelf anglerfish during 2003–2011.

| Year | Single-stock exploitation boundary | Basis | West of Scotland TAC[4] | West of Scotland % change in F associated with TAC | West of Scotland WG landings | North Sea TAC[5] | North Sea % change in F associated with TAC | North Sea WG landings |
|---|---|---|---|---|---|---|---|---|
| 2003 | <6700[1] | Reduce F below $F_{pa}$ | 3180 | 49% reduction | 4126 | 7000 | 49% reduction | 8268 |
| 2004 | <8800[2] | Reduce F below $F_{pa}$ [2] | 3180 | 48% reduction | 3296 | 7000 | 48% reduction | 9027 |
| 2005 | - | No effort increase[2] | 4686 | - | n/a | 10 314 | - | n/a |
| 2006 | - | No effort increase[2] | 4686 | - | n/a | 10 314 | - | n/a |
| 2007 | - | No effort increase[2] | 5155 | - | n/a | 11 345 | - | n/a |
| 2008 | - | No effort increase[3] | 5155 | - | | 11 345 | - | |
| 2009 | - | No effort increase[3] | 5567 | - | | 11 345 | - | |
| 2010 | - | No effort increase[3] | 5567 | - | | 11 345 | - | |
| 2011 | - | Decrease effort | 5456 | - | | 9643 | - | |

**All values in tonnes.**

**1) Advice for Division IIIa, Subarea IV and Subarea VIa combined.**

**2) Advice for Division IIIa, Subarea IV and Subarea VI combined.**

**3) Advice for Division IIa, Division IIIa, Subarea IV and Subarea VI combined.**

**4) TAC applies to Vb(EC), VI, XII and XIV.**

**5) TAC applies to IIa and IV (EC).**

Although there is no minimum landing size for this species, there is an EU minimum weight of 500 g for marketing purposes (EC Regulation 2406/96).

An additional quota of 1500 t is also available for EU vessels fishing in the Norwegian zone of Subarea IV in 2010.

*The fishery in 2010*

A description of the fisheries on the northern shelf is given in the stock annex.

The official landings by area are given in Table 5.2.1 and the breakdown by country and ICES Division in Tables 5.2.2–5.2.4. In 2010, total [officially reported] landings (11 978 t) were lower than in 2009 (16 539 t). This was due to a reduction in the TAC and in [officially reported] landings in Division VIa by France (Table 5.2.2). Total officially reported landings of anglerfish from the Northern Shelf and ICES Division are shown in Figure 5.2.1. During the 1970s landings were fairly stable at around 9000 t, but from about 1983 they increased steadily to a peak of over 35 000 t in 1996, then declined rapidly during the following five years. However, any subsequent declines in reported landings may have been due to restrictive TACs and are not necessarily representative of actual landings. The overall trend in landings is driven by the landings from the Northern North Sea and West of Scotland. Together these two areas account on average for approximately 80% of the total landings over 1973–2010.

Uptake of EC quota in 2010, based on the officially reported landings was as follows:

| | TAC[1] | Landings | Uptake (%) | TAC | | | Landings | Uptake (%) |
|---|---|---|---|---|---|---|---|---|
| | VI | VI | | IV (Norwegian) | IIa & IV | IIa & IV (total) | IIa & IV (total) | |
| Belgium | 196 | 0 | 0 | 45 | 341 | 386 | 131 | 34 |
| Denmark | | 0 | | 1258 | 972 | 2230 | 1337 | 60 |
| France | 2412 | 1183 | 49 | | 70 | 70 | 13 | 19 |
| Germany | 224 | 0 | 0 | 18 | 367 | 385 | 0 | 0 |
| Ireland | 546 | 617 | 113 | | | | 0 | |
| Netherlands | 189 | 0 | 0 | 16 | 258 | 274 | 56 | 20 |
| Spain | 210 | 0 | 0 | | | | 0 | |
| Sweden | | 0 | | | 9 | 9 | 9 | 100 |
| UK (total) | 1679 | 2213 | 132 | 269 | 7846 | 8115 | 6355 | 78 |
| Total | 5456 | 4013 | 74 | 1500 | 9643 | 11 469 | 7901 | 69 |

**1TAC applies to VI, Vb(EC), and international waters of XII and XIV.**

**2 Provisional.**

Catches in Division IIIa are not regulated: Table 5.2.4 shows the official landings which came to altogether 476 t in 2010, a figure very similar to last year. The landings by fleet for Denmark (ICES Division IV and IIIa) and Norway (ICES Division IIIa) are given in Figures 5.2.2 and 5.2.3 respectively. The Scottish and Irish fleets are dominated by demersal trawlers and so they are not shown here.

#### 5.2.1.2 Data

*Landings*

The TACs for both the West of Scotland and North Sea areas were reduced substantially in 2003 and 2004, and at previous WGs it has been highlighted that these reductions would likely imply an increased incentive to misreport landings and increase discarding unless fishing effort was reduced accordingly (Section 6.4.6, ICES WGNSDS 2003). Anecdotal information from the fishery in 2003 to 2005 appeared to suggest that the TACs were particularly restrictive in these years. The official statistics for these years are, therefore, likely to be particularly unrepresentative of actual landings. The introduction of UK and Irish legislation requiring registration of all fish buyers and sellers (See Section 1.7) may mean that the total reported landings from 2006 onwards are more representative of actual total landings in the UK and Ireland.

In the meantime, collation of an international landings-at-age dataset is being hampered by the different approaches to age determination by the institutes which could provide these data. Several countries use the illicia to age, whilst others use otoliths. An anglerfish ageing exchange will be held in 2011 and is due to report to ICES in November 2011.

The absence of a TAC for Subarea IV prior to 1999 means that before 1999, landings in excess of the TAC in other areas were likely to be misreported into the North Sea. In 1999, a precautionary TAC was introduced for North Sea anglerfish, but unfortunately for current and future reporting purposes, the TAC was set in accord with recent catch levels from the North Sea which includes a substantial amount misreported from Subarea VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4°W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish. The Working Group historically (prior to 2005) provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. This adjustment has been adapted to include landings declared from the whole of Area VI. Details of how the correction has been applied are given in the Stock Annex. Scottish officially reported landings adjusted for area misreporting are shown along with landings from Ireland, Denmark, France and Norway in Figure 5.2.4. The adjusted distribution of landings is more indicative of the distribution of fishing effort by trawlers which may not be specifically targeting anglerfish, rather than the underlying distribution of anglerfish (e.g. as observed by the survey in Figure 5.2.8). Due to a lack of landings data provided to the Working Group by some of the major nations exploiting the fishery, WG estimates of the actual Division VIa and IVa landings have not been calculated for recent years (2005–2011). This and other shortcomings will be addressed at the benchmark exercise due to take place in February 2012.

The corrected spatial distribution of anglerfish landings shows a typical pattern, with most landings being taken from the area around Shetland and also the area to the west of Scotland close to the shelf edge. Some landings, associated with the *Nephrops* fishery, are taken from the Fladen ground in the middle of the northern North Sea. A substantial amount of landings were taken from Rockall. The spatial distribution of Danish landings shows the typical pattern of higher landings around the Norwegian deeps. The Irish fishery in 2010 landed principally from the west coast of Ireland and in the south of Division VIa, with some landings from Rockall.

Consideration should be given in future to examining the distribution of landings combined with vessel monitoring system (VMS) data, perhaps using a kilowatt fishing hours metric to produce spatial distributions of lpue.

### *Commercial catch–effort data*

#### *Scotland*

Reliable effort data (in terms of hours fished) are not available from the Scottish trawl fleets due to changes in the practices of effort recording and non-mandatory recording of hours fished in recent years. Further details can be found in Section B4 of the Stock Annex and the Report of the 2000 WGNSSK (ICES, 2001). Effort data in terms of days fished are available from official logbooks and these data are presented by gear in the report of WGNSDS 2007. However, given the uncertainties associated with the official landings from the recent past, no attempt has been made to use these data to calculate an lpue series and they have not been updated this year.

Attempts have recently been made to obtain more reliable data on catch and effort from the Scottish anglerfish fishery. In 2005, an analysis of data collated from the personal diaries of Scottish skippers operating across the Northern Shelf was presented to this WG (ICES, 2006 and Bailey *et al*., 2004). Following recommendations made by ACFM that this data collection scheme should be continued and extended, in 2006, Marine Scotland Science (in consultation with the fishing industry) established a monkfish tallybook project. A fuller description and analysis of these data can be found in the WGNSDS 2008 Report and Dobby *et al*. (2008). However, there have been problems in the scheme in terms of falling participation levels (four vessels in 2008; two vessels in 2009 and 2010): this is unlikely to give a representative picture of the fishery and so updates of these data are not included. After attempting to address the low participation levels by contacting potential participants, MSS has decided to end the project.

#### *Ireland*

Trends in official landings, effort in hours fished from the Irish otter trawl fleets (OTB) operating in Division VIa and VIb are shown in Table 5.2.5 and Figure 5.2.5. This fleet is responsible for the majority of the landings from the south of Division VIa. Landings and effort data from the other fleets (1995–2006) are available in the Stock Annex. The Irish lpues from logbooks are shown in Figure 5.2.5. The time-series show increasing trends in (particularly) Division VIa in recent years. However, it is not clear whether such trends are indicative of stock trends as such increases in lpue could also be due to changes in targeting behaviour due to reductions in fishing opportunities for other species and changes in reporting practices. Trends in lpue have increased in recent years. These trends show some similarity [in direction] to the survey trends (see below) in the case of VIb (Rockall); although the trends are not comparable in the case of VIa, where the surveys indicate a more stable stock.

#### *Denmark*

Danish logbook data for anglerfish landings and corresponding effort by main fishery in the North Sea and IIIA for the period 2001–2010 are shown in Tables 5.2.6 and Table 5.2.7. Figure 5.2.6 shows the fluctuations in lpue for anglerfish in mixed demersal fisheries (targeting roundfish, anglerfish, *Nephrops*) in the northeastern North Sea) and the shrimp (*Pandalus*) fishery (small-meshed). The lpue series for the mixed demersal trawl fisheries in the North Sea represents the fisheries where most anglerfish is taken (Table 5.2.6). On the other hand, the lpue series for shrimp trawl represents a 'bycatch *LPUE*' and may be a better indicator of stock fluctuations. Note the upwards trend, especially from 2003 to 2004 for both series. Since 2006 the trends of the two series have differed. There has been a decline in overall (nominal) effort in 2010 compared to the previous two years (Table 5.2.7).

The decline in effort (measured in days) reflects the development in the Danish mixed fishery taking anglerfish in recent years, where there have been TAC constraints on the Danish fishery in the Norwegian EEZ which was not in evidence in earlier years. In 2008–2009 around 30 vessels were engaged in this fishery, but in 2010 only ten vessels participated. Several factors are causing this reduction in number of vessels (and therefore also fishing trips): TACs in the Norwegian EEZ (1258 t in 2010), increasing fuel prices and also the system of vessel ITQs used in the national management of the Danish fishery. Restrictive bycatch rules in the Norwegian zone have probably also influenced the decline in number of vessels.

Due to increasing fishing power of the vessels the decline in effective effort is probably much less than indicated by the nominal effort.

*Norway*

Norwegian landings by fishery are given in Table 5.2.8. Available logbook data from Norwegian trawlers have been examined for the possibility of establishing a cpue time-series for anglerfish. However, several problems were encountered in the dataset, and it is still considered insufficient for providing any reliable information on trends in stock abundance.

Six gillnetters have been included in a self-sampling scheme established along the Norwegian coast within IVa and IIIa. Detailed information about effort and catch will be provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

*Other countries*

No effort data were available for the Spanish and French fleets operating in Subarea VI.

*Research vessel surveys*

At previous meetings of this WG it has been concluded that the traditional groundfish surveys are ineffective at catching anglerfish and do not provide a reliable indication of stock size. As a result of this conclusion, and the urgent requirement for fishery-independent data, Marine Scotland Science, began a new joint science/industry survey in 2005. This is a targeted anglerfish survey using commercial gear. In 2006, 2007 and 2009, Ireland also participated extending the anglerfish survey to cover the remaining part of VIa (from 54°30′ to 56°39′) and, in 2006 and 2007, into ICES Areas VIIb,c,j. Further details of the survey including information on design, sampling, gear and vessel were recently considered by ICES WKAGME and are available in ICES (2009).

The estimation of abundance and biomass from these surveys was described in previous working documents to this WG (WD 5, Fernandes, 2010 and WD 6, Yuan *et al.*, 2010). Estimates for the 2005–2010 surveys are summarized in Table 5.2.9, with the appropriate error and its propagation. The estimates represent the best available knowledge to date from the six surveys carried out (2005–2010) and as such they take into account the following factors:

1 ) herding of anglerfish by the trawl doors and sweeps;

2 ) escapes of fish under the trawl footrope;

3 ) anglerfish abundance and biomass in the southern part of Area VI not covered in 2005 and 2008;

4 ) visual counts of anglerfish in areas closed to trawling at Rockall;

5 ) variability due to:

  5.1 ) sampling;

  5.2 ) missing ages;

  5.3 ) herding (based on experimental data);

  5.4 ) footrope escapes (based on experimental data).

The estimates currently do not take account of the following:

1 ) areas in the central and southern North Sea (eastern part of ICES Division IVa and all of IVb and IVc);

2 ) areas inaccessible to the trawl in Division VIa.

Methods to account for these factors are under development.

The 2010 survey took place in April: the sample locations (n = 168) are illustrated in Figure 5.2.7 as the number density (number per square kilometre) and Figure 5.2.8 as the weight density (kilograms per square kilometre) of anglerfish. The highest densities of anglerfish occurred close to the 200 m contour in the northern and western areas, including the northwestern North Sea. The highest densities were found on the eastern Rockall plateau. The results of the survey are presented in Table 5.2.9. The total estimate for the Northern Shelf in 2010 was 42 221 t. The 95% confidence limit estimates for this estimate were between 34 629 and 51 466 t. The Relative Standard Errors were 13.1% and 13.3% for abundance and biomass respectively.

Estimates of biomass from the survey in ICES Area IV (21 944 t) were larger than those in Area VI (20 277 t). The estimates-at-age (Figure 5.2.9) indicate that despite corrections for catchability, which largely affect the smaller, younger fish, there is still an issue with catchability which is unaccounted for. The difference between the estimates provided here and those provided prior to 2010 can be seen in Figure 5.2.9: the different colours represent the different components in the estimation process. Prior to 2010, estimates of footrope escapes were not available; and because Ireland had participated in the survey, extrapolation into the area southern part of Area VI was not required. Both of these components are now included in the estimation and are highlighted by different colours in the stacked barplots of Figure 5.2.9.

It should also be noted that ageing of anglerfish is still uncertain. The last angler (*Lophius* spp.) otolith exchange took place in 2001 and the last black-bellied angler (*L. budegassa*) otolith exchange took place in 2004. Landa *et al.* (2008), however, noted that previously used ageing criteria are not accurate. There is ongoing research to establish if a new protocol should be established when using illicia to estimate age. Exchanges of otoliths and illicia willl be carried out in 2011, when new ageing criteria are expected (ICES 2010).

The time-series point estimates indicate a decline in numbers over the five year period in all areas except Rockall (Figure 5.2.10), but an increase in biomass to 2008 followed by a sharp decline in 2009 and a subsequent increase in 2010 (Table 5.2.9 and Figure 5.2.10). The estimates of abundance of anglerfish from the surveys from 2005–2009 are in line with previous attempts to quantify their abundance (ICES 2004): the last assessment estimated the total-stock biomass to be just under 37 000 t in 2002. There are still several factors which make the survey estimates likely to be underestimates or minimum estimates. Firstly, although experiments have been carried out to estimate escapes from under the footrope, and a model applied to account for this component of catchability, the estimates of younger anglerfish (ages 0–3) still look to be underestimated (Figure 5.2.9). This could be due to either a net selectivity issue, or an availability [to the trawl] issue, as it is known that younger fish occur in shallower water (Hislop *et al*., 2001), or both. Methods to compensate for these additional catchability and availability factors are being considered by developing a survey based assessment model. Secondly, the area considered was not complete. Although only a small part of ICES Area VI was missed, quite a large part of ICES Area IV was not surveyed (Figure 5.2.8). Although repeated requests have been made to countries with an interest in the anglerfish fishery to consider participating, no other countries have done so, with the exception of the Irish who participated in 2006, 2007 and 2009. The problem is, therefore, being tackled by an examination of data from the International Bottom-trawl survey. If a relationship can be found between the IBTS survey data and the data from the anglerfish survey where they overlap, then abundance estimates in the southern North Sea could be derived by interpolation where there is only IBTS data. These methods are currently under development (see ICES WKAGME 2009).

#### 5.2.1.3 Historical stock development

There has been no assessment of this stock since the length-based assessment presented in ICES (2004). This indicated a total stock size of approximately 36 590 t in 2002.

The estimates of abundance of anglerfish from the surveys from 2005–2010 are in line with these previous attempts to quantify their abundance. There are still several factors which make the survey estimates likely to be underestimates or minimum estimates (see above).

#### 5.2.1.4 Short-term projections

In the absence of an age based assessment, there are no short-term projections for this stock.

In terms of setting the TAC for 2012, this needs to be based on the 2011 survey which has recently been completed (April 2011). The data from the 2011 survey should be considered along with other ICES survey updates later on in the year.

#### 5.2.1.5 MSY evaluations

In terms of the status of F in relation to $F_{msy}$ there are two major uncertainties. The first is the value of $F_{msy}$. Previous WG have considered that the fishing mortality corresponding to 35% of the unfished SSB/R could be an approximation of $\mathbf{F}_{MSY}$: this is what $F_{pa}$ was set to ($\mathbf{F}_{35\%SPR}$ = $F_{pa}$ = 0.30). Another suitable proxy might be $F_{0.1}$, which like $\mathbf{F}_{35\%SPR}$, would be derived from a yield-per-recruit analysis. However, as yet no assessment is available to determine the fishing mortality [selection] pattern which is required for a Y/R analysis. The second uncertainty is the current level of fishing mortality, where, in the absence of an assessment, this is also unknown. However, if the ageing of anglerfish in the surveys described above is assumed to be accurate and the survey is sampling the population in an unbiased way then a provisional estimate of total mortality (Z) from abundance curves at age would be approximately 0.42. This was estimated (ICES 2009) for the 2004–2001 year classes (ages 6–9 in 2010) as the mean of the four gradients of the abundance (catch) curves for consistent (i.e. z>0) segments of the abundance (catch) curves. Given an assumed natural mortality of 0.15 (as used in past assessments) this would imply an F at about 0.27. The average estimate of total mortality for these age classes in 2010 was 0.36. The last time a yield-per-recruit was carried out (ICES 2004), $F_{0.1}$ was estimated at 0.12 and $F_{35\%SPR}$ was 0.12.

$F_{pa}$ for this stock was based on an earlier estimate of $F_{35\%SPR}$ at 0.3. Even with the various uncertainties expressed, it seems likely that this stock is, therefore, being exploited at a fishing mortality close to or in excess of $F_{msy}$.

#### 5.2.1.6 Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| Precautionary approach | $B_{lim}$ | Not defined | There is currently no biological basis for defining $B_{lim}$ |
| | $B_{pa}$ | Not defined | |
| | $F_{lim}$ | Not defined | There is currently no biological basis for defining $F_{lim}$ |
| | $F_{pa}$ | 0.30 | $F_{35\%SPR}$ = 0.30. This fishing mortality corresponds to 35% of the unfished SSB/R. It is considered to be an approximation of $F_{MSY}$. |
| Targets | $F_y$ | Not defined | |

**(unchanged since 1998).**

#### 5.2.1.7 Management plans

There is no management plan for this stock.

#### 5.2.1.8 Uncertainties and bias in assessment and forecast

This WG has previously attempted assessments of the anglerfish stock(s) within its remit using a number of different approaches. As yet none have proven entirely satisfactory. The catch-at-length analysis used in previous years appears to have addressed a number of the suspected problems with the data due to the rapid development of the fishery, and has also provided a satisfactory fit to the catch-at-length distribution data. However, since 2003, the WG has been unable to present an analytic assessment due to the lack of reliable fishery and insufficient survey information, and in addition it is not known to what extent the dynamic pool assumptions of the traditional assessment model are valid for anglerfish.

*Commercial data*

For a number of years the WG has expressed concerns over the quality of the commercial catch-at-length data because of:

- Accuracy of landings statistics due to species and area misreporting.
- Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the northwest of the British Isles (See the Stock annex for further details of this fishery).

However, the introduction of legislation on buyers and sellers registration in the UK and Ireland since 2006 may mean that the reported landings for 2006 onwards are more reliable for these two countries (which account for the majority of landings).

A Scottish tallybook scheme was implemented from 2007–2009 as part of a long-term approach to provide better information on the fishery. The scheme had the potential to deliver relatively extensive information on spatial and depth distribution of catch rates provided that participation remained high. In addition to total catch rate information, the fishermen were also asked to provide information on landings by size category, discards, catches of mature females and bycatches of other species. However, participation in this scheme fell significantly in the final year because of data sensitivities associated with the compliance of fishery regulations. The tallybook programme has since been terminated.

*Survey data*

In addition to obtaining estimates of abundance from swept-area methods (and in future a time-series of data for use in survey based assessments), a visual count method is being developed at Marine Scotland Science to provide alternative estimates of anglerfish density in areas where trawling is prohibited (at Rockall for example). It is also anticipated that the new Scottish-Irish science/industry survey will provide further useful information on the biology and stock structure of anglerfish. So far, in all 48 live anglerfish have been tagged with data storage tags (DSTs) on the Marine Scotland Science surveys which if and when recovered will provide information on the vertical migration, depth distribution and temperature regime of individuals. So far two tags have been returned from fish tagged in 2005: these data are currently being analysed. Tagging carried out on the Irish survey (800 ribbon tags) should also provide information on movement of anglerfish. So far, only three tags have been returned and indicate little movement between release and capture.

In 2006, 2007 and 2009 Ireland extended the survey area to include the more southerly regions of the Northern Shelf stock of anglerfish area not covered by the Scottish survey. However the participation of other nations in a collaborative survey to include coverage of waters in the east and south of the North Sea would be invaluable. It is intended that Ireland will participate annually from 2012 onwards.

*Biological information*

Knowledge of the biology of anglerfish is improving. Some of the basic biological parameters used in the assessments, such as mean weight-at-age in the stock, are now becoming available from the industry science surveys. Difficulties still remain in finding mature females. However, recent studies by Laurenson *et al*. (2005; 2008) carried out whilst observing the fishery, have obtained similar growth parameters and maturity ogives to those previously used. A further discussion of the biology can be found in the Stock Annex.

In addition, ageing has not been validated and should still be regarded as uncertain. An ageing exchange is due to be carried out in 2011. Previous work has shown different age estimates obtained from ilicia and otoliths taken from the same fish. Agreement on a common structure is required.

*Stock structure*

Currently, anglerfish on the Northern Shelf are split into Subarea VI (including Vb(EC), XII and XIV) and the North Sea (& IIa (EC)) for management purposes. However, genetic studies have found no evidence of separate stocks over these two regions (including Rockall) and particle-tracking studies have indicated interchange of larvae between the two areas (Hislop *et al*., 2001). So, at previous WGs, assessments have been made for the whole Northern Shelf area combined. In fact, both microsatellite DNA analysis (O'Sullivan *et al*., 2005) and particle tracking studies carried out as part of EC 98/096 (Anon, 2001) also suggested that anglerfish from further south (Subarea VII) could also be part of the same stock.

Following the recent expansion of the anglerfish fishery in ICES Divisions IIa and V, in 2004 the WG group was asked to consider the stock structure on the wider Northern European scale (Section 16 of the $\text{WGNSDS}_{2004}$ Report). It was concluded that there was currently insufficient information to conclusively define new stock areas for assessment and further coordinated work is still required. Given the request to also assess anglerfish in Division IIa and that there may be an extension to include ICES Division V in the near future, the likely spatial disaggregation of the stock (drift of larvae and possible migration of mature fish back into deeper water) means that any assessment model would need to be spatially structured, possibly supported by assessments for each of the stock units separately. Given the problems with data quality associated with Northern Shelf anglerfish, the WG wishes to highlight fundamentals required for a wider area assessment:

- Accurate information on the spatial distribution of catch and effort;
- Data on movement and migration of mature and immature individuals; and,
- An internationally coordinated, dedicated anglerfish survey over the wider Northern European area to include waters further east. Currently the Scottish survey provides a biomass estimate for the whole of Sub-area VI, but there is only partial coverage of the North Sea. The survey should be expanded to cover the entire distribution of the stock and this would require the participation of other nations.

#### 5.2.1.9 Recommendations for the next benchmark

ICES has previously advised a two-stage approach for management of the anglerfish fishery. The first stage was to substantially improve the quality and quantity of data collected in the fishery while maintaining exploitation at its current level. It has stated that this was expected to take at least five years to establish useable time-series. The second stage would then be to use these data to examine alternative management approaches and harvest control rules. The data collection stage of this process is ongoing and an assessment approach is in preparation. WGCSE 2010 considers that significant progress towards assessment has been made for this stock which is still on track for a benchmark meeting in 2012.

The biological data associated with the anglerfish surveys should be evaluated and compared with existing estimates (e.g. maturity-at-age, growth rates, length distributions, sex ratios and species compositions). There are still uncertainties about the validity of age readings of anglerfish: this will be addressed by an age determination exchange. Depending on the outcome of this exchange, the catch-at-age data should then be evaluated for use in any assessment.

Irrespective of any ageing concerns, the survey estimates have underestimated the younger ages. This is despite the recent incorporation of a correction to account for escapes of small fish under the footrope of the survey trawl, which clearly has not accounted for all small fish. Some developments of the latter bias correction are still possible; however, it seems likely that a survey based assessment model could also be developed to determine the absolute abundance of the total population.

A number of recommendations were made at ICES WKAGME for the improvement of the anglerfish surveys. Some of these have been addressed and other will be addressed in the coming year in advance of the Benchmark. These include: improving the survey design in the light of previous estimates of density (allocation of samples to strata); providing estimates for the two species separately so that they may be incorporated separately in any assessment model (for cohort tracking for example); accounting for areas not surveyed in the North Sea using IBTS data; and improving the estimates of footrope escapes.

Finally, it should be stressed that, to date, efforts to extrapolate estimates of abundance into areas that have not been surveyed (southern North Sea and Subarea IIIa) have not proved particularly successful. Additional participation of nations with an interest in this fishery should be encouraged before the next Benchmark. In 2009 only Scotland and Ireland participated in this survey and in 2010 and 2011 only Scotland was able to conduct a survey.

### 5.2.2 Anglerfish in Division IIa

The WGNSDS considered the stock structure on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is therefore treated in this separate chapter.

*Type of assessment in 2011*

No assessment was performed.

*ICES advice applicable to 2010 and 2011*

ICES advice for 2010 and 2011 (Single-stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV, Division IIIa and Division IIa:

*"ICES advises on the basis of precautionary considerations that the effort in fisheries that catch anglerfish should not be allowed to increase."*

#### 5.2.2.1 General

*Stock description and management units*

The WGNSDS considered the stock structure on a wider European scale in 2004, and found no conclusive evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is therefore treated in this separate chapter.

*Fishery in 2010*

There has been a significant expansion of the fishery in recent years. This is largely due to a northward expansion of the Norwegian gillnet fishery, which has seen landings double since 2005. The official landings from the areas north of 64° account for approximately 77% of the total figure for Division IIa in 2010, which is 12% higher than in 2009 and 20% higher than 2008.Norway is by far the largest exploiter of the IIa fishery accounting for over 95% of official landings. UK is now the next most important exploiter in this area, with landings of approximately 2.5% of the total reported to ICES (Table 5.2.10). The coastal gillnetting accounts for 85–90% of the landings, while 4–6% is taken as bycatch in different offshore gillnet fisheries (Table 5.2.11).

No TAC is given for Division IIa, Norwegian waters. Catches of anglerfish in Division IIa, EC waters are taken as a part of the TAC for Subarea IV. The Norwegian fishery is regulated through:

- A prohibition against targeting anglerfish with other fishing gear than 360 mm gillnets. A discard ban on anglerfish regardless of size.
- A maximum of 10% bycatch of anglerfish in the shrimp trawl fishery, maximum 20% bycatch of anglerfish in the trawl and Danish seine fishery.
- 72 hours maximum soak time in the gillnet fishery.
- A maximum of 500 gillnets (each net being 27.5 m) per vessel.

- A closure of the gillnet fishery from 1 March to 20 May. This closure period was expanded to 20 December to 20 May in the areas north of N 65° in 2008 and this area was expanded southwards to N 64° in 2009.

#### 5.2.2.2 Data

*Landings*

The official landings for each country are shown in Table 5.2.10. Landings in 2010 as reported to ICES for the total Division IIa were 5394 t, which is 21% higher than the year before. No information suggests that the official landing figures from Norway give a biased estimate of the actual landings.

*Discards*

The absence of a TAC in Norwegian waters probably reduces the incentive to under-report landings. Anecdotal evidence from the industry, observer trips and data from the self-sampling-fleet suggest that a small percentage of the catch (not marketable) is discarded. This happens when the soaking time is too long, mostly due to bad weather. Data from the self-sampling-fleet are not adequate for estimating discards yet.

*Biological*

Length distributions are available from the directed gillnetting during the period 1992–2010, but data are lacking 1997–2001 (Figure 5.2.11). The length data indicates a decrease in mean length of 15–20 cm occurring during the period without length samples. The mean length has increased somewhat during the last five years, but is still below the level seen during the 1990s (Figure 5.2.12). One third of the anglerfish measured during the 1990s were above 100 cm, this proportion was between 1–6% for the early 2000s and 12–17% in 2006–2010. For 2006–2010, some length data from anglerfish caught as bycatch in other fisheries are presented in Figure 5.2.13.

*Surveys*

Anglerfish appears in demersal trawl surveys along the Norwegian shelf, but in very small numbers. There has been a change in the surveys, going from single species to multispecies surveys, during recent years. The procedures for data collection on anglerfish have varied and, at present, no time-series from surveys in Division IIa yields reliable information on the abundance of anglerfish.

*Commercial cpue*

Reliable effort data are not available from the Norwegian gillnetters due to non-mandatory effort recording. In late 2005, ten gillnetters were included in a self-sampling scheme established along the Norwegian coast within Division IIa. Detailed information about effort and catch is provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area. The time-series was examined prior to WGCSE 2010, and this revealed some data quality problems for the first two years which have to be solved before any further analysis.

#### 5.2.2.3 Historical stock development

Anglerfish in Div IIa have never been assessed quantitatively and it is not possible to describe the historical stock development.

#### 5.2.2.4 Management considerations

The WG notes the apparent changes in size composition in anglerfish caught in the gillnet fishery. If the selectivity in the gillnets has been stable, this could be interpreted as an altering of the size spectrum in the stock. As the information on trends in effort is lacking for the main fishery, it remains unclear whether the increased landings last year might reflect an increased abundance in the area. Time-series on effort and catch by length should be established to facilitate future analytical assessments of this stock. The possibility of establishing a survey, similar to the one being carried out for the Northern Shelf area, should also be considered for Division IIa.

There are limited management controls in this area. Given the rapidly expanding nature of the fishery it would seem sensible to consider what can be done to evaluate the effects of this expansion, to determine an appropriate exploitation regime, and to put effective management measures in place.

#### 5.2.2.5 References

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**Table 5.2.1. Anglerfish on the Northern Shelf (IIIa, IV & VI). Total official landings by area (tonnes).**

| | IIIa | IVa | IVb | IVc | VIa | VIb | Total |
|---|---|---|---|---|---|---|---|
| 1973 | 140 | 2085 | 575 | 41 | 9221 | 127 | 12189 |
| 1974 | 202 | 2737 | 1171 | 39 | 3217 | 435 | 7801 |
| 1975 | 291 | 2887 | 1864 | 59 | 3122 | 76 | 8299 |
| 1976 | 641 | 3624 | 1252 | 49 | 3383 | 72 | 9021 |
| 1977 | 643 | 3264 | 1278 | 54 | 3457 | 78 | 8774 |
| 1978 | 509 | 3111 | 1260 | 72 | 3117 | 103 | 8172 |
| 1979 | 687 | 2972 | 1578 | 112 | 2745 | 29 | 8123 |
| 1980 | 652 | 3450 | 1374 | 175 | 2634 | 200 | 8485 |
| 1981 | 549 | 2472 | 752 | 132 | 1387 | 331 | 5623 |
| 1982 | 529 | 2214 | 654 | 99 | 3154 | 454 | 7104 |
| 1983 | 506 | 2465 | 1540 | 181 | 3417 | 433 | 8542 |
| 1984 | 568 | 3874 | 1803 | 188 | 3935 | 707 | 11075 |
| 1985 | 578 | 4569 | 1798 | 77 | 4043 | 1013 | 12078 |
| 1986 | 524 | 5594 | 1762 | 47 | 3090 | 1326 | 12343 |
| 1987 | 589 | 7705 | 1768 | 66 | 3955 | 1294 | 15377 |
| 1988 | 347 | 7737 | 2061 | 95 | 6003 | 1730 | 17973 |
| 1989 | 334 | 7868 | 2121 | 86 | 5729 | 313 | 16451 |
| 1990 | 570 | 8387 | 2177 | 34 | 5615 | 822 | 17605 |
| 1991 | 595 | 9235 | 2522 | 26 | 5061 | 923 | 18362 |
| 1992 | 938 | 10209 | 3053 | 39 | 5479 | 1089 | 20807 |
| 1993 | 843 | 12309 | 3144 | 66 | 5553 | 681 | 22596 |
| 1994 | 811 | 14505 | 3445 | 210 | 5273 | 777 | 25021 |
| 1995 | 823 | 17891 | 2627 | 402 | 6354 | 830 | 28927 |
| 1996 | 702 | 25176 | 1847 | 304 | 6408 | 602 | 35039 |
| 1997 | 776 | 23425 | 2172 | 160 | 5330 | 899 | 32762 |
| 1998 | 626 | 16857 | 2088 | 78 | 4506 | 900 | 25055 |
| 1999 | 660 | 13326 | 1517 | 24 | 4284 | 1401 | 21212 |
| 2000 | 602 | 12338 | 1617 | 31 | 3311 | 1074 | 18973 |
| 2001 | 621 | 12861 | 1832 | 21 | 2660 | 1309 | 19304 |
| 2002 | 667 | 11048 | 1244 | 21 | 2280 | 718 | 15978 |
| 2003 | 478 | 8523 | 847 | 20 | 2493 | 643 | 13004 |
| 2004 | 519 | 8987 | 851 | 15 | 2453 | 671 | 13496 |
| 2005 | 458 | 8424 | 688 | 5 | 3019 | 958 | 13552 |
| 2006 | 423 | 10338 | 685 | 3 | 2785 | 916 | 15150 |
| 2007 | 433 | 10632 | 749 | 4 | 3352 | 1260 | 16430 |
| 2008 | 486 | 11038 | 769 | 5 | 3373 | 1630 | 17300 |
| 2009 | 479 | 10096 | 658 | 8 | 3029 | 2119 | 16389 |
| 2010 | 476 | 6855 | 598 | 11 | 2696 | 1342 | 11978 |
| Min | 140 | 2214 | 575 | 3 | 1387 | 29 | 5623 |
| Max | 938 | 25176 | 3445 | 402 | 9221 | 2119 | 35039 |
| Average | 560 | 8713 | 1572 | 81 | 3972 | 797 | 15694 |

**Table 5.2.2. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.**

**Anglerfish in Division VIa (West of Scotland).**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 3 | 2 | 9 | 6 | 5 | - | 5 | 2 | - | - | + | + | - | + | - | - | - | - | - | - |
| Denmark | 1 | 3 | 4 | 5 | 10 | 4 | 1 | 2 | 1 | + | + | . | + | + | - | - | - | - | - | - |
| Faroe Is. | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 3 | 2 | 1 | 2 | 4 |
| France | 1,910 | 2,308 | 2,467 | 2,382 | 2,648 | 2,899 | 2,058 | 1,634 | 1,814 | 1,132 | 943 | 739 | 1,212 | 1,191 | 1,392 | 1,314 | 1763 | 1746 | 1555 | 1,160 |
| Germany | 1 | 2 | 60 | 67 | 77 | 35 | 72 | 137 | 50 | 39 | 11 | 3 | 27 | 39 | 39 | 1 | - | 54 | 79 | - |
| Ireland | 250 | 403 | 428 | 303 | 720 | 717 | 625 | 749 | 617 | 515 | 475 | 304 | 322 | 219 | 356 | 392 | 470 | 295 | 328 | 510 |
| Netherlands | - | - | - | - | - | - | 27 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Norway | 6 | 14 | 8 | 6 | 4 | 4 | 1 | 3 | 1 | 3 | 2 | 1 | + | + | 1 | 1 | 1 | 2 | - | 1 |
| Spain | 7 | 11 | 8 | 1 | 37 | 33 | 63 | 86 | 53 | 82 | 70 | 101 | 196 | 110 | 82 | 76 | 3 | 174 | 189 | - |
| UK(E,W&NI) | 270 | 351 | 223 | 370 | 320 | 201 | 156 | 119 | 60 | 44 | 40 | 32 | 31 | 30 | 20 | 24 | 42 | 5 | - | - |
| UK(Scot.) | 2,613 | 2,385 | 2,346 | 2,133 | 2533 | 2,515 | 2,322 | 1,773 | 1,688 | 1,496 | 1,119 | 1,100 | 705 | 862 | 1,127 | 974 | 1,071 | 1096 | - | - |
| UK (total) | | | | | | | | | | | | | | | | | | | 876 | 1,021 |
| Total | 5,061 | 5,479 | 5,553 | 5,273 | 6,354 | 6,408 | 5,330 | 4,506 | 4,284 | 3,311 | 2,660 | 2,280 | 2,493 | 2,453 | 3,019 | 2,785 | 3,352 | 3,373 | 3,029 | 2,696 |
| Unallocated | 296 | 2,638 | 3,816 | 2,766 | 5,112 | 11,148 | 7,506 | 5,234 | 3,799 | 3,114 | 2,068 | 1,882 | 985 | 1,938 | | | | | | |
| As used by WG | 5,357 | 8,117 | 9,369 | 8,039 | 11,466 | 17,556 | 12,836 | 9,740 | 8,083 | 6,425 | 4,728 | 4,162 | 3,478 | 4,391 | | | | | | |

*Preliminary.

**Table 5.2.2. contd. Anglerfish in Subarea VI. Nominal landings (t) as officially reported to ICES.**

**Anglerfish in Division VIb (Rockall).**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estonia | - | - | - | - | - | - | - | - | - | - | - | - | - | + - | - | | - | - | | |
| Faroe Is. | - | 2 | - | - | - | 15 | 4 | 2 | 2 | - | 1 | - | - - | - | - | | - | 1 | 4 | 8 |
| France | - | - | 29 | - | - | - | 1 | 1 | …[1] | 48 | 192 | 43 | 191 | 175 | 293 | 224 | 327 | 327 | 637 | 23 |
| Germany | - | - | 103 | 73 | 83 | 78 | 177 | 132 | 144 | 119 | 67 | 35 | 64 | 66 | 77 | 72 | 222 | 0 | 132 | |
| Ireland | 272 | 417 | 96 | 135 | 133 | 90 | 139 | 130 | 75 | 81 | 134 | 51 | 26 | 13 | 35 | 53 | 70 | 76 | 91 | 107 |
| Norway | 18 | 10 | 17 | 24 | 14 | 11 | 4 | 6 | 5 | 11 | 5 | 3 | 6 | 5 | 4 | 6 | 7 | 5 | 9 | 12 |
| Portugal | - | - | - | - | - | - | - | + | 429 | 20 | 18 | 8 | 4 | 19 | 63 - | - | - | - | | |
| Russia | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 2 | 4 | 1 | 1 | 35 - | | |
| Spain | 333 | 263 | 178 | 214 | 296 | 196 | 171 | 252 | 291 | 149 | 327 | 128 | 59 | 43 | 34 | 36 | 12 | 85 | 57 | |
| UK(E,W&NI) | 99 | 173 | 76 | 50 | 105 | 144 | 247 | 188 | 111 | 272 | 197 | 133 | 133 | 54 | 93 | 46 | 146 | 5 - | | |
| UK(Scot) | 201 | 224 | 182 | 281 | 199 | 68 | 156 | 189 | 344 | 374 | 367 | 317 | 160 | 294 | 355 | 478 | 475 | 1096 - | | |
| UK (total) | | | | | | | | | | | | | | | | | | | 1189 | 1192 |
| Total | 923 | 1089 | 681 | 777 | 830 | 602 | 899 | 900 | 1401 | 1074 | 1309 | 718 | 643 | 671 | 958 | 916 | 1260 | 1630 | 2119 | 1342 |
| Unallocated | | | | | | | | | -9 | 17 | -178 | -47 | 145 | 121 | | | | | | |
| As used by WG | 923 | 1,089 | 681 | 777 | 830 | 602 | 899 | 900 | 1392 | 1091 | 1131 | 671 | 788 | 792 | | | | | | |

**Total Anglerfish in Sub-area VI (West of Scotland and Rockall).**

| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total official | 5,984 | 6,568 | 6,234 | 6,050 | 7,184 | 7,010 | 6,229 | 5,406 | 5,685 | 4,385 | 3,969 | 2,998 | 3,136 | 3,124 | 3,977 | 3,701 | 4,612 | 5,003 | 5,148 | 4,038 |
| Total ICES | 6,280 | 9,206 | 10,050 | 8,816 | 12,296 | 18,158 | 13,735 | 10,640 | 9,475 | 7,516 | 5,859 | 4,833 | 4,266 | 5,183 | | | | | | |

***Preliminary.**

**Table 5.2.3. Nominal landings (t) of Anglerfish in the North Sea, as officially reported to ICES.**

**Northern North Sea (IVa).**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 2 | 9 | 3 | 3 | 2 | 8 | 4 | 1 | 5 | 12 | - | 8 | 1 | - | - | - | - | - | - | |
| Denmark | 1,245 | 1265 | 946 | 1,157 | 732 | 1,239 | 1,155 | 1,024 | 1,128 | 1,087 | 1,289 | 1,308 | 1,523 | 1,538 | 1,379 | 1,311 | 961 | 1,071 | 1,134 | 1,143 |
| Faroes | 1 | - | 10 | 18 | 20 | - | 15 | 10 | 6 | . | 2 | + | 3 | 11 | 22 | 2 | + | - | 4 | |
| France | 124 | 151 | 69 | 28 | 18 | 7 | 7 | 3* | 18[1*] | 8 | 9 | 8 | 8 | 8 | 4 | 7 | 13 | 13 | 48 | 6 |
| Germany | 71 | 68 | 100 | 84 | 613 | 292 | 601 | 873 | 454 | 182 | 95 | 95 | 65 | 20 | 84 | 173 | 186 | 344 | 216 | |
| Netherlands | 23 | 44 | 78 | 38 | 13 | 25 | 12 | - | 15 | 12 | 3 | 8 | 9 | 38 | 13 | 14 | 14 | 12 | 5 | 8 |
| Norway | 587 | 635 | 1,224 | 1,318 | 657 | 821 | 672 | 954 | 1,219 | 1,182 | 1,212 | 928 | 769 | 999 | 880 | 1,005 | 831 | 860 | 859 | 735 |
| Sweden | 14 | 7 | 7 | 7 | 2 | 1 | 2 | 8 | 8 | 78 | 44 | 56 | 8 | 6 | 5 | 5 | 20 | 67 | … | 4 |
| UK(E, W&NI) | 129 | 143 | 160 | 169 | 176 | 439 | 2,174 | 668 | 781 | 218 | 183 | 98 | 104 | 83 | 34 | 99 | 303 | 13 | | |
| UK (Scotland) | 7,039 | 7,887 | 9,712 | 11,683 | 15,658 | 22,344 | 18,783 | 13,319 | 9,710 | 9,559 | 10,024 | 8,539 | 6,033 | 6,284 | 6,003 | 7,722 | 8,304 | 8,658 | | |
| UK (total) | | | | | | | | | | | | | | | | | | | 7,830 | 6101 |
| Total | 9,235 | 10,209 | 12,309 | 14,505 | 17,891 | 25,176 | 23,425 | 16,857 | 13,326 | 12,338 | 12,861 | 11,048 | 8,523 | 8,987 | 8,424 | 10,338 | 10,632 | 11,038 | 10,096 | 7,997 |

*** Preliminary.**

**Table 5.2.3. continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.**

**Central North Sea (IVb).**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 357 | 538 | 558 | 713 | 579 | 287 | 336 | 371 | 270 | 449 | 579 | 435 | 180 | 260 | 207 | 138 | 179 | 181 | 134 | 124 |
| Denmark | 345 | 421 | 347 | 350 | 295 | 225 | 334 | 432 | 368 | 260 | 251 | 255 | 191 | 274 | 237 | 276 | 173 | 237 | 248 | 194 |
| Faroes | - | - | 2 | - | - | - | - | - | - | - | - | 10 | - | - | - | - | - | - | - | - |
| France | - | 1 | - | 2 | - | - | - | -* | …2* | - | - | - | - | + | - | - | - | - | 9 | 6 |
| Germany | 4 | 2 | 13 | 15 | 10 | 9 | 18 | 19 | 9 | 14 | 9 | 17 | 11 | 11 | 9 | 14 | 12 | 22 | 17 | - |
| Ireland | | | | | | | | | | | | | 1 | - | - | - | - | - | - | - |
| Netherlands | 285 | 356 | 467 | 510 | 335 | 159 | 237 | 223 | 141 | 141 | 123 | 62 | 42 | 25 | 31 | 33 | 61 | 58 | 36 | 46 |
| Norway | 17 | 4 | 3 | 11 | 15 | 29 | 6 | 13 | 17 | 9 | 15 | 10 | 12 | 22 | 16 | 14 | 24 | 15 | 21 | 10 |
| Sweden | - | - | - | 3 | 2 | 1 | 3 | 3 | 4 | 3 | 2 | 9 | 2 | 1 | 4 | 4 | 6 | 9 | - | 5 |
| UK(E, W&NI) | 669 | 998 | 1,285 | 1,277 | 919 | 662 | 664 | 603 | 364 | 423 | 475 | 236 | 167 | 120 | 96 | 108 | 122 | 105 | | |
| UK (Scotland) | 845 | 733 | 469 | 564 | 472 | 475 | 574 | 424 | 344 | 318 | 378 | 210 | 241 | 138 | 88 | 98 | 172 | 142 | | |
| UK (total) | | | | | | | | | | | | | | | | | | | 193 | 213 |
| Total | 2,522 | 3,053 | 3,144 | 3,445 | 2,627 | 1,847 | 2,172 | 2,088 | 1,517 | 1,617 | 1,832 | 1,244 | 847 | 851 | 688 | 685 | 749 | 769 | 658 | 598 |

*** Preliminary**

**Table 5.2.3. continued. Nominal landings (t) of Anglerfish in the North Sea as officially reported to ICES.**

**Southern North Sea (IVc).**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 13 | 12 | 34 | 37 | 26 | 28 | 17 | 17 | 11 | 15 | 15 | 16 | 9 | 5 | 4 | 3 | 3 | 4 | 6 | 7 |
| Denmark | 2 | + | - | + | + | + | + | + | + | + | + | + | + | + | + | - | - | | - | - |
| France | - | - | - | - | - | - | - | 10 | - | + | - | + | - | - | - | - | - | + | - | 1 |
| Germany | - | - | - | - | - | - | - | - | - | + | - | + | + | - | - | - | - | - | - | - |
| Netherlands | 5 | 10 | 14 | 20 | 15 | 17 | 11 | 15 | 10 | 15 | 6 | 5 | 1 | - | 1 | - | 1 | 1 | - | 2 |
| Norway | - | - | - | - | + | - | - | - | + | - | + | - | - | - | - | - | - | - | 1 | - |
| UK(E&W&NI) | 6 | 17 | 18 | 136 | 361 | 256 | 131 | 36 | 3 | 1 | - | - | 10 | 3 | - | - | - … | - | | - |
| UK (Scotland) | - | - | - | 17 | - | 3 | 1 | + | + | + | - | - | - | 7 | - | - | - … | - | | - |
| UK (Total) | | | | | | | | | | | | | | | | | | + | 1 | 1 |
| Total | 26 | 39 | 66 | 210 | 402 | 304 | 160 | 78 | 24 | 31 | 21 | 21 | 20 | 15 | 5 | 3 | 4 | 5 | 8 | 11 |

*** Preliminary.**

**Total North Sea.**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 11,783 | 13,301 | 15,519 | 18,162 | 20,920 | 27,327 | 25,757 | 19,023 | 14,867 | 13,986 | 14,714 | 12,313 | 9,390 | 9,853 | 9,117 | 11,026 | 11,385 | 11,812 | 10,762 | 7,464 |
| WG estimate | 10,566 | 11,728 | 13,078 | 15,432 | 15,794 | 16,240 | 18,217 | 14,027 | 11,719 | 11,564 | 12,677 | 10,334 | 8,273 | 9,027 | | | | | | |
| Unallocated | -1,217 | -1,573 | -2,441 | -2,730 | -5,126 | -11,087 | -7,540 | -4,996 | -3,148 | -2,422 | -2,037 | -1,979 | -1,117 | -826 | | | | | | |

*** Preliminary.**

**Table 5.2.4. Nominal landings (t) of Anglerfish in Division IIIa, 1991–2010, as officially reported to ICES.**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 15 | 48 | 34 | 21 | 35 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Denmark | 493 | 658 | 565 | 459 | 312 | 367 | 550 | 415 | 362 | 377 | 375 | 369 | 215 | 311 | 274 | 227 | 255 | 287 | 344 | 270 |
| Germany | - | - | 1 | - | - | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 1 | 1 | 2 | 1 | 1 | 1 | - |
| Netherlands | | | | | | | - | - | - | - | - | . | 3 | 4 | 4 | 3 | 1 | 3 | - | 5 |
| Norway | 64 | 170 | 154 | 263 | 440 | 309 | 186 | 177 | 260 | 197 | 200 | 242 | 189 | 130 | 100 | 137 | 132 | 144 | 134 | 158 |
| Sweden | 23 | 62 | 89 | 68 | 36 | 25 | 39 | 33 | 36 | 27 | 46 | 55 | 71 | 73 | 79 | 54 | 44 | 51 | … | 43 |
| Total | 595 | 938 | 843 | 811 | 823 | 702 | 776 | 626 | 660 | 602 | 621 | 667 | 478 | 519 | 458 | 423 | 433 | 486 | 479 | 476 |

***Preliminary.**

**Table 5.2.5. Anglerfish in Subarea VI. Landings, effort and lpue from the Irish OTB fleet.**

| Year | Hours (VIa) | Kw.Days (VIa) | Hours VIb) | kw.Days (VIb) | Landings (VIa) | Landings (VIb) | LPUE (VIa_Hours) | LPUE (VIa kw.days) | LPUE (VIb_Hours) | LPUE (VIb kw.days) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 56 863 | 1 408 312 | 9029 | 599 053 | 655 | 114 | 11.52 | 0.47 | 12.63 | 0.019 |
| 1996 | 60 960 | 1 388 902 | 7219 | 469 212 | 624 | 74 | 10.24 | 0.45 | 10.25 | 0.022 |
| 1997 | 63 159 | 1 462 368 | 7169 | 377 836 | 587 | 93 | 9.29 | 0.40 | 12.97 | 0.025 |
| 1998 | 57 398 | 1 343 782 | 7337 | 403 310 | 558 | 99 | 9.72 | 0.42 | 13.49 | 0.024 |
| 1999 | 54 075 | 1 348 480 | 8680 | 437 920 | 449 | 64 | 8.30 | 0.33 | 7.37 | 0.019 |
| 2000 | 52 847 | 1 325 585 | 9883 | 613 229 | 410 | 62 | 7.76 | 0.31 | 6.27 | 0.013 |
| 2001 | 47 224 | 1 320 179 | 7232 | 593 467 | 315 | 93 | 6.67 | 0.24 | 12.86 | 0.011 |
| 2002 | 35 016 | 1 007 965 | 2626 | 217 918 | 276 | 41 | 7.88 | 0.27 | 15.61 | 0.036 |
| 2003 | 39 211 | 1 536 279 | 4543 | 478 464 | 314 | 26 | 8.01 | 0.20 | 5.72 | 0.017 |
| 2004 | 35 217 | 1 279 049 | 2234 | 205 349 | 210 | 13 | 5.96 | 0.16 | 5.82 | 0.029 |
| 2005 | 30 748 | 1 075 974 | 3844 | 216 991 | 351 | 35 | 11.42 | 0.33 | 9.11 | 0.053 |
| 2006 | 28 014 | 1 031 169 | 5903 | 464 965 | 386 | 53 | 13.78 | 0.37 | 8.98 | 0.030 |
| 2007 | 25 373 | 911 973 | 6589 | 548 392 | 467 | 69 | 18.41 | 0.51 | 10.47 | 0.034 |
| 2008 | 17 327 | 630 615 | 9740 | n/a | 295 | 78 | 17.03 | 0.47 | 8.01 | n/a |
| 2009 | 17 108 | 567 289 | 4354 | | 332 | 91 | 19 | | 20.90 | |
| 2010 | 24 870 | 825 760 | 3280 | | 210 | 107 | 21 | | 32.53 | |

**Landings in tonnes.**

**Lpue estimates on '000 hours fished or '000 kw.days.**

**Table 5.2.6. Total Danish Anglerfish landings (tonnes) and effort (days fishing) by fishery. Landings by fishery (from logbook data).**

| | North Sea | | | | | | NS | IIIA | | | | | | IIIA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | Beam_trawl | Demersal_trawl | Industrial_trawl | Lobster_trawl | Other_gear | Shrimp_trawl | **Total** | Beam_trawl | Demersal_trawl | Industrial_trawl | Lobster_trawl | Other_gear | Shrimp_trawl | **total** | **Grand Total** |
| 1992 | 80 | 815 | 261 | 350 | 125 | 63 | 1694 | 22 | 259 | 32 | 139 | 162 | 37 | 650 | 2344 |
| 1993 | 45 | 621 | 346 | 94 | 96 | 90 | 1293 | 12 | 262 | 9 | 163 | 83 | 34 | 564 | 1857 |
| 1994 | 59 | 827 | 196 | 285 | 93 | 60 | 1520 | 51 | 201 | 5 | 108 | 61 | 23 | 449 | 1969 |
| 1995 | 57 | 347 | 128 | 256 | 79 | 169 | 1036 | 82 | 97 | 1 | 62 | 48 | 21 | 312 | 1348 |
| 1996 | 17 | 762 | 130 | 282 | 42 | 234 | 1467 | 70 | 125 | 2 | 90 | 40 | 40 | 368 | 1834 |
| 1997 | 58 | 1148 | 105 | 57 | 33 | 89 | 1489 | 137 | 183 | 8 | 139 | 59 | 24 | 550 | 2040 |
| 1998 | 118 | 1036 | 96 | 41 | 62 | 102 | 1456 | 86 | 167 | 2 | 89 | 58 | 13 | 415 | 1871 |
| 1999 | 98 | 1127 | 86 | 39 | 69 | 77 | 1496 | 41 | 121 | 1 | 105 | 82 | 12 | 362 | 1858 |
| 2000 | 88 | 1066 | 68 | 16 | 52 | 56 | 1347 | 47 | 117 | 0 | 140 | 61 | 13 | 377 | 1724 |
| 2001 | 18 | 1343 | 67 | 7 | 53 | 52 | 1540 | 18 | 86 | 4 | 211 | 45 | 11 | 375 | 1915 |
| 2002 | 59 | 1268 | 53 | 86 | 42 | 54 | 1562 | 41 | 116 | 1 | 161 | 35 | 15 | 369 | 1931 |
| 2003 | 40 | 1515 | 30 | 59 | 28 | 42 | 1714 | 4 | 27 | 1 | 144 | 31 | 8 | 215 | 1929 |
| 2004 | 45 | 1524 | 42 | 67 | 83 | 48 | 1809 | 13 | 39 | 0 | 20 | 231 | 7 | 310 | 2119 |
| 2005 | 48 | 1423 | 26 | 97 | 15 | 16 | 1625 | 5 | 84 | 0 | 136 | 39 | 8 | 274 | 1898 |
| 2006 | 8 | 1454 | 10 | 96 | 9 | 9 | 1587 | 1 | 107 | 0 | 105 | 10 | 3 | 227 | 1814 |
| 2007 | 24 | 1020 | 10 | 67 | 10 | 2 | 1134 | 10 | 124 | | 97 | 14 | 9 | 255 | 1389 |
| 2008 | 33 | 1162 | 1 | 86 | 18 | 8 | 1308 | 8 | 91 | 0 | 145 | 27 | 17 | 287 | 1595 |
| 2009 | 19 | 1186 | 0 | 133 | 35 | 8 | 1382 | 3 | 77 | 1 | 225 | 17 | 20 | 343 | 1725 |
| 2010 | 12 | 1242 | 0 | 45 | 34 | 4 | 1337 | 3 | 66 | 0 | 175 | 18 | 9 | 270 | 1607 |

**Tables 5.2.7. Total Danish Anglerfish landings (tonnes) and effort (days fishing) by fishery. Effort by fishery (from logbook data).**

| | North Sea | | | | | | NS | IIIA | | | | | | IIIA | Grand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Beam_trawl | Demersal_trawl | Industrial_trawl | Lobster_trawl | Other_gear | Shrimp_trawl | total | Beam_trawl | Demersal_trawl | Industrial_trawl | Lobster_trawl | Other_gear | Shrimp_trawl | total | Total |
| 1992 | 575 | 5105 | 3498 | 1784 | 1319 | 1434 | 13714 | 206 | 2632 | 256 | 2547 | 1097 | 1145 | 7885 | 21599 |
| 1993 | 292 | 3370 | 4414 | 968 | 1286 | 1534 | 11864 | 228 | 2914 | 81 | 3452 | 651 | 928 | 8253 | 20117 |
| 1994 | 356 | 3694 | 1963 | 2423 | 971 | 831 | 10239 | 595 | 2267 | 42 | 1991 | 618 | 616 | 6129 | 16369 |
| 1995 | 363 | 1898 | 1913 | 2274 | 957 | 2548 | 9954 | 617 | 1586 | 23 | 1288 | 391 | 594 | 4499 | 14453 |
| 1996 | 110 | 2869 | 1597 | 2027 | 394 | 2364 | 9360 | 739 | 1267 | 29 | 1767 | 424 | 820 | 5046 | 14407 |
| 1997 | 221 | 4707 | 1562 | 729 | 461 | 1415 | 9096 | 980 | 1820 | 106 | 2207 | 526 | 468 | 6108 | 15204 |
| 1998 | 413 | 4482 | 1321 | 379 | 549 | 1702 | 8845 | 665 | 1447 | 14 | 1455 | 390 | 262 | 4234 | 13079 |
| 1999 | 523 | 5056 | 1069 | 409 | 648 | 1214 | 8919 | 475 | 1463 | 23 | 2305 | 621 | 237 | 5123 | 14042 |
| 2000 | 787 | 6297 | 808 | 285 | 699 | 1095 | 9970 | 568 | 1332 | 6 | 3007 | 438 | 314 | 5664 | 15634 |
| 2001 | 250 | 8165 | 1039 | 182 | 789 | 1122 | 11548 | 361 | 1047 | 42 | 3940 | 431 | 291 | 6111 | 17659 |
| 2002 | 536 | 7412 | 1155 | 740 | 689 | 1011 | 11544 | 432 | 1277 | 22 | 3115 | 370 | 253 | 5468 | 17012 |
| 2003 | 447 | 7952 | 530 | 714 | 306 | 814 | 10763 | 78 | 409 | 9 | 2436 | 301 | 192 | 3424 | 14187 |
| 2004 | 419 | 6210 | 517 | 356 | 623 | 592 | 8717 | 191 | 235 | 5 | 226 | 3195 | 154 | 4006 | 12723 |
| 2005 | 404 | 6123 | 242 | 440 | 180 | 259 | 7649 | 123 | 695 | 4 | 2359 | 513 | 205 | 3899 | 11548 |
| 2006 | 96 | 5912 | 125 | 543 | 174 | 154 | 7003 | 54 | 675 | 2 | 1758 | 124 | 65 | 2679 | 9682 |
| 2007 | 194 | 3808 | 106 | 362 | 107 | 36 | 4613 | 164 | 882 | | 1475 | 135 | 214 | 2870 | 7482 |
| 2008 | 191 | 3985 | 38 | 469 | 189 | 104 | 4977 | 63 | 855 | 1 | 2517 | 230 | 492 | 4159 | 9136 |
| 2009 | 175 | 3936 | 11 | 362 | 338 | 136 | 4959 | 45 | 815 | 15 | 3009 | 177 | 578 | 4640 | 9599 |
| 2010 | 116 | 3468 | 0 | 255 | 428 | 126 | 4393 | 24 | 649 | 1 | 2772 | 198 | 374 | 4018 | 8411 |

**Table 5.2.8. Anglerfish in IV and IIIa. Norwegian landings (tonnes) by fishery in 2005–2009 and preliminary data from 2010.**

| Fleet | 2005 Div IIIa | 2005 Div IVa | 2006 Div IIIa | 2006 Div IVa | 2007 Div IIIa | 2007 Div Iva | 2008 Div IIIa | 2008 Div IVa | 2009 Div IIIa | 2009 Div Iva | 2010 Div IIIa | 2010 Div Iva |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coastal gillnetting | 61 | 526 | 103 | 696 | 87 | 574 | 97 | 554 | 90 | 481 | 111 | 443 |
| Offshore gillnetting | 1 | 16 | + | 19 | + | 32 | + | 24 | + | 21 | + | 34 |
| Coastal shrimp trawling | 22 | 50 | 25 | 46 | 26 | 36 | 27 | 35 | 30 | 29 | 31 | 22 |
| Offshore dem trawling | 5 | 102 | + | 142 | 8 | 154 | 12 | 206 | 6 | 265 | 5 | 179 |
| Offshore shrimp trawling | 3 | 68 | 5 | 66 | 8 | 39 | 7 | 32 | 6 | 40 | 5 | 40 |
| Other gears | 7 | 119 | 3 | 36 | 3 | 24 | + | 24 | 2 | 23 | 6 | 17 |
| Total | 100 | 880 | 137 | 1005 | 132 | 860 | 144 | 875 | 134 | 859 | 158 | 735 |

**Table 5.2.9. Abundance (millions of individuals) and biomass (thousands of tonnes) estimates from the 2005–2010 Northern shelf anglerfish surveys by ICES area and division.**

| Abundance (millions) | | | | | | |
|---|---|---|---|---|---|---|
| ICES Subarea / Division | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Subarea IV (partial) | 14.201 | 13.603 | 15.608 | 12.582 | 8.287 | 7.366 |
| Division VIa | 12.201 | 10.985 | 8.859 | 7.719 | 5.15 | 5.161 |
| Division VIb | 2.049 | 3.174 | 4.142 | 3.924 | 3.536 | 3.118 |
| Subarea VI | 14.249 | 14.159 | 13.000 | 11.643 | 8.686 | 8.279 |
| Northern Shelf (partial) | 28.451 | 27.762 | 28.608 | 24.225 | 16.973 | 15.645 |

| Biomass (thousand tonnes) | | | | | | |
|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Subarea IV (partial) | 19.059 | 21.998 | 28.572 | 29.671 | 17.058 | 21.944 |
| Division VIa | 14.266 | 12.222 | 11.157 | 14.381 | 6.232 | 11.59 |
| Division VIb | 5.948 | 6.676 | 10.526 | 9.311 | 12.461 | 8.687 |
| Subarea VI | 20.214 | 18.898 | 21.683 | 23.692 | 18.693 | 20.277 |
| Northern Shelf (partial) | 39.273 | 40.896 | 50.256 | 53.363 | 35.751 | 42.221 |

**Table 5.2.10. Nominal catch (t) of Anglerfish in Division IIa, 1994–2009, as officially reported to ICES and preliminary data for 2010.**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | + | + | + | + | + | + | 2 | + | - | 1 | - | - | - | - | + | |
| Faroes | + | + | + | + | + | - | 1 | 1 | 2 | 5 | 11 | 4 | 7 | 4 | 2 | |
| France | - | - | - | - | + | - | - | - | - | - | - | 1 | | | 2 | |
| Germany | 1 | 4 | 20 | 53 | 4 | 17 | 65 | 59 | 55 | 70 | 55 | - | | - | | |
| Norway | 526 | 893 | 576 | 1488 | 1731 | 2952 | 3552 | 2000 | 2404 | 2906 | 2649 | 4253 | 4455 | 3999 | 4289 | 5351 |
| Russia | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | | |
| Sweden | - | + | + | + | + | + | + | - | - | - | - | - | - | - | | |
| UK (total) | 74 | 15 | 5 | 7 | 6 | 30 | 2 | 10 | 15 | 18 | 19 | 86 | 115 | 138 | 152 | 40 |
| Other | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 6 | 3 |
| Total | 601 | 912 | 601 | 1548 | 1741 | 2999 | 3622 | 2070 | 2476 | 2999 | 2672 | 4341 | 4577 | 4143 | 4451 | 5394 |

***Preliminary.**

**Table 5.2.11. Anglerfish in IIa. Norwegian landings (tonnes) by fishery in 2005-2009 and preliminary data for 2010.**

| Fleet | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Coastal gillnetting | 2301 | 3723 | 4039 | 3574 | 3934 | 4791 |
| Offshore gillnetting | 115 | 261 | 204 | 240 | 171 | 391 |
| Offshore dem trawling | 77 | 71 | 52 | 26 | 27 | 25 |
| Coastal Danish seine | 54 | 54 | 63 | 75 | 68 | 40 |
| Other gears | 102 | 144 | 98 | 84 | 89 | 104 |
| Total | 2649 | 4253 | 4456 | 3999 | 4289 | 5351 |

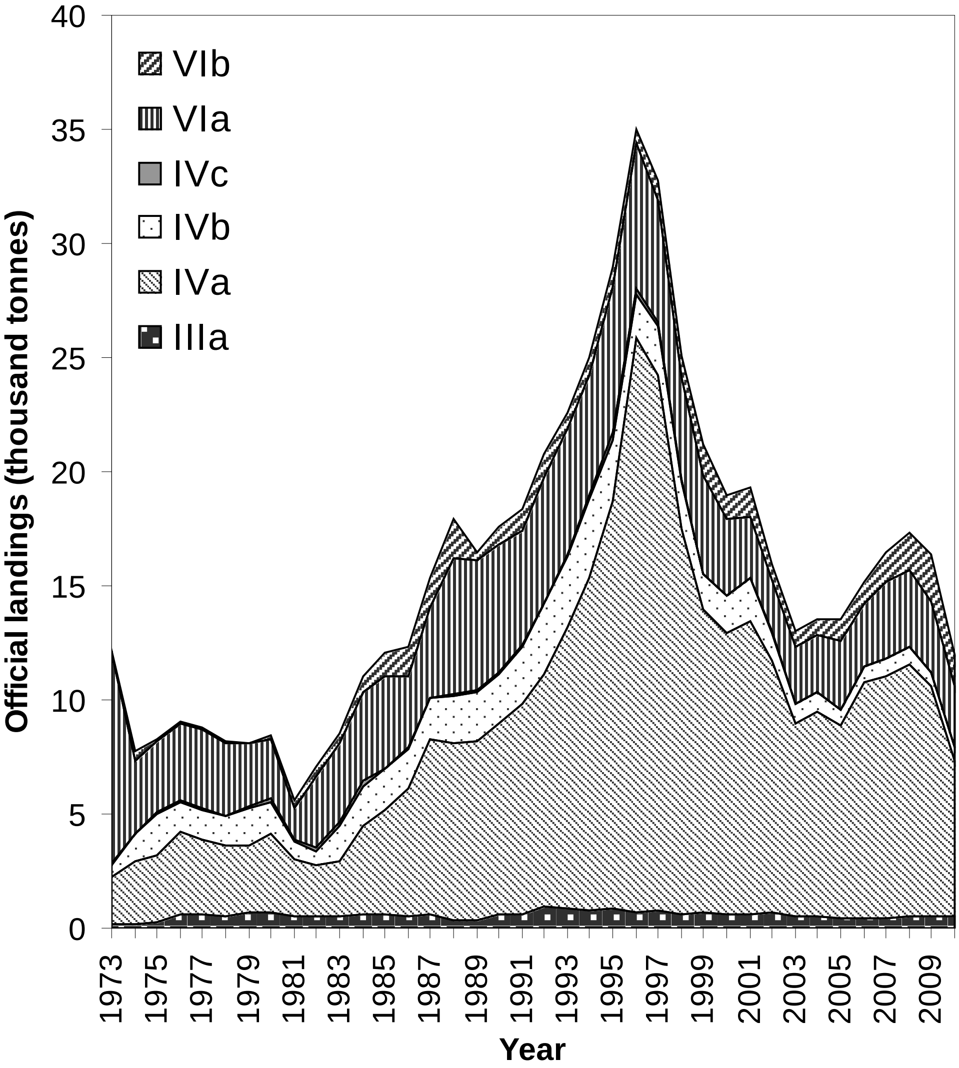
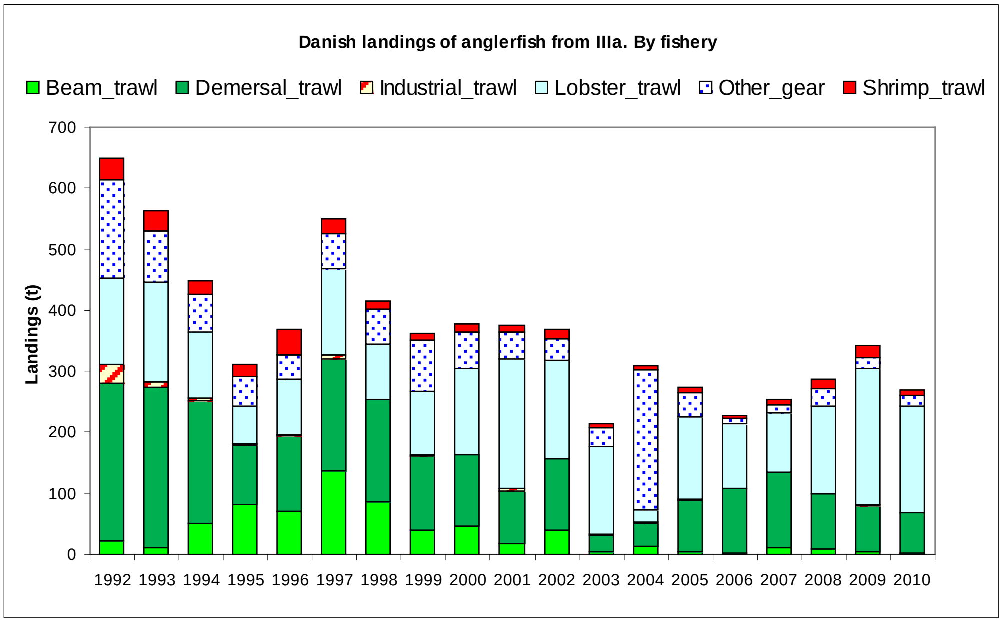



**Figure 5.2.1. Northern Shelf anglerfish. Officially reported landings by ICES area.**



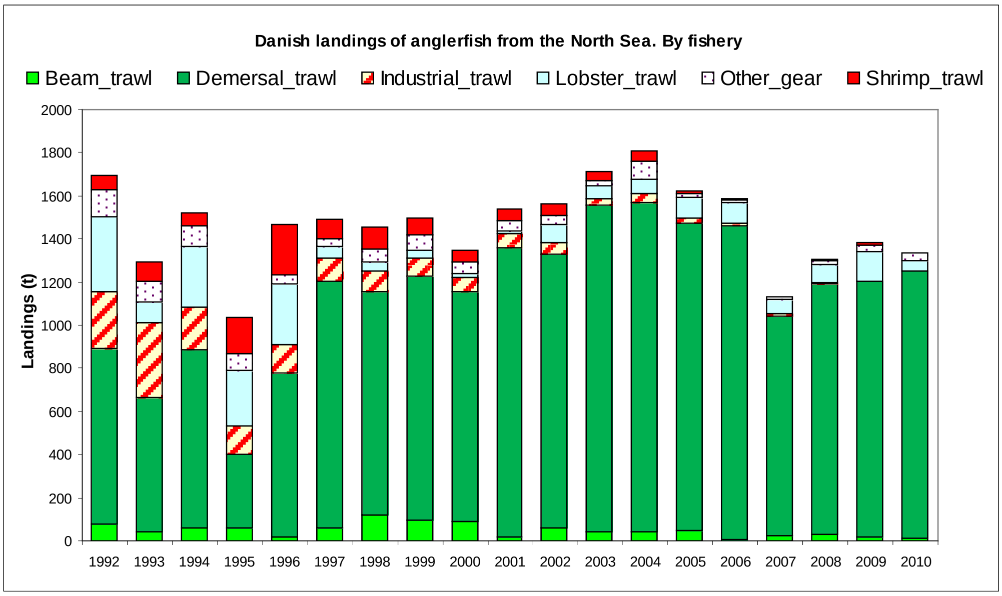




**Figure 5.2.2. Danish landings of Anglerfish by fishery in the North Sea (top) and Division IIIa (bottom) 1992–2010.**

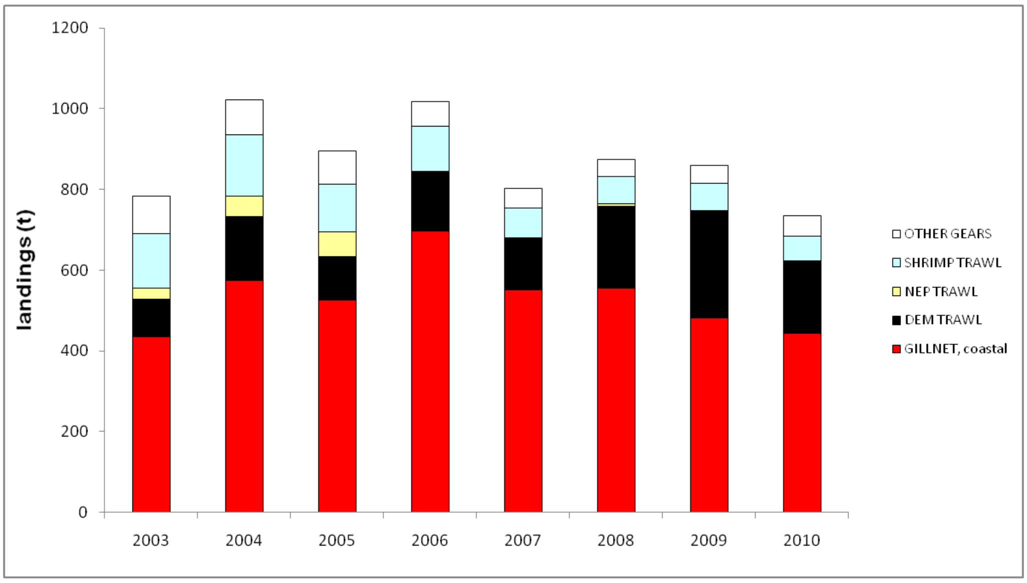



**Figure 5.2.3. Anglerfish in Division IVa. Norwegian landings by fleet from 2003–2010.**

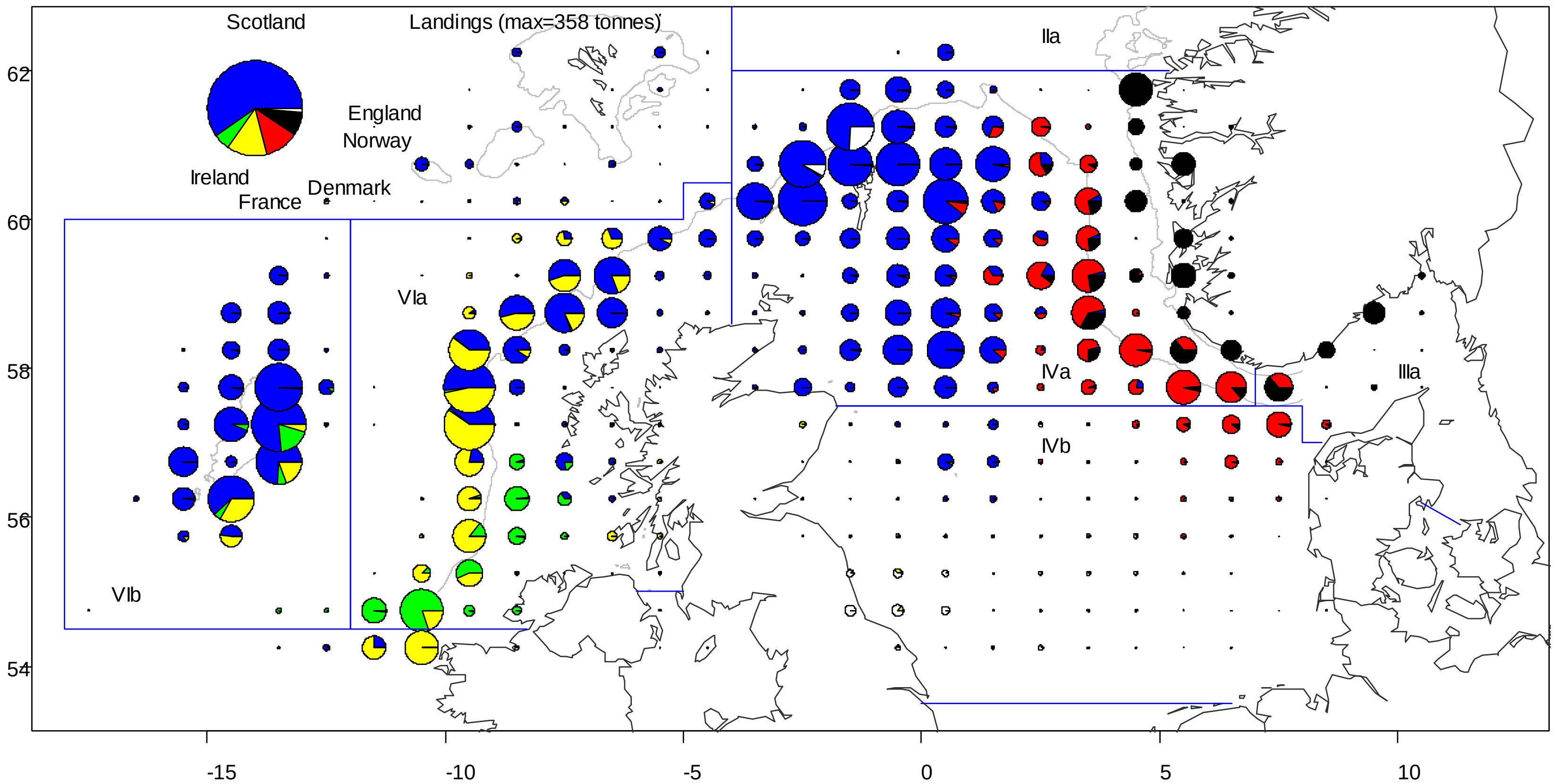



**Figure 5.2.4. Map of the European Northern Shelf showing the distribution of reported landings of anglerfish for 2010 from Scotland, Ireland, France, Denmark, Norway, and England. The circles are centred on each ICES rectangle and segmented according to the landings of each country according to the legend. The legend is divided according to the total reported landings of each country. The area of each circle is proportional to the landings in tonnes relative to the maximum as indicated. The Scottish data have been corrected according to certain assumptions about area misreporting (see Stock Annex).**

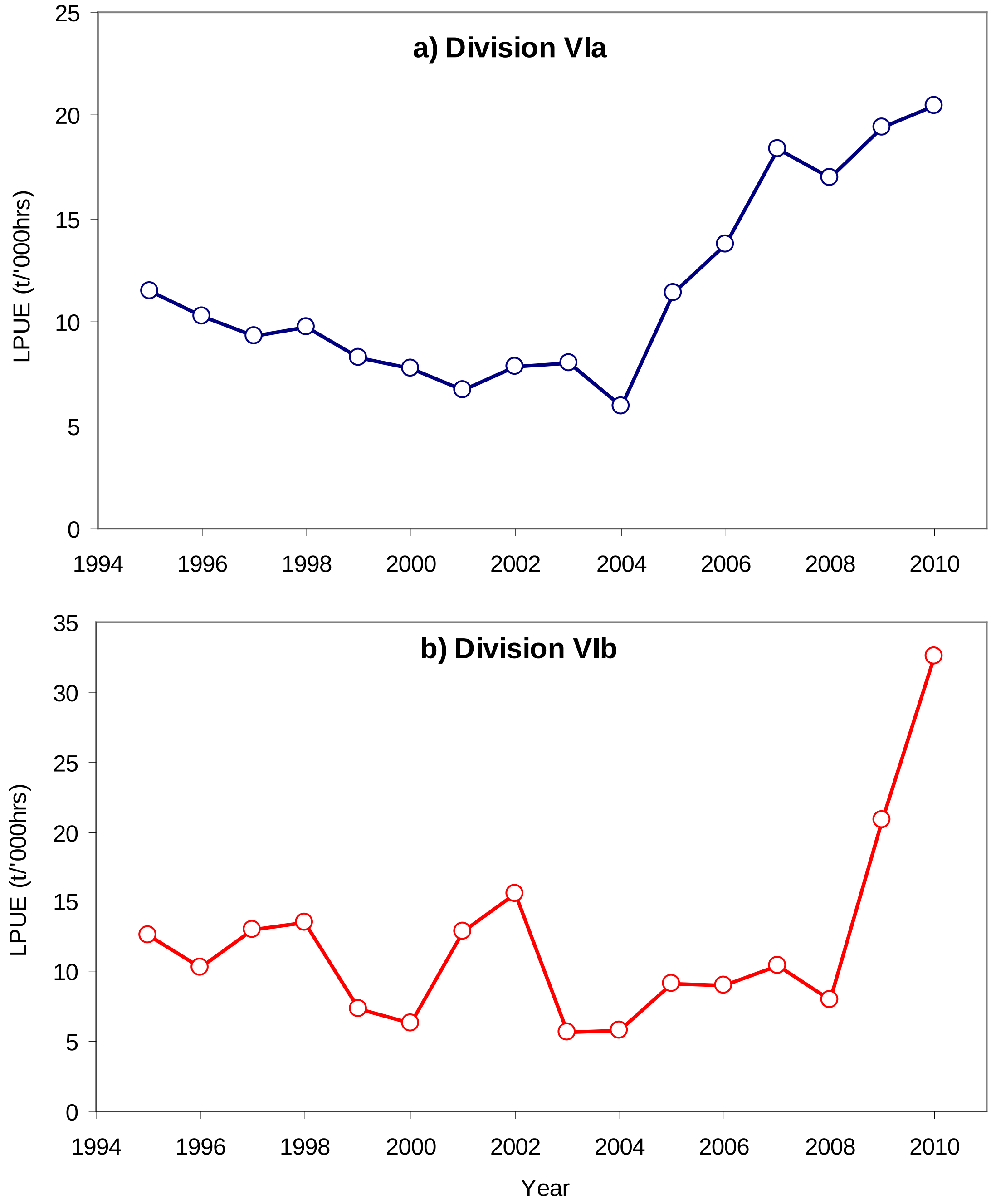



**Figure 5.2.5. Lpue for the Irish otter trawl fleet with effort in hours fished for a) Division VIa, and b) Division VIb.**

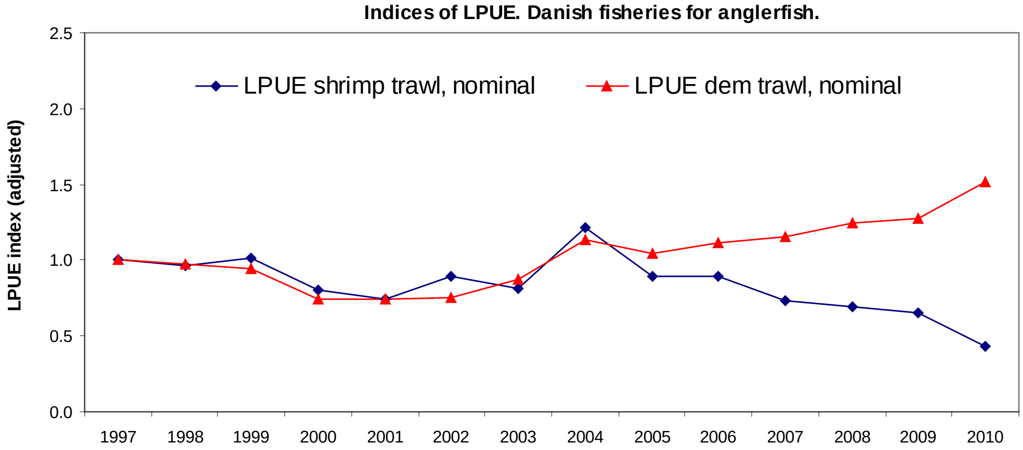



**Figure 5.2.6. Anglerfish in the North Sea & Division IIIa. Danish lpue by demersal trawl and shrimp trawl, relative to 1997. Based on nominal logbook records.**

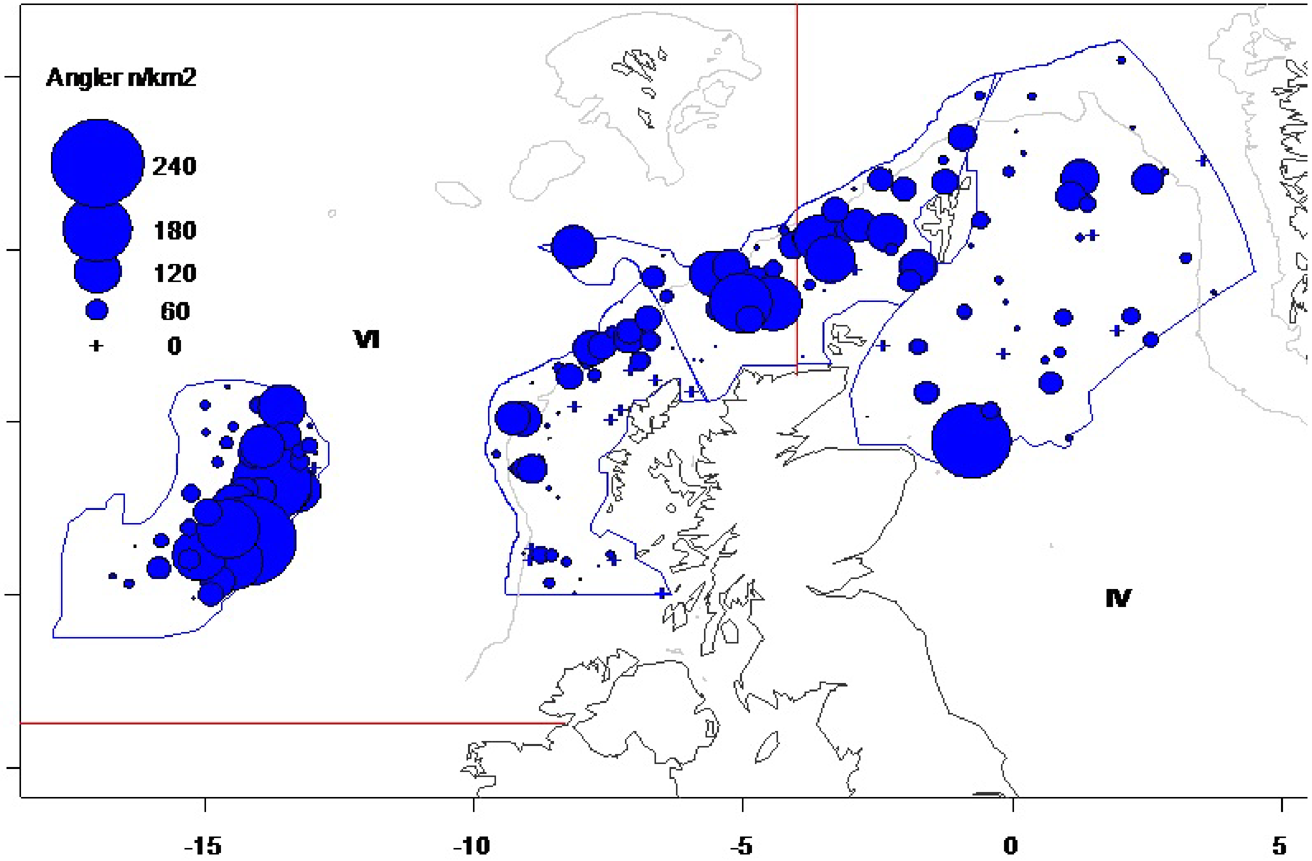



**Figure 5.2.7. Map of the northern continental shelf around Scotland showing the number density of anglerfish during the 2010 surveys. Each circle is centred on the sample location and circle size is proportional to the number density in n/km² according to the legend (top left). Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).**

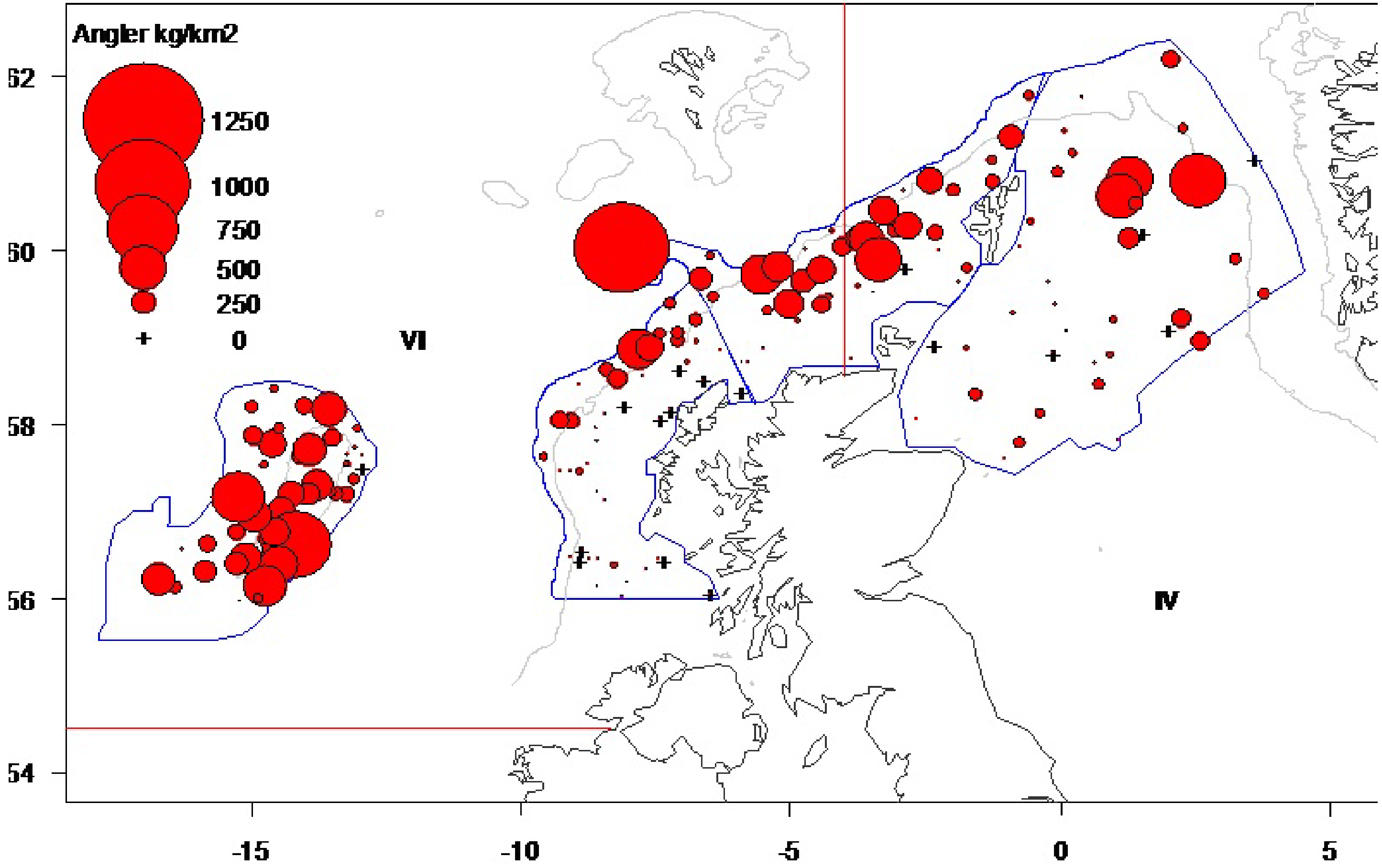



**Figure 5.2.8. Map of the northern continental shelf around Scotland showing the weight density of anglerfish during the 2010 anglerfish survey. Each circle is centred on the sample location and circle size is proportional to weight density in kg/km² according to the legend. Trawl densities in this figure account for herding but not footrope escapes. The red lines separate the ICES subareas indicated by roman numerals: IV (east) and VI (west).**

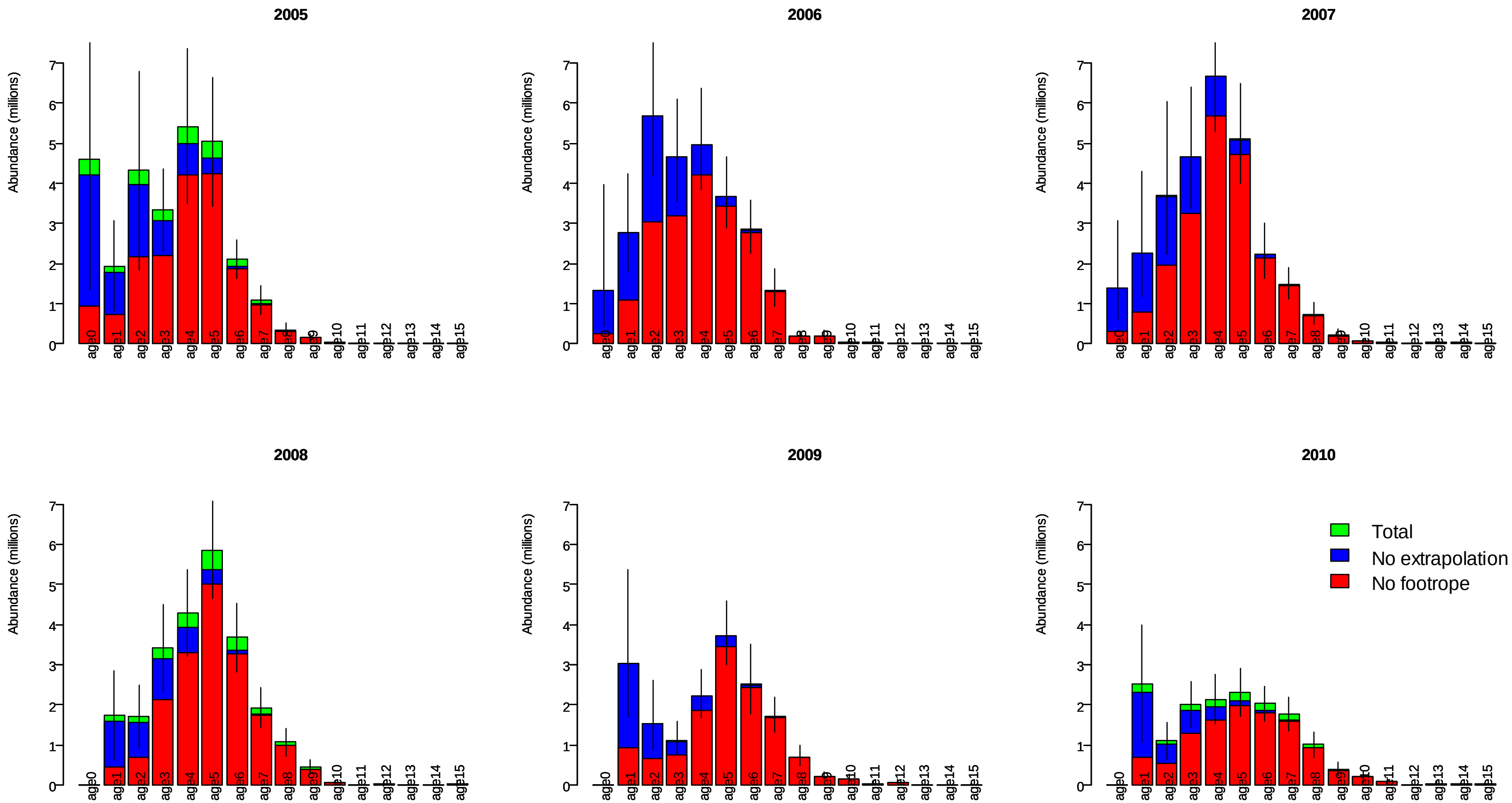



**Figure 5.2.9. Estimates of total abundance-at-age for each of the anglerfish surveys 2005–2010. Red bars indicate estimates prior to correction for footrope escapes; blues bars include the latter correction; green bars indicate an additional correction for the unsurveyed part of ICES Division VIa based on data when the area was surveyed by the Irish. Error bars are 95% confidence intervals.**

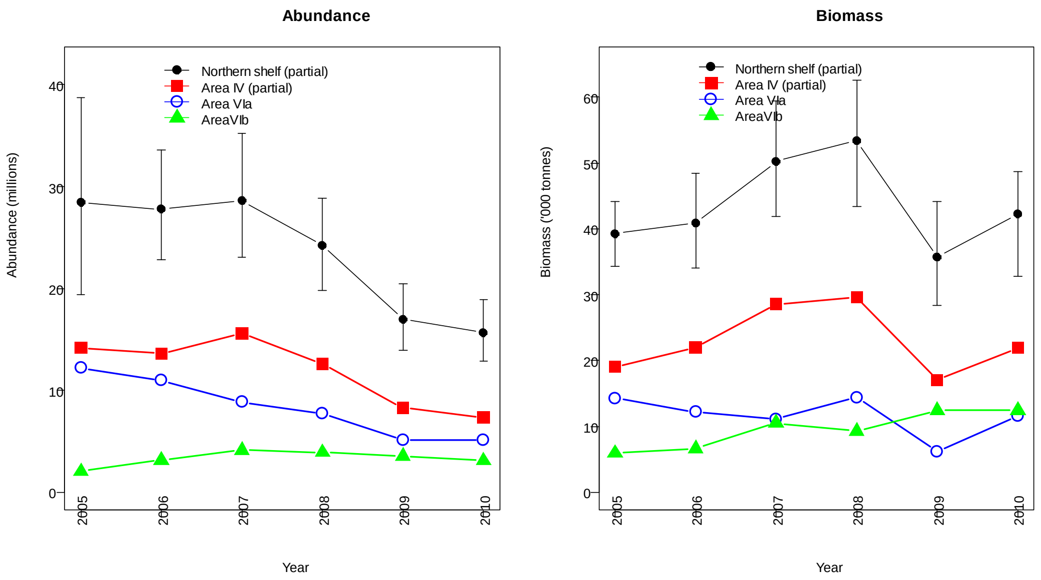



**Figure 5.2.10. Estimates of total abundance (left) and biomass (right) of anglerfish for the Northern shelf (black filled circles), with confidence intervals derived from variance estimates of the Scottish surveys. Estimates are also provided for ICES Subarea IV (red filled squares), Division VIa (blue open circles) and Division VIb (green filled triangles). Confidence limits for 2005 biomass are provisional.**

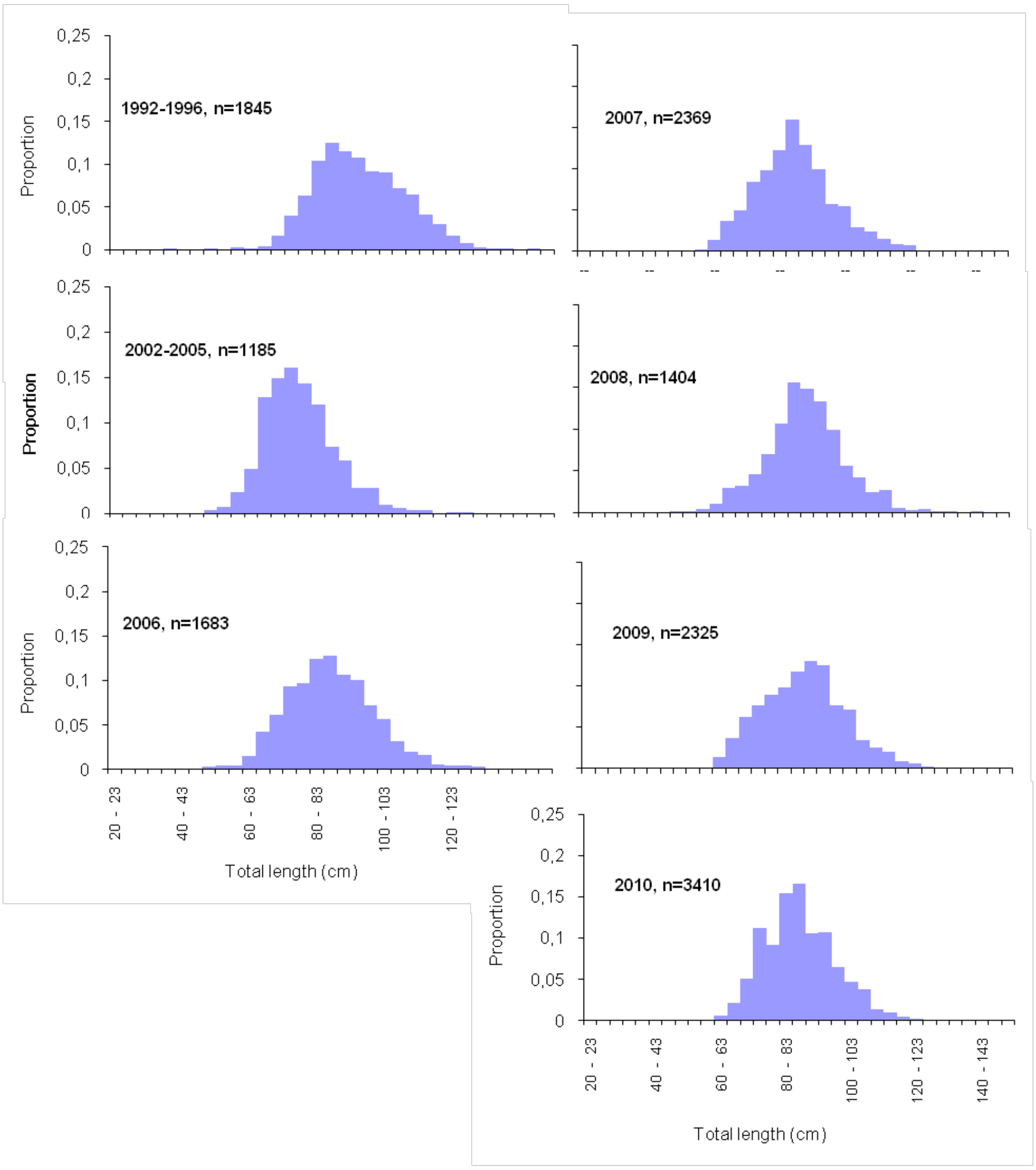



**Figure 5.2.11. Anglerfish in IIa. Length distributions for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2010. Note that data are lacking for 1997–2001.**

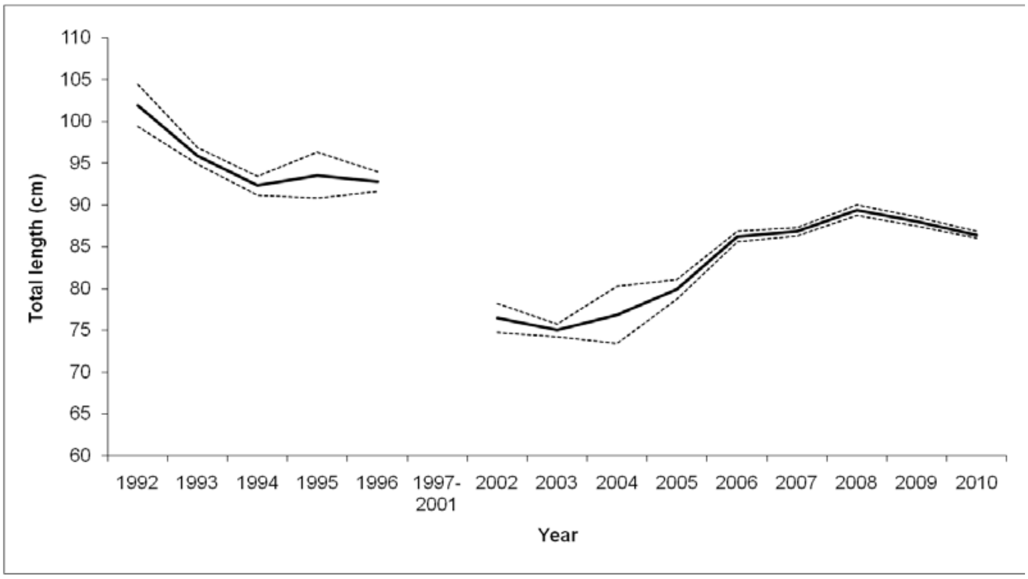



**Figure 5.2.12. Anglerfish in IIa. Mean lengths for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2010, dotted lines represents ±2SE of the mean. Note that data are lacking for 1997–2001.**

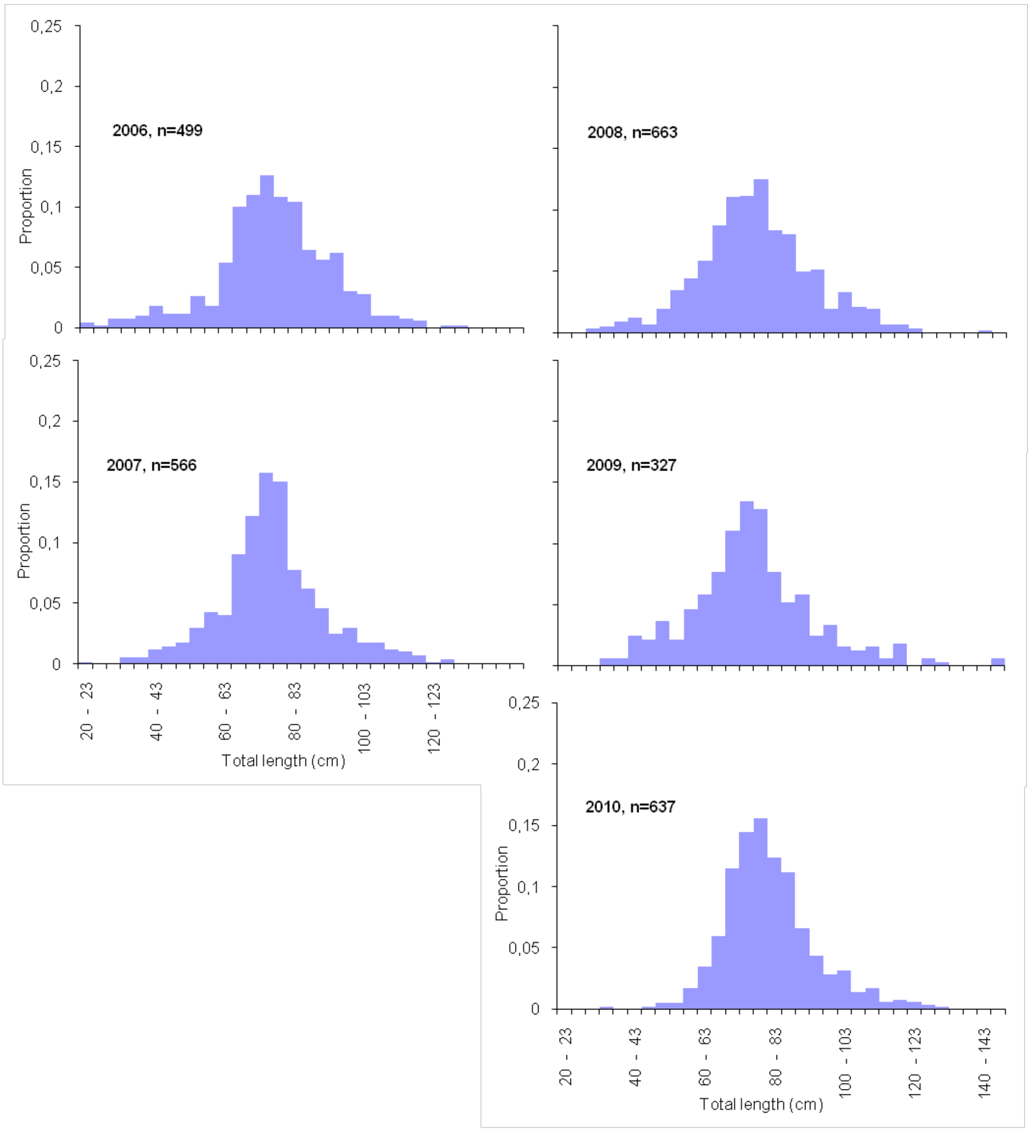



**Figure 5.2.13. Anglerfish in IIa. Length distribution for anglerfish caught as bycatch by other gears (offshore gillnetting and longlining) in Division IIa in 2005–2010.**

## 5.3 Megrim in IVa and VIa (Northern North Sea and West of Scotland) and Megrim in VIb (Rockall)

Based on the recommendation of WGNSDS (2008), in addition to megrim in VI, WGCSE now also considers megrim in IVa and IIa. Spatial data from both the commercial fishery (using VMS and catches by statistical rectangle) and from fishery-independent surveys provide little evidence to support the view that megrim in VIa and IVa are indeed separate stocks. Based on the recommendations from WKFLAT (2011), megrim in VIa and IVa are considered a single unit stock and assessed accordingly. Megrim in VIb is considered a separate stock unit for assessment purposes.

### 5.3.1 Megrim in Divisions IVa and VIa (Northern North Sea and West of Scotland)

#### Type of assessment in 2011

ICES has not conducted an analytical assessment of this stock since 1999. Megrim continues to be a monitored stock. The stock was benchmarked in 2011 (WKFLAT, 2011) and an exploration of landings numbers-at-age for VIa only was undertaken. However, due to relatively low age sampling in recent years (post 2002), resulting in poor cohort tracking and the absence of a time-series of age data from IVa (pre 2006) all preclude the development of an age based assessment.

The current assessment is based on survey trends in relative biomass from the ISP-Anglerfish survey conducted annually in VIa, IVa and VIb.

As an alternative to an age based approach, biomass dynamic (surplus production) models were explored during WKFLAT (2011). Two non-equilibrium surplus production models (ASPIC, NOAA toolbox) and a Bayesian state space surplus production model (Meyer and Millar, 1999). The latter approach is currently being developed and model outputs from the initial explanatory runs are presented in working document WD07. The exploratory analysis, using fishery-independent survey data from the International Bottom-trawl Survey (1985–2010), indicates a substantial decline in mortality since 2000 with increases in biomass. It should be noted however, that the initial estimates of intrinsic rate of growth appear high compared with other flatfish species and this is largely driven by the recent large increases in survey indices. At this stage, the approach is presented as relative changes in mortality and biomass over time and not in terms of absolute levels.

#### ICES advice applicable to 2010

*ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that the effort in fisheries that catch megrim should not be allowed to increase.*

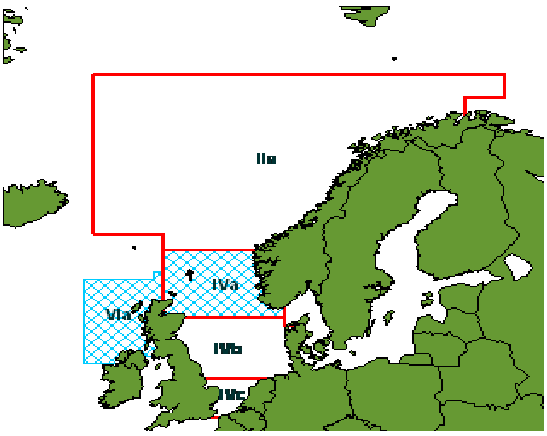
#### ICES advice applicable to 2011

*ICES advises that effort should be consistent with no increase in catches.*

#### 5.3.1.1 General

***Stock description and management units***

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in VIa and VIb as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in VIa and VIb (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. As noted by WGNSDS (2008), megrim in IVa has historically not been considered by ICES and WGNSDS (2008). Since 2009 data from IV and IIa are included in this report, but international catch and weight-at-age data for IV prior 2006 was not available to the working group or WKFLAT (2011). Given that there is little evidence to suggest that megrim in VIa and IVa are separate stocks, based on a visual inspection of the spatial distribution of commercial landings and fishery-independent survey data, WKFLAT (2011) concluded that megrim in VIa and IVa should be considered as a single stock. As a consequence, the assessment area is now incompatible with the management area.




**Management area (red boxes) and assessment area (blue hatched boxes).**

| **Species:** Megrims *Lepidorhombus* spp. | | **Zone:** EU waters of IIa and IV (LEZ/2AC4-C) |
|---|---|---|
| Belgium | 6 | |
| Denmark | 5 | |
| Germany | 5 | |
| France | 30 | |
| The Netherlands | 24 | |
| United Kingdom | 1 775 | |
| EU | 1 845 | |
| TAC | 1 845 | |
| | | Analytical TAC |

| **Species:** Megrims *Lepidorhombus* spp. | | **Zone:** VI; EU and international waters of Vb; international waters of XII and XIV (LEZ/561214) |
|---|---|---|
| Spain | 385 | |
| France | 1 501 | |
| Ireland | 439 | |
| United Kingdom | 1 062 | |
| EU | 3 387 | |
| TAC | 3 387 | Analytical TAC |

### *Fishery in 2010*

The introduction of the Cod Long-Term Management Plan (EC Regulation 1342/2008) and additional emergency measures applicable to VIa in 2009 (EC Regulation 43/2009, annex III 6) has impacted on the amount of effort deployed and increased the gear selectivity pattern of the main otter trawl fleets. Figure 5.3.1 shows the effort pattern for the main fleets catching megrim in VIa. Additionally, EC Regulation 43/2009 has effectively prohibited the use of mesh sizes <120 mm for vessels targeting fish, which had been used particularly by the Irish fleet up to that point, the resultant rapid decline in effort for this category (IRE TR2) can be seen in Figure 5.3.1 Much of the effort has been transferred into the TR1 fleet. Effort associated with the French fleet has continued to decline while the substantial declines seen in the Scottish TR1 fleets (120 mm mesh) appears to have stabilized at levels well below the earlier part of the time-series. Note that 2010 data are only available for the Irish fleets. The increase in mesh size (from 100 to 120 mm) has also impacted on the retention length of megrim, increasing L50 from 28 cm to 42 cm, an increase of almost 50%.

Fishing effort in IVa (Figure 5.3.2) for the main Scottish otter fleets (TR1 and TR2) have stabilized since the large total effort reductions observed between 2000 and 2003.

Based on landings data presented to the Working Group, only 50% of the overall TAC for VI, EC waters of Vb and international waters of XII and XIV was used. It should be noted that no landings data were made available to the Working Group by Spain therefore the uptake during 2010 will be higher, while historically, France only utilizes ~10% of its available quota, although this has increased to 20% in 2010, Historically, Spanish uptake has been ~80%.

**2010 TAC for VI, EC waters of Vb and international waters of XII and XIV.**

| | TAC | WG Landings | % TAC uptake[1] |
|---|---|---|---|
| Spain | 350 | Nr* | |
| France | 1364 | 270 | 20% |
| Ireland | 399 | 364 | 91% |
| United Kingdom | 966 | 917 | 95% |
| EC Total | 3079 | 1551 | 50% |

***nr – not reported to the Working Group.**

**[1] post regulation quota swaps have not been taken into account.**

**[2] Provisional figures.**

The uptake of the TAC for ICES Division IV and IIa was 82%.

**2010 TAC for EC IV and IIa.**

| | TAC | WG landings | % TAC uptake[1] |
|---|---|---|---|
| Belgium | 5 | 0 | 0% |
| Denmark | 5 | 22 | 440% |
| Germany | 5 | 0 | 0% |
| France | 29 | 5 | 17% |
| Netherlands | 23 | 1 | 4% |
| UK | 1690 | 1439 | 85% |
| EC | 1757 | 1439 | 82% |

**[1] post regulation quota swaps have not been taken into account.**

#### 5.3.1.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

As part of the 2011 benchmark for this stock, landings-at-age data from 1990 to 2010 have been compiled based on data from the UK and Ireland for VIa (with the exception of UK data from 2005). The earlier component of the time-series (pre 2000) aggregated landings-at-age across VIa and VIb using a combined ALK. For IVa, raised landings numbers-at-age have been complied for the period 2006–2009, but no data prior to 2006 was made available to WKFLAT (2011).

*Landings*

Official landings data for each country together with Working Group best estimates of landings from VIa are shown in Table 5.3.1 and for IVa in Table 5.3.2. The distributions of landings by statistical rectangle for 2010 in VIa, IVa and VIb are shown in Figure 5.3.3. The WG best estimates of landings are those supplied by stock coordinators of the various countries and differ from the official statistics in some years. These were supplied for VIa by Ireland, France and Scotland in 2010 and by Scotland for Division IVa. Landings have increased in recent years and are more in line with historical trends.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al.*, 1995; Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned by megrim species. Megrim are caught in association with anglerfish by some fleets and are area-misreported along with anglerfish. Previously, the reported Division VIa landings have been adjusted to the Working Groups estimate of catch by including landings declared from Subarea IVa in the ICES statistical rectangles immediately east of the 4 degree W line (see anglerfish Annex 5.2 for a detailed methodology). Area-misreporting peaked in 1996 and 1997 when around 50% of the estimated Working Group landings for Division VIa were area-misreported. The correction process has not been conducted for the past two years. There are indications that more recently the process has reversed. Laurenson and MacDonald (2008) note that in more recent years that megrim TAC in the North Sea has become more restrictive and anecdotal evidence suggest that megrim catches from IVa are misreported as coming from Division VIa. Therefore, because of conflicting information on the potential direction of area-misreporting, megrim landings at a statistical rectangle level has not been adjusted. However, the decision to consider megrim in VIa and IVa as single unit stock negates this problem. However, it is unknown whether misreporting from Division VIb is an issue.

#### *Discards*

Discard data were made available by Scotland (VIa and IVa) and Ireland (VIa). Scottish data give a discard rate (by weight) of 23% and 26% for IVa and VIa respectively. Irish discards were considerably lower, with 2% discarded by number and 1% by weight. The contrast is probably due to the low usage of TR2 by Ireland in VIa. Laurenson and MacDonlad (2008) note that while discarding of megrim below minimum landing size is low (<1%), discarding of legal sized fish was much higher at 22% over the six observed trips. This is attributed to low market price for small grades and bruised fish, resulting in highgrading of catches on length/quality reasons to maximize the value of a restrictive quota. Other studies (BIM, unpublished data) show that highgrading of damaged fish is in the range of 10 to 15% of the marketable megrim catch.

#### *Surveys*

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish (see Section 5.2). Five surveys have been carried out to date and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim and as such is recommended by WKAGME (2008) as the main source of data of megrim relative biomass for all megrim stocks the Northern Shelf. Currently, six years of data are available (2005–2010). The data from the 2011 survey (SCO-IV-VI-AMISS-Q2; IRE-IV-VI-AMISS-Q2) are not yet available, but the time-series will be updated as soon as this becomes available (summer 2011). The area stratified survey provides a minimum estimate of absolute abundance as the survey catches are raised based on swept-area raised and weighted by area. The survey assumes that all megrim in the trawl path are retained as there are no catchability estimates for this species. Assuming full retention is overly optimistic therefore providing a minimum estimate of stock biomass.

For the six years of survey data available, the sample locations and the density of megrim are illustrated in Figure 5.3.4 as numbers (number per square kilometre) and in Figure 5.3.5, as weight (kilograms per square kilometre). The highest densities of megrim occurred close to the 200 m contour in the northern and western areas, and on the eastern slopes of the Rockall plateau; high densities were also present in the northern North Sea. Prior to 2011, survey indices for VI and IV (partial) were presented. However, based on the recommendations of WKFLAT (2011), the megrim in

VIa and IVa are considered as a unit stock and VIb as a separate stock. A combined index for IVa and VIa is presented in Figure 5.3.6.

The results of the survey are presented in Table 5.3.3. Abundance and biomass in VIa/VIa and from 2005 to 2010 have increased considerably.

Using the ratio of the average abundance estimate from the first two years of the time-series with the last two years in line with the method proposed by the EC for setting TACs for category six stocks, gives an increase in relative biomass of 31% for VIb with zero change in biomass in VIa/IVa (Table 5.3.4).

Exploratory analysis to estimate $B_{msy}$ and $U_{msy}$ using a state–space biomass dynamic model is currently being undertaken. This model uses all available survey cpue time-series from the IBTS data from VIa, IVa (Figure 5.3.7). Exploratory runs from this approach indicate that the relative change in biomass in recent years has been stable with the medium estimate increasing in recent years and the relative exploitation rate suggests a downward trend. Converting the exploitation rate to fishing mortality through $C/TB=U=F/(F+M)*(1-\exp(-(F+M)))$, where C is catch and TB is total biomass and M is assumed to be 0.15, it is possible to estimate F. The historic trends in total biomass and F are shown in Figure 5.3.8. Attention is drawn to the large credible intervals (Figure 5.3.7) highlighting a high degree of uncertainty in the estimates, although since the introduction of the monkfish survey data (post 2005), the credible intervals have contracted. Additionally, the initial runs estimate a high intrinsic rate of growth (*r*), and it is considered that these may be too optimistic to be used as the basis for deifying a MSY exploitation rate ($U_{msy} = 2/r$). Until further analysis is undertaken, the absolute estimates of F and total biomass should not be overly interpreted and used as an indication of relative trends only.

*Commercial cpue*

Logarithmic lpues for Scottish, French and Irish vessels split by mesh bands corresponding to gear groups TR1 (>100 mm) and TR2 (>70<100 mm) as defined by 1342/2008 are available for, VIa (Ireland, France, Scotland) and IVa (Scotland) based on data presented to SGMOS 09-05 (Part 2). These are presented in Figure 5.3.9 (IVa/VIa). Between 2005 and 2010, both the commercial lpues and the survey cpues trends are reasonable consistent across fleets with all showing generally positive increases. It should be noted that the IRE TR2 fleet has been discontinued due to the prohibition of mesh sizes <120 mm for vessels targeting fish (EC regulation 43/2008).

Since 2007, the lpues for both the SCO TR1 and FR TR1 fleets show a dramatic increase as has the IRE TR1 since 2008 in VIa. These signals give a much stronger positive signal than the survey-series during this period. It is not possible to determine how much this could be attributed to changes in megrim abundances or changes in targeting behaviour, but there is anecdotal information from the fishery that indicate changes in targeting behaviour. Over the period, there have been reduced fishing opportunities for other species (e.g. cod) and reduced effort allocations inside the West of Scotland management line, particularly affecting Scottish and Irish vessels; this may have resulted in increased targeting of anglerfish and megrim to the west of the management line, where effort opportunities are far less constrained.

Logarithmic lpues for two Scottish commercial fleets (SCO TR1 and SCO TR2) in Area IV from 2003 to 2009 are given in Figure 5.3.9. The trends between the two commercial lpue indices are consistent and show a positive trend during the past few years. Care should be taken in interpreting the commercial lpue’s given possible shifts in targeting behaviour.

#### 5.3.1.3 Historical stock development

No analytical assessment has been agreed for this stock since 1999.

*State of the stock*

The state of the stock is unknown.

#### 5.3.1.4 Short-term projections

There is no accepted analytical assessment for this stock.

#### 5.3.1.5 Biological reference points

*Precautionary approach reference points*

No precautionary reference points have been defined for this stock.

*Yield-per-recruit analysis*

It was not possible to define $F_{0.1}$ and $F_{max}$ values for this stock due to the lack of international catch-at-age data and recent changes in fleet selectivity due to likely changes in targeting behaviour and recent changes in mesh selectivity, which, if fully implemented, will result in a significant change in age selectivity in the fishery.

#### 5.3.1.6 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

#### 5.3.1.7 Recommendation for next benchmark

This stock was recently subject to benchmark. Due to incomplete age data, particularly for IVa, it was not possible to undertake any exploratory age based assessments. Until a complete landings-at-age matrix is compiled this stock should not be considered for benchmark. Intersessional work on a Bayesian state–space surplus production model is continuing.

#### 5.3.1.8 Management considerations

The TAC in VI has not been fully utilized. However, the uptake rate is country specific, with full uptake being reported by some member states. Partial quota by individual member states may be an artefact of reduction in effort rather than reflective of a reduction in biomass. The TAC in IV has been fully utilized and the data from the anglerfish survey indicate a decrease in biomass in the last year of the time-series, although confidence bands are large. The TAC and assessment area are incompatible.

#### References

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (west of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Subarea IVa. Scottish Industry Science Partnership Report No 05/08.

Meyer and Millar, 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals pg. 1078

### 5.3.2 Megrim in VIb

#### Type of assessment in 2011

Based on the recommendation of WGNSDS (2008), in addition to megrim in VI, WGCSE now also considers megrim in IVa and IIa. Spatial data from both the commercial fishery (using VMS and catches by statistical rectangle) and from fishery-independent surveys provide little evidence to support the view that megrim in VIa and IVa are indeed separate stocks. Based on the recommendations from WKFLAT (2011) Megrim in VIb is considered a separate stock unit for assessment purposes.

The stock was benchmarked in 2011 (WKFLAT, 2011) and an exploration of landings numbers-at-age for VIa only was undertaken. However, due to lack of specific ageing data from VIb, precludes the development of an age based assessment.

The current assessment is based on survey trends in relative biomass from the ISP-Anglerfish survey conducted annually in VIa, IVa and VIb.

#### ICES advice applicable to 2010

*ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that the effort in fisheries that catch megrim should not be allowed to increase.*

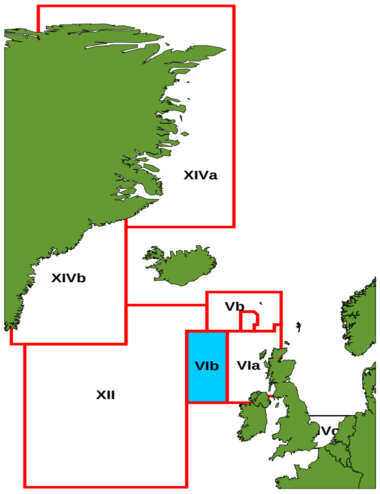
#### ICES advice applicable to 2011

*ICES advises that effort should be consistent with no increase in catches.*

#### 5.3.2.1 General

***Stock description and management units***

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in VIa and VIb as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' showed significantly different growth parameters and significant population structure difference between megrim sampled in VIa and VIb (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear. WKFLAT (2011) concluded that megrim in VIb should be considered as a single stock. As a consequence, the assessment area is now incompatible with the management area.




**Management area (red box) and assessment area (blue hatched area).**

| Species: Megrims *Lepidorhombus* spp. | | Zone: VI; EU and international waters of Vb; international waters of XII and XIV (LEZ/561214) |
|---|---|---|
| Spain | 385 | |
| France | 1 501 | |
| Ireland | 439 | |
| United Kingdom | 1 062 | |
| EU | 3 387 | |
| TAC | 3 387 | Analytical TAC |

### *Fishery in 2010*

Following the increases in Irish effort in subdivision VIb from 2004–2008, effort in 2009 (the last available year) has declined significantly (Figure 5.3.10) while Scottish effort has increased. Based on landings data presented to the Working Group, only 50% of the overall TAC for VI, EC waters of Vb and international waters of XII and XIV was taken. It should be noted that no landings data were made available to the Working Group by Spain therefore the uptake during 2010 will be higher, while historically, France only utilizes ~10% of its available quota, Spanish uptake has been ~80%.

**2010 TAC for VI, EC waters of Vb and international waters of XII and XIV.**

| | TAC | WG Landings | % TAC uptake[1] |
|---|---|---|---|
| Spain | 350 | Nr* | |
| France | 1364 | 270 | 20% |
| Ireland | 399 | 364 | 91% |
| United Kingdom | 966 | 917 | 95% |
| EC Total | 3079 | 1551 | 50% |

***nr not reported to the Working Group.**

**1 post regulation quota swaps have not been taken into account.**

**2 Provisional figures.**

#### 5.3.2.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

As part of the 2011 benchmark, landings-at-age data were compiled from 1990 to 2010. However, there is very sparse age data available from VIb and prior to 2002 age a common Subarea VI ALK was applied to megrim from VIa and VIb. Commencing in 2012, area specific age data will be gathered during the Anglerfish survey.

*Landings*

Official landings data for each country together with Working Group best estimates of landings from VIb are shown in Table 5.3.5. The distributions of landings by statistical rectangle from 2007 to 2010 in VIa, IVa and VIb are shown in Figure 5.3.3. The WG best estimates of landings are those supplied by stock coordinators of the various countries and differ from the official statistics in some years. These were supplied for VIb by Ireland and Scotland in 2010.

Catches of megrim comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al.*, 1995; Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned by megrim species. Megrim are caught in association with anglerfish by some fleets and are area-misreported along with anglerfish. However, it is unknown whether misreporting from Division VIb is an issue.

*Discards*

No discard data were made available.

*Surveys*

In 2005, Scotland initiated a new industry–science partnership survey to provide an absolute abundance estimate for anglerfish (see Section 5.2). Five surveys have been carried out to date and these cover the main distribution of the anglerfish fishery. The survey is also considered to have greater spatial coverage for megrim and as such is recommended by WKAGME (2008) as the main source of data of megrim relative biomass for all megrim stocks the Northern Shelf. Currently, six years of data are available (2005–2010) as data from the 2011 survey (SCO-IV-VI-AMISS-Q2) are not yet available, but the time-series will be updated as soon as this becomes available (summer 2011). The area stratified survey provides a minimum estimate of absolute abundance as the survey catches are raised based on swept-area raised and weighted by area. The survey assumes that all megrim in the trawl path are retained as there are no catchability estimates for this species. Assuming full retention is overly optimistic therefore providing a minimum estimate of stock biomass.

For the six years of survey data available, the sample locations and the density of megrim are illustrated in Figure 5.3.4 as numbers (number per square kilometre) and in Figure 5.3.5, as weight (kilograms per square kilometre). The highest densities of megrim occurred close to the 200 m contour in the northern and western areas, and on the eastern slopes of the Rockall plateau; high densities were also present in the northern North Sea. Prior to 2011, survey indices for VI and IV (partial) were presented. However, based on the recommendations of WKFLAT (2011), the megrim in VIb is considered as a separate stock. The survey index for VIb is presented in Figure 5.3.11.

The results of the survey are presented in Table 5.3.3. Abundance and biomass in VIb and from 2005 to 2010 has increased considerably (Table 5.3.4) and is stable at higher levels.

*Commercial cpue*

Logarithmic lpues for Scottish and Irish OTB vessels are available for, VIb. These are presented in Figure 5.3.12. The commercial data does not follow the trends observed in the survey time-series and the commercial lpue's between the two fleets in 2009 are contradictory. Care should be taken in interpreting the commercial lpue's given possible shifts in targeting behaviour and the conflicting signal between the two fleets in recent years.

#### 5.3.2.3 Historical stock development

No analytical assessment has been agreed for this stock since 1999.

*State of the stock*

The state of the stock is unknown.

#### 5.3.2.4 Short-term projections

There is no accepted analytical assessment for this stock.

#### 5.3.2.5 Biological reference points

*Precautionary approach reference points*

No precautionary reference points have been defined for this stock.

*Yield-per-recruit analysis*

It was not possible to define $F_{0.1}$ and $F_{max}$ values for this stock due to the lack of international catch-at-age data and recent changes in fleet selectivity due to likely changes in targeting behaviour and recent changes in mesh selectivity, which, if fully implemented, will result in a significant change in age selectivity of the gear.

#### 5.3.2.6 Uncertainties and bias in assessment and forecast

There is no accepted analytical assessment for this stock.

#### 5.3.2.7 Recommendation for next benchmark

This stock was recently subject to benchmark. Due to lack of age data specific to megrim in VIb, it was not possible to undertake any exploratory age based assessments. Age data will be gathered during the surveys from 2012 onwards. Intersessional work on a Bayesian state–space surplus production model is continuing.

#### 5.3.2.8 Management considerations

The TAC in VI has not been fully utilized. However, the uptake rate is country specific, with full uptake being reported by some Member States. Partial quota by individual Member States may be an artefact of reduction in effort rather than reflective of a reduction in biomass. The TAC and assessment area are incompatible.

### References

Kunzlik, P. A., A. W. Newton and A. W. Jermyn. 1995. Exploitation of monks (*Lophius* spp.) and megrims (*Lepidorhombus* spp.) by Scottish fishermen in ICES Division VIa (west of Scotland). Final report EU FAR contract MA-2-520.

Laurenson, C. and MacDonald, P. 2008. Collection of fisheries and biological data on megrim in ICES Subarea IVa. Scottish Industry Science Partnership Report No 05/08.

Meyer and Millar, 1999. BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Sciences; Jun 1999; 56, 6; Canadian Periodicals pg. 1078.

**Table 5.3.1. Megrim in Subarea VIa. Nominal catch (t) of Megrim West of Scotland, as officially reported to ICES and WG best estimates of landings.**

| Country | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denmark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 398 | 455 | 504 | 517 | 408 | 618 | 462 | 192 | 172 | 0 | 135 | 252 | 79 | 92 | 50 | 48 | 53 | 104 | 92 | 134 | 270 |
| Ireland | 317 | 260 | 317 | 329 | 304 | 535 | 460 | 438 | 433 | 438 | 417 | 509 | 280 | 344 | 278 | 156 | 221 | 191 | 172 | 188 | 318 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 91 | 48 | 25 | 7 | 1 | 24 | 22 | 87 | 111 | 83 | 98 | 92 | 89 | 98 | 45 | 69 | 52 | 5 | 149 | | |
| UK - Eng+Wales+N.Irl. | 25 | 167 | 392 | 298 | 327 | 322 | 156 | 123 | 65 | 42 | 20 | 7 | 14 | 13 | 17 | 10 | 0 | 8 | 6 | | |
| UK – Scotland | 1093 | 1223 | 887 | 896 | 866 | 952 | 944 | 954 | 841 | 831 | 754 | 770 | 643 | 558 | 469 | 269 | 336 | 658 | 868 | 953 | |
| UK | | | | | | | | | | | | | | | | | | | | | 822 |
| | | | | | | | | | | | | | | | | | | | | | |
| Offical Total | 1924 | 2154 | 2125 | 2047 | 1907 | 2451 | 2044 | 1795 | 1622 | 1394 | 1424 | 1630 | 1105 | 1105 | 859 | 552 | 662 | 966 | 1287 | 1275 | 1410 |
| | | | | | | | | | | | | | | | | | | | | | |
| Unallocated | 286 | 278 | 424 | 674 | 786 | 1047 | 2010 | 1477 | 1083 | 1254 | 823 | 843 | 723 | 537 | 469 | 9 | 213 | n/a | 8 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | |
| As used by WG | 2210 | 2432 | 2549 | 2721 | 2693 | 3498 | 4054 | 3272 | 2705 | 2648 | 2247 | 2473 | 1828 | 1642 | 1328 | 561 | 875 | 1301 | 1545 | 1275 | 1410 |
| | | | | | | | | | | | | | | | | | | | | | |
| Area Mispreported landings | 339 | 338 | 466 | 735 | 871 | 1126 | 2062 | 1556 | 1156 | 1066 | 868 | 829 | 731 | 544 | 421 | n/a | 212 | 478 | 250 | 0 | 0 |

**Table 5.3.2. Megrim in Subarea IV and IIa. Nominal catch (t) of Megrim North Sea, as officially reported to ICES and WG best estimates of landings.**

| Country | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 4 | 3 | 2 | 7 | 2 | 7 | 5 | 3 | 5 | 4 | 10 | 2 | 5 | 3 | - | - | 2 | 6 | 3 | 1.6 | |
| Denmark | 2 | 1 | 4 | 6 | 1 | 2 | 7 | 5 | 18 | 21 | 29 | 52 | 8 | 11 | 7 | 1 | 6 | 11 | 31 | | 22 |
| France | - | - | 36 | 25 | 27 | 24 | 14 | 16 | 14 | . | 7 | 5 | 6 | 11 | 9 | 3 | 4 | 18 | 21 | | 5 |
| Germany | . | 6 | 3 | 4 | 1 | 2 | 1 | 2 | 4 | 1 | 3 | 1 | - | 2 | 2 | 4 | 7 | 16 | 5 | 4 | |
| Germany, Fed. Rep. of | 3 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | | |
| Ireland | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | . | | | |
| Netherlands | 24 | 28 | 27 | 30 | 28 | 26 | 9 | 20 | 30 | 26 | 20 | 11 | 9 | 7 | 11 | 19 | 22 | 20 | 3 | 2 | 1 |
| Norway | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | 1 | 1 | 4 | | 2 |
| Spain | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | . | | | |
| Sweden | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | |
| UK - Eng+Wales+N.Irl. | 17 | 9 | 47 | 8 | 19 | 44 | 4 | 3 | 5 | 4 | 2 | 2 | 3 | 1 | 1 | 1 | 9 | 17 | | | |
| UK - England & Wales | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 6 | | |
| UK - N. Ireland | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | | |
| UK - Scotland | 1126 | 1169 | 1372 | 1736 | 2000 | 2193 | 3221 | 3091 | 2628 | 2121 | 2044 | 1854 | 1675 | 1235 | 1130 | 958 | 1340 | 1436 | 1526 | | |
| UK | | | | | | | | | | | | | | | | | | | | 1476 | 1469 |
| | | | | | | | | | | | | | | | | | | | | | |
| Official total | 1176 | 1216 | 1491 | 1816 | 2078 | 2298 | 3261 | 3140 | 2704 | 2177 | 2115 | 1927 | 1706 | 1271 | 1160 | 986 | 1391 | 1525 | 1599 | 1484 | 1499 |
| | | | | | | | | | | | | | | | | | | | | | |
| As used by WG | 837 | 878 | 1025 | 1081 | 1207 | 1172 | 1199 | 1584 | 1548 | 1111 | 1247 | 1098 | 975 | 727 | 739 | n/a | 1179 | 1047 | 1349 | 1484 | 1499 |
| | | | | | | | | | | | | | | | | | | | | | |
| Area Mispreported landings | 339 | 338 | 466 | 735 | 871 | 1126 | 2062 | 1556 | 1156 | 1066 | 868 | 829 | 731 | 544 | 421 | n/a | 212 | 478 | 250 | 0 | 0 |

**Table 5.3.3. Estimates of megrim abundance and biomass from Scottish-Irish anglerfish surveys.**

| | ABUNDANCE (MILLIONS) | | | | | | BIOMASS (TONNES) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| VIa IVa | 15.8 | 16.8 | 23.8 | 26.8 | 21.3 | 22.2 | 6326 | 5846 | 8478 | 9288 | 7166 | 8555 |
| VIb | 1.1 | 3.5 | 4.8 | 6.5 | 6.6 | 9.2 | 679 | 910 | 1289 | 1728 | 1507 | 1911 |

**Table 5.3.4. Changes in relative megrim abundance and biomass from Scottish-Irish anglerfish surveys based on percentage changes in mean abundance and biomass from the first three years of the survey relative to the mean of the last two years.**

| | Abundance | | Biomass | | Percentage Change | |
|---|---|---|---|---|---|---|
| Trend mean (2006/2008)/(2009–2010) | Mean 06/08 | Mean 09/10 | Mean 06/08 | Mean 09/10 | Abundance | Biomass |
| VIa IVa | 22.5 | 21.7 | 7870 | 7860 | -3% | 0% |
| VIb | 4.9 | 7.9 | 1309 | 1709.0 | 60% | 31% |

**Table 5.3.5. Megrim in Subarea VIb. Nominal catch (t) of Megrim Rockall, as officially reported to ICES and WG best estimates of landings.**

| Country | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | |
| France | - | - | - | - | - | - | - | - | - | . | 4 | <0.5 | <0.5 | - | - | - | - | - | | | |
| Ireland | 196 | 240 | 139 | 128 | 176 | 117 | 124 | 141 | 218 | 127 | 167 | 176 | 87 | 83 | 43 | 68 | 95 | 87 | 68 | 48 | 47 |
| Spain | 363 | 587 | 683 | 594 | 574 | 520 | 515 | 628 | 549 | 404 | 427 | 370 | 120 | 93 | 71 | 88 | 59 | 19 | 84 | 0 | 0 |
| UK - Eng+Wales+N.Irl. | 19 | 14 | 53 | 56 | 38 | 27 | 92 | 76 | 116 | 57 | 57 | 42 | 41 | 74 | 42 | 19 | 9 | . | | | |
| UK - England & Wales | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | | . | . | 1 | | |
| UK - Scotland | 226 | 204 | 198 | 147 | 258 | 152 | 112 | 164 | 208 | 278 | 309 | 236 | 207 | 382 | 372 | 207 | 181 | . | 141 | 178 | |
| UK | | | | | | | | | | | | | | | | | | | | | 92 |
| | | | | | | | | | | | | | | | | | | | | | |
| Offical Total | 804 | 1045 | 1073 | 925 | 1046 | 816 | 843 | 1009 | 1091 | 866 | 964 | 824 | 455 | 632 | 528 | 382 | 344 | 106 | 294 | 226 | 139 |
| | | | | | | | | | | | | | | | | | | | | | |
| Unallocated | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| As used by WG | 804 | 1045 | 1073 | 925 | 1046 | 816 | 843 | 1009 | 1091 | 866 | 964 | 824 | 455 | 632 | 528 | 382 | 344 | 106 | 294 | 226 | 139 |

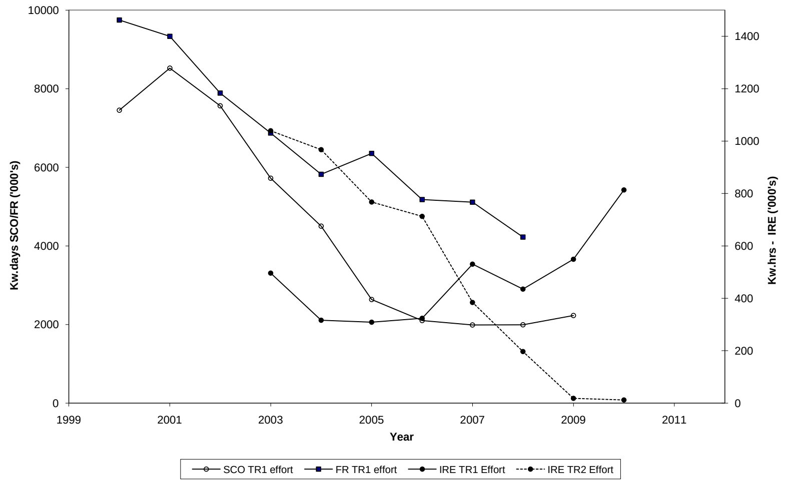



**Figure 5.3.1. Fishing effort in ICES Division VIa for Irish, French and Scottish vessels by mesh category.**

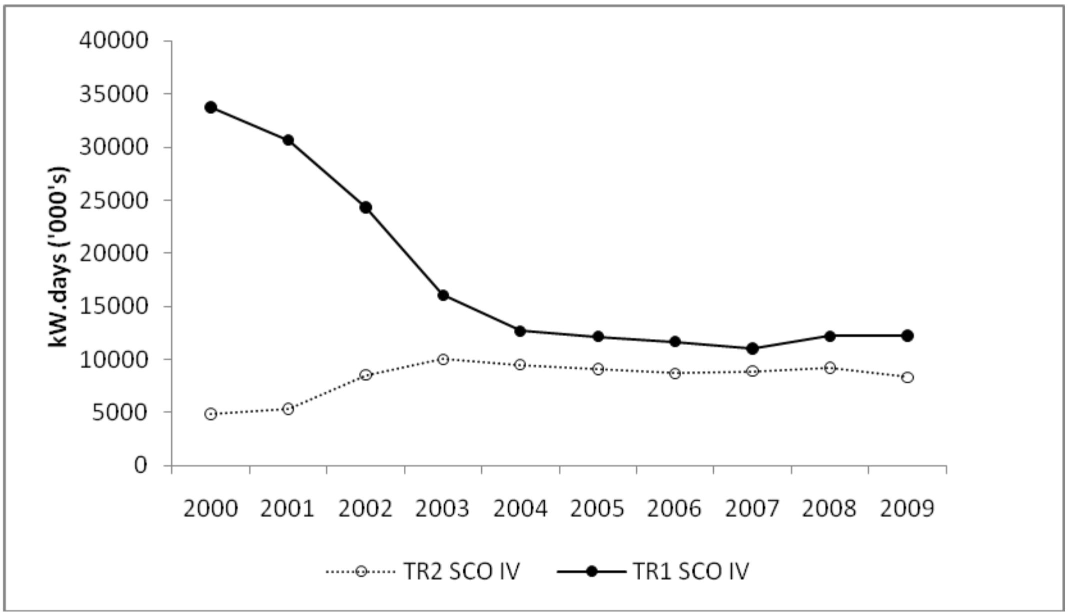



**Figure 5.3.2. Scottish TR1 and TR2 effort in ICES Division IVa expressed in kw.days.**

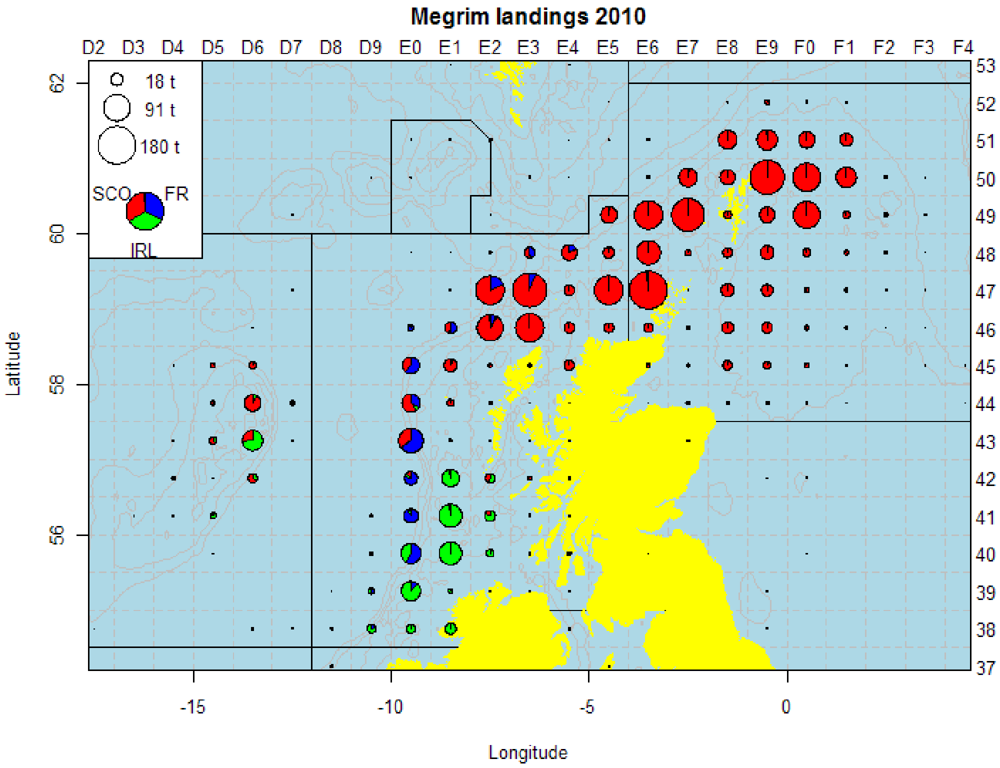



**Figure 5.3.3. International megrim landing by ICES statistical rectangle for ICES Divisions VIa, VIb and IVa for 2010.**

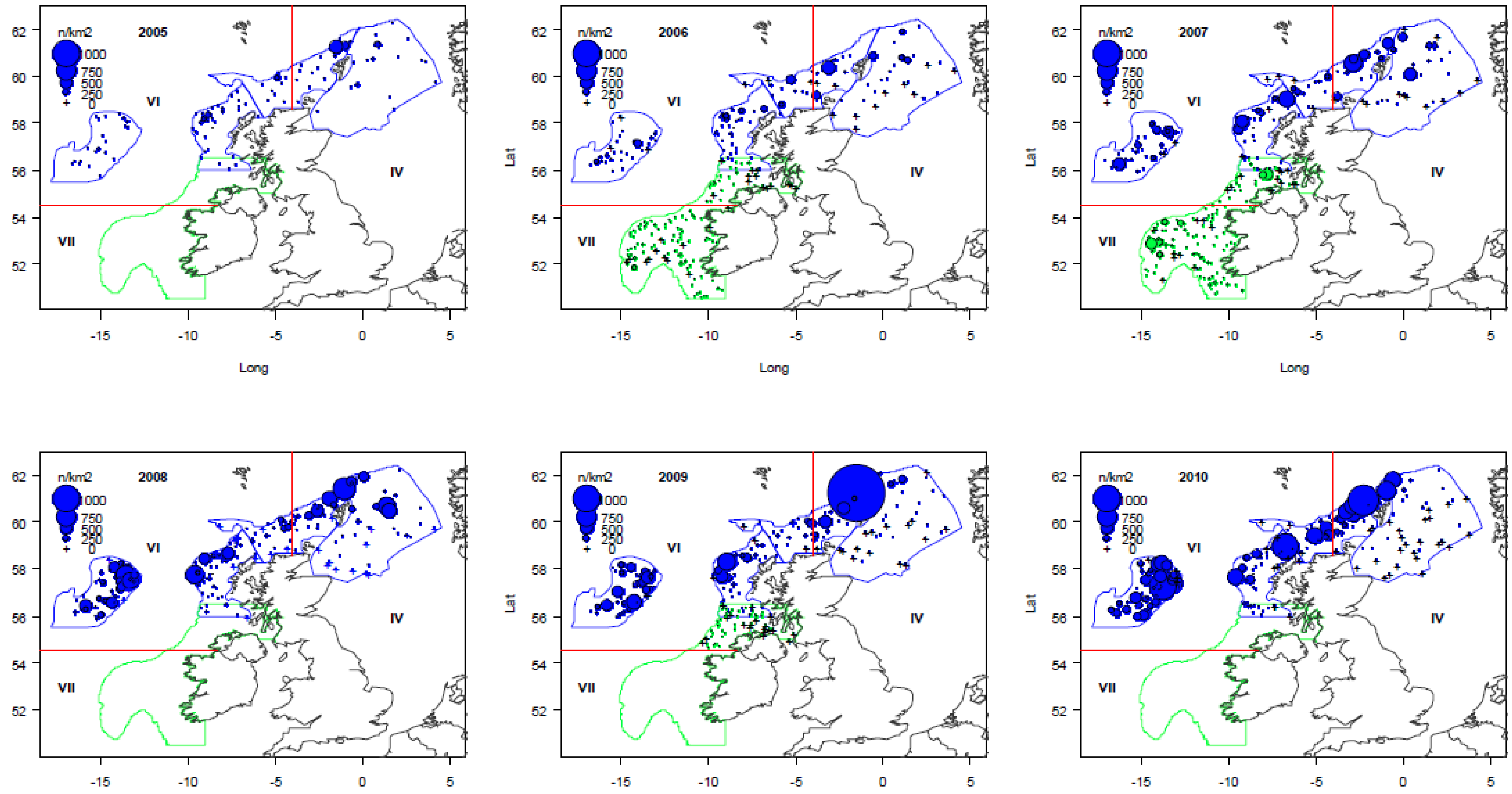



**Figure 5.3.4. Maps of the northern continental shelf around the British Isles showing the number density of megrim caught during the anglerfish surveys 2005–2009. Each circle (blue for Scottish surveys; green for Irish surveys) is centred on the sample location and the size of the circle is proportional to the number density in n/km² according to the legend (top left). The red lines indicate the position of the borders between the main ICES subareas (labelled with Roman numerals).**

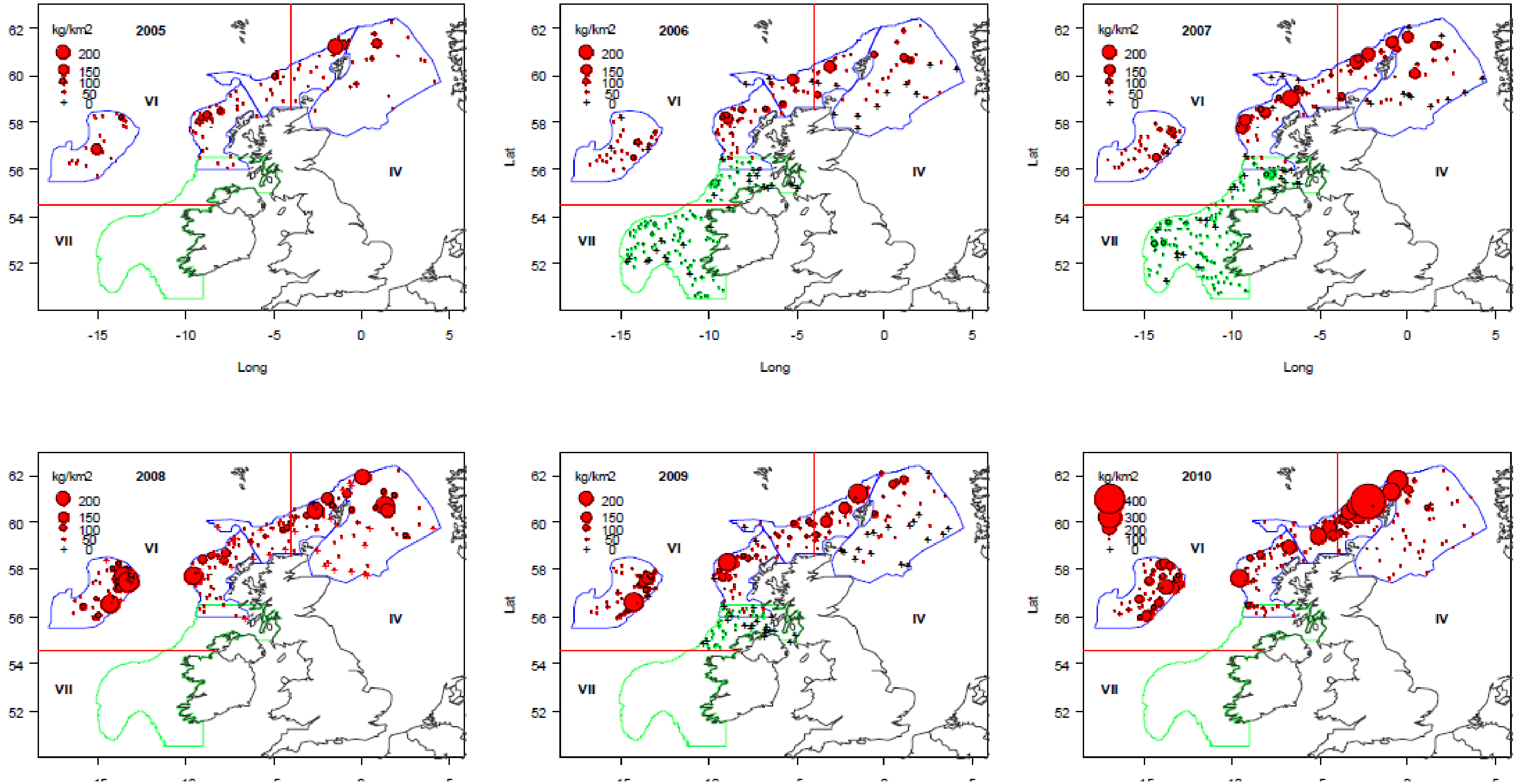



**Figure 5.3.5. Maps of the northern continental shelf around the British Isles showing the weight–density of megrim during the anglerfish surveys 2005–2010. Each circle (blue for Scottish surveys; green for Irish surveys) is centred on the sample location and the size of the circle is proportional to the weight density in kg/km² according to the legend (top left). The red lines indicate the position of the borders between the main ICES subareas (labelled with Roman numerals).**

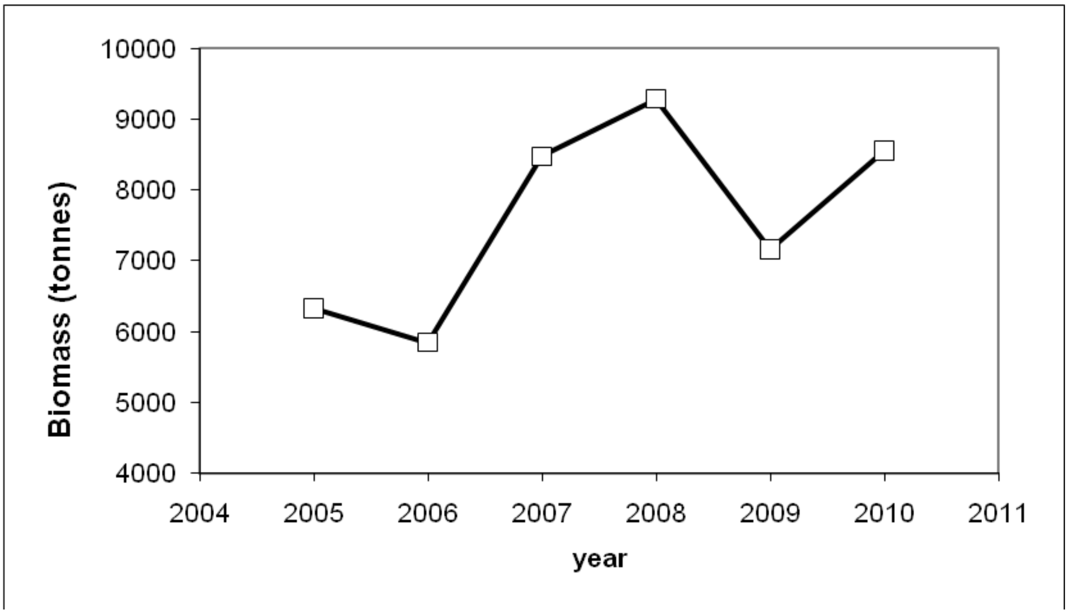



**Figure 5.3.6. Change in megrim biomass in ICES Division VIa and IVa combined from the 2005–2010 anglerfish survey.**

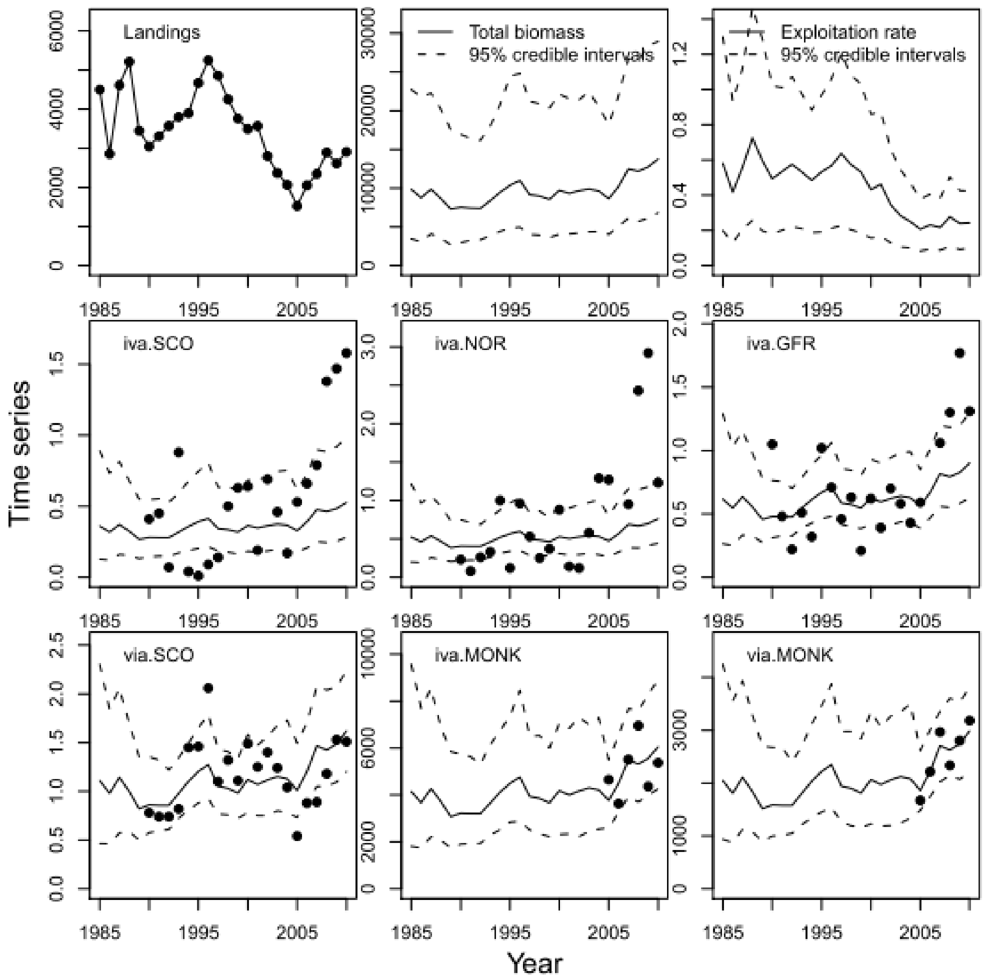



**Figure 5.3.7. Trends in landings of VIa and IVa and estimated trends in total biomass and exploitation rate (upper panels) Trends in annual cpue from the NS-IBTS, W-IBTS and IRE-IV.VI.-AMISS-Q2 and SCO-IV.VI.AMISS-Q2 surveys used in the surplus production model. The solid line is the modelled cpue trend across all surveys.**

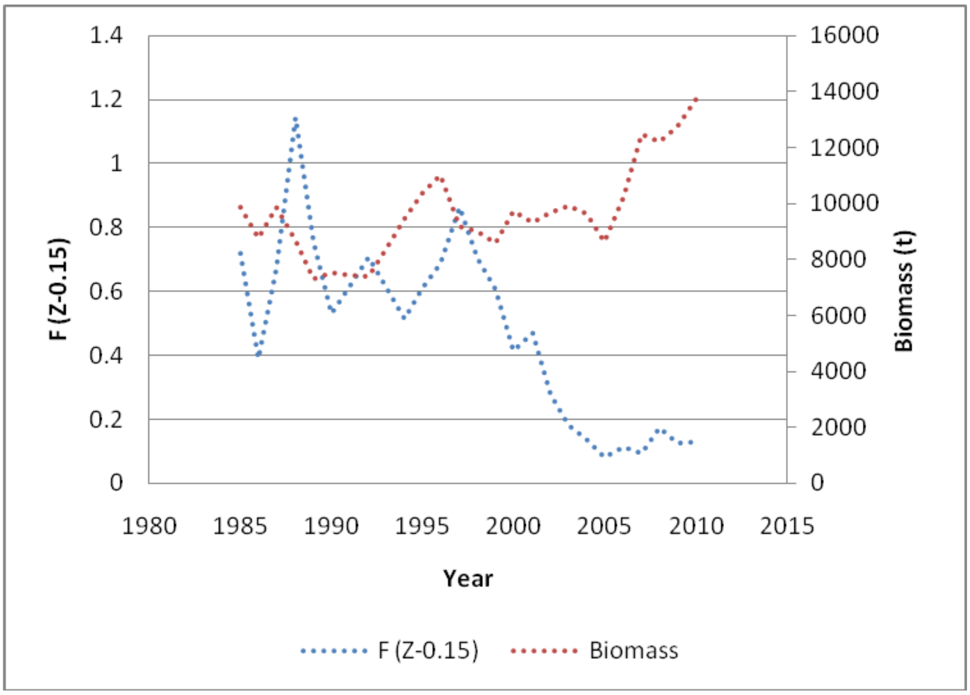



**Figure 5.3.8. Change in megrim biomass in ICES Division VIa and IVa combined from the 2005–2010 anglerfish survey.**

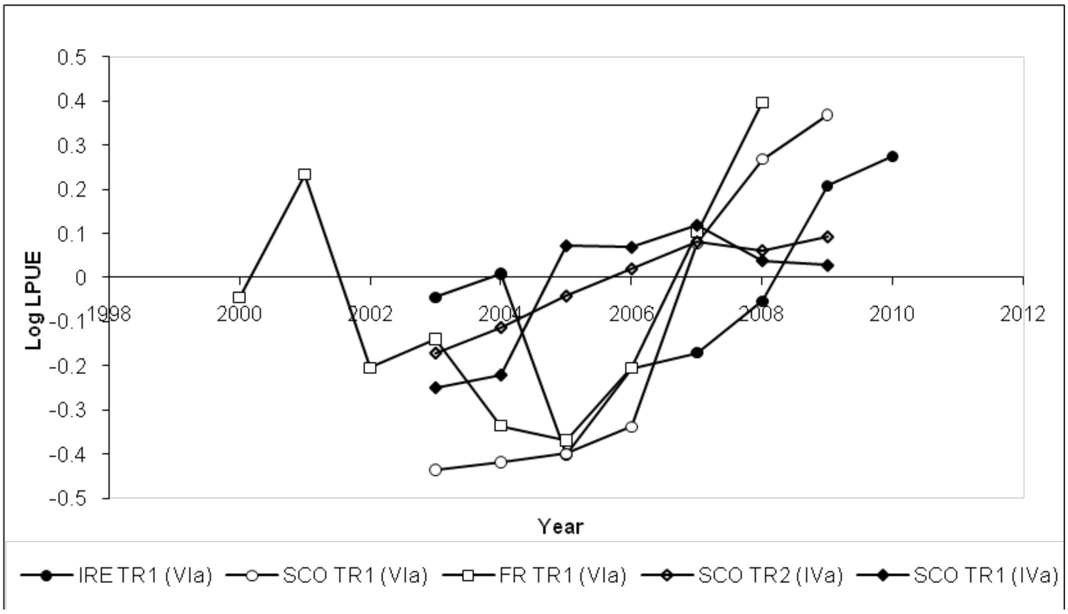



**Figure 5.3.9. Change in commercial standardized log lpue and relative to long-term average for Megrim in VIa and IVa.**

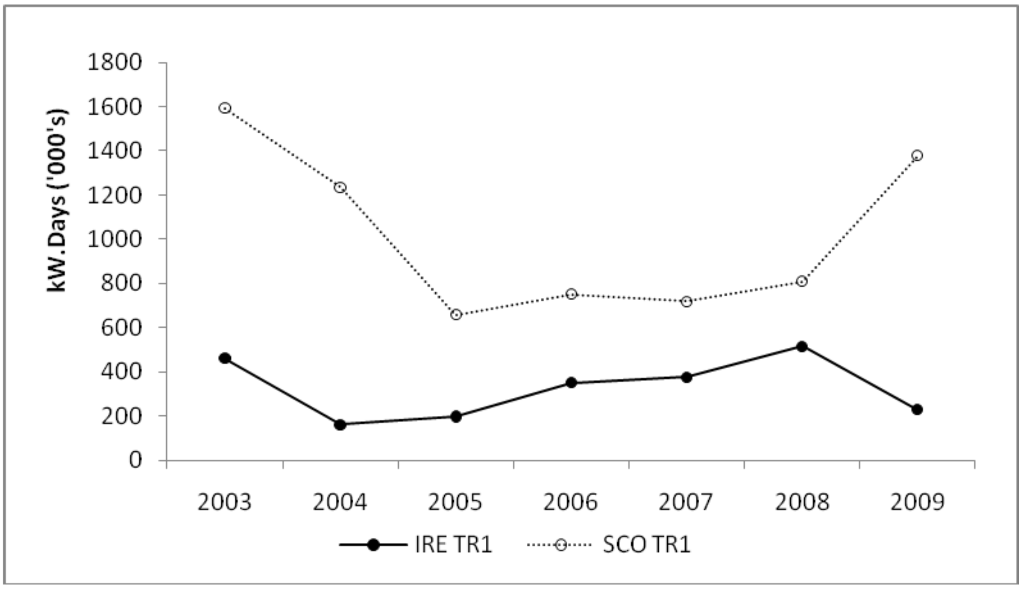



**Figure 5.3.10. Irish and Scottish TR1 effort in ICES Subdivision VIb (Rockall) expressed in kw.days.**

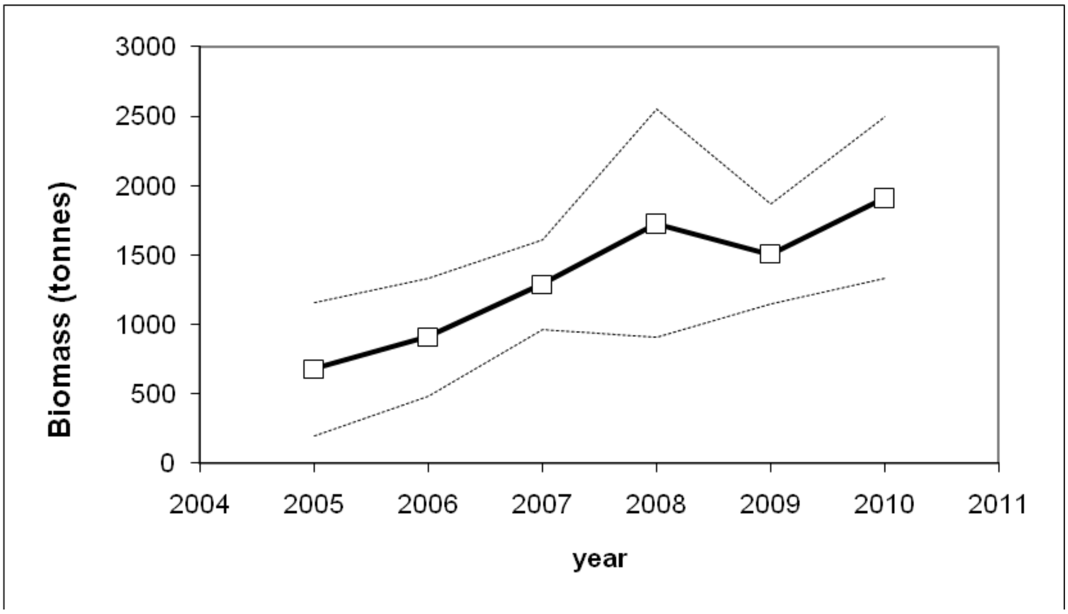



**Figure 5.3.11. Change in megrim biomass in ICES Division VIb from the 2005–2010 anglerfish survey.**

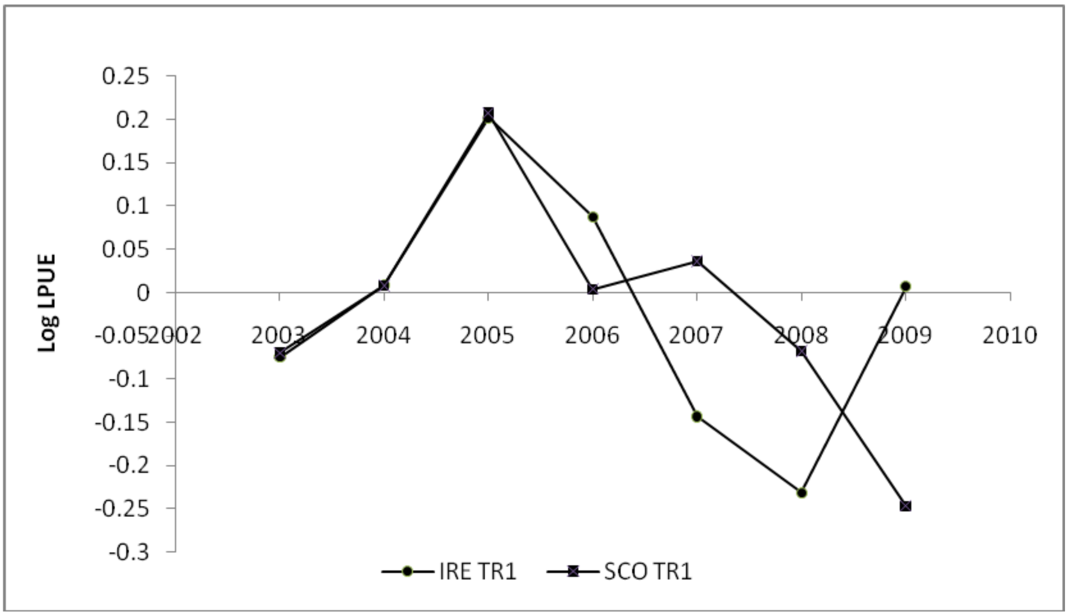



**Figure 5.3.12. Change in commercial Log lpue relative to long-term average for Megrim in VIb.**

## 6.1 Irish Sea overview

There is no overview.

## 6.2 Cod in VIIa

### Type of assessment

This is an update assessment. The assessment has not yet been included in ICES benchmarking process.

### ICES advice applicable to 2010

*"ICES has evaluated the long-term management plan and found it not precautionary. … ICES continues to advise on exploitation boundaries in relation to precautionary limits and recommends that the fisheries for cod be closed until an initial recovery of the cod SSB has been proven. Any catches that are taken in 2010 will prolong the recovery to* $B_{pa}$*."*

### ICES advice applicable to 2011

*"ICES has evaluated the long-term management plan and found it not precautionary. … Given the low SSB and low recruitment it is not possible to identify any non zero catch which would be compatible with the MSY transition scheme. This implies no targeted fishing should take place on cod in Division VIIa. Bycatches including discards of cod in all fisheries in VIIa should be reduced to the lowest possible level."*

### 6.2.1 General

#### Stock description and management units

The stock and the management unit are both ICES Division VIIa (Irish Sea).

### Management applicable to 2010 and 2011

**TACs and quotas set for 2010**

| Species: | Cod *Gadus morhua* | Zone: | VIIa (COD/07A.) |
|---|---|---|---|
| Belgium | 9 | | |
| France | 25 | | |
| Ireland | 444 | | |
| The Netherlands | 2 | | |
| United Kingdom | 194 | | |
| EU | 674 | | |
| TAC | 674 | | Analytical TAC |

**TACs and quotas set for 2011**

| Species: | Cod *Gadus morhua* | Zone: | VIIa (COD/07A.) |
|---|---|---|---|
| Belgium | 7 | | |
| France | 19 | | |
| Ireland | 332 | | |
| The Netherlands | 2 | | |
| United Kingdom | 146 | | |
| EU | 506 | | |
| TAC | 506 | | Analytical TAC |

Management of cod is by TAC, days-at-sea limits and technical measures. Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 6.1.

#### Fishery in 2010

Landings of cod in 2010 (Table 6.2.1) were the lowest recorded. Northern Ireland landed approximately 60% (Table 6.2.2), with the majority taken by whitefish otter trawlers and *Nephrops* trawlers. The percentages landed into southern Ireland in 2010 have increased to around 30%, with Belgium and UK (England and Wales) having similar values to 2009 at roughly 5% and 4% respectively. Irish landings over that last few years have been adjusted downwards to take account of catches taken in the Celtic Sea off SE Ireland. In 2010 138 tonnes of cod landings reported as taken in VIIa were reallocated to the Celtic Sea (see Section 7.2.1). WG landings figures in 2010 were 70% of the TAC, and have been at this uptake level or lower since 2003.

## 6.2.2 Data

An overview of the data provided and used by the WG is provided in Table 6.2.1 in the WGCSE Report.

#### Fishery landings

The input data on fishery landings and age compositions are split into three periods (Figure 6.2.4):

1 ) 1968–1990. Landings in this period, provided to ICES by stock coordinators from all countries, were assumed to be accurate and were used directly as the input data for the assessment.

2 ) 1991–1999. TAC reductions in this period caused substantial misreporting of cod landings into several major ports in one country, mainly species misreporting. Landings into these ports were estimated based on observations of cod landings by different fleet sectors during regular port visits (see Stock Annex). For other national landings, the WG figures provided to ICES stock coordinators were used, as in period (1).

3 ) 2000 onwards. Cod recovery measures were considered to have caused greater problems with estimation of fishery removals than in period (2). The ICES WG landings data provided by stock coordinators for all countries, as in period (1) were input to B-Adapt and the annual total removals (in excess of the assumed M) were estimated within the assessment model.

In addition to the above Irish landings of cod reported from ICES rectangles immediately north of the Irish Sea–Celtic Sea boundary (ICES rectangles 33E2 and 33E3) have been reallocated into the Celtic Sea as they represent a combination of inaccurate area reporting and catches of cod considered by ICES to be part of the Celtic Sea stock (ICES, 2009). The amount of Irish landings transferred from VIIa to VIIe–k by year is shown below:

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Tonnes | 108 | 54 | 103 | 527 | 558 | 193 | 143 |

The higher level in 2007 and 2008 was a consequence of limited quota in VIIe–k and available quota in VIIa. Since 2009 more restrictive monthly quotas have been set for VIIa during periods of high cod abundance close to the VIIa–VIIg boundary.

The annual numbers-at-age landed, total landed weight, and the mean weights-at-age in the landings by age class, are given in Tables 6.2.2–6.2.4 and Figures 6.2.1–6.2.4. Previous WG's have shown there are no long-term trends in catch weights-at-age from 1982 onwards. However, weights-at-age prior to 1982 are fixed at constant values lower than estimated for subsequent years, leading to sums-of-products errors, and weights-at-ages 7+ are becoming patchy for the last few years (Figure 6.2.1). Given these problems, and the likelihood of further deterioration in the quality of the older aged fish, revision of historical catch-at-age data and associated weights is needed.

The catch-at-age data were screened using separable VPA (reference age 3; terminal F = 1.5; S = 1.0; default year and age weighting). The data continue to show a persistent change in residuals for log catch ratios at ages 1–2 after 1991 (Figure 6.2.5). Outliers at age 5–6 in 2003/2004 and age 1–2 in 2006/2007 are not associated with any obvious anomalies in any national dataset and reflect small catches and sample sizes.

#### Discards data

No discards data are included in the assessment. Suitable discards estimates are not available prior to the mid-1990s and are not complete for many subsequent years. Available data indicates that discarding has historically been mainly a function of MLS (35 cm) and therefore mainly restricted to catches of <= 1-gp cod. Discarding patterns appear to have changed in 2010 with the Northern Irish data showing an increase in the discarding of older/larger fish, and the Irish data showing a greater number of 1-gp fish being discarded than 0-gp (Figures 6.2.6 to 6.2.9 and Table 6.2.5). Historical F and recruitment for 1-gp cod are therefore underestimated, but it has not been possible yet to compile a matrix of international fleet-raised discards estimates by year and age for use in assessments. Belgian estimates are included for the first time this year, and this discards data should be fully evaluated in any future benchmark assessment.

#### Biological data

The assessment uses constant values of M=0.2 (all ages) and combined-sex proportion mature values of 0 at age 1, 0.38 at age 2 and 1.0 for older ages (see Stock Annex for derivation).

#### Survey data used in assessment

The surveys used in the assessment are described in the Stock Annex, and the series are updated in Table 6.2.6.

#### Internal consistency of survey data

The survey data during spring each year are of critical importance for tuning the B-Adapt and estimating catch bias because adult cod are better represented than during the autumn surveys. The data for these surveys were screened by fitting the SURBA model using settings described in the Stock Annex, and examining the diagnostic plots. The NIGFS-Mar and ScoGFS-1Q surveys do not exhibit any marked year-effects, and appear to track year-class variations with good consistency (Figure 6.2.10). Strong positive residuals at age 1 are noted for 1994–1996 in the SURBA model fit for NIGFS-Mar (Figure 6.2.10, bottom panels).

#### Consistency between survey-series

The three series of summer–autumn 0-gp indices used in the update B-Adapt assessment do not consistently follow the trends in year-class effects from the SURBA model applied to the NIGFS-Mar and ScoGFS-1Q data (Figure 6.2.11). While the surveys give similar signals for some year classes, there are some years (e.g. 2001 and 2004–2005 where the series diverge noticeably. The NIGFS-Mar and ScoGFS-1Q SURBA models provide very similar trends in year-class strength.

#### Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

#### Other relevant data

Table 6.2.6 includes indices of abundance from the UK Fisheries Science Partnership (www. cefas.co.uk/fsp). These are not used in the update assessment and have not yet been evaluated through any benchmarking process, although are presented as supporting evidence (WD 11). The SSB trends from the UK Fisheries Science Partnership trawl surveys support the trends given by the NIGFS-1Q survey from 2004 onwards (Figure 6.2.12) although show less optimistic increases in SSB from 2010.

The state space model SAM was fitted to the Irish Sea cod assessment datasets in order to evaluate an alternative approach to estimating the stock and fishery parameters using differing assumptions. The SAM model assumes that log-transformed stock sizes and fishing mortalities, which are the so-called states, follow separate random walks. Observed catches and survey indices are considered to be random variables with associated observation noise. The model has recently been adopted for the North Sea cod assessment. The SAM model fits exhibit similar patterns in SSB (Figure

6.2.13) and recruitment as B-ADAPT. The overall development in Fbar is very similar in the estimates from SAM and B-ADAPT. Advice based on the SAM model would be equivalent to that from the B-ADAPT fit.

A UK(E&W)-IBTS-Q4 trawl survey-series covering the Irish Sea and Celtic Sea in November commenced in 2004. Cod abundance indices will be provided from this survey in future.

The latest in a series of cod SSB estimates from applications of the annual egg production method, using gene probes to identify early stage cod eggs, are available for 2010 (WD 9). Preliminary estimates are 1113 t (RSE 21%) in the western Irish Sea, 498 t (RSE 23%) in the eastern Irish Sea and 1610 t (RSE 18%) for the whole Irish Sea (Figure 6.2.22**)**. The update B-Adapt assessment provides an SSB estimate of 947 t for the Irish Sea in 2010, roughly 60% of the egg production estimate. Although the estimates vary both methods give SSB below $B_{lim}$, and both indicate drops in SSB in recent years. These data will be evaluated in future benchmark assessments.

### 6.2.3 Historical stock development

#### Deviations from Stock Annex

The assessment does not deviate from the procedure used last year and described in the Stock Annex.

#### Software used and model options chosen

The B-Adapt method is described in the Stock Annex. Software version B-Adapt-F.exe (13/5/06) was used to allow estimation of removals bias from 2000 onwards.

Model settings for the update assessment are given in Table 6.2.7. B-Adapt can use survey data for the year after the last year of catch data, and in this assessment the survey indices for NIGFS-Mar in 2011 are used. An input F-multiplier for 2011 is required for adjusting the survey indices to the start of the year. In view of the new cod recovery measures which involved a 25% reduction in cod TAC in 2011, an F-multiplier of 0.75 was applied in 2011.

#### Input data types and characteristics

New data added to the update B-Adapt assessment are the fishery landings data for 2010, the NIGFS-Mar survey data for 2011 and the NIGFS-Oct, UK (BTS-3Q) and NIMIK 0-gp indices for 2010. The update B-Adapt assessment follows the same procedure as in the 2010 assessment by including the sample-based estimates of landings at three major ports from 1991–1999, while estimating removals in excess of the assumed natural mortality rate in subsequent years. The sample based estimates of landings for 2000–2002 and 2005 provide a comparison with the B-Adapt removals estimates.

#### Data screening

Screening of input catch and survey data is described in Section 6.2.2.

#### Final update assessment: diagnostics

The diagnostics of the update B-Adapt run are given in Table 6.2.8. Note that these are from the non-bootstrap application of the model. The catchability residuals from the update assessment are given in Figure 6.2.14. A trend in catchability residuals for 2–4 year old cod exists in the first five years of the NIGFS-Mar survey-series. This is not reflected in the SURBA residuals shown in Figure 6.2.10. In contrast, the three positive values at age 1 in 1994–1996 in NIGFS-Mar B-Adapt residuals are evident in the SURBA analysis, indicating a change in survey selectivity.

#### Final update assessment: retrospective analysis

The estimation of catch bias in B-Adapt effectively removes survey catchability trends from 2000 onwards, and the assessment therefore exhibits no retrospective bias (Figure 6.2.15).

#### Final update assessment: long-term trends

The population numbers and F at age from the update B-Adapt assessment are given in Tables 6.2.9 and 6.2.10, and the VPA summary data are given in Table 6.2.11. These are the point estimates from the non-bootstrap option. The long-term trends in landings, F, SSB and recruitment are shown in Figure 6.2.16, using the bootstrap option to give 5th and 95th percentiles from 1000 bootstrap runs selecting randomly from the survey catchability residuals. Note that the 50th percentiles generally differ slightly from the point estimates from the non-bootstrap option, but the 2010 F point estimate shows greater divergence from the median bootstrap value implying a degree of bias in this final year.

The B-Adapt estimates of total removals for 2000–2010 (in excess of the WG landings figures and natural mortality M=0.2) may represent unaccounted discards, landings and additional natural mortality. The B-Adapt estimates of total removals (including unaccounted removals) were close to the WG landings figures including sample-based estimates for 2000 and 2001, but the 90% confidence limits of the B-Adapt estimates for 2002 and 2005 lie just above the WG landings estimates.

The recruitment trends from B-Adapt are very similar to the indices from SURBA for the NIGFS-Mar and ScoGFS-1Q surveys (Figure 6.2.17), indicating that the historical trends are well captured by the survey and fishery age-composition data. The SURBA and B-Adapt indices of SSB indicate very low SSB since 2005, but the NIGFS-Mar survey predicts and increase in SSB in 2011 as the 2009 year class enters the SSB. All surveys indicate continued high total mortality rates but given the highly truncated age composition in the stock, and the internal procedure in SURBA for estimating recent Z, the SURBA trends in Z are probably poorly estimated.

In order to investigate the sensitivity of this assessment to the B-Adapt estimates of total removals, another assessment was conducted using the same software and settings, but without estimating the bias. Figure 6.2.18 presents the results. Although the values of SSB and recruitment are lower without the estimated additional removals, both assessment runs indicate that recent SSB and recruitment both have been at historic lows in recent years. Trends in $F_{bar}$ are reasonably consistent between the model runs.

#### Comparison with previous assessments

The retrospective analysis (Figure 6.2.15) provides a comparison with the results of the assessment carried out in 2010. The current assessment is a direct update without any changes to procedures or data. The current assessment is consistent with the previous assessment.

#### The state of the stock

The spawning–stock biomass has declined tenfold since the late 1980s and is suffering reduced reproductive capacity (SSB < $B_{lim}$ of 6000 t).

The fishing mortality estimates since 1988 have remained above the $F_{lim}$ value of F=1.0 and the stock has therefore been harvested unsustainably over this period.

Fishing mortality throughout the assessment period has been well above the candidate reference points ($\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$) associated with high long-term yields and a low risk of depleting the productive potential of the stock.

Recruitment has been below average for the past eighteen years. The 2002 to 2008 year classes are among the smallest on record and all lie below a segmented regression line fitted to the stock–recruit data, indicating lower than expected recruitment given the SSB estimates (Figure 6.2.19). The 2010 data show increased recruitment compared the recent period of poor recruitment, but still below the long-term average. Preliminary indications suggest the 2010 year class is some way below the 2009 estimate, but this recruitment is above the segmented regression line on Figure 6.2.19, and thus indicates a higher than expected recruitment given the estimated SSB. The estimated breakpoint in the regression is close to the $B_{pa}$ of 10 000 t.

### 6.2.4 Short-term predictions

Due to the inability to identify the source of the bias in removals estimates from B-Adapt assessment, and the relationship between future TACs and total removals, detailed short-term catch forecasts have not been given for this stock for several years. The update B-Adapt assessment, including a 25% F reduction in 2011, indicates a 70% increase in SSB between 2011 and 2012. This is a consequence of the high 2009 recruitment entering the spawning stock, after numerous years of very weak recruitment.

| SSB PERCENTILE | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| 5th | 908 | 750 | 1440 | 2336 |
| 25th | 1094 | 907 | 1865 | 3169 |
| 50th | 1255 | 1032 | 2220 | 3820 |
| 75th | 1429 | 1179 | 2657 | 4544 |
| 95th | 1720 | 1419 | 3382 | 5807 |

### 6.2.5 Medium-term projections and MSY evaluation

#### Medium-term projections

Medium-term projections are carried out to look at the possible future trends in the stock in response to changes in total mortality. The contribution of the fishery to the total removals estimates over and above reported landings is unknown.

#### Estimating recruiting year-class strength

Following the recommendation from RGNSDS (2007) that bootstrapping the 1992–2006 recruitment estimates may have led to overoptimistic forecasts, 2002 was chosen as the starting year for this assessment's medium-term projections.

The stock–recruit plot (Figure 6.2.19) shows that from 2002 to 2008 the recruitment estimates were below the segmented regression line, but above it in 2009 and 2010.

| Year | Year class | Source | Number-at-age 0 ('000) |
|---|---|---|---|
| 2008 | 2008 | B-Adapt (point estimate) | 881 |
| 2009 | 2009 | B-Adapt (point estimate) | 3240 |
| 2010 | 2010 | B-Adapt (point estimate) | 1551 |
| 2011 | 2011 | Bootstrap 2002–2010 y.c.: (50th percentile) | 1263[1] |
| | | GM (2002–2010 y.c.) | 1277 |

**[1] Average of 50th percentiles over 10-year B-Adapt projection**

#### Scenarios examined

The mortality rate due to removals in excess of the assumed natural mortality of M=0.2 is referred to below as F*. Two medium-term stochastic projections were carried out using the bootstrap option in B-Adapt:

1 ) Zero F* from 2012 onwards with recruitment estimated from model estimates for the year classes observed from 2002–2010.

2 ) 25% reduction in F* per year until F* attains the value of F=0.4 adopted by the Commission as the long-term management objective. Recruitment estimated from model estimates for the year classes observed from 2002–2010.

Projection 2 represents annual reductions in F* equivalent to reductions in F that Management Plan may seek to achieve through annual 25% reductions in TAC. However, the bootstrap procedure does not simulate any additional variability and risk associated with limits on interannual TAC variability, or any changes in discarding or compliance.

The removals figures generated in the projection implicitly include the level of removals bias estimated by B-Adapt for 2010 in each simulation. It is currently not possible to attribute these to any actual losses not accounted for in the model inputs, or to any remaining bias due to incorrect assumptions in the B-Adapt implementation.

#### Model inputs

Model inputs were as follows:

- *Number of simulations*: 1000.
- *Recruitment from 2011 onwards*: bootstrapped in each simulation from model estimates for the year classes described in the scenarios examined section.
- *Status quo F*: B-Adapt F(2–4) for 2010 in each simulation.
- *Intermediate year assumption*: To allow for a potential reduction in F* in 2011 associated with the 25% TAC reduction, an F-multiplier of 0.75 was applied in 2011.

#### Results

Reducing F* to zero from 2012 onwards allows a high probability (95 percent) of recovery of SSB to above $B_{pa}$ by 2015 (Figures 6.2.20). A stepwise reduction in F* by 25% per year (until the year when the 50th percentile of F* reaches 0.40) is less optimistic (Figure 6.2.21). The results show a 35% probability of SSB > $B_{lim}$ by 2015 and 5% probability of achieving $B_{pa}$.

#### $F_{msy}$ evaluations

A full FMSY evaluation was carried out at WGCSE in 2010 and the suggested level of FMSY for this stock was F's within the range of 0.25 to 0.54. No further work was carried out this year.

### 6.2.6 Biological reference points

The current precautionary reference points for Irish Sea cod are given below:

| Precautionary approach (unchanged since 1998) | | | |
|---|---|---|---|
| $B_{lim}$ | 6000 t | $B_{pa}$ | 10 000 t |
| $F_{lim}$ | 1.00 | $F_{pa}$ | 0.72 |
| $F_{msy}$ | 0.25–0.54 | | |

### 6.2.7 Management plans

The Irish Sea cod management plan, as described in Council Regulation (EC) 1342/2008 was evaluated independently by ICES in 2009 using the approach adopted in AGCREMP 2008 and found to be not consistent with ICES Precautionary Approach (WGCSE 2009).

The long-term target for the management plan is a fishing mortality of 0.4, based on the EU–Norway negotiated target for North Sea cod. This target is within $F_{msy}$ range for Irish Sea cod, and well below the current estimates of total removals mortality in excess of M=0.2.

### 6.2.8 Uncertainties and bias in assessment and forecast

#### Landings data

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The Working Group has, since the 1990s, attempted to overcome this problem by incorporating sample-based estimates of landings from three major ports in the WG landings figures. The data for this method have become more limited since 2003, and the WG uses the B-Adapt modelling approach to estimate subsequent removals from 2000 onwards. The unaccounted removals figures given by B-Adapt could potentially include components due to increased natural mortality and discarding as well as misreported landings or catches from the stock taken outside VIIa, albeit distributed according to the age composition in the landings.

#### Discarding

Estimates of discards are patchy for Irish Sea cod, although more comprehensive sampling is now required through the EU Data Collection Framework. Discarding has historically been mainly at age 1, and the absence of raised estimates of discarding for all fleets will result in underestimation of historical F at age 1. Strict controls on catch reporting following the introduction of the Registration of Fish Buyers and Sellers regulations has resulted in documented increases in discarding of cod above the MLS off the west of Scotland and in the Celtic Sea (see Sections 3.2 and 7.2). Observer data provided no evidence of this in the Irish Sea in 2008–2009, but the 2010 Irish and Northern Irish data do show shifts towards the discarding of older fish. It is as yet unclear whether this is a long-term or a temporary change. Compliance with catch composition rules for some fleets could also result in increased discarding of cod. Implementation of unbiased sampling schemes to estimate discarding with adequate precision is likely to be of increasing importance for this stock to prevent further deterioration in fishery catch data.

#### Surveys

The Irish Sea has relatively good survey coverage up to 2011. The surveys in general give consistent signals of fish abundance-at-age. All survey data except the UK(BTS-3Q) indicate a severe depletion of the SSB during a run of very poor recruitment from 2002, with one reasonable recruitment estimated in 2009. The UK(E&W)-BTS-Q3 survey does not show this improved recruitment in 2009, but the data only represent a small area of the Irish Sea and may not be representative of the Irish Sea as a whole. The UK Fisheries-Science Partnership surveys of the Irish Sea cod spawning grounds in spring 2005–2011 (not in the assessment), carried out using commercial trawlers, indicated a widespread distribution of cod mostly at low density but with some localized aggregations (WGCSE 2011, WD11). The time-series of SSB indices shows a downward trend similar to that shown by NIGFS-WIBTS-Q1 which is used in the assessment (Figure 6.2.12), and the highly truncated age composition of cod in the FSP surveys supports the ICES assessment, indicating continuing high mortality rates. Estimates of cod SSB from applications of the annual egg production method, although slightly higher than the B-Adapt estimates, are still below $B_{lim}$ and show a similar trend in SSB to the assessment (Figure 6.2.22).

#### Model formulation

The B-Adapt estimates of removals bias continue to vary around relatively high values of 2.0–3.0 despite more accurate catch reporting and lack of evidence of significant discarding of cod above MLS. There could potentially be unaccounted losses from other sources, for example due to fishery catches taken outside VIIa during seasonal migrations, a gradual shift in distribution to areas beyond VIIa, or increases in natural mortality. The estimates of bias could also be influenced by any remaining non-randomness of survey catchability or outlying values, or by incorrect assumptions in the model (e.g. constant survey catchability, removals bias not age-dependent). For this reason, the absolute values of the estimated unallocated removals should not be over-interpreted. There is currently no evidence from surveys and fishery age compositions of a significant improvement in age structure that could be caused by management measures. The interpretation in B-Adapt is that there continues to be a relatively large unaccounted-for removal of fish from the stock, but unfortunately there is currently very little direct evidence to evaluate the potential source(s) of this and how much is due to fishing in VIIa or elsewhere.

#### Stock structure and migrations

The VIIa commercial fishery for cod extends into the North Channel, particularly for vessels using midwater trawls. It is not clear if the cod in this region belong to the Irish Sea stock, the nearby Clyde stock which exhibits dense aggregations of adult fish during spring in the area covered by the Clyde closure, or to other VIa cod populations. Incorrect allocation of catches to stocks could lead to biases in the assessments.

Tagging of cod off Greencastle on the north coast of Ireland (Ó Cuaig and Officer, 2007), and more limited tagging on UK Fisheries Science Partnership surveys (Armstrong *et al*., WD2 to WGNSDS 2007), have demonstrated movements of cod between Division VIa and VIIa. Most recaptures in VIIa from cod tagged in VIa have come from the North Channel and in or near the deep basin in the western Irish Sea that is a southward extension of the North Channel. The research surveys used for tuning the VIIa cod assessment cover only the western and eastern Irish Sea, and do not extend into the deeper water of the North Channel, where large catches of cod were made by midwater trawlers in the 1980s and 1990s.

Recently more Irish Sea cod mark and recapture experiments, and electronic data storage tag (DST) results have been collected and analysed (Bendall *et al*., 2009). These results show not only spring/summer migrations of cod out of the Irish Sea into the North Channel and VIa, but also migrations south through the deeper channel into the Celtic Sea. This work is continuing and a further 150 cod have been tagged with DST's in the Irish Sea and Celtic Sea in 2010.

Historical tagging studies have also shown more limited movements of cod between spawning components in the western and eastern Irish Sea, for which the migrations tend to be in a north–south direction. STECF Subgroup SGRST (2005, Appendix 4) concluded that management of the Irish Sea stock on the basis of substock assessment regions would be difficult in practice, particularly the separation of catches when the stock units are mixed. Further tagging and genetics studies are required to investigate stock structure, seasonal movements and mixing in VIIa and neighbouring areas.

### 6.2.9 Recommendations for next benchmark assessment

| Year | Candidate stocks | Supporting justification and comment(s) | Indicated expertise necessary at the benchmark meeting |
|---|---|---|---|
| 2012? | Western waters cod stocks (Area VI and VII excl VIId). | Cod stocks in Divisions VI and VII comprise an assemblage of metapopulations with varying degrees of mixing. Fishing effort, predation and other environmental drivers including climate change impact the populations in different ways across the range of the stocks. The stocks have proven difficult to assess due to data deficiencies and an inability to demonstrate responses to changes in fishing effort and other management controls. Improved management advice may benefit more from quantifying the spatial dynamics of cod in relation to spatial variations in fishing and other pressures than by trying to refine the current modelling approaches applied to the current stock definitions and management units. To make progress towards this, an initial Data Workshop is proposed to collate and interpret existing and new data on cod stock structure and mixing, distribution patterns, spatial variations in size/age structure and biological characteristics as well as pressures including predation, fishing and climate. Such analyses will be facilitated by high-resolution spatial data on fishery catches and effort by métier using VMS, rectangle data, employing GIS methods. It will be necessary to develop an international database holding spatially resolved datasets (landings, discards, effort, size/age/biological data, surveys, environmental variables) and data manipulation routines to allow evaluation of the effect on the assessments of altering the stock unit definition. Data on cod movement parameters will be required to allow development of operating models for testing assessment and management procedures and ultimately developing and testing spatially disaggregated assessment models. New datasets e.g. on discarding, biology, predation, surveys and fishing effort/cpue would be evaluated. The Data Workshop would build on and review the outcomes of a major UK collaborative programme on cod stock structure and spatial dynamics, which will be completed in 2011. The ensuing Benchmark Assessment workshop would evaluate the appropriateness of current assessment methods in the light of the Data Workshop outcomes, and explore alternative approaches as candidates for providing management advice. This could potentially include changes to the spatial units for assessment or the development of spatially disaggregated assessment models including mixing coefficients. | |

### 6.2.10 Management considerations

A number of emergency and cod recovery plan measures have been introduced since 2000 to conserve Irish Sea cod. These include a spawning closure since 2000 and effort control since 2003. There have also been several vessel decommissioning schemes. As it has not been possible to provide analytical catch forecasts in recent years, the TAC has been reduced by 15–20% annually since 2006 and by 25% since 2009. These measures may have prevented a further increase in fishing mortality of cod or may have resulted in some reduction in fishing mortality. However, the current assessment does not provide sufficiently robust estimates of fishing mortality to allow the possible changes to be determined.

Although recent recruitment patterns appear well estimated in the assessment, the problem of inaccurate landings and discards estimates makes it difficult to estimate the absolute value and recent trends in fishing mortality. However, all sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, indicates a continued paucity of cod older than four years of age in the Irish Sea indicating a continued very high mortality rate. Possible causes of this include:

- TACs have not restricted catches as intended. Substantial underreporting of landings is known to have occurred since the 1990s, although there is some indication that this is reduced since 2006. However the assessment continues to indicate a large unaccounted removal of fish. The relative contribution of fishing to this has not been identified;
- The effort reductions have not been sufficient, although considerable effort reductions have been observed in some fleets (particularly vessels using >100 mm mesh);
- Cod continues to be taken in mixed demersal fisheries (particularly for haddock, sole and *Nephrops*);
- Time and area closures have not been sufficient to lead to rebuilding of this stock;
- Other non-fishery causes, such as increased natural mortality, have increased over time.

It is difficult to reconcile the large apparent mortality rate and unaccounted removals in recent years with the reduction in fishing effort by whitefish trawlers (shown by STECF Subgroup SGMOS (2010) the very low abundance of cod, and the evidence of more accurate catch reporting since the introduction of the Registration of Buyers and Sellers.

The scientific evaluation of the revised cod Management Plan (Council Regulation (EC) 1342/2008) indicates that it may not be sufficiently precautionary to allow rebuilding of the Irish Sea cod stock to a level where it can regain historical productivity by 2015 (see WGCSE 2009 Report, Section 9.2). The probability of recovery of the cod stock will be increased by measures to eliminate discards of cod which historically have mainly comprised undersized fish.

A closure of the western Irish Sea spawning grounds for cod from mid February to end of April has been in place since 2000, with an extension to the eastern Irish Sea in 2000. The closure was reviewed in 2007 by STECF SGMOS-07-03. On the basis of the information available, SGMOS-07-03 was unable to determine the extent to which the closure has reduced fishing mortality to a lower value than would otherwise have occurred, through protection of adult cod during spawning or influencing changes in fishing effort in the different fleets. SGMOS advised that a comprehensive evaluation of how fleet activities have been affected by the closure and other regulations and factors is required to evaluate the cod closure.

Surveys of cod eggs in the Irish Sea (WD 11 and Figure 6.2.23) in 2010 involving the UK and Ireland indicated that spawning of cod reached a peak around 28 February in the western Irish Sea and around 10 March in the east. Some cod spawning in the western Irish Sea had commenced prior to the cod closure on 15 February, and spawning was effectively completed by mid April, two weeks prior to the reopening of the cod closure. Currently ~30% of the spawning took place in the eastern areas not included in the spring-spawning closure, indicating that the design of the closure may no longer be optimal.

Preliminary 2010 estimates of spawning–stock biomass of cod based on the annual egg production and estimates of fecundity and sex ratio are 1113 t (RSE 21%) in the western Irish Sea, 498 t (RSE 23%) in the eastern Irish Sea and 1610 t (RSE 18%) for the whole Irish Sea (Figure 6.2.22**)**. The update B-Adapt assessment provides an SSB estimate of 947 t for the Irish Sea in 2010, roughly 60% of the egg production estimate. Although the estimates vary both methods give SSB below $B_{lim}$, and both indicate drops in SSB in recent years.

### References

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND), January 16–23 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:32. 259 pp.

Bendall, V. Ó Cuaig, M. Schön, PJ. Hetherington, S, Armstrong, M. Graham, N. Righton, D. 2009. Spatio-temporal dynamics of Atlantic cod (*Gadus morhua*) in the Irish and Celtic Sea: results from a collaborative tagging programme. ICES CM 2009/J:06, 35 pp.

**Table 6.2.1. Nominal landings (t) of COD in Division VIIa as officially reported to ICES, and figures used by ICES.**

| Country | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 187 | 142 | 183 | 316 | 150 | 60 | 283 | 318 | 183 | 104 | 115 | 60 | 67 | 26 | 19 | 21 |
| France | 166 | 148 | 268 | 269 | n/a | 53 | 74 | 116 | 151 | 29 | 35 | 18[2] | 17[2] | 3 | 1[2] | 1 |
| Ireland | 1,414 | 2,476 | 1,492 | 1,739 | 966 | 455 | 751 | 1,111 | 594 | 380 | 220 | 275 | 608 | 618[2] | 323[2] | 289 |
| Netherlands | - | 25 | 29 | 20 | 5 | 1 | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | 14 | - | - | - | - | - | - | - |
| UK (England, Wales & NI) | 2,330 | 2,359 | 2,370 | 2,517 | 1,665 | 799 | 885 | 1,134 | 505 | 646 | 594 | 589[2] | 423 | 543[2] | 387[2] | 282 |
| UK (Isle of Man) | 22 | 27 | 19 | 34 | 9 | 11 | 1 | 7 | 7 | 5 | n/a | n/a | n/a | 2[2] | 1[2] | 1 |
| UK (Scotland) | 414 | 126 | 80 | 67 | 80 | 38 | 32 | 29 | 23 | 15 | 3 | 6 | 2 | 1[2] | 1[2] | - |
| Total | 4,533 | 5,303 | 4,441 | 4,962 | 2,875 | 1,417 | 2,026 | 2,715 | 1,477 | 1,179 | 967 | 948 | 1,117 | 1224 | 754 | 594 |
| Unallocated | 54 | -339 | 1,418 | 356 | 1,909 | -143 | 226 | -20 | -192 | -107 | -57 | -108 | -415 | -563 | -286 | -130 |
| Total as used by WG | 4587[3] | 4964[3] | 5859[3] | 5318[3] | 4784[3] | 1274[4] | 2252[4] | 2695[4] | 1285[4] | 1072[4] | 910[4] | 840[4] | 702[4] | 661[4] | 468[4] | 464[4] |

**[1]Preliminary. [2]Revised. n/a = not available [3] includes sample-based estimates of landings into three ports [4] based on official data only.**

**Table 6.2.2. Cod in VIIa. Working Group figures for annual landings by country since 2000.**

(a) WG landings (tonnes)

| Year | NI | E&W | Scotland | Ireland | France | Belgium | Isle of Man | Netherlands | Total | TAC | %uptake |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 638 | 156 | 39 | 321 | 52 | 56 | 11 | 0 | 1273 | 2100 | 61 |
| 2001 | 697 | 209 | 32 | 645 | 361 | 300 | 8 | 0 | 2251 | 2100 | 107 |
| 2002 | 983 | 171 | 39 | 953 | 251 | 294 | 1 | 2 | 2695 | 3200 | 84 |
| 2003 | 381 | 118 | 32 | 415 | 145 | 187 | 7 | 0 | 1285 | 1950 | 66 |
| 2004 | 539 | 103 | 15 | 271 | 37 | 103 | 5 | 0 | 1072 | 2150 | 50 |
| 2005 | 523 | 72 | 4 | 168 | 31 | 108 | 3 | 0 | 910 | 2150 | 42 |
| 2006 | 552 | 32 | 6 | 172 | 17 | 59 | 3 | 0 | 840 | 1828 | 46 |
| 2007 | 396 | 27 | 2 | 191 | 18 | 66 | 2 | 0 | 702 | 1462 | 48 |
| 2008 | 523 | 22 | 1 | 85 | 3 | 27 | 1 | 0 | 662 | 1199 | 55 |
| 2009 | 375 | 15 | 0 | 55 | 3 | 19 | 1 | 0 | 468 | 899 | 52 |
| 2010 | 274 | 17 | 0 | 151 | 1 | 21 | 1 | 0 | 465 | 674 | 69 |

(b) Percentage of annual total

| Year | NI | E&W | Scotland | Ireland | France | Belgium | Isle of Man | Netherlands | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 50.1 | 12.3 | 3.0 | 25.2 | 4.1 | 4.4 | 0.9 | 0.0 | 100 |
| 2001 | 31.0 | 9.3 | 1.4 | 28.6 | 16.1 | 13.3 | 0.4 | 0.0 | 100 |
| 2002 | 36.5 | 6.4 | 1.5 | 35.4 | 9.3 | 10.9 | 0.0 | 0.1 | 100 |
| 2003 | 29.7 | 9.2 | 2.5 | 32.3 | 11.3 | 14.6 | 0.6 | 0.0 | 100 |
| 2004 | 50.3 | 9.6 | 1.4 | 25.2 | 3.5 | 9.6 | 0.4 | 0.0 | 100 |
| 2005 | 57.5 | 7.9 | 0.5 | 18.5 | 3.5 | 11.8 | 0.3 | 0.0 | 100 |
| 2006 | 65.7 | 3.8 | 0.7 | 20.4 | 2.0 | 7.1 | 0.3 | 0.0 | 100 |
| 2007 | 56.5 | 3.8 | 0.3 | 27.2 | 2.5 | 9.5 | 0.3 | 0.0 | 100 |
| 2008 | 78.9 | 3.4 | 0.2 | 12.8 | 0.5 | 4.0 | 0.2 | 0.0 | 100 |
| 2009 | 80.1 | 3.1 | 0.0 | 11.7 | 0.6 | 4.1 | 0.3 | 0.0 | 100 |
| 2010 | 58.9 | 3.7 | 0.0 | 32.5 | 0.2 | 4.5 | 0.2 | 0.0 | 100 |

**Table 6.2.3. Cod in VIIa. Landings numbers-at-age used in the update B-Adapt assessment.**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1968 | 0 | 364 | 1563 | 1003 | 456 | 177 | 28 | 2 |
| 1969 | 0 | 882 | 1481 | 1050 | 269 | 186 | 76 | 37 |
| 1970 | 0 | 1317 | 1385 | 352 | 204 | 163 | 52 | 19 |
| 1971 | 0 | 2739 | 2022 | 904 | 144 | 67 | 39 | 12 |
| 1972 | 0 | 789 | 3267 | 824 | 250 | 58 | 39 | 20 |
| 1973 | 0 | 2263 | 1091 | 1783 | 430 | 173 | 60 | 21 |
| 1974 | 0 | 530 | 3559 | 557 | 494 | 131 | 46 | 28 |
| 1975 | 0 | 1699 | 642 | 1407 | 294 | 249 | 95 | 22 |
| 1976 | 0 | 1135 | 3007 | 363 | 500 | 61 | 79 | 25 |
| 1977 | 0 | 816 | 511 | 1233 | 163 | 218 | 31 | 40 |
| 1978 | 0 | 687 | 1092 | 310 | 311 | 39 | 47 | 18 |
| 1979 | 0 | 1762 | 1288 | 608 | 127 | 164 | 38 | 33 |
| 1980 | 0 | 2533 | 2797 | 729 | 243 | 49 | 51 | 4 |
| 1981 | 0 | 1299 | 3635 | 1448 | 244 | 99 | 23 | 24 |
| 1982 | 0 | 345 | 2284 | 1455 | 557 | 102 | 57 | 22 |
| 1983 | 0 | 814 | 932 | 751 | 499 | 154 | 27 | 19 |
| 1984 | 0 | 1577 | 1195 | 439 | 240 | 161 | 56 | 19 |
| 1985 | 0 | 1218 | 2105 | 703 | 158 | 84 | 51 | 26 |
| 1986 | 0 | 974 | 2248 | 699 | 203 | 64 | 33 | 32 |
| 1987 | 0 | 4323 | 1793 | 841 | 252 | 75 | 19 | 24 |
| 1988 | 0 | 2792 | 4734 | 702 | 263 | 71 | 27 | 11 |
| 1989 | 0 | 582 | 2163 | 1886 | 231 | 86 | 21 | 16 |
| 1990 | 0 | 710 | 1075 | 545 | 372 | 70 | 23 | 7 |
| 1991 | 0 | 1973 | 1408 | 442 | 127 | 98 | 15 | 7 |
| 1992 | 0 | 1375 | 1243 | 664 | 132 | 42 | 46 | 3 |
| 1993 | 0 | 223 | 2907 | 403 | 119 | 16 | 6 | 7 |
| 1994 | 0 | 749 | 569 | 848 | 68 | 20 | 9 | 1 |
| 1995 | 0 | 498 | 1283 | 180 | 163 | 7 | 3 | 3 |
| 1996 | 0 | 317.6 | 1112.8 | 700.3 | 38.3 | 38.8 | 4.4 | 1.7 |
| 1997 | 0 | 523.2 | 1148.8 | 500.6 | 212.5 | 16.5 | 11.5 | 4.5 |
| 1998 | 0 | 204.4 | 1926.1 | 335.1 | 79.9 | 28 | 6.5 | 1.2 |
| 1999 | 0 | 69.6 | 842.8 | 871.1 | 65.7 | 21.2 | 6.2 | 0.3 |
| 2000 | 0 | 289 | 176 | 107 | 50 | 4 | 1 | 0.2 |
| 2001 | 0 | 338 | 841 | 53 | 13 | 9 | 0.3 | 2 |
| 2002 | 0 | 196 | 564 | 405 | 7 | 2 | 2 | 1 |
| 2003 | 0 | 45 | 439 | 93 | 35 | 1 | 0.1 | 0.03 |
| 2004 | 0 | 68 | 101 | 158 | 21 | 6 | 1.9 | 0.6 |
| 2005 | 0 | 42 | 224 | 62 | 33 | 5 | 0.7 | 0.2 |
| 2006 | 0 | 14 | 142 | 112 | 16 | 8.2 | 3.2 | 0.2 |
| 2007 | 0 | 49 | 205 | 56 | 11 | 0.5 | 0.4 | 0 |
| 2008 | 0 | 13.7 | 165.7 | 87.1 | 9.4 | 2.7 | 0.1 | 0.02 |
| 2009 | 0 | 19.7 | 53.2 | 65.5 | 16.9 | 2.9 | 0.4 | 0 |
| 2010 | 0 | 40.2 | 127.6 | 15 | 7.4 | 1.5 | 0.3 | 0.2 |

**Table 6.2.4. Cod in VIIa. Mean weights-at-age in the landings (used for stock and catch).**

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
| 1968 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1969 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1970 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1971 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1972 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1973 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1974 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1975 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1976 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1977 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1978 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1979 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1980 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1981 | 0 | 0.61 | 1.66 | 3.33 | 5.09 | 6.19 | 6.76 | 8.3 |
| 1982 | 0 | 1.01 | 1.524 | 3.488 | 5.573 | 7.592 | 8.697 | 10.18 |
| 1983 | 0 | 0.995 | 1.842 | 3.988 | 5.964 | 7.966 | 9.306 | 10.925 |
| 1984 | 0 | 0.679 | 1.813 | 3.808 | 5.865 | 7.475 | 9.818 | 10.748 |
| 1985 | 0 | 0.783 | 2.023 | 4.244 | 5.825 | 7.5 | 8.81 | 9.504 |
| 1986 | 0 | 0.805 | 1.825 | 3.862 | 5.855 | 7.391 | 8.116 | 9.471 |
| 1987 | 0 | 0.713 | 2.161 | 3.91 | 6.41 | 7.821 | 9.888 | 10.658 |
| 1988 | 0 | 0.607 | 1.563 | 3.756 | 5.668 | 8.017 | 9.749 | 10.208 |
| 1989 | 0 | 0.936 | 1.846 | 3.223 | 5.408 | 6.571 | 8.256 | 11.052 |
| 1990 | 0 | 0.842 | 1.938 | 3.572 | 5.277 | 7.531 | 8.398 | 12.699 |
| 1991 | 0 | 0.856 | 1.637 | 3.542 | 5.419 | 6.39 | 8.507 | 10.397 |
| 1992 | 0 | 0.813 | 1.964 | 3.993 | 5.975 | 6.923 | 8.509 | 11.1 |
| 1993 | 0 | 0.847 | 1.706 | 3.666 | 5.675 | 7.365 | 9.486 | 10.761 |
| 1994 | 0 | 0.798 | 1.923 | 3.608 | 6.08 | 7.68 | 8.272 | 11.258 |
| 1995 | 0 | 0.9 | 1.84 | 4 | 5.791 | 8.452 | 8.712 | 9.56 |
| 1996 | 0 | 0.98 | 1.625 | 3.256 | 5.298 | 7.721 | 8.836 | 12.256 |
| 1997 | 0 | 0.846 | 1.937 | 3.624 | 5.291 | 6.115 | 8.672 | 11.263 |
| 1998 | 0 | 0.925 | 1.647 | 3.729 | 5.371 | 7.033 | 8.833 | 12.155 |
| 1999 | 0 | 0.853 | 1.624 | 3.179 | 5.505 | 7.517 | 10.137 | 12.618 |
| 2000 | 0 | 0.851 | 1.985 | 3.573 | 5.138 | 7.148 | 8.528 | 7.692 |
| 2001 | 0 | 0.99 | 1.823 | 4.149 | 5.606 | 7.332 | 8.471 | 9.667 |
| 2002 | 0 | 0.942 | 1.836 | 3.439 | 5.727 | 7.708 | 9.639 | 10.761 |
| 2003 | 0 | 1.205 | 1.662 | 3.287 | 5.425 | 10.198 | 10.308 | 13.696 |
| 2004 | 0 | 1.112 | 2.202 | 3.634 | 6.505 | 7.638 | 8.937 | 7.572 |
| 2005 | 0 | 0.913 | 1.938 | 3.514 | 5.318 | 7.739 | 7.94 | 12.237 |
| 2006 | 0 | 0.826 | 1.843 | 3.666 | 4.709 | 6.393 | 7.562 | 12.236 |
| 2007 | 0 | 0.832 | 1.852 | 3.781 | 5.347 | 7.991 | 10.038 | 0 |
| 2008 | 0 | 0.894 | 1.586 | 3.543 | 6.001 | 7.573 | 9.723 | 8.123 |
| 2009 | 0 | 1.097 | 2.006 | 3.458 | 5.314 | 7.1 | 6.815 | 0 |
| 2010 | 0 | 1.259 | 2.288 | 3.931 | 6.335 | 7.33 | 8.69 | 11.056 |

**Table 6.2.5. Cod in VIIa. Estimates of numbers discarded in 1996–2010. Data are numbers ('000 fish) discarded by each fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Sampling scheme (a) provides independent self-sampling estimates for the UK(NI) *Nephrops* fishery also covered by observer data in schemes (b) and (d). An asterisk indicates years/fleets where the data are raised to the trip level rather than to the entire fleet.**

a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching *Nephrops* (single and twin trawl)

| | **1996 Q1-4** | **1997 Q1-4** | **1998 Q1-4** | **1999 Q1-4** | **2000 Q1-4** | **2001 Q1-4** | **2002 Q1-4** | **2003 Q1** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 43 trips | 39 trips | 48 trips | 39 trips | 44 trips | 43 trips | 35 trips | 8 trips | 0 trips | 0 trips | 0 trips | 0 trips | | | |
| 0 | 56 | 3 | 0 | 70 | 32 | 4 | 0 | 0 | | | | | | | |
| 1 | 82 | 63 | 14 | 83 | 397 | 31 | 22 | 0 | | | | | | | |

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only) (*not raised to fleet level – no. of fish)

| | **1996** | **1997** | **1998** | **1999 Q3-4** | **2000 Q1-3** | **2001 Q1** | **2002** | **2003** | **2004** | **2005** | **2006 Q3-4*** | **2007 Q1-4** | **2008 Q1-4** | **2009 Q1-4** | **2010 Q1-4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | 0 trips | 0 trips | 4 trips | 6 trips | 1 trip | 0 trips | 0 trips | 0 trips | 0 trips | 9 trips * | 29 trips | 55 trips | 30 trips | 36 trips |
| 0 | | | | 0 | 0 | 0 | | | | | 19 | 5.0 | 2.5 | 50.0 | 4.7 |
| 1 | | | | 0 | 53 | 0 | | | | | 7 | 15.2 | 2.7 | 8.7 | 23.7 |
| 2 | | | | | | | | | | | | 0.6 | 0.7 | 0.3 | 3.6 |

(c) Observer scheme: N.Ireland midwater trawl

| | **1996** | **1997 Q2-4** | **1998 Q1-3** | **1999 Q3-4** | **2000 Q1** | **2001 Q1** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010 Q1,2,4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | n/a | n/a | 5 trips | 4 trips | 2 trips | 0 trips | 0 trips | 0 trips | 0 trips | 0 trips | 0 trips | 1 trip | 1 trip | 3 trips |
| 0 | | 0 | 0 | 1.6 | 0 | 0 | | | | | | | 0 | 0 | 0.1 |
| 1 | | 17 | 4 | 0 | 0.8 | 0 | | | | | | | 0.45 | 0.03 | 1.70 |
| 2 | | 0.5 | 2 | 0 | 0 | 0 | | | | | | | 0 | 0.03 | 0.1 |

(d) Observer scheme: N.Ireland twin trawl (*not raised to fleet level – no. of fish)

| | **1996** | **1997 Q2-4** | **1998 Q1-3** | **1999 Q4** | **2000 Q1-4** | **2001 Q1** | **2002** | **2003** | **2004** | **2005** | **2006 Q3-4*** | **2007 Q1-4** | **2008 Q1-4** | **2009 Q1-4** | **2010 Q1-4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | n/a | n/a | 1 trips | 10 trips | 2 trips | 0 trips | 0 trips | 0 trips | 0 trips | incl. with single Nephrops trawls | 14 trips | 16 trips | 18 trips | 21 trips |
| 0 | | 12 | 0 | 12 | 33 | 0 | | | | | | 0.8 | 2.8 | 172.2 | 5.0 |
| 1 | | 19 | 38 | 1 | 45 | 0 | | | | | | 12.5 | 12.9 | 17.9 | 24.8 |
| 2 | | 0.2 | 13 | 0 | 0 | 0 | | | | | | 0.1 | 0.2 | 0.0 | 44.0 |

**Table 6.2.5. Continued.**

(e) Observer scheme: Republic of Ireland otter trawlers (*not raised to fleet level – total no. of fish for trips sampled )

| | 1996 Q1-4 | 1997 Q1-4 | 1998 Q1-4 | 1999 Q1-4 | 2000 Q1-4 | 2001 Q1-4 | 2002 Q1-4 | 2003 Q1-4 | 2004 Q1-4 | 2005 Q1-4 | 2006 Q1-4 | 2007 Q1-4 | 2008 Q1-4 | 2009 Q1-4 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 8 trips * | 8 trips * | 7 trips * | 4 trips * | 10 trips * | 2 trips * | 1 trip * | 9 trips * | 11 trips * | 8 trips * | 5 trips * | 15 trips * | 18 trips* | 12 trips | 4 trips |
| 0 | 52 | 301 | 0 | 8 | 2320 | 58 | 124 | 0 | 3213 | 8268 | 774 | 0 | 0 | 107 | 29 |
| 1 | 374 | 333 | 202 | 16 | 798 | | 176 | 0 | 2577 | 632 | 150 | 691 | 441 | 8 | 70 |
| 2 | 6 | 87 | 0 | 0 | 10 | | 0 | 0 | 598 | 0 | 0 | 0 | 0 | 0 | 0 |

(f) Observer scheme: UK(E&W) Demersal otter trawl

| | 1996 | 1997 | 1998 | 1999 | 2000 Q1-2 | 2001 Q1,2,4 | 2002 Q1,3,4 | 2003 Q1,2,4 | 2004 Q1-4 | 2005 Q1,2 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | 0 trips | 0 trips | 0 trips | 21 trips | 8 trips | 4 trips | 4 trips | 7 trips | 4 trips | | | | | |
| 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | see comment 1 | | | | |
| 1 | | | | | 38.91 | 9.21 | 3.43 | 0.6 | 17.71 | 1.26 | | | | | |
| 2 | | | | | 0.05 | 4.46 | 0 | 0.62 | 0.81 | 0.36 | | | | | |

(g) Observer scheme: UK(E&W) Nephrops trawl

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 Q1,2 | 2002 Q3,4 | 2003 Q2 | 2004 Q1-3 | 2005 Q2 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | 0 trips | 0 trips | 0 trips | 0 trips | 8 trips | 3 trips | 2 trips | 7 trips | 1 trip | | | | | |
| 0 | | | | | | 0 | 0 | 0 | 0.03 | 0 | see comment 1 | | | | |
| 1 | | | | | | 3.09 | 0.03 | 0 | 0.24 | 0 | | | | | |
| 2 | | | | | | 0.7 | 0 | 0 | 0 | 0 | | | | | |

(h) Observer scheme: UK(E&W) Danish anchor seine

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 Q2 | 2002 Q3 | 2003 | 2004 Q3 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | 0 trips | 0 trips | 0 trips | 0 trips | 2 trips | 1 trip | 0 trips | 1 trip | | | | | | |
| 0 | | | | | | 0 | 0 | | 0 | | see comment 1 | | | | |
| 1 | | | | | | 0 | 0 | | 0 | | | | | | |

(i) Observer scheme: UK(E&W) beam trawl

| | 1996 | 1997 | 1998 | 1999 | 2000 Q2 | 2001 | 2002 Q1 | 2003 | 2004 | 2005 Q4 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 trips | 0 trips | 0 trips | 0 trips | 1 trip | 0 trips | 1 trip | 0 trips | 0 trips | 2 trips | | | | | |
| 0 | | | | | 0 | | 0 | | | 0 | see comment 1 | | | | |
| 1 | | | | | 4.34 | | 0.54 | | | 0 | | | | | |

comment 1 UK data for 2006-2009 available to WGNSDS/WGCSE as length compositions only, for combined gears

**Table 6.2.6. Cod in VIIa: survey indices. Approximate relative standard errors for age groups used in the assessment are given for UK(NI) groundfish surveys. Years/ages used in assessments are in bold.**

ScoGFS :Scottish spring groundfish survey of the Irish Sea Feb-March — Numbers per 10 Hours Fishing

| Survey | 1-gp | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ |
|---|---|---|---|---|---|---|---|
| 1996 | **3** | **31** | **44** | **7** | 9 | 0 | 0 |
| 1997 | **22** | **29** | **15** | **13** | 2 | 0 | 1 |
| 1998 | **5** | **81** | **27** | **5** | 1 | 0 | 0 |
| 1999 | **7** | **33** | **93** | **15** | 5 | 0 | 0 |
| 2000 | **51** | **6** | **11** | **16** | 0 | 1 | 0 |
| 2001 | **28** | **56** | **1** | **1** | 4 | 0 | 0 |
| 2002 | **13** | **18** | **37** | **1** | 1 | 0 | 0 |
| 2003 | **8** | **69** | **18** | **9** | 0 | 0 | 0 |
| 2004 | **8** | **11** | **49** | **0** | 3 | 0 | 0 |
| 2005 | **1** | **25** | **8** | **9** | 1 | 0 | 0 |
| 2006 | **2** | **5** | **11** | **0** | 2 | 0 | 0 |

ScoGFS :Scottish autumn groundfish survey of the Irish Sea October — Numbers per 10 Hours Fishing

| Survey | 0-gp | 1-gp | 2-gp | 3-gp | 4-gp |
|---|---|---|---|---|---|
| 1997 | 3 | 28 | 19 | 1 | 2 |
| 1998 | 0 | 8 | 42 | 5 | 0 |
| 1999 | 164 | 2 | 24 | 6 | 2 |
| 2000 | 24 | 136 | 4 | 0 | 0 |
| 2001 | 0 | 0 | 7 | 0 | 0 |
| 2002 | 0 | 18 | 15 | 9 | 0 |
| 2003 | 2 | 0 | 27 | 0 | 0 |
| 2004 | 2 | 12 | 5 | 5 | 0 |
| 2005 | 3 | 8 | 25 | 2 | 0 |

NI-GFS March groundfish survey — Numbers per 3-miles (approx. 1-h tow) — RSE = approximate relative standard error

| Survey | 1-gp | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ | RSE(1gp) | RSE(2gp) | RSE(3gp) | RSE(4gp) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | 23.257 | 5.005 | 1.965 | 0.248 | 0.000 | 0.031 | 0.017 | 0.58 | 0.36 | 0.26 | 0.40 |
| 1993 | **1.381** | **6.488** | **0.446** | **0.104** | 0.014 | 0.028 | 0.000 | 0.67 | 0.22 | 0.25 | 0.39 |
| 1994 | **13.804** | **1.097** | **1.203** | **0.084** | 0.014 | 0.000 | 0.000 | 0.48 | 0.35 | 0.21 | 0.35 |
| 1995 | **7.007** | **3.862** | **0.200** | **0.108** | 0.000 | 0.010 | 0.000 | 0.30 | 0.25 | 0.41 | 0.39 |
| 1996 | **11.061** | **3.293** | **1.117** | **0.014** | 0.088 | 0.000 | 0.013 | 0.62 | 0.18 | 0.21 | 1.00 |
| 1997 | **5.373** | **4.158** | **0.667** | **0.214** | 0.014 | 0.000 | 0.000 | 0.32 | 0.21 | 0.21 | 0.38 |
| 1998 | **1.694** | **7.692** | **0.569** | **0.120** | 0.000 | 0.000 | 0.000 | 0.21 | 0.16 | 0.30 | 0.53 |
| 1999 | **0.495** | **2.531** | **2.419** | **0.153** | 0.028 | 0.000 | 0.000 | 0.27 | 0.20 | 0.15 | 0.43 |
| 2000 | **6.296** | **1.011** | **0.346** | **0.330** | 0.000 | 0.023 | 0.000 | 0.36 | 0.13 | 0.31 | 0.44 |
| 2001 | **4.067** | **5.614** | **0.184** | **0.058** | 0.040 | 0.000 | 0.000 | 0.29 | 0.15 | 0.39 | 0.42 |
| 2002 | **6.622** | **2.533** | **3.335** | **0.000** | 0.000 | 0.011 | 0.000 | 0.59 | 0.19 | 0.38 | - |
| 2003 | **0.739** | **10.792** | **1.041** | **0.327** | 0.037 | 0.030 | 0.058 | 0.32 | 0.21 | 0.30 | 0.26 |
| 2004 | **2.170** | **1.720** | **0.886** | **0.054** | 0.044 | 0.000 | 0.000 | 0.57 | 0.30 | 0.21 | 0.40 |
| 2005 | **0.635** | **2.251** | **0.294** | **0.280** | 0.183 | 0.000 | 0.000 | 0.56 | 0.29 | 0.60 | 0.64 |
| 2006 | **1.700** | **1.308** | **0.583** | **0.025** | 0.000 | 0.000 | 0.011 | 0.52 | 0.26 | 0.37 | 0.71 |
| 2007 | **1.644** | **1.244** | **0.306** | **0.051** | 0.000 | 0.000 | 0.000 | 0.41 | 0.21 | 0.38 | 0.66 |
| 2008 | **0.407** | **2.172** | **0.130** | **0.052** | 0.042 | 0.010 | 0.000 | 0.46 | 0.32 | 0.39 | 0.66 |
| 2009 | **1.440** | **0.590** | **0.330** | **0.090** | 0.000 | 0.000 | 0.000 | 0.60 | 0.23 | 0.26 | 0.68 |
| 2010 | **10.221** | **2.090** | **0.147** | **0.023** | 0.000 | 0.000 | 0.000 | 0.59 | 0.22 | 0.34 | 0.66 |
| 2011 | **3.540** | **4.147** | **0.460** | **0.023** | 0.020 | 0.000 | 0.000 | 0.46 | 0.26 | 0.30 | 0.66 |

NI-GFS October groundfish survey — Numbers per 3-miles (approx. 1-h tow) — RSE = approximate relative standard error

| Survey | 0-gp | 1-gp | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ | RSE(0gp) | RSE(1gp) | RSE(2gp) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | **0.579** | 11.094 | 0.501 | 0.476 | 0.086 | 0.000 | 0.000 | 0.000 | 0.58 | 0.36 | 0.28 |
| 1993 | **7.808** | 5.532 | 1.464 | 0.008 | 0.000 | 0.000 | 0.000 | 0.034 | 0.43 | 0.84 | 0.34 |
| 1994 | **19.962** | 16.725 | 0.254 | 0.104 | 0.000 | 0.000 | 0.000 | 0.000 | 0.28 | 0.43 | 0.42 |
| 1995 | **7.886** | 12.068 | 0.333 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.55 | 0.91 | 0.38 |
| 1996 | **14.813** | 4.866 | 0.501 | 0.065 | 0.000 | 0.000 | 0.000 | 0.000 | 0.42 | 0.50 | 0.30 |
| 1997 | **4.204** | 13.222 | 0.972 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.45 | 0.41 | 0.40 |
| 1998 | **0.370** | 3.765 | 1.639 | 0.057 | 0.000 | 0.000 | 0.000 | 0.000 | 0.38 | 0.36 | 0.37 |
| 1999 | **20.225** | 0.585 | 0.325 | 0.095 | 0.000 | 0.000 | 0.000 | 0.000 | 0.34 | 0.68 | 0.43 |
| 2000 | **7.242** | 3.016 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.36 | 0.33 | 1.00 |
| 2001 | **8.411** | 5.068 | 1.099 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.45 | 0.35 | 0.35 |
| 2002 | **0.897** | 4.879 | 0.377 | 0.125 | 0.000 | 0.000 | 0.000 | 0.000 | 0.86 | 0.58 | 0.55 |
| 2003 | **2.759** | 1.614 | 0.294 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.48 | 0.66 | 0.63 |
| 2004 | **4.437** | 5.790 | 0.237 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.30 | 0.48 | 0.75 |
| 2005 | **8.245** | 7.061 | 1.077 | 0.173 | 0.029 | 0.000 | 0.000 | 0.000 | 0.52 | 0.89 | 0.62 |
| 2006 | **1.170** | 1.302 | 0.015 | 0.066 | 0.000 | 0.000 | 0.000 | 0.000 | 0.45 | 0.53 | 1.00 |
| 2007 | **0.068** | 0.870 | 0.000 | 0.030 | 0.000 | 0.000 | 0.000 | 0.000 | 0.66 | 0.80 | - |
| 2008 | **0.190** | 0.170 | 0.170 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.57 | 1.00 | 1.00 |
| 2009 | **5.356** | 2.136 | 0.061 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.33 | 0.76 | 1.00 |
| 2010 | **2.780** | 1.718 | 0.030 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.35 | 0.91 | 1.00 |

**Table 6.2.6. continued.**

Irish GFS. Irish groundfish survey of the Irish Sea. RV Celtic Explorer — Total nos. per survey

| October | 0-gp | 1-gp | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ |
|---|---|---|---|---|---|---|---|---|
| 2003 | 16 | 29 | 31 | 3 | 1 | 0 | | |
| 2004 | 23 | 74 | 7 | 2 | 0 | | | |

UK Fishery Science Partnership western Irish Sea pelagic trawl survey (mean nos. per hour) SSB index = kg/hr

| Feb-March | 0-gp | 1-gp (revised) | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ | SSB index |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | | - | - | - | - | - | - | - | 13.29 |
| 2005 | | 0.000 | 0.427 | 1.409 | 0.990 | 0.084 | 0.025 | 0.035 | 12.01 |
| 2006 | | 0.003 | 0.536 | 2.815 | 0.427 | 0.104 | 0.010 | 0.007 | 8.26 |
| 2007 | | 0.008 | 0.611 | 1.322 | 0.585 | 0.055 | 0.058 | 0.029 | 11.78 |
| 2008 | | 0.003 | 0.221 | 0.824 | 0.147 | 0.084 | 0.020 | 0.019 | 3.93 |
| 2009 | | 0.009 | 0.171 | 1.152 | 0.377 | 0.099 | 0.018 | 0.012 | 5.10 |
| 2010 | | 0.000 | 0.735 | 0.452 | 0.467 | 0.130 | 0.023 | 0.003 | 4.40 |
| 2011 | | 0.000 | 0.407 | 1.681 | 0.144 | 0.095 | 0.039 | 0.017 | 6.20 |

UK Fishery Science Partnership eastern Irish Sea otter trawl survey (mean nos. per hour) SSB index = kg/hr

| Feb-March | 0-gp | 1-gp (revised) | 2-gp | 3-gp | 4-gp | 5-gp | 6-gp | 7+ | SSB index |
|---|---|---|---|---|---|---|---|---|---|
| 2005 | | 0.06 | 4.02 | 0.25 | 0.38 | 0.004 | 0.01 | 0.00 | 5.97 |
| 2006 | | 0.83 | 0.77 | 0.67 | 0.007 | 0.042 | 0.00 | 0.001 | 3.31 |
| 2007 | | 0.59 | 1.43 | 0.09 | 0.08 | 0.00 | 0.00 | 0.00 | 1.77 |
| 2008 | | 0.01 | 1.80 | 0.32 | 0.02 | 0.03 | 0.003 | 0.01 | 2.60 |
| 2009 | | 0.50 | 0.36 | 0.21 | 0.09 | 0.01 | 0.004 | 0.00 | 1.56 |
| 2010 | | 0.97 | 0.65 | 0.03 | 0.04 | 0.01 | 0.000 | 0.00 | 0.86 |
| 2011 | | 0.46 | 1.57 | 0.06 | 0.00 | 0.00 | 0.000 | 0.00 | 1.34 |

ENG BTS-Sept beam trawl survey. No. per 100km

| September Survey | 0-gp | (revised) |
|---|---|---|
| 1991 | | |
| 1992 | | |
| 1993 | **22** | |
| 1994 | **30** | |
| 1995 | **40** | |
| 1996 | **29** | |
| 1997 | **32** | |
| 1998 | **2** | |
| 1999 | **49** | |
| 2000 | **37** | |
| 2001 | **24** | |
| 2002 | **7** | |
| 2003 | **9** | |
| 2004 | **22** | |
| 2005 | **41** | |
| 2006 | **6** | |
| 2007 | **4** | |
| 2008 | **7** | |
| 2009 | **6** | |
| 2010 | **4** | |

NIMIKNET pelagic 0-gp index

| May-June Survey | 0-gp |
|---|---|
| 1994 | **57.4** |
| 1995 | **6.9** |
| 1996 | **66.3** |
| 1997 | **5.7** |
| 1998 | **0.1** |
| 1999 | **26.2** |
| 2000 | **6.1** |
| 2001 | **9.6** |
| 2002 | **3.4** |
| 2003 | **3.2** |
| 2004 | **25.8** |
| 2005 | **11.4** |
| 2006 | **9.0** |
| 2007 | **0** |
| 2008 | **0.8** |
| 2009 | **23.6** |
| 2010 | **5.7** |

**Table 6.2.7. B-Adapt model settings for update run in 2011. Same settings as 2010.**

| Setting | Values |
|---|---|
| Plus group | 5-plus |
| $F_{bar}$ range | 2–4 (arithmetic mean) |
| Year range for tuning VPA | 1992 onwards |
| Surveys after final year of catch data used. | Yes; $F_{mult}$ = 0.75 for 2011 WGCSE |
| VPA model or cohort analysis used | v (exact) |
| First age with constant catchability | Entered as 0 for all tuning fleets |
| q-plateau | Entered as 3 for all tuning fleets |
| Tapered time weighting applied | No |
| Number of missing catch multipliers | 11 for WGCSE 2011 (bias estimated from 2000 onwards) |
| No. ages for terminal F mean, and scaling factor for mean | ages = 1; scaling factor = 1.0; arithmetic mean (i.e. F(4) = F(3)) |
| Constraint on F or catch? Stiffness weight (λ) | Constrain F; λ = 1.0 |
| Prior weighting of fleets | None |
| Output tables | VPA output table 16 (not SOP corrected) |

## Table 6.2.8. Selected diagnostics from update B-Adapt (not bootstrap run)

Lowestoft VPA Program

16/05/2011 10:49

Adapt Analysis

"IRISH SEA COD WGCSE 2011 COMBS PLUSGROUP"

CPUE data from file cod7tun.txt

Catch data for 43 years : 1968 to 2010. Ages 0 to 5+

| Fleet | First year | Last year | First age | Last age | Alpha | Beta |
|---|---|---|---|---|---|---|
| NIGFSMAR(1-4gp) | 1993 | 2011 | 1 | 4 | 0.25 | 0.35 |
| ScoGFS-Q1 Survey (No | 1996 | 2011 | 1 | 4 | 0.25 | 0.35 |
| NIGFSOCT(0 2-gp) | 1992 | 2011 | 0 | 0 | 0.83 | 0.88 |
| ENGBTS-Sept | 1993 | 2011 | 0 | 0 | 0.75 | 0.79 |
| NIMIKNET | 1994 | 2011 | 0 | 0 | 0.38 | 0.46 |

Time series weights :

Tapered time weighting not applied

Catchability analysis :

| Fleet | PowerQ ages<x | QPlateau ages>x |
|---|---|---|
| NIGFSMAR(1-4gp) | 0 | 3 |
| ScoGFS-Q1 Survey (No | 0 | 3 |
| NIGFSOCT(0 2-gp) | 0 | 3 |
| ENGBTS-Sept | 0 | 3 |
| NIMIKNET | 0 | 3 |

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 11 years.

Oldest age F estimates in 1968 to 2011 calculated as 1.000 * the mean F of ages 3- 3

Total F penalty applied lambda = 1.000

Individual fleet weighting not applied

| | |
|---|---|
| INITIAL SSQ = | 1749.69962 |
| PARAMETERS = | 15 |
| OBSERVATIONS = | 218 |

| | |
|---|---|
| SSQ = | 100.37616 |
| QSSQ = | 93.57441 |
| CSSQ = | 6.80176 |
| IFAIL = | 0 |
| IFAILCV = 0 | |

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2.00E+03 | 2.00E+03 | 2.00E+03 | 2.00E+03 | 2.01E+03 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0 | 0 | 0 | 0 | 0 |
| 1 | 2.38E-01 | 1.50E-01 | 2.05E-01 | 1.56E-01 | 1.26E-01 | 0.044 | 0.154 | 0.14 | 0.073 | 0.044 |
| 2 | 7.32E-01 | 1.24E+00 | 1.11E+00 | 7.69E-01 | 7.90E-01 | 1.143 | 0.956 | 1.048 | 1.063 | 1.044 |
| 3 | 1.59E+00 | 1.74E+00 | 1.44E+00 | 1.47E+00 | 1.20E+00 | 2.245 | 1.612 | 1.556 | 1.738 | 1.27 |
| 4 | 1.59E+00 | 1.74E+00 | 1.44E+00 | 1.47E+00 | 1.20E+00 | 2.245 | 1.612 | 1.556 | 1.738 | 1.27 |

Population numbers (Thousands)

| YEAR \ AGE | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 2001 | 4.67E+03 | 3.27E+03 | 3.30E+03 | 1.34E+02 | 3.29E+01 |
| 2002 | 1.24E+03 | 3.82E+03 | 2.11E+03 | 1.30E+03 | 2.25E+01 |
| 2003 | 2.08E+03 | 1.01E+03 | 2.69E+03 | 4.99E+02 | 1.88E+02 |
| 2004 | 1.27E+03 | 1.70E+03 | 6.76E+02 | 7.28E+02 | 9.68E+01 |
| 2005 | 1.47E+03 | 1.04E+03 | 1.19E+03 | 2.57E+02 | 1.37E+02 |
| 2006 | 1.20E+03 | 1.20E+03 | 7.50E+02 | 4.44E+02 | 6.34E+01 |
| 2007 | 3.52E+02 | 9.85E+02 | 9.42E+02 | 1.96E+02 | 3.85E+01 |
| 2008 | 8.81E+02 | 2.88E+02 | 6.91E+02 | 2.97E+02 | 3.20E+01 |
| 2009 | 3.24E+03 | 7.21E+02 | 2.05E+02 | 1.99E+02 | 5.12E+01 |
| 2010 | 1.55E+03 | 2.65E+03 | 5.49E+02 | 5.79E+01 | 2.86E+01 |

**Table 6.2.8. Continued.**

Estimated population abundance at 1st Jan 2011

| | | | | |
|---|---|---|---|---|
| 0.00E+00 | 1.27E+03 | 2.08E+03 | 1.58E+02 | 1.33E+01 |

Taper weighted geometric mean of the VPA populations:

| | | | | |
|---|---|---|---|---|
| 4.13E+03 | 3.46E+03 | 2.30E+03 | 8.31E+02 | 2.23E+02 |

Standard error of the weighted Log(VPA populations) :

| | | | | |
|---|---|---|---|---|
| 0.8759 | 0.8624 | 0.819 | 0.8969 | 1.0834 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Mean Log q | -1.8122 | -1.2504 | -1.5247 | -1.5247 |
| S.E(Log q) | 0.5613 | 0.3839 | 0.4805 | 0.7633 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | 0.78 | 1.671 | 3.04 | 0.79 | 18 | 0.41748 | -1.81 |
| 2 | 1.2 | -1.532 | 0.06 | 0.78 | 18 | 0.44415 | -1.25 |
| 3 | 1.03 | -0.207 | 1.39 | 0.74 | 18 | 0.50975 | -1.52 |
| 4 | 1.13 | -0.439 | 1.45 | 0.45 | 17 | 0.82447 | -1.79 |

Fleet : ScoGFS-Q1 Survey (No

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Mean Log q | -5.4517 | -3.7817 | -2.8298 | -2.8298 |
| S.E(Log q) | 0.8618 | 0.4394 | 0.6661 | 0.9357 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | 0.81 | 0.538 | 5.85 | 0.48 | 11 | 0.72758 | -5.45 |
| 2 | 0.79 | 1.31 | 4.54 | 0.81 | 11 | 0.33375 | -3.78 |
| 3 | 0.65 | 2.128 | 4.04 | 0.8 | 11 | 0.37043 | -2.83 |
| 4 | 0.93 | 0.257 | 2.35 | 0.65 | 9 | 0.63031 | -2.18 |

Fleet : NIGFSOCT(0 2-gp)

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 0 |
|---|---|
| Mean Log q | -1.8146 |
| S.E(Log q) | 0.9957 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 0.53 | 3.662 | 4.53 | 0.78 | 19 | 0.40903 | -1.81 |

Fleet : ENGBTS-Sept

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 0 |
|---|---|
| Mean Log q | -4.8454 |
| S.E(Log q) | 0.7281 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 1.14 | -0.517 | 4.46 | 0.47 | 18 | 0.84579 | -4.85 |

Fleet : NIMIKNET

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 0 |
|---|---|
| Mean Log q | -5.6256 |
| S.E(Log q) | 1.2667 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 0.6 | 1.368 | 6.46 | 0.45 | 16 | 0.7359 | -5.63 |

**Table 6.2.8. Continued.**

| Year | Est.Landings | Landings | Bias |
|---|---|---|---|
| 1968 | 9779 | 8541 | |
| 1969 | 9834 | 7991 | |
| 1970 | 6831 | 6426 | |
| 1971 | 9549 | 9246 | |
| 1972 | 10710 | 9234 | |
| 1973 | 12968 | 11819 | |
| 1974 | 11955 | 10251 | |
| 1975 | 10650 | 9863 | |
| 1976 | 10557 | 10247 | |
| 1977 | 8173 | 8054 | |
| 1978 | 5556 | 6271 | |
| 1979 | 7430 | 8371 | |
| 1980 | 10534 | 10776 | |
| 1981 | 13858 | 14907 | |
| 1982 | 13503 | 13381 | |
| 1983 | 10183 | 10015 | |
| 1984 | 8274 | 8383 | |
| 1985 | 10442 | 10483 | |
| 1986 | 9819 | 9852 | |
| 1987 | 12891 | 12894 | |
| 1988 | 14166 | 14168 | |
| 1989 | 12781 | 12751 | |
| 1990 | 7400 | 7379 | |
| 1991 | 7074 | 7095 | |
| 1992 | 7715 | 7735 | |
| 1993 | 7551 | 7555 | |
| 1994 | 5404 | 5402 | |
| 1995 | 4587 | 4587 | |
| 1996 | 4962 | 4964 | |
| 1997 | 5858 | 5859 | |
| 1998 | 5309 | 5318 | |
| 1999 | 4785 | 4784 | |
| 2000 | 2438 | 1274 | 1.915 |
| 2001 | 4205 | 2252 | 1.87 |
| 2002 | 6652 | 2695 | 2.465 |
| 2003 | 4897 | 1285 | 3.793 |
| 2004 | 3548 | 1072 | 3.297 |
| 2005 | 2437 | 910 | 2.671 |
| 2006 | 2784 | 840 | 3.321 |
| 2007 | 1820 | 702 | 2.603 |
| 2008 | 1652 | 662 | 2.496 |
| 2009 | 1089 | 466 | 2.326 |
| 2010 | 1193 | 464 | 2.57 |

Parameters

| Age | Survivors | s.e log est |
|---|---|---|
| 0 | 1269.45708 | 0.36934 |
| 1 | 2078.36073 | 0.32283 |
| 2 | 158.18414 | 0.47398 |
| 3 | 13.3226 | 0.47417 |

| Year | Multiplier | s.e log est |
|---|---|---|
| 33 | 1.91498 | 0.22848 |
| 34 | 1.87004 | 0.24679 |
| 35 | 2.4651 | 0.23103 |
| 36 | 3.79283 | 0.23881 |
| 37 | 3.29676 | 0.24487 |
| 38 | 2.67081 | 0.2404 |
| 39 | 3.32085 | 0.22067 |
| 40 | 2.60328 | 0.2482 |
| 41 | 2.49643 | 0.25406 |
| 42 | 2.32638 | 0.2677 |
| 43 | 2.57018 | 0.28788 |

Variance covariance matrix

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.13641 | 0.01262 | 0.0097 | 0.00606 | 0.00921 | 0.01048 | 0.0103 | 0.0098 | 0.00943 | 0.0094 | 0.0095 | 0.01036 | 0.01093 | 0.01112 | 0.01191 |
| 0.01262 | 0.10422 | 0.01133 | 0.00761 | 0.00903 | 0.01025 | 0.01007 | 0.0096 | 0.00934 | 0.0094 | 0.0095 | 0.00957 | 0.00833 | 0.00665 | 0.02693 |
| 0.0097 | 0.01133 | 0.22466 | 0.00605 | 0.00876 | 0.00994 | 0.00976 | 0.0093 | 0.00921 | 0.0093 | 0.0094 | 0.00917 | 0.0053 | 0.01129 | -0.01148 |
| 0.00606 | 0.00761 | 0.00605 | 0.22483 | 0.00841 | 0.00952 | 0.00873 | 0.0085 | 0.009 | 0.009 | 0.0088 | 0.00714 | 0.00481 | -0.0041 | 0.00509 |
| 0.00921 | 0.00903 | 0.00876 | 0.00841 | 0.05221 | 0.01674 | 0.00794 | 0.0078 | 0.00895 | 0.0096 | 0.0097 | 0.00939 | 0.00903 | 0.00883 | 0.00889 |
| 0.01048 | 0.01025 | 0.00994 | 0.00952 | 0.01674 | 0.06091 | 0.01693 | 0.0068 | 0.00792 | 0.0101 | 0.011 | 0.01077 | 0.0103 | 0.01001 | 0.01006 |
| 0.0103 | 0.01007 | 0.00976 | 0.00873 | 0.00794 | 0.01693 | 0.05338 | 0.0178 | 0.00771 | 0.0079 | 0.0096 | 0.01029 | 0.00998 | 0.00965 | 0.00967 |
| 0.00983 | 0.0096 | 0.0093 | 0.00847 | 0.00777 | 0.0068 | 0.0178 | 0.057 | 0.01665 | 0.0072 | 0.0072 | 0.00901 | 0.00945 | 0.00936 | 0.00935 |
| 0.00943 | 0.00934 | 0.00921 | 0.009 | 0.00895 | 0.00792 | 0.00771 | 0.0167 | 0.05996 | 0.019 | 0.0062 | 0.00644 | 0.00819 | 0.00908 | 0.00932 |
| 0.00941 | 0.00942 | 0.00931 | 0.00903 | 0.00958 | 0.01007 | 0.00789 | 0.0072 | 0.019 | 0.0578 | 0.0152 | 0.00578 | 0.00612 | 0.00793 | 0.00898 |
| 0.00952 | 0.00947 | 0.00942 | 0.00883 | 0.00965 | 0.01095 | 0.00962 | 0.0072 | 0.00615 | 0.0152 | 0.0487 | 0.01732 | 0.00791 | 0.00663 | 0.00794 |
| 0.01036 | 0.00957 | 0.00917 | 0.00714 | 0.00939 | 0.01077 | 0.01029 | 0.009 | 0.00644 | 0.0058 | 0.0173 | 0.0616 | 0.02069 | 0.0071 | 0.00626 |

**Table 6.2.9. Cod in VIIa. Point estimates of population numbers-at-age from the update B-Adapt assessment. Figures for 2011 are the values assumed for a 25% reduction in F in the intermediate year.**

Population numbers (Thousands)

| YEAR | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| 1968 | 6512 | 3424 | 3710 | 1600 | 727 | 330 |
| 1969 | 8506 | 5332 | 2475 | 1640 | 420 | 467 |
| 1970 | 15131 | 6964 | 3571 | 711 | 412 | 473 |
| 1971 | 5239 | 12388 | 4516 | 1684 | 268 | 220 |
| 1972 | 13883 | 4289 | 7680 | 1891 | 574 | 269 |
| 1973 | 3107 | 11366 | 2802 | 3367 | 812 | 480 |
| 1974 | 11055 | 2544 | 7270 | 1317 | 1168 | 485 |
| 1975 | 3533 | 9051 | 1606 | 2777 | 580 | 722 |
| 1976 | 5103 | 2893 | 5881 | 740 | 1020 | 336 |
| 1977 | 5529 | 4178 | 1353 | 2135 | 282 | 500 |
| 1978 | 12082 | 4527 | 2686 | 650 | 652 | 218 |
| 1979 | 14196 | 9892 | 3087 | 1222 | 255 | 472 |
| 1980 | 7923 | 11623 | 6513 | 1376 | 459 | 196 |
| 1981 | 3461 | 6487 | 7238 | 2832 | 477 | 286 |
| 1982 | 5264 | 2833 | 4142 | 2685 | 1028 | 334 |
| 1983 | 7879 | 4310 | 2009 | 1359 | 903 | 362 |
| 1984 | 7922 | 6451 | 2796 | 813 | 444 | 437 |
| 1985 | 6350 | 6486 | 3864 | 1221 | 274 | 280 |
| 1986 | 18442 | 5199 | 4214 | 1290 | 375 | 238 |
| 1987 | 8743 | 15099 | 3380 | 1448 | 434 | 203 |
| 1988 | 3803 | 7158 | 8481 | 1170 | 438 | 182 |
| 1989 | 4904 | 3113 | 3361 | 2732 | 335 | 178 |
| 1990 | 5648 | 4015 | 2025 | 835 | 570 | 153 |
| 1991 | 8751 | 4624 | 2648 | 701 | 201 | 190 |
| 1992 | 1709 | 7165 | 2022 | 914 | 182 | 125 |
| 1993 | 5110 | 1399 | 4629 | 553 | 163 | 40 |
| 1994 | 3699 | 4184 | 945 | 1212 | 97 | 43 |
| 1995 | 3121 | 3028 | 2751 | 268 | 243 | 19 |
| 1996 | 5793 | 2555 | 2031 | 1107 | 61 | 71 |
| 1997 | 2106 | 4743 | 1806 | 672 | 285 | 44 |
| 1998 | 882 | 1724 | 3412 | 460 | 110 | 49 |
| 1999 | 5672 | 722 | 1227 | 1080 | 81 | 34 |
| 2000 | 4000 | 4644 | 529 | 260 | 121 | 13 |
| 2001 | 4668 | 3275 | 3303 | 134 | 33 | 29 |
| 2002 | 1238 | 3822 | 2112 | 1301 | 22 | 16 |
| 2003 | 2082 | 1014 | 2694 | 499 | 188 | 6 |
| 2004 | 1270 | 1704 | 676 | 728 | 97 | 39 |
| 2005 | 1468 | 1040 | 1193 | 257 | 137 | 24 |
| 2006 | 1203 | 1202 | 750 | 444 | 63 | 46 |
| 2007 | 352 | 985 | 942 | 196 | 38 | 3 |
| 2008 | 881 | 288 | 691 | 297 | 32 | 10 |
| 2009 | 3240 | 721 | 205 | 199 | 51 | 10 |
| 2010 | 1551 | 2652 | 549 | 58 | 29 | 8 |
| 2011 | 0 | 1269 | 2078 | 158 | 13 | 8 |

**Table 6.2.10. Cod in VIIa. Point estimates of fishing mortality-at-age from the update B-Adapt assessment.**

| YEAR | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5+ | F(2-4) |
| 1968 | 0 | 0.1245 | 0.6164 | 1.13692 | 1.13692 | 1.13692 | 0.963 |
| 1969 | 0 | 0.20079 | 1.04717 | 1.1811 | 1.1811 | 1.1811 | 1.136 |
| 1970 | 0 | 0.23302 | 0.55169 | 0.7749 | 0.7749 | 0.7749 | 0.700 |
| 1971 | 0 | 0.27816 | 0.67049 | 0.87669 | 0.87669 | 0.87669 | 0.808 |
| 1972 | 0 | 0.2259 | 0.62467 | 0.64557 | 0.64557 | 0.64557 | 0.639 |
| 1973 | 0 | 0.24688 | 0.55469 | 0.85845 | 0.85845 | 0.85845 | 0.757 |
| 1974 | 0 | 0.25995 | 0.76226 | 0.61958 | 0.61958 | 0.61958 | 0.667 |
| 1975 | 0 | 0.23107 | 0.5744 | 0.80211 | 0.80211 | 0.80211 | 0.726 |
| 1976 | 0 | 0.56022 | 0.81335 | 0.76423 | 0.76423 | 0.76423 | 0.781 |
| 1977 | 0 | 0.24161 | 0.53305 | 0.98629 | 0.98629 | 0.98629 | 0.835 |
| 1978 | 0 | 0.18265 | 0.58731 | 0.73405 | 0.73405 | 0.73405 | 0.685 |
| 1979 | 0 | 0.21794 | 0.60822 | 0.78036 | 0.78036 | 0.78036 | 0.723 |
| 1980 | 0 | 0.2736 | 0.63284 | 0.85897 | 0.85897 | 0.85897 | 0.784 |
| 1981 | 0 | 0.24851 | 0.79172 | 0.81347 | 0.81347 | 0.81347 | 0.806 |
| 1982 | 0 | 0.1439 | 0.91462 | 0.88982 | 0.88982 | 0.88982 | 0.898 |
| 1983 | 0 | 0.23266 | 0.70515 | 0.91805 | 0.91805 | 0.91805 | 0.847 |
| 1984 | 0 | 0.31241 | 0.62861 | 0.88556 | 0.88556 | 0.88556 | 0.800 |
| 1985 | 0 | 0.23117 | 0.89705 | 0.98131 | 0.98131 | 0.98131 | 0.953 |
| 1986 | 0 | 0.23058 | 0.86803 | 0.88948 | 0.88948 | 0.88948 | 0.882 |
| 1987 | 0 | 0.37677 | 0.86069 | 0.99513 | 0.99513 | 0.99513 | 0.950 |
| 1988 | 0 | 0.55588 | 0.93275 | 1.0518 | 1.0518 | 1.0518 | 1.012 |
| 1989 | 0 | 0.23 | 1.19212 | 1.36679 | 1.36679 | 1.36679 | 1.309 |
| 1990 | 0 | 0.21616 | 0.86141 | 1.22304 | 1.22304 | 1.22304 | 1.102 |
| 1991 | 0 | 0.62718 | 0.86353 | 1.14933 | 1.14933 | 1.14933 | 1.054 |
| 1992 | 0 | 0.23688 | 1.09733 | 1.52344 | 1.52344 | 1.52344 | 1.381 |
| 1993 | 0 | 0.19268 | 1.14022 | 1.53816 | 1.53816 | 1.53816 | 1.406 |
| 1994 | 0 | 0.21916 | 1.05845 | 1.40628 | 1.40628 | 1.40628 | 1.290 |
| 1995 | 0 | 0.19947 | 0.7104 | 1.28938 | 1.28938 | 1.28938 | 1.096 |
| 1996 | 0 | 0.1471 | 0.90539 | 1.15533 | 1.15533 | 1.15533 | 1.072 |
| 1997 | 0 | 0.12947 | 1.16694 | 1.61263 | 1.61263 | 1.61263 | 1.464 |
| 1998 | 0 | 0.13986 | 0.95008 | 1.53169 | 1.53169 | 1.53169 | 1.338 |
| 1999 | 0 | 0.11217 | 1.35273 | 1.98599 | 1.98599 | 1.98599 | 1.775 |
| 2000 | 0 | 0.14061 | 1.17177 | 1.86649 | 1.86649 | 1.86649 | 1.635 |
| 2001 | 0 | 0.23841 | 0.73186 | 1.58569 | 1.58569 | 1.58569 | 1.301 |
| 2002 | 0 | 0.14982 | 1.24391 | 1.73646 | 1.73646 | 1.73646 | 1.572 |
| 2003 | 0 | 0.20477 | 1.10817 | 1.43923 | 1.43923 | 1.43923 | 1.329 |
| 2004 | 0 | 0.15637 | 0.76897 | 1.47367 | 1.47367 | 1.47367 | 1.239 |
| 2005 | 0 | 0.12648 | 0.78969 | 1.19856 | 1.19856 | 1.19856 | 1.062 |
| 2006 | 0 | 0.04359 | 1.14253 | 2.24474 | 2.24474 | 2.24474 | 1.877 |
| 2007 | 0 | 0.15384 | 0.95559 | 1.6115 | 1.6115 | 1.6115 | 1.393 |
| 2008 | 0 | 0.14008 | 1.04754 | 1.55632 | 1.55632 | 1.55632 | 1.387 |
| 2009 | 0 | 0.07262 | 1.06343 | 1.73785 | 1.73785 | 1.73785 | 1.513 |
| 2010 | 0 | 0.0439 | 1.04425 | 1.27005 | 1.27005 | 1.27005 | 1.195 |

**Table 6.2.11. Cod in VIIa. Summary data from the update B-Adapt assessment. "B-Adapt removals" are the estimated total removals from 2000 onwards in excess of removals due to the assumed natural mortality rate.**

Summary (without SOP correction)

| Year | Recruits age 0 (thousands) | Total biomass (t) | Spawning stock biomass (t) | Input landings (t) | B-Adapt removals (t) | FBAR 2- 4 |
|---|---|---|---|---|---|---|
| 1968 | 6512 | 19351 | 13444 | 8541 | | 0.9634 |
| 1969 | 8506 | 18040 | 12241 | 7991 | | 1.1365 |
| 1970 | 15131 | 17709 | 9785 | 6426 | | 0.7005 |
| 1971 | 5239 | 23476 | 11271 | 9246 | | 0.808 |
| 1972 | 13883 | 26393 | 15873 | 9234 | | 0.6386 |
| 1973 | 3107 | 30044 | 20227 | 11819 | | 0.7572 |
| 1974 | 11055 | 27155 | 18121 | 10251 | | 0.6671 |
| 1975 | 3533 | 25060 | 17886 | 9863 | | 0.7262 |
| 1976 | 5103 | 21465 | 13647 | 10247 | | 0.7806 |
| 1977 | 5529 | 16614 | 12673 | 8054 | | 0.8352 |
| 1978 | 12082 | 14188 | 8662 | 6271 | | 0.6851 |
| 1979 | 14196 | 19638 | 10426 | 8371 | | 0.723 |
| 1980 | 7923 | 26103 | 12310 | 10776 | | 0.7836 |
| 1981 | 3461 | 29723 | 18317 | 14907 | | 0.8062 |
| 1982 | 5264 | 27025 | 20249 | 13381 | | 0.8981 |
| 1983 | 7879 | 21842 | 15260 | 10015 | | 0.8471 |
| 1984 | 7922 | 18773 | 11249 | 8383 | | 0.7999 |
| 1985 | 6350 | 21980 | 12055 | 10483 | | 0.9532 |
| 1986 | 18442 | 20979 | 12026 | 9852 | | 0.8823 |
| 1987 | 8743 | 28289 | 12995 | 12894 | | 0.9503 |
| 1988 | 3803 | 26056 | 13492 | 14168 | | 1.0121 |
| 1989 | 4904 | 21061 | 14300 | 12751 | | 1.3086 |
| 1990 | 5648 | 14540 | 8725 | 7379 | | 1.1025 |
| 1991 | 8751 | 13177 | 6531 | 7095 | | 1.0541 |
| 1992 | 1709 | 15518 | 7231 | 7735 | | 1.3814 |
| 1993 | 5110 | 12376 | 6295 | 7555 | | 1.4055 |
| 1994 | 3699 | 10460 | 5995 | 5402 | | 1.2903 |
| 1995 | 3121 | 10439 | 4575 | 4587 | | 1.0964 |
| 1996 | 5793 | 10298 | 5747 | 4964 | | 1.072 |
| 1997 | 2106 | 11796 | 5614 | 5859 | | 1.4641 |
| 1998 | 882 | 9889 | 4811 | 5318 | | 1.3378 |
| 1999 | 5672 | 6772 | 4920 | 4784 | | 1.7749 |
| 2000 | 4000 | 6647 | 2044 | 1274 | 2440 | 1.6349 |
| 2001 | 4668 | 10227 | 3252 | 2252 | 4211 | 1.3011 |
| 2002 | 1238 | 12227 | 6223 | 2695 | 6643 | 1.5723 |
| 2003 | 2082 | 8417 | 4420 | 1285 | 4874 | 1.3289 |
| 2004 | 1270 | 6970 | 4152 | 1072 | 3534 | 1.2388 |
| 2005 | 1468 | 5083 | 2700 | 910 | 2431 | 1.0623 |
| 2006 | 1203 | 4612 | 2763 | 840 | 2790 | 1.8773 |
| 2007 | 352 | 3538 | 1637 | 702 | 1827 | 1.3929 |
| 2008 | 881 | 2670 | 1733 | 662 | 1652 | 1.3867 |
| 2009 | 3240 | 2231 | 1185 | 466 | 1084 | 1.513 |
| 2010 | 1551 | 5065 | 947 | 464 | 1192 | 1.1948 |
| 2011 | | 6160* | 2260* | | | |
| Average (1968-2010) | 5651 | 15905 | 9256 | 6912 | 2971 | 1.0964 |

* = calculated from surviver point estimates

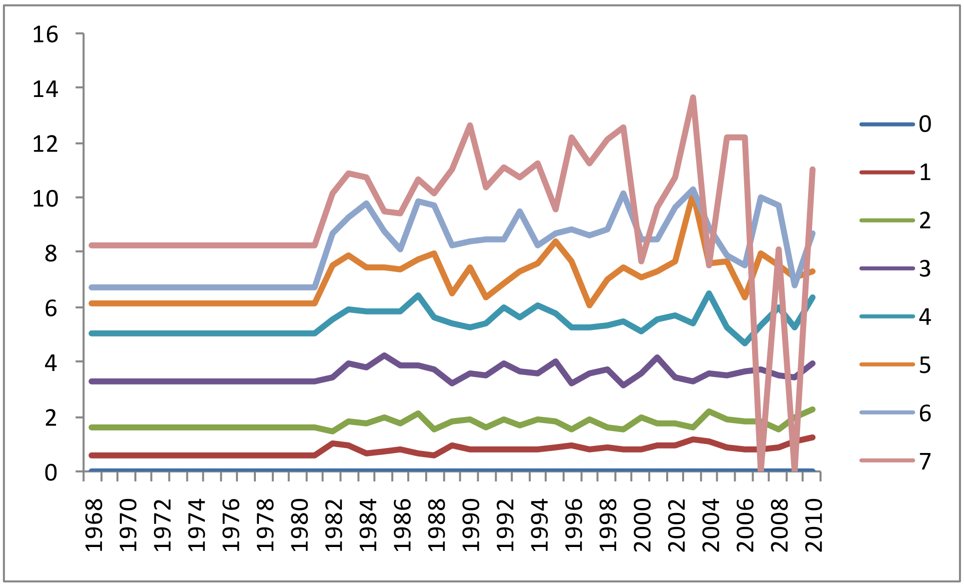



**Figure 6.2.1. Cod in VIIa. Catch weights-at-age (same as stock weights).**

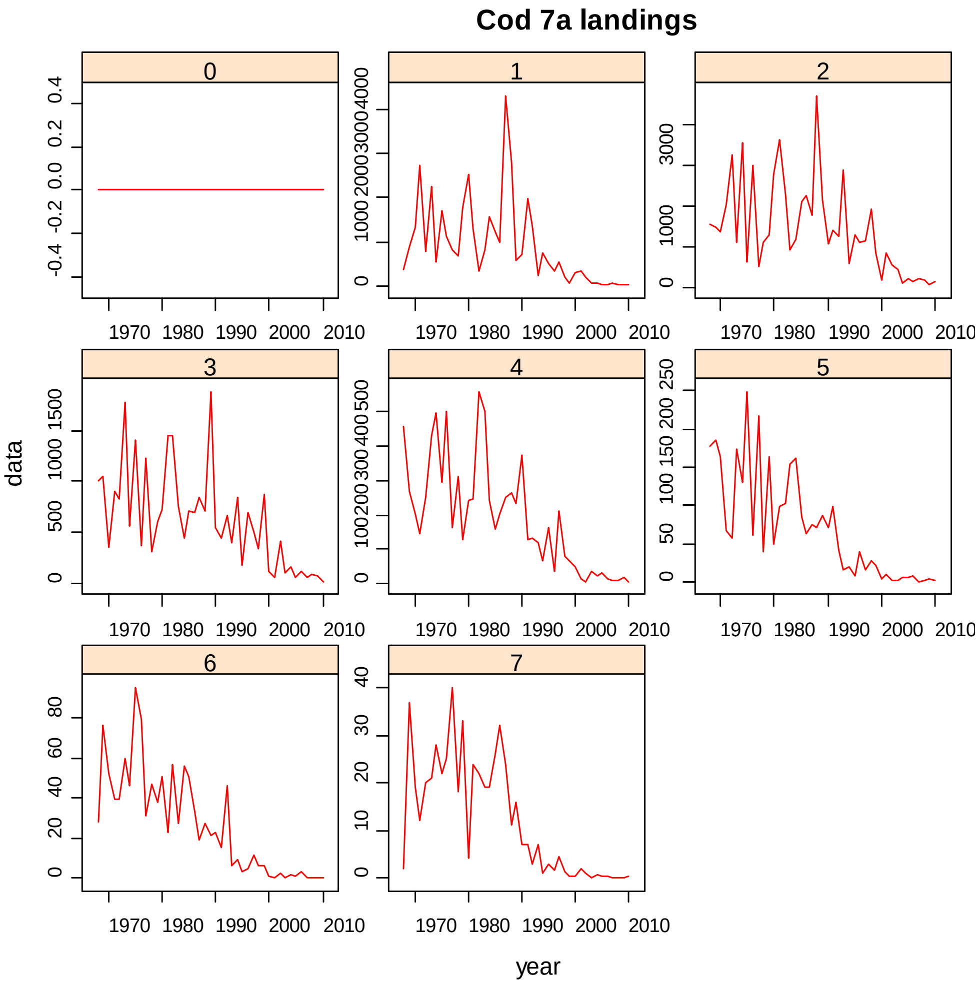



**Figure 6.2.2. Cod in VIIa. Landings number per age.**

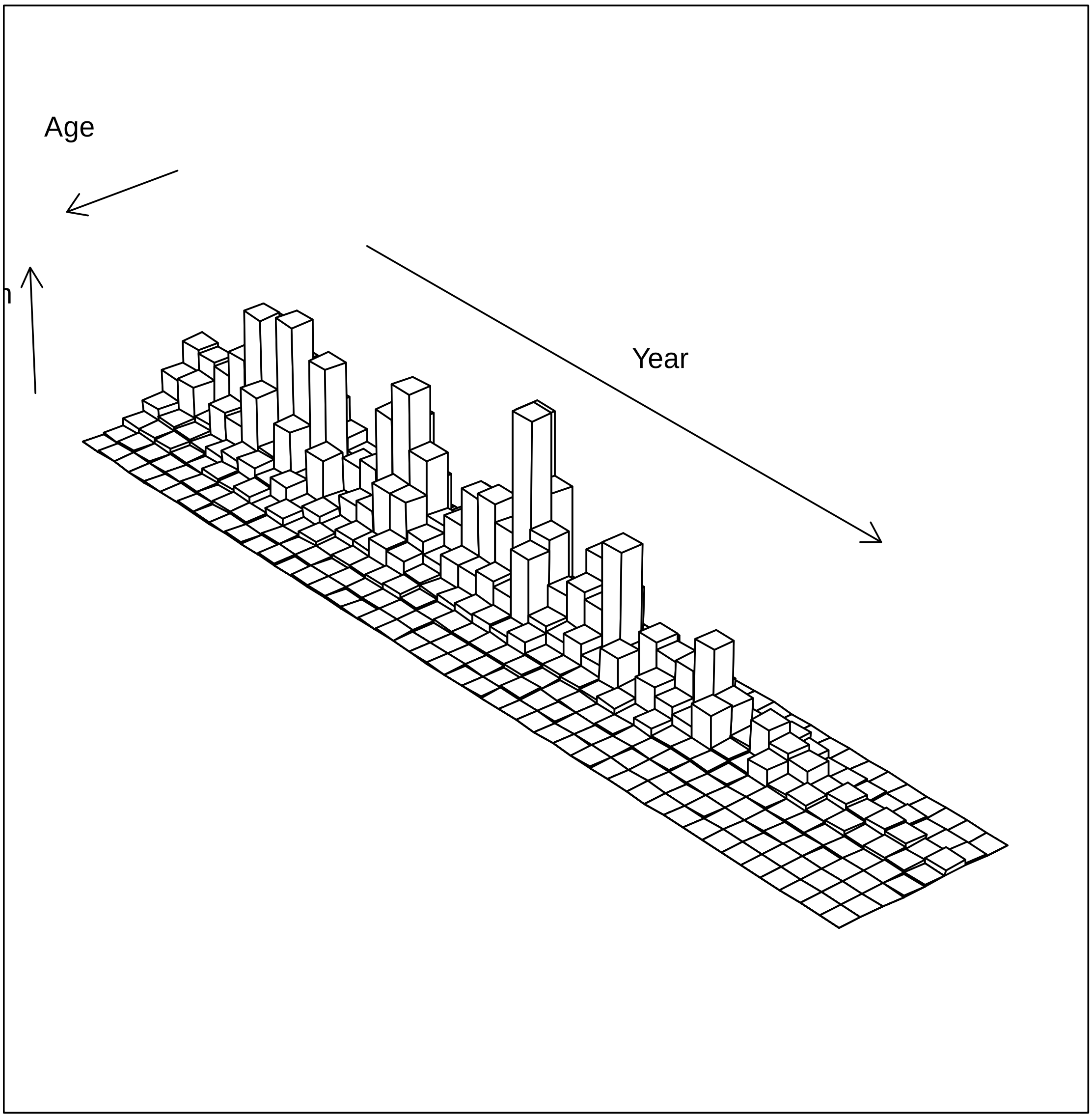



**Figure 6.2.3. Cod in VIIa. Landings per age as 3D bars.**

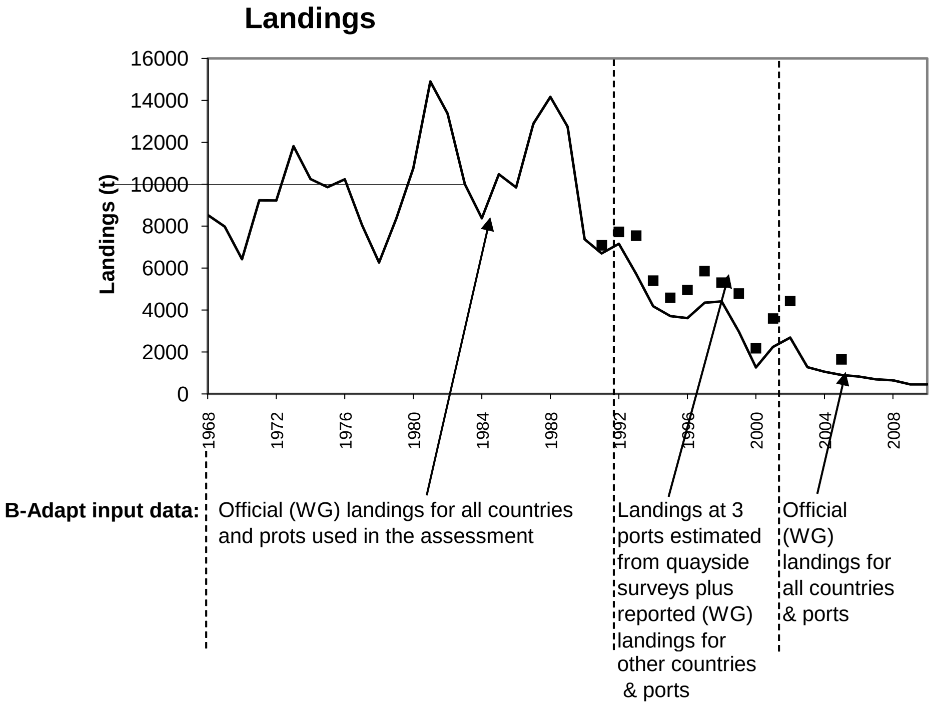



**Figure 6.2.4. Cod in VIIa. Landings data used in the B-Adapt assessment.**

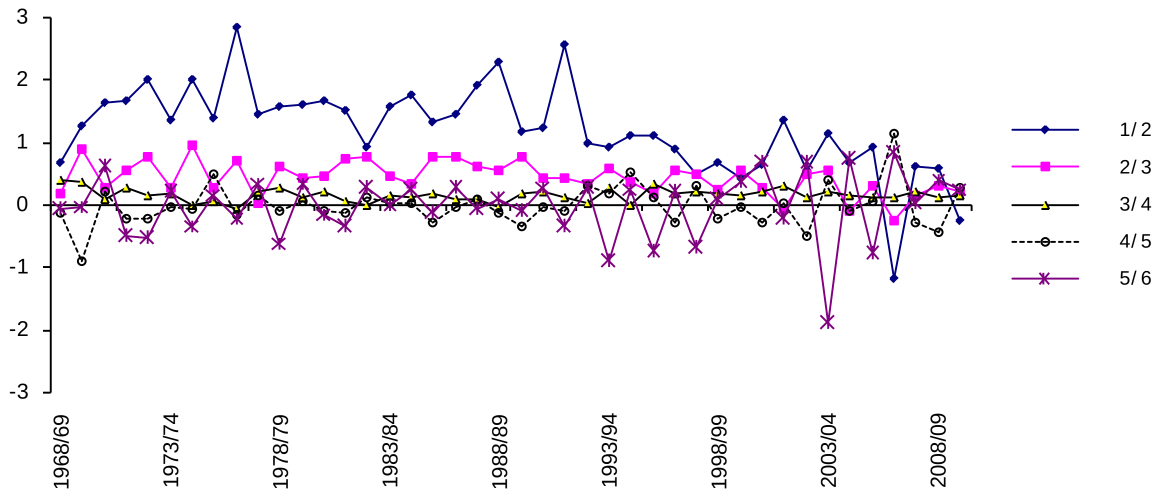
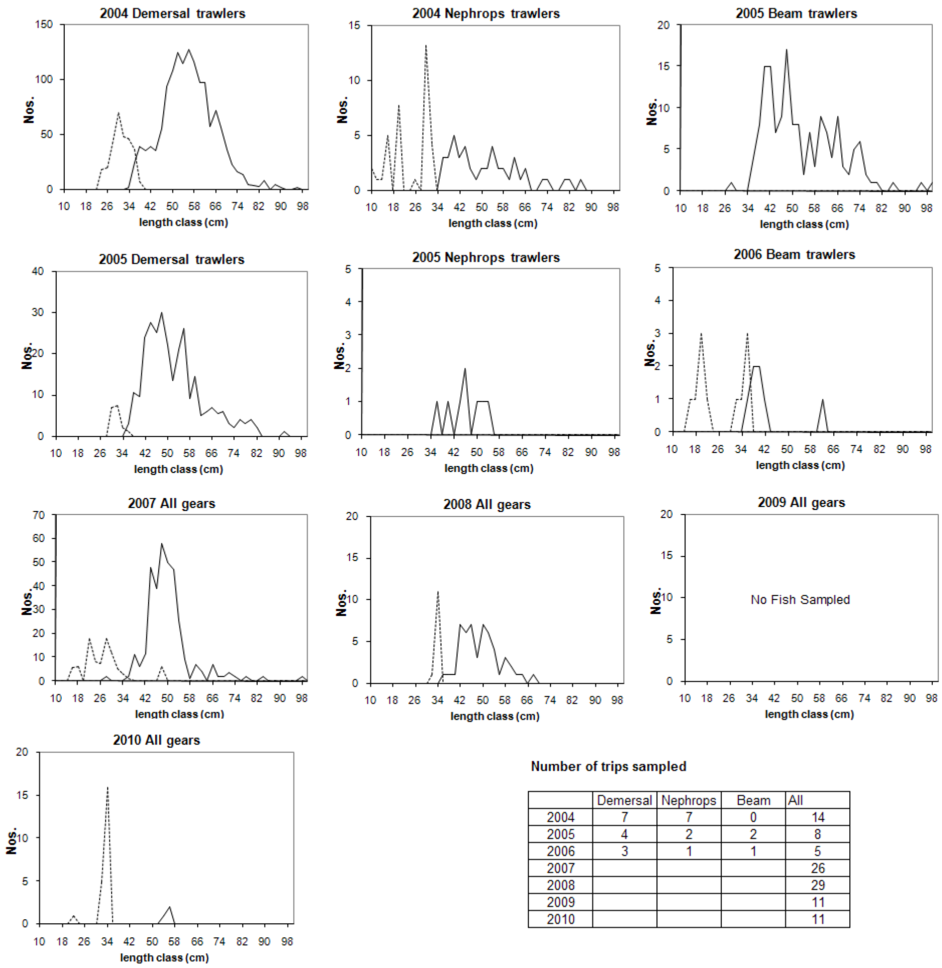



**Figure 6.2.5. Cod in VIIa. Separable VPA residuals.**




Number of trips sampled

| | Demersal | Nephrops | Beam | All |
|---|---|---|---|---|
| 2004 | 7 | 7 | 0 | 14 |
| 2005 | 4 | 2 | 2 | 8 |
| 2006 | 3 | 1 | 1 | 5 |
| 2007 | | | | 26 |
| 2008 | | | | 29 |
| 2009 | | | | 11 |
| 2010 | | | | 11 |

**Figure 6.2.6. Cod in VIIa. Length frequencies of retained and discarded cod recorded by observers on UK(E&W) fishing vessels in 2004–2010 (nos. for observed trips).**

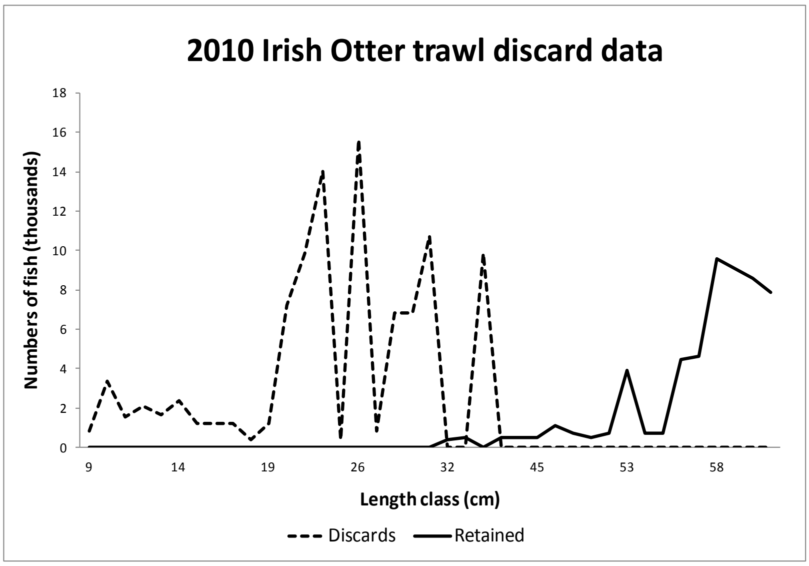



**Figure 6.2.7. Cod in VIIa. Length frequencies of retained and discarded cod recorded by observers on Irish otter trawl vessels in 2010, raised to fleet level (no. trips sampled = 4).**

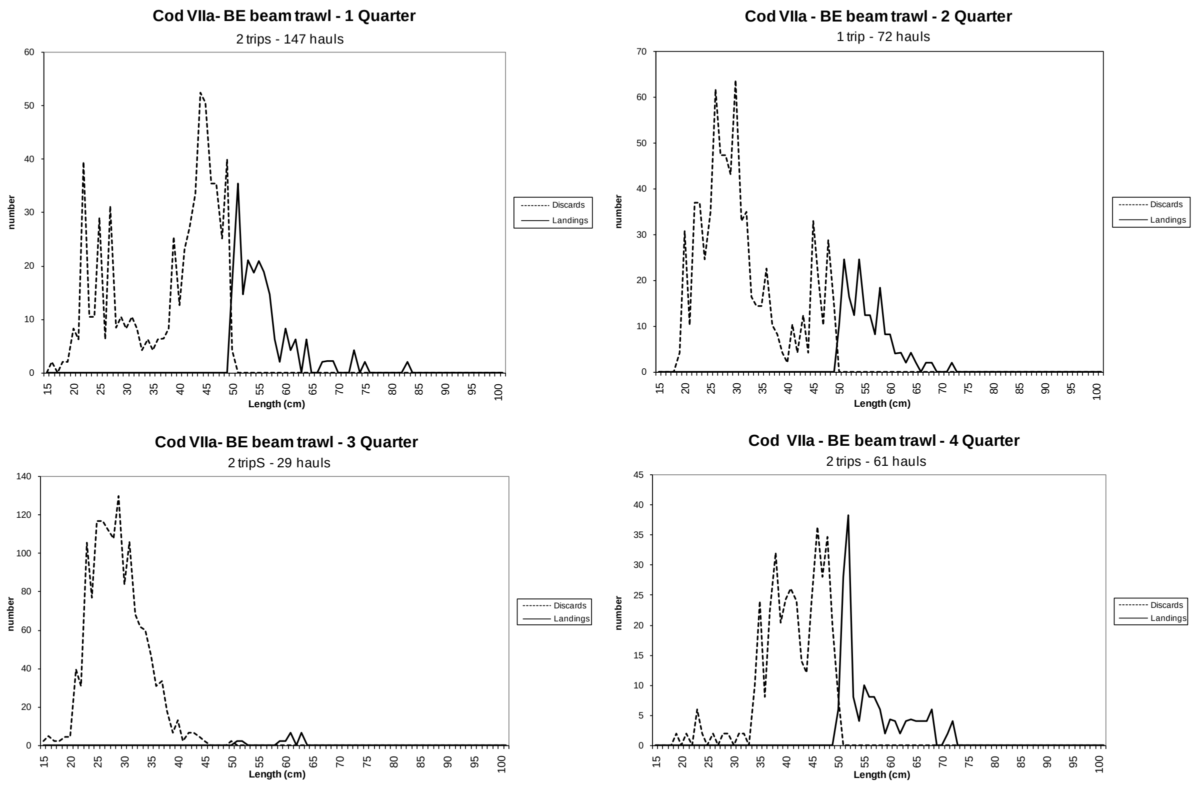



**Figure 6.2.8. Cod in VIIa. Belgian length frequencies of retained and discarded cod.**

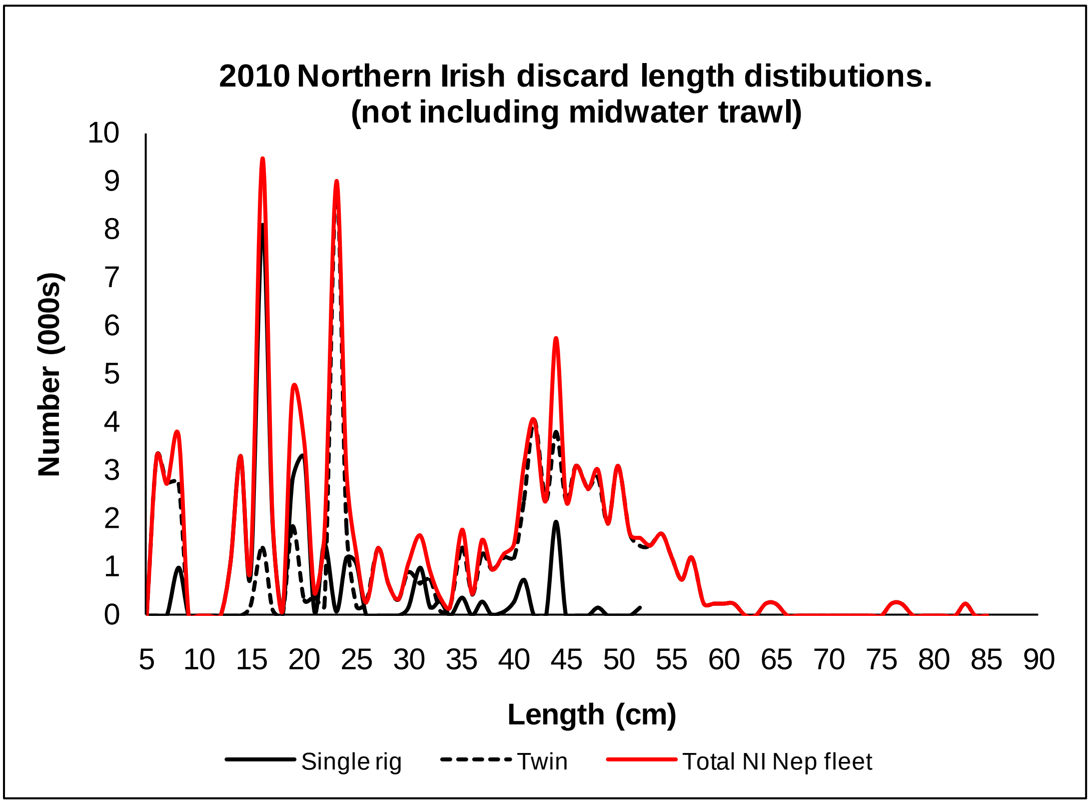



**Figure 6.2.9. Cod in VIIa. Length frequencies of discarded cod on Northern Irish Nephrops fleet (single and twin trawl).**

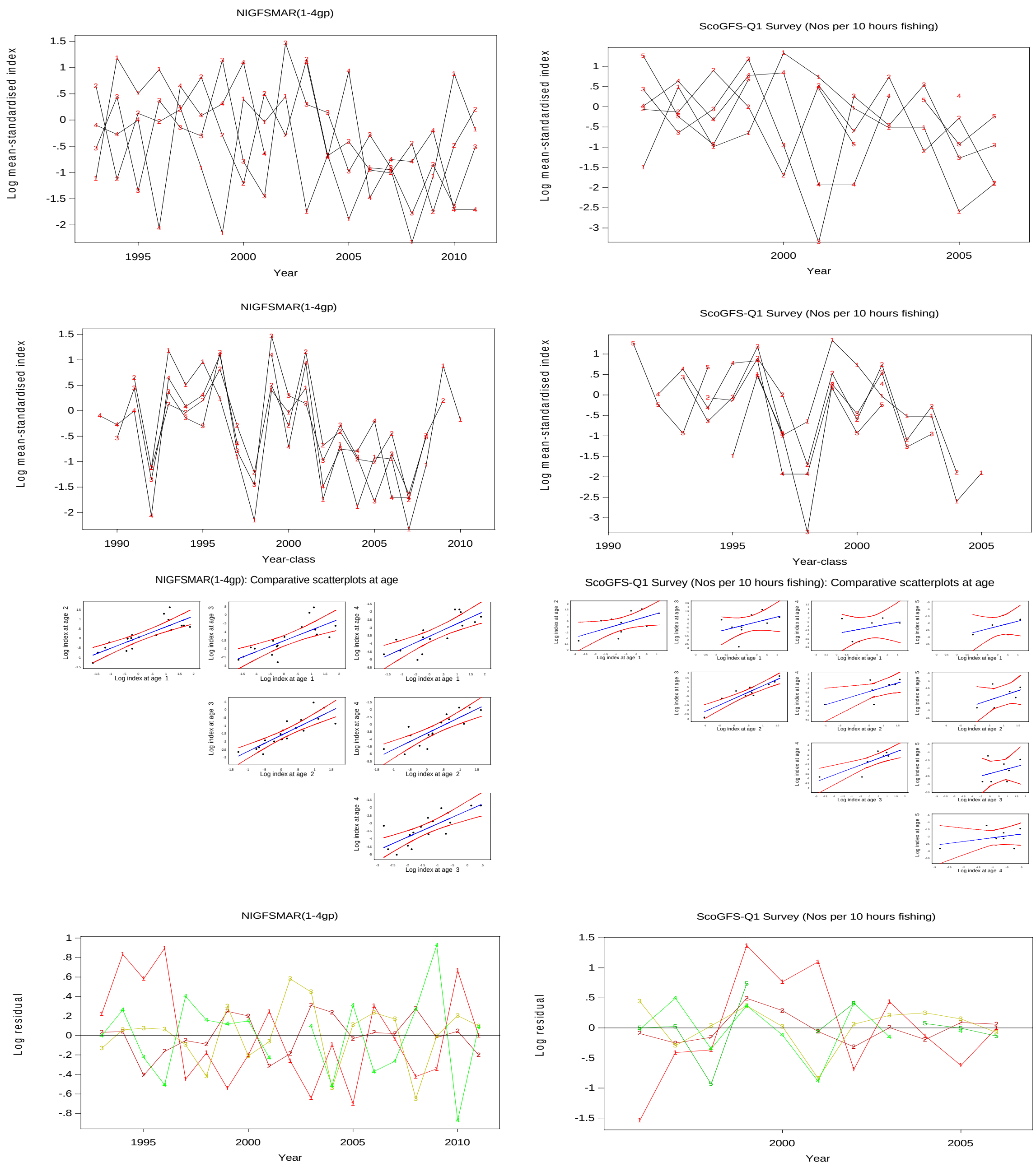



**Figure 6.2.10. Cod in VIIa. Log survey indices for NIGFS-Mar and ScoGFS-Q1 trawl surveys by year and year class; comparative scatterplots of indices within year classes, and residuals from Surba model fits.**

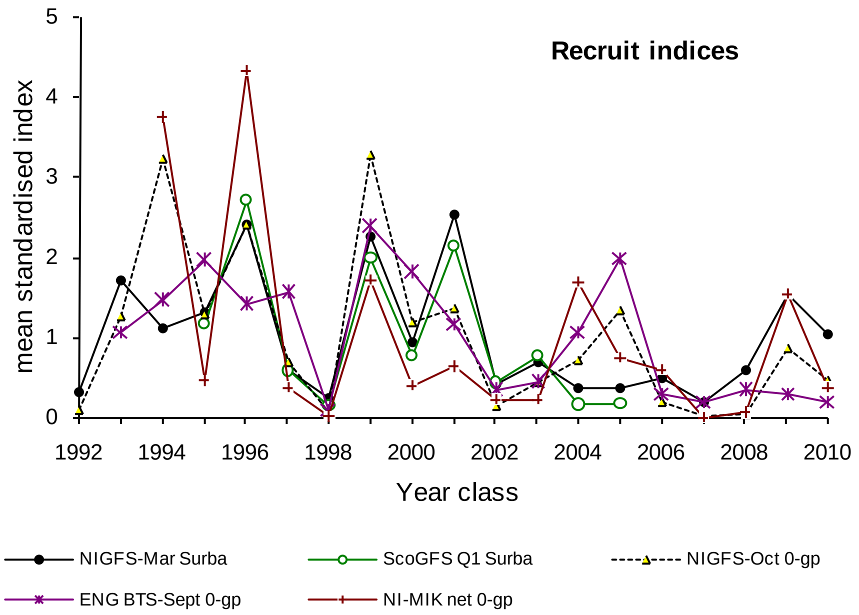



**Figure 6.2.11. Cod in VIIa. Consistency between trends in year-class strength estimated from SURBA analysis of NIGFS-Mar and ScoGFS-Q1 surveys and the other 0-gp indices used in the assessment.**

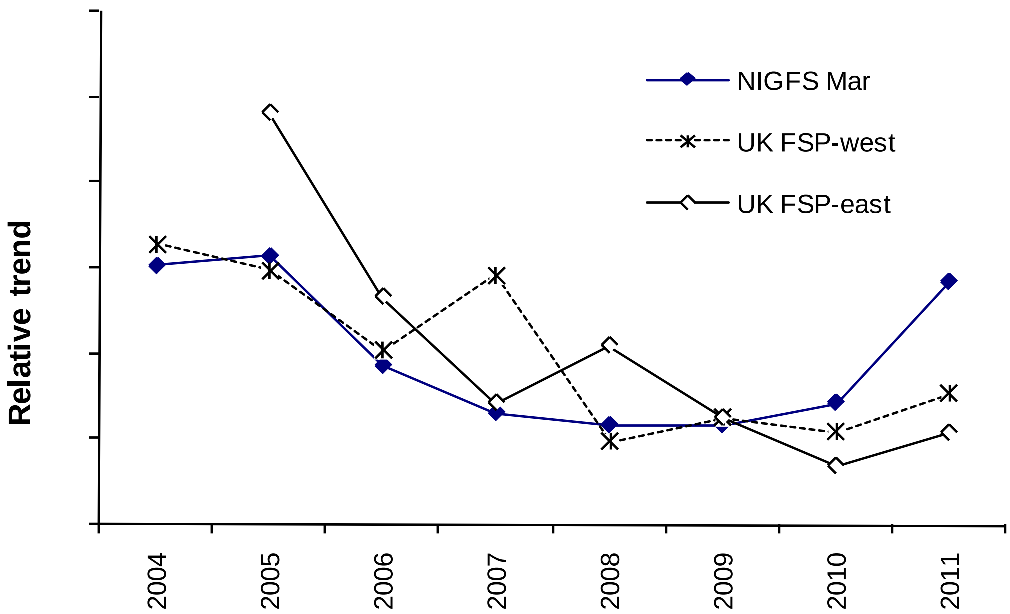



**Figure 6.2.12. Cod in VIIa. Trends in empirical SSB indices from 2004 onwards from the NIGFS-Mar compared with equivalent indices from UK Fisheries Science Partnership surveys of the western and eastern Irish Sea in February–March.**

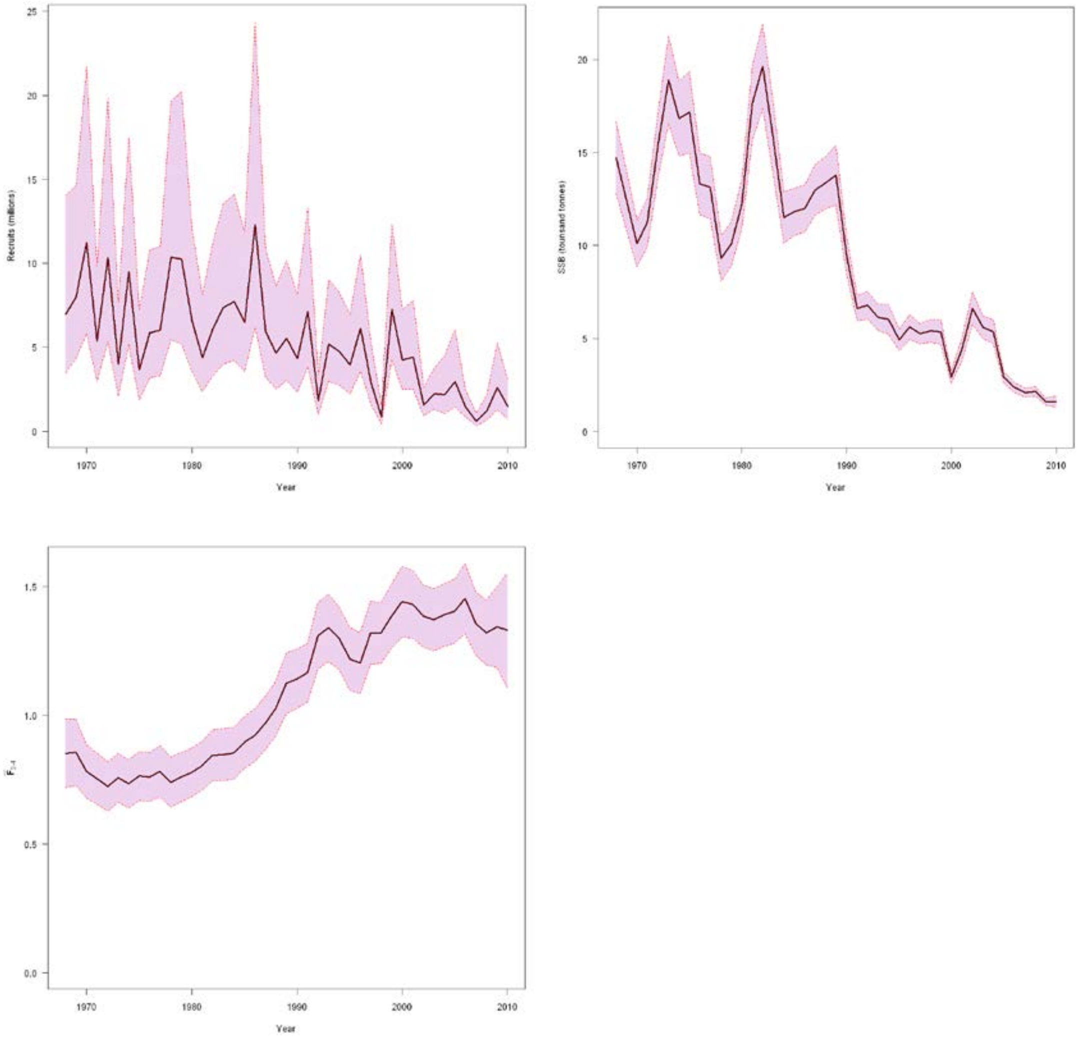



**Figure 6.2.13. SAM model estimates of recruitment (top left) spawning-stock biomass (top right) and fishing mortality (bottom left).**

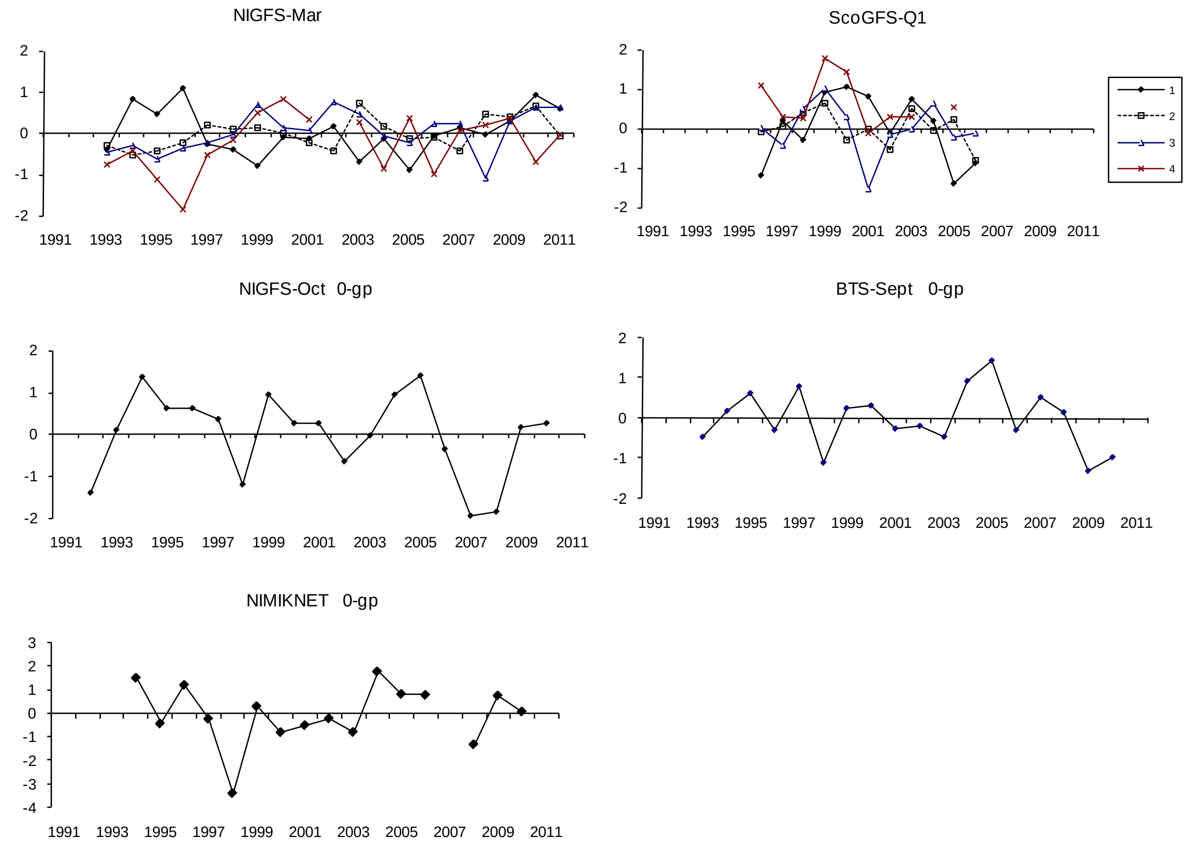



**Figure 6.2.14. Cod in VIIa: Catchability residuals from the update B-Adapt run (non-bootstrap option).**

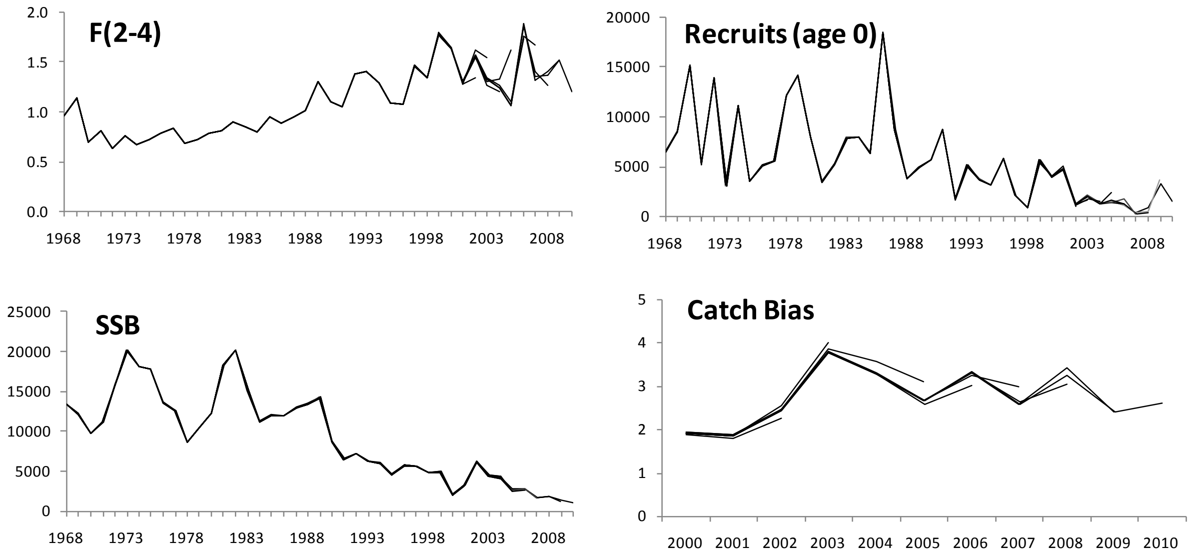



**Figure 6.2.15. Retrospective plots for B-Adapt cod assessment. All runs use the non-bootstrap option and therefore give point estimates rather than bootstrap 50th percentiles.**

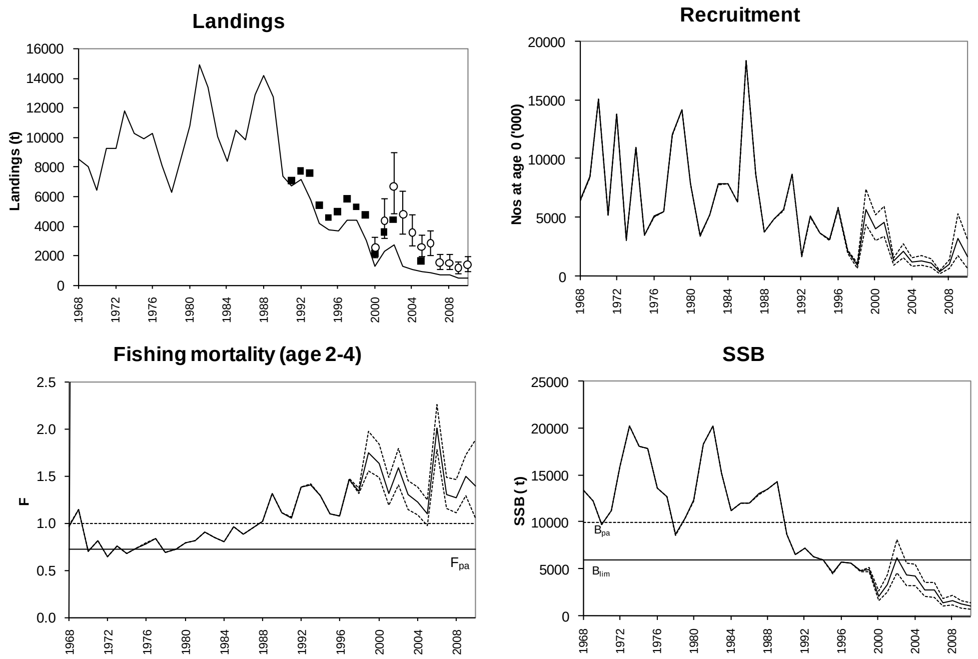



**Figure 6.2.16. Stock summary plot from update B-Adapt run. Continuous line on landings plot is the reported landings; filled squares are landings in 1991–2002 and 2005 including sample-based estimates at three ports; open circles with 90% confidence intervals are total removals estimates (in excess of assumed natural mortality) from B-Adapt. Dotted lines on plots are 5th and 95th bootstrap percentiles, with the continuous line the median value.**

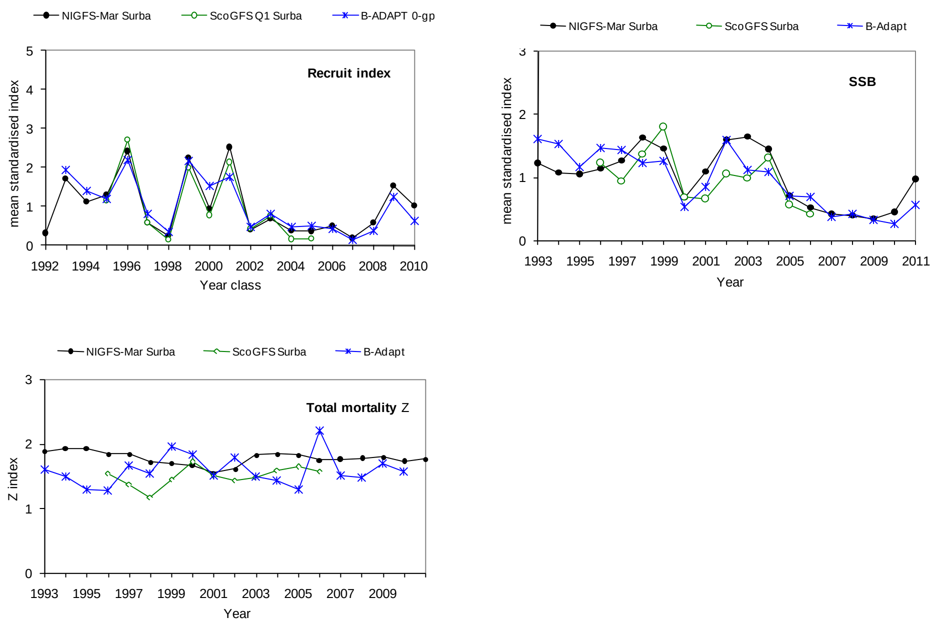



**Figure 6.2.17. Cod in VIIa: comparison of updated B-ADAPT stock trends with indices of recruitment, SSB and fishing mortality from SURBA runs with NIGFS-Mar and ScoGFS-Q1 surveys. The B-Adapt estimates of F have been increased by M=0.2 to give Z indices comparable with the SURBA values.**

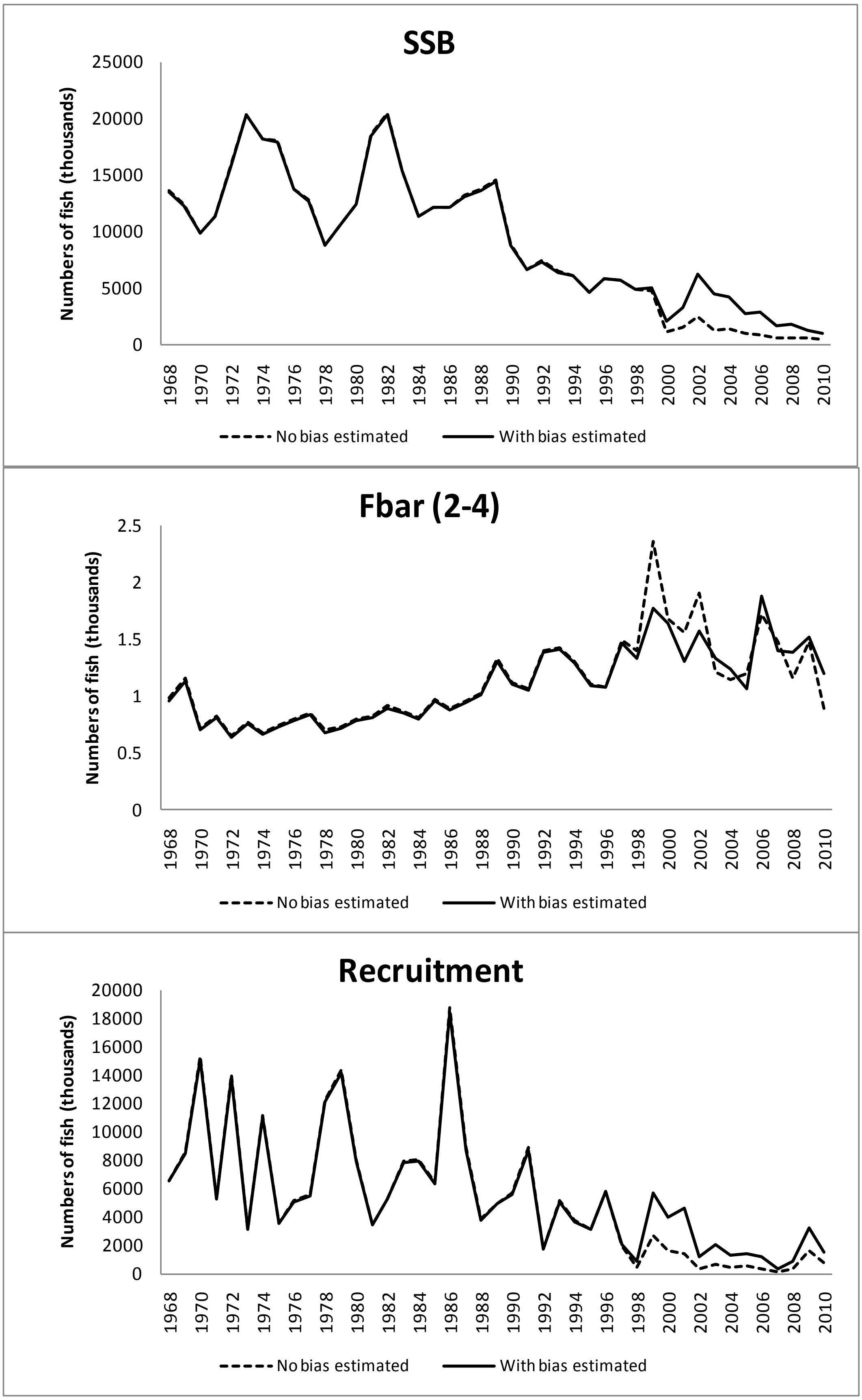



**Figure 6.2.18. Comparison plots for non-bootstrap B-Adapt cod assessments with and without the bias estimated.**

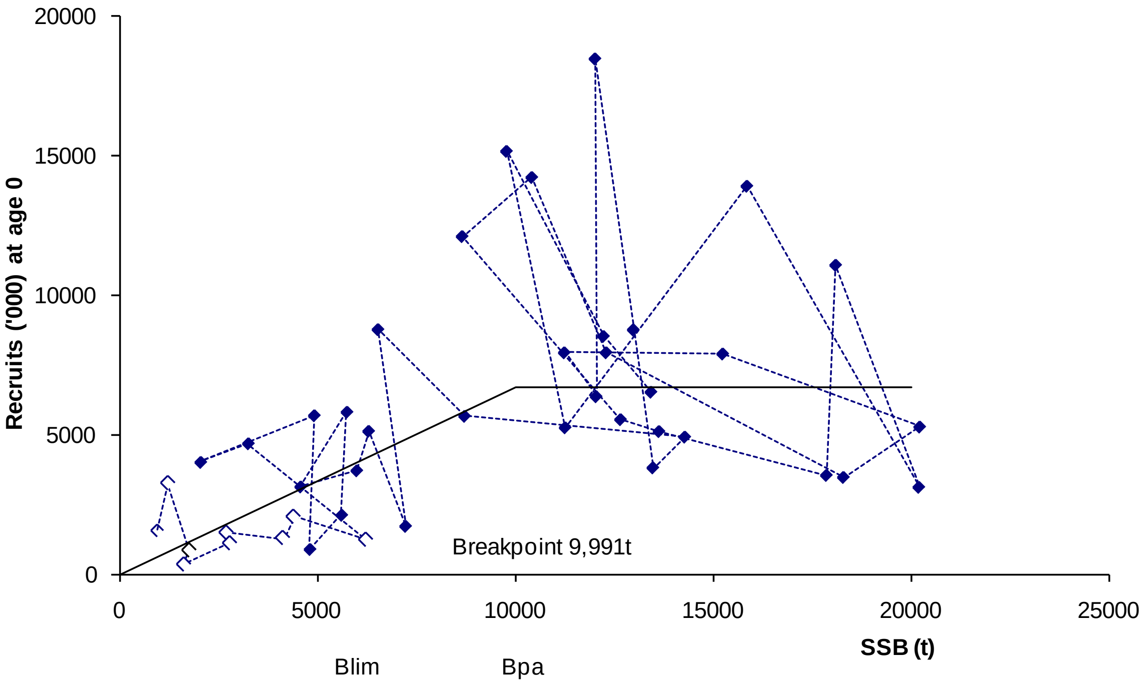



**Figure 6.2.19. Cod in VIIa. Stock–recruit data with segmented regression model fitted assuming lognormal variability of recruitment. The most recent nine year classes are indicated by open symbols.**

| Fbar(2-4) | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 0.80 | 0.00 | 0.00 |
| 0.25 | 0.92 | 0.00 | 0.00 |
| 0.5 | 1.03 | 0.00 | 0.00 |
| 0.75 | 1.17 | 0.00 | 0.00 |
| 0.95 | 1.40 | 0.00 | 0.00 |

| SSB | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 1440 | 2336 | 4958 |
| 0.25 | 1865 | 3169 | 6475 |
| 0.5 | 2220 | 3820 | 7779 |
| 0.75 | 2657 | 4544 | 9270 |
| 0.95 | 3382 | 5807 | 11676 |

| Removals | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 1512 | 0 | 0 |
| 0.25 | 2034 | 0 | 0 |
| 0.5 | 2512 | 0 | 0 |
| 0.75 | 3139 | 0 | 0 |
| 0.95 | 4078 | 0 | 0 |

| P(SSBYear > Blim) | | | |
|---|---|---|---|
| 2011 | 2012 | 2013 | 2015 |
| 0.00 | 0.04 | 0.82 | 1.00 |

| P(SSBYear > Bpa) | | | |
|---|---|---|---|
| 2011 | 2012 | 2013 | 2015 |
| 0.00 | 0.00 | 0.16 | 0.95 |

Zero F projection
25% F reduction in 2011
Recruitment used = 2002 - 2010

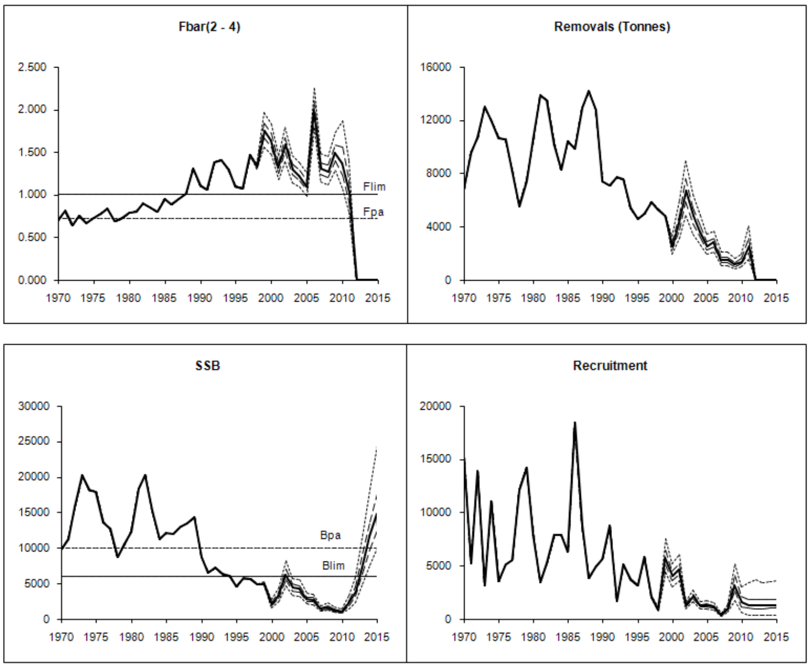



**Figure 6.2.20. Cod in VIIa. Projection to 2015 based on the update B-Adapt assessment, assuming 25% F reduction in 2011 and zero F in subsequent years. Recruitment is bootstrapped from the 2002–2010 year classes. Percentiles of F, SSB and removals, and probability of SSB>$B_{lim}$, are tabulated for selected years.**

| Fbar(2-4) | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 0.80 | 0.60 | 0.45 |
| 0.25 | 0.92 | 0.69 | 0.52 |
| 0.5 | 1.03 | 0.77 | 0.58 |
| 0.75 | 1.17 | 0.88 | 0.66 |
| 0.95 | 1.40 | 1.05 | 0.79 |

| SSB | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 1440 | 2336 | 2509 |
| 0.25 | 1865 | 3169 | 3285 |
| 0.5 | 2220 | 3820 | 4003 |
| 0.75 | 2657 | 4544 | 4868 |
| 0.95 | 3382 | 5807 | 6456 |

| Removals | Year | | |
|---|---|---|---|
| Percentile | 2011 | 2012 | 2013 |
| 0.05 | 1512 | 1596 | 1357 |
| 0.25 | 2034 | 2077 | 1742 |
| 0.5 | 2512 | 2545 | 2083 |
| 0.75 | 3139 | 2989 | 2445 |
| 0.95 | 4078 | 3742 | 3318 |

| P(SSBYear > Blim) | | | |
|---|---|---|---|
| 2011 | 2012 | 2013 | 2015 |
| 0.00 | 0.04 | 0.08 | 0.35 |

| P(SSBYear > Bpa) | | | |
|---|---|---|---|
| 2011 | 2012 | 2013 | 2015 |
| 0.00 | 0.00 | 0.00 | 0.05 |

25 % reduction in F to F=0.4
Recruitment used = 2002 - 2010

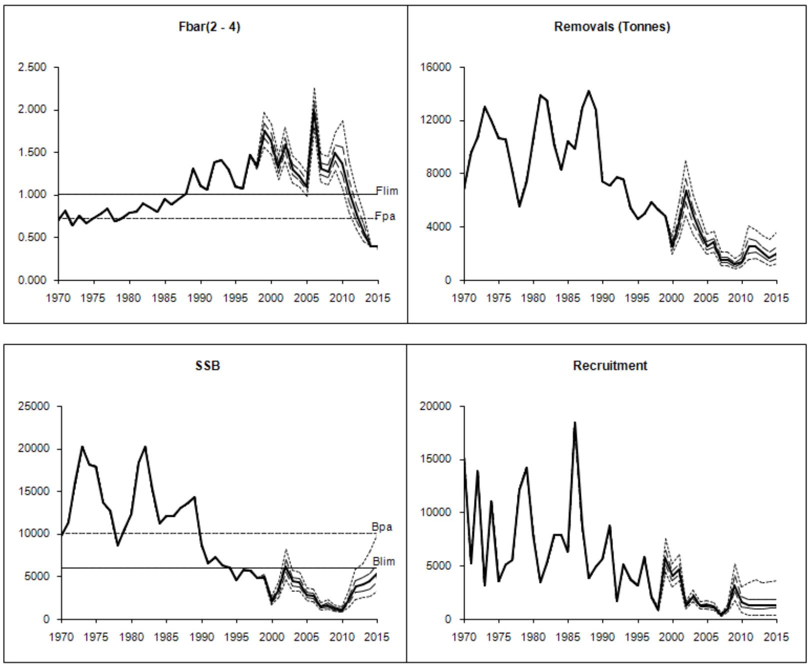



**Figure 6.2.21. Cod in VIIa. Projection to 2015 based on the update B-Adapt assessment, assuming 25% annual F reduction in 2011 until the year when median F reaches a value of 0.4. Recruitment is bootstrapped from the 2002–2010 year classes. Percentiles of F, SSB and removals, and probability of SSB>$B_{lim}$, are tabulated for selected years.**

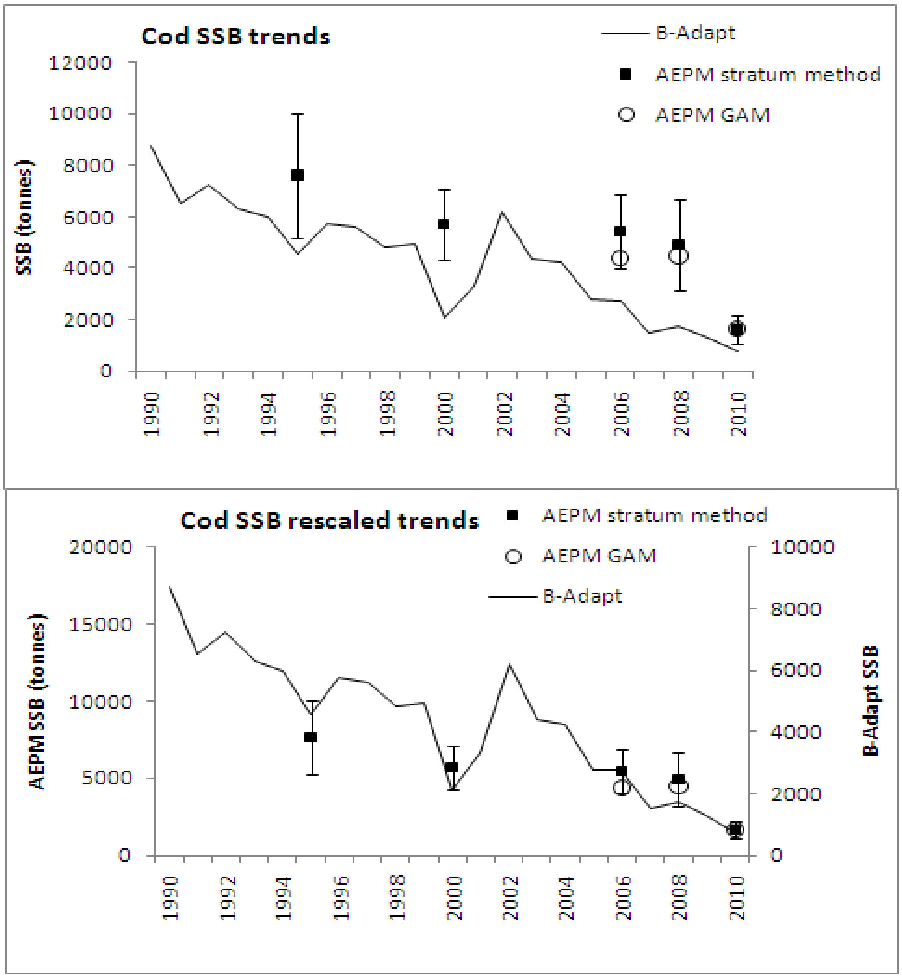



**Figure 6.2.22. Time-series of AEPM estimates of SSB for Irish Sea cod (+ 2 SE), based on stratified mean (design-based) estimates, relative to ICES estimates using the B-Adapt model (ICES, 2010). The point estimates of SSB using a GAM model for 2006, 2008 and 2010 are shown. Top plot shows the estimates on the same scale. Bottom plot has the B-Adapt and AEPM estimates re-scaled on different axes to compare the relative trends. (Reproduced from WD 9)**

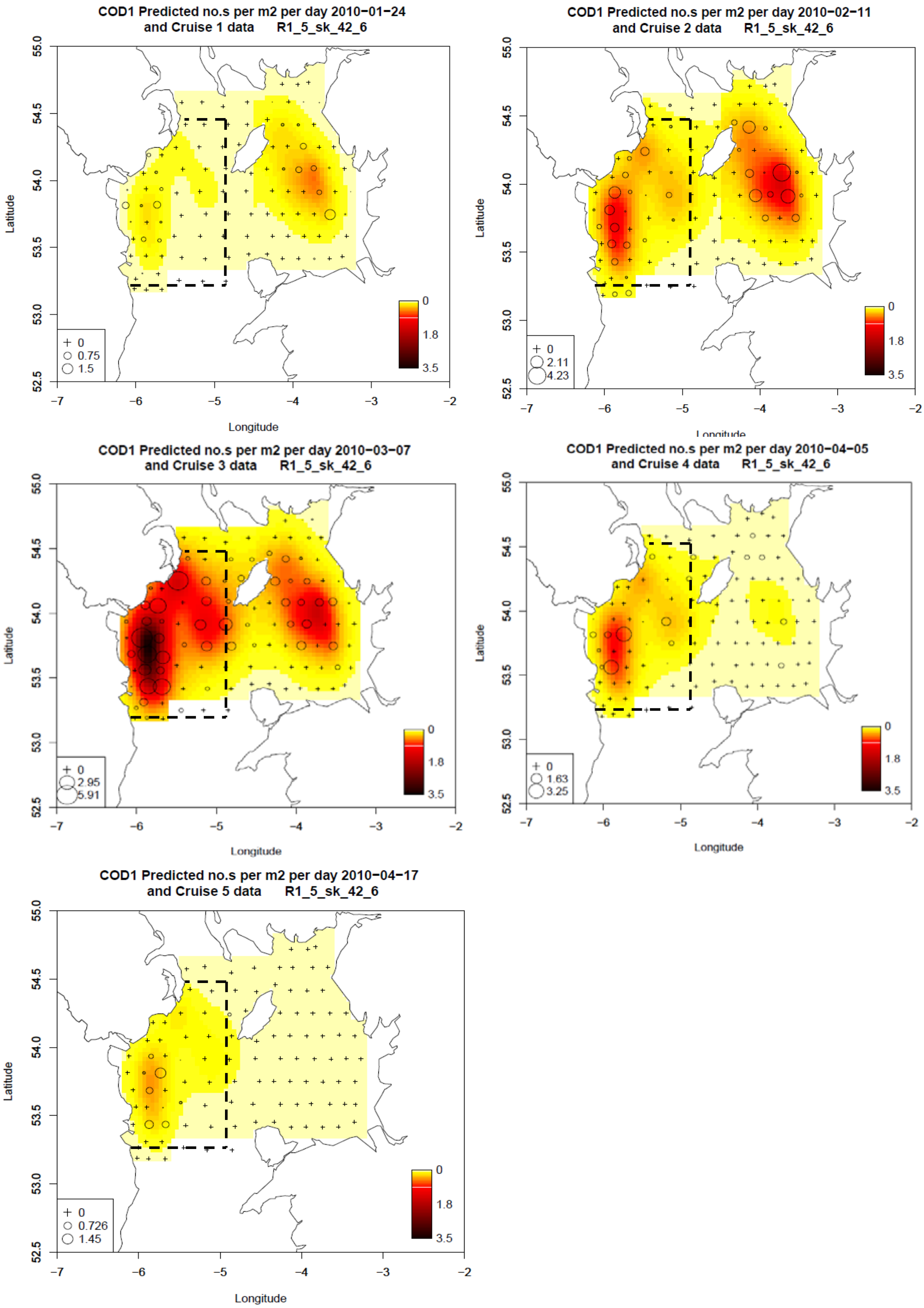



Figure 6.2.23. Annual Egg Production Method (AEPM) distribution of Stage 1 cod eggs during 2010. Station estimates of egg production given by circles, GAM predictions by contours. The dotted line gives an indication of the cod closed area. (Reproduced from WD 9).

## 6.3 Haddock in Division VIIa

### Type of assessment

The Working Group performed an update assessment for this stock in 2011.

### ICES advice applicable to 2010

*The state of the stock is uncertain. Stock trends indicate an increase in SSB over the time-series but a decrease in 2008. Recruitment in the last two years appears to be below average. Total mortality appears relatively stable. ICES advises on the basis of precautionary considerations that there should be no increase in effort relative to 2009.*

### ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Unknown | Unknown | Unknown |
| $F_{PA}$ | Unknown | Unknown | Unknown |
| | | | |
| Spawning–stock biomass (SSB) | 2008 | 2009 | 2010 |
| MSY $B_{trigger}$ | Unknown | Unknown | Unknown |
| $B_{PA}$/$B_{lim}$ | Unknown | Unknown | Unknown |

#### *MSY approach*

*SSB is fluctuating widely considering the full time-series. The underlying data do not support the provision of estimates of $F_{MSY}$. However it is likely that current F is above $F_{MSY}$ at the current selection pattern. Therefore, effort in fisheries that catch haddock should be reduced.*

*Management by TAC is inappropriate to this stock because landings-but not catches-are controlled. Management measures should be introduced in the Irish Sea to reduce discarding of small haddock in order to maximize their contribution to future yield and SSB.*

#### *PA considerations*

*There are no signs of impaired recruitment at recent catch levels. Therefore there should be no increase in effort relative to 2010.*

### 6.3.1 General

#### Stock descriptions and management units

The stock and management units are both ICES Division VIIa (Irish Sea).

#### Management applicable to 2010 and 2011

Management measures include TAC and effort restrictions as well as technical measures. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod recovery plan.

TAC regulations for 2010 and 2011 are given below:

**2010**

| Species: Haddock *Melanogrammus aeglefinus* | | Zone: VIIa (HAD/07A.) |
|---|---|---|
| Belgium | 23 | |
| France | 103 | |
| Ireland | 617 | |
| United Kingdom | 681 | |
| EU | 1 424 | |
| TAC | 1 424 | Precautionary TAC |

**2011**

| Species: Haddock *Melanogrammus aeglefinus* | | Zone: VIIa (HAD/07A.) |
|---|---|---|
| Belgium | 21 | |
| France | 95 | |
| Ireland | 570 | |
| United Kingdom | 631 | |
| EU | 1 317 | |
| TAC | 1 317 | Analytical TAC |

The minimum landing size for haddock in the Irish Sea is 30 cm.

#### Fishery in 2010

The characteristics of the fishery are described in the Stock Annex. An overview of the fisheries in the Irish Sea is given in Section 6.1.

The fishery in 2010 was prosecuted by the same fleets and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The targeted white-fish fishery that developed during the 1990 using semi-pelagic trawls, continued to decline during 2010.

The reported uptake of TAC has been poor since 2004, with the exception of 2007. The estimated percentage uptake of UK, Irish and Belgium vessels in 2010 were 88% (estimated 597 t of 681 t quota), 54% (333 t of 617 t) and 40% (9 t of 23 t), respectively. The French fleet had <2% uptake of the TAC. For these figures, quota swaps have, however, not been taken into account.

Table 6.3.1 gives nominal landings of haddock from the Irish Sea (Division VIIa) as reported by each country to ICES since 1984.

### 6.3.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1. The landings of the fleets sampled by quarter comprise 74% of the international total in 2010. No sampling information is available for some of the smaller fleets contributing to the international landings.

#### Landings

Table 6.3.2 gives the long-term trend of nominal landings of haddock from the Irish Sea (Division VIIa) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates (excl. 2003) include sampled-based estimates of landings into a number of Irish Sea ports. Sampled-based evidence suggests that WG estimates are close to reported landings since 2006.

The methods for estimating quantities and composition of haddock landings from VIIa, used in previous years, are described in the Stock Annex (Annex 6.3). The series of numbers-at-age in the international commercial landings is given in Table 6.3.3. Sampling levels were not considered adequate to derive catch age compositions in 2003. The time-series mean weight-at-age in the landings is given Table 6.3.4.

#### Discards

The series of the Irish and Northern Irish discard data, raised to the number of trips, were updated. Discard numbers-at-age for the different sampled fleets are given in Table 6.3.5. The proportions of discards-by-age for the different sampled fleets are given in Table 6.3.6. There are various issues relating to the reliability of the data, which needs to be addressed at the next benchmark assessment for this stock.

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the Stock Annex (Annex 6.3). Sampling levels have increased in recent years, but the highly variable. The very large estimates of discarding for *Nephrops* fleets observed by previous WG are still evident. Discard levels from the Irish otter trawl fleet are substantially less in 2010 compared to recent years; now of similar magnitude to the estimates from the Northern Irish otter trawl fleets.

#### Biological data

The derivation of biological parameters and variables is described in the Stock Annex Natural mortality was assumed as 0.2 for all ages and years, and proportion mature knife-edged at age 2 for all years.

There is evidence of a decline in mean length of adult haddock over time (Figure 6.3.1), which needs to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights by fitting a von Bertalanffy growth curve to all available survey estimates of mean length-at-age in March, described in the Stock Annex 6.3. The procedure was updated this year using NIGFS-WIBTS-Q1 and quarter one commercial landings data for 2010. The time-series of length–weight parameters indicate a reduction in expected weight-at-length since 1996 (see Stock Annex for historical data):

| | Length–weight parameters | | Expected weight–at–length | |
|---|---|---|---|---|
| Year | A | B | 30 cm | 40 cm |
| 2005 | 0.00489 | 3.174 | 238 | 593 |
| 2006 | 0.00506 | 3.165 | 239 | 595 |
| 2007 | 0.00469 | 3.194 | 244 | 612 |
| 2008 | 0.00523 | 3.159 | 242 | 601 |
| 2009 | 0.00431 | 3.224 | 249 | 629 |
| 2010 | 0.00413 | 3.238 | 250 | 635 |
| 2011 | 0.00457 | 3.207 | 250 | 629 |

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean $LI_{yc}$ = 79.8 cm (80.3); K = 0.189 (0. 191); $t_0$ = -0.442 ( -0. 418)

Year-class effects giving estimates of asymptotic length relative to the mean were as follows (2008 and 2009 data were combined as there is only one observation for the 2009 year class):

| Year class | Effect | Year class | Effect |
|---|---|---|---|
| 1990 | 1.215 | 2000 | 0.959 |
| 1991 | 1.153 | 2001 | 0.985 |
| 1992 | 1.085 | 2002 | 0.948 |
| 1993 | 1.098 | 2003 | 0.893 |
| 1994 | 1.112 | 2004 | 0.823 |
| 1995 | 1.085 | 2005 | 0.843 |
| 1996 | 0.998 | 2006 | 0.833 |
| 1997 | 0.974 | 2007 | 0.856 |
| 1998 | 0.986 | 2009 | 0.895 |
| 1999 | 0.940 | 2009/2010 | 0.890 |

The year-class effects show a smooth decline from the mid-1990s coincident with the rapid growth of the stock and may represent density-dependent growth effects, although other environmental factors may contribute. The close fit of the model to observed length-at-age data is shown by year class in Figure 6.3.1. The resultant stock weights-at-age are given in Table 6.3.7.

#### Surveys

The survey data considered in the assessment for this stock are given in Table 6.3.8. Survey-series for haddock available to the Working Group are described in the Stock Annex for 7a haddock. The following age-structured abundance indices were used in the assessment:

- UK (NI) groundfish survey (NIGFS) in March (age classes 1 to 5, years 1992–2011). Acronym changed from NIGFS-Mar to NIGFS-WIBTS-Q1.

Additional age-structured abundance indices, that provided auxiliary information, are available from the following sources:

- UK (NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2010). . Acronym changed from NIGFS-Oct to NIGFS-WIBTS-Q4.
- UK (NI) Methot–Isaacs–Kidd (MIK) net survey in June (age 0; years 1994–2010).
- UK Fishery Science Partnership (FSP) Irish Sea roundfish survey, 2004–2011 (www.cefas.co.uk/fsp, Amstrong *et al.*, WD11).
- UK Irish Sea Annual Egg Production Method survey (AEPM), 2006–2010 (Armstrong *et al.*, WD09).

The relative abundance indices are plotted against time in Figure 6.3.2. Surveys give similar signals for all ages (0–4). The two 0-group indices indicate decreased recruitment in 2010, with only the 2009 recruitment above average since 2007. Strong year classes were evident for all age groups in all surveys, indicating that the different surveys were capturing the prominent year-class signals in this stock (Figure 6.3.3). The strength of the 2010 year class is uncertain with the 0-gp survey indices indicating weaker recruitment than the quarter 1 survey at age 1 (Figure 6.3.3) used in the assessment. Correlation between survey indices by age is positive for all surveys and show high consistency within each fleet, but patchy consistency between the fleets (Stock Annex 6.3). The indices from the UK FSP survey ((Armstrong *et al.*, WD10) in the western Irish Sea also show similar year-class signals to the other survey-series, but are noisy with obvious year effects (Figure 6.3.2). Haddock SSB estimates derived from an annual egg production method in the Irish Sea show a similar trends as the SURBA estimates from NIGFS-WIBTS-Q1 data (Figure 6.3.4), where SSB decreased substantially in 2010 from the high 2006–2008 levels. The international landings-at-age (excl. 2003) show similar patterns of year-class variation to the surveys (Figure 6.3.2), giving confidence in the combined ability of the surveys to track year classes through time. The signal from the landings-at-age data is, however, much reduced since 2004.

The empirical trend in SSB from both the NIGFS series show the growth in SSB in the mid-1990s, a decline to 2000 and a subsequent variable trend (Figure 6.3.5). In recent years, both surveys show a marked increasing trend in SSB from 2005–2007 then a decreasing trend to 2010 (diverging considerably in 2008).

#### Commercial cpue

Commercial cpue data are available for this stock but are not currently used in the assessment.

#### Other relevant data

An IBTS-coordinated UK trawl survey started in the Irish Sea in November/December 2004. Survey index data from this survey have not yet been provided to the Working Group.

### 6.3.3 Historical stock development

#### Deviation from Stock Annex

The assessment presented is the single fleet SURBA analysis, using only the NIGFS-WIBTS-Q1 survey. The assessment does not deviate from the procedure used last year, as described in the Stock Annex.

SURBA 3.0 was used for the assessment and model settings (similar to last year's assessment) are given below:

| | WGCSE 2010 |
|---|---|
| Year range: | 1992–2011 |
| Age range: | 1–5 |
| Catchability: | 1.0 at all ages |
| Age weighting | 1.0 at all ages |
| Smoothing (Lambda): | 1.0 |
| Cohort weighting: | not applied |
| Reference age | 2 |
| Survey used | NIGFS-WIBTS-Q1 |

#### Data screening

Screening of internal and between survey consistency is described in Section 6.3.2.

#### Final update assessment

SURBA model residuals (log-population indices) for the NIGFS-WIBTS-Q1 survey show noisy residuals (Figure 6.3.6). Residuals show some evidence of year effects in older ages in some years. The age 2 residual pattern from the NIGFS-WIBTS-Q1 survey continue to show a better pattern than the other ages. The NIGFS-WIBTS-Q1 survey model show quite large retrospective patterns in SSB (Figure 6.3.6) during the early 2000s, probably related to an overestimation of the 2001 year class. There are also large retrospective patterns in mortality estimates, highlighting the difficulty in estimating mortality for this stock.

The trends in Z, SSB and recruitment for the assessment using the NIGFS-WIBTS-Q1 survey data, and the model residuals are given in Figures 6.3.7 and 6.3.8. The SURBA fitted numbers-at-age and total mortality-at-age given in Table 6.3.9. The SURBA index of Z generally follows the much noisier empirical estimates. Both the empirical and SURBA estimates of SSB give a similar increasing trend from 2005–2008 followed by in decrease since 2009. There is a slight increase in the 2011 SSB estimate following the stronger 2009 recruitment. The recruitment estimates at age 1 indicate an above average recruitment in 2009, following two years of poorer recruitment. The strength of the 2010 year class is uncertain with conflicting survey indices (Figure 6.3.3), with the survey used in the assessment estimating recruitment to be higher than the other available survey indices. In general, the SURBA results capture similar year-class dynamics than observed from the raw survey indices (Figure 6.3.2).

#### Comparison with previous assessments

The perception of the stock has not changed since last year's assessment. Figure 6.3.9 compares the relative trends between the SURBA fitted estimates from this year's to last year's assessment. The two series show similar trends. The most recent SSB estimate indicates that the stock has increased following increased recruitment in 2009decline further since last year. The relative SSB estimate for 2010 is below the series average.

#### State of the stock

Stock trends indicate an increase in SSB over the time-series. SSB trend is declining since 2008. The stock is characterized by highly variable recruitment. The model indicates above average recruitment for the 2009 year class after below average recruitment for the 2007 and 2008 year classes. Recruitment in 2010 is uncertain due to conflicting survey indices. Total mortality remains stable.

### 6.3.4 Short-term projections

No short-term forecast has been performed for this stock. This year the WG projected the SSB for 2012 using the 2011 survey information. Since maturity for the stock is considered as knife-edge at age 2, all the age classes that will comprise the 2012 SSB are already represented by the 2011 quarter one survey index. SSB for 2012 was projected using an average of the last three years total mortality from the SURBA model, a three year average of stock weights (2009–2011) and ten year geometric mean recruitment.

The projected SSB trend is illustrated in Figure 6.3.10, indicating a stabilization of the decreasing trend in SSB. SURBA fitted recruitment estimates are also compared to recruitment from the 0-gp indices (NIGF-WIBTS-Q4 and NIMIK), indicating that the model estimates might overestimate the strength of the 2007, 2008 and 2010 year classes, suggesting that the projected SSB might also be an overestimate.

### 6.3.5 MSY evaluations

MSY evaluations have been performed by the 2010 Working Group and these have not been updated. The MSY evaluations were performed on a very limited dataset. Input data were taken from the last accepted catch-at-age assessment in 2002 from the ICES network (similar input data to the yield-per-recruit analysis presented in Table 6.3.11). The analysis was performed using the srmsymc ADMB package. The evaluation was based on this historical catch-at-age data, including the underlying problems with the accuracy of the data.

The three stock–recruit relationships fitted by srmsymc are illustrated in Figure 6.3.11. The high uncertainty around these fits reflects the shortage of information within the limited dataseries to inform any stock–recruit relationship. The data are very noisy with relatively high rejection rates for the Ricker and Beverton–Holt models. Mathematically there is very little to distinguish between the three models, based on the AIC values that indicate equal fits (Table 6.3.10). F reference points are poorly defined with wide distributions and very high levels of uncertainty (cv values are high for all three models). $F_{msy}$ values falls within the range of $F_{crash}$ in all cases (Table 6.3.10).

Stock–recruit relationships are generally poorly defined for haddock stocks. These models assume a positive relationship between spawning–stock size and recruitment. However, haddock is characterized by sporadic high recruitment even at low spawning–stock levels making any relationship difficult to define. Recent trends within the Irish Sea haddock stock showed that an increase in spawning–stock biomass depends on these impulses of high recruitment, i.e. recruit–stock. Density-dependent growth is also evident by year class, which will have an effect on the overall yield of large year classes. This all makes an evaluation for the stock at equilibrium very difficult.

The Working Group is thus unable to provide absolute values for $F_{msy}$ or $F_{msy}$ proxies, as there are insufficient data to derive absolute estimates of $F_{msy}$ with any degree of precision.

There are some additional considerations in relations to exploitation levels to maximize long-term yield, which might indicate that current F might be above $F_{msy}$:

- The stock has a high growth rate with considerable growth potential. Estimates of 0-gp and 1-gp discards are high, thus any improvement in the selectivity pattern would result in increased future yield.
- The age structure is narrow and is not recovering despite a significant decrease in overall effort from the midwater pelagic fleet.

### 6.3.6 Biological reference points

#### Precautionary approach reference points

There is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period (ACFM, October 2002). ACFM (2007) proposed that $F_{pa}$ be set at 0.5 by association with other haddock stocks, however, the Working Group no longer considers an $F_{pa}$ value determined in association with other haddock stocks as appropriate. The absolute level of F in this stock at present is poorly known.

#### Yield and biomass-per-recruit

Yield-per-recruit (YPR) and SSB per recruit (SPR) for the Irish Sea stock were calculated by the 2004 WGNSDS, conditional on the exploitation pattern for landings in 2000–2002 given for ages 0 to 5+ by XSA, using MFYPR software. Long-term (1993–2003) catch weights and stock weights-at-age were used. Input data are given in Table 6.3.11, and the summary output is given in Table 6.3.12. The YPR and SPR curves are plotted in Figure 6.3.13. The deterministic output from this model is, however, highly uncertain. Figure 6.3.12 illustrates the uncertainty in the yield-per-recruit curve. Any estimate from the analysis is highly uncertain (high cv values in Table 6.3.10) implying poorly defined F reference point as well as the absolute level of yield.

### 6.3.7 Management plans

There is no specific management plan for haddock in the Irish Sea. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan (Council Regulation (EC) 1342/2008).

### 6.3.8 Uncertainties and bias in assessment and forecast

This assessment is based on survey trends only as recent levels of catch are uncertain. After a period of poor sampling of landings for length and age, the sampling levels and coverage since 2007 are adequate to allow compilation of catch-at-age data. Discard sampling levels also increased significantly in the last three years. The highly variable and very large estimates of discarding for this fleet observed by previous WG are still evident. Historical landings data for this stock are uncertain, but sample-based estimates of landings suggest that the accuracy of officially reported landings has improved substantially since 2006. The recent catch-at-age data (2003–2006) are still considered too inaccurate, due to poor sampling information, to form the basis for a traditional analytical assessment based on catch-at-age data.

The narrow age range in the haddock stock and the resulting small numbers caught at older ages in the surveys restricted the number of age classes that could be used in the model. This and the differences in catchability-at-age between surveys make the total mortality difficult to estimate. The survey data used in the assessment are quite consistent both internally and between fleets, probably due to the very large data contrast between year-class strengths as well as the restricted distribution of the stock. The recruitment pattern for this stock since the early 1990s is relatively well established and can be tracked fairly consistently through both the surveys and commercial catches. Hence it can be established with some confidence how, qualitatively, the catch and stock is likely to be impacted in the short term by recent year classes.

Knowledge of basic biology of Irish Sea haddock is expanding through data on growth, maturity and distribution obtained during trawl surveys. Patterns of movement within the Irish Sea and between the Irish Sea and surrounding areas are poorly understood, and it is assumed that the Irish Sea stock is essentially self-sustaining at present. Trends in length and weight-at-age in the stock over time are apparent and reduced growth appears to have coincided with the growth of the stock. This may represent density-dependent growth effects (although other environmental factors may contribute) that will affect any forecast and lead to overoptimistic forecast estimates unless correctly predicted.

The projected survey estimate of biomass should only be used for interpreting trends rather than a relative estimate. F/Z is poorly estimated and currently unknown. The problem is with using Z-M as a proxy for F in the SURBA-based assessment, when total mortality from the model is poorly defined. The SURBA Z-values are only a relative measure and do not mean anything unless the catchability-at-age in the survey(s) are quantified. The SURBA Z-values cannot be taken as an absolute, which makes effort based management very difficult, especially measured against a non-stock specific reference point.

The Annual Egg Production (AEMP) survey estimates of haddock SSB confirm the trend in SSB from the assessment. The absolute estimates in 2006 and 2008 (8.8 kt and 9.4 with CV of 32% and 24%, respectively) are very large compared to the WG landings of 650 and 870 t for these years. Even when discard estimates at age 2+ are taken into account the total catch estimates are ~1000–1200 t (from raised discard estimates by fleet Table 6.3.5 and stock weights) during this period. This would imply a much lower mortality than given by the age profile in the groundfish surveys (which indicate Z of around 1.5). There is, however, no evidence from any fishery data for an age composition that would reflect low mortality. The AEMP estimate for 2010 is in contrast to the 2006 and 2008 estimates, substantially lower at 870 t (CV of 26%) corresponding to landing of 940 t and catch estimates of ~1100 t.

The additional recruitment survey indices indicate low recruitment in the last year, which is in conflict with the above average recruitment indicated by the survey based assessment. The NIGFS-WIBTS-Q4 survey has good internal consistency (see Stock Annex) and both 0-gp indices appear to indicate relative year-class strength well historically (Figure 6.3.2 and 6.3.3).

The perception of the stock from this year’s assessment does not differ qualitatively from that obtained last year.

### 6.3.9 Recommendations for next benchmark assessment

The primary concern with this stock is that recent catch-at-age data are considered inaccurate to form the basis for a traditional analytical assessment based on catch-at-age data. This has been attributed to poor sampling information, which has improved in the last two years. The absence of reliable discard estimates is also serious deficiency that must be addressed if management is to be based on catch-at-age analysis. Levels of discard sampling have increased substantially in the last three years and reliable discards-at-age matrix could be formulated over the next few years.

The problems in terms of generating reliable catch-at-age numbers for this stock are not likely to be solved in the short term. Furthermore, with the sharp decline in whitefish directed effort in the Irish Sea, sampling opportunities for haddock from landings, are not likely to improve.

Given the availability of data other than those used in the survey assessment (other survey data; egg production estimates; discards data) there is an urgent need for a data compilation workshop and benchmark assessment for this stock to establish a more comprehensive evidence base and a robust quantitative procedure for developing management advice. Benchmarking alongside the haddock VIIb–k stock would be beneficial.

### 6.3.10 Management considerations

Following decades of very low recruitment and biomass as indicated by very low fishery catches, this stock grew substantially in the 1990s following sudden pulses of recruitment, and has gone from a minor bycatch species to one of the most economically valuable target species in the Irish Sea. Since the mid-1990s the haddock population in the Irish Sea is experiencing one of the largest and most sustained period of growth. The recruitment signals are clearly revealed by surveys, but the steep age profile in the catches and the resultant dependence of the fishery on highly variable recent year classes means that catch and SSB forecasts will be uncertain. The prevention of directed fishing for haddock during the cod closures in 2000–2011, other than during limited fishing experiments, should have curtailed the directed fisheries on mature haddock that occur in spring.

EU has adopted a long-term plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). The long-term management plan for cod implemented in the Irish Sea from 2008 will affect catches of species caught in related fisheries, including haddock. The current directed fishery for haddock in the Irish Sea is likely to generate bycatches of cod in the same area.

Sampling schemes since the 1990s have shown high rates of discarding of haddock less than three years old and variable discarding of 3-year-olds in fisheries using 70–89 mm mesh nets. Samples from whitefish vessels since the introduction of 100+ mm mesh and other recent technical measures are too few to form a basis for evaluation of discards in that fleet. Discard rates could be reduced by using more selective fishing gears in the small mesh fisheries. The decline in growth rate might also result in discarding occurring at progressively older ages. However, any measures to reduce discards will result in increased future yield.

Current TAC management measures are not responsive enough considering the dynamic nature of changes in stock abundance. Under the assumption of constant effort, the increase in abundance from 2005–2008, created increased catch opportunities. During this period the TAC remained relatively constant and resulted in increased discarding of older fish (particularly in 2007). The TAC for 2009 was increased based on the increasing trend of stock abundance, despite evidence of weaker recruitment and possible decreasing abundance.

Landings data have not been used in the assessment. Landings data for this stock are uncertain because of species misreporting, which has been estimated from quayside observations in one country only. Restrictive quotas for some countries caused extensive misreporting during the 1990s prior to the introduction of a separate TAC allocation for the Irish Sea. Estimates of misreporting have been included in the estimates of landings, except for 2003. The recent implementation of buyers and sellers legislation has improved the quality of the landings data since 2006.

**Table 6.3.1. Nominal landings (t) of HADDOCK in Division VIIa, 1984–2010, as officially reported to ICES. (Working Group figures are given in Table 6.3.2).**

| Country | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 3 | 4 | 5 | 10 | 12 | 4 | 4 | 1 | 8 | 18 |
| France | 38 | 31 | 39 | 50 | 47 | n/a | n/a | n/a | 73 | 41 |
| Ireland | 199 | 341 | 275 | 797 | 363 | 215 | 80 | 254 | 251 | 252 |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| UK (England & Wales)[1] | 29 | 28 | 22 | 41 | 74 | 252 | 177 | 204 | 244 | 260 |
| UK (Isle of Man) | 2 | 5 | 4 | 3 | 3 | 3 | 5 | 14 | 13 | 19 |
| UK (N. Ireland) | 38 | 215 | 358 | 230 | 196 | … | … | … | … | … |
| UK (Scotland) | 78 | 104 | 23 | 156 | 52 | 86 | 316 | 143 | 114 | 140 |
| Total | 387 | 728 | 726 | 1,287 | 747 | 560 | 582 | 616 | 703 | 730 |

| Country | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 22 | 32 | 34 | 55 | 104 | 53 | 22 | 68 | 44 | 20 |
| France | 22 | 58 | 105 | 74 | 86 | n/a | 49 | 184 | 72 | 146 |
| Ireland | 246 | 320 | 798 | 1,005 | 1,699 | 759 | 1,238 | 652 | 401 | 229 |
| Netherlands | - | - | 1 | 14 | 10 | 5 | 2 | - | - | - |
| UK (England & Wales)[1] | 301 | 294 | 463 | 717 | 1,023 | 1,479 | 1,061 | 1,238 | 551 | 248 |
| UK (Isle of Man) | 24 | 27 | 38 | 9 | 13 | 7 | 19 | 1 | - | - |
| UK (N. Ireland) | … | … | … | … | … | … | … | … | … | … |
| UK (Scotland) | 66 | 110 | 14 | 51 | 80 | 67 | 56 | 86 | 47 | 31 |
| Total | 681 | 841 | 1,453 | 1,925 | 3,015 | 2,370 | 2,447 | 2,229 | 1,115 | 674 |

| Country | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Belgium | 15 | 22 | 23 | 30 | 15 | 7 | 9* |
| France | 20 | 36 | 20 | 11 | 6 | 3 | 2* |
| Ireland | 296 | 139 | 184 | 477 | 319 | 388 | 333* |
| Netherlands | - | - | | - | - | - | - |
| UK (England & Wales)[1] | 421 | 344 | 419 | 559 | 521 | 446 | |
| UK (Isle of Man) | - | - | - | - | 1 | 1 | |
| UK (N. Ireland) | … | … | … | … | … | … | |
| UK (Scotland) | 9 | 6 | 9 | 1 | 17 | 1 | |
| United Kingdom | | | | | | | 591* |
| Total | 761 | 547 | 655 | 1078 | 879 | 846 | 936* |

***Preliminary.**

**[1]1989–2010 Northern Ireland included with England and Wales.**

**n/a = not available.**

**Table 6.3.2. Haddock in VIIa. Total international landings of haddock from the Irish Sea, 1972–2010, as officially reported to ICES. Working Group figures, assuming 1972–1992 official landings to be correct, are also given. The 1993–2005 WG estimates include sampled-based estimates of landings at a number of Irish Sea ports. Sample-based evidence confirms more accurate catch reporting since 2006. Landings in tonnes live weight.**

| Year | Official landings | WG landings |
|---|---|---|
| 1972 | 2204 | 2204 |
| 1973 | 2169 | 2169 |
| 1974 | 683 | 683 |
| 1975 | 276 | 276 |
| 1976 | 345 | 345 |
| 1977 | 188 | 188 |
| 1978 | 131 | 131 |
| 1979 | 146 | 146 |
| 1980 | 418 | 418 |
| 1981 | 445 | 445 |
| 1982 | 303 | 303 |
| 1983 | 299 | 299 |
| 1984 | 387 | 387 |
| 1985 | 728 | 728 |
| 1986 | 726 | 726 |
| 1987 | 1287 | 1287 |
| 1988 | 747 | 747 |
| 1989 | 560 | 560 |
| 1990 | 582 | 582 |
| 1991 | 616 | 616 |
| 1992 | 703 | 656 |
| 1993 | 730 | 813 |
| 1994 | 681 | 1043 |
| 1995 | 841 | 1753 |
| 1996 | 1453 | 3023 |
| 1997 | 1925 | 3391 |
| 1998 | 3015 | 4902 |
| 1999 | 2370 | 4129 |
| 2000 | 2447 | 1380 |
| 2001 | 2229 | 2498 |
| 2002 | 1115 | 1972 |
| 2003 | 674 | n/a |
| 2004 | 761 | 1278 |
| 2005 | 547 | 699 |
| 2006 | 655 | 647 |
| 2007 | 1078 | 1066 |
| 2008 | 879 | 872 |
| 2009 | 846 | 843 |
| 2010 | n/a | 942 |

**Table 6.3.3. Haddock in VIIa: Catch numbers-at-age (=landings number-at-age; no discard data included).**

| | Table 1 Landings numbers-at-age | | | | | Numbers*10**-3 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| | AGE | | | | | | | | | | | | | | | | | | |
| 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | n/a | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | | 94 | 30 | 1341 | 109 | 1285 | 100 | 91 | 459 | 597 | 120 | n/a | 54 | 38 | 7 | 13 | 111 | 93 | 18 |
| 2 | | 1250 | 123 | 1322 | 4619 | 700 | 6427 | 519 | 915 | 2263 | 632 | n/a | 203 | 523 | 340 | 918 | 391 | 590 | 365 |
| 3 | | 18 | 861 | 107 | 735 | 2411 | 292 | 4462 | 238 | 1116 | 1853 | n/a | 751 | 133 | 631 | 695 | 802 | 686 | 484 |
| 4 | | 1 | 3 | 222 | 16 | 203 | 539 | 49 | 374 | 80 | 196 | n/a | 76 | 219 | 74 | 141 | 239 | 185 | 524 |
| | +gp | 1 | 2 | 5 | 30 | 16 | 35 | 72 | 28 | 127 | 28 | n/a | 97 | 43 | 78 | 52 | 67 | 56 | 115 |
| 0 | TOTALNUM | 1364 | 1019 | 2997 | 5509 | 4615 | 7393 | 5193 | 2014 | 4183 | 2829 | n/a | 1181 | 956 | 1130 | 1819 | 1610 | 1610 | 1506 |
| | TONSLAND | 813 | 1043 | 1753 | 3023 | 3391 | 4902 | 4129 | 1380 | 2498 | 1971 | n/a | 1278 | 699 | 647 | 1066 | 872 | 843 | 942 |
| | SOPCOF % | 100 | 100 | 100 | 100 | 95 | 100 | 100 | 97 | 100 | 100 | n/a | 100 | 99 | 100 | 100 | 100 | 100 | 100 |

**Table 6.3.4. Haddock in VIIa: catch weights-at-age (=landings weight-at-age; no discard data included.**

| Catch weights-at-age (kg) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003* | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| | AGE | | | | | | | | | | | | | | | | | | |
| 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | | 0.351 | 0.346 | 0.361 | 0.346 | 0.348 | 0.19 | 0.325 | 0.329 | 0.3 | 0.279 | 0.367 | 0.401 | 0.273 | 0.244 | 0.240 | 0.300 | 0.306 | 0.327 |
| 2 | | 0.596 | 0.56 | 0.545 | 0.474 | 0.592 | 0.53 | 0.416 | 0.474 | 0.452 | 0.357 | 0.411 | 0.519 | 0.417 | 0.354 | 0.440 | 0.377 | 0.427 | 0.399 |
| 3 | | 1.688 | 1.103 | 0.898 | 0.917 | 1.002 | 1.13 | 0.802 | 0.786 | 0.859 | 0.749 | 0.700 | 1.007 | 0.697 | 0.505 | 0.638 | 0.534 | 0.507 | 0.534 |
| 4 | | 2.52 | 2.73 | 1.983 | 2.034 | 1.349 | 2 | 2.064 | 1.573 | 1.243 | 1.361 | 1.098 | 1.940 | 1.256 | 0.872 | 0.786 | 0.743 | 0.779 | 0.728 |
| | +gp | 2.52 | 2.522 | 2.178 | 2.682 | 1.955 | 2.55 | 2.854 | 2.365 | 1.869 | 2.107 | 1.789 | 2.544 | 2.268 | 1.841 | 1.987 | 1.261 | 1.266 | 1.304 |
| 0 | SOPCOFAC | 0.9995 | 1.0008 | 1.0007 | 1.0029 | 0.9465 | 0.9958 | 0.9996 | 0.9675 | 1.0002 | 0.9991 | | | | | | | | |

***calculated from average (1993–2002) catch weight–stock weight ratio by age (see Section 9.3 WGNSDS 2004).**

**Table 6.3.5. Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2010. Data are numbers ('000 fish) discarded by the fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Tables (b) and (d) represent estimates from limited observer sampling of N.Ireland vessels also included within the self-sampling estimates for N.Ireland trawlers catching *Nephrops* (Table (a)). Table (f) is the total for sampled fleets and quarters, excluding missing quarters or fleets. Table (e) is the revised figures supplied to the 2005 WG.**

a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching *Nephrops* (single and twin trawl)

| | 1996 Q1-4 | 1997 Q1-4 | 1998 Q1-4 | 1999 Q1-4 | 2000 Q1-4 | 2001 Q1-4 | 2002 Q1-4 | 2003 Q1 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 43 trips | 39 trips | 48 trips | 39 trips | 44 trips | 43 trips | 35 trips | 8 trips | | | | | | | |
| 0 | 4485 | 100 | 1552 | 1274 | 110 | 1083 | 851 | 0 | n/a | n/a | n/a | n/a | | | |
| 1 | 229 | 1209 | 318 | 342 | 2384 | 140 | 1073 | 62 | n/a | n/a | n/a | n/a | | | |
| 2 | 179 | 88 | 210 | 69 | 253 | 199 | 37 | 28 | n/a | n/a | n/a | n/a | | | |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | n/a | n/a | n/a | n/a | | | |

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only) (*not raised to fleet level – no. of fish)

| | | | | 1999 Q3-4 | 2000 Q1-3 | 2001 Q1 | | | | | 2006 Q3-4* | 2007 Q1-4 | 2008 Q1-4 | 2009 Q1-4 | 2010 Q1-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | | | | 4 trips | 6 trips | 1 trip | | | | | 9 trips | 29 trips | 55 trips | 30 trips | 36 trips |
| 0 | | | | 2185 | 210 | 0 | | | | | 8391 | 901 | 625 | 1609 | 924 |
| 1 | | | | 22 | 280 | 1677 | | | | | 809 | 1553 | 295 | 284 | 763 |
| 2 | | | | 0 | 57 | 1593 | | | | | 60 | 681 | 124 | 101 | 16 |
| 3 | | | | 0 | 0 | 0 | | | | | 15 | 74 | 16 | 23 | 1 |
| 4 | | | | 0 | 0 | 0 | | | | | 0 | 0 | 1 | 0 | 0 |

(c) Observer scheme: N.Ireland midwater trawl

| | | 1997 Q2-4 | 1998 Q1-3 | 1999 Q3-4 | 2000 Q1 | 2001 Q1 | | | | | | | 2008 Q4 | 2009 Q2 | 2010 Q1,2,4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | | n/a | n/a | 5 trips | 4 trips | 2 trips | | | | | | | 1 trip | 1 trip | 3 trip |
| 0 | | 0 | 0 | 68 | 0 | 0 | | | | | | | 0 | 0 | 0 |
| 1 | | 178 | 316 | 96 | 20 | 0.4 | | | | | | | 7 | 1 | 33 |
| 2 | | 19 | 1342 | 35 | 83 | 19 | | | | | | | 15 | 39 | 28 |
| 3 | | 4 | 0 | 2 | 5 | 0 | | | | | | | 2 | 19 | 4 |

(d) Observer scheme: N.Ireland twin trawl (*not raised to fleet level – no. of fish)

| | | 1997 Q2-4 | 1998 Q1-3 | 1999 Q4 | 2000 Q1-4 | 2001 Q1 | | | | | 2006 Q3-4* | 2007 Q1-4 | 2008 Q1-4 | 2009 Q1-4 | 2010 Q1-4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | | n/a | n/a | 1 trips | 10 trips | 2 trips | | | | | 2 trip | 14 trips | 16 trips | 18 trips | 21 trips |
| 0 | | 34 | 4 | 26 | 10 | 0 | | | | | 363 | 369 | 676 | 3219 | 493 |
| 1 | | 284 | 205 | 3 | 13 | 3 | | | | | 59 | 275 | 183 | 315 | 1849 |
| 2 | | 6 | 382 | 0 | 10 | 19 | | | | | 9 | 77 | 70 | 600 | 277 |
| 3 | | 0.5 | 0 | 0 | 0 | 0 | | | | | 0 | 9 | 6 | 200 | 39 |
| 4 | | 0 | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 | 1 | 3 |

**Table 6.3.5. (Cont.) Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2009.**

(e) Observer scheme: Republic of Ireland otter trawlers

| | **1996 Q1-4** | **1997 Q1-4** | **1998 Q1-4** | **1999 Q1-4** | **2000 Q1-4** | **2001 Q1-4** | **2002 Q1-4** | **2003 Q1-4** | **2004 Q1-4** | **2005 Q1-4** | **2006 Q1-4** | **2007 Q1-4** | **2008 Q1-4** | **2009 Q1-4** | **2010 Q1-4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 8 trips | 8 trips | 7 trips | 4 trips | 10 trips | 2 trips | 1 trip | 9 trips | 11 trips | 8 trips | 5 trips | 16 trips | 18 trips | 18 trips | 4 trips |
| 0 | 3808 | 165 | 565 | 87 | 182 | 5349 | 47 | 1169 | 5663 | 776 | 3966 | 1122 | 322 | 5759 | 233 |
| 1 | 713 | 11396 | 1973 | 58 | 2193 | 7354 | 31 | 1747 | 6566 | 2350 | 10140 | 8735 | 1226 | 5654 | 374 |
| 2 | 297 | 303 | 3564 | 59 | 580 | 140 | 0 | 1178 | 2301 | 996 | 3856 | 3995 | 783 | 334 | 105 |
| 3 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 10 | 225 | 120 | 132 | 435 | 44 | 72 | 57 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |

(f) Observer scheme: Republic of Ireland GEAR TECH otter trawlers (using grids)

| | **2010** |
|---|---|
| Age | 9 trips |
| 0 | 43 |
| 1 | 125 |
| 2 | 43 |
| 3 | 26 |
| 4 | 1 |

(g) Total for sampled fleets and quarters: NI self sampling scheme (a); NI midwater trawl (c); ROI otter trawl (e)

| | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 51 trips | n/a | n/a | 48 trips | 58 trips | 47 trips | 36 trips | 17 trips | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 0 | 8293 | 265 | 2117 | 1429 | 292 | 47 | 36 | 17 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 1 | 942 | 12783 | 2607 | 496 | 4597 | 6432 | 898 | 1169 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 2 | 476 | 410 | 5116 | 163 | 916 | 7494 | 1104 | 1809 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 3 | 0 | 4 | 0 | 2 | 5 | 358 | 37 | 1206 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| 4 | 0 | 0 | 0 | 0 | 0 | 15 | 11 | 10 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |

**Table 6.3.6. Haddock in VIIa: Proportion by number-at-age discarded by sampled fleets.**

| | | Proportion discarded | | | |
|---|---|---|---|---|---|
| Fleet | Period | age 0 | age 1 | age 2 | age 3 |
| Midwater trawl | Q2-Q4 1997 | | 0.93 | 0.37 | 0.02 |
| Midwater trawl | Q1-Q3 1998 | | 0.99 | 0.16 | 0.00 |
| Midwater trawl | Q3-Q4 1999 | 1.00 | 0.79 | 0.31 | 0.00 |
| Midwater trawl | Q1 2000 | | 1.00 | 0.44 | 0.04 |
| Midwater trawl | Q1 2001 | | 1.00 | 0.30 | |
| Midwater trawl | Q4 2008 | 1.00 | 0.97 | 0.90 | 0.30 |
| Midwater trawl | Q2 2009 | | - | 0.44 | 0.14 |
| Midwater trawl | Q1-2,4 2010 | 1.00 | 0.92 | 0.22 | 0.03 |
| Single Nephrops | Q3-Q4 1999 | 1.00 | 0.94 | | |
| Single Nephrops | Q1-Q3 2000 | 1.00 | 0.97 | 0.45 | |
| Single Nephrops | Q1 2001 | | 1.00 | 0.49 | |
| Single Nephrops | Q3-Q4 2006 | 1.00 | 1.00 | 0.96 | 0.50 |
| Single Nephrops | Q1-Q4 2007 | 1.00 | 1.00 | 0.94 | 0.79 |
| Single Nephrops | Q1-Q4 2008 | 1.00 | 0.99 | 0.78 | 0.18 |
| Single Nephrops | Q1-Q4 2009 | 1.00 | 1.00 | 0.88 | 0.46 |
| Single Nephrops | Q1-Q4 2010 | 1.00 | 1.00 | 0.96 | 0.68 |
| Twin trawl | Q2-Q4 1997 | 1.00 | 1.00 | 0.61 | 0.04 |
| Twin trawl | Q1-Q3 1998 | 1.00 | 1.00 | 0.76 | 0.00 |
| Twin trawl | Q4 1999 | 1.00 | 1.00 | | |
| Twin trawl | Q1 – Q4 2000 | 1.00 | 0.96 | 0.28 | |
| Twin trawl | Q1 2001 | | 1.00 | 0.12 | |
| Twin trawl | Q3-Q4 2006 | 1.00 | 1.00 | 0.81 | 0.00 |
| Twin trawl | Q1-Q4 2007 | 1.00 | 1.00 | 0.91 | 0.63 |
| Twin trawl | Q1-Q4 2008 | 1.00 | 0.95 | 0.50 | 0.05 |
| Twin trawl | Q1-Q4 2009 | 1.00 | 0.99 | 0.95 | 0.75 |
| Twin trawl | Q1-Q4 2010 | 1.00 | 1.00 | 0.85 | 0.42 |
| OTB | Q1-Q4 2007 | 1.00 | 1.00 | 0.93 | 0.65 |
| OTB | Q1-Q4 2008 | 1.00 | 0.97 | 0.90 | 0.17 |
| OTB | Q1-Q4 2009 | 1.00 | 1.00 | 0.62 | 0.24 |
| OTB | Q1-Q4 2010 | 1.00 | 0.99 | 0.59 | 0.29 |

**Table 6.3.7. Haddock in VIIa: stock weights-at-age.**

Table 3 Stock weights-at-age (kg)

| YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.097 | 0.085 | 0.087 | 0.085 | 0.072 | 0.061 | 0.058 | 0.049 | 0.053 | 0.057 | 0.051 | 0.042 | 0.032 | 0.035 | 0.034 | 0.038 | 0.043 | 0.042 | 0.041 |
| 2 | 0.429 | 0.344 | 0.354 | 0.367 | 0.363 | 0.258 | 0.229 | 0.233 | 0.204 | 0.218 | 0.234 | 0.201 | 0.168 | 0.131 | 0.143 | 0.138 | 0.152 | 0.177 | 0.174 |
| 3 | 1.077 | 0.979 | 0.792 | 0.794 | 0.872 | 0.747 | 0.566 | 0.512 | 0.549 | 0.475 | 0.487 | 0.514 | 0.460 | 0.382 | 0.302 | 0.323 | 0.321 | 0.352 | 0.405 |
| 4 | 1.797 | 2.047 | 1.708 | 1.315 | 1.430 | 1.383 | 1.286 | 0.962 | 0.924 | 0.974 | 0.794 | 0.811 | 0.900 | 0.796 | 0.679 | 0.514 | 0.581 | 0.564 | 0.609 |
| +gp | 2.592 | 3.065 | 3.152 | 2.512 | 2.167 | 2.024 | 2.140 | 1.966 | 1.625 | 1.485 | 1.420 | 1.195 | 1.260 | 1.366 | 1.290 | 1.055 | 0.871 | 0.904 | 0.868 |

**Table 6.3.8. Haddock in VIIa: Available tuning data (file name: h7ani.tun).**

```
IRISH SEA haddock,2011 WG,ANON,COMBSEX,TUNING DATA(effort, nos at age)
104
NIGFS March
1992 2011
1 1 0.21 0.25
1 5
       1   1525    23     0     0   0  0
       1    139   569    31     0   0  0
       1    644    58   183     0   0  0
       1  24823   437     0    43   0  0
       1   1065  3743    67     3   1  0
       1  25118   474  1457    44   0  2
       1   3913  8694    70   105   1  0
       1   6058   680  2072    16  11  0
       1  14028  1853    64   147   2  3
       1   3277  6990   770    40  20  0
       1  28755   842  1059    78   1  0
       1   6966 14162   341   356  26  0
       1  19945  2379  2206    45  35  0
       1  24488  6454   406   234  13  2
       1  13444 12721  2194    91  33  0
       1  20918 11325  3661   240  16 11
       1   7480 12009  2559   495  48  0
       1   9345  3888  2877   163  37  5
       1  17058  1765   524   239  26  1
       1  17278  5543   299    67  46  4
```

**Fleets below not included in assessment**

```
NIGFS Oct
1991 2010
1 1 0.83  0.88
0 3
        1   15780      70      0      0  0  0  0
        1     124     784    151      0  0  0  0
        1    4462     101    375      3  0  0  0
        1   56683    1137     12     79  0  0  1
        1    1661   10153     74      0  5  0  0
        1  143300    1167   1480     13  0  0  0
        1   16400   39680    174     98  1  0  0
        1   41820    1243   3778     22  3  4  0
        1   80674    2835     71    145  0  1  0
        1    6545    8598    763     31 39  0  0
        1   75017    2003   2742    311  0 20  0
        1   15116   10501     86    365  0  0  0
        1   53922    7125   3008     59 79  0  0
        1   70337   14413   1261    649  0  0  0
        1   47030   12962   1743     59  8  0  0
        1   35748   10788   3607    392 52  0  0
        1    9654    9804   4050   1057 41  0  0
        1    9037    4880   2242    277 24  0  0
        1   45869    4269    951    459 29 12  3
        1   22538    8433    587    197 85  0  3
MIK net May/June
1994 2010
1 1 0.38 0.47
0 0
        1     47000
        1      1700
        1     47800
        1     14500
        1      2500
        1     15400
        1      1700
        1     17100
        1      1200
        1      4250
        1     25970
        1      8250
        1     40240
        1      3820
        1      6638
        1     18540
        1      4532
```

**Table 6.3.9. Haddock in VIIa: SURBA 3.0 fitted numbers-at-age, total mortality-at-age, SSB and Z using the NIGFS-WIBTS-Q1 survey data.**

| Numbers-at-age | | | | | | Total mortality-at-age | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Age | | | | | Age | | | | |
| Year | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1992 | 0.349 | 0.013 | 0 | 0 | 0 | 0.641 | 0.693 | 1.085 | 1.312 | 1.312 |
| 1993 | 0.055 | 0.184 | 0.007 | 0 | 0 | 0.836 | 0.903 | 1.415 | 1.710 | 1.710 |
| 1994 | 0.400 | 0.024 | 0.074 | 0.002 | 0 | 1.003 | 1.083 | 1.697 | 2.051 | 2.051 |
| 1995 | 5.618 | 0.147 | 0.008 | 0.014 | 0 | 1.290 | 1.394 | 2.184 | 2.639 | 2.639 |
| 1996 | 0.464 | 1.547 | 0.036 | 0.001 | 0.001 | 0.920 | 0.994 | 1.557 | 1.882 | 1.882 |
| 1997 | 9.183 | 0.185 | 0.573 | 0.008 | 0 | 1.230 | 1.329 | 2.083 | 2.517 | 2.517 |
| 1998 | 0.735 | 2.684 | 0.049 | 0.071 | 0.001 | 1.224 | 1.323 | 2.072 | 2.504 | 2.504 |
| 1999 | 2.909 | 0.216 | 0.715 | 0.006 | 0.006 | 1.192 | 1.288 | 2.018 | 2.439 | 2.439 |
| 2000 | 5.613 | 0.883 | 0.060 | 0.095 | 0.001 | 1.084 | 1.172 | 1.836 | 2.219 | 2.219 |
| 2001 | 1.207 | 1.898 | 0.274 | 0.010 | 0.010 | 1.196 | 1.292 | 2.024 | 2.446 | 2.446 |
| 2002 | 6.919 | 0.365 | 0.521 | 0.036 | 0.001 | 0.811 | 0.876 | 1.373 | 1.659 | 1.659 |
| 2003 | 2.146 | 3.075 | 0.152 | 0.132 | 0.007 | 0.990 | 1.070 | 1.676 | 2.026 | 2.026 |
| 2004 | 6.901 | 0.797 | 1.055 | 0.028 | 0.017 | 1.103 | 1.192 | 1.868 | 2.257 | 2.257 |
| 2005 | 10.186 | 2.290 | 0.242 | 0.163 | 0.003 | 1.077 | 1.164 | 1.823 | 2.203 | 2.203 |
| 2006 | 6.600 | 3.470 | 0.715 | 0.039 | 0.018 | 0.934 | 1.009 | 1.580 | 1.910 | 1.910 |
| 2007 | 10.646 | 2.595 | 1.265 | 0.147 | 0.006 | 0.968 | 1.046 | 1.638 | 1.980 | 1.980 |
| 2008 | 3.095 | 4.045 | 0.912 | 0.246 | 0.020 | 1.190 | 1.286 | 2.015 | 2.435 | 2.435 |
| 2009 | 2.210 | 0.941 | 1.118 | 0.122 | 0.022 | 1.212 | 1.309 | 2.051 | 2.479 | 2.479 |
| 2010 | 6.188 | 0.658 | 0.254 | 0.144 | 0.010 | 1.130 | 1.221 | 1.913 | 2.312 | 2.312 |
| 2011 | 6.215 | 1.999 | 0.194 | 0.038 | 0.014 | 1.177 | 1.272 | 1.993 | 2.409 | 2.409 |

| Stock summary | | | | | | |
|---|---|---|---|---|---|---|
| Year | Recruits | log SE | SSB | TSB | Z(2-3) | SE (Z) |
| 1992 | 0.349 | 0.352 | 0.006 | 0.040 | 0.889 | 0.368 |
| 1993 | 0.055 | 0.288 | 0.086 | 0.091 | 1.159 | 0.262 |
| 1994 | 0.400 | 0.260 | 0.084 | 0.118 | 1.390 | 0.206 |
| 1995 | 5.618 | 0.278 | 0.082 | 0.571 | 1.789 | 0.181 |
| 1996 | 0.464 | 0.242 | 0.600 | 0.640 | 1.275 | 0.202 |
| 1997 | 9.183 | 0.257 | 0.578 | 1.239 | 1.706 | 0.174 |
| 1998 | 0.735 | 0.255 | 0.829 | 0.874 | 1.697 | 0.170 |
| 1999 | 2.909 | 0.255 | 0.475 | 0.643 | 1.653 | 0.169 |
| 2000 | 5.613 | 0.247 | 0.329 | 0.604 | 1.504 | 0.172 |
| 2001 | 1.207 | 0.261 | 0.563 | 0.627 | 1.658 | 0.172 |
| 2002 | 6.919 | 0.235 | 0.364 | 0.758 | 1.125 | 0.176 |
| 2003 | 2.146 | 0.244 | 0.908 | 1.018 | 1.373 | 0.176 |
| 2004 | 6.901 | 0.250 | 0.746 | 1.036 | 1.530 | 0.172 |
| 2005 | 10.186 | 0.250 | 0.646 | 0.972 | 1.493 | 0.171 |
| 2006 | 6.600 | 0.241 | 0.783 | 1.014 | 1.295 | 0.174 |
| 2007 | 10.646 | 0.242 | 0.861 | 1.223 | 1.342 | 0.176 |
| 2008 | 3.095 | 0.262 | 1.001 | 1.118 | 1.650 | 0.172 |
| 2009 | 2.210 | 0.279 | 0.591 | 0.686 | 1.680 | 0.170 |
| 2010 | 6.188 | 0.313 | 0.296 | 0.556 | 1.567 | 0.183 |
| 2011 | 6.215 | 0.396 | 0.462 | 0.716 | 1.633 | 0.062 |

**Table 6.3.10. Haddock VIIa: Estimates of biomass and fishing mortality reference levels derived from the fit of three stock and recruit relationships and the yield-per-recruit $F_{msy}$ proxies.**

Stock name
Had-7a
Sen filename
had-7a.sen
pf, pm
0 0
Number of iterations
1000
Simulate variation in Biological parameters
TRUE
SR relationship constrained
TRUE

Ricker
767/1000 Iterations resulted in feasible parameter estimates

| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
|---|---|---|---|---|---|---|---|---|---|
| Deterministic | 1.45 | 0.46 | 4629 | 2523 | 1.15 | 0.30 | 4.04 | 0.00022 | 34.25 |
| Mean | 1.36 | 0.55 | 7784 | 4833 | 1.70 | 0.44 | 8.15 | 0.00033 | |
| 5%ile | 0.44 | 0.21 | 1594 | 1414 | 0.74 | 0.07 | 2.29 | 5.00E-05 | |
| 25%ile | 0.72 | 0.33 | 2507 | 2195 | 1.07 | 0.24 | 3.65 | 0.00018 | |
| 50%ile | 1.07 | 0.47 | 3441 | 2778 | 1.42 | 0.42 | 5.49 | 0.00031 | |
| 75%ile | 1.68 | 0.65 | 5575 | 3732 | 2.02 | 0.60 | 8.96 | 0.00044 | |
| 95%ile | 3.36 | 1.22 | 17254 | 8047 | 3.43 | 0.93 | 21.81 | 0.0007 | |
| CV | 0.67 | 0.62 | 4.86 | 5.25 | 0.61 | 0.61 | 1.13 | 0.61 | |

Beverton-Holt
813/1000 Iterations resulted in feasible parameter estimates

| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
|---|---|---|---|---|---|---|---|---|---|
| Deterministic | 2.80 | 0.29 | 7030 | 2580 | 0.44 | 0.80 | 7964 | 1111 | 34.12 |
| Mean | 1.15 | 0.20 | 58936 | 9346 | 0.45 | 1.31 | 41130 | 22121 | |
| 5%ile | 0.31 | 0.07 | 2363 | 848 | 0.05 | 0.63 | 3484 | 153 | |
| 25%ile | 0.51 | 0.14 | 4913 | 1657 | 0.22 | 0.89 | 5903 | 1014 | |
| 50%ile | 0.82 | 0.19 | 9186 | 2574 | 0.38 | 1.12 | 9186 | 2705 | |
| 75%ile | 1.46 | 0.25 | 19246 | 4389 | 0.59 | 1.45 | 16093 | 6579 | |
| 95%ile | 3.15 | 0.36 | 129006 | 17393 | 1.00 | 2.31 | 70557 | 40158 | |
| CV | 0.82 | 0.43 | 7.6 | 8.4 | 1.27 | 0.80 | 11.25 | 13.45 | |

Smooth hockeystick
918/1000 Iterations resulted in feasible parameter estimates

| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
|---|---|---|---|---|---|---|---|---|---|
| Deterministic | 0.87 | 0.41 | 5359 | 2661 | 0.49 | 0.92 | 1.27 | 2727 | 34.55 |
| Mean | 0.90 | 0.38 | 10384 | 3359 | 0.60 | 0.99 | 1.56 | 2941 | |
| 5%ile | 0.33 | 0.14 | 2439 | 1534 | 0.30 | 0.49 | 0.78 | 1439 | |
| 25%ile | 0.50 | 0.28 | 3943 | 2304 | 0.43 | 0.66 | 1.13 | 1960 | |
| 50%ile | 0.69 | 0.37 | 5546 | 3010 | 0.56 | 0.95 | 1.45 | 2797 | |
| 75%ile | 1.04 | 0.47 | 8645 | 4073 | 0.71 | 1.30 | 1.85 | 3830 | |
| 95%ile | 2.05 | 0.66 | 22638 | 6218 | 1.06 | 1.64 | 2.76 | 4840 | |
| CV | 0.77 | 0.42 | 2.44 | 0.48 | 0.41 | 0.38 | 0.41 | 0.38 | |

Per recruit

| | F35 | F40 | F01 | Fmax | Bmsypr | MSYpr | Fpa | Flim |
|---|---|---|---|---|---|---|---|---|
| Deterministic | 0.24 | 0.20 | 0.20 | 0.41 | 0.77 | 0.38 | 0 | 0 |
| Mean | 0.20 | 0.17 | 0.18 | 0.39 | 1.20 | 0.39 | | |
| 5%ile | 0.05 | 0.04 | 0.05 | 0.15 | 0.39 | 0.28 | | |
| 25%ile | 0.15 | 0.12 | 0.14 | 0.29 | 0.55 | 0.34 | | |
| 50%ile | 0.20 | 0.17 | 0.19 | 0.38 | 0.71 | 0.38 | | |
| 75%ile | 0.26 | 0.22 | 0.23 | 0.48 | 0.97 | 0.44 | | |
| 95%ile | 0.34 | 0.29 | 0.29 | 0.67 | 2.20 | 0.55 | | |
| CV | 0.44 | 0.43 | 0.39 | 0.43 | 2.06 | 0.22 | | |

**Table 6.3.11. Haddock in VIIa: Input for yield/Recruit.**

MFYPR version 2a
Run: Had7a_2004WG_yield
Had7a_2004WG_yieldMFYPR Index file 11/05/2004
Time and date: 10:55 13/05/2004
Fbar age range: 2-4

| Age | M | Mat | PF | PM | SWt | Sel | CWt |
|---|---|---|---|---|---|---|---|
| 0 | 0.2 | 0 | 0 | 0 | 0.000 | 0.000 | 0.000 |
| 1 | 0.2 | 0 | 0 | 0 | 0.061 | 0.140 | 0.322 |
| 2 | 0.2 | 1 | 0 | 0 | 0.302 | 0.544 | 0.492 |
| 3 | 0.2 | 1 | 0 | 0 | 0.754 | 1.118 | 0.967 |
| 4 | 0.2 | 1 | 0 | 0 | 1.377 | 1.057 | 1.814 |
| 5 | 0.2 | 1 | 0 | 0 | 2.259 | 1.057 | 2.308 |

Weights in kilograms

**Table 6.3.12. Haddock in VIIa: Yield-per-recruit output table.**

MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 5.5167 | 5.8695 | 3.6979 | 5.8200 | 3.6979 | 5.8200 |
| 0.1000 | 0.0906 | 0.2211 | 0.3492 | 4.4167 | 3.5229 | 2.5980 | 3.4733 | 2.5980 | 3.4733 |
| 0.2000 | 0.1813 | 0.3298 | 0.4658 | 3.8781 | 2.4296 | 2.0593 | 2.3801 | 2.0593 | 2.3801 |
| 0.3000 | 0.2719 | 0.3951 | 0.5037 | 3.5564 | 1.8139 | 1.7377 | 1.7644 | 1.7377 | 1.7644 |
| 0.4000 | 0.3626 | 0.4390 | 0.5098 | 3.3412 | 1.4279 | 1.5225 | 1.3783 | 1.5225 | 1.3783 |
| 0.5000 | 0.4532 | 0.4709 | 0.5022 | 3.1861 | 1.1681 | 1.3674 | 1.1186 | 1.3674 | 1.1186 |
| 0.6000 | 0.5439 | 0.4952 | 0.4888 | 3.0683 | 0.9843 | 1.2496 | 0.9347 | 1.2496 | 0.9347 |
| 0.7000 | 0.6345 | 0.5146 | 0.4735 | 2.9752 | 0.8490 | 1.1564 | 0.7995 | 1.1564 | 0.7995 |
| 0.8000 | 0.7252 | 0.5305 | 0.4580 | 2.8993 | 0.7464 | 1.0805 | 0.6969 | 1.0805 | 0.6969 |
| 0.9000 | 0.8158 | 0.5438 | 0.4431 | 2.8358 | 0.6666 | 1.0171 | 0.6170 | 1.0171 | 0.6170 |
| 1.0000 | 0.9065 | 0.5552 | 0.4293 | 2.7818 | 0.6030 | 0.9631 | 0.5535 | 0.9631 | 0.5535 |
| 1.1000 | 0.9971 | 0.5651 | 0.4167 | 2.7350 | 0.5515 | 0.9163 | 0.5019 | 0.9163 | 0.5019 |
| 1.2000 | 1.0878 | 0.5739 | 0.4052 | 2.6939 | 0.5090 | 0.8751 | 0.4594 | 0.8751 | 0.4594 |
| 1.3000 | 1.1784 | 0.5817 | 0.3947 | 2.6573 | 0.4733 | 0.8386 | 0.4238 | 0.8386 | 0.4238 |
| 1.4000 | 1.2691 | 0.5887 | 0.3853 | 2.6245 | 0.4431 | 0.8057 | 0.3936 | 0.8057 | 0.3936 |
| 1.5000 | 1.3597 | 0.5951 | 0.3768 | 2.5947 | 0.4172 | 0.7760 | 0.3676 | 0.7760 | 0.3676 |
| 1.6000 | 1.4503 | 0.6009 | 0.3692 | 2.5676 | 0.3946 | 0.7489 | 0.3451 | 0.7489 | 0.3451 |
| 1.7000 | 1.5410 | 0.6063 | 0.3622 | 2.5427 | 0.3749 | 0.7240 | 0.3253 | 0.7240 | 0.3253 |
| 1.8000 | 1.6316 | 0.6113 | 0.3559 | 2.5197 | 0.3574 | 0.7010 | 0.3079 | 0.7010 | 0.3079 |
| 1.9000 | 1.7223 | 0.6159 | 0.3501 | 2.4983 | 0.3418 | 0.6796 | 0.2923 | 0.6796 | 0.2923 |
| 2.0000 | 1.8129 | 0.6202 | 0.3449 | 2.4784 | 0.3278 | 0.6597 | 0.2783 | 0.6597 | 0.2783 |

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(2-4) | 1.0000 | 0.9065 |
| FMax | 0.3811 | 0.3455 |
| F0.1 | 0.2074 | 0.188 |
| F35%SPR | 0.2494 | 0.2261 |

Weights in kilograms

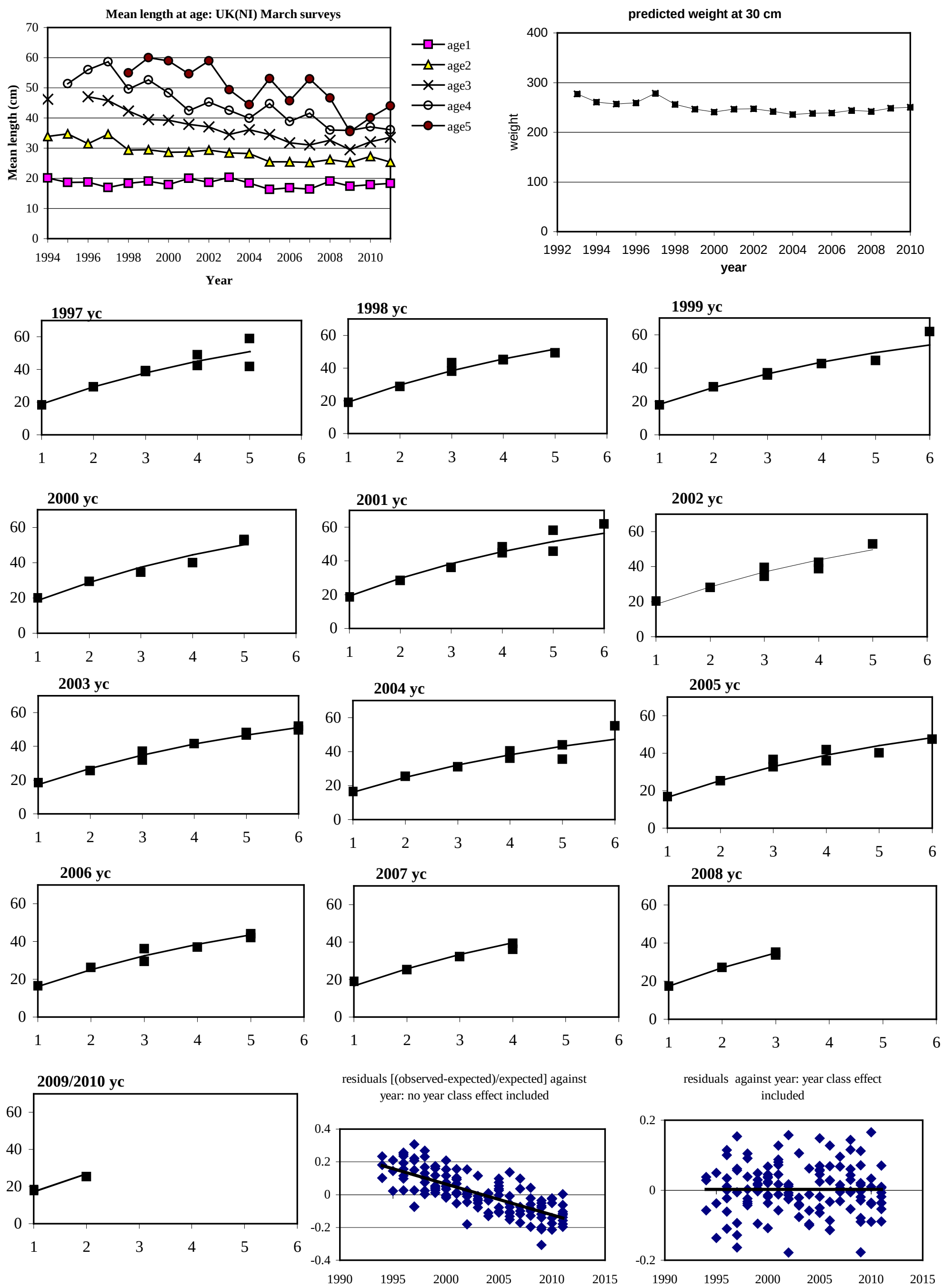



**Figure 6.3.1. Haddock in VIIa: Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in UK(NI) groundfish surveys in March, by year and age, and expected mean weight-at-length based on length–weight parameters from each survey. Lower panels: mean length-at-age from March surveys, and from Quarter 1 commercial landings-at-age 3 and over, by year class. Lines are von Bertalanffy model fits with year-class effect included. Model residuals are shown for the fit without year-class effects, and for the fit with year-class effects.**

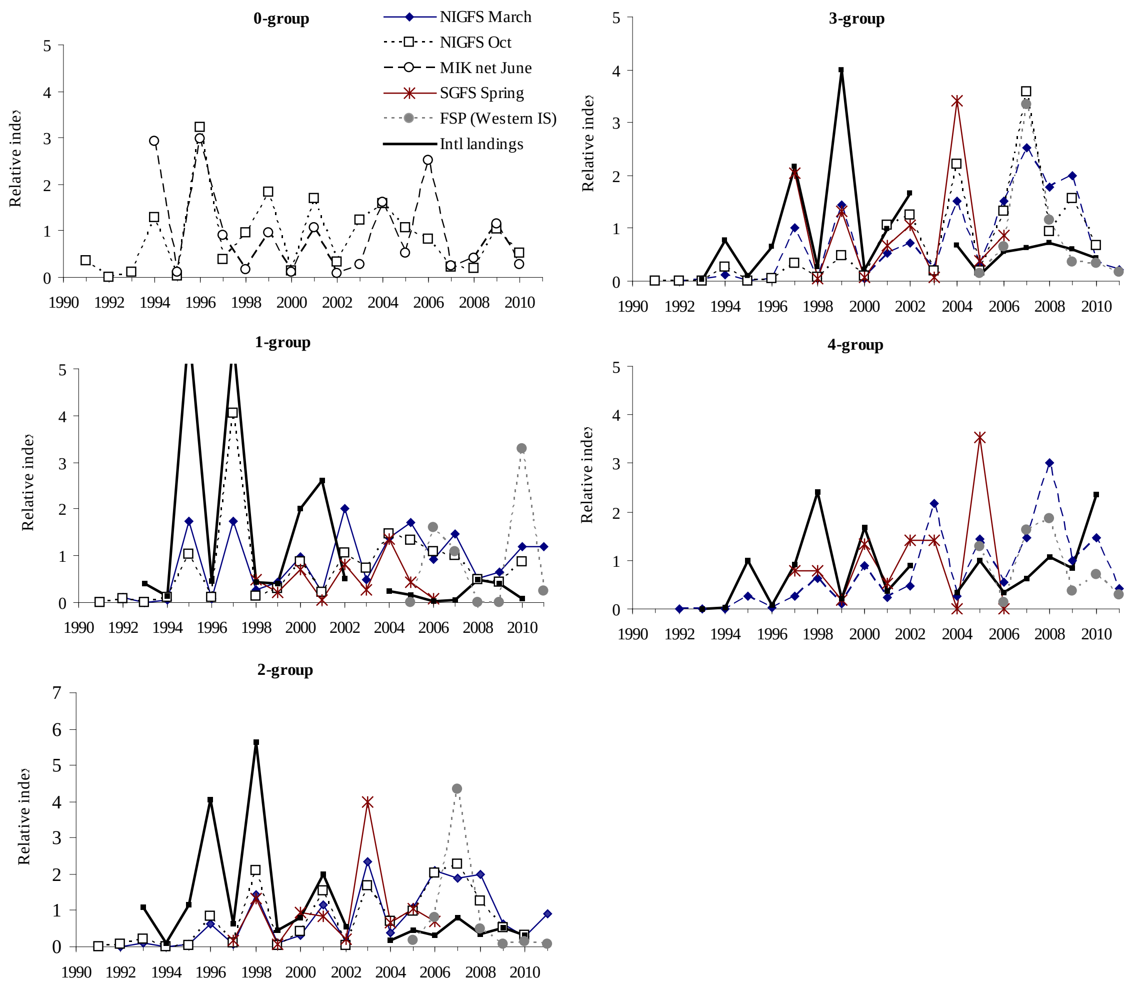



**Figure 6.3.2. Haddock in VIIa: Trends in raw survey indices compared with international landings, by age class and year. All values are standardized to the mean for years common to all series in each plot (except for short FSP series).**

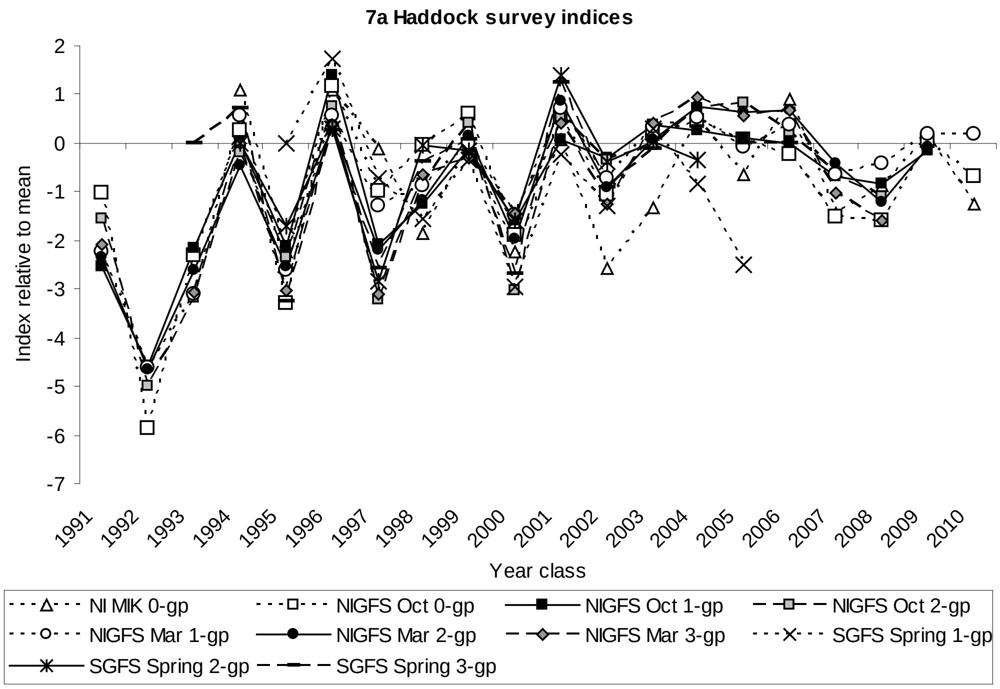



**Figure 6.3.3. Haddock in VIIa: Time-series plots of the logarithms of survey indices at age by year class, after standardizing by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year-class signals.**

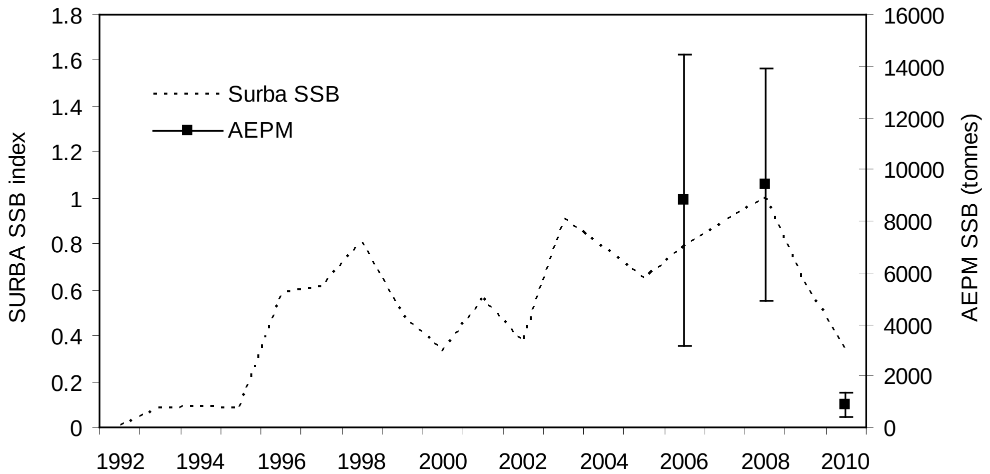



**Figure 6.3.4. Haddock in VIIa: Comparison in the relative trends of SSB form 2010 SURBA run and the Irish Sea annual egg production method survey estimates of SSB (+ 2 SE) (Armstrong *et al.*, WD09).**

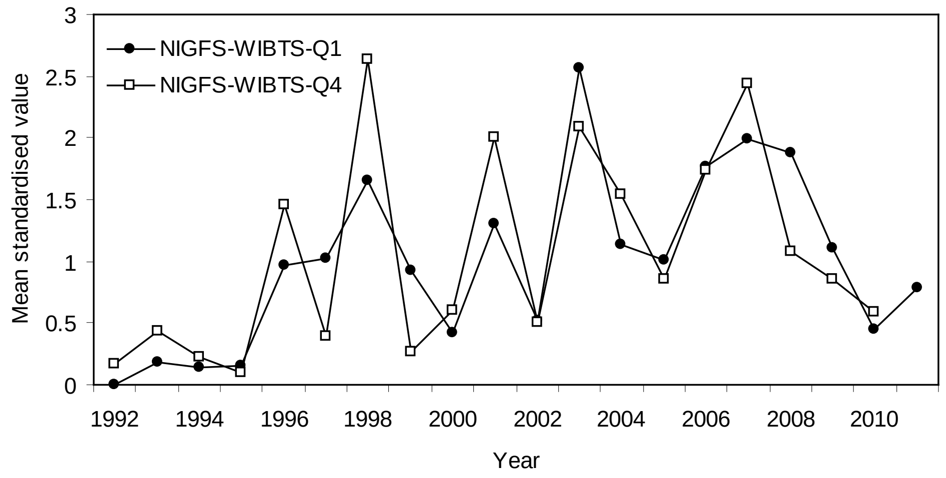
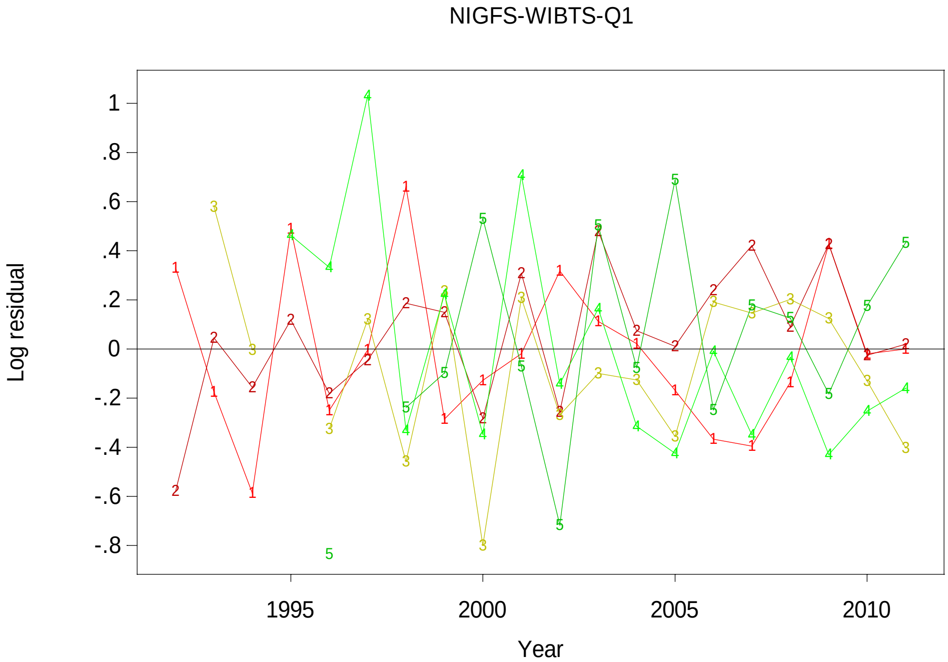



**Figure 6.3.5. Haddock in VIIa: Mean Standardized empirical SSB indices from the NIGFS-WIBTS-Q1 and NIGFS- WIBTS-Q4 surveys, based on raw indices up to age 6.**



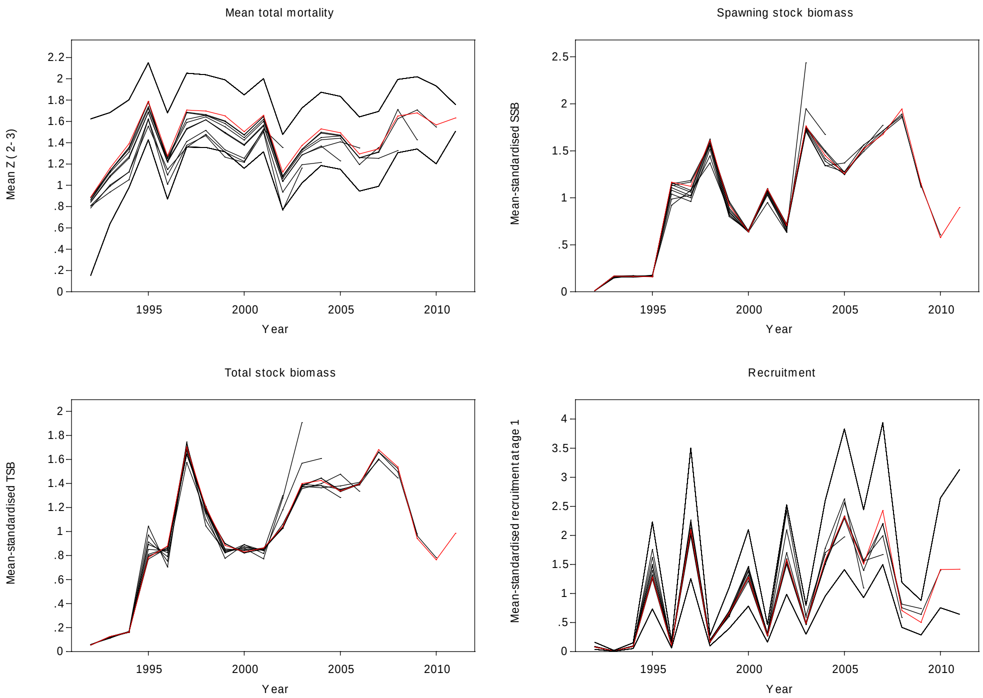




**Figure 6.3.6. Haddock VIIa: SURBA 3.0 Residuals at age (top panel) and retrospective plots (bottom panel) for the NIGFS-WIBTS-Q1 survey.**

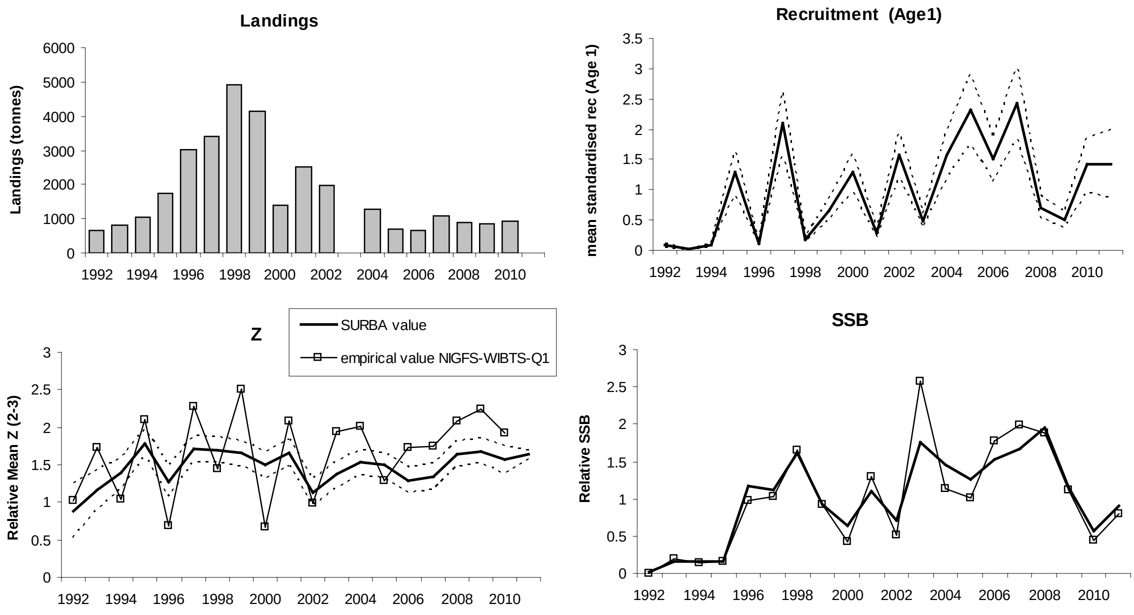



**Figure 6.3.7. Haddock VIIa: Summary plots of landings and results of final SURBA 3.0 run using the NIGFS-WIBTS-Q1 survey data. Dotted lines are +/- 1SE. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.**

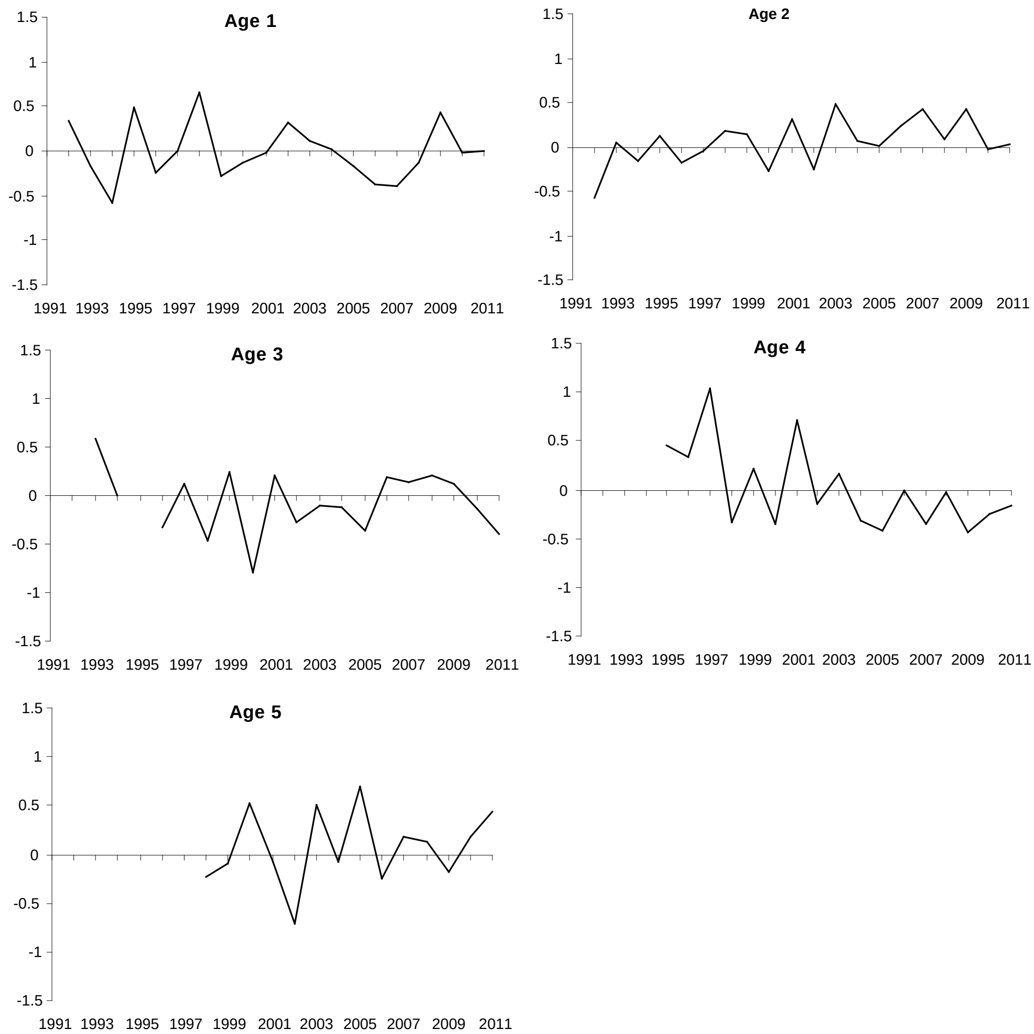



**Figure 6.3.8. Haddock VIIa: SURBA 3.0 Residuals at age for final run using the NIGFS-WIBTS-Q1 survey data.**

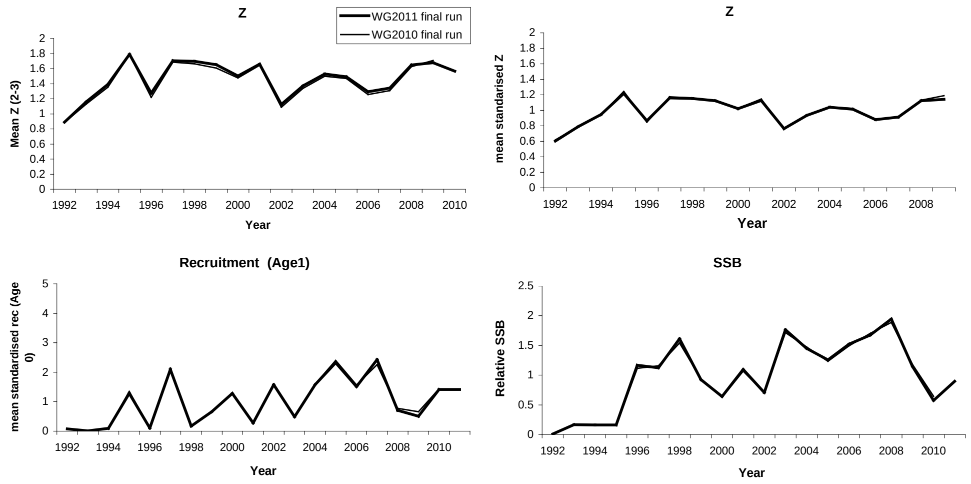



**Figure 6.3.9. Haddock VIIa: Trends in SSB, recruitment and Z(2–3) from the 2010 and 2011 SURBA. SSB and recruitment are standardized to the mean for years common to all series (1992–2010) in each plot.**

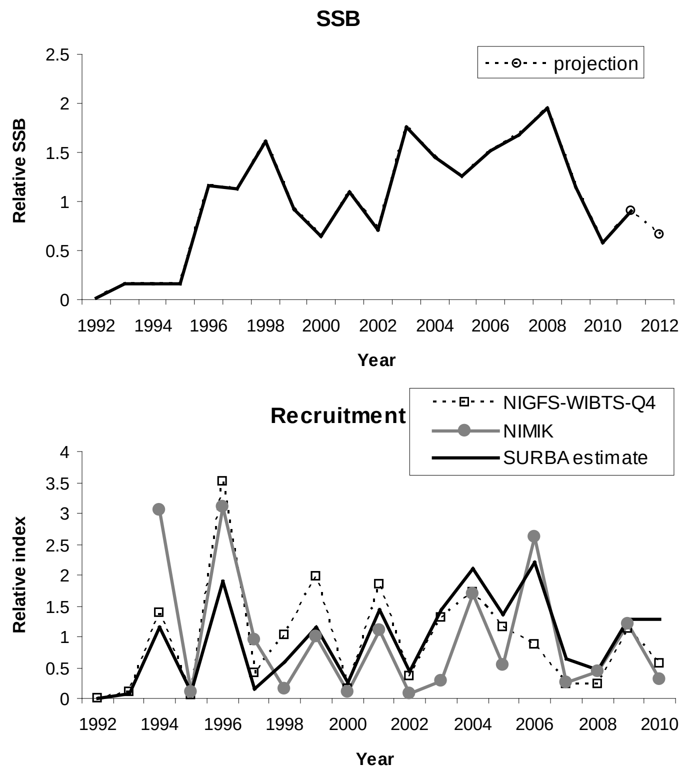



**Figure 6.3.10. Haddock VIIa: Trend in SSB form 2011 SURBA projected to 2012 (top panel) and SURBA estimate of recruitment compared to available 0-gp indices. SSB and recruitment are standardized to the mean for years common to all series (1994–2010) in each plot.**

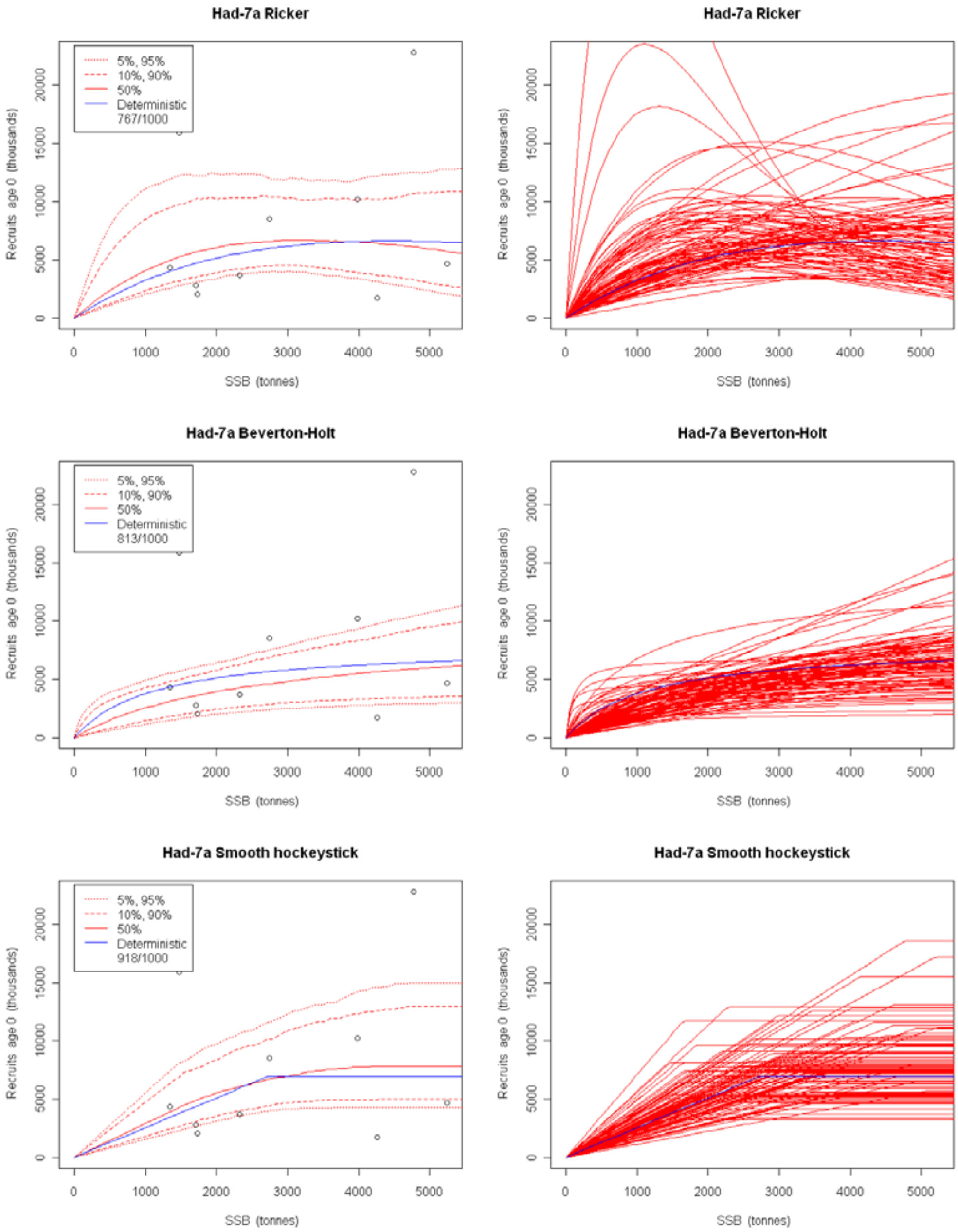



**Figure 6.3.11. Haddock VIIa: MSY fitted stock–recruitment relationships. Left hand panels: blue line indicates the deterministic estimate; red line median and percentiles of curves with converged estimates of $F_{MSY}$. Right hand panels: curves plotted from the first 100 MCMC resamples with converged $F_{MSY}$ estimates. The legends for each recruitment model show the number of converged values of $F_{MSY}$ from the 1000 resamples.**

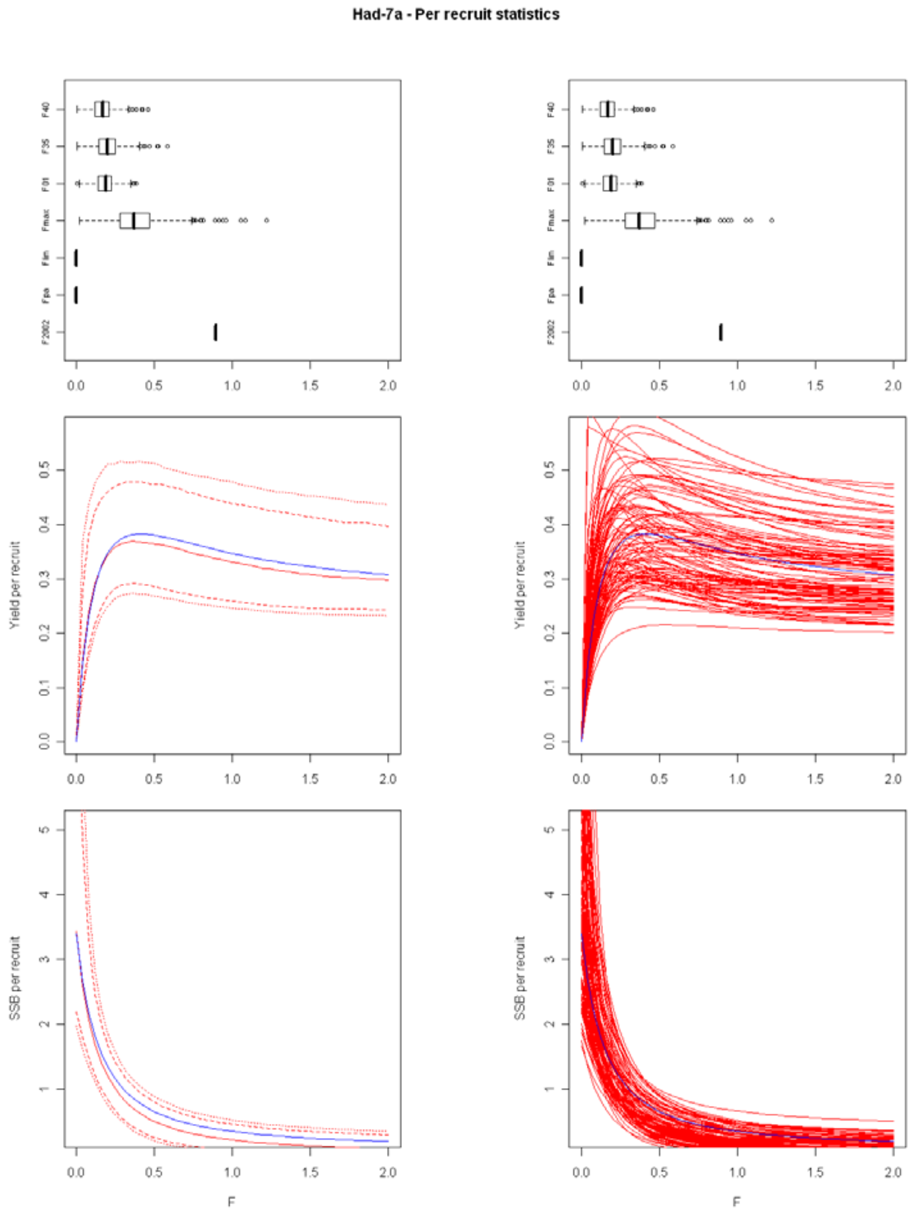
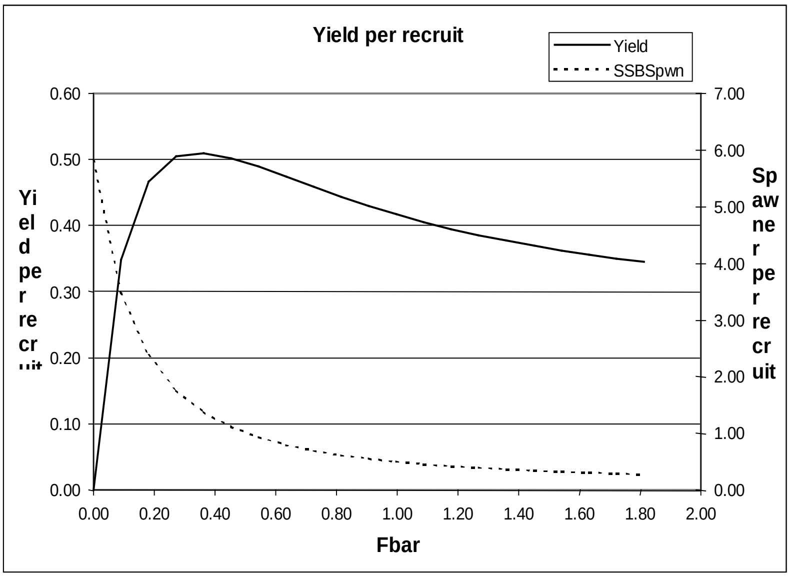



**Figure 6.3.12. Haddock VIIa: Fitted yield-per-recruit F reference points, yield-per-recruit and SSB per recruit against fishing mortality with confidence intervals estimated by parametric re-sampling of the selection, weight-at-age, natural mortality and maturity estimates and their c.v. Left hand panels: blue line indicates the deterministic estimate, red lines the median and percentiles. Right hand panels: the first 100 resamples.**




MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(2-4) | 1.0000 | 0.9065 |
| FMax | 0.3811 | 0.3455 |
| F0.1 | 0.2074 | 0.1880 |
| F35%SPR | 0.2494 | 0.2261 |

Weights in kilograms

**Figure 6.3.13. Haddock VIIa: Yield-per-recruit based on analysis carried out in 2004.**

## 6.4 *Nephrops* in Division VIIa (Irish Sea East, FU14)

### Type of assessment in 2011

UWTV survey data are used to calculate absolute abundance estimates for 2010 and catch options following the process defined by WKNEPH (2009). Revisions to the UWTV processing algorithms used to generate abundance estimates for 2008–2009 have resulted in a substantial increase in the abundance estimates for these years.

### ICES advice applicable to 2010

The advice was biannual and still valid from the 2008 assessment which implied that effort should not increase compared to 2007 levels.

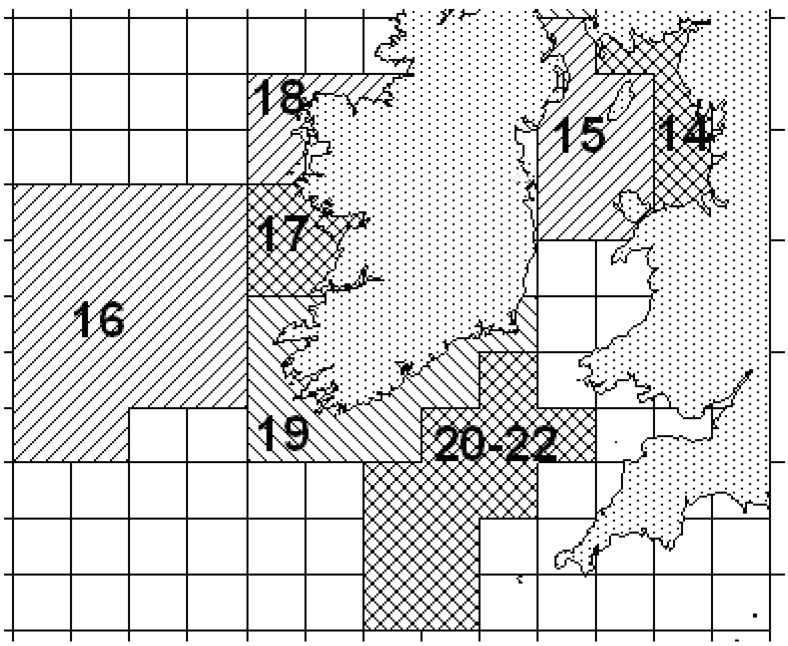
### ICES advice applicable to 2011

Transition to an MSY approach with caution at low stock size implying landings of less than 680 t.

### 6.4.1 General

#### Stock description and management units

The Irish Sea east *Nephrops* stock (FU14) is in ICES Subarea VII which includes the Irish Sea west (FU15) stock; the Porcupine Bank (FU16); Aran Grounds (FU17); northwest Irish Coast (FU18), southeast and southwest Irish Coast (FU19); and the Celtic Sea stock (FU20-22). The TAC is set for the whole of Subarea VII which does not correspond to the areas occupied by these stocks.




**Functional units in VIIa**

#### Management applicable in 2010 and 2011

The TAC is currently set for the larger TAC Area VII. The TAC for 2011 was 21 759t a 3% reduction on the 22 432 quota for 2010. The TAC area includes a number of *Nephrops* stocks showing different levels of exploitation. A single TAC covering a number of distinct stocks allows the possibility of unrestricted catches being taken from a heavily exploited stock when advice suggests they should be limited.

In 2010 the main fleets targeting *Nephrops* include directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Ireland. Details of all regulations including effort controls in place are provided in the Stock Annex.

#### The fishery in 2010

Between 1999 and 2003 the number of vessels fishing for *Nephrops* in FU14 declined by 40% to a fleet of around 50 vessels. This was largely due to the reduction in the number of visiting UK vessels and the decommissioning of part of the Northern Ireland and local English fleets. Since then, the number of vessels fishing the area has returned to and settled at around 80 vessels over the last four years mainly from Northern Ireland. Currently, just less than 30 of these vessels, between 9 and 21 m in length, have their 'home' ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is generally made up of larger vessels from Northern Ireland.

Over the last 12 years over 70% of the landings from this fishery were made to Whitehaven and about 20% to Kilkeel but this changed in 2006 and 2010 to ~60% Whitehaven and ~25% Killkeel. Over half of the Northern Ireland and a few of the English vessels use twin or triple trawls and between 2006 and 2010 account for just over 30% of the *Nephrops* landings.

There has been little apparent change in the make-up of the English and Welsh fleet over the last three of years. However the current state of other stocks, technical conservation and cod recovery measures has had an effect on mesh sizes and fishing patterns. Traditionally a summer fishery, anecdotal data and records of monthly landings indicate the season is starting earlier and ending earlier.

### 6.4.2 Data available

An overview of the data provided and used by the WG is provided in Table 2.3.

#### Landings

Official landings as reported to ICES from FU14 are presented in Table 6.4.1 and were updated for 2010. Between 1987 and 2006 landings from FU 14 appeared relatively stable, fluctuating around a long-term average of about 550 t (Figure 6.4.1 and Table 6.4.1). Landings in 2007 were at their highest level since 1978 at 959 t. Landings in 2010 were 20% down on the 2009 level and over 40% down on the peak of 2007. The introduction of the buyers and sellers legislation in 2006 by the UK precludes direct comparison with previous years as reported levels are considered to have significantly improved.

Over the last ten years UK vessels have landed, on average, 87% of the reported annual international landings. Irish vessels increased their share of the landings to 35% in 2002 but it has since declined to less than 5% since 2008 (Table 6.4.2).

The official landings as reported by each country were updated for 2010.

#### Length composition

Quarterly length compositions of landings, catch and discards were available from the UK England and Wales for most of the period 1992–2009. In 2010 only five samples were made as part of the English discard observer programme and there was no other catch sampling. Landings sampling was undertaken but the catch sampling was considered insufficient to derive catch and discard length frequencies for 2010. As a result none of the length derived metrics have been updated for 2010.

Historical trends in length distributions are shown in Figure 6.4.5. Discard rates have been estimated from the same figures and have declined in the terminal six years from 24% to 4% of total catch by weight and 43% and 8% by number. Females generally have a higher discard rate because they are generally smaller. The sharp decline in the discard rate from 2008 to 2009 particularly for males might suggest a change in discard practice but the shift to the right for the catch distribution in 2009 and the minimum observed size suggests something else. This could be partly a sampling artefact. Only ten observer trips were carried out in 2009, around a third of the number carried out in 2008. These observer trips have been the only source for catch and discard data in recent years. The landings were still well sampled so these concerns are only limited to defining the discarded component of the catch in 2009.

A summary of the historical mean size information is provided Table 6.4.5. The mean sizes in the catch and landings appear relatively stable. The increasing lpue of the <35 mm CL categories and decline in mean size of the landings (Figures 6.4.1 and 6.4.3) and the increase in the range of sizes in the catch (Figure 6.4.5) up to 2007 could be indicative of good recruitment. This is supported by the local enforcement agency who noted an increase in the proportion of tails landed in 2007. In 2009 the same agency remarked on improved catches of good sized prawns and better fishing than had been seen for some time. The mean size in the landings remains relatively stable.

#### Commercial cpue

A 10% TAC increase in 2006 followed by a 17% increase in 2007 coupled with the implementation in the UK of buyers and sellers regulations effective from and throughout 2006, has improved the accuracy of reported landings information. This appears to have reduced the reasons to misreport, despite the declines in TAC for 2009 and 2010 in Area VII and the legislation provides the quality control. Landings do not appear to have exceeded the advised TAC for this Functional Unit.

The introduction of the buyers and sellers legislation for 2006 complicates the interpretation of any prior trends. In 2010, most of the landings were made into England with a large proportion of these landings (60 % of the directed landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort fluctuated around a downward trend since 1978. After a period of relative stability between 2002–2007 effort has resumed its decline and was at a 35 year low in 2010. Quarterly effort plots show a predominance of effort in the 2nd and 3rd quarters (Figure 6.4.2).

The UK lpue series is based on a combination of directed *Nephrops* voyages by English and Welsh (E&W) vessels landing to Fleetwood and Whitehaven, where the weight of *Nephrops* landed is more than 25% of the total landing and all trips by visiting Northern Irish (NI) vessels which target *Nephrops* (Table 6.4.4). The lpue trends of the E&W fleet compared to the NI fleet are broadly similar in their interannual trends although there are several step-changes in absolute level (Figure 6.4.1). There is little correspondence between the lpue of the Republic of Ireland vessels (Table 6.4.3) and the UK except that the Northern Irish vessels are now reporting lpues at generally the same level as the Republic of Ireland vessels.

Lpue between gear-types for targeted trips (Figure 6.4.4) also shows divergence in the trends. English twin trawls underwent a gradual decline in lpue between 1997 and 2006 before rising sharply whereas the single trawls fluctuated without trend. Northern Irish lpues were similar in magnitude between 1994 and 2003 and have recently diverged. Northern Irish lpue is generally higher than English lpue. The step change in lpue around the time of the introduction of buyers and sellers legislation in 2006 is considered to be driven by a change in reporting levels as more than a change in biological productivity.

Historically, male *Nephrops* predominate landings and the annual proportion of females appears highly dependent on the fishing effort in the third quarter (Figure 6.4.2) but due to the low sampling levels in 2010 these data have not been updated. Lpues for males and females <35 mm CL (Figure 6.4.3) appear to exhibit the same general trends. Minima in 2003 were followed by upward trends to the highest values in both series in 2007. They have both since declined but still remain above any other values in the series. The lpue of the larger males (>35 mm) has been increasing since 2002 and continues to rise. The quarterly pattern of availability to the fishery of females >35 mm, means that meaningful statistics for this portion of the population are highly dependent upon the level of fishing and the sampling effort deployed in the 3rd quarter.

#### Surveys

In August of 2007–2010 the UK and the Republic of Ireland carried out an underwater TV survey of the *Nephrops* grounds in the eastern Irish Sea. The survey was of a fixed grid design and was carried out using the same protocols used in UWTV surveys in the western Irish Sea. This survey was not reviewed at WKNEPH 2009 but the protocols and standardized process has been adopted see Stock Annex. The survey area is shown in Figure 6.4.6 giving the survey stations (black circles), VMS coverage (grey dots), and reported fishing area overlayed on BGS sediment data. There is a clear mismatch between the area considered to be fishing ground during interview with fishers compared to the area actually fished as recorded by VMS. The boundary used to define the ground limits for absolute abundance runs close to the outer survey stations.

In 2007 poor visibility hampered the survey and despite repeated attempts at over 15 stations, turbidity scores precluded the use of some of the counts. On first analysis only 20 were initially considered usable, however following reanalysis in 2010 these data were considered too unreliable. The subsequent surveys in 2008, 2009 and 2010 were far more successful. A new camera and sledge improved the resolution of the footage captured and the sea conditions were far better so the quality of the video data collected was much improved.

The algorithm used to determine the distance towed on each station changed in 2011. GPS measurements are recorded at one second intervals during each tow. Last year the distance towed was determined by summing up the distance travelled between each positional record. As the GPS transceiver is mounted high up on the research vessel, the positional data generated will be influenced by the sea-state far more than the sledge. Close examination of the GPS points showed that rolling of the vessel was recorded and this motion is not transmitted to the sledge. In order to reduce the influence of ship-motion on the sledge distance, a smooth spline model of position was fitted to each tow with sufficient flexibility to capture large, slow movements while capable of smoothing through the short frequency movement cause by wave action. The previous practice of determining distance travelled by summing up the distance between each recorded “ping” appears to have significantly overestimated the distance travelled (typically +30%, but variable depending upon the sea state for any given station) which translated into a reduced density of burrows.

### 6.4.3 Data analyses

#### Exploratory analyses of survey data

The TV abundance estimate is now made using a geostatistical approach, as opposed to the approach used last year which calculated the mean density of non-zero counts which was raised to the total fished area. The former approach ignored the spatial distribution of the counts and was highly sensitive to the total area used for raising. The geostatistical procedure takes the spatial position of the burrow density estimates and fits a semi-variogram model to describe the how variance changes with distance. The results of this model are then used in a Kriging process to produce a 3D surface of burrow density on a 500 m*500 m grid, bounded by polygon defined by the outermost survey stations. The area within the polygon is 1032 $km^2$. Uncertainty estimation of the overall abundance estimate is performed by bootstrapping the counts (resampling with replacement), refitting the semi-variogram and re-estimating the surface.

The surveys show a clear spatial pattern of distribution, largest in the central north of the patch and variable area further south. The grounds are fairly well delineated by consistently low density ground to the northeast and west (Figure 6.4.7).

As described in previous reports, the limited number of stations available on the 2007 survey and the poor quality of the data processed preclude its use in formal assessment.

The time-series of abundance estimates is too short for any meaningful comparison with lpue trends. The lpue trends (Figures 6.4.1 and 6.4.4) of the different fleet components are contradictory in terms of the direction of change in the last three years with some increasing, some flat and some declining.

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WKNEPH (2009). A number of potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. Using the same process adopted at WKNEPH, a cumulative bias correction factor for this FU was predicted to be 1.14 for FU14 (see Annex) which means the TV survey is likely to overestimate *Nephrops* abundance by 14%. The burrow abundances shown in Table 6.4.6 and Figure 6.4.7 have been adjusted to account for this estimation bias.

Comparison with the density estimates made in 2010 are presented in Table 6.4.7. The change in the algorithm used to calculate distance can be seen in the ratio of survey densities of ~+20% ~30% for 2008 and 2009 respectively. The additional effect of the change to using a geostatistical method is to further increase average denstity which a result of taking into account the spatial relationship of the measured density estimates.

### 6.4.4 Short-term projections

A landings prediction for 2011 was made for FU14 using the approach agreed at the Benchmark Workshop (WKNEPH, 2009). As the length frequency data for 2010 (and to a lesser extent 2009) to have been poorly represented by sampling, the Length Cohort Analysis presented in WGNSSK 2010 (using lengths 2006–2008) continues to be used as the basis for determining Harvest Rates as proxies for $F_{MSY}$.

The table below shows landings predicted at a range of harvest ratios including those equivalent to fishing at $F_{msy}$ proxies for the fishery in 2011 as well as $F_{current}$. Only the Harvest Rates associated with the male and combined sex $F_{msy}$ proxies are identified in the table as they are considered more appropriate to this stock (see below). The inputs to the landings forecast were as follows:

Mean weight in landings (2006–2008) = 28.9 g

Discard rate based on sampling (2006–2008) = 27.9%

Survey bias = 1.14.

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest Rate | Bias-corrected abundance (Millions) | Retained number (Millions) | Landings (tonnes) |
| | 0% | 469.45 | 0.0 | 0 |
| | 2% | | 6.8 | 196 |
| | 4% | | 13.5 | 391 |
| | 6% | | 20.3 | 587 |
| $F_{current}$ | 7.4% | | 25.0 | 722 |
| | 8% | | 27.1 | 783 |
| Transition | 8.8% | | 29.8 | 861 |
| $F_{0.1Male}$ | 9.62% | | 32.6 | 941 |
| $F_{0.1Comb}$ | 9.81% | | 33.2 | 960 |
| | 10% | | 33.8 | 978 |
| | 12% | | 40.6 | 1174 |
| $F_{35\%Male}$ | 12.50% | | 42.3 | 1223 |
| $F_{35\%Comb}$ | 13.00% | | 44.0 | 1272 |
| | 14% | | 47.4 | 1369 |
| | 15.00% | | 50.8 | 1467 |
| $F_{maxMale}$ | 15.79% | | 53.4 | 1545 |
| | 16% | | 54.2 | 1565 |
| $F_{maxComb}$ | 16.40% | | 55.5 | 1604 |
| | | | Basis | |
| Landings Mean Weight (kg) | | 0.0289 | Sampling 2006–2008 | |
| Survey Overestimate Bias | | 1.14 | As per WKNEPH 2009 (See Annex) | |
| Prop of removals retained by the fishery | | 0.79 | Sampling 2006–2008 | |

### 6.4.5 Medium-term projection

No medium-term projection was performed for this stock.

### 6.4.6 Biological reference points

Biological reference points have not been updated since 2010 as the current sampling levels are considered too low for reliable length frequency determination. MSY $B_{trigger}$ is not defined for this stock as the time-series of abundance estimates is too short.

The results of the Length Cohort Analysis model in the text-table below show the F multipliers required to achieve the potential $F_{msy}$ proxies, the harvest rates that correspond to those multiplers and the resulting level of spawner per recruit as a percentage of the virgin level.

| | | $F_{bar}$ 20-40mm | | Harvest Rates | SPR | |
|---|---|---|---|---|---|---|
| | | Female | Male | | Female | Male |
| $F_{0.1}$ | Combined | 0.10 | 0.14 | 9.8% | 44.6% | 42.6% |
| | Female | 0.11 | 0.15 | 10.2% | 43.5% | 41.4% |
| | Male | 0.10 | 0.14 | 9.6% | 45.3% | 43.3% |
| $F_{35\%Spr}$ | Combined | 0.14 | 0.20 | 13.0% | 35.9% | 33.4% |
| | Female | 0.15 | 0.21 | 13.5% | 34.7% | 32.2% |
| | Male | 0.14 | 0.19 | 12.5% | 37.1% | 34.6% |
| $F_{max}$ | Combined | 0.20 | 0.28 | 16.4% | 28.9% | 26.2% |
| | Female | 0.21 | 0.30 | 17.4% | 27.3% | 24.5% |
| | Male | 0.19 | 0.26 | 15.8% | 30.0% | 27.2% |

- Compared to other *Nephrops* fisheries in ICES Area VII the absolute population density of this stock is relatively low.
- The area covered by this fishery is relatively small and the confidence intervals for the abundance estimate are large for a geostatistical survey due to the sample density. The differences in the spatial distribution (Figure 6.4.7) suggest some degree of variation between years.
- The perception in the Irish Sea is that the growth rates in the Eastern Irish Sea are similar to those in the western Irish Sea but the mean sizes (mm CL) in each fishery are markedly different, eastern Irish Sea *Nophrops* being the larger.
- This fishery is highly seasonal, in effect a spring to early summer fishery, where the landings are predominantly male. Landings are around 60% male by weight and have ranged from 55 to 75% over the last ten years.
- The annual variability of lpue for the smaller component of the catch, plus the recent lack of recruit signals in the length frequencies suggest that recruitment to this fishery, though apparently high in 2007, is quite variable.
- Current Harvest Ratios at around 7.4% are below.

Only the combined sex $F_{msy}$ and male proxies are considered here to limit the potential of overfishing the males to meet a female MSY, in a seasonal male dominant fishery.

According to the guidelines Section 2.2, the limited time-series in the abundance indices, the uncertainties about the stability of the stock over the reference period and uncertainties about the variability of recruitment might suggest that $F_{0.1}$ be used as a proxy.

### 6.4.7 Management plans

A number of cod recovery measures have been introduced since 2000 to conserve promote recovery of Irish Sea cod stocks. These include a closure of the western Irish Sea cod spawning grounds from mid February to end of April since 2000, with a later extension to the eastern Irish Sea. Despite a partial derogation for *Nephrops* vessels during the closed period the distribution of effort on *Nephrops* has been affected by this management plan. There have also been various decommissioning schemes to reduce fishing effort. A 25% effort reduction on cod is in hand along with technical measures to reduce cod bycatch.

### 6.4.8 Uncertainties and bias in assessment and forecast

There are several key uncertainties and bias sources in the method proposed (these are discussed further in WKNEPH 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007, WKNEPHBID 2008, SGNEPS 2009). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (WKNEPH 2009).

The cumulative bias estimates for FU 14 are largely based on expert opinion. However these were based on experience on other grounds and relatively limited experience on these grounds which would make this less reliable. The precision of these cannot yet be characterized. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates.

The effect of this assumption on realized harvest rates has not been investigated but remains a key uncertainty.

### 6.4.9 Quality of assessment

The length composition and sex ratio of catches have generally been well sampled over the last ten years by E &W. However the variability of the discard rate and discard selectivity within this fishery would suggest that sampling needs to be carried out at a high level to improve on discard estimates.

The quality of landings data has improved in the last four years but because of concerns over the accuracy of earlier years, this limits the period we can be confident about trends in lpue and landings.

Underwater TV surveys have been conducted annually for this stock since 2007. The quality of the data from the first survey and the limited number of valid stations in the survey limits the number of useable surveys to 2008–2010.

The revised algorithm used to derive distance covered by the sledge in considered to be significantly more robust than the previous algorithm.

There may be the need to increase the survey area further south to ensure that the edge of the ground has been sampled.

### 6.4.10 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the Functional Unit level could confer controls to ensure effort and catch were in line with the scale of the resource.

In view of uncertainties about historical catch statistics interpretation of trends in lpue prior to 2006 should be treated with caution. Recent catch, effort and historical trends in size still offer some reference to the status of the stock. The reliability of landings statistics has improved and effort appears to be relatively stable although evidence would suggest it has become more targeted. There are no explicit recruitment indices.

The new UWTV survey data allows for the provision of catch options and also to adopt the MSY approach. The UWTV surveys are conducted annually and a benchmarked process has been adopted. Over the last four years this stock has only been assessed biannually. These data provide the opportunity to reassess this stock more reliably on an annual basis.

**Table 6.4.1. Irish Sea: Landings (tonnes) by FU, 2000–2010.**

| Year | FU14 | FU15 | Other | Total |
|---|---|---|---|---|
| 2000 | 567 | 8370 | 1 | 8938 |
| 2001 | 532 | 7441 | 3 | 7976 |
| 2002 | 577 | 6793 | 1 | 7371 |
| 2003 | 376 | 7052 | 3 | 7431 |
| 2004 | 472 | 7267 | 25 | 7764 |
| 2005 | 570 | 6554 | 103 | 7227 |
| 2006 | 628 | 7561 | 52 | 8241 |
| 2007 | 959 | 8491 | 83 | 9533 |
| 2008 | 676 | 1050 | 122 | 11306 |
| 2009 | 708 | 9198 | 57 | 9963 |
| 2010* | 563 | | | |

**Table 6.4.2. Irish Sea east (FU14): Landings (tonnes) by country, 2000–2010.**

| | Rep. Of Ireland | UK | Other Countries | Total |
|---|---|---|---|---|
| 2000 | 114 | 451 | 2 | 567 |
| 2001 | 26 | 506 | 0 | 532 |
| 2002 | 203 | 373 | 1 | 577 |
| 2003 | 69 | 306 | 1 | 376 |
| 2004 | 62 | 409 | 1 | 472 |
| 2005 | 34 | 536 | 0 | 570 |
| 2006 | 34 | 594 | 0 | 628 |
| 2007 | 86 | 873 | 0 | 959 |
| 2008 | 29 | 652 | 0 | 681 |
| 2009 | 16 | 692 | 0 | 708 |
| 2010 | 25 | 538 | 0 | 563 |

**Table 6.4.3. Irish Sea east (FU14): Effort ('000 hours trawling) and lpue (kg/hour trawling) of *Nephrops* directed voyages by UK trawlers, 2000–2010.**

| | Effort | Lpue |
|---|---|---|
| 2000 | 10.4 | 19.5 |
| 2001 | 10.1 | 17.9 |
| 2002 | 8.1 | 20.3 |
| 2003 | 6.9 | 15.9 |
| 2004 | 6.7 | 20.4 |
| 2005 | 6.6 | 20.1 |
| 2006 | 7.4 | 21.4 |
| 2007 | 6.3 | 24.0 |
| 2008 | 6.1 | 26.8 |
| 2009 | 5.6 | 25.8 |
| 2010 | 5.8 | 27.9 |

**Table 6.4.4. Irish Sea east (FU14): Effort ('000 hours trawling) and lpue (kg/hour trawling) of *Nephrops* directed voyages by Republic of Ireland trawlers, 2000–2010.**

| | Effort | Lpue |
|---|---|---|
| 2000 | 2.5 | 43.6 |
| 2001 | 0.5 | 43.9 |
| 2002 | 3.3 | 57.1 |
| 2003 | 1.1 | 37.6 |
| 2004 | 1.4 | 39.7 |
| 2005 | 0.8 | 40.6 |
| 2006 | 0.7 | 53.7 |
| 2007 | 1.7 | 49.3 |
| 2008 | 0.6 | 41.6 |
| 2009 | 0.4 | 40.1 |
| 2010 | 0.7 | 60.5 |

**Table 6.4.5. Irish Sea east (FU14): Mean sizes (mm CL) of male and female *Nephrops* from UK vessels landing in England and Wales, 2000–2009.**

| | Catch | | Landings | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| 2000 | 29.2 | 28.3 | 33.7 | 32.3 |
| 2001 | 31.6 | 29.2 | 34.2 | 32.5 |
| 2002 | 32 | 29.2 | 35.1 | 32 |
| 2003 | 36.4 | 30.7 | 38.4 | 34.5 |
| 2004 | 32.2 | 29.4 | 35.2 | 33.1 |
| 2005 | 32.8 | 29.9 | 34.6 | 32.3 |
| 2006 | 33.8 | 31.4 | 36.1 | 32.6 |
| 2007 | 31.7 | 30 | 33.5 | 32.1 |
| 2008 | 33 | 30 | 34 | 31.4 |
| 2009 | 34.5 | 31.3 | 34.6 | 31.8 |

**Table 6.4.6. Irish Sea east (FU14): Results from NI/ROI/E&W collaborative UWTV surveys of *Nephrops* grounds in 2007–2009. Corrected for bias and Wigtown Bay area.**

| Year | No stations | Mean station density | Mean Kriged density | Bias-corrected abundance (millions) | 95% CI | Removals (millions) | Harvest Rate |
|---|---|---|---|---|---|---|---|
| 2007 | | | | | | | |
| 2008 | 32 | 0.43 | 0.49 | 451.4 | 93 | 32.4 | 7.19% |
| 2009 | 32 | 0.33 | 0.40 | 369.0 | 73 | 33.9 | 9.20% |
| 2010 | 26 | 0.42 | 0.51 | 469.5 | 106 | 27.0 | 5.75% |

**Table 6.4.7. Irish Sea east (FU 14). Comparison of TV survey results with those obtained by WGCSE 2010.**

| Survey year | 2010 burrow density estimate | 2011 burrow density estimate | ratio to 2010 | 2011 kriged density | ratio to 2010 |
|---|---|---|---|---|---|
| 2008 | 0.36 | 0.43 | 1.19 | 0.49 | 1.36 |
| 2009 | 0.25 | 0.33 | 1.32 | 0.40 | 1.60 |

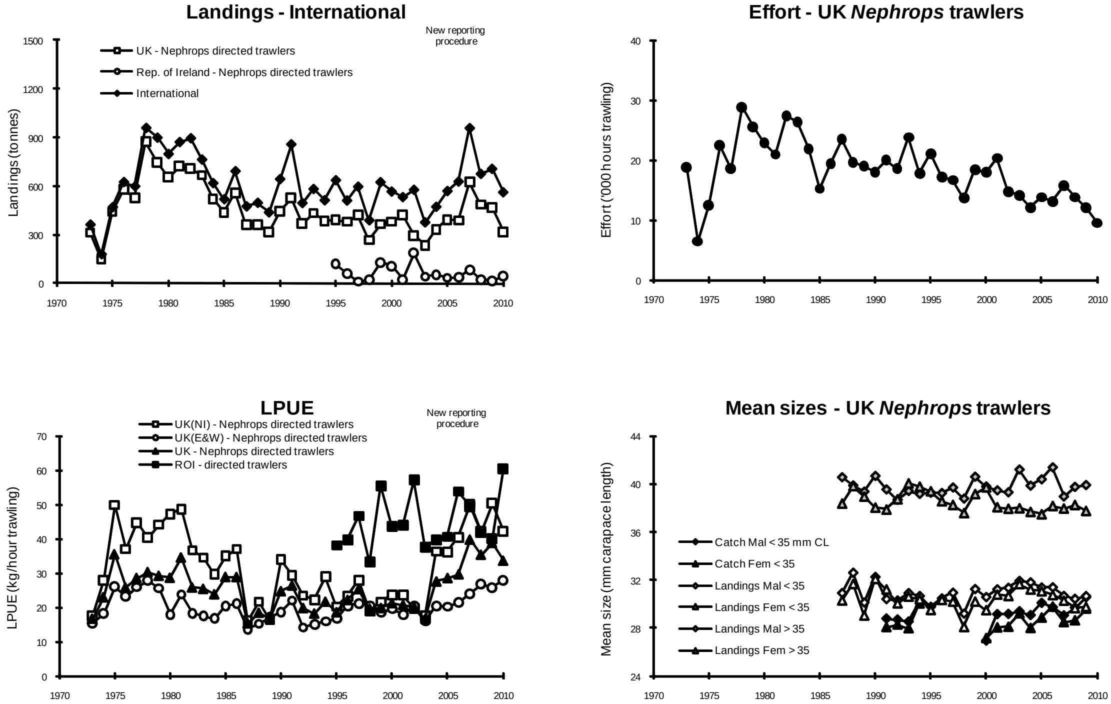



**Figure 6.4.1. Irish Sea east (FU14). Long-term trends in landings, effort, lpues and mean sizes of *Nephrops*. Note that Mean sizes were not updated in 2011 due to insufficient sampling levels.**

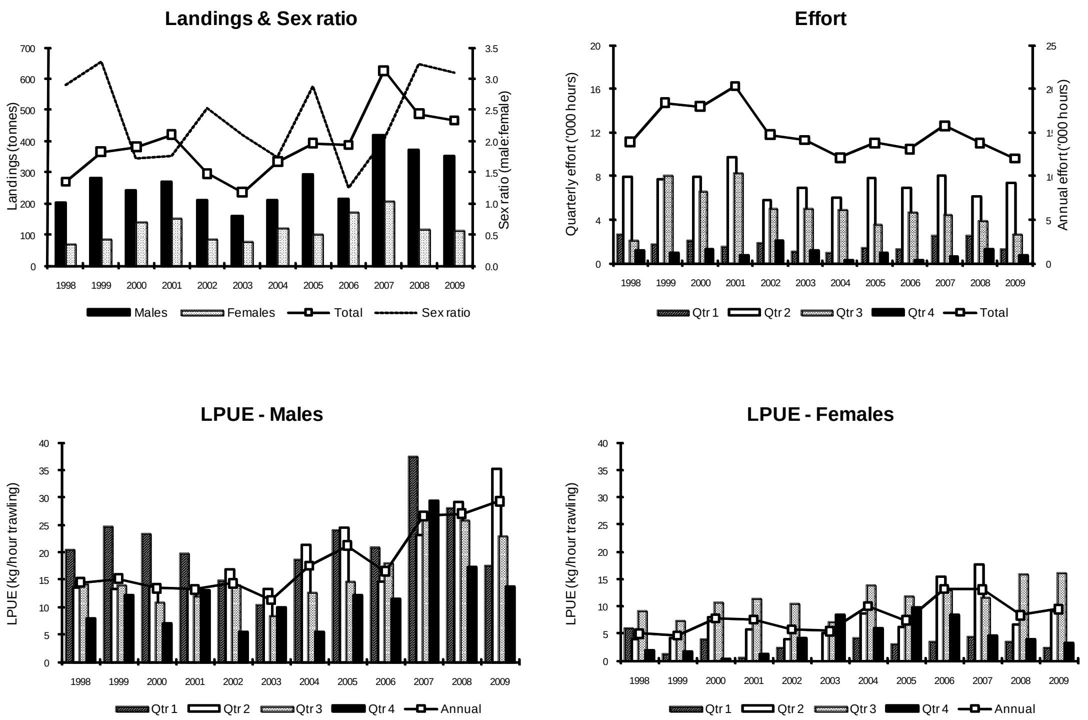



**Figure 6.4.2. Irish Sea east (FU14). Landings, effort and lpues by quarter and sex from UK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels.**

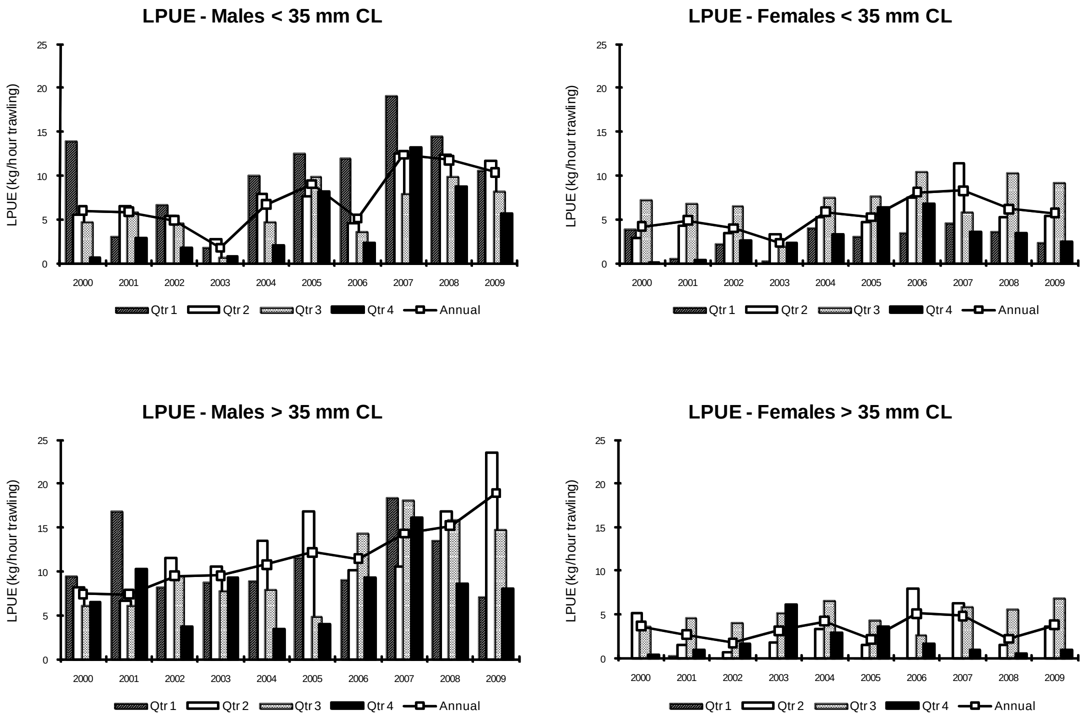



**Figure 6.4.3. Irish Sea east (FU14). Lpues by sex and quarter for selected size groups, IK *Nephrops* directed trawlers. Not updated in 2011 due to insufficient sampling levels.**

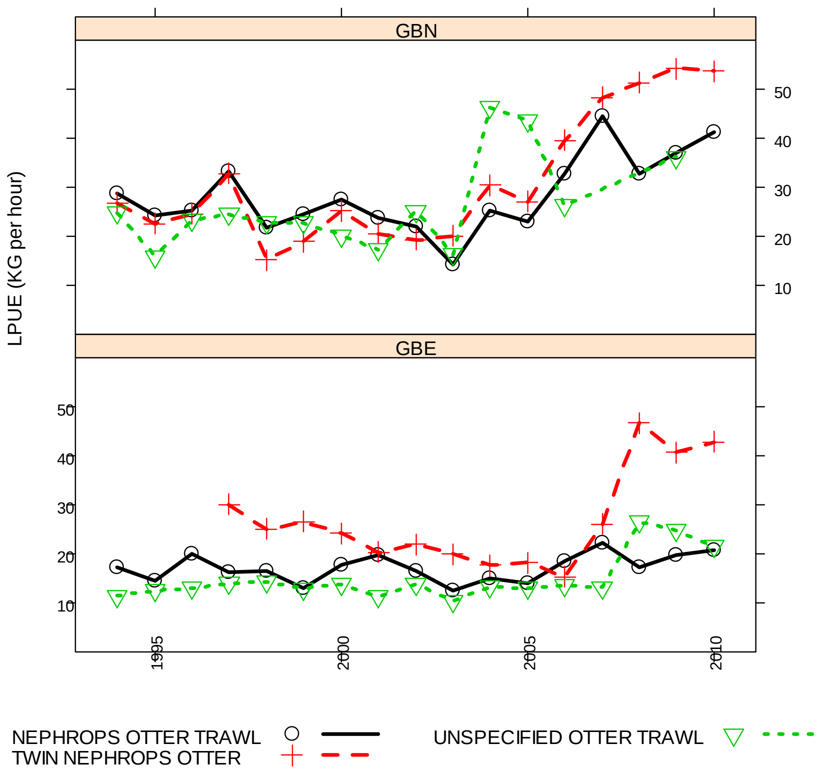



**Figure 6.4.4. Lpue (kg per hour) by gear type for English (GBE) and Northern Irish (GBN) vessels targeting *Nephrops* (>25% *Nephrops* in landings, using towed gears 70–99 mm mesh).**

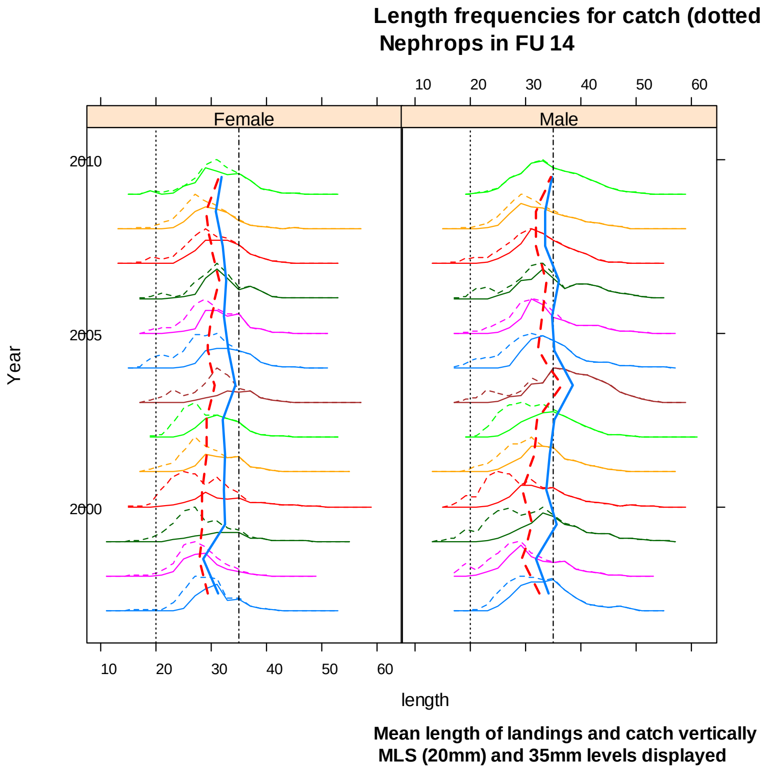



**Figure 6.4.5. Irish Sea east (FU14): Length frequency distributions of male and female landings and catch, 1997–2009. Not updated in 2011 due to insufficient sampling levels.**

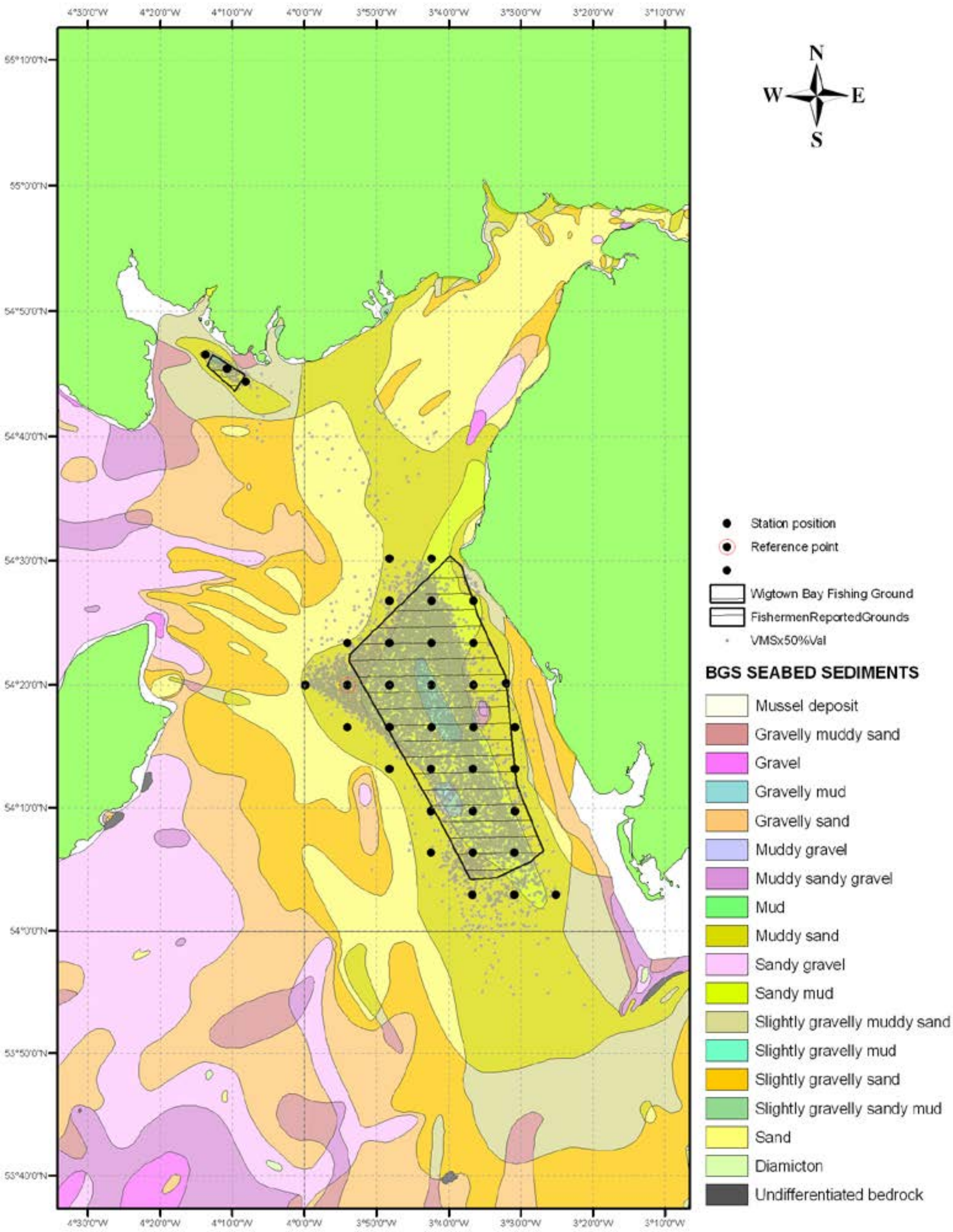



**Figure 6.4.6. Irish Sea east (FU14): UWTV Survey stations (black circles), VMS positions for *Nephrops* fishing activity, fishers' reported fishing grounds and BGS sediment map.**

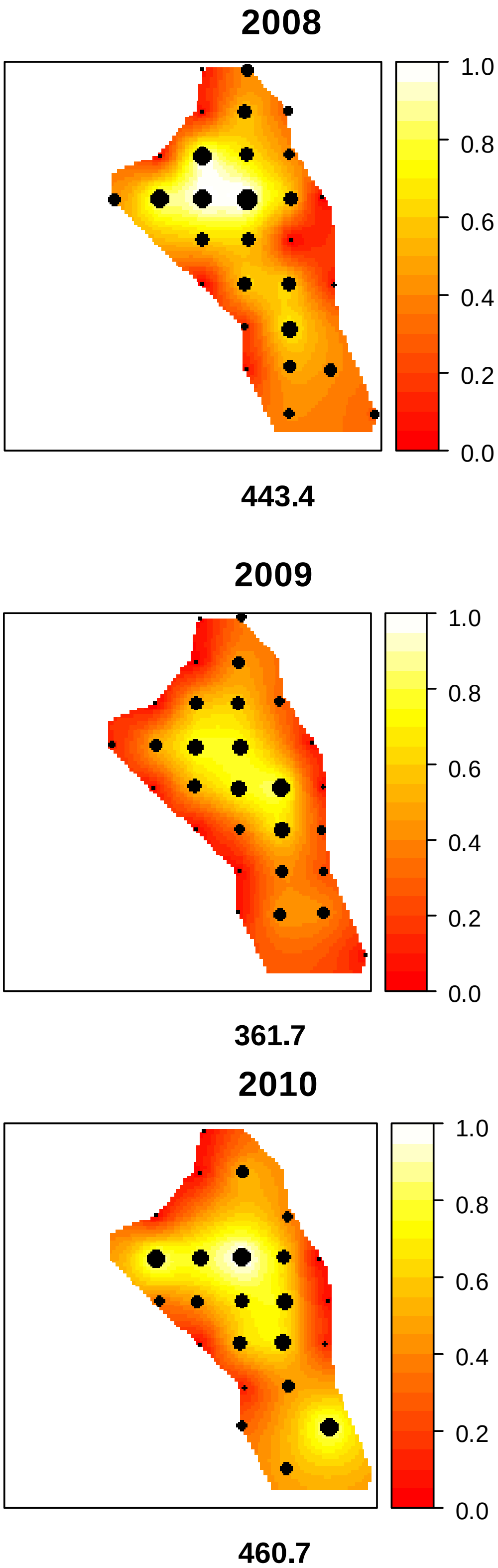



**Figure 6.4.7. Irish Sea east (FU14): Burrow density estimates from the UWTV Survey. Abundance estimates given at the bottom of each plot are bias-adjusted (but does not contain the additional 1.9% for Wigtown Bay).**

## 6.5 Irish Sea West, FU15

### Type of assessment in 2011

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the general process defined by WK*NEPH* (2009) described in the Stock Annex.

### 6.5.1 General

#### Stock description and management units

A TAC is in place for ICES Areas VII which does not correspond to the assessment units. As *Nephrops* are limited to muddy habitats the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as six separate Functional Units (Figure 6.1.1, FU15 is shaded light yellow). There are also some smaller catches from areas outside these Functional Units. The ICES statistical rectangles covered by the Functional Units ICES Area VII are listed in the table below.

| FU no. | Name | ICES Divisions | Statistical rectangles |
|---|---|---|---|
| 14 | Irish Sea East | VIIa | 35–38E6; 38E5 |
| 15 | Irish Sea West | VIIa | 36E3; 35–37 E4–E5; 38E4 |
| 16 | Porcupine Bank | VIIb,c,j,k | 31–36 D5–D6; 32–35 D7–D8 |
| 17 | Aran Grounds | VIIb | 34–35 D9–E0 |
| 19 | Ireland SW and SE coast | VIIa,g,j | 31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3 |
| 20–22 | Celtic Sea | VIIg,h | 28–30 E1; 28–31 E2; 30–32 E3; 31 E4 |

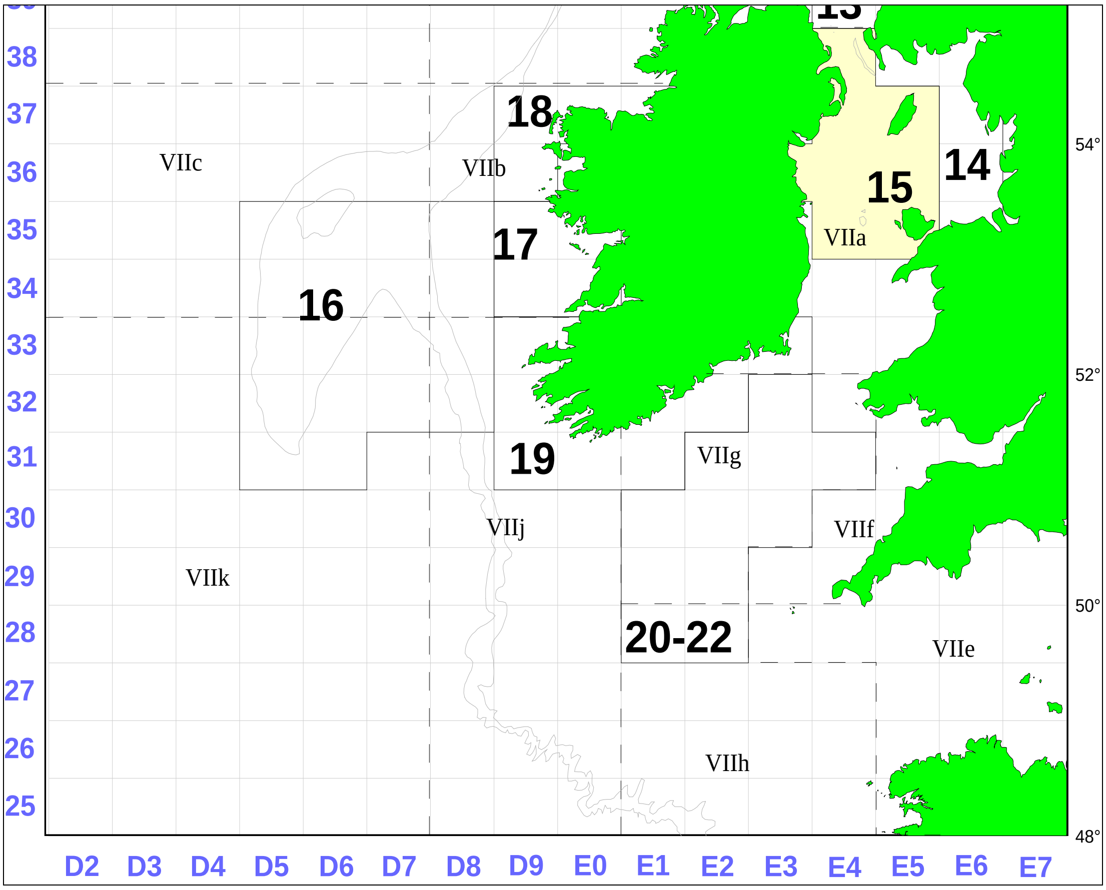



**Figure 6.1.1.** ***Nephrops*** **Functional Units in Subarea VII. The TAC covers all of Subarea VII. The stock area FU15 is shaded yellow.**

## Management applicable to 2010 and 2011

**TAC in 2010**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 346 | |
| France | 5 455 | |
| Ireland | 8 273 | |
| United Kingdom | 7 358 | |
| EU | 22 432 | |
| TAC | 22 432 | Analytical TAC |

**TAC in 2011**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 306 ([1]) | |
| France | 5 291 ([1]) | |
| Ireland | 8 025 ([1]) | |
| United Kingdom | 7 137 ([1]) | |
| EU | 21 759 ([1]) | |
| TAC | 21 759 ([1]) | Analytical TAC |

([1]) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

| | |
|---|---|
| Spain | 75 |
| France | 305 |
| Ireland | 463 |
| United Kingdom | 411 |
| EU | 1 254 |

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VIIIa, VIIIb, VIIId and VIIIe (NEP/8ABDE.) |
|---|---|---|
| Spain | 234 | |
| France | 3 665 | |
| EU | 3 899 | |
| TAC | 3 899 | Analytical TAC |

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VIIIc (NEP/08C.) |
|---|---|---|
| Spain | 87 | |
| France | 4 | |
| EU | 91 | |
| TAC | 91 | Analytical TAC |

The minimum landings size implemented by EC for the Irish Sea is 20 mm CL, which is less than the rest of the ICES Area VII (set at 25 mm).

### The fishery in 2010

The *Nephrops* fishery in the Irish Sea west is economically the most important in ICES Division VIIa and is mainly prosecuted by vessels from UK (Northern Ireland) and Ireland. A decommissioning programme was in operation in Ireland during 2007 and 2008. 14 vessels active in the FU15 fishery were decommissioned. These vessels accounted for approximately 28% of the Irish landings in 2007–2008.

Working Group landings from FU 15 are presented in Table 6.5.1 and Figure 6.5.1. Total declared international *Nephrops* landings reported from FU15 in 2010 was 8963 t and was the third highest since 1999. Ireland's landings were 2578 t, of similar magnitude to 2009 landings. UK vessels landed 6384 t in 2010 and Northern Ireland landings contributed to over 95% of this figure.

Effort by the UK fleet remained relatively stable since 2002 following a steady decline from the early 1990s. Following a small reduction in effort in 2009, there has been a slight increase in effort in 2010, back to the 2008 levels (Table 6.5.2). Ireland's effort showed a marked reduction in 2009 and effort remained at similar levels in 2010 (Table 6.5.3). The Irish fleet lpue remained at record high levels in 2010, whereas Northern Ireland lpue decreased. The mean sizes of *Nephrops* in the catches of both the Northern Ireland and Ireland fisheries have fluctuated for the last decade (Table 6.5.4–6.5.5, Figure 6.5.1). There has been an increasing trend in the mean size of males and females in the landings in catches over the longer term (Figure 6.5.2).

Discarding is highly variable, mainly driven by market demand, and was 24% of the catch by number in 2010 (Table 6.5.6).

Further general information on the fishery can be found in the Stock Annex.

#### ICES advice applicable to 2010

*"Single-stock exploitation boundaries*

*June*

*ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed $F_{0.1}$. This corresponds to landings of no more than 5465 t for the western Irish Sea stock.*

*November*

*ICES advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed $F_{0.1}$. This corresponds to landings of no more than 5892 t for the western Irish Sea stock."*

#### ICES advice applicable to 2011

*MSY approach*

*Following the ICES MSY framework implies harvest ratio to be reduced to 17.1, resulting in landings of 8700 t in 2011.*

*Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced (0.8 x harvest ratio (F2010) + 0.2 x harvest ratio($F_{MSY}$) = 19.0*0.8 + 17.1*0.2 to 18.6% resulting in landings of 9500 t in 2011.*

### 6.5.2 Data

An overview of the data provided and used by the WG is shown in Table 2.1. Commercial size composition data for landings and discards were provided by Northern Ireland and Ireland. Other biological data used in the assessment were as listed in the Stock Annex compiled by the benchmark meeting WK*NEPH* (2009).

#### Surveys

Since 2003 Ireland and Northern Ireland have jointly carried out underwater television surveys of the main *Nephrops* grounds in the western Irish Sea. These surveys were based on a randomized fixed grid design. The methods used during the surveys were similar to those employed for UWTV surveys of other *Nephrops* stocks and were as agreed by WKNEPHTV, WKNEPBID, SGNEPS and WK*NEPH*. An average of 145 valid stations was covered by the two surveys combined and the data were raised to a stock area of around 5340 x $10^{-6}$ $km^2$ as detailed in Table 6.5.7. Details of the survey methodology are available in WKNEPHTV. Figure 6.5.3 shows the distribution of stations sampled in 2010 which was a slightly offset grid from those sampled in 2009. Figure 6.5.6 is a contour plot of the krigged density estimates for FU15 over the period 2003–2010. The survey abundance estimate in 2010 is approximately 8% higher than the 2009 estimate, but remains just below the average of the time-series.

The use of the UWTV surveys for the provision of *Nephrops* management advice was extensively reviewed by WK*NEPH* (ICES, 2009) and potential biases were highlighted including those due to edge effects; species burrow misidentification and burrow occupancy. A cumulative bias correction factor estimated for FU15 was 1.14 which means the TV survey is likely to overestimate *Nephrops* abundance by 14%.

In addition to UWTV surveys Northern Ireland have completed spring (April) and summer (August) *Nephrops* trawl surveys since 1994 and provide data on catch rates, size composition and biological data from fixed stations in the western Irish Sea as detailed in the Stock Annex (Figure 6.5.4). Due to reduced financial resources the spring survey-series was terminated in 2010 as part of a national rationalization of the survey programme considering benefits to management and stock assessment. The summer trawl survey catch rates correlate somewhat with UWTV survey abundance estimates (Figure 6.5.5), but shows a deviating trend over the last two years. The longer time-series of the trawl survey shows that catch rates in the last few years (2005–2010) are close to the mean of the series when UWTV burrow abundances were in the range of 5–6 billion burrows. Mean carapace length-by-sex has remained stable over the time-series (Figure 6.5.4).

### 6.5.3 Assessment

#### Approach in 2011

The assessment approach used by WGCSE 2011 is consistent with that set out in the Stock Annex and WK*NEPH* (ICES, 2009).

Last year the final SCAs (Separable cohort analysis) used landings and discard length distributions by sex derived from 2008–2009 sampling only, due to limited sampling in 2006–2007. Since the most recent three years of sampling data were available, three year averages of mean weighs in the landings and proportions retained in the fishery have been used (2008–2010). This is in line with the procedure for other stocks. Different selection patterns between sexes were included in the model to take into account differences in selection observed in the fishery.

Both the SCA and LCA were performed including the three year sampling information (2008–2010). The model fits were similar to last year and the harvest rates corresponding to $F_{MSY}$ proxies were very similar (see table below from the SCA output with level and direction of change from the 2010 WG analysis in parentheses, if any).

| | | Fbar 20–40 mm | | Harvest Rate | % Virgin Spawner per Recruit | |
|---|---|---|---|---|---|---|
| | | Female | Male | | Female | Male |
| $F_{0.1}$ | Comb | 0.13 (-0.01) | 0.16 | 10.3% (-0.3) | 41.0% (+0.4) | 42.2% (-1.8) |
| $F_{0.1}$ | Female | 0.13 | 0.15 (-0.01) | 9.9% (-0.3) | 42.2% (+0.5) | 43.3% (-1.8) |
| $F_{0.1}$ | Male | 0.14 | 0.16 (-0.01) | 10.7% (-0.3) | 39.9% (+0.4) | 41.1% (-1.8) |
| $F_{35\%}$ | Comb | 0.18 | 0.21 (-0.01) | 13.0% (-0.4) | 33.5% (+0.4) | 34.5% (-0.7) |
| $F_{35\%}$ | Female | 0.17 | 0.20 | 12.7% | 34.3% (-0.4) | 35.4% (-2.5) |
| $F_{35\%}$ | Male | 0.18 (-0.01) | 0.21 (-0.02) | 13.4% (-0.7) | 32.8% (+0.8) | 33.8% (-0.8) |
| $F_{max}$ | Comb | 0.25 (+0.01) | 0.30 (+0.01) | 17.2% (+0.1) | 25.0% (-0.5) | 25.7% (-2.3) |
| $F_{max}$ | Female | 0.25 (+0.01) | 0.30 (+0.01) | 17.2% (+0.1) | 25.0% (-0.5) | 25.7% (-2.3) |
| $F_{max}$ | Male | 0.25 (+0.01) | 0.30 (+0.01) | 17.2% (+0.1) | 25.0% (-0.5) | 25.7% (-2.3) |

#### Comparison with previous assessments

The assessment in 2011 is based on trends in population indicators and catch options derived from UWTV surveys as last year, i.e. same methods and similar data. Last year the mean size and discard rates were derived from two years data. A reanalysis was performed using three years data (2008–2010), similar to other stocks, and the results were consistent with last year's assessment. The stock size is estimated to have increased and harvest ratio has decreased slightly based on the UWTV survey (Figure 6.5.10).

#### State of the stock

This stock has sustained landings at around 9000 t for many years. The stock increased until 2003. Since then, the stock has decreased but is still at high levels. UWTV abundance estimates suggest that the stock size has increased in 2010 and is close to average of the UWTV time-series 2003–2010 (geometric mean: 5.8 billion). Figure 6.5.10 is the stock summary plot for FU15. Recent harvest rates have fluctuated around $F_{MSY}$.

### 6.5.4 MSY explorations

The MSY explorations carried out above proved very consistent with that analysis carried out last year. As discussed by WGCSE 2009, no dynamic population model is fitted to the data so no estimates of spawning–stock and recruitment were available to determine $F_{MSY}$. In response to the recommendations of WKFRAME (2010), the Bell/Dobby combined sex–length cohort analysis (LCA) model used to determine Harvest Rates associated with fishing at $F_{0.1}$ and $F_{max}$ at WK*NEPH* (2009) was adapted to also output estimates of $F_{35\%Spr}$. These F estimates could be used as a proxy for $F_{MSY}$. The underwater TV survey is presented as the best available information on the FU15 *Nephrops* stock and provides a fishery-independent estimate of *Nephrops* abundance. Catch–length data were available for Ireland and Northern Ireland for 2008 and 2009 and were used in an SLCA model along with the biological parameter described in the Stock Annex. For other stocks three years of length data were used in the analysis but in this case there was a gap in sampling in 2006 and 2007. YPR curves and other plots generated by the model are shown in Figure 6.5.8. The F multipliers required to achieve the various $F_{MSY}$ proxies are shown in the text table below along with the harvest rates that correspond to those multipliers.

| | | Fbar 20-40 mm | | Harvest Rate | % Virgin Spawner per Recruit | |
|---|---|---|---|---|---|---|
| | | Female | Male | | Female | Male |
| $F_{0.1}$ | Comb | 0.14 | 0.16 | 10.6% | 40.6% | 44.0% |
| $F_{0.1}$ | Female | 0.13 | 0.16 | 10.2% | 41.7% | 45.1% |
| $F_{0.1}$ | Male | 0.14 | 0.17 | 11.0% | 39.5% | 42.9% |
| $F_{35\%}$ | Comb | 0.18 | 0.22 | 13.4% | 33.1% | 36.2% |
| $F_{35\%}$ | Female | 0.17 | 0.20 | 12.7% | 34.7% | 37.9% |
| $F_{35\%}$ | Male | 0.19 | 0.23 | 14.1% | 31.6% | 34.6% |
| $F_{max}$ | Comb | 0.24 | 0.29 | 17.1% | 25.5% | 28.0% |
| $F_{max}$ | Female | 0.24 | 0.29 | 17.1% | 25.5% | 28.0% |
| $F_{max}$ | Male | 0.24 | 0.29 | 17.1% | 25.5% | 28.0% |

WGCSE took into account the following considerations:

- Compared to other *Nephrops* fisheries in the ICES area the population density of FU15 is the highest of all stocks >~1/m$^2$ (Figure 6.5.9). These high densities are observed throughout time and space. The high observed density implies intense competition for space and food on the seabed and that sperm limitation is not likely to be a problem.
- The seven year time-series of UWTV data for FU15 and the 2009 survey shows the stock is relatively stable. Trawl survey cpue since 1994 indicates that abundance has been at high levels over the last seven years (assuming constant survey catachability).
- The growth rate of *Nephrops* in this stock is known to be slow and they exhibit a relatively small size of maturity (McQuaid *et al.*). There appears to be little change is the size composition in catches despite over 40 years of intensive fishing (Lordan, 2010, WD2).
- This fishery occurs throughout the year and does not exhibit major inter annual changes seasonal pattern. Landings have fluctuated around 9000 t for over the 35 years.
- Larval production studies show that over 440 x $10^9$ larvae were produced in 1995 (Briggs *et al.*, 2002). This >70 times more larvae produced annual than current stock size estimates. The high larval production is coupled with a strong retention mechanizm and depositional environment due to the western Irish Sea gyre ensures continued good recruitment (Hill *et al.*, 1994).
- The harvest rate in recent years is thought to have been above $F_{max}$ (note: harvest rates prior to 2007 are lower bounds as landings may have been under reported) with no apparent affect on the stock (Figure 6.5.10).

The WG and Review Group concluded that a combined sex $F_{max}$ was a suitable $F_{msy}$ proxy for this stock. This corresponds to a harvest rate of 17.1%. On the basis of the MSY explorations carried out in 2011 WGCSE concluded that there was no need to adjust the harvest rate proposed in 2010.

### 6.5.5 Short-term projections

A landings prediction for 2011 was made for FU15 using the approach agreed at the Benchmark Workshop (WK*NEPH* ICES, 2009). Catch option table inputs are given in (Table 6.5.8).

Table 6.5.9 shows landings predictions at various harvest ratios, including those equivalent to fishing within the range of $F_{0.1}$ to $F_{max}$. The $F_{2010}$ (mean F 2008–2010) for the western Irish Sea is estimated to be slightly below the $F_{msy}$ proxy proposed by ICES.

### 6.5.6 Biological reference points

The cpue data from the trawl surveys was scaled to the UWTV index to provide a $B_{trigger}$ approximation based on the mean of the five lowest survey catch rates in the time-series (Figure 6.5.5). Harvest ratios equating to a range of fishing mortalities including $F_{0.1}$, $F_{35\%}$ and $F_{max}$ are provided above. These calculations assumed that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium. The WG concluded that a combined sex $F_{max}$ was a suitable $F_{msy}$ proxy for this stock. This corresponds to a harvest rate of 17.1%.

### 6.5.7 Management plans

A number of cod recovery measures have been introduced since 2000 to promote recovery of Irish Sea cod stocks. These include a closure of the western Irish Sea cod spawning grounds from mid February to end of April since 2000, with a later extension to the eastern Irish Sea closure. Despite a partial derogation for *Nephrops* vessels during the closed period the distribution of effort on *Nephrops* has been affected by this management plan. There have also been decommissioning schemes to reduce fishing effort.

### 6.5.8 Uncertainties in the assessment and forecast

Uncertainties in the survey, mean weight in the landings and discard rates are not taken into account in the deterministic catch option. There is some variability of these over time. Due to the lack of sampling in 2006 and 2007 the deterministic estimates of mean weights in the landings and discard rates were based on 2008 and 2009 sampling only in the 2010 assessment. This year the catch options calculations uses the usual three data (2008–2010). The YPR analysis with the updated three years of data showed that harvest rates for various $F_{msy}$ proxies were very consistent with reference values calculated last year (corresponding harvest rate at $F_{max}$ was 17.2% compared to 17.1% determined last year). The WG concluded that there is no need to update the reference points.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WK*NEPH* 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007, WKNEPHBID 2008, SGNEPS 2009). These have lead to a revision in the historical time-series of survey abundance estimates for FU15, which was presented to last year's Working Group. Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al*., 1996).

Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (WK*NEPH*

2009). The survey estimates themselves are very precisely estimated (CVs 3–5%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU15 are largely based on expert opinion (see Stock Annex). The precision of these bias corrections cannot yet be characterized but is likely to be higher than that observed in the survey.

There is a gap of 16 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realized harvest rates has not been investigated but remains a key uncertainty.

The quality of landings data has improved since 2007 with the implementation of sales notes and buyers and sellers legislation. Prior to that there were concerns that landings were underreported. The harvest ratio may be underestimated prior to 2007.

### 6.5.9 Management considerations

The FU15 *Nephrops* fishery first developed in the late 1950s. Since then it has sustained landings of around 9000 t for more than 35 years. Fishing effort in the past has been very high but has declined somewhat in recent years. The environment in the western Irish Sea is very suitable for *Nephrops* with a large mud patch and gyre which retains the larvae over the mud patch thus ensuring good recruitment. The ground can be characterized as an area of very high densities of small *Nephrops*. All available information indicates that size structure of catches appears to have changed little since the fishery first began.

The *Nephrops* trawl fisheries take bycatches of other species, especially juvenile whiting but also cod. Catches of these species should be reduced to as low as possible a level because of the poor status of these stocks.

The cod long-term plan was introduced in 2009 (EC 1342/2008). Annual effort in *Nephrops* trawl fisheries (Effort group TR2 OTB 70–99 mm) in Division VIIa has been reduced by 25% in 2009 and a further 25% in 2010 and is expected to be very restrictive. Although Irish effort decreased by 23% from the 2008 level, the 2010 UK TR2 effort remains at the 2008 level. The implementation of the cod long-term plan is expected to cause large changes in fishing patterns as effort allocations become more restrictive. Vessels may also start using more selective gears to reduce cod catches to less than 1 or 1.5% of total catch. Since 2009, four Irish vessels began using "Swedish grids" in the fishery and significantly reduced bycatches of cod, whiting and haddock (STECF 01-2010).

ICES has repeatedly advised that management should be at a smaller scale than ICES Subarea VII. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort are at the same scale as the resource.

### 6.5.10 References

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STECF 01-2010. 33rd Plenary meeting report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-10-01) plenary meeting, 26–30 April 2010, Norwich. Edited by John Casey and Hendrik Dörner.

**Table 6.5.1. Irish Sea west (FU15): Landings (tonnes) by country, 2000–2010.**

| Year | Rep. of Ireland | Isle of Man | UK | Other countries | Total |
|---|---|---|---|---|---|
| 2000 | 3,433 | 0 | 4937 | 0 | 8370 |
| 2001 | 2,689 | 3 | 4749 | 0 | 7441 |
| 2002 | 2,291 | 1 | 4501 | 0 | 6793 |
| 2003 | 2,709 | 4 | 4352 | 0 | 7065 |
| 2004 | 2,786 | 13 | 4470 | 1 | 7270 |
| 2005 | 2,133 | 0 | 4420 | 0 | 6554 |
| 2006 | 2,051 | 1 | 5508 | 1 | 7561 |
| 2007 | 2,767 | 0 | 5724 | 0 | 8491 |
| 2008 | 3,132 | 50 | 7323 | 2 | 10508 |
| 2009 | 2,343 | 1 | 6855 | 0 | 9198 |
| 2010* | 2,578 | 0 | 6384 | 0 | 8963 |

* provisional

**Table 6.5.2. Irish Sea west (FU15): Landings (tonnes), effort ('000 hours trawling), and lpue (kg/hour trawling) of Northern Ireland *Nephrops* trawlers, 2000–2010.**

| Year | Effort | Landings | LPUE |
|---|---|---|---|
| 2000 | 168.7 | 4758 | 28.2 |
| 2001 | 163.7 | 4587 | 28.0 |
| 2002 | 130.8 | 4495 | 34.4 |
| 2003 | 136.1 | 4146 | 29.0 |
| 2004 | 144.3 | 4273 | 29.6 |
| 2005 | 138.4 | 4235 | 30.6 |
| 2006 | 144.1 | 5356 | 37.2 |
| 2007 | 126.9 | 5512 | 43.4 |
| 2008 | 141.4 | 7056 | 49.9 |
| 2009 | 134.7 | 6487 | 48.2 |
| 2010* | 141.1 | 5888 | 41.7 |

* provisional

**Table 6.5.3. Irish Sea west (FU15): Catches and landings (tonnes), effort ('000 hours trawling), cpue and lpue (kg/hour trawling) Republic of Ireland *Nephrops* Directed Trawlers 2000–2010.**

| Year | Effort | Landings | LPUE |
|---|---|---|---|
| 2000 | 61.1 | 3160 | 51.7 |
| 2001 | 52.4 | 2475 | 47.2 |
| 2002 | 49.0 | 2238 | 45.7 |
| 2003 | 45.4 | 2680 | 59.1 |
| 2004 | 51.5 | 2535 | 49.3 |
| 2005 | 48.6 | 2062 | 42.4 |
| 2006 | 50.6 | 1959 | 38.7 |
| 2007 | 48.0 | 2578 | 53.7 |
| 2008 | 47.1 | 3076 | 65.3 |
| 2009 | 34.0 | 2290 | 67.3 |
| 2010* | 36.1 | 2481 | 68.8 |

* provisional

**Table 6.5.4. Irish Sea west (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 2000–2010.**

| Year | Catches | | Landings | | Discards | |
|---|---|---|---|---|---|---|
| | Males | Females | Males | Females | Males | Females |
| 2000 | 27.7 | 24.5 | 29.4 | 26.3 | 22.5 | 22.6 |
| 2001 | 25.7 | 23.6 | 26.1 | 24.4 | 21.7 | 21.2 |
| 2002 | 26.7 | 24.1 | 26.7 | 24.9 | 21.8 | 21.7 |
| 2003 | na | na | na | na | na | na |
| 2004 | na | na | na | na | na | na |
| 2005 | na | na | na | na | na | na |
| 2006 | na | na | na | na | na | na |
| 2007 | na | na | na | na | na | na |
| 2008 | 25.9 | 24.6 | 26.9 | 25.5 | 21.4 | 21.5 |
| 2009 | 27.7 | 25.1 | 29.3 | 26.5 | 23.6 | 23.2 |
| 2010* | 28.3 | 25.6 | 29.5 | 26.3 | 23.2 | 22.8 |

* provisional   na = not available

**Table 6.5.5. Irish Sea west (FU15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 2000–2010.**

| Year | Catches | | Landings | | Discards | |
|---|---|---|---|---|---|---|
| | Males | Females | Males | Females | Males | Females |
| 2000 | 29.1 | 27.1 | 32.2 | 29.7 | 24.3 | 24.0 |
| 2001 | 26.7 | 24.8 | 28.6 | 27.0 | 23.0 | 22.2 |
| 2002 | 28.9 | 25.4 | 30.2 | 27.8 | 24.6 | 23.6 |
| 2003 | 27.7 | 24.9 | 29.7 | 26.9 | 24.0 | 23.1 |
| 2004 | 28.1 | 26.1 | 29.7 | 27.8 | 23.9 | 23.7 |
| 2005 | 28.5 | 26.8 | 30.1 | 29.1 | 23.9 | 23.2 |
| 2006 | 27.7 | 25.5 | 29.5 | 27.1 | 23.8 | 23.1 |
| 2007 | 27.7 | 25.4 | 29.8 | 27.9 | 24.0 | 23.3 |
| 2008 | 27.4 | 24.6 | 28.9 | 26.6 | 22.0 | 21.4 |
| 2009 | 28.5 | 26.3 | 30.5 | 29.2 | 24.3 | 23.4 |
| 2010* | 28.0 | 25.9 | 29.6 | 27.6 | 23.8 | 23.3 |

* provisional

**Table 6.5.6. Irish Sea west (FU15): Proportion discarded by weight and number from FU15. (note a 10% survivorship of discards is assumed in HR and forecast calculations).**

| Year | Discards By Weight | Discards by number |
|---|---|---|
| 1986 | 0.14 | 0.27 |
| 1987 | 0.14 | 0.24 |
| 1988 | 0.07 | 0.15 |
| 1989 | 0.08 | 0.16 |
| 1990 | 0.03 | 0.07 |
| 1991 | 0.03 | 0.08 |
| 1992 | 0.13 | 0.22 |
| 1993 | 0.17 | 0.29 |
| 1994 | 0.13 | 0.25 |
| 1995 | 0.18 | 0.32 |
| 1996 | 0.14 | 0.27 |
| 1997 | 0.12 | 0.23 |
| 1998 | 0.15 | 0.27 |
| 1999 | 0.21 | 0.35 |
| 2000 | 0.22 | 0.36 |
| 2001 | 0.22 | 0.36 |
| 2002 | 0.20 | 0.31 |
| 2003 | 0.27 | 0.42 |
| 2004 | 0.22 | 0.34 |
| 2005 | 0.18 | 0.31 |
| 2006 | 0.23 | 0.36 |
| 2007 | 0.28 | 0.42 |
| 2008 | 0.12 | 0.20 |
| 2009 | 0.24 | 0.37 |
| 2010 | 0.15 | 0.24 |
| Max | 0.28 | 0.42 |
| Min | 0.03 | 0.07 |
| Average | 0.16 | 0.27 |

**Table 6.5.7. Irish Sea west (FU15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003–2010.**

| Ground | Year | Number of stations | Mean Density (No./M²) | Domain Area (km²) | Estimate (billions) | CV on Burrow estimate |
|---|---|---|---|---|---|---|
| Western Irish Sea | 2003 | 160 | 1.12 | 5295 | 6.3 | 3% |
| | 2004 | 147 | 1.13 | 5310 | 6.3 | 3% |
| | 2005 | 141 | 1.16 | 5281 | 6.5 | 4% |
| | 2006 | 138 | 1.10 | 5194 | 6.2 | 4% |
| | 2007 | 148 | 1.06 | 5285 | 5.9 | 3% |
| | 2008 | 141 | 0.88 | 5287 | 4.9 | 3% |
| | 2009 | 142 | 0.95 | 5267 | 5.3 | 3% |
| | 2010 | 149 | 1.02 | 5307 | 5.7 | 3% |

**Table 6.5.8. Irish Sea west (FU15): Catch option table inputs. Data used for 2012 catch prediction are shaded.**

| Year | Landings in Number (millions) | Discards in Number (millions) | Removals in Number (millions) | Prop Removals Retained | Adjusted Survey (billions) | Harvest Ratio | Landings (t) | Discards (t) | Mean Weight in landings (gr) |
|---|---|---|---|---|---|---|---|---|---|
| 1986 | 740 | 268 | 981 | | | | 9,978 | 1,680 | |
| 1987 | 774 | 242 | 992 | | | | 9,753 | 1,608 | |
| 1988 | 576 | 104 | 669 | | | | 8,586 | 639 | |
| 1989 | 644 | 121 | 753 | | | | 8,147 | 673 | |
| 1990 | 678 | 53 | 726 | | | | 8,308 | 276 | |
| 1991 | 792 | 65 | 850 | | | | 9,566 | 345 | |
| 1992 | 525 | 151 | 661 | | | | 7,547 | 1,079 | |
| 1993 | 679 | 275 | 926 | | | | 8,102 | 1,622 | |
| 1994 | 619 | 203 | 801 | | | | 7,606 | 1,185 | |
| 1995 | 554 | 260 | 787 | | | | 7,796 | 1,724 | |
| 1996 | 469 | 170 | 622 | | | | 7,247 | 1,202 | |
| 1997 | 731 | 214 | 924 | | | | 9,971 | 1,330 | |
| 1998 | 616 | 229 | 822 | | | | 9,128 | 1,560 | |
| 1999 | 710 | 388 | 1060 | | | | 10,780 | 2,913 | |
| 2000 | 533 | 298 | 801 | | | | 8,370 | 2,293 | |
| 2001 | 573 | 315 | 857 | | | | 7,438 | 2,112 | |
| 2002 | 491 | 223 | 692 | | | | 6,792 | 1,732 | |
| 2003 | 404 | 291 | 666 | 0.61 | 5.5 | 0.12 | 7,052 | 2,659 | 17.5 |
| 2004 | 416 | 218 | 612 | 0.68 | 5.5 | 0.11 | 7,267 | 1,993 | 17.5 |
| 2005 | 346 | 157 | 488 | 0.71 | 5.7 | 0.09 | 6,530 | 1,412 | 18.9 |

| Year | Landings in Number (millions) | Discards in Number (millions) | Removals in Number (millions) | Prop Removals Retained | Adjusted Survey (billions) | Harvest Ratio | Landings (t) | Discards (t) | Mean Weight in landings (gr) |
|---|---|---|---|---|---|---|---|---|---|
| 2006 | 467 | 261 | 701 | 0.67 | 5.4 | 0.13 | 7,534 | 2,285 | 16.1 |
| 2007 | 511 | 375 | 848 | 0.60 | 5.1 | 0.16 | 8,424 | 3,246 | 16.5 |
| 2008 | 755 | 191 | 927 | 0.81 | 4.3 | 0.22 | 10,478 | 1,421 | 13.9 |
| 2009 | 567 | 335 | 868 | 0.65 | 4.6 | 0.19 | 9,199 | 2,934 | 16.2 |
| 2010 | 572 | 180 | 733 | 0.78 | 5.0 | 0.15 | 8,963 | 1,539 | 15.7 |
| Max | 792 | 388 | 1060 | 0.81 | 5.67 | 0.22 | 10,780 | 3,246 | 18.9 |
| Min | 346 | 53 | 488 | 0.60 | 4.29 | 0.09 | 6,530 | 276 | 13.9 |
| Average | 590 | 223 | 791 | 0.69 | 5.14 | 0.15 | 8,422 | 1,658 | 16.5 |
| Avg. 08–09 | | | | 0.75 | | | | | 15.27 |

**Table 6.5.9. Irish Sea west (FU15): Catch options at various harvest ratios.**

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Adjusted Survey Index (Millions) | Retained number (Millions) | Landings (tonnes) |
| MSY framework | 17% | 4,990 | 639 | 9,753 |
| | 0% | 4,990 | 0 | 0 |
| | 2% | 4,990 | 75 | 1,141 |
| | 4% | 4,990 | 149 | 2,281 |
| | 6% | 4,990 | 224 | 3,422 |
| | 8% | 4,990 | 299 | 4,563 |
| | 10% | 4,990 | 374 | 5,704 |
| Male F0.1 | 11% | 4,990 | 411 | 6,274 |
| | 12% | 4,990 | 448 | 6,844 |
| Combined F35% | 13.4% | 4,990 | 500 | 7,638 |
| F2010 | 14.7% | 4,990 | 549 | 8,383 |
| | 16% | 4,990 | 609 | 9,297 |
| Combined Fmax | 17.1% | 4,990 | 639 | 9,753 |
| | 18% | 4,990 | 673 | 10,267 |
| F2008-2010 | 18.4% | 4,990 | 686 | 10,474 |
| | 20% | 4,990 | 747 | 11,407 |
| | 22.0% | 4,990 | 822 | 12,548 |
| | 24% | 4,990 | 897 | 13,689 |

| | | Basis |
|---|---|---|
| Landings Mean Weight (KG) | 0.0153 | Sampling 2008–2010 |
| Survey Overestimate Bias | 1.14 | WKNEPH 2009 |
| Survey Numbers (Millions) | 5689 | UWTV Survey 2010 |
| Prop of removals retained by the Fishery | 0.75 | Sampling 2008–2010 |

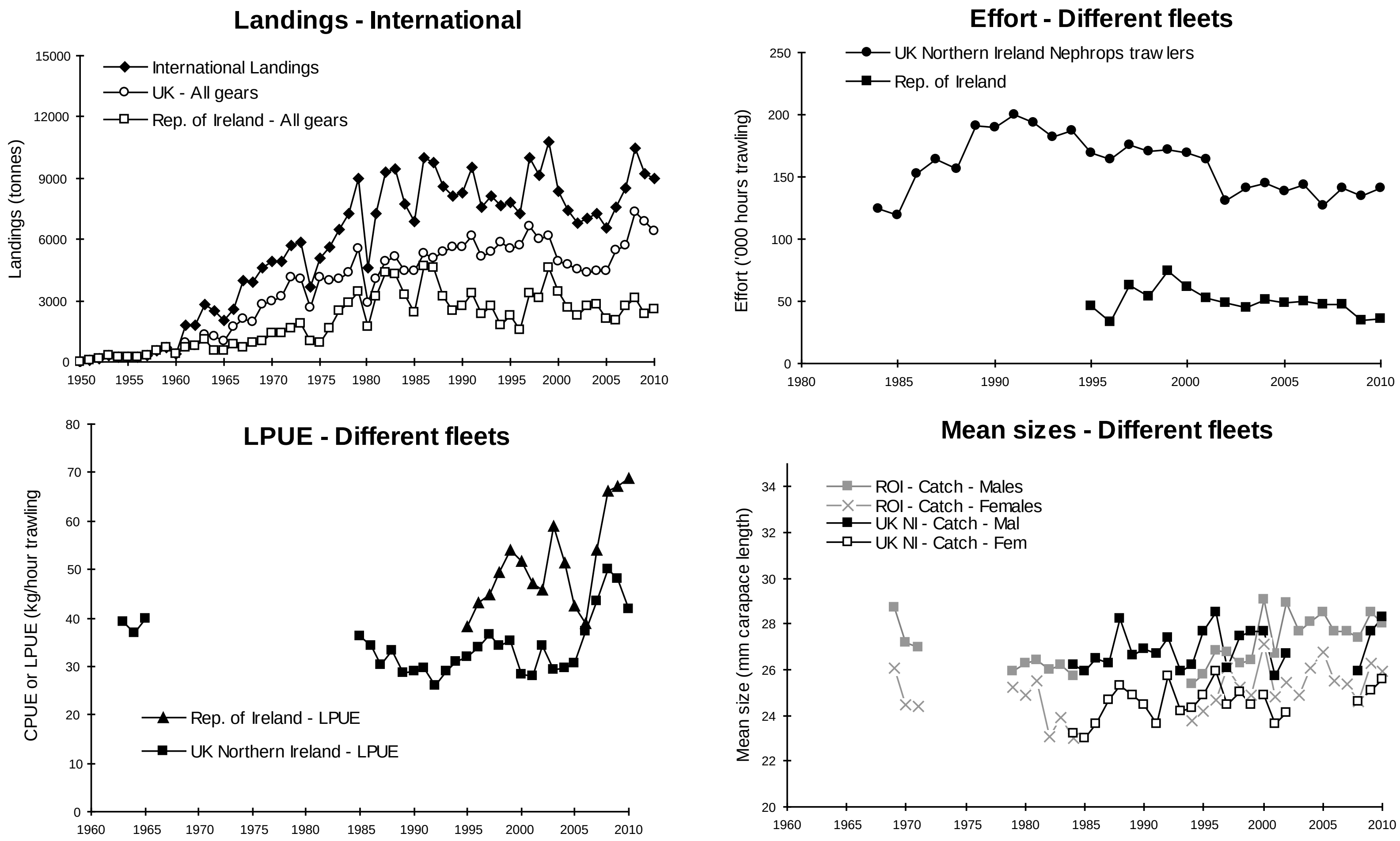



**Figure 6.5.1. Irish Sea west (FU15): Long-term trends in landings, effort, cpues and/or lpues, and mean sizes of *Nephrops*.**

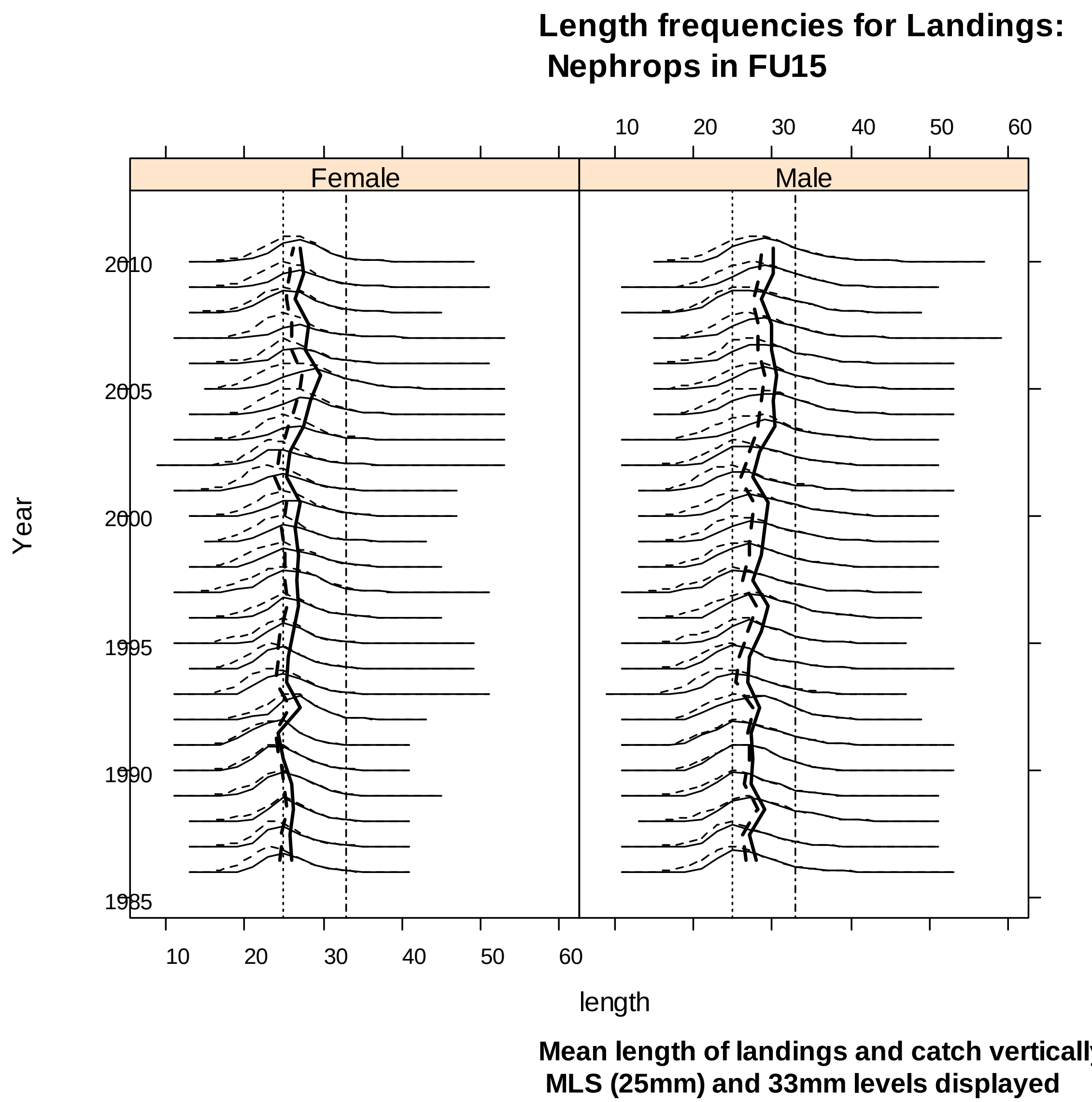



**Figure 6.5.2. Irish Sea west (FU15): Length distributions in the landings and catches, 1986–2010.**

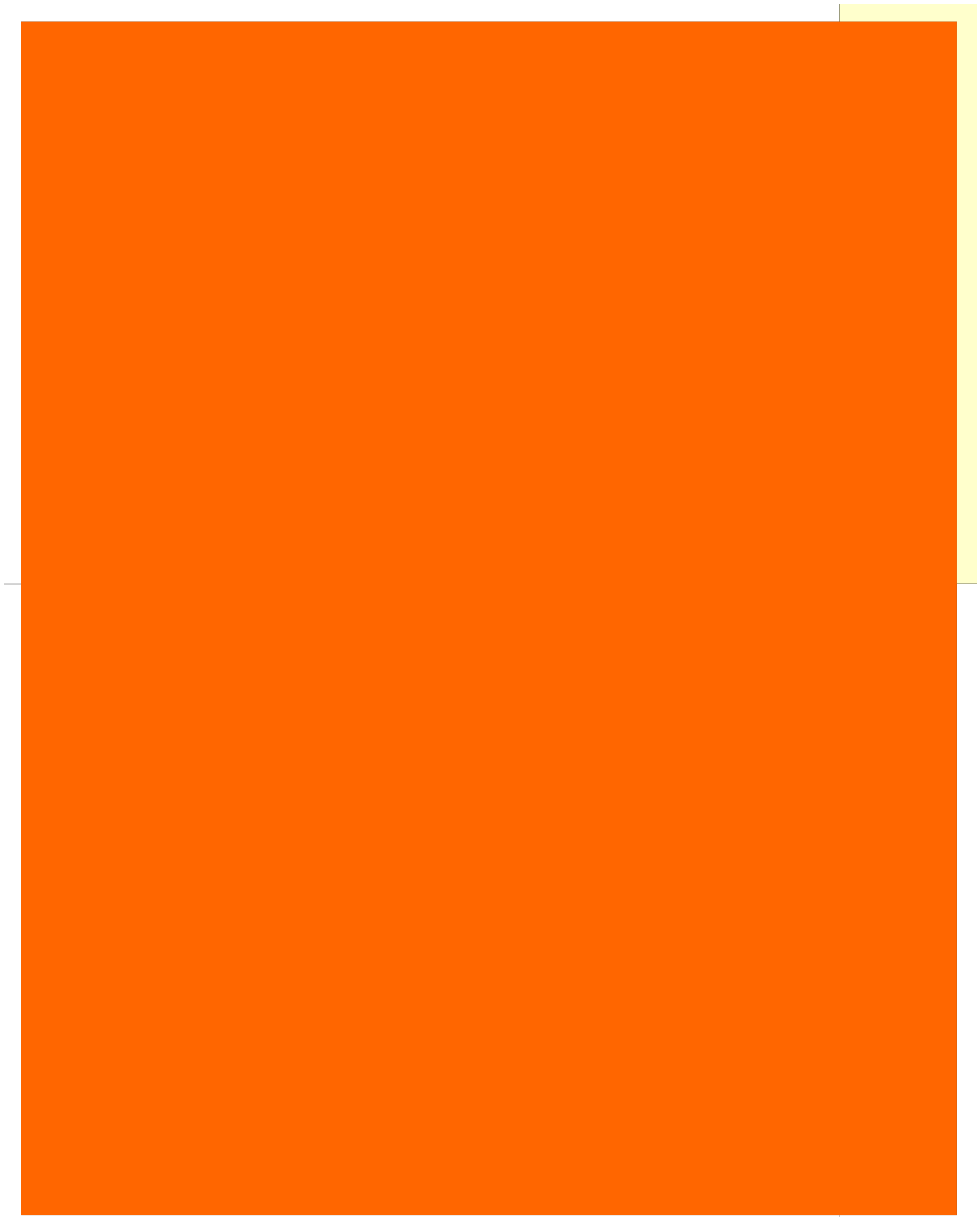
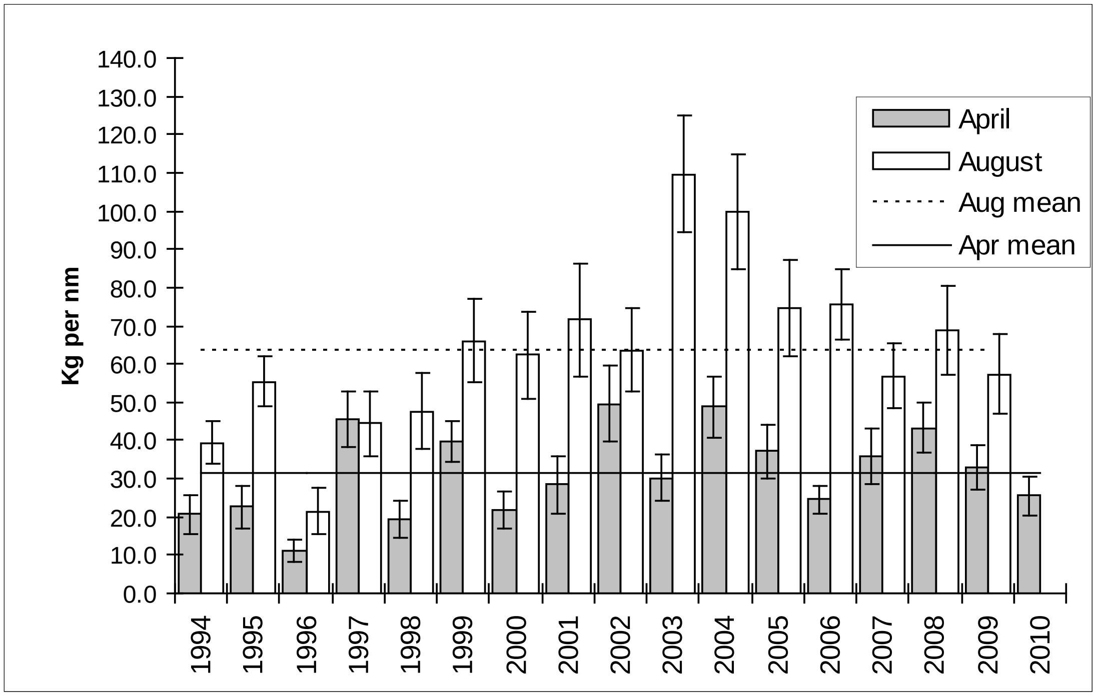


**Figure 6.5.3. Irish Sea west (FU15): 2010 UWTV survey planned stations (red crosses) and completed stations (open black circles)**



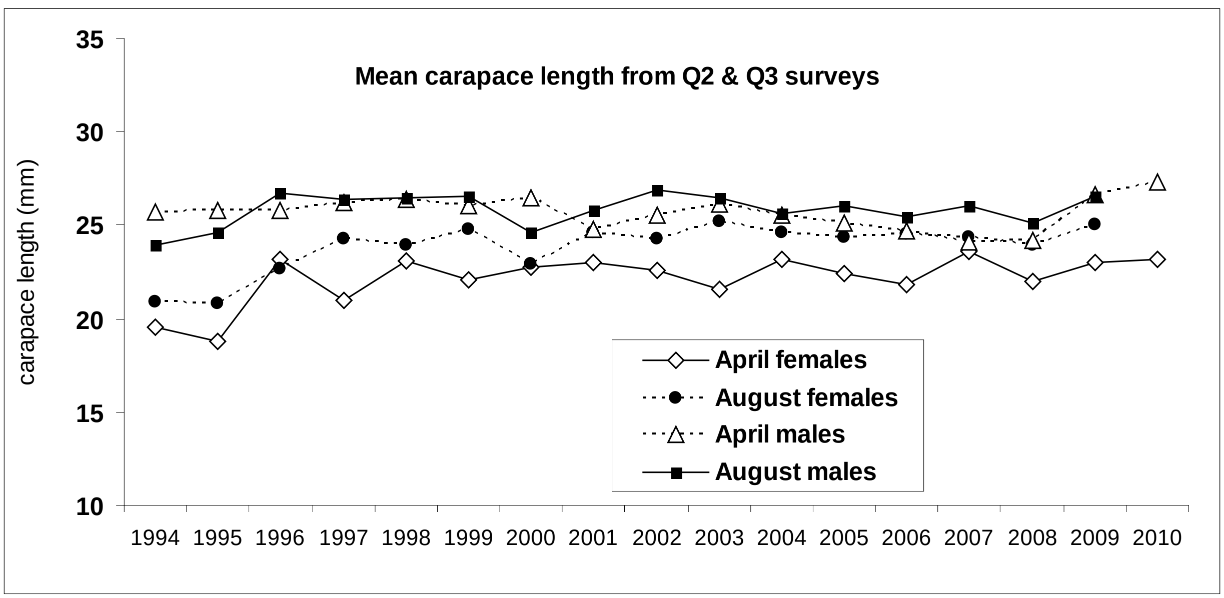




**Figure 6.5.4. Irish Sea west (FU15):** ***Nephrops*** **catches, sex ratio mean size from NI trawl surveys.**

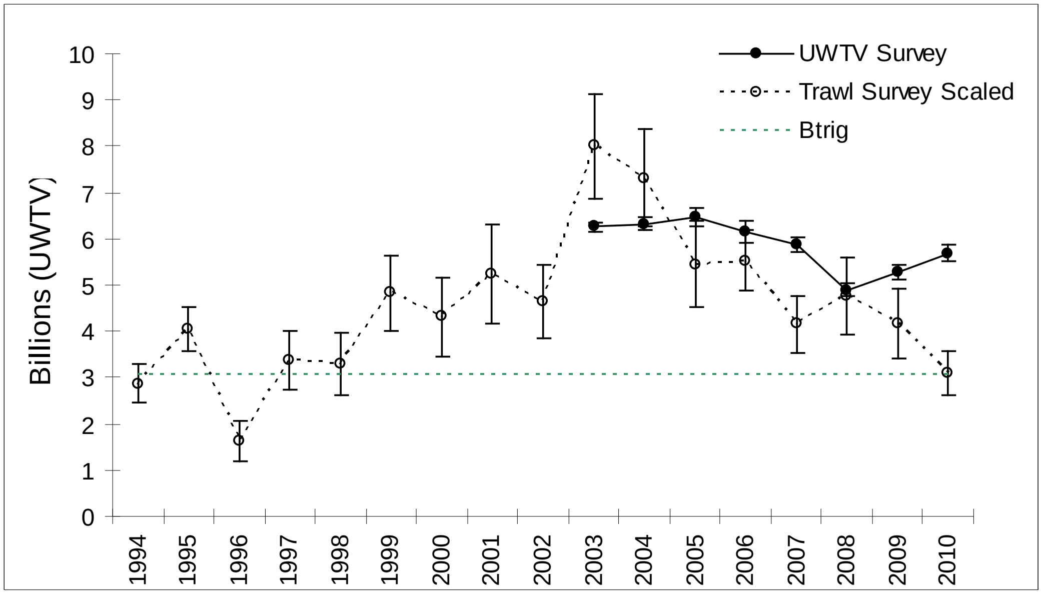



**Figure 6.5.5. Irish Sea west (FU15): Revised UWTV index and scaled trawl survey. Cpue along with $B_{trigger}$ based upon mean of five lowest trawl survey values.**

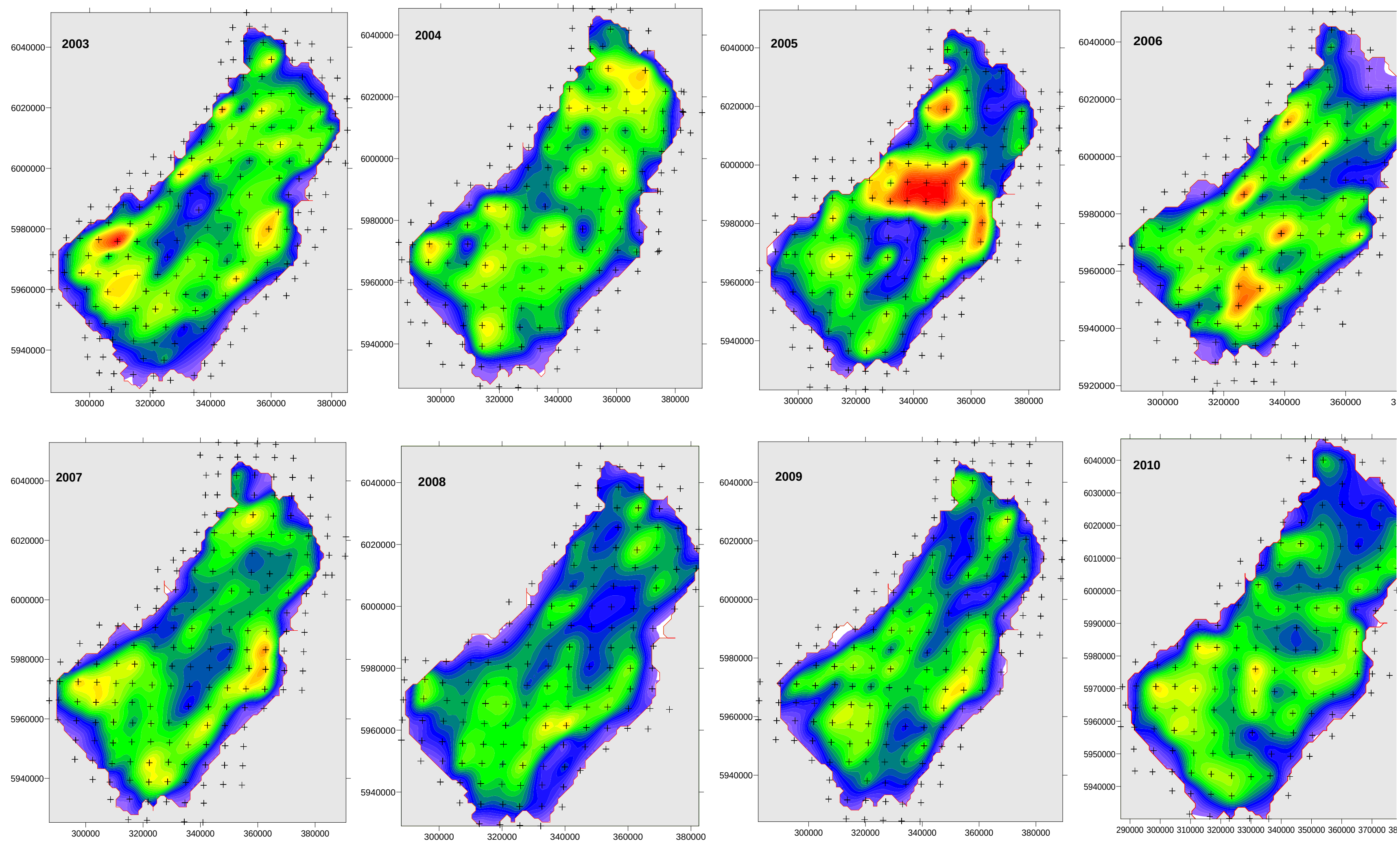



**Figure 6.5.6. Irish Sea west (FU15): Contour plots of the krigged density estimates for the Irish Sea from 2003–2010.**

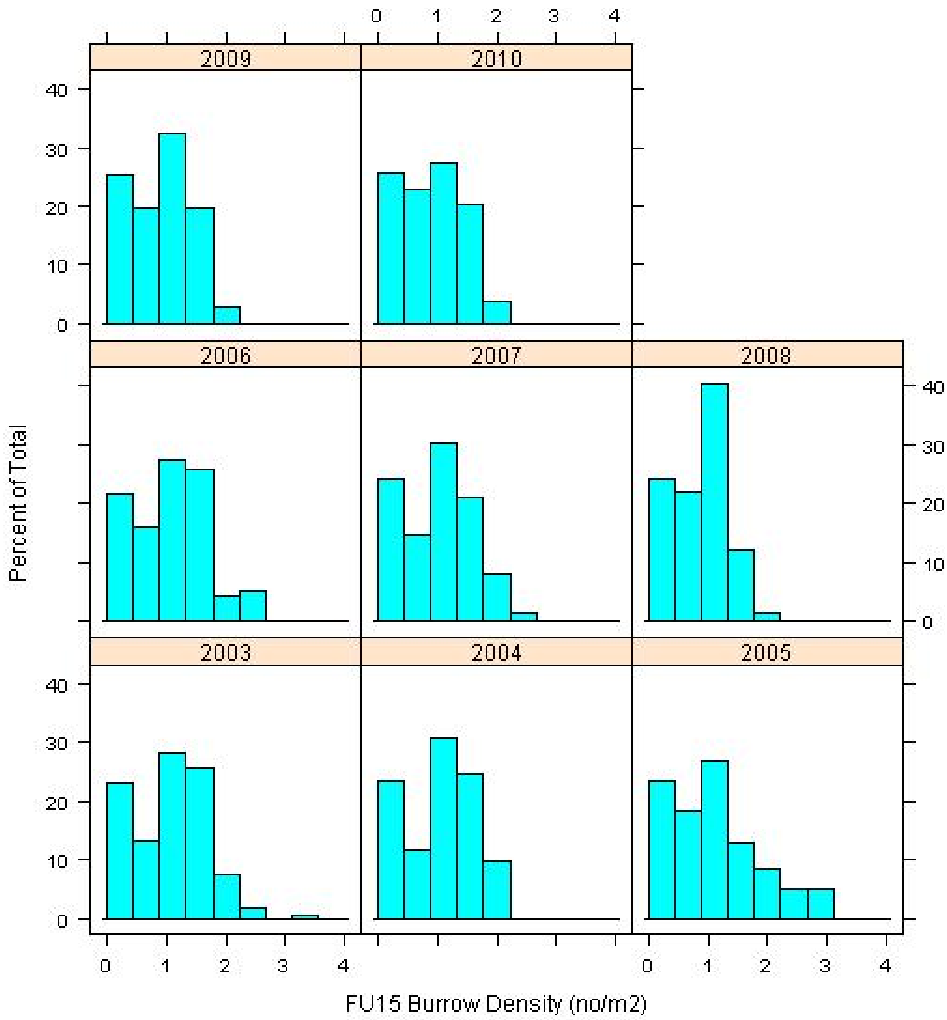



**Figure 6.5.7. Irish Sea west (FU15): Burrow density distributions 2003–2010.**

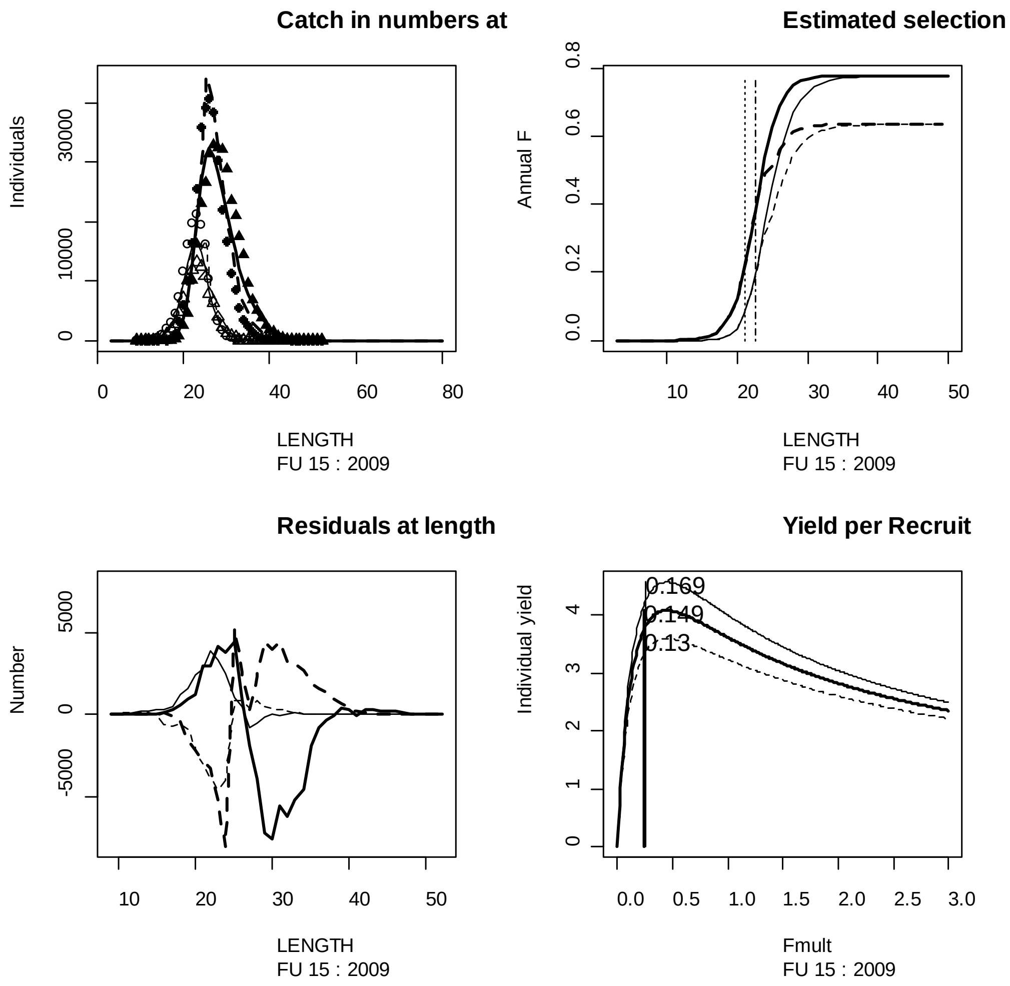



**Figure 6.5.8. Irish Sea west (FU15): Separable Cohort analysis (SCA) model fit from 2010 analysis. Solid lines are for males, dashed lines are females, thick lines represent the landings component, the thin lines represent the discarded component. The top left panel gives observed and predicted numbers-at-length in the discards and landings, top right gives the fishing mortality-at-length with the vertical lines representing length at 25% selection and 50% selection. Bottom left shows residual numbers (observed–expected) at length. The bottom right gives the Yield-per-recruit against fishing mortality, the thick solid line gives the combined value and vertical lines represent $F_{0.1}$ for the three curves.**

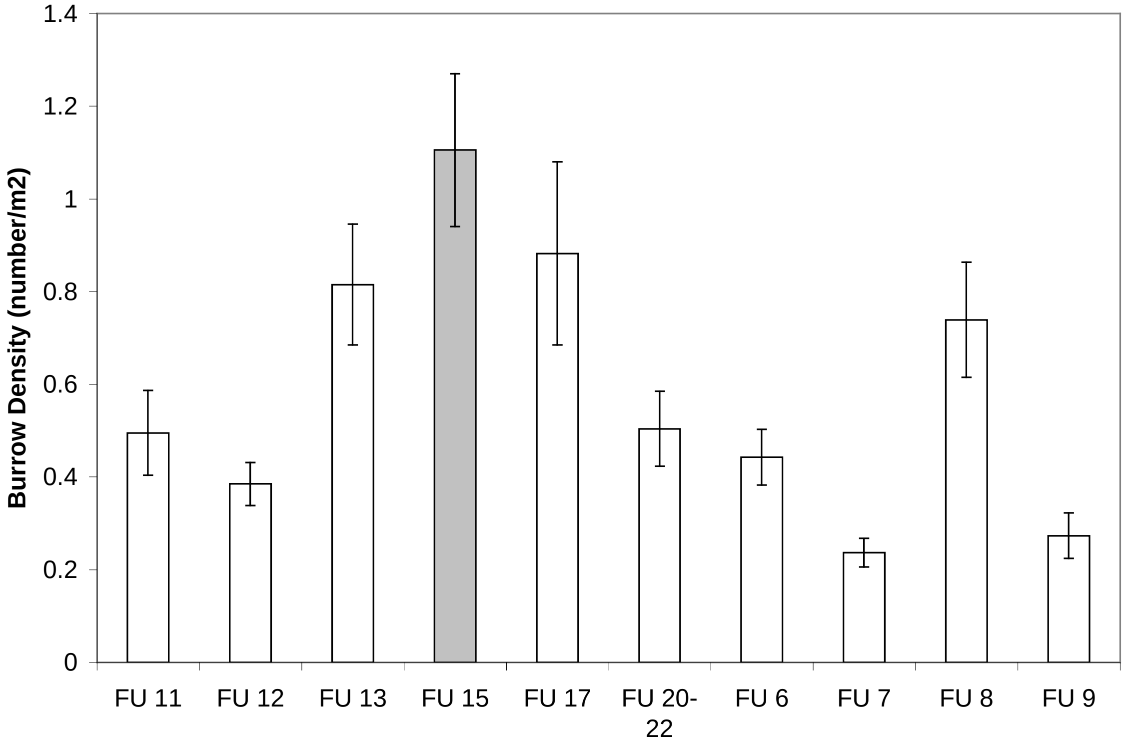
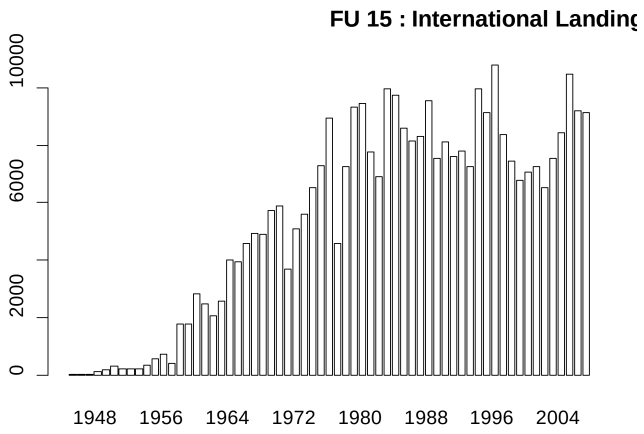
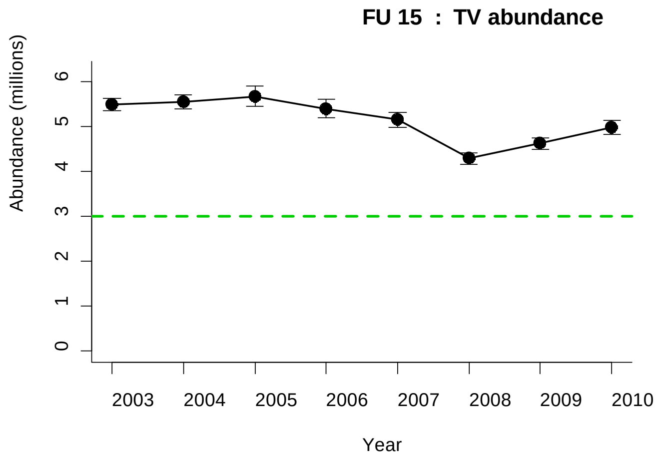



**Figure 6.5.9. Irish Sea west (FU15): Estimated burrow density compared with most recent density estimates from surveys carried out on other *Nephrops* populations.**



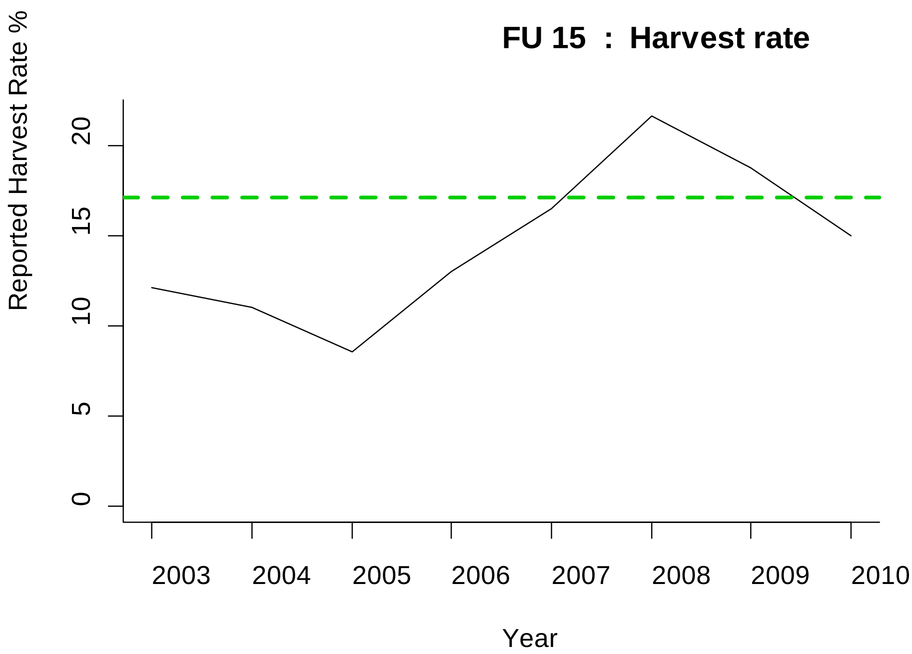




**Figure 6.5.10. Irish Sea west (FU15): Stock summary plot of landings (tonnes), UWTV abundance and harvest rate (ratio).**

## 6.6 Whiting in VIIa

### Type of assessment

This year single fleet SURBA runs were carried out for two of the main surveys assessing this stock, the NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 (referred to as NIGFS March and NIGFS October in this section) to provide trends in the stock. Overall it is clear that the stock is in a state of decline. Landings have decreased, and have been at low levels in recent years (≤200 t). The survey results indicate a decline in SSB to low levels in recent years. Total mortality has been variable over the time-series.

### ICES advice applicable to 2010

The Single-stock Exploitation Boundary advised by ICES for 2010 was as follows:

- Exploitation boundaries in relation to precautionary limits.

On the basis of the stock status ICES advises that catches of whiting in 2010 should be the lowest possible.

### ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Unknown | Unknown | Unknown |
| $F_{PA}/F_{lim}$ | Unknown | Unknown | Unknown |

| Spawning-stock biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | Unknown | Unknown | Unknown |
| $B_{PA}/B_{lim}$ | Unknown | Unknown | Unknown |

*MSY approach*

SSB has declined to a very low level. The underlying data do not support the provision of estimates of $F_{MSY}$. However it is likely that current F is above $F_{MSY}$. Therefore, catches (mainly discards) of whiting should be reduced.

Management by TAC is inappropriate to this stock because landings–but not catches–are controlled. Further management measures should be introduced in the Irish Sea to reduce discarding of small whiting in order to maximize their contribution to future yield and SSB.

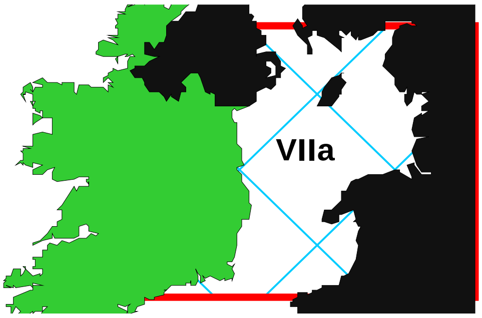
*PA considerations*

ICES considers that catches should be reduced to the lowest possible levels in 2011.

### 6.6.1 General

#### Stock description and management units

The stock and the management unit are both ICES Division VIIa (Irish Sea).




Red Box-TAC/Management Area
Blue Shading– Assessment Area

#### Management applicable to 2010 and 2011

The minimum landing size of whiting is 27 cm. The 2011 TAC for whiting VIIa has been reduced from 157 t to 118 t. This TAC has not been considered restrictive, with officially reported VIIa landings totalling 121 t in 2010.

**TAC 2010**

| **Species:** Whiting *Merlangius merlangus* | | **Zone:** VIIa (WHG/07A.) |
|---|---|---|
| Belgium | 0 | |
| France | 5 | |
| Ireland | 91 | |
| The Netherlands | 0 | |
| United Kingdom | 61 | |
| EU | 157 | |
| TAC | 157 | Analytical TAC |

**TAC 2011**

| **Species:** Whiting *Merlangius merlangus* | | **Zone:** VIIa (WHG/07A.) |
|---|---|---|
| Belgium | 0 | |
| France | 4 | |
| Ireland | 68 | |
| The Netherlands | 0 | |
| United Kingdom | 46 | |
| EU | 118 | |
| TAC | 118 | Analytical TAC |

#### Fishery in 2010

ICES officially reported landings for Division VIIa and landings as used by the Working Group are given in Table 6.6.1. In recent years the values provided to the WG are very similar to officially reported landings. In 2010 international landings provided to the Working Group have increased by 19% to those of 2009, although actual numbers remain extremely low, 121 t.

The Irish Sea whiting stock is primarily caught by otter trawlers and to a lesser extent, Scottish seines, beam trawls and gillnets. Otter trawlers utilize two main mesh size ranges, 70–89 mm and 100–119 mm. Effort of trawlers utilizing the larger mesh range, traditionally targeting whitefish (cod, haddock, whiting) has seen a large declined since 2003, partially as a result of effort management restrictions. The smaller range however has remained relatively stable. The primary target species of this smaller mesh range is *Nephrops* from which whiting is discarded at a high rate.

The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, was continued in 2010 but is unlikely to have affected whiting catches which are mainly bycatch in the derogated *Nephrops* fishery. *Nephrops* vessels can obtain a derogation to fish in certain sections of the closed area, providing they fit separator panels to their nets to allow escape of cod and other fish. The Irish and UK NI *Nephrops* fishery shows a peak in activity in summer, after the reopening of the Irish Sea codbox.

In late 2009 and 2010, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. It is expected that this will reduce the whiting catches of these vessels by ~60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel expected to reduce whiting catch by ~75% in weight (STECF, 2010). Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these gear technology mitigation measures.

For a fourth successive year, Irish East Coast *Nephrops* vessels have moved away from their traditional Irish Sea grounds to the Smalls grounds (FU22; VIIg) which is not controlled by effort limitation and generally better prices are obtained for their catch.

During 2008 Ireland introduced a further decommissioning scheme with the aim of removing 11 140 GT from the fleet register. This was targeted at vessels over ten years and >18 m. Of the decommissioned vessels 29 operated within the Irish Sea, primarily targeting *Nephrops* landing into east, and to a lesser extent south coast ports.

### 6.6.2 Data

An overview of the data provided and used by the WG is shown in Table 2.1 in the WGCSE Report.

#### Fishery landings

Table 6.6.1 gives the nominal landings of VIIa whiting as reported by each country to ICES. The officially reported landings have declined since 1996. Landings remained at a very low level in 2010, although show an increase of 19% to 2009, Working Group estimates of catch available since 1980 are illustrated in Figure 6.6.1 and indicate the declining trend since the start of the time-series. Minor revisions were made to last year's Working Group estimate of landings (1 t).

There is evidence that officially reported landings of whiting in the past (especially around the mid 1990s) have been inaccurate due to misreporting. Landings data have previously been partially corrected for by using sample-based estimates of landings at a number of Irish Sea ports. Due to the low level of landings recently, this has not been carried out since 2003.

The introduction of UK and Irish legislation requiring registration of fish buyers and sellers may mean that the reported landings from 2006 onwards are more representative of actual landings.

Sampling and raising methods previously used are described in the Stock Annex for VIIa whiting. Methods for estimating quantities and composition of landings are described in the Stock Annex (Section B1.1).

Landings, discards and total catch numbers and weights-at-age for the period 1980 to 2002 as estimated by WGNSDS 2002 are given in Tables 6.6.3 to 6.6.8. The proportion of the total catch comprising of discards from the *Nephrops* fleets increased over time for ages 1 and above (Table 6.6.9), although this will also reflect trends in catch of vessels not sampled for discards. While the proportion of discarded fish has increased it is largely due to the decline in abundance of marketable sized whiting (>27 cm) and the total volume over time has declined as shown in Table 6.6.10. Mean weights-at-age for landings and discards are presented in Figure 6.6.3.

Since 2003 it has not been possible to construct catch numbers-at-age for this stock. This is due to a number of factors including low levels of landings, leading to low sampling levels, in addition to restricted access to some ports in some years.

#### Discards data

Discarding of whiting is high within the Irish Sea. The on-board observer trips carried out in 2010 by UK (E&W), UK (NI) and Ireland, showed negligible fish were retained on board, while large numbers of small fish were discarded. Raised discards from the main national fleets landing whiting show over 22 million whiting, greater than 1000 t in weight, were discarded in 2010. This focused on the two youngest ages, and to a lesser extent age 2. In some years up to age 4 fish are discarded. The following discard data were available for this stock:

- Discard numbers-at-age from 1980–2002 estimated from the NI *Nephrops* fishery and raised to the International Fleet (from the NI self sampling scheme).
- Discard numbers-at-age from the Irish Otter Trawl Fleet from 1996–2010, including length frequency data. Note the data in 2010 is not thought to be fully representative of discarding in the Irish Sea for the Irish OTB fleet as there were only four trips sampled.
- Discard Length Frequencies for the UK (E and W) fleet, 2004–2010, raised to trip.
- Discard numbers-at-age for the NI fleet for 1997–2001, and 2006, 2007, 2009 and 2010, raised to trip, including length frequency data from the NI observer scheme.

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the Stock Annex Section B.1.2. Irish otter trawl fleet discard estimates (1996–2010), raised according to the methods described in Borges *et al.*, 2005, were available to the Working Group (Table 6.6.11).

Mean weights-at-age for the Irish otter trawl fleet are also presented (Figure 6.6.4b).

The length frequency of discards of national sampled fleets in 2010 is given in Figure 6.6.5. There appears to be a distinct bimodal distribution in the length frequencies in the Northern Irish fleet indicating tracking of the year classes.

#### Biological data

The derivation of these parameters and variables is described in the Stock Annex 6.6.

#### Survey data used in assessment

Table 6.6.2 describes the survey data made available to the Working Group. Slight revisions to the NIGFS West-October survey for 1994 were made in the tuning table (Table 10.6.6.2) to reflect the same data as received by the NI data files.

Figure 6.6.2 provides a comparison of mean catch weights of whiting from the eastern and western Irish Sea for UK NIGFS-Mar groundfish surveys from 1992 to March 2011 indicating low level catch rates since 2003.

Further information on whiting distribution is detailed in the results of Fisheries Science Partnership surveys of Irish Sea round fish stocks (www.cefas.co.uk/fsp, WD10). An index of biomass for 2-year-old and older whiting in the eastern Irish Sea survey show elevated values in 2009 and 2010 with a decline in 2011.

WGNSDS 2006 also provides information on the distribution of whiting less than MLS in the Irish Sea up to 2006.

Survey-series for whiting provided to the Working Group are further described in the Stock Annex for VIIa whiting (SectionB.3).

#### Commercial cpue

Commercial catch and effort series data available to the Working Group are described in the Stock Annex for VIIa whiting (Section B.4). Although effort data were provided for the UK (E&W) and Ireland, it was decided not to include these data in the report as it was considered not to be indicative of lpue trends due to the low levels of landings and changes in discard practices.

### 6.6.3 Historical stock development

No assessment was carried out for this stock in 2009 or 2010. The last assessment for this stock was a survey based assessment in 2007.

Catch-at-age data were not updated and commercial catch data were not explored in 2010.

#### Data screening

The general methodology is outlined in Section 2.

#### Final update assessment

Single fleet survey based runs were carried out on the NIGFS-Mar and NIGFS-Oct surveys using SURBA (version 2.2). Default values were used for both catchability and smoothing settings.

Log-mean standardized indices and scatterplots of log-index at age for the NIGFS-March are presented in Figures 6.6.6a and Figure 6.6.7a, respectively. Both plots indicate poor internal consistency within the survey. The survey appears to track the 1991 year class but examination of the internal consistency via the scatterplots indicates poor correlation between age classes. Corresponding figures for the NIGFS-Oct are plotted in Figures 6.6.6b and 6.6.7b. There is some indication of tracking for the 1991, 1994 and 1995 year class but scatterplots at age are noisy and do not show strong positive correlations.

Catch curves for the NIGFS-Mar and NIGFS-Oct survey are plotted in Figure 6.6.8(a) and (b). Both surveys show a steep decline in log numbers-at-age over time.

Empirical SSB estimates are presented in Figure 6.6.9 for the NIGFS March and the NIGFS October surveys. Both NIGFS surveys show slightly increased SSB levels in the terminal year but SSB is still at a low levels compared to earlier on in the time-series.

Figure 6.6.10 shows the residual plots by age for the NIGFS March survey, the model fits well for age one but for older ages residuals are quite noisy, especially in the latter part of the time-series. Stock summary for the NIGFS March is shown in Figure 6.6.11. The temporal F trend is variable in later years with the current year increasing from a relatively low level in 2009; there are no extreme age or cohort effects. The plot of empirical SSB with model fit (bottom, centre) shows good fit for most years. Figure 6.6.12 shows the retrospective summary plot for the NIGFS March survey. SSB is declining since 2002 but shows a light upturn in 2011. It is still at comparatively low levels and there is no apparent retrospective pattern. F shows an increasing trend over the time-series, although it appears to have temporarily declined in 2008. Recruitment is also variable but estimated to be been good in 2006 and 2008. There is no strong retrospective pattern for recruitment and the previously seen noisy periods between 1995–2000 and 2004–2008 seem to have improved with the inclusion of the 2011 data.

Residual plots by age for the NIGFS October survey are shown in Figure 6.6.13. Residuals are quite noisy for all ages apart from age 0. Figure 6.6.14 shows the stock summary plot for the NIGFS October. The temporal F trend is variable throughout the time-series. There appears to be an age effect for age 3 for this survey but no strong cohort effects. The plot of empirical SSB vs. model estimates shows improved fit for the latter part of the time-series. Retrospective patterns for the summary plots (Figure 6.6.15) show a variable F trend over the time-series, with a decline in 2009. SSB has been declining since 2003 and shows an increase in 2010. Recruitment appears to have been good in 2006 and 2008. No strong retrospective bias is evident in F, SSB or recruitment, although there appears to be a noisy period for recruitment in 2006–2007.

#### The state of the stock

The decline in fishery landings to under 1000 t since 2000 has been interpreted in all assessment models as a collapse in biomass, despite the absence of an analytical assessment. Generally, trends in biomass have been declining in recent years. Recruitment also appears to have declined recently. However the long-term trends of recruitment for this stock are difficult to interpret given the uncertainty in discard estimates for younger ages.

### 6.6.4 Short-term predictions

None.

### 6.6.5 Medium-term projection

There is no analytical assessment for this stock.

### 6.6.6 Maximum sustainable yield evaluation

High discarding, low landings and poor sampling has lead to uncertain catch data in recent years. These data do not support the evaluation or estimation of $F_{msy}$. However it is likely that recent F is above $F_{msy}$ at the current selection pattern.

### 6.6.7 Biological reference points

#### Precautionary approach reference points

No precautionary reference points have been defined for this stock.

### 6.6.8 Management plans

No management plan has been agreed or proposed.

### 6.6.9 Uncertainties and bias in assessment and forecast

There is no analytical assessment for this stock.

### 6.6.10 Recommendations for next benchmark assessment

Before a benchmark can be recommended, it is first necessary to construct international catch numbers/weights-at-length and age for the main fleets engaged in the fishery since 2003. Effort data for the main fleets engaged in whiting VIIa fisheries are required to provide a time-series of trends in commercial lpue. None of these issues will be resolved in the short term and a benchmark assessment of this stock in the near future is unlikely.

### 6.6.11 Management considerations

Technical measures applied to this stock include a minimum landing size (≥27 cm) and minimum mesh sizes applicable to the mixed demersal fisheries. These measures are set depending on areas and years by several regulations.

Whiting are caught within a number of different fisheries as a non-target species, primarily within demersal otter trawl fisheries. Significant decline of the mixed gadoid directed fishery has occurred within the Irish Sea to minimal levels. Bycatches also occur within flatfish and ray beam trawl fisheries.

Management by TAC is inappropriate to this stock because landings, but not catches, are controlled. Discarding of this stock is a major consideration and efforts should be made to reduce catches of undersized fish through technical considerations. In late 2009 and 2010, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. It is expected that this will reduce the whiting catches of these vessels by ~60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel expected to reduce whiting catch by ~75% in weight (STECF, 2010). Implementation of such measures should be actively encouraged. Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these gear technology mitigation measures.

Effort limitations are in force within the Irish Sea as a result of the cod long-term management plan. Although vessels catching whiting will be affected by this regulation at present it is not believed that the effort limitations will prove beneficial to the whiting stock.

Whiting has a low market value, which is likely to contribute to discarding rates.

### 6.6.12 References

STECF 01. 2011. 36th Plenary meeting report of the Scientific, Technical and Economic Committee for Fisheries (PLEN-11-01) plenary meeting, 11–15 April 2011, Norwich. Edited by John Casey and Hendrik Dörner.

**Table 6.6.1. Nominal catch (t) of whiting in Division VIIa, 1988–2010, as officially reported to ICES and Working Group. Discard estimates available until 2001.**

| Country | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 90 | 92 | 142 | 53 | 78 | 50 | 80 | 92 | 80 | 47 | 52 |
| France | 1,063 | 533 | 528 | 611 | 509 | 255 | 163 | 169 | 78 | 86 | 81 |
| Ireland | 4,394 | 3,871 | 2,000 | 2,200 | 2,100 | 1,440 | 1,418 | 1,840 | 1,773 | 1,119 | 1,260 |
| Netherlands | | | | | | | | | 17 | 14 | 7 |
| UK(Engl. & Wales)[a] | 1,202 | 6,652 | 5,202 | 4,250 | 4,089 | 3,859 | 3,724 | 3,125 | 3,557 | 3,152 | 1,900 |
| Spain | | | | | | | | | | | |
| UK (Isle of Man) | 15 | 26 | 75 | 74 | 44 | 55 | 44 | 41 | 28 | 24 | 33 |
| UK (N.Ireland) | 4,621 | | | | | | | | | | |
| UK (Scotland) | 107 | 154 | 236 | 223 | 274 | 318 | 208 | 198 | 48 | 30 | 22 |
| UK | | | | | | | | | | | |
| Total human consumption | 11,492 | 11,328 | 8,183 | 7,411 | 7,094 | 5,977 | 5,637 | 5,465 | 5,581 | 4,472 | 3,355 |
| Estimated Nephrops fishery discards used by the WG[b] | 1,611 | 2,103 | 2,444 | 2,598 | 4,203 | 2,707 | 1,173 | 2,151 | 3,631 | 1,928 | 1,304 |
| Working Group Estimates | 11,856 | 13,408 | 10,656 | 9,946 | 12,791 | 9,230 | 7,936 | 7,044 | 7,966 | 4,205 | 3,533 |

| Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 46 | 30 | 27 | 22 | 13 | 11 | 10 | 4.2 | 3 | 2 | 2 |
| France | 150 | 59 | 25 | 33 | 29 | 8 | 13 | 3.7 | 3 | 2 | |
| Ireland | 509 | 353 | 482 | 347 | 265 | 96 | 94 | 55.3 | 187 | 68 | 78 |
| Netherlands | 6 | 1 | | | | | | | | | |
| UK(Engl. & Wales)[a] | 1,229 | 670 | 506 | 284 | 130 | 82 | 47 | 21.7 | 3 | 11 | 20 |
| Spain | | | | | 85 | | | | | | |
| UK (Isle of Man) | 5 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | |
| UK (N.Ireland) | | | | | | | | | | | |
| UK (Scotland) | 44 | 15 | 25 | 27 | 31 | 6 | <0.5 | <0.5 | <0.5 | | |
| UK | | | | | | | | | | | |
| Total human consumption | 1,989 | 1,130 | 1,066 | 714 | 554 | 204 | 164 | 84.9 | 197 | 84 | 100 |
| Estimated Nephrops fishery discards used by the WG[b] | 1,092 | 2,118 | 1,012 | 740 | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Working Group Estimates | 2,762 | 2,880 | 1,745 | 1,487 | 676 | 184 | 158 | 86 | 196 | 81 | 102 |

| Country | 2010* |
|---|---|
| Belgium | 5 |
| France | 3 |
| Ireland | 97 |
| Netherlands | |
| UK(Engl. & Wales)[a] | 16 |
| Spain | |
| UK (Isle of Man) | <0.5 |
| UK (N.Ireland) | |
| UK (Scotland) | |
| UK | |
| Total human consumption | 121 |
| Estimated Nephrops fishery discards used by the WG[b] | n/a |
| Working Group Estimates | 121 |

[a] 1989-onwards Northern Ireland included with England and Wales.
[b] Based on UK(N.Ireland) and Ireland data.
[*] Preliminary (and rounded).

**Table 6.6.2. Whiting in 7a. Survey data available to WGCSE 2011. Updated Survey Titles highlighted in bold.**

**NIGFS West-October : Northern Ireland October Groundfish Survey - Irish Sea West - Nos. per 3 nm**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1994 | 2010 | | | | | | |
| 1 | 1 0.83 | 0.88 | | | | | |
| 0 | 5 | | | | | | |
| 1 | 5903 | 1278 | 55 | 48.1 | 2.7 | 0.2 | 1994 |
| 1 | 4660 | 962 | 130 | 10.0 | 4.7 | 1.5 | 1995 |
| 1 | 5933 | 792 | 117 | 20.0 | 1.7 | 0.5 | 1996 |
| 1 | 8722 | 628 | 125 | 10.0 | 4.9 | 0.2 | 1997 |
| 1 | 8199 | 708 | 134 | 16.0 | 0.7 | 0.0 | 1998 |
| 1 | 7481 | 360 | 44 | 4.0 | 1.4 | 0.0 | 1999 |
| 1 | 4037 | 593 | 32 | 2.0 | 2.1 | 0.3 | 2000 |
| 1 | 15262 | 761 | 205 | 16.0 | 0.1 | 0.0 | 2001 |
| 1 | 7229 | 1712 | 114 | 11.7 | 0.9 | 0.5 | 2002 |
| 1 | 8487 | 1600 | 469 | 19.1 | 1.2 | 0.1 | 2003 |
| 1 | 11446 | 1119 | 124 | 12.0 | 0.0 | 0.0 | 2004 |
| 1 | 5433 | 299 | 54 | 7.2 | 0.5 | 0.0 | 2005 |
| 1 | 4625 | 173 | 22 | 4.7 | 0.5 | 0.0 | 2006 |
| 1 | 5932 | 1491 | 125 | 4.2 | 0.2 | 0.0 | 2007 |
| 1 | 13253 | 2814 | 294 | 10.0 | 0.0 | 0.0 | 2008 |
| 1 | 5927 | 555 | 117 | 14.5 | 1.9 | 0.1 | 2009 |
| 1 | 5532 | 542 | 87 | 4.1 | 0.2 | 0.0 | 2010 |

**NIGFS West-March : Northern Ireland March Groundfish Survey - Irish Sea West - Nos. per 3 nm**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1994 | 2011 | | | | | |
| 1 | 1 0.21 | 0.25 | | | | |
| 0 | 4 | | | | | |
| 1 | 4307 | 73 | 121 | 6 | 0 | 1994 |
| 1 | 3604 | 988 | 53 | 30 | 1 | 1995 |
| 1 | 2323 | 587 | 188 | 11 | 15 | 1996 |
| 1 | 3250 | 447 | 52 | 14 | 1 | 1997 |
| 1 | 3857 | 535 | 71 | 9 | 3 | 1998 |
| 1 | 2373 | 228 | 39 | 7 | 2 | 1999 |
| 1 | 4037 | 231 | 23 | 3 | 0 | 2000 |
| 1 | 1998 | 631 | 30 | 2 | 1 | 2001 |
| 1 | 3580 | 163 | 36 | 3 | 0 | 2002 |
| 1 | 2952 | 812 | 25 | 6 | 1 | 2003 |
| 1 | 3568 | 174 | 36 | 1 | 0 | 2004 |
| 1 | 1219 | 97 | 6 | 1 | 0 | 2005 |
| 1 | 1266 | 150 | 12 | 0 | 0 | 2006 |
| 1 | 1825 | 190 | 10 | 1 | 0 | 2007 |
| 1 | 1254 | 290 | 17 | 1 | 0 | 2008 |
| 1 | 1941 | 227 | 10 | 1 | 0 | 2009 |
| 1 | 1485 | 297 | 20 | 1 | 0 | 2010 |
| 1 | 818 | 211 | 32 | 1 | 0 | 2011 |

**Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.**

**NIGFS East-October : Northern Ireland October Groundfish Survey - Irish Sea East - Nos. per 3 nm**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1994 | 2010 | | | | | | |
| 1 | 1 0.83 | 0.88 | | | | | |
| 0 | 5 | | | | | | |
| 1 | 749 | 472 | 179 | 165.0 | 29.0 | 3.0 | 1994 |
| 1 | 2515 | 259 | 178 | 41.0 | 47.0 | 9.0 | 1995 |
| 1 | 1005 | 517 | 127 | 64.0 | 15.0 | 10.0 | 1996 |
| 1 | 640 | 668 | 682 | 88.0 | 26.0 | 6.0 | 1997 |
| 1 | 1446 | 277 | 178 | 95.0 | 11.0 | 4.0 | 1998 |
| 1 | 2287 | 1388 | 260 | 102.0 | 79.0 | 3.0 | 1999 |
| 1 | 1972 | 1288 | 216 | 26.0 | 22.0 | 9.0 | 2000 |
| 1 | 2998 | 691 | 300 | 35.0 | 7.0 | 5.0 | 2001 |
| 1 | 1296 | 1285 | 349 | 76.0 | 8.5 | 2.0 | 2002 |
| 1 | 3783 | 1939 | 1104 | 155.4 | 25.0 | 3.2 | 2003 |
| 1 | 1820 | 521 | 347 | 109.1 | 7.7 | 1.7 | 2004 |
| 1 | 1247 | 865 | 296 | 17.5 | 1.9 | 0.6 | 2005 |
| 1 | 2304 | 150 | 52 | 9.0 | 2.1 | 0.0 | 2006 |
| 1 | 1094 | 827 | 165 | 18.4 | 2.9 | 3.1 | 2007 |
| 1 | 2329 | 873 | 81 | 1.3 | 0.2 | 0.0 | 2008 |
| 1 | 641 | 675 | 48 | 4.4 | 1.1 | 0.0 | 2009 |
| 1 | 807 | 260 | 326 | 9.1 | 1.4 | 0.3 | 2010 |

**NIGFS East-March : Northern Ireland March Groundfish Survey - Irish Sea East - Nos. per 3 nm**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1993 | 2011 | | | | | |
| 1 | 1 0.21 | 0.25 | | | | |
| 1 | 5 | | | | | |
| 1 | 611 | 290 | 390 | 47 | 12.0 | 1994 |
| 1 | 448 | 522 | 142 | 109 | 25.0 | 1995 |
| 1 | 1094 | 221 | 203 | 40 | 44.0 | 1996 |
| 1 | 561 | 1054 | 91 | 33 | 2.0 | 1997 |
| 1 | 409 | 903 | 522 | 32 | 11.0 | 1998 |
| 1 | 1023 | 407 | 135 | 52 | 6.0 | 1999 |
| 1 | 1481 | 524 | 229 | 35 | 4.0 | 2000 |
| 1 | 631 | 739 | 162 | 15 | 9.0 | 2001 |
| 1 | 869 | 1043 | 243 | 54 | 13.1 | 2002 |
| 1 | 1118 | 1328 | 178 | 24 | 5.7 | 2003 |
| 1 | 1026 | 302 | 69 | 4 | 1.6 | 2004 |
| 1 | 499 | 129 | 41 | 12 | 3.9 | 2005 |
| 1 | 964 | 323 | 39 | 10 | 0.7 | 2006 |
| 1 | 623 | 120 | 11 | 3 | 0 | 2007 |
| 1 | 669 | 417 | 51 | 3 | 0 | 2008 |
| 1 | 956 | 313 | 47 | 2 | 0 | 2009 |
| 1 | 671 | 357 | 24 | 2 | 2 | 2010 |
| 1 | 530 | 164 | 33 | 4 | 1 | 2011 |

**Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.**

**UKE&W-BTS : Corystes Irish Sea Beam Trawl Survey (Sept) - Prime stations only - Effort and numbers-at-age (per km towed)**

| | | | |
|---|---|---|---|
| 1988 | 2010 | | |
| 1 | 1 0.75 | 0.79 | |
| 0 | 1 | | |
| 1 | 326 | 134 | 1988 |
| 1 | 226 | 66 | 1989 |
| 1 | 316 | 242 | 1990 |
| 1 | 494 | 74 | 1991 |
| 1 | 451 | 596 | 1992 |
| 1 | 297 | 197 | 1993 |
| 1 | 196 | 133 | 1994 |
| 1 | 1952 | 74 | 1995 |
| 1 | 172 | 207 | 1996 |
| 1 | 406 | 277 | 1997 |
| 1 | 905 | 186 | 1998 |
| 1 | 581 | 153 | 1999 |
| 1 | 321 | 139 | 2000 |
| 1 | 596 | 197 | 2001 |
| 1 | 283 | 103 | 2002 |
| 1 | 520 | 184 | 2003 |
| 1 | 908 | 339 | 2004 |
| 1 | 845 | 293 | 2005 |
| 1 | 1019 | 222 | 2006 |
| 1 | 369 | 90 | 2007 |
| 1 | 826 | 85 | 2008 |
| 1 | 397 | 385 | 2009 |
| 1 | 206 | 31 | 2010 |

**NIGFS-Oct E&W : Northern Ireland October Groundfish Survey - Irish Sea East & West - Nos. per 3 nm**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1992 | 2010 | | | | | | |
| 1 | 1 0.83 | 0.88 | | | | | |
| 0 | 5 | | | | | | |
| 1 | 1454 | 995 | 96 | 26.0 | 4.0 | 0.0 | 1992 |
| 1 | 1554 | 425 | 300 | 27.0 | 2.0 | 0.1 | 1993 |
| 1 | 2450 | 686 | 133 | 123.0 | 20.0 | 2.0 | 1994 |
| 1 | 3199 | 483 | 163 | 30.9 | 33.6 | 6.9 | 1995 |
| 1 | 2628 | 605 | 124 | 50.0 | 10.8 | 6.8 | 1996 |
| 1 | 3219 | 655 | 504 | 63.0 | 19.0 | 4.0 | 1997 |
| 1 | 3601 | 414 | 164 | 70.0 | 7.9 | 3.0 | 1998 |
| 1 | 3945 | 1060 | 191 | 70.0 | 54.1 | 1.7 | 1999 |
| 1 | 2631 | 1066 | 158 | 18.0 | 15.8 | 6.1 | 2000 |
| 1 | 6911 | 713 | 270 | 29.0 | 4.7 | 3.1 | 2001 |
| 1 | 3189 | 1421 | 274 | 55.4 | 6.1 | 1.5 | 2002 |
| 1 | 5284 | 1831 | 901 | 111.9 | 17.4 | 2.2 | 2003 |
| 1 | 4892 | 712 | 276 | 78.1 | 5.3 | 1.2 | 2004 |
| 1 | 2583 | 684 | 219 | 14.2 | 1.5 | 0.4 | 2005 |
| 1 | 3045 | 157 | 43 | 7.6 | 1.6 | 0.0 | 2006 |
| 1 | 2638 | 1039 | 153 | 13.8 | 2.0 | 2.1 | 2007 |
| 1 | 5815 | 1492 | 149 | 4.1 | 0.1 | 0.0 | 2008 |
| 1 | 2328 | 637 | 70 | 7.6 | 1.3 | 0.0 | 2009 |
| 1 | 2315 | 350 | 250 | 7.5 | 1.0 | 0.2 | 2010 |

**Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.**

**NIGFS-March E&W : Northern Ireland March Groundfish Survey- Irish Sea East & West - Nos. per 3 nm**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1992 | 2011 | | | | | | |
| 1 | 1 0.21 | 0.25 | | | | | |
| 1 | 5 | | | | | | |
| 1 | 1477 | 456 | 94 | 29 | 5.0 | 0.0 | 1992 |
| 1 | 667 | 655 | 67 | 9 | 2.0 | 0.5 | 1993 |
| 1 | 1790 | 221 | 304 | 34 | 8.0 | 5.0 | 1994 |
| 1 | 1696 | 698 | 116 | 85 | 17.0 | 3.0 | 1995 |
| 1 | 1478 | 280 | 160 | 28 | 32.0 | 5.6 | 1996 |
| 1 | 1419 | 860 | 79 | 27 | 1.7 | 4.3 | 1997 |
| 1 | 1730 | 767 | 196 | 12 | 3.3 | 0.1 | 1998 |
| 1 | 1453 | 350 | 104 | 38 | 5.0 | 1.0 | 1999 |
| 1 | 2297 | 431 | 163 | 25 | 2.7 | 0.0 | 2000 |
| 1 | 1067 | 704 | 120 | 11 | 7 | 1.6 | 2001 |
| 1 | 1734 | 762 | 177 | 38 | 9 | 0.3 | 2002 |
| 1 | 1703 | 1163 | 129 | 18 | 4 | 0.0 | 2003 |
| 1 | 1837 | 261 | 59 | 3 | 1 | 0.1 | 2004 |
| 1 | 729 | 119 | 30 | 9 | 3 | 0.3 | 2005 |
| 1 | 1054 | 274 | 31 | 7 | 1 | 0.1 | 2006 |
| 1 | 1007 | 142 | 11 | 2 | 0.1 | 0.0 | 2007 |
| 1 | 856 | 376 | 40 | 3 | 0.2 | 0.0 | 2008 |
| 1 | 1270 | 285 | 35 | 1 | 0.1 | 0.1 | 2009 |
| 1 | 931 | 338 | 23 | 2 | 1.5 | 0.0 | 2010 |
| 1 | 622 | 179 | 33 | 3 | 0.4 | 0.0 | 2011 |

**UKNI-MIK : Northern Ireland MIK Net Survey**

| | | |
|---|---|---|
| 1994 | 2010 | |
| 1 | 1 0.46 | 0.50 |
| 0 | 0 | |
| 1 | 778 | 1994 |
| 1 | 225 | 1995 |
| 1 | 397 | 1996 |
| 1 | 205 | 1997 |
| 1 | 59 | 1998 |
| 1 | 91 | 1999 |
| 1 | 40 | 2000 |
| 1 | 167 | 2001 |
| 1 | 19 | 2002 |
| 1 | 148 | 2003 |
| 1 | 101 | 2004 |
| 1 | 135 | 2005 |
| 1 | 118 | 2006 |
| 1 | 82 | 2007 |
| 1 | 99 | 2008 |
| 1 | 173 | 2009 |
| 1 | 78 | 2010 |

ScoGFS Spring : Scottish groundfish survey in Spring

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1996 | 2006 | | | | | | | | |
| 1 | 1 | 0.15 0.21 | | | | | | | |
| 1 | 8 | | | | | | | | |
| 1 | 11610 | 4051 | 1898 | 362 | 229 | 59 | 3 | 4 | 1996 |
| 1 | 16322 | 16200 | 2953 | 964 | 250 | 105 | 39 | 1 | 1997 |
| 1 | 22145 | 8187 | 3817 | 137 | 110 | 0 | 5 | 0 | 1998 |
| 1 | 19815 | 6642 | 1706 | 282 | 11 | 0 | 27 | 0 | 1999 |
| 1 | 13019 | 1662 | 169 | 71 | 36 | 6 | 0 | 0 | 2000 |
| 1 | 9419 | 4541 | 407 | 40 | 2 | 0 | 0 | 0 | 2001 |
| 1 | 15605 | 3060 | 430 | 34 | 1 | 0 | 0 | 0 | 2002 |
| 1 | 14798 | 5404 | 375 | 45 | 0 | 4 | 0 | 0 | 2003 |
| 1 | 9199 | 2219 | 583 | 27 | 1 | 0 | 0 | 0 | 2004 |
| 1 | 3783 | 899 | 200 | 56 | 3 | 0 | 0 | 0 | 2005 |
| 1 | 7317 | 1040 | 319 | 32 | 2 | 0 | 0 | 0 | 2006 |

**Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.**

ScoGFS Autumn : Scottish groundfish survey

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1995 | 2005 | | | | | | | |
| 1 | 1 | 0.83 | 0.91 | | | | | |
| 0 | 6 | | | | | | | |
| 1 | | | | | | | | |
| 1 | 30094 | 8827 | 2530 | 435 | 215 | 4 | 0 | 1997 |
| 1 | 18457 | 7166 | 1291 | 37 | 35 | 26 | 0 | 1998 |
| 1 | 73309 | 7357 | 2166 | 263 | 219 | 0 | 6 | 1999 |
| 1 | 16862 | 8677 | 503 | 242 | 25 | 12 | 0 | 2000 |
| 1 | 0 | 140 | 133 | 13 | 0 | 0 | 0 | 2001 |
| 1 | 30324 | 16655 | 1435 | 224 | 2 | 28 | 0 | 2002 |
| 1 | 26671 | 7170 | 1138 | 69 | 0 | 0 | 0 | 2003 |
| 1 | 42435 | 19333 | 3321 | 319 | 3 | 0 | 0 | 2004 |
| 1 | 16510 | 3382 | 97 | 4 | 2 | 3 | 0 | 2005 |

IR-ISCSGFS : Irish Sea Celtic Sea GFS 4th Qtr - Effort min. towed - No. at age

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1997 | 2002 | | | | | | |
| 1 | 1 0.8 | 0.9 | | | | | |
| 0 | 5 | | | | | | |
| 540 | 1566 | 3330 | 793 | 154 | 23 | 12 | 1997 |
| 1020 | 48396 | 6534 | 2249 | 170 | 15 | 0 | 1998 |
| 1170 | 208494 | 3302 | 624 | 24 | 28 | 2 | 1999 |
| 1128 | 97502 | 4402 | 25 | 1 | 0 | 0 | 2000 |
| 1221 | 28881 | 29577 | 3123 | 177 | 1 | 0 | 2001 |
| 1035 | 12112 | 10237 | 1497 | 225 | 33 | 5 | 2002 |

IR-Q4 IBTS: IRISH GFS RV Celtic Explorer: NUMBERS-AT-AGE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2003 | 2004 | | | | | | |
| 1 | 1 0.89 | 0.91 | | | | | |
| 0 | 5 | | | | | | |
| 1 | 72340 | 19658 | 13391 | 1617 | 605 | 0 | 2003 |
| 1 | 75196 | 14563 | 1293 | 147 | 5 | 2 | 2004 |

IR-OTB : Irish Otter trawl - Effort in h - VIIa Whiting numbers-at-age - Year

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1995 | 2002 | | | | | | |
| 1 | 1 0 | 1 | | | | | |
| 1 | 6 | | | | | | |
| 80314 | 6 | 437 | 206 | 261 | 21 | 1 | 1995 |
| 64824 | 64 | 682 | 1528 | 266 | 71 | 4 | 1996 |
| 92178 | 3 | 368 | 494 | 418 | 55 | 19 | 1997 |
| 93533 | 20 | 395 | 838 | 117 | 27 | 30 | 1998 |
| 110275 | 34 | 398 | 531 | 130 | 19 | 3 | 1999 |
| 82690 | 40 | 192 | 155 | 58 | 8 | 0 | 2000 |
| 77541 | 13 | 397 | 444 | 42 | 22 | 3 | 2001 |
| 77863 | 21 | 173 | 383 | 88 | 8 | 8 | 2002 |

**Table 6.6.2. (cont'd). Whiting in 7a. Survey data available to WGCSE 2011.**

UKNI-Pelagic trawl : Northern Ireland Midwater trawlers - Effort in h - No per h fished

| | | | | | | |
|---|---|---|---|---|---|---|
| 1993 | 2002 | | | | | |
| 1 | 1 0 | 1 | | | | |
| 2 | 6 | | | | | |
| 74014 | 3174 | 1060 | 172 | 29.5 | 4.8 | 1993 |
| 73778 | 1706 | 4340 | 574 | 72.8 | 16.2 | 1994 |
| 52773 | 1997 | 416 | 719 | 37.9 | 7.2 | 1995 |
| 53083 | 1432 | 2276 | 361 | 327.4 | 41.8 | 1996 |
| 55863 | 1241 | 660 | 549 | 12.3 | 17.5 | 1997 |
| 61153 | 438 | 423 | 98 | 45.8 | 2.7 | 1998 |
| 72859 | 162 | 185 | 57 | 13.5 | 11.6 | 1999 |
| 46412 | 67 | 53 | 11 | 7.9 | 1.1 | 2000 |
| 50302 | 7 | 4 | 2 | 0.5 | 0.2 | 2001 |
| 57754 | 189 | 316 | 90 | 11 | 15 | 2002 |

UKNI-Otter trawl : Northern Ireland single-rig otter trawlers - Effort in h - No per h fished - includes discards

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1993 | 2002 | | | | | | | |
| 1 | 1 0 | 1 | | | | | | |
| 0 | 6 | | | | | | | |
| 195323 | 10308 | 9217 | 21444 | 2791 | 261 | 28 | 2 | 1993 |
| 191705 | 3172 | 11286 | 3957 | 9723 | 747 | 75 | 16 | 1994 |
| 161025 | 5228 | 10692 | 8874 | 987 | 1312 | 17 | 1 | 1995 |
| 154418 | 8663 | 20784 | 6748 | 4623 | 551 | 460 | 56 | 1996 |
| 165612 | 4344 | 12001 | 5864 | 1292 | 528 | 7 | 7 | 1997 |
| 149088 | 5869 | 11381 | 2368 | 1135 | 200 | 50 | 1 | 1998 |
| 146990 | 14625 | 3517 | 1202 | 344 | 59 | 12 | 8 | 1999 |
| 130117 | 4403 | 12613 | 3082 | 520 | 61 | 14 | 8 | 2000 |
| 131418 | 10658 | 6663 | 1833 | 228 | 64 | 13 | 10 | 2001 |
| 108616 | 4601 | 8586 | 1068 | 265 | 44 | 3 | 2 | 2002 |

UKE&W-Otter trawl : England/Wales Otter Trawl

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1981 | 2000 | | | | | | |
| 1 | 1 0 | 1 | | | | | |
| 2 | 6 | | | | | | |
| 107 | 906 | 766 | 162 | 103 | 4 | 1981 | |
| 127 | 1984 | 893 | 340 | 67 | 49 | 1982 | |
| 88 | 685 | 1065 | 227 | 67 | 21 | 1983 | |
| 103 | 1395 | 439 | 475 | 80 | 29 | 1984 | |
| 103 | 2077 | 889 | 148 | 125 | 25 | 1985 | |
| 90 | 2246 | 1006 | 158 | 20 | 17 | 1986 | |
| 131 | 2206 | 1505 | 316 | 58 | 5 | 1987 | |
| 132 | 1885 | 827 | 161 | 30 | 6 | 1988 | |
| 140 | 1344 | 1201 | 234 | 40 | 10 | 1989 | |
| 117 | 2076 | 671 | 222 | 35 | 14 | 1990 | |
| 107 | 2374 | 793 | 165 | 48 | 5 | 1991 | |
| 97 | 2072 | 1020 | 177 | 42 | 3 | 1992 | |
| 79 | 784 | 654 | 157 | 31 | 5 | 1993 | |
| 43 | 110 | 454 | 91 | 15 | 3 | 1994 | |
| 43 | 460 | 188 | 375 | 7 | 1 | 1995 | Revised at NSWG 1997 |
| 42 | 260 | 604 | 102 | 90 | 10 | 1996 | |
| 40 | 331 | 211 | 155 | 7 | 1 | 1997 | |
| 37 | 311 | 355 | 81 | 28 | 1 | 1998 | |
| 23 | 194 | 175 | 46 | 11 | 8 | 1999 | |
| 27 | 186 | 134 | 47 | 36 | 4 | 2000 | |

**Table 6.6.3. VIIa whiting International numbers-at-age ('000) for human consumption, 1980–2002 (partially corrected for misreporting). Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 14520 | 11203 | 5427 | 4886 | 18254 | 15540 | 6306 | 10149 | 6983 | 11645 |
| 2 | 21811 | 29011 | 18098 | 9943 | 12683 | 35324 | 16839 | 21563 | 25768 | 14029 |
| 3 | 6468 | 16004 | 19340 | 9100 | 5257 | 8687 | 10809 | 6968 | 6989 | 13011 |
| 4 | 2548 | 2596 | 6108 | 4530 | 2571 | 996 | 1877 | 1943 | 1513 | 3645 |
| 5 | 350 | 821 | 813 | 1165 | 1045 | 675 | 285 | 242 | 396 | 490 |
| 6+ | 621 | 339 | 400 | 321 | 402 | 372 | 270 | 111 | 197 | 177 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 102 | 0 | 38 | 0 | 0 | 129 | 0 | 0 | 1 |
| 1 | 9502 | 7426 | 8380 | 2742 | 3245 | 1124 | 1652 | 610 | 329 | 341 |
| 2 | 17604 | 18406 | 21907 | 21468 | 6983 | 10095 | 6162 | 4239 | 3287 | 2806 |
| 3 | 4734 | 5829 | 7959 | 7327 | 18509 | 3020 | 7432 | 2567 | 4727 | 2607 |
| 4 | 1477 | 993 | 1374 | 932 | 1801 | 4444 | 1263 | 1795 | 888 | 741 |
| 5 | 318 | 311 | 462 | 135 | 208 | 233 | 1082 | 87 | 261 | 160 |
| 6+ | 128 | 84 | 93 | 27 | 50 | 21 | 135 | 79 | 95 | 119 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 319 | 111 | 67 |
| 2 | 1364 | 1189 | 748 |
| 3 | 1002 | 1006 | 1480 |
| 4 | 299 | 171 | 376 |
| 5 | 115 | 53 | 48 |
| 6+ | 15 | 20 | 41 |

**Table 6.6.4. VIIa whiting International discard numbers-at-age ('000), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 12786 | 9865 | 4047 | 23847 | 26394 | 12380 | 28364 | 16594 | 6922 | 17247 |
| 1 | 32318 | 24935 | 8489 | 7328 | 33900 | 26461 | 21111 | 40598 | 17958 | 20701 |
| 2 | 6888 | 9162 | 560 | 2036 | 1568 | 1859 | 1464 | 1875 | 1940 | 2476 |
| 3 | 65 | 162 | 19 | 9 | 11 | 9 | 33 | 0 | 0 | 26 |
| 4 | 26 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4216 | 20349 | 1497 | 12639 | 3731 | 7118 | 12732 | 8163 | 6096 | 20851 |
| 1 | 31810 | 29334 | 61451 | 13979 | 12063 | 17613 | 39647 | 25497 | 27131 | 7677 |
| 2 | 3353 | 3823 | 10404 | 17707 | 1812 | 7015 | 8168 | 5352 | 2293 | 2117 |
| 3 | 72 | 146 | 97 | 426 | 1702 | 492 | 1976 | 689 | 550 | 228 |
| 4 | 0 | 1 | 0 | 5 | 29 | 234 | 81 | 141 | 44 | 34 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 7321 | 16940 | 8538 |
| 1 | 38922 | 12631 | 13412 |
| 2 | 4395 | 3150 | 1588 |
| 3 | 564 | 102 | 231 |
| 4 | 55 | 10 | 33 |
| 5 | 1 | 0 | 0 |
| 6+ | 10 | 0 | 1 |

**Table 6.6.5. VIIa whiting International catch numbers-at-age ('000) combined landings and discards, 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 12786 | 9865 | 4088 | 23847 | 26394 | 12380 | 28364 | 16594 | 6922 | 17247 |
| 1 | 46838 | 36138 | 13916 | 12214 | 52154 | 42001 | 27417 | 50747 | 24941 | 32346 |
| 2 | 28699 | 38173 | 18658 | 11979 | 14251 | 37183 | 18303 | 23438 | 27708 | 16505 |
| 3 | 6533 | 16166 | 19359 | 9109 | 5268 | 8696 | 10842 | 6968 | 6989 | 13037 |
| 4 | 2574 | 2622 | 6108 | 4530 | 2571 | 996 | 1877 | 1943 | 1513 | 3645 |
| 5 | 350 | 821 | 813 | 1165 | 1045 | 675 | 285 | 242 | 396 | 490 |
| 6+ | 621 | 339 | 400 | 321 | 402 | 372 | 270 | 111 | 197 | 177 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4216 | 20451 | 1497 | 12677 | 3731 | 7118 | 12861 | 8163 | 6096 | 20852 |
| 1 | 41312 | 36760 | 69831 | 16721 | 15308 | 18737 | 41299 | 26107 | 27460 | 8018 |
| 2 | 20957 | 22229 | 32311 | 39175 | 8795 | 17110 | 14330 | 9591 | 5580 | 4923 |
| 3 | 4806 | 5975 | 8056 | 7753 | 20211 | 3512 | 9408 | 3256 | 5277 | 2835 |
| 4 | 1477 | 994 | 1374 | 937 | 1830 | 4678 | 1344 | 1936 | 932 | 776 |
| 5 | 318 | 311 | 462 | 135 | 208 | 233 | 1082 | 87 | 261 | 161 |
| 6+ | 128 | 84 | 93 | 27 | 50 | 21 | 135 | 79 | 95 | 121 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 7321 | 16940 | 8538 |
| 1 | 39242 | 12742 | 13479 |
| 2 | 5758 | 4338 | 2336 |
| 3 | 1566 | 1108 | 1711 |
| 4 | 354 | 181 | 409 |
| 5 | 115 | 53 | 48 |
| 6+ | 25 | 20 | 42 |

**Table 6.6.6. VIIa whiting International landings mean weight-at-age (kg), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.133 | 0.133 | 0.133 | 0 | 0.144 | 0 | 0.134 | 0 | 0 | 0 |
| 1 | 0.216 | 0.216 | 0.216 | 0.215 | 0.208 | 0.174 | 0.184 | 0.173 | 0.152 | 0.197 |
| 2 | 0.269 | 0.269 | 0.269 | 0.279 | 0.257 | 0.250 | 0.225 | 0.223 | 0.214 | 0.209 |
| 3 | 0.365 | 0.365 | 0.365 | 0.397 | 0.403 | 0.333 | 0.342 | 0.363 | 0.330 | 0.269 |
| 4 | 0.533 | 0.533 | 0.533 | 0.491 | 0.550 | 0.478 | 0.512 | 0.535 | 0.547 | 0.433 |
| 5 | 0.630 | 0.630 | 0.630 | 0.605 | 0.699 | 0.567 | 0.709 | 0.720 | 0.763 | 0.680 |
| 6+ | 0.772 | 0.888 | 0.736 | 0.655 | 0.745 | 0.642 | 0.940 | 0.933 | 1.005 | 1.079 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0.115 | 0 | 0.117 | 0 | 0 | 0 | 0 | 0 | 0.120 |
| 1 | 0.198 | 0.172 | 0.160 | 0.151 | 0.169 | 0.188 | 0.196 | 0.171 | 0.169 | 0.166 |
| 2 | 0.220 | 0.210 | 0.198 | 0.186 | 0.198 | 0.219 | 0.217 | 0.219 | 0.202 | 0.218 |
| 3 | 0.313 | 0.266 | 0.274 | 0.233 | 0.227 | 0.273 | 0.244 | 0.244 | 0.240 | 0.255 |
| 4 | 0.436 | 0.352 | 0.361 | 0.332 | 0.304 | 0.334 | 0.288 | 0.296 | 0.274 | 0.328 |
| 5 | 0.676 | 0.453 | 0.513 | 0.454 | 0.378 | 0.551 | 0.365 | 0.396 | 0.350 | 0.352 |
| 6+ | 0.800 | 0.692 | 1.007 | 0.892 | 0.496 | 1.320 | 0.415 | 0.537 | 0.421 | 0.328 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 0.064 | 0 | 0 |
| 1 | 0.179 | 0.182 | 0.145 |
| 2 | 0.216 | 0.250 | 0.214 |
| 3 | 0.269 | 0.319 | 0.273 |
| 4 | 0.317 | 0.346 | 0.356 |
| 5 | 0.347 | 0.538 | 0.449 |
| 6+ | 0.412 | 0.337 | 0.428 |

**Table 6.6.7. VIIa whiting International discard mean weight-at-age (kg), 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.034 | 0.034 | 0.029 | 0.033 | 0.024 | 0.022 | 0.023 | 0.024 | 0.021 | 0.026 |
| 1 | 0.062 | 0.062 | 0.072 | 0.101 | 0.075 | 0.080 | 0.058 | 0.078 | 0.069 | 0.063 |
| 2 | 0.125 | 0.125 | 0.125 | 0.147 | 0.130 | 0.137 | 0.126 | 0.157 | 0.114 | 0.105 |
| 3 | 0.230 | 0.230 | 0.141 | 0.245 | 0 | 0 | 0.155 | 0 | 0.449 | 0.091 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.034 | 0.030 | 0.014 | 0.029 | 0.029 | 0.031 | 0.026 | 0.026 | 0.017 | 0.028 |
| 1 | 0.060 | 0.051 | 0.050 | 0.050 | 0.048 | 0.055 | 0.051 | 0.041 | 0.034 | 0.038 |
| 2 | 0.113 | 0.115 | 0.110 | 0.089 | 0.123 | 0.120 | 0.111 | 0.101 | 0.090 | 0.086 |
| 3 | 0.115 | 0.130 | 0.137 | 0.143 | 0.154 | 0.153 | 0.161 | 0.141 | 0.130 | 0.147 |
| 4 | 0 | 0 | 0 | 0.175 | 0.149 | 0.179 | 0.186 | 0.170 | 0.145 | 0.237 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.218 |
| 6+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.174 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 0.024 | 0.017 | 0.016 |
| 1 | 0.036 | 0.034 | 0.033 |
| 2 | 0.100 | 0.088 | 0.082 |
| 3 | 0.128 | 0.119 | 0.127 |
| 4 | 0.150 | 0.194 | 0.141 |
| 5 | 0.213 | 0 | 0 |
| 6+ | 0.152 | 0 | 0.213 |

**Table 6.6.8. VIIa whiting International catch mean weight-at-age (kg) combined landings and discard, 1980–2002. Estimates have not been possible since 2003 due to low landings and resulting poor sampling.**

| Age | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.034 | 0.040 | 0.031 | 0.033 | 0.032 | 0.021 | 0.025 | 0.024 | 0.021 | 0.026 |
| 1 | 0.110 | 0.118 | 0.135 | 0.146 | 0.125 | 0.107 | 0.100 | 0.101 | 0.088 | 0.111 |
| 2 | 0.235 | 0.240 | 0.265 | 0.256 | 0.244 | 0.245 | 0.217 | 0.217 | 0.201 | 0.193 |
| 3 | 0.363 | 0.364 | 0.365 | 0.397 | 0.403 | 0.333 | 0.342 | 0.363 | 0.330 | 0.269 |
| 4 | 0.529 | 0.529 | 0.533 | 0.491 | 0.550 | 0.478 | 0.512 | 0.535 | 0.547 | 0.433 |
| 5 | 0.630 | 0.630 | 0.630 | 0.605 | 0.700 | 0.567 | 0.709 | 0.720 | 0.763 | 0.680 |
| 6+ | 0.772 | 0.888 | 0.736 | 0.655 | 0.745 | 0.642 | 0.940 | 0.933 | 1.005 | 1.079 |

| Age | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.036 | 0.031 | 0.014 | 0.029 | 0.030 | 0.031 | 0.027 | 0.026 | 0.017 | 0.028 |
| 1 | 0.094 | 0.077 | 0.063 | 0.067 | 0.074 | 0.063 | 0.057 | 0.044 | 0.035 | 0.044 |
| 2 | 0.204 | 0.194 | 0.170 | 0.142 | 0.183 | 0.179 | 0.159 | 0.153 | 0.156 | 0.161 |
| 3 | 0.310 | 0.263 | 0.272 | 0.228 | 0.221 | 0.257 | 0.230 | 0.222 | 0.228 | 0.246 |
| 4 | 0.436 | 0.352 | 0.361 | 0.331 | 0.301 | 0.326 | 0.284 | 0.287 | 0.268 | 0.324 |
| 5 | 0.676 | 0.453 | 0.513 | 0.454 | 0.378 | 0.551 | 0.364 | 0.396 | 0.350 | 0.351 |
| 6+ | 0.800 | 0.692 | 1.007 | 0.892 | 0.496 | 1.320 | 0.715 | 0.679 | 0.421 | 0.325 |

| Age | 2000 | 2001 | 2002 |
|---|---|---|---|
| 0 | 0.024 | 0.017 | 0.016 |
| 1 | 0.038 | 0.036 | 0.033 |
| 2 | 0.127 | 0.132 | 0.124 |
| 3 | 0.218 | 0.301 | 0.253 |
| 4 | 0.291 | 0.338 | 0.339 |
| 5 | 0.347 | 0.538 | 0.449 |
| 6+ | 0.310 | 0.337 | 0.425 |

**Table 6.6.9. VIIa whiting estimates of discard numbers-at-age from the *Nephrops* fleet as a proportion of total International numbers-at-age.**

| Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 1981 | 1.000 | 0.690 | 0.240 | 0.010 | 0.010 | 0 |
| 1982 | 0.990 | 0.610 | 0.030 | 0.001 | 0 | 0 |
| 1983 | 1.000 | 0.600 | 0.170 | 0.001 | 0 | 0 |
| 1984 | 1.000 | 0.650 | 0.110 | 0.002 | 0 | 0 |
| 1985 | 1.000 | 0.630 | 0.050 | 0.001 | 0 | 0 |
| 1986 | 1.000 | 0.770 | 0.080 | 0.003 | 0 | 0 |
| 1987 | 1.000 | 0.800 | 0.080 | 0 | 0 | 0 |
| 1988 | 1.000 | 0.720 | 0.070 | 0 | 0 | 0 |
| 1989 | 1.000 | 0.640 | 0.150 | 0.002 | 0 | 0 |
| 1990 | 1.000 | 0.770 | 0.160 | 0.015 | 0 | 0 |
| 1991 | 0.995 | 0.798 | 0.172 | 0.024 | 0.001 | 0 |
| 1992 | 1.000 | 0.880 | 0.322 | 0.012 | 0 | 0 |
| 1993 | 0.997 | 0.836 | 0.452 | 0.055 | 0.005 | 0 |
| 1994 | 1.000 | 0.788 | 0.206 | 0.084 | 0.016 | 0 |
| 1995 | 1.000 | 0.940 | 0.410 | 0.140 | 0.050 | 0 |
| 1996 | 0.990 | 0.960 | 0.570 | 0.210 | 0.060 | 0 |
| 1997 | 1.000 | 0.977 | 0.558 | 0.212 | 0.073 | 0 |
| 1998 | 1.000 | 0.988 | 0.411 | 0.104 | 0.047 | 0 |
| 1999 | 1.000 | 0.957 | 0.430 | 0.081 | 0.044 | 0.009 |
| 2000 | 1.000 | 0.992 | 0.763 | 0.360 | 0.154 | 0.005 |
| 2001 | 1.000 | 0.991 | 0.726 | 0.092 | 0.055 | 0 |
| 2002 | 1.000 | 0.995 | 0.680 | 0.135 | 0.081 | 0.000 |
| Mean 81-02 | 0.999 | 0.817 | 0.311 | 0.070 | 0.027 | 0.001 |

**Table 6.6.10. VIIa whiting estimated landed and discarded catch (t). Data partially corrected for misreporting.**

| | Catch (t) | |
|---|---|---|
| Year | Landed | Discarded |
| 1980 | 13461 | 3324 |
| 1981 | 17646 | 2960 |
| 1982 | 17304 | 808 |
| 1983 | 10525 | 1820 |
| 1984 | 11802 | 3433 |
| 1985 | 15582 | 2654 |
| 1986 | 10300 | 2115 |
| 1987 | 10519 | 3899 |
| 1988 | 10245 | 1611 |
| 1989 | 11305 | 2103 |
| 1990 | 8212 | 2444 |
| 1991 | 7348 | 2598 |
| 1992 | 8588 | 4203 |
| 1993 | 6523 | 2707 |
| 1994 | 6763 | 1173 |
| 1995 | 4893 | 2151 |
| 1996 | 4335 | 3631 |
| 1997 | 2277 | 1928 |
| 1998 | 2229 | 1304 |
| 1999 | 1670 | 1092 |
| 2000 | 762 | 2118 |
| 2001 | 733 | 1012 |
| 2002 | 747 | 740 |
| 2003 | 401 | n/a |
| Mean: | 7990 | 2253 |

**Table 6.6.11. VIIa whiting discard numbers- and mean weights-at-age from the Irish otter board trawl fleet 1996–2010.**

| | 1996 | | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) |
| 0 | 5631.20 | 0.015 | 4110.63 | 0.027 | 5073.57 | 0.027 | 187.26 | 0.036 | 7850.12 | 0.033 | 20981.54 | 0.016 | 29017.16 |
| 1 | 5925.33 | 0.035 | 8361.19 | 0.044 | 5939.53 | 0.064 | 276.50 | 0.102 | 3098.24 | 0.047 | 8883.11 | 0.054 | 12097.93 |
| 2 | 1802.90 | 0.111 | 3243.45 | 0.120 | 3826.20 | 0.107 | 150.99 | 0.174 | 137.80 | 0.153 | 1413.48 | 0.126 | 576.17 |
| 3 | 144.34 | 0.217 | 696.18 | 0.200 | 440.05 | 0.185 | 43.70 | 0.235 | 30.31 | 0.229 | 479.38 | 0.133 | 152.95 |
| 4 | 6.02 | 0.206 | 68.71 | 0.241 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 5 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 22.95 | 0.136 | 17.66 |
| 6 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 7 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 8 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 9 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 10+ | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| Total weight (t) | | 520.8 | | 1024.1 | | 1010.3 | | 71.6 | | 434.3 | | 1054.5 | |
| Sampling Information | 1996 | | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 200 |
| Number of Trips | | 8 | | 8 | | 7 | | 4 | | 10 | | 2 | |
| Number of Hauls | | 48 | | 44 | | 58 | | 40 | | 111 | | 34 | |

| | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) | Weight (kg) | Numbers ('000) |
| 0 | 1921.76 | 0.016 | 17091.56 | 0.018 | 442.07 | 0.010 | 1534.97 | 0.016 | 5138.89 | 0.043 | 4585.77 | 0.025 | 13319.29 |
| 1 | 2419.56 | 0.036 | 7347.29 | 0.034 | 2531.84 | 0.035 | 1483.43 | 0.060 | 23000.16 | 0.038 | 7879.78 | 0.040 | 12913.10 |
| 2 | 1287.21 | 0.178 | 731.35 | 0.101 | 783.68 | 0.091 | 621.58 | 0.133 | 3282.67 | 0.095 | 1485.70 | 0.093 | 712.51 |
| 3 | 603.20 | 0.246 | 142.50 | 0.165 | 129.28 | 0.159 | 99.02 | 0.218 | 916.09 | 0.145 | 161.03 | 0.119 | 2.60 |
| 4 | 108.64 | 0.268 | 96.30 | 0.218 | 40.12 | 0.154 | 16.82 | 0.312 | 10.96 | 0.276 | 13.46 | 0.130 | 0.89 |
| 5 | 0.00 | 0.000 | 0.00 | 0.000 | 24.48 | 0.371 | 0.00 | 0.000 | 1.92 | 0.304 | 0.00 | 0.000 | 0.00 |
| 6 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 7 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 8 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 9 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| 10+ | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 |
| Total weight (t) | | 523.6 | | 680.3 | | 201.3 | | 223.2 | | 1544.7 | | 585.3 | |
| Sampling Information | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 200 |
| Number of Trips | | 9 | | 11 | | 8 | | 5 | | 15 | | 18 | |
| Number of Hauls | | 60 | | 122 | | 96 | | 56 | | 90 | | 91 | |

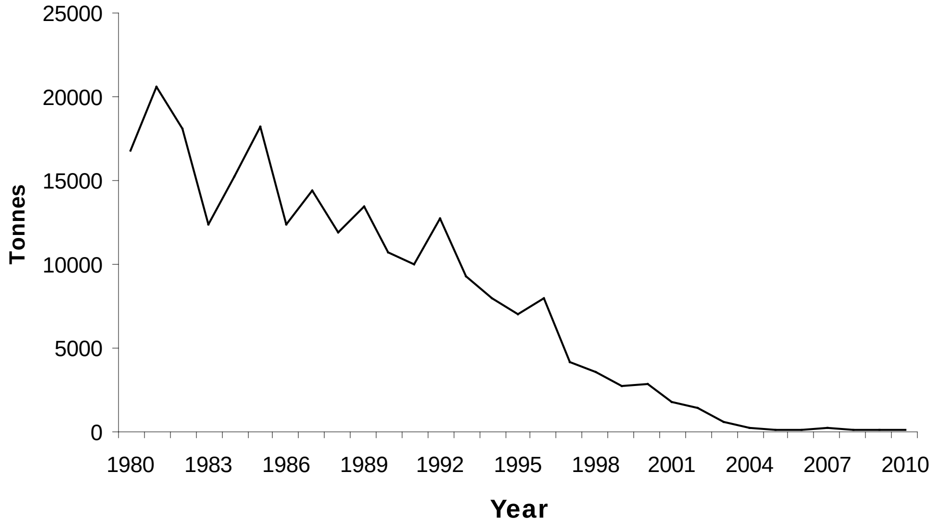



**Figure 6.6.1. Whiting VIIa. Working group estimates of landings 1980–2010. Note landings data prior to 2003 has been adjusted for misreporting and includes estimates of discards.**

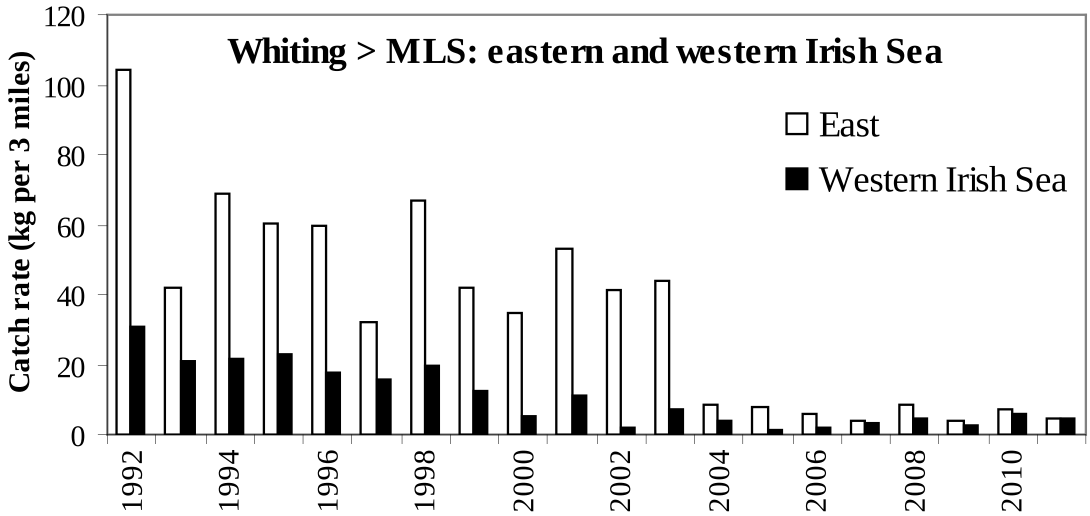
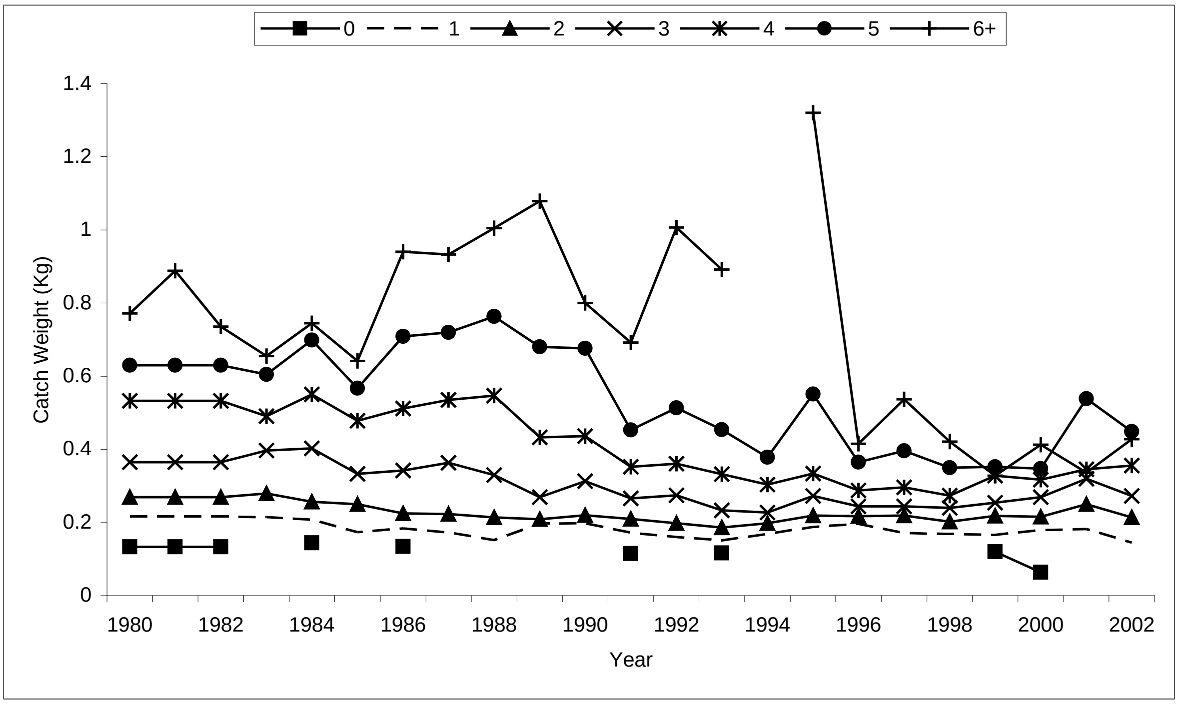



**Figure 6.6.2. Eastern and western VIIa whiting mean catch rates in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) from the UK(NI) March groundfish survey, 1992–2011.**

a)




b)

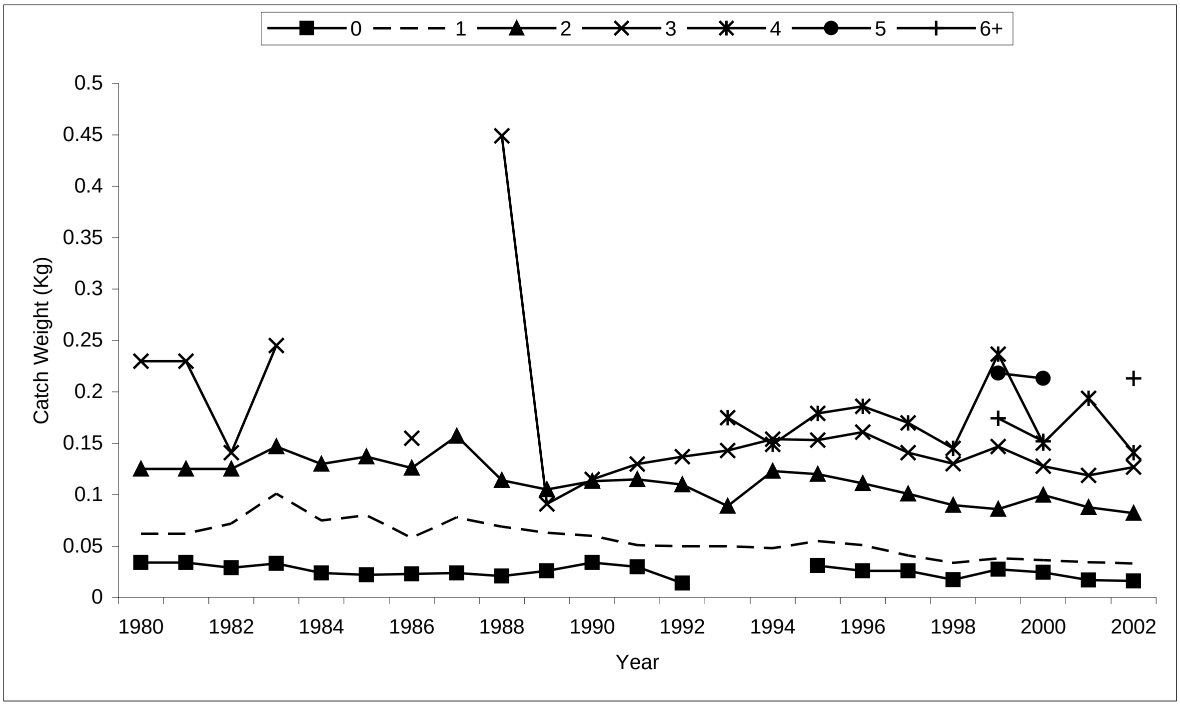
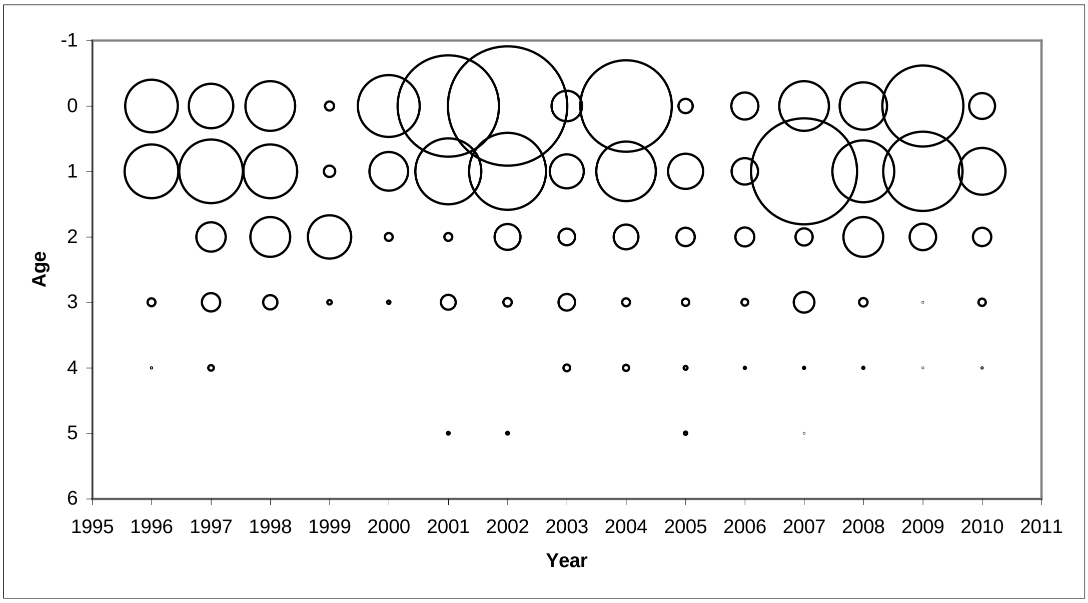



**Figure 6.6.3. VIIa whiting International mean weights-at-age in (a) landings (Human Consumption Fishery) and (b) discards, 1980–2002.**

a)




b)

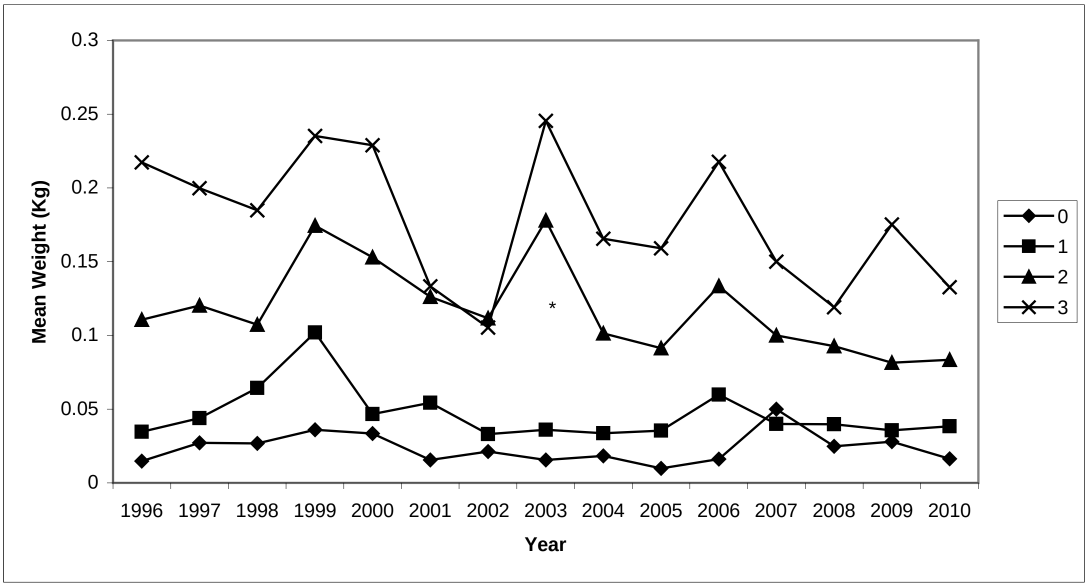
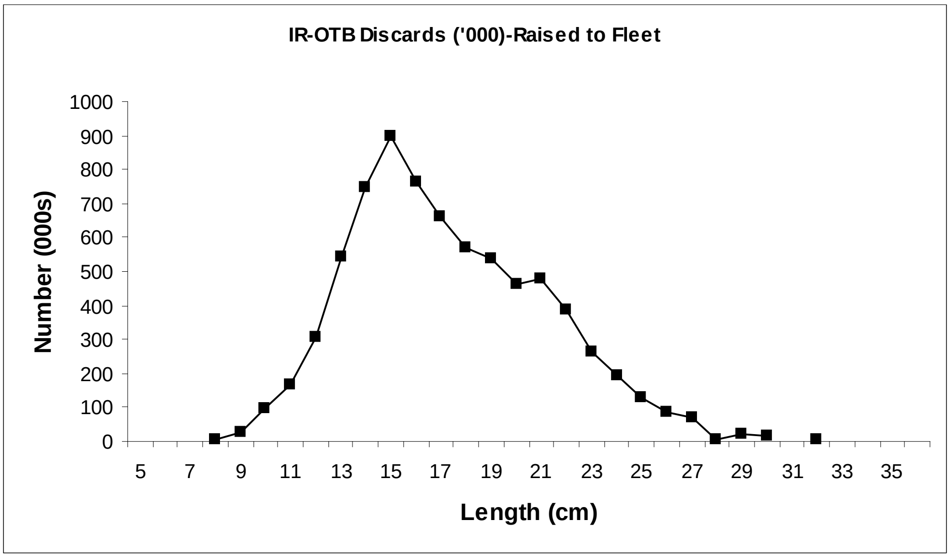
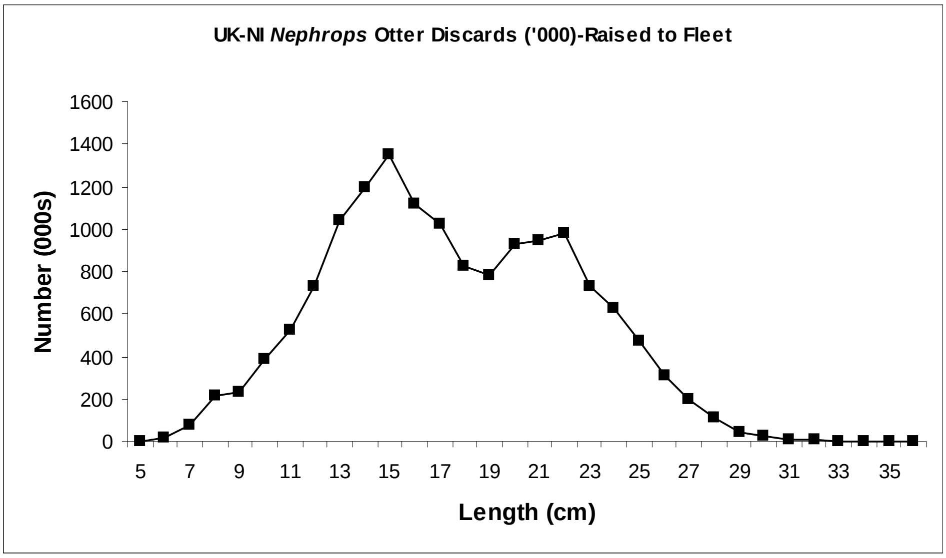



**Figure 6.6.4. VIIa whiting discard information for the Irish commercial otter board trawl fleet (a) numbers-at-age and (b) mean weights-at-age, 1996–2010.**



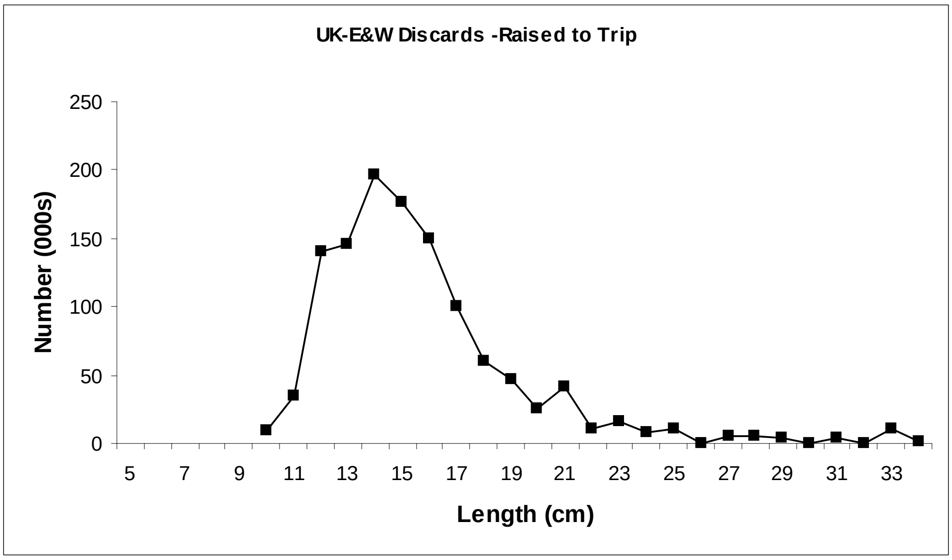
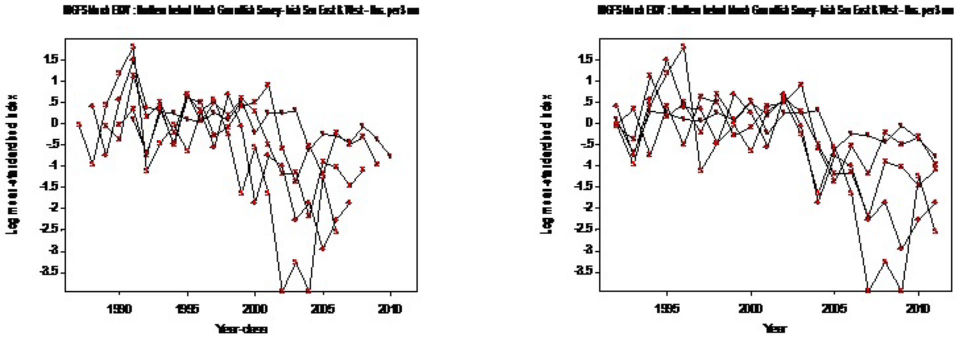




**Figure 6.6.5. VIIa Whiting discard length frequency by national fleets in 2010. Note due to low levels of retained catch, and hence low sampling, these data are not presented.**

a)




b)

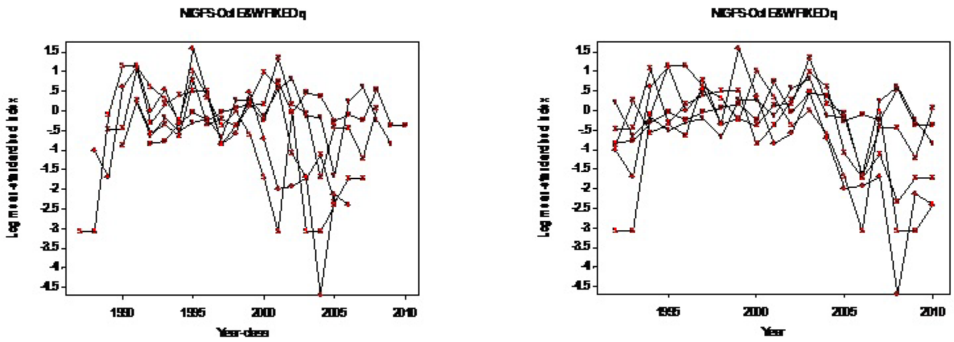
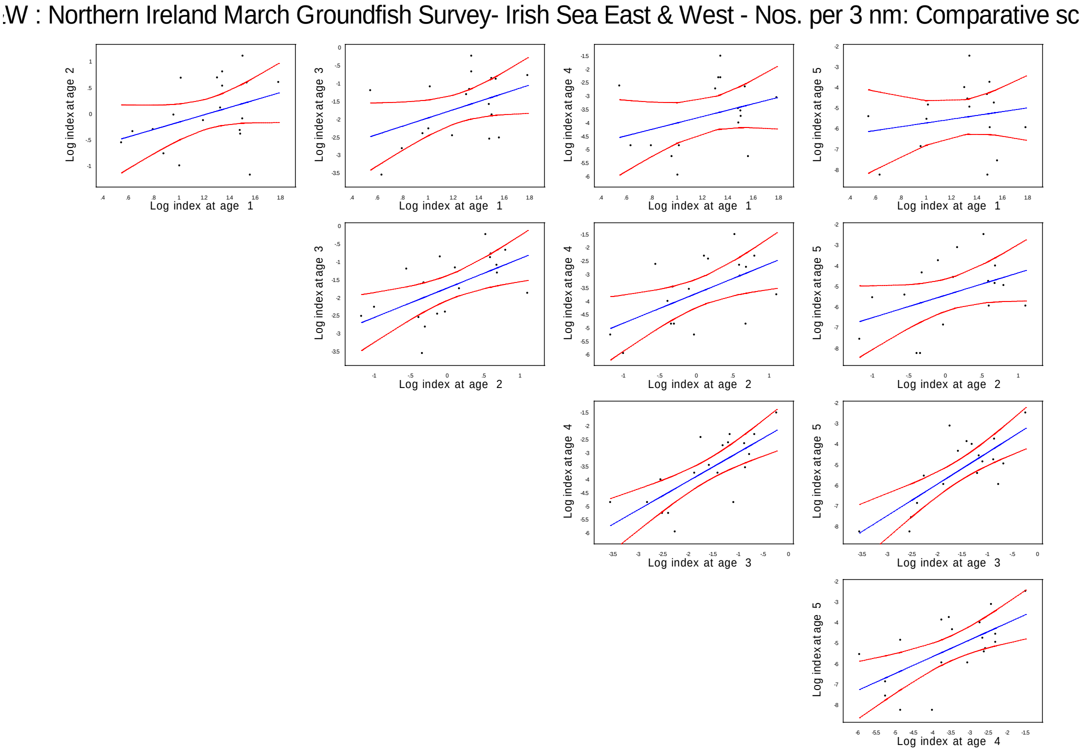



**Figure 6.6.6. Log Mean Standardized Indices for (a) NIGFS March and (b) NIGFS October by year class and year.**

a)




b)

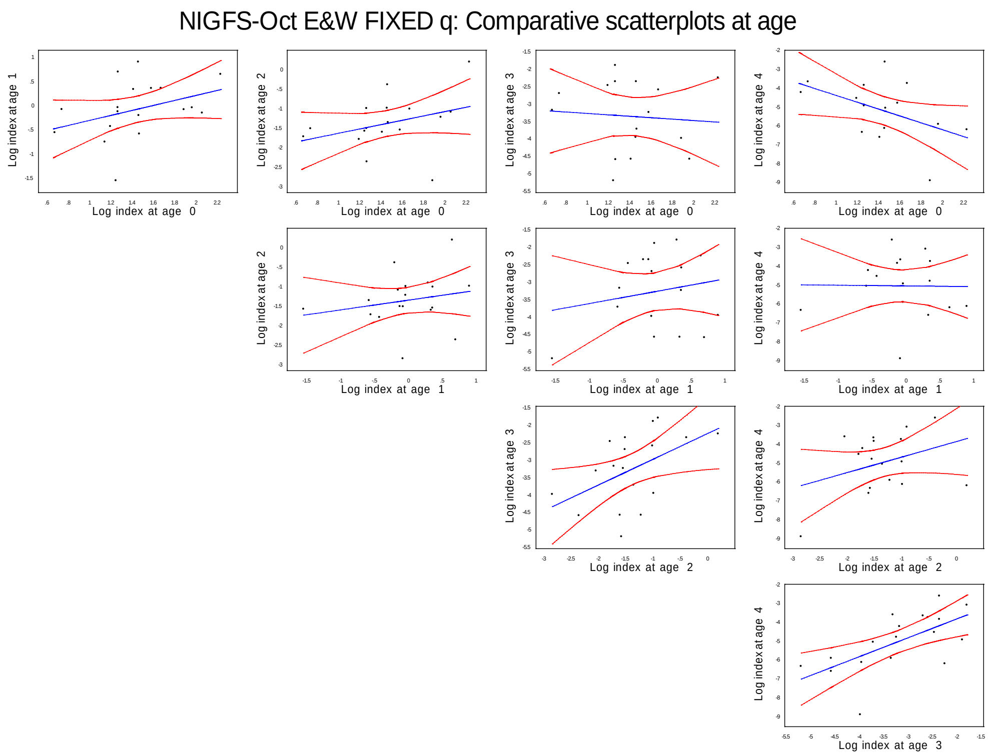



**Figure 6.6.7. Scatterplots of Log index-at-age for the NIGFS March (a) and NIGFS October (b) surveys.**

**a)**


**b)**

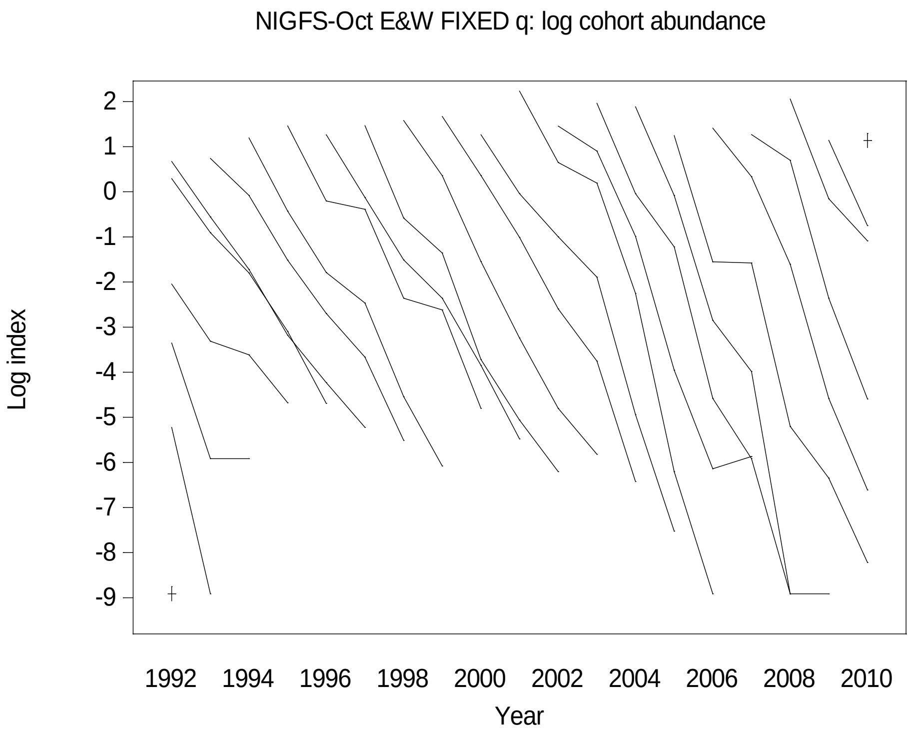
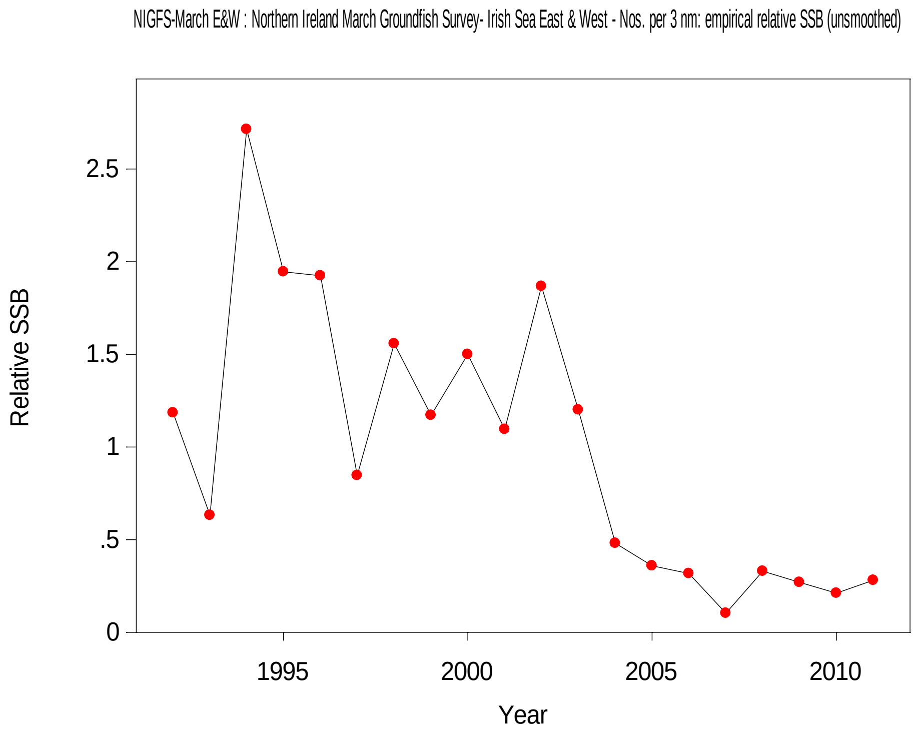



**Figure 6.6.8. Catch Curves for NIGFS-March (a) and NIGFS-October (b) surveys.**

a)




b)

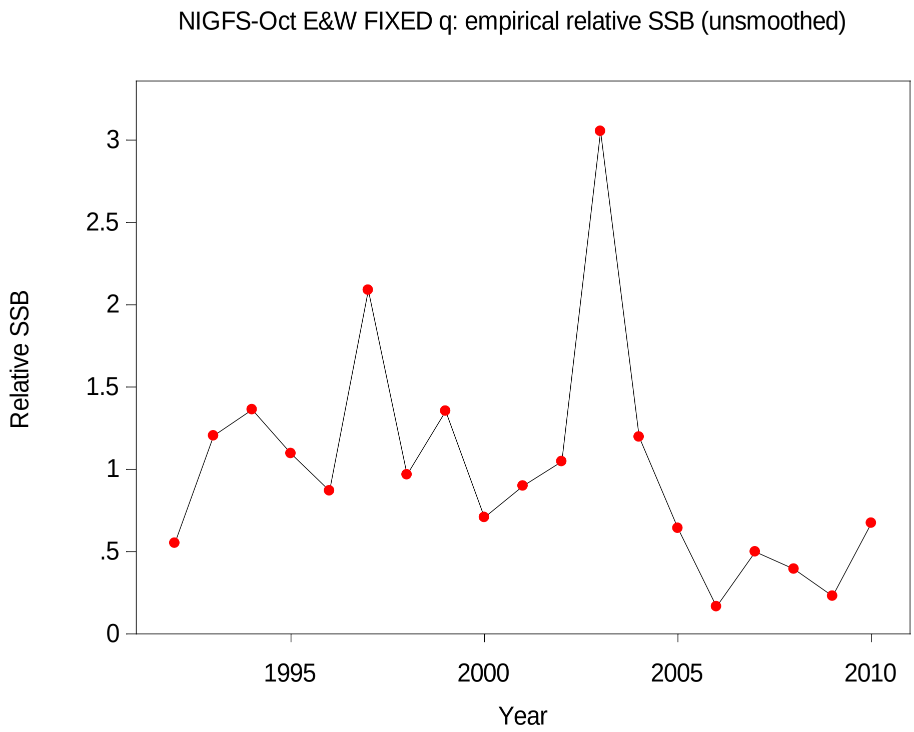



**Figure 6.6.9. Empirical Estimates of SSB for NIGFS March (a) and NIGFS October (b) surveys.**

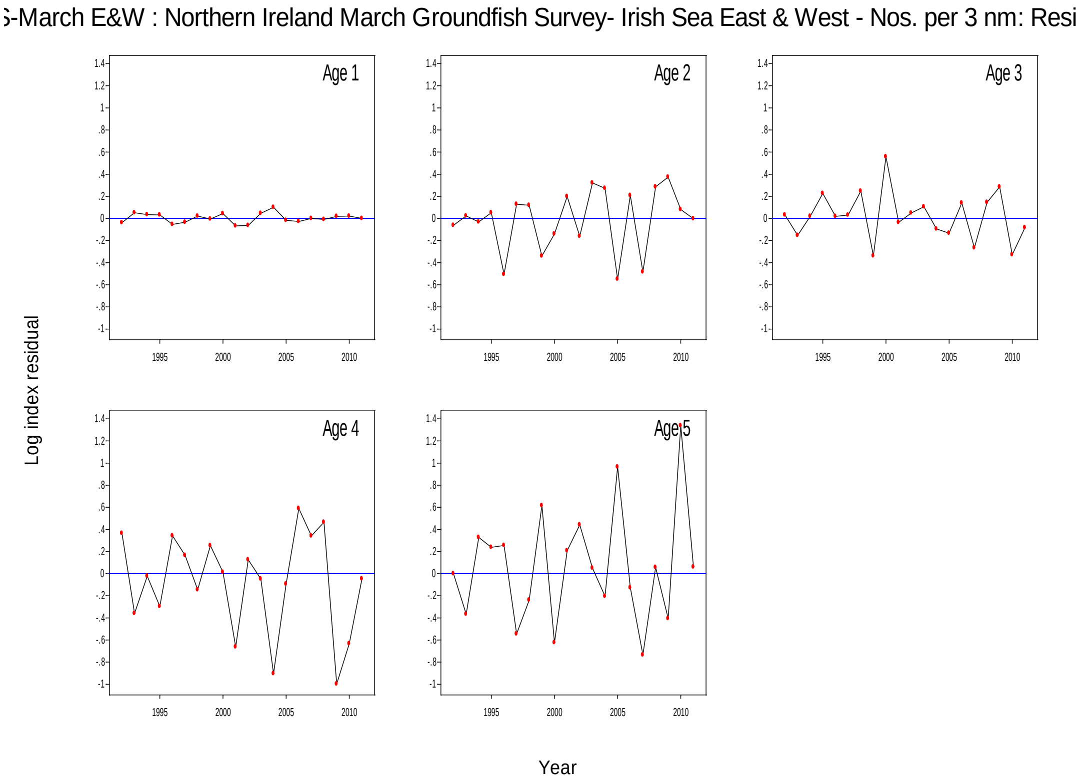



**Figure 6.6.10. Residual Plots by Age of the NIGFS March survey.**

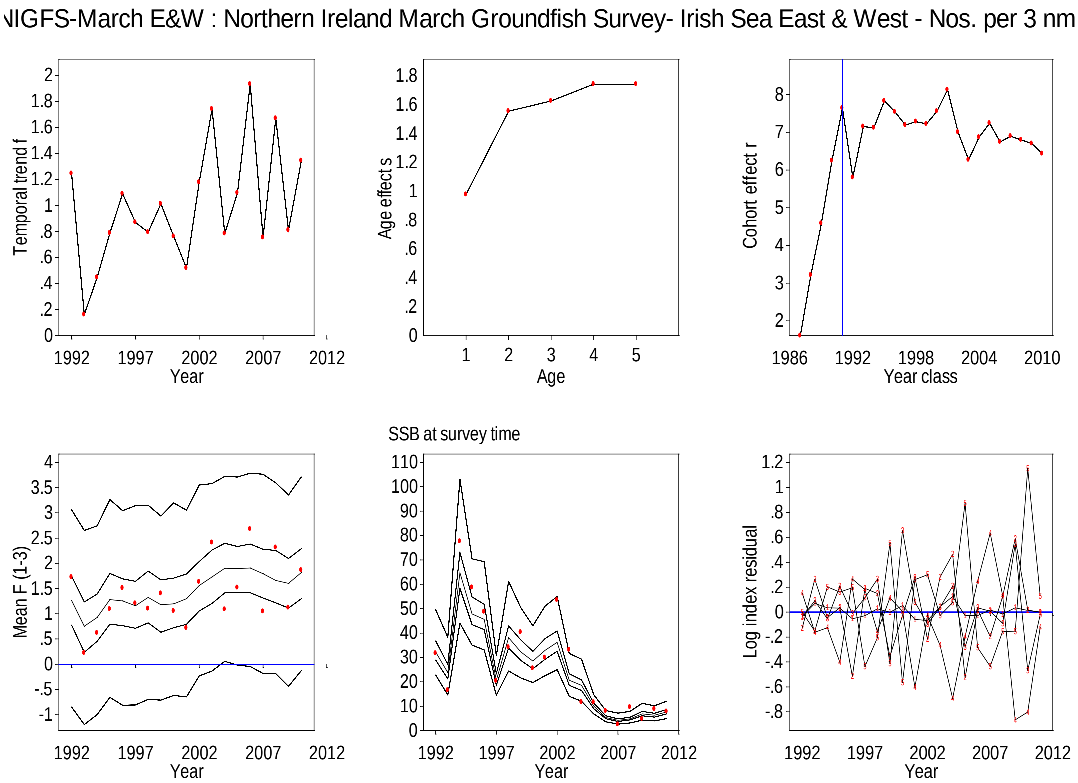



**Figure 6.6.11. Stock Summary of the SURBA model fit for the NIGFS March survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.**

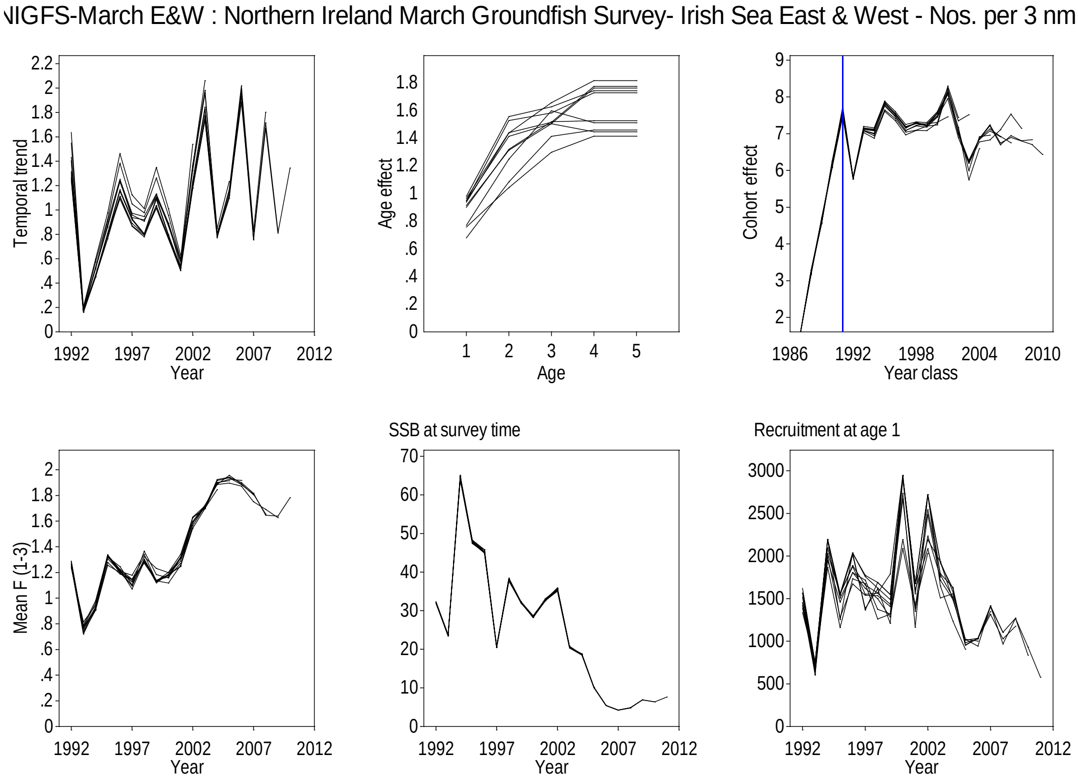



Figure 6.6.12. Retrospective pattern of Single fleet SURBA run for NIGFS March survey.

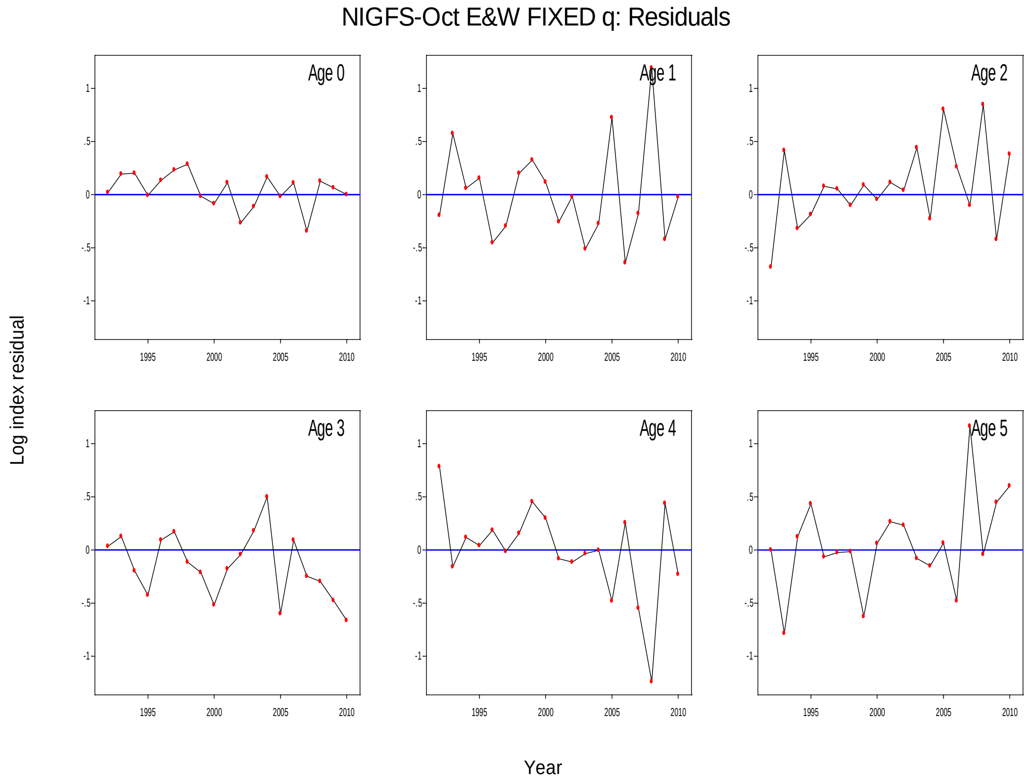



Figure 6.6.13. Residual Plots by Age of the NIGFS October survey.

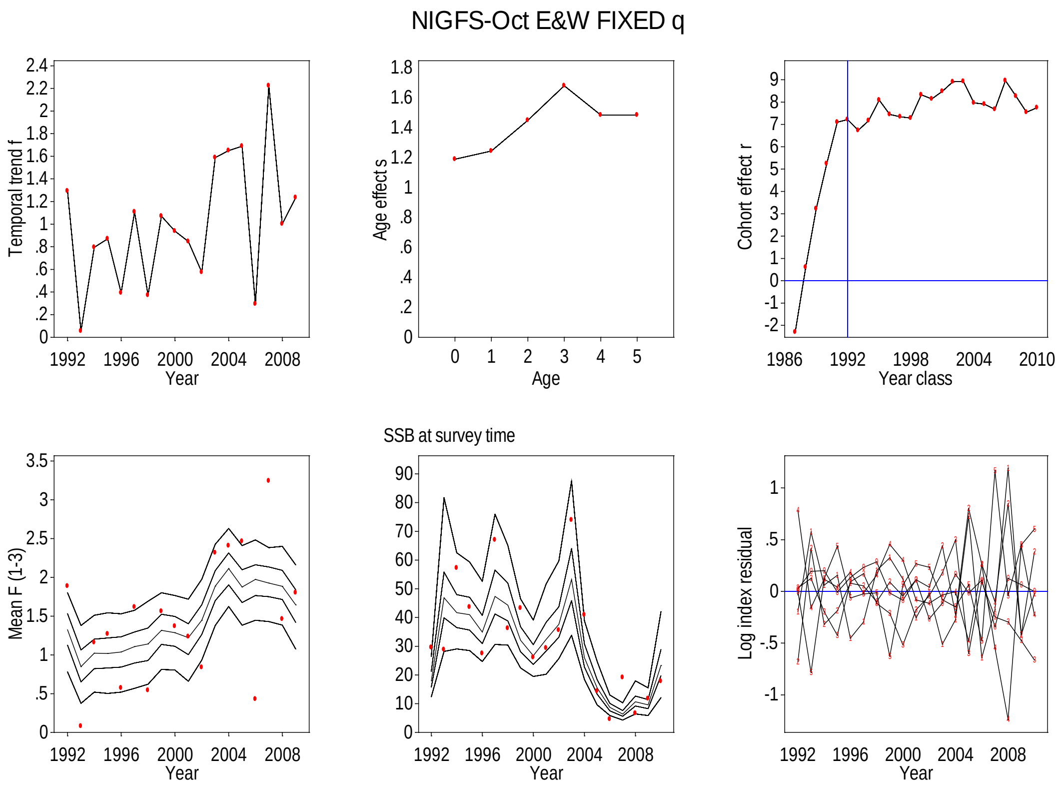



**Figure 6.6.14. Stock summary of the SURBA model fit for the NIGFS October survey. Empirical SSB (red dots) with model estimates of SSB (black line) are shown in bottom centre panel.**

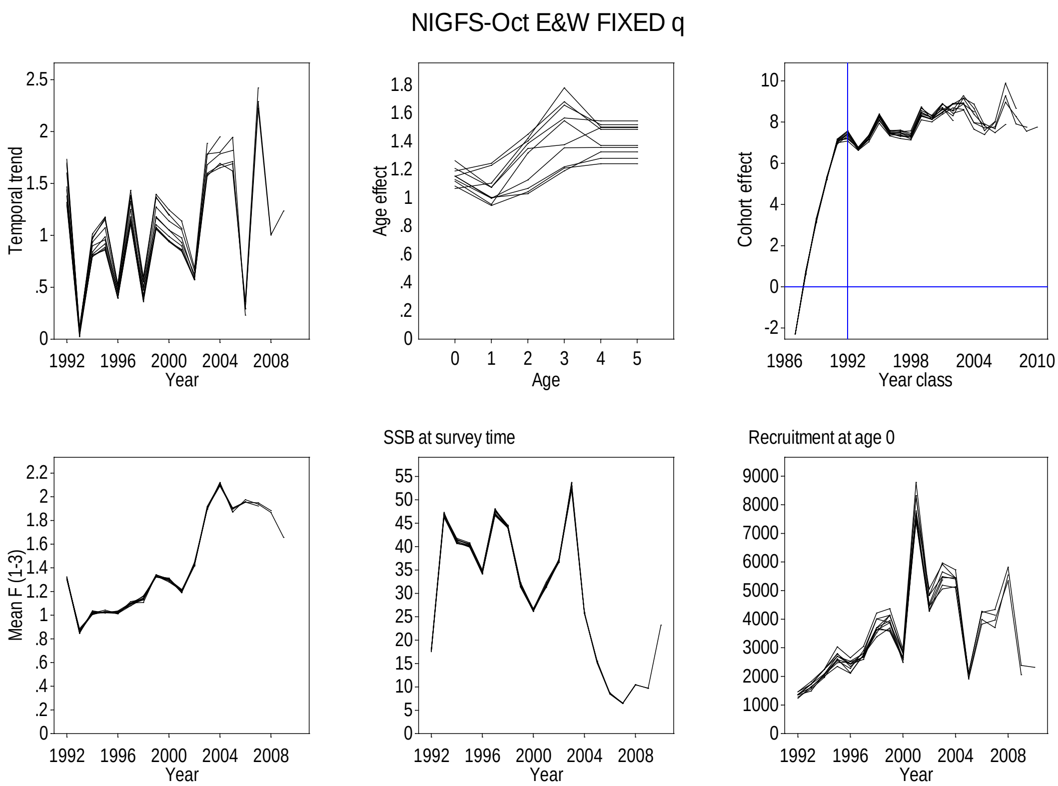



**Figure 6.6.15. Retrospective pattern of Single fleet SURBA run for NIGFS October survey.**

## 6.7 Plaice in Division VIIa (Irish Sea)

### Type of assessment in 2011

Update of the analytic assessment used to derive relative trends. ICES WKFLAT (2011) benchmarked this assessment and included estimates of discards-at-age from 2004 into the catch matrix. However, due to the short time-series of discard data available considerable uncertainty exists regarding the historical levels of discarding. This uncertainty translates into uncertain stock size and unknown exploitation status, therefore the assessment is indicative of trends only.

### ICES advice applicable to 2010

*ICES advises on the basis of high long-term yield that catches should not exceed 1627 t in 2010.*

### ICES advice applicable to 2011

*Effort should be consistent with no increase in catches.*

### 6.7.1 General

#### Stock description and management units

The stock assessment area and the management unit are both Division VIIa (Irish Sea).

#### Management applicable in 2010 and 2011

Management of plaice in Division VIIa is by TAC and there is a minimum landing size (MLS) of 27 cm in force. The agreed TACs and associated implications for plaice in Division VIIa are detailed in the tables below.

**2010**

| **Species:** | Plaice *Pleuronectes platessa* | **Zone:** | VIIa (PLE/07A.) |
|---|---|---|---|
| Belgium | 42 | | |
| France | 18 | | |
| Ireland | 1 063 | | |
| The Netherlands | 13 | | |
| United Kingdom | 491 | | |
| EU | 1 627 | | |
| TAC | 1 627 | | Analytical TAC |

**2011**

| **Species:** | Plaice *Pleuronectes platessa* | **Zone:** | VIIa (PLE/07A.) |
|---|---|---|---|
| Belgium | 42 | | |
| France | 18 | | |
| Ireland | 1 063 | | |
| The Netherlands | 13 | | |
| United Kingdom | 491 | | |
| EU | 1 627 | | |
| TAC | 1 627 | | Analytical TAC |

### The fishery in 2010

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1.

The TAC in 2010 was 1627 tonnes and the working group estimate of landings in 2010 was 377 tonnes, which is a 22% decrease in landings comparable to 2009 and only 23% of the TAC in 2010. This shortfall in estimated landings relative to the TAC has occurred in previous years, increasing steadily from 7% of the TAC in 2003 to a 70% shortfall in 2008 and 2009. It seems unlikely that the poor uptake of the quota is a consequence of an inability to catch sufficient quantities of plaice greater than the MLS; rather the shortfall in the uptake of the TAC is likely due to limited consumer demand and poor value of the catch.

Landings (based on working group estimates) by the Belgian, UK (E&W), NI, and Irish fleets comprised approximately 36%, 31%, 9% and 24% respectively of total landings in 2010. The landings of plaice are split evenly between beam trawlers (primarily Belgian vessels then Irish vessels) targeting sole, and otter trawlers (UK and Irish vessels). Historically, otter trawling was dominated by UK vessels fishing for whitefish, but in recent years many vessels have switched to target *Nephrops* (Figure 6.7.2.1). Otter trawlers from Ireland and N. Ireland typically target *Nephrops* in the western Irish Sea.

High levels of discarding are known to occur in all fisheries that catch plaice in the Irish Sea (see Figures 6.7.2.3 to 6.7.2.5).

A general description of the fishery can be found in the stock annex (Annex 6.6) and also in 'Other Relevant Data' section below. For general mixed fisheries advice applicable to this stock and other species taken in the same fisheries, see Section 6.1.

### 6.7.2 Data

#### Landings

National landings data reported to ICES and Working Group estimates of total landings are given in Table 6.7.2.1. Landed numbers-at-age for the younger ages (ages 2 to 4) have declined more rapidly over the last two decades than landings of older fish (Figure 6.7.2.2), despite the fact that large numbers of younger fish are caught by the beam trawl survey, suggesting that the selection pattern and/or discarding behaviour of the fleets has changed over time. The procedures used to determine the total international landings figures are documented in the stock annex. The landings-at-age matrix alone is not representative of the true catch (Figure 6.7.2.2).

#### Discards

Prior to 2010, indications were that discard rates, although variable, were substantial. At the ICES WKFLAT (2010) meeting discard data from the countries participating in the fishery was raised and collated to the total international level for the years 2004–2010 (Table 6.7.2.1). Discard information was available for Belgium, Ireland, N. Ireland and UK(E+W).

Routine discard sampling has been conducted by the UK (E&W) since 2002 and by Ireland since 1993. Northern Ireland has collected data from 1996 (but not between 2003 and 2005), and by Belgium since 2003. Length distributions (LD) of landed and discarded fish estimates are presented for UK (E&W) (Figure 6.7.2.3), Irish (Figure 6.7.2.4) and Belgian fleets (Figure 6.7.2.5). While, the discarding pattern is dominated by discarding of small fish (below MLS) in some years the Irish and Belgian fleets have discarded a small number of fish of a much greater size (e.g. 2004). Both, the UK(E&W) and Belgian observer data indicate overall mean (2004–2010) lengths of discarded and retained plaice at 23 cm and 30 cm respectively. However, the UK(E&W) data show that the mean length of discarded fish between 2007 and 2009 was 1 cm below the overall mean. Although variable, the Irish annual discard sampling LDs indicate that the overall mean (2004–2010) length of fish discarded is 19 cm, while the mean length of the retained component is 33 cm. However, in 2010, the mean length of both discarded and retained fish in the Irish data was ~3 cm greater (22 cm and 35 cm).

The UK estimates were raised to incorporate equivalent levels of discards for Ireland and Northern Ireland on the basis of similar gear types and given the limitations of their data. A raising factor based on tonnages 'landed' for these countries was calculated and applied to the UK(E+W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give estimates of total international discard numbers-at-age. The total estimates (Table 6.7.2.1) confirm the perception of the significant level of discarding; discards were therefore included within the assessment for the first time in the 2010 assessment. WG estimates of the combined, raised, level of discards are available from 2004 and they have shown a steady increase in time to levels higher than landings since 2006 (Figure 6.7.2.8).

There is a considerable historic time period for which no international raised discards are available. Work is ongoing on the issue of raising additional samples from Irish and Northern Irish observer programmes.

#### Biological

Landings numbers-at-age are given in Table 6.7.2.5 and plotted in Figure 6.7.2.2. Weights-at-age in the landings and stock are given in Table 6.7.2.6 and since 1995 are no longer altered by fitting a quadratic model. The stock weights are taken as the landings weights. However, prior to 1995 the data have not yet been revised to remove the quadratic smoother. Discard weights-at-age are given in Table 6.7.2.7 and modified weights-at-age in the stock in Table 6.7.2.8. The history of the derivation of the landings weights and stock weights used in this assessment is described in the stock annex.

Mean weight-at-age in the landings and survey data indicate declines in both sexes throughout the Irish Sea since 1993 (see stock annex, Figure A2).

#### Surveys

All available tuning data are shown in Tables 6.7.2.3 and 6.7.2.4. Due to inconsistencies in the available commercial tuning fleets, Irish Sea plaice assessments since 2004 have only included the UK (E&W) beam trawl survey (UK (E&W)-BTS-Q3) and the two NIGFS-WIBTS spawning biomass indices based on groundfish surveys (NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4 ). For more information see WGNSDS 2004. The UK (E&W)-BTS-Q3 index was revised by WKFLAT 2011 to include stations in the western Irish Sea and in St Georges Channel.

Inspection of UK (E&W)-BTS-Q3 mean standardized cpue plots (Figure 6.7.2.6) indicates that the survey has fair internal consistency and suggests increases in the abundance of plaice of both sexes in the eastern Irish Sea (ISE and ISN). In the western Irish Sea the cohort strength was high during 1995–2002 and fell thereafter. The biomass index of age 1–4 fish calculated from the UK (E&W)-BTS-Q3 also indicates an upwards trend since 1993 (Figure 6.7.2.2). Although the UK (E&W)-BTS-Q3 and the NIGFS-WIBTS surveys show similar increases in biomass between 1993 and 2003, low biomass values were recorded between 2004 and 2007 in the autumn index of the NIGFS-WIBTS surveys and between 2004 and 2009 in the spring index. Nevertheless, the autumn (Q4) index reached high levels in 2009 and the spring (Q1) index in 2010.

The NIGFS-WIBTS survey strata can be disaggregated into eastern (Strata 4–7) and western (Strata 1–3) subareas, where the subareas are divided by the deep trench that runs roughly north–south to the west of the Isle of Man (Figure 6.7.2.7, Table 6.7.2.3). The notable difference in mean biomass between spring and autumn in the western area (Strata 1–3) suggests either that spawning fish migrate into the area during spring or that catchability of plaice increases during spawning.

The SSB of plaice in the Irish Sea is also independently estimated using the Annual Egg Production Method (AEPM, Figure 6.7.2.2):

| Year | SSB |
|---|---|
| 1995 | 9081 |
| 2000 | 13 303 |
| 2006 | 14 417 |
| 2008 | 14 352 |
| 2010 | 15 071 |

The results (revised in 2011 to ensure consistency across years, see WD #, WGCSE 2011) confirm that SSB of plaice in the Irish Sea is lightly exploited. Splitting the SSB estimates from the AEPM into eastern and western Irish Sea areas also indicates that the perceived increase in plaice biomass is due to increased production in the eastern Irish Sea only (For more details see stock annex).

In summary, the UK (E&W)-BTS-Q3 in September, the NIGFS-WIBTS-Q4 index in October (but not NIGFS-WIBTS-Q1 March), and the AEPM indicate a sustained increase in biomass in the eastern Irish Sea, but this rise does not appear to extend across the deep channel to plaice in the western Irish Sea (Figure 6.7.2.9).

Work is currently being undertaken to supply cpue values for the Q4 western IBTS survey (UK, E&W) for the Irish Sea area. However, the time-series is currently too short to include in the assessment.

#### Commercial cpue

All available tuning data are shown in Table 6.7.2.4. Age based tuning data available for this assessment comprise three commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W)OTB, from 2008), the UK(E&W) beam trawl fleet (UK(E&W)BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have omitted these indices. For more information see WGNSDS 2004. The effort and catch by these commercial fleets has been very low in recent years and the cpue data are no longer considered informative.

#### Other relevant data

Table 6.7.2.2 and Figure 6.7.2.1 show that effort levels have decreased between 2008 and 2009 for all fleets. Both the UK otter and beam trawl fleets are at their lowest recorded effort levels in time-series extending back to 1972 and 1978 respectively. Effort by UK *Nephrops* trawlers has increased since 2006 and this fleet is now the dominant UK fleet in terms of hours fished in VIIa. Belgian vessels operating in Division VII typically move in and out of the Irish Sea, depending on the season, from specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea.

In 2010, landings by the Belgian fleet decreased by 60 tonnes relative to 2009 landings; similarly landings by UK(E&W) decreased by 40 tonnes. In contrast landings by Ireland increased by 17 tonnes, landings decreased by 41 tonnes. The Irish fishery landings in 2009 were split between otter trawlers (49%), and beam trawlers (50%). The beam trawl component is mostly taken as part of a mixed fishery, and some of the landings also come as bycatch from the *Nephrops* fishery.

Landings by the Belgian fleet in 2010 were split relatively evenly across quarters 1–3 (34%, 24%, 30% each). Landings by UK(E&W) were largely taken in the second and third quarters (38% and 40% respectively). Landings by the Irish fleet were high in the third and fourth quarters (39% and 34%).

### 6.7.3 Historical stock development

Model: Aarts and Poos (AP)

Software: R version 2.10.1 (2009-12-14) with additional packages (version in parentheses):

FLCore (3.0); stats4 (2.10.1); grid (2.10.1); splines (2.10.1); boot (1.2-4); mvtnorm (0.9-9); MASS (7.2-46).

#### Model options chosen

Settings for this update stock assessment are given in the table below. The update AP assessment follows the same procedure as in the WKFLAT 2011 benchmark assessment as described in the stock annex. WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Irish Sea plaice. This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries). Although a good start, the AP model is not considered the definitive assessment tool for Irish Sea plaice but a temporary solution to the fitting of datasets which include recent discards estimates but for which historic discard information is not available. The model reconstructs historic discard rates using a time variant spline. Given that the spline extrapolates beyond the range of the recent data to which it is fitted, it can potentially result in spurious estimates of historic discarding, which may change markedly as new discard data are added to the short time-series. In addition, it is highly likely that the discard patterns currently observed differ from those that would have been observed historically as a result of substantial changes in the composition of the gear types that have been used to prosecute the fisheries in which plaice is caught. A model which incorporates estimates of historic discards that are derived from the proportional allocation of the effort deployed by the dominant gear types is considered more appropriate in the long term.

#### Input data types and characteristics

New data added to the update AP assessment are the fishery landings data for 2010, discard estimates for 2010 and survey data for 2010 for the following surveys: UK (E&W)-BTS-Q3, NIGFS-WIBTS-Q1 and NIGFS-WIBTS-Q4.

#### Data screening

Data were screened as described in the stock annex.

#### Final update assessment

The assessment settings are shown in the following table, with changes to the previous year's settings highlighted in bold. Historic settings are given in the stock annex. Final model parameters and diagnostics are shown in Table 6.7.3.1.

| Assessment year | | 2010 | 2011 |
|---|---|---|---|
| Assessment model | | ICA | **AP** |
| Tuning fleets | UK (E&W)-BTS-Q3 | 1989–2009, ages 2–7 | **Series omitted** |
| | Extended UK (E&W)-BTS-Q3 | n/a | **1993–2010, ages 1–6** |
| | UK(E&W) BTS Mar | Survey omitted | Survey omitted |
| | UK(E&W) OTB | Series omitted | Series omitted |
| | UK(E&W) BT | Series omitted | Series omitted |
| | IR-OTB | Series omitted | Series omitted |
| | NIGFS-WIBTS-Q1 | 1992–2009 | **1993–2010** |
| | NIGFS-WIBTS-Q4 | 1992–2009 | **1993–2010** |
| Time-series weights | | Full time-series - unweighted | **n/a** |
| Num yrs for separable | | 9 | **n/a** |
| Reference age | | 5 | **n/a** |
| Terminal S | | 1 | **n/a** |
| Catchability model fitted | | linear | **n/a** |
| SRR fitted | | No | **n/a** |
| Selectivity model | | n/a | **Linear Time Varying Spline at age (TVS)** |
| Discard fraction | | n/a | **Polynomial Time Varying Spline at age (PTVS)** |
| Landings num-at-age, range: | | 2–9+ | 1–9+ |
| Discards N-at-age, yrs, ages: | | n/a | **2004–2010, ages 1–5** |

The estimated selectivity patterns split into the landed and discarded components is shown in Figure 6.7.2.10; the landings selectivity is initially flat topped (indicating that older age fish are selected) but becomes dome shaped during the 2000s and falls over time to very low values relative to the discard pattern which expands to the older aged fish during the 2000s (Figures 6.7.2.11 and 6.7.2.12). The catchability of the UK (E&W)-BTS-Q3 survey is elevated for ages 1 and 2 and reflects the nature of the survey, which was designed as a recruit index (Figure 6.7.2.12). Diagnostic output from the AP model is printed in Table 6.7.3.1. A year effect in 2004 is present in the UK (E&W)–BTS-Q3 residuals (Figure 6.7.2.13). Although, the estimated recruitments from the AP model largely follow the UK (E&W)–BTS-Q3 numbers-at-age 1 there is some mismatch for the early years (1993–1994; Figure 6.7.2.14), which is a result of the high discards predicted by the model (Figure 6.7.2.18). A pattern of negative residuals between 2004 and 2008 is present in the residuals of the NIGFS-WIBTS due to fluctuations in the SSB indices, which are due potentially to variability of catchability of the survey (Figure 6.7.2.15). In the catch residuals (Figure 6.7.2.16), negative values are apparent in all years of the discard matrix for age 1 (the model underestimates discards-at-age 1), while in the landings matrix age 8 residuals are all similarly negative since 1999.

The estimated SSB from the AP model shows an increasing trend until 2005, after which time the SSB stabilizes and this is largely in agreement with independent SSB estimates from the Annual Egg Production Method (AEPM, Figure 6.7.2.17; see WD 9). While this SSB pattern agrees well with the survey data used in the assessment between 1993 and 2003 (NIGFS-WIBTS-Q1 and –Q4; UK (E&W)-BTS-Q3, Figure 6.7.2.17), notable differences exist, particularly the high biomass value in the UK (E&W)-BTS-Q3 in 2004 and the low values all indices (NIGFS-WIBTS-Q1 and -Q4; UK (E&W)-BTS-Q3) during 2006–2008.

Estimates of numbers-at-age in the landings, discards and population, and fishing mortality numbers-at-age are given in Tables 6.7.3.2–6.7.3.5. A summary plot for the final update AP assessment is shown in Figure 6.7.2.18 and bootstrapped time-series estimates for F, SSB and recruitment are given in Table 6.7.3.6.

No retrospective analysis can be performed for this assessment due to limited discard data. A general trend of increasing SSB and decreasing fishing mortality during the 1990s to stable levels is evident.

#### Comparison with previous assessments

Comparisons between this year's AP assessment and last year's ICA assessment are shown in Figure 6.7.2.19. The two assessments perform similarly in terms of temporal trends in SSB, recruitment and $F_{bar}$ during the 1990s. However, in the previous ICA assessment the F and SSB did not stabilize from 2003 due to the lack of discard information.

#### State of the stock

Trends in $F_{bar}$, SSB, recruitment and landings, for the full time-series, are shown in Tables 6.7.3.4 and Figure 6.7.2.18. The update assessment estimates that fishing mortality declined from high levels in the early 1990s to very low levels since 2000, while SSB increased between 1995 and 2005 and has been stable thereafter. Estimated recruitments are highly variable but stable since 2000. Landings have decreased to low levels, and discards have increased slightly: the proportion by weight of the catch discarded has subsequently increased markedly since 2004 (Figure 6.7.2.18) and is now at very high levels (greater than 80%).

### 6.7.4 Short-term projections

There are no short-term projections for this stock.

### 6.7.5 Medium-term projections

There are no medium-term projections for this stock.

### 6.7.6 MSY explorations

There are no MSY explorations for this stock.

### 6.7.7 Biological reference points

#### Precautionary approach reference points

There have been no biological reference points determined for this stock since discards have been included in the assessment. Previously reference points were proposed by the 1998 working group as below:

| | | |
|---|---|---|
| $F_{lim}$ | No proposal | |
| $F_{pa}$ | 0.45 | (on the basis of Fmed and long-term considerations) |
| $B_{lim}$ | No proposal | |
| $B_{pa}$ | 3100 t | (on the basis of $B_{loss}$ and evidence of high recruitments at low SSBs) |

#### Yield-per-recruit analysis

There are no yield-per-recruit analyses for this stock.

### 6.7.8 Management plans

There are no management plans for this stock.

### 6.7.9 Uncertainties and bias in assessment and forecast

Although, WKFLAT 2011 revised the UK (E&W)-BTS-Q3, there is still some disagreement between this survey and the NIGFS-WIBTS indices. Further work should focus on improving the NIGFS-WIBTS to take into account spatial and temporal change in the maturity ogive and length–weight relationships.

There is evidence of a decline in weight-at-age from the raw commercial landings data and survey data and in length-at-age in the survey data. Temporal changes in maturity-at-age should be investigated.

There are no raised estimates of discard levels for the period prior to 2004. The uncertainty in the discard data requires evaluation.

### 6.7.10 Recommendations for next benchmark

Further work on the discard raising procedures is required and bootstrap estimates of variability need to be developed. Historical data collected by Northern Ireland exist and require further evaluation.

There is evidence of substantial substock structure and, if the catch data can be partitioned, then exploratory assessments for the eastern and western subareas would merit further study.

Annual maturity ogives should be determined from UK (E&W)-BTS-Q3 data and incorporated into the procedure for calculating the NIGFS-WIBTS indices.

Commercial indices and their horse-power (HP) corrections for the older ages should be re-analysed. Inclusion of the historic UK (E&W)-BTS-Q1 data may benefit the assessment in the historic period.

Ecosystem information ought to be explored.

| Year | Candidate Stock | Supporting Justification | Suggested time | Indicate expertise necessary at benchmark meeting |
|---|---|---|---|---|
| 2011 | VIIa Plaice | Weights and lengths-at-age show trends in recent years.<br>Maturity ogives appear to have changed.<br>The NIGFS-WIBTS indices require recalculation.<br>Variability of discards should be quantified. | 2013 | Expert group members. |

### 6.7.11 Management considerations

The high level of discarding in this fishery indicates a mismatch between the minimum landing size and the mesh size of the gear being used. Any measures that effect a reduction in discards will result in increased future yield. However, decreasing the mesh size may not have the desired result since the market demand for plaice is poor and small plaice are particularly undesirable.

Whereas the precise levels of $F_{bar}$ and SSB are considered poorly estimated, the overall state of the stock is consistently estimated to have low fishing mortality and high spawning biomass. Therefore the stock is considered to be within safe biological limits.

Due to the uncertainty in the assessment the working group does not provide a short-term forecast.

Discarding has increased throughout the period in which data are available, while landings of plaice have decreased, although the TAC is not restrictive. Effort has decreased in fisheries targeting plaice (including UK (E&W) and Belgian beam trawl fisheries and UK(E&W) and Irish otter trawl fisheries targeting demersal fish). In contrast, effort by the UK(E&W) *Nephrops* fleet has increased. However, this is still small in comparison to effort by the Irish *Nephrops* fleet. The *Nephrops* grounds are located in the western Irish Sea, where relatively small plaice are found. Technical measures to mitigate discarding by all *Nephrops* fleets could include the use of sorting grids: gear selectivity trials and monitoring from four Irish *Nephrops* trawlers using grids since 2009 indicate a potential reduction in fish discarding by 75% (BIM, 2009).

### Sources


Aarts, G., and Poos, J.J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. ICES Journal of Marine Science, 66: 763–771.

BIM. 2009. Summary report of Gear Trials to Support Ireland's Submission under Articles 11 & 13 of Reg. 1342/2008. Nephrops Fisheries VIIa & VIIb-k. Project 09.SM.T1.01. Bord Iascaigh Mhara (BIM) May 2009.

ICES. 2011. Report of the Benchmark Workshop on Flatfish (WKFLAT), 1–8 February 2011, Copenhagen, Denmark. ICES CM 2011/ACOM:39.

**Table 6.7.2.1. Nominal landings of PLAICE in Division VIIa as officially reported to ICES.**

| Country | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 [1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 321 | 128 | 332 | 327 | 344 | 459 | 327 | 275 | 325 | 482 | 636 | 628 | 431 | 566 | 343 | 194 | 157 | 197 | 138 |
| France | 42 | 19 | 13 | 10 | 11 | 8 | 8 | 5 | 14 | 9 | 8 | 7 | 2 | 9 | 2 | 2 | 2 | 0.4 | 0.2 |
| Ireland | 1355 | 654 | 547 | 557 | 538 | 543 | 730 | 541 | 420 | 378 | 370 | 490 | 328 | 272 | 179 | 194 | 102 | 73 | 90 |
| Netherlands | - | - | - | - | 69 | 110 | 27 | 30 | 47 | - | - | - | - | - | - | - | - | - | - |
| UK (Eng.&Wales)[2] | 1381 | 1119 | 1082 | 1050 | 878 | 798 | 679 | 687 | 610 | 607 | 569 | 409 | 369 | 422 | 413 | 412 | 300 | 185 | 148 |
| UK (Isle of Man) | 24 | 13 | 14 | 20 | 16 | 11 | 14 | 5 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | … | 0.5 |
| UK (N. Ireland) | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … | … |
| UK (Scotland) | 70 | 72 | 63 | 60 | 18 | 25 | 18 | 23 | 21 | 11 | 7 | 9 | 4 | 1 | 0 | 0 | 1 | 0 | 0.1 |
| UK (Total) | | | | | | | | | | | | | | | | | | | |
| Total | 3193 | 2005 | 2051 | 2024 | 1874 | 1954 | 1803 | 1566 | 1443 | 1488 | 1591 | 1544 | 1134 | 1270 | 937 | 802 | 562 | 455 | 377 |
| Discards | - | - | - | - | - | - | - | - | - | - | - | - | 620 | 1195 | 1259 | 1734 | 1270 | 1224 | 2516 |
| Unallocated | 74 | -9 | 15 | -150 | -167 | -83 | -38 | 34 | -72 | -15 | 32 | 15 | 9 | 11 | -5 | 3 | 1 | 2 | 0 |
| Total figures used by the Working Group for stock assessment | 3267 | 1996 | 2066 | 1874 | 1707 | 1871 | 1765 | 1600 | 1371 | 1473 | 1623 | 1559 | 1763 | 2476 | 2191 | 2539 | 1833 | 1681 | 2892 |

**[1]Provisional.**

**[2]Northern Ireland included with England and Wales.**

**{UK (Total) excludes Isle of Man data}.**

**Table 6.7.2.2. Irish Sea plaice: English standardized lpue and effort, Belgian beam trawl lpue and effort and Irish otter trawl lpue and effort series.**

| Year | CPUE | | | LPUE | | | | | Effort ('000hrs) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UK(E&W) Beam trawl survey[4] | | | English[1] | | Belgian[3] | Irish[7] | | English | | | Belgian[5] | Irish | |
| | March | September Prime only | September Extended | Otter Trawl | Beam Trawl | Beam Trawl | Otter Trawl | Beam Trawl | Otter[2] Trawl | Beam[2] Trawl | Nephrops Trawl | Beam Trawl | Otter Trawl | Beam Trawl |
| 1972 | | | | 6.96 | | 9.8 | | | 128.4 | | | 6.8 | | |
| 1973 | | | | 6.33 | | 9.0 | | | 147.6 | | | 16.5 | | |
| 1974 | | | | 7.45 | | 10.4 | | | 115.2 | | | 14.2 | | |
| 1975 | | | | 7.71 | | 10.7 | | | 130.7 | | | 16.2 | | |
| 1976 | | | | 5.03 | | 5.8 | | | 122.3 | | | 15.1 | | |
| 1977 | | | | 4.82 | | 5.3 | | | 101.9 | | | 13.4 | | |
| 1978 | | | | 6.77 | 4.88 | 6.9 | | | 89.1 | 0.9 | | 12.0 | | |
| 1979 | | | | 7.18 | 15.23 | 8.0 | | | 89.9 | 1.7 | | 13.7 | | |
| 1980 | | | | 8.24 | 8.98 | 8.6 | | | 107.0 | 4.3 | | 20.8 | | |
| 1981 | | | | 6.87 | 4.91 | 7.1 | | | 107.1 | 6.4 | | 26.7 | | |
| 1982 | | | | 4.92 | 1.77 | 4.4 | | | 127.2 | 5.5 | | 21.3 | | |
| 1983 | | | | 5.32 | 3.08 | 7.8 | | | 88.1 | 2.8 | | 18.5 | | |
| 1984 | | | | 7.77 | 6.98 | 6.8 | | | 103.1 | 4.1 | | 13.6 | | |
| 1985 | | | | 9.97 | 25.70 | 8.8 | | | 102.9 | 7.4 | | 21.9 | | |
| 1986 | | | | 9.27 | 4.21 | 8.7 | | | 90.3 | 17.0 | | 38.3 | | |
| 1987 | | | | 7.20 | 3.57 | 8.2 | | | 130.6 | 22.0 | | 43.2 | | |
| 1988 | | 392 | | 5.02 | 3.05 | 6.3 | | | 132.0 | 18.6 | | 32.7 | | |
| 1989 | | 253 | | 5.51 | 13.59 | 6.2 | | | 139.5 | 25.3 | | 36.7 | | |
| 1990 | | 239 | | 5.93 | 12.02 | 7.2 | | | 117.1 | 31.0 | | 38.3 | | |
| 1991 | | 157 | | 4.79 | 10.56 | 7.5 | | | 107.3 | 25.8 | | 15.4 | | |
| 1992 | | 188 | | 4.20 | 9.99 | 11.9 | | | 96.8 | 23.4 | | 23.0 | | |
| 1993 | 91 | 235 | 152 | 3.97 | 9.50 | 5.0 | | | 78.9 | 21.5 | | 24.4 | | |
| 1994 | 128 | 225 | 137 | 4.90 | 7.79 | 9.2 | | | 43.0 | 20.1 | 0.0 | 31.6 | | |
| 1995 | 134 | 169 | 111 | 5.08 | 7.69 | 9.5 | 3.2 | 17.0 | 43.1 | 20.9 | 0.0 | 27.1 | 80.3 | 8.6 |
| 1996 | -[6] | 210 | 113 | 5.37 | 12.96 | 11.8 | 4.1 | 18.9 | 42.2 | 13.3 | 0.0 | 22.2 | 64.8 | 6.3 |
| 1997 | 147 | 262 | 153 | 5.25 | 7.66 | 13.9 | 3.1 | 13.7 | 39.9 | 10.8 | 0.0 | 29.3 | 92.2 | 9.0 |
| 1998 | 113 | 249 | 148 | 5.00 | 5.66 | 12.3 | 3.7 | 22.2 | 36.9 | 10.4 | 0.0 | 23.8 | 93.5 | 11.6 |
| 1999 | -[6] | 264 | 155 | 5.38 | 7.76 | 7.1 | 2.3 | 23.2 | 22.9 | 11.0 | 0.0 | 37.2 | 110.3 | 14.7 |
| 2000 | -[6] | 357 | 170 | 5.02 | 13.04 | 7.8 | 2.0 | 13.8 | 27.0 | 6.3 | 0.0 | 27.0 | 82.7 | 11.4 |
| 2001 | | 281 | 151 | 3.35 | 8.33 | 9.2 | 2.5 | 10.8 | 33.0 | 12.5 | 0.0 | 41.9 | 77.5 | 13.1 |
| 2002 | | 340 | 199 | 5.66 | 5.46 | 7.4 | 2.8 | 7.9 | 24.8 | 8.0 | 0.0 | 52.5 | 77.9 | 17.7 |
| 2003 | | 503 | 245 | 2.60 | 3.76 | 7.5 | 4.1 | 9.5 | 23.9 | 14.0 | 0.0 | 48.7 | 73.8 | 18.7 |
| 2004 | | 540 | 248 | 3.17 | 4.20 | 11.2 | 2.1 | 8.6 | 23.5 | 7.4 | 0.0 | 36.1 | 72.5 | 14.2 |
| 2005 | | 367 | 176 | 4.85 | 4.67 | 12.8 | 2.0 | 8.0 | 16.7 | 11.6 | 1.0 | 42.1 | 68.3 | 14.7 |
| 2006 | | 356 | 164 | 6.50 | 2.19 | 10.8 | 1.4 | 6.3 | 5.2 | 4.6 | 10.9 | 28.9 | 64.9 | 11.9 |
| 2007 | | 432 | 187 | 17.94 | 4.22 | 6.9 | 1.2 | 6.1 | 4.4 | 3.2 | 12.6 | 23.8 | 73.2 | 14.0 |
| 2008 | | 416 | 186 | 9.03 | 4.47 | 9.5 | 0.9 | 5.2 | 2.7 | 1.3 | 11.5 | 12.4 | 58.8 | 9.5 |
| 2009 | | 467 | 196 | 6.49 | 1.21 | 10.1 | 1.0 | 3.8 | 1.5 | 0.46 | 10.0 | 14.7 | 41.5 | 7.6 |
| 2010 | | 400 | 156 | 10.71 | 14.39 | 7.9 | 1.0 | 4.8 | 1.0 | 0.19 | 9.2 | 15.2 | 45.8 | 9.4 |

1 Whole weight (kg) per corrected hour fished, weighted by area
2 Corrected for fishing power (GRT)
3 Kg/hr
4 Kg/100km. Sept Prime: ISS/ISN Traditional Prime Stations Only. Sept Extended: ISS/ISN/ISW/SGC All Stations.
5 Corrected for fishing power (HP) [data for 1999-2010, replaced at 2011WG following recalculation at WKFLAT 2011].
6 Carhelmar survey, Kg/100km not available
7 All years updated in 2007 due to slight historical differences

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

**Table 6.7.2.3. Irish Sea plaice: NIGFS-WIBTS indices of relative SSB trends by region.**

| UK(NI) GFS Mar | Estimated mean abundance | | | Estimated standard error | | |
|---|---|---|---|---|---|---|
| Spring | | | | | | |
| | Combined | West | East | Combined | West | East |
| Year | Str1–7 | Str1–3 | Str4–7 | Str1–7 | Str1–3 | Str4–7 |
| 1992 | 9.59 | 6.40 | 10.54 | 4.39 | 2.13 | 5.66 |
| 1993 | 13.27 | 21.40 | 10.85 | 2.22 | 5.56 | 2.36 |
| 1994 | 10.09 | 5.38 | 11.50 | 2.56 | 1.83 | 3.27 |
| 1995 | 7.59 | 6.56 | 7.89 | 1.39 | 1.66 | 1.74 |
| 1996 | 7.96 | 14.41 | 6.04 | 1.68 | 5.94 | 1.28 |
| 1997 | 13.73 | 15.80 | 13.11 | 3.99 | 6.78 | 4.76 |
| 1998 | 12.50 | 19.61 | 10.38 | 3.62 | 10.88 | 3.39 |
| 1999 | 9.37 | 19.10 | 6.46 | 2.34 | 7.42 | 2.09 |
| 2000 | 15.79 | 35.36 | 9.96 | 5.40 | 22.56 | 1.97 |
| 2001 | 13.52 | 23.78 | 10.46 | 2.11 | 6.21 | 2.02 |
| 2002 | 13.36 | 25.65 | 9.70 | 3.24 | 8.93 | 3.25 |
| 2003 | 26.79 | 55.52 | 18.23 | 8.36 | 32.38 | 4.95 |
| 2004 | 10.55 | 8.60 | 11.13 | 4.77 | 5.23 | 7.58 |
| 2005 | 15.86 | 27.20 | 12.48 | 3.54 | 8.59 | 3.82 |
| 2006 | 9.57 | 16.33 | 7.55 | 1.80 | 6.15 | 1.45 |
| 2007 | 8.73 | 21.76 | 4.84 | 1.81 | 7.00 | 1.06 |
| 2008 | 6.33 | 9.26 | 5.46 | 0.90 | 5.71 | 1.01 |
| 2009 | 11.00 | 17.85 | 8.96 | 1.89 | 4.61 | 2.03 |
| 2010 | 22.67 | 16.49 | 24.51 | 3.80 | 4.49 | 4.75 |
| 2011 | 23.68 | 32.44 | 21.06 | 4.60 | 8.37 | 5.42 |
| UK(NI) GFS Oct | Estimated mean abundance | | | Estimated standard error | | |
| Autumn | | | | | | |
| | Combined | West | East | Combined | West | East |
| Year | Str1-7 | Str1-3 | Str4-7 | Str1-7 | Str1-3 | Str4-7 |
| 1991 | 0.81 | 3.38 | 0.04 | 0.39 | 1.71 | 0.03 |
| 1992 | 4.83 | 2.76 | 5.45 | 0.85 | 1.26 | 1.04 |
| 1993 | 4.64 | 2.91 | 5.16 | 0.95 | 1.18 | 1.18 |
| 1994 | 9.20 | 8.65 | 9.36 | 2.27 | 3.74 | 2.72 |
| 1995 | 4.77 | 8.31 | 3.72 | 1.28 | 3.52 | 1.29 |
| 1996 | 8.69 | 9.95 | 8.32 | 2.15 | 5.67 | 2.22 |
| 1997 | 8.22 | 7.67 | 8.38 | 2.18 | 2.80 | 2.71 |
| 1998 | 5.39 | 4.21 | 5.74 | 1.45 | 2.39 | 1.75 |
| 1999 | 6.90 | 4.91 | 7.50 | 2.29 | 3.12 | 2.82 |
| 2000 | 10.50 | 2.84 | 12.78 | 6.42 | 1.16 | 8.33 |
| 2001 | 13.93 | 4.03 | 16.88 | 6.45 | 1.96 | 8.35 |
| 2002 | 9.98 | 6.63 | 10.98 | 3.80 | 3.45 | 4.82 |
| 2003 | 18.65 | 10.09 | 21.20 | 5.41 | 4.87 | 6.87 |
| 2004 | 8.49 | 2.52 | 10.28 | 1.90 | 1.10 | 2.44 |
| 2005 | 11.58 | 3.88 | 13.88 | 4.39 | 2.39 | 5.66 |
| 2006 | 7.20 | 2.59 | 8.57 | 1.98 | 1.47 | 2.53 |
| 2007 | 8.48 | 6.09 | 9.19 | 1.69 | 2.55 | 2.05 |
| 2008 | 11.28 | 4.66 | 13.26 | 3.06 | 2.50 | 3.91 |
| 2009 | 14.83 | 5.36 | 17.66 | 3.25 | 3.71 | 4.07 |
| 2010 | 17.61 | 7.50 | 20.63 | 5.40 | 5.72 | 6.80 |

**Table 6.7.2.4. Irish Sea plaice: tuning fleet data available. Figures shown in bold are those used in the assessment.**

Tuning index of the extended UK (E&W)-BTS-Q3 survey (extended area). Effort (km towed) and numbers-at-age.

| year | distance towed (kms) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 292.77 | 58 | 1358 | 1179 | 265 | 126 | 7 | 14 | 37 | 1 | 10 |
| 1994 | 281.66 | 162 | 1162 | 699 | 401 | 90 | 24 | 15 | 6 | 19 | 14 |
| 1995 | 281.66 | 316 | 1566 | 553 | 237 | 117 | 24 | 16 | 8 | 0 | 22 |
| 1996 | 277.95 | 78 | 1611 | 604 | 146 | 53 | 55 | 20 | 1 | 0 | 4 |
| 1997 | 281.66 | 449 | 1539 | 820 | 356 | 78 | 45 | 47 | 21 | 0 | 8 |
| 1998 | 281.66 | 158 | 1269 | 1201 | 307 | 114 | 59 | 24 | 20 | 1 | 4 |
| 1999 | 277.95 | 726 | 1102 | 1086 | 553 | 190 | 81 | 31 | 30 | 0 | 0 |
| 2000 | 281.66 | 442 | 2462 | 788 | 415 | 313 | 133 | 50 | 41 | 3 | 3 |
| 2001 | 281.66 | 235 | 1686 | 1020 | 314 | 168 | 153 | 30 | 21 | 2 | 0 |
| 2002 | 281.66 | 111 | 1819 | 1392 | 639 | 247 | 150 | 147 | 29 | 5 | 0 |
| 2003 | 277.95 | 934 | 1701 | 1625 | 726 | 440 | 162 | 149 | 72 | 0 | 10 |
| 2004 | 281.66 | 306 | 2273 | 1510 | 1111 | 530 | 324 | 59 | 78 | 4 | 8 |
| 2005 | 281.66 | 584 | 1058 | 1337 | 558 | 400 | 227 | 144 | 38 | 25 | 0 |
| 2006 | 281.66 | 1004 | 1411 | 972 | 693 | 309 | 223 | 101 | 56 | 5 | 16 |
| 2007 | 281.66 | 475 | 2244 | 1258 | 467 | 337 | 182 | 71 | 83 | 38 | 0 |
| 2008 | 270.54 | 503 | 1266 | 1544 | 548 | 312 | 99 | 55 | 40 | 0 | 0 |
| 2009 | 281.66 | 345 | 1335 | 957 | 930 | 278 | 185 | 179 | 46 | 37 | 0 |
| 2010 | 277.95 | 560 | 1730 | 1199 | 568 | 401 | 183 | 152 | 104 | 78 | 12 |

Biomass tuning indices from the NIGFS-WIBTS: DARDS is the Q1 spring index and DARDA the Q4 autumn index.

Irish Sea Plaice SSB indices.

2 20 2

| Year | DARDS | DARDA |
|---|---|---|
| 1992 | 9.59 | 4.83 |
| 1993 | 13.27 | 4.64 |
| 1994 | 10.09 | 9.2 |
| 1995 | 7.59 | 4.77 |
| 1996 | 7.96 | 8.69 |
| 1997 | 13.73 | 8.22 |
| 1998 | 12.5 | 5.39 |
| 1999 | 9.37 | 6.9 |
| 2000 | 15.79 | 10.5 |
| 2001 | 13.52 | 13.93 |
| 2002 | 13.36 | 9.98 |
| 2003 | 26.79 | 18.65 |
| 2004 | 10.55 | 8.49 |
| 2005 | 15.86 | 11.58 |
| 2006 | 9.57 | 7.2 |
| 2007 | 8.73 | 8.48 |
| 2008 | 6.33 | 11.28 |
| 2009 | 11 | 14.83 |
| 2010 | 22.67 | 17.61 |
| 2011 | 23.68 | |

UK BT SURVEY (Sept-Trad) - Prime stations only.

1989–2010

1 1 0.75 0.85

1 8

129.710 309 441 530 77 13 44 3 0

128.969 1688 405 176 90 54 30 3 1

123.780 591 481 68 47 4 4 24 3

129.525 1043 470 267 23 19 14 14 3

131.192 1106 812 136 101 16 8 21 4

124.892 815 608 307 68 33 12 17 8

126.004 1283 387 179 84 16 18 0 1

126.004 1701 601 124 74 49 9 11 1

126.004 1363 668 322 65 50 23 8 7

126.004 1167 767 212 95 34 23 14 3

126.004 1189 965 344 113 38 17 7 7

126.004 2112 659 298 141 73 22 7 3

126.004 1468 663 218 130 89 28 10 7

126.004 1734 1615 647 243 79 51 16 17

126.004 1480 1842 827 296 122 62 39 10

126.004 1816 1187 1184 404 261 57 57 14

122.298 869 1295 666 499 297 111 17 17

126.004 1120 840 722 411 178 83 59 16

126.004 2667 1255 525 417 196 95 45 37

122.298 1293 1893 628 339 243 76 55 33

126.004 1460 1083 1225 310 189 251 65 31

126.004 1806 1407 670 505 185 173 100 60

UK(E+W)TRAWL FLEET (calculated using ABBT age compositions)

1987–2010

1 1 0 1

1 14

130.597 24.4 1475.8 1434.6 1593.3 409.0 291.2 31.4 46.8 16.9 24.2 11.2 1.4 3.2 3.6

131.950 22.0 1374.8 1421.0 455.0 295.5 142.5 78.9 8.1 28.9 6.7 9.6 3.5 4.1 1.1

139.521 10.6 771.5 2102.0 801.1 235.2 99.8 48.0 37.6 13.7 11.0 6.3 6.7 3.2 1.7

117.058 8.2 501.0 1094.3 983.9 217.0 82.8 60.0 17.5 15.9 4.5 3.2 6.7 3.0 2.2

107.288 94.3 949.9 451.3 419.5 245.0 99.7 35.2 38.7 12.1 11.1 0.6 3.6 1.8 1.5

96.802 80.8 851.1 907.2 181.3 114.6 82.4 28.6 8.3 17.8 7.3 5.4 0.4 1.3 0.8

78.945 12.9 387.7 519.1 367.7 63.5 55.7 69.5 21.8 5.2 10.7 2.6 1.1 0.0 0.2

42.995 38.8 408.3 534.9 142.5 92.5 18.2 12.3 15.9 7.3 1.8 1.3 2.2 0.5 0.0

43.146 7.3 350.1 512.5 255.7 88.9 46.1 10.9 4.8 8.3 2.4 1.7 0.7 0.2 0.2

42.239 10.9 326.5 280.3 198.7 80.5 32.9 15.3 4.8 2.0 10.0 2.1 0.7 0.6 0.1

39.886 11.2 250.6 214.7 125.2 74.2 37.5 12.8 12.4 1.8 0.8 1.4 0.4 0.2 0.7

36.902 1.6 202.7 318.6 105.3 40.6 37.6 16.5 9.8 4.5 0.5 0.5 1.0 0.3 0.2

22.903 17.6 139.2 200.5 120.0 35.0 14.0 9.0 5.4 1.6 0.8 0.2 0.1 0.1 0.0

26.967 0.0 107.1 233.3 185.0 95.5 18.5 14.4 9.8 5.9 2.7 2.1 0.9 0.4 .01

32.964 5.5 65.9 130.4 124.0 108.7 53.2 17.4 10.6 7.1 3.0 0.5 0.7 0.1 0.1

24.762 0.5 78.6 175.8 95.3 58.6 33.0 23.8 3.3 2.5 1.4 0.4 0.4 0.0 0.1

23.851 0.0 34.1 79.6 88.7 35.6 16.1 12.3 7.4 2.3 0.4 0.3 0.2 0.0 0.2

23.456 1.5 34.8 149.1 103.1 60.6 27.0 8.7 5.8 4.3 1.2 0.7 0.2 0.1 0.0

16.683 0.0 32.6 52.6 108.1 95.1 40.0 17.8 7.5 5.4 1.7 1.3 0.6 0.2 0.1

5.218 0.8 15.1 46.9 34.8 55.1 23.4 13.9 4.9 2.6 1.9 0.7 0.6 0.1 0.0

4.404 0.0 2.5 33.7 94.5 58.4 50.4 17.3 16.7 2.2 1.5 0.5 0.3 0.1 0.0

2.710 0.1 5.8 27.8 37.9 40.9 23.9 15.4 7.3 2.9 1.1 0.5 0.2 0.1 0.0

1.535 0.0 0.2 4.1 8.7 7.4 6.6 3.1 2.0 0.8 0.5 0.1 0.1 0.0 0.0

1.026 0.0 0.1 1.5 7.0 6.9 4.2 3.1 1.8 1.2 0.5 0.3 0.2 0.0 0.0

UK(E+W)BEAM TRAWL FLEET

1987–2010

1 1 0 1

1 14

21.997 0.0 1.1 27.1 113.1 36.0 31.3 2.9 6.7 1.9 3.1 0.6 0.1 0.2 0.1

18.564 0.0 2.0 48.0 23.7 24.4 13.2 8.5 1.4 2.6 1.6 1.5 0.6 0.8 0.3

25.291 3.1 132.8 297.5 163.4 52.6 42.4 25.1 16.1 4.3 5.3 3.3 5.7 2.6 1.1

31.003 2.2 136.2 391.9 361.1 78.2 30.2 17.2 8.4 3.6 1.5 1.9 3.8 1.4 0.5

25.838 17.3 282.5 182.9 174.5 91.8 35.9 11.2 11.8 3.5 4.7 0.2 1.0 0.6 0.3

23.399 3.9 141.5 335.6 79.6 64.6 45.5 18.6 8.0 12.2 7.1 4.0 0.2 0.7 1.0

21.503 0.6 73.4 112.8 95.2 23.3 24.2 32.0 11.8 4.5 7.1 2.2 1.2 0.0 0.4

20.145 13.4 151.8 186.1 39.9 26.0 6.8 6.6 7.8 3.5 1.2 0.9 1.2 0.2 0.0

20.932 5.2 183.4 229.1 100.6 33.1 16.1 3.9 1.7 3.3 1.0 0.9 0.5 0.1 0.2

13.320 13.4 144.0 111.4 75.3 30.8 11.0 5.9 2.1 1.2 2.7 0.5 0.2 0.4 0.3

10.760 0.9 98.6 69.5 39.0 30.2 13.5 3.7 3.2 0.5 0.4 0.3 0.2 0.1 0.1

10.386 0.3 63.5 103.7 32.6 12.0 9.7 6.3 2.7 1.8 0.3 0.2 0.5 0.2 0.0

11.016 4.8 51.3 124.4 80.4 24.4 12.5 10.5 5.6 0.9 0.8 0.2 0.2 0.2 0.1

6.275 0.0 25.2 61.4 46.6 27.9 7.3 6.5 4.5 1.9 0.7 0.7 0.7 0.1 0.1

12.495 1.5 20.6 47.5 56.6 42.7 20.8 7.0 4.5 2.5 1.2 0.4 0.1 0.1 0.0

8.017 0.0 11.5 33.1 21.0 18.8 14.9 8.0 2.3 1.3 1.4 0.4 0.4 0.0 0.0

13.996 0.0 11.4 45.5 47.7 20.9 10.0 8.7 5.4 1.7 0.3 0.0 0.3 0.0 0.1

7.396 0.2 18.0 29.4 11.7 11.9 5.1 1.7 1.4 1.0 0.3 0.2 0.1 0.0 0.0

11.406 0.1 6.5 11.0 24.0 20.7 9.2 3.4 1.6 1.3 0.4 0.4 0.1 0.1 0.0

4.649 0.2 2.7 8.1 4.9 8.2 3.8 2.6 0.9 0.6 0.5 0.2 0.2 0.1 0.0

3.197 0.0 0.2 3.2 7.2 4.5 5.3 1.8 1.3 0.3 0.3 0.1 0.1 0.0 0.0

1.300 0.0 0.0 1.4 3.5 3.9 2.1 1.7 0.8 0.3 0.1 0.1 0.0 0.0 0.0

0.462 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

0.186 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

UK BT SURVEY (March) - Prime stations only

1993–1999

1 1 0.15 0.25

1 8

126.931 480 662 141 71 12 8 11 3

115.442 361 662 370 98 47 5 7 10

126.189 859 647 340 120 29 28 0 10

134.343 1559 908 295 98 49 16 8 1

121.742 967 905 351 63 39 31 10 13

130.081 648 957 217 82 24 23 12 1

130.822 570 770 389 98 26 11 9 6

IR-JPS : Irish Juvenile Plaice Survey 2nd Qtr - Effort min. towed - Plaice No. at age

1991–2004

1 1 0.37 0.43

1 7

555 185 206 60 21 9 1 1

570 1785 268 48 16 7 2 2

600 643 630 189 45 8 21 3

585 614 254 196 33 8 2 0

570 840 321 110 86 18 5 2

675 752 221 134 39 57 7 0

675 665 303 105 41 22 17 5

675 311 466 191 48 11 7 4

660 0 0 0 0 0 0 0

645 805 342 72 61 32 9 2

675 743 739 213 88 43 14 5

660 273 145 40 2 1 1 0

660 346 322 152 78 20 9 7

660 1046 501 171 86 50 10 6

IR-OTB : Irish Otter trawl - Effort in hours - VIIa Plaice numbers-at-age - Year 1995–2010

1 1 0 1

2 12

70682 5 84 263 202 51 29 24 10 5 1 1

58166 4 94 157 227 97 26 8 6 4 2 1

75029 27 136 197 147 74 74 21 12 16 3 2

81073 49 140 176 124 104 128 64 29 21 10 5

93221 51 129 152 126 71 46 32 19 4 2 1

64320 11 92 98 88 24 10 8 3 1 4 0

77541 55 90 97 104 100 38 16 11 3 1 0

77863 6 67 179 122 90 53 22 11 6 1 0

73854 18 177 278 174 102 48 19 5 3 1 13

72507 25 105 116 90 31 23 16 12 1 4 0

68336 1 45 89 129 80 43 17 10 8 1 2

64876 4 40 34 51 40 37 19 12 12 4 0

73157 14 47 77 58 40 17 11 5 2 1 0

58812 4 16 35 45 23 11 6 2 1 1 1

42829 2 24 27 21 22 8 8 2 2 1 0

45451 2 20 24 21 24 9 9 2 2 1 0

**Table 6.7.2.5. Irish Sea plaice: Landings number-at-age 1 to 15+ (thousands), where rows are years 1964–2010 and columns are ages 1 to 15+.**

Irish sea plaice

1 2

1964–2010

1 15

1

| 0 | 997 | 1911 | 1680 | 446 | 851 | 480 | 140 | 26 | 155 | 30 | 2 | 1 | 1 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 1416 | 3155 | 2841 | 1115 | 555 | 309 | 300 | 17 | 20 | 5 | 2 | 1 | 1 | 1 |
| 0 | 120 | 4303 | 3605 | 2182 | 620 | 588 | 386 | 181 | 13 | 20 | 7 | 7 | 3 | 6 |
| 0 | 164 | 1477 | 5593 | 4217 | 995 | 642 | 267 | 210 | 176 | 86 | 35 | 5 | 6 | 1 |
| 0 | 171 | 1961 | 3410 | 4641 | 1611 | 319 | 113 | 135 | 24 | 17 | 3 | 4 | 1 | 1 |
| 59 | 430 | 2317 | 2932 | 2080 | 2227 | 779 | 184 | 58 | 100 | 80 | 22 | 9 | 4 | 1 |
| 9 | 803 | 2278 | 2179 | 1877 | 1028 | 899 | 239 | 64 | 29 | 52 | 51 | 20 | 3 | 2 |
| 0 | 427 | 3392 | 3882 | 1683 | 1371 | 491 | 497 | 244 | 60 | 65 | 36 | 11 | 9 | 1 |
| 0 | 142 | 3254 | 5136 | 1461 | 752 | 555 | 627 | 353 | 169 | 55 | 40 | 38 | 19 | 12 |
| 0 | 925 | 4091 | 5233 | 2682 | 642 | 345 | 238 | 183 | 238 | 129 | 40 | 14 | 11 | 17 |
| 7 | 1200 | 2530 | 2694 | 2125 | 1045 | 191 | 139 | 56 | 47 | 95 | 40 | 5 | 5 | 5 |
| 18 | 1370 | 4313 | 1902 | 1158 | 933 | 152 | 119 | 81 | 94 | 47 | 72 | 18 | 16 | 4 |
| 23 | 2553 | 4333 | 2425 | 902 | 563 | 391 | 198 | 59 | 79 | 47 | 22 | 58 | 11 | 5 |
| 565 | 4124 | 2767 | 2470 | 839 | 236 | 150 | 112 | 63 | 21 | 15 | 8 | 8 | 10 | 3 |
| 22 | 3063 | 5169 | 1535 | 542 | 202 | 98 | 54 | 52 | 43 | 10 | 9 | 4 | 4 | 2 |
| 12 | 3380 | 5679 | 1835 | 363 | 187 | 109 | 61 | 68 | 68 | 17 | 5 | 6 | 4 | 6 |
| 3 | 2783 | 6738 | 2560 | 646 | 312 | 125 | 64 | 24 | 54 | 16 | 13 | 7 | 5 | 5 |
| 22 | 1742 | 5939 | 2984 | 837 | 222 | 105 | 53 | 52 | 41 | 28 | 35 | 13 | 3 | 11 |
| 27 | 715 | 3288 | 3082 | 1358 | 330 | 137 | 69 | 44 | 36 | 11 | 15 | 11 | 14 | 13 |
| 51 | 2924 | 2494 | 3211 | 1521 | 648 | 211 | 110 | 53 | 30 | 13 | 15 | 9 | 11 | 11 |
| 41 | 3159 | 5179 | 1182 | 1054 | 459 | 299 | 113 | 60 | 13 | 22 | 15 | 10 | 6 | 13 |
| 4 | 2357 | 6152 | 3301 | 614 | 429 | 262 | 181 | 78 | 36 | 21 | 8 | 7 | 3 | 6 |
| 31 | 1652 | 5280 | 2942 | 1287 | 344 | 371 | 112 | 92 | 54 | 24 | 9 | 5 | 3 | 9 |
| 62 | 3717 | 5317 | 5252 | 1341 | 1072 | 123 | 121 | 75 | 74 | 25 | 8 | 10 | 12 | 13 |
| 46 | 2923 | 5040 | 2552 | 1400 | 750 | 316 | 84 | 112 | 44 | 41 | 28 | 38 | 21 | 37 |
| 24 | 1735 | 5945 | 2671 | 854 | 436 | 214 | 153 | 56 | 47 | 26 | 38 | 18 | 7 | 19 |
| 15 | 1019 | 2715 | 2935 | 1132 | 465 | 259 | 98 | 51 | 22 | 15 | 15 | 9 | 6 | 7 |
| 180 | 2008 | 1506 | 1929 | 1205 | 465 | 182 | 122 | 49 | 34 | 5 | 6 | 3 | 3 | 4 |
| 151 | 1958 | 3209 | 1435 | 1358 | 903 | 388 | 118 | 74 | 44 | 27 | 15 | 9 | 3 | 4 |
| 28 | 910 | 1649 | 1357 | 474 | 556 | 377 | 179 | 42 | 50 | 16 | 8 | 2 | 3 | 2 |
| 97 | 1146 | 2173 | 1309 | 644 | 318 | 245 | 134 | 86 | 18 | 6 | 9 | 6 | 1 | 3 |
| 21.2 | 960.8 | 1702.7 | 1935.7 | 764.1 | 318.2 | 137.9 | 70 | 46.7 | 22.6 | 8.9 | 4.5 | 0.8 | 0.7 | 2.9 |
| 37 | 855.7 | 1345.2 | 1196.2 | 943.4 | 370 | 128.3 | 43.9 | 25.1 | 36.7 | 14 | 7 | 4.8 | 1.1 | 2.5 |
| 27.8 | 829.6 | 1589.6 | 1513.4 | 1002.6 | 482.3 | 285.1 | 139.1 | 42.3 | 52.6 | 12.3 | 6.7 | 1.3 | 2.2 | 0.8 |
| 5.5 | 691.4 | 1739.2 | 1024.7 | 611.6 | 475.7 | 403 | 176.9 | 91.2 | 51.6 | 24.7 | 17.5 | 19.2 | 2.1 | 1.3 |
| 68.2 | 802.6 | 1504.8 | 1293.6 | 695.5 | 280.4 | 196.4 | 117 | 68.9 | 43.4 | 5.6 | 4.3 | 1.2 | 0.4 | 1 |
| 0 | 450 | 1174.3 | 1283.7 | 685.5 | 211.8 | 219.3 | 101.9 | 55.5 | 19.1 | 13.7 | 7.1 | 2.4 | 1.6 | 2 |
| 13.9 | 374.2 | 1138.1 | 1083 | 767 | 408.6 | 178.5 | 90.3 | 45.4 | 17.6 | 6.3 | 2.4 | 3.7 | 0.3 | 0.4 |
| 1.1 | 205.6 | 939.8 | 1481.7 | 842.2 | 538.9 | 317.7 | 95.9 | 48.4 | 17.3 | 4.4 | 3.1 | 0.3 | 0.2 | 0.3 |
| 0 | 285.7 | 1030.9 | 1314.1 | 706.7 | 415 | 252.7 | 127.2 | 48.4 | 22.3 | 12.4 | 7.4 | 1 | 2.6 | 0.2 |
| 7.5 | 198.3 | 966.8 | 1104.2 | 705 | 246.5 | 114.3 | 87.7 | 74.2 | 10.7 | 10.8 | 1.1 | 1 | 0.4 | 0.3 |
| 6.4 | 228.4 | 708.4 | 1177.2 | 889.5 | 461.1 | 204 | 91.8 | 54.6 | 36.7 | 11.5 | 11.5 | 4.4 | 1.5 | 0.8 |
| 4.5 | 180.3 | 619.8 | 550.2 | 684 | 346.4 | 220 | 86.9 | 53.4 | 46.4 | 20.2 | 6.5 | 1.8 | 1.3 | 1.1 |
| 0 | 64.2 | 350.5 | 859.9 | 506.6 | 401.2 | 150.5 | 114.2 | 27 | 14.3 | 5 | 2.9 | 0.5 | 0.4 | 0.02 |
| 0.6 | 98.5 | 385.5 | 388.6 | 409.3 | 214.6 | 141.3 | 61 | 36.4 | 9.2 | 6.9 | 3.3 | 0.8 | 1.2 | 0 |
| 0 | 12.6 | 204.3 | 373.9 | 351.2 | 272.4 | 116.5 | 73.3 | 26 | 12.1 | 3.6 | 2 | 0.9 | 1.1 | 0.7 |
| 0 | 7.2 | 74.3 | 269.8 | 305.6 | 192.8 | 159.6 | 57.3 | 31.2 | 13.1 | 8.3 | 3.3 | 1 | 0.3 | 0.5 |

**Table 6.7.2.6. Irish Sea plaice: Landings weight-at-age 1 to 15+ (kg) (unsmoothed from 1995, bold).**

Plaice in VIIa, 2011

1 3

1964 2010

1 15

1

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.190 | 0.292 | 0.413 | 0.463 | 0.597 | 0.831 | 1.042 | 1.155 | 0.552 | 1.358 | 1.015 | 1.544 | 1.605 | 1.654 |
| 0.070 | 0.177 | 0.269 | 0.388 | 0.556 | 0.653 | 0.690 | 0.719 | 0.801 | 1.198 | 1.167 | 0.971 | 1.477 | 1.535 | 1.581 |
| 0.000 | 0.152 | 0.223 | 0.316 | 0.418 | 0.532 | 0.697 | 0.691 | 0.939 | 0.983 | 1.074 | 1.071 | 1.233 | 1.281 | 1.320 |
| 0.000 | 0.133 | 0.218 | 0.299 | 0.382 | 0.516 | 0.518 | 0.759 | 0.791 | 0.682 | 0.783 | 0.514 | 1.152 | 1.198 | 1.234 |
| 0.000 | 0.149 | 0.213 | 0.313 | 0.413 | 0.509 | 0.584 | 0.777 | 0.893 | 0.957 | 1.017 | 0.887 | 1.174 | 1.220 | 1.257 |
| 0.056 | 0.146 | 0.215 | 0.311 | 0.405 | 0.541 | 0.643 | 0.787 | 0.897 | 0.744 | 0.723 | 1.097 | 1.185 | 1.231 | 1.269 |
| 0.058 | 0.149 | 0.219 | 0.324 | 0.417 | 0.523 | 0.648 | 0.685 | 0.908 | 0.925 | 0.877 | 0.603 | 1.231 | 1.279 | 1.318 |
| 0.000 | 0.140 | 0.207 | 0.295 | 0.396 | 0.489 | 0.595 | 0.753 | 0.654 | 0.852 | 0.731 | 1.079 | 1.153 | 1.198 | 1.235 |
| 0.000 | 0.143 | 0.235 | 0.332 | 0.432 | 0.560 | 0.737 | 0.712 | 0.959 | 1.071 | 1.144 | 1.208 | 1.288 | 1.339 | 1.379 |
| 0.000 | 0.143 | 0.218 | 0.316 | 0.415 | 0.491 | 0.645 | 0.694 | 0.791 | 0.898 | 0.927 | 0.863 | 1.204 | 1.252 | 1.290 |
| 0.063 | 0.158 | 0.246 | 0.334 | 0.445 | 0.514 | 0.686 | 0.847 | 0.964 | 1.052 | 1.108 | 1.048 | 1.326 | 1.378 | 1.420 |
| 0.072 | 0.185 | 0.275 | 0.398 | 0.531 | 0.644 | 0.749 | 0.924 | 1.147 | 1.169 | 1.359 | 1.360 | 1.533 | 1.593 | 1.641 |
| 0.060 | 0.150 | 0.228 | 0.323 | 0.419 | 0.525 | 0.590 | 0.719 | 0.797 | 0.842 | 0.834 | 1.003 | 1.267 | 1.317 | 1.357 |
| 0.059 | 0.153 | 0.226 | 0.340 | 0.430 | 0.510 | 0.592 | 0.738 | 0.840 | 1.016 | 0.945 | 1.100 | 1.252 | 1.301 | 1.340 |
| 0.071 | 0.185 | 0.268 | 0.391 | 0.525 | 0.672 | 0.720 | 0.910 | 1.035 | 1.049 | 1.264 | 1.329 | 1.497 | 1.556 | 1.603 |
| 0.069 | 0.176 | 0.262 | 0.376 | 0.557 | 0.668 | 0.794 | 0.915 | 0.997 | 0.968 | 1.274 | 1.227 | 1.471 | 1.529 | 1.575 |
| 0.066 | 0.177 | 0.255 | 0.365 | 0.483 | 0.517 | 0.671 | 0.884 | 1.047 | 1.072 | 1.259 | 1.273 | 1.403 | 1.458 | 1.503 |
| 0.069 | 0.176 | 0.267 | 0.376 | 0.512 | 0.592 | 0.678 | 0.863 | 1.097 | 0.804 | 1.276 | 1.310 | 1.309 | 1.509 | 1.554 |
| 0.201 | 0.274 | 0.284 | 0.348 | 0.421 | 0.545 | 0.650 | 0.651 | 0.780 | 0.777 | 1.185 | 1.164 | 1.147 | 1.164 | 1.744 |
| 0.232 | 0.261 | 0.290 | 0.319 | 0.368 | 0.426 | 0.484 | 0.552 | 0.629 | 0.716 | 0.803 | 0.910 | 1.026 | 1.161 | 1.316 |
| 0.260 | 0.290 | 0.330 | 0.380 | 0.470 | 0.560 | 0.660 | 0.760 | 0.870 | 0.980 | 1.100 | 1.240 | 1.420 | 1.630 | 1.940 |
| 0.290 | 0.310 | 0.340 | 0.390 | 0.470 | 0.540 | 0.630 | 0.730 | 0.840 | 0.940 | 1.060 | 1.200 | 1.380 | 1.600 | 1.900 |
| 0.270 | 0.280 | 0.340 | 0.420 | 0.500 | 0.540 | 0.630 | 0.830 | 0.920 | 1.020 | 1.210 | 1.480 | 1.420 | 1.720 | 1.610 |
| 0.260 | 0.290 | 0.315 | 0.370 | 0.440 | 0.520 | 0.610 | 0.720 | 0.820 | 0.950 | 1.080 | 1.210 | 1.360 | 1.520 | 1.700 |
| 0.230 | 0.260 | 0.300 | 0.370 | 0.460 | 0.550 | 0.680 | 0.820 | 0.960 | 1.120 | 1.300 | 1.480 | 1.690 | 1.900 | 2.130 |
| 0.227 | 0.272 | 0.321 | 0.374 | 0.430 | 0.491 | 0.555 | 0.623 | 0.694 | 0.770 | 0.849 | 0.932 | 1.019 | 1.109 | 1.205 |
| 0.200 | 0.257 | 0.316 | 0.376 | 0.439 | 0.504 | 0.570 | 0.639 | 0.709 | 0.781 | 0.856 | 0.932 | 1.010 | 1.091 | 1.173 |
| 0.247 | 0.267 | 0.295 | 0.332 | 0.377 | 0.431 | 0.494 | 0.566 | 0.646 | 0.735 | 0.832 | 0.938 | 1.053 | 1.176 | 1.309 |
| 0.169 | 0.218 | 0.274 | 0.337 | 0.407 | 0.484 | 0.568 | 0.658 | 0.756 | 0.860 | 0.971 | 1.089 | 1.213 | 1.345 | 1.483 |
| 0.260 | 0.270 | 0.292 | 0.328 | 0.375 | 0.436 | 0.508 | 0.594 | 0.691 | 0.802 | 0.925 | 1.060 | 1.208 | 1.368 | 1.541 |
| 0.156 | 0.207 | 0.268 | 0.338 | 0.416 | 0.504 | 0.600 | 0.706 | 0.821 | 0.945 | 1.077 | 1.219 | 1.370 | 1.530 | 1.698 |
| **0.201** | **0.229** | **0.266** | **0.312** | **0.366** | **0.429** | **0.501** | **0.581** | **0.670** | **0.768** | **0.874** | **0.990** | **1.114** | **1.246** | **1.387** |
| **0.144** | **0.203** | **0.268** | **0.338** | **0.414** | **0.496** | **0.584** | **0.677** | **0.776** | **0.881** | **0.992** | **1.108** | **1.230** | **1.358** | **1.492** |
| **0.134** | **0.184** | **0.239** | **0.299** | **0.362** | **0.430** | **0.502** | **0.579** | **0.660** | **0.745** | **0.834** | **0.928** | **1.027** | **1.129** | **1.236** |
| **0.202** | **0.222** | **0.252** | **0.294** | **0.346** | **0.410** | **0.484** | **0.569** | **0.665** | **0.773** | **0.891** | **1.020** | **1.160** | **1.310** | **1.472** |
| **0.174** | **0.213** | **0.257** | **0.309** | **0.366** | **0.430** | **0.501** | **0.577** | **0.661** | **0.751** | **0.847** | **0.949** | **1.058** | **1.174** | **1.296** |
| **0.000** | **0.222** | **0.257** | **0.302** | **0.357** | **0.422** | **0.497** | **0.581** | **0.676** | **0.780** | **0.894** | **1.018** | **1.152** | **1.296** | **1.450** |

**0.142 0.205 0.269 0.337 0.407 0.479 0.554 0.632 0.712 0.795 0.880 0.968 1.058 1.151 1.247**

**0.185 0.225 0.271 0.324 0.383 0.449 0.521 0.600 0.685 0.776 0.874 0.978 1.089 1.206 1.329**

**0.000 0.244 0.289 0.340 0.395 0.455 0.520 0.590 0.665 0.745 0.830 0.920 1.014 1.114 1.219**

**0.207 0.230 0.261 0.300 0.348 0.404 0.468 0.542 0.623 0.713 0.811 0.918 1.033 1.157 1.289**

**0.172 0.212 0.254 0.299 0.345 0.394 0.445 0.499 0.554 0.612 0.672 0.734 0.799 0.865 0.934**

**0.227 0.232 0.249 0.278 0.320 0.374 0.440 0.518 0.609 0.712 0.827 0.954 1.094 1.246 1.410**

**0.000 0.215 0.247 0.283 0.325 0.371 0.422 0.479 0.540 0.606 0.677 0.753 0.834 0.920 1.011**

**0.000 0.224 0.233 0.252 0.280 0.318 0.365 0.421 0.486 0.560 0.644 0.737 0.840 0.951 1.072**

**0.000 0.174 0.224 0.272 0.315 0.355 0.391 0.424 0.453 0.478 0.499 0.517 0.531 0.542 0.549**

**0.000 0.355 0.314 0.294 0.297 0.321 0.366 0.434 0.523 0.634 0.767 0.921 1.097 1.295 1.514**

**Table 6.7.2.7. Plaice VIIa: weight-at-age in the discards (unsmoothed).**

Irish Sea plaice, 2010 WG, COMBSEX, PLUSGROUP, Discard weights-at-age (age 0 exc, 9+ set to 0).

1 3 2004–2010

1 14

1

| 0.075 | 0.118 | 0.142 | 0.158 | 0.201 | 0.422 | 0.421 | 0.456 | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.109 | 0.116 | 0.133 | 0.174 | 0.171 | 0.252 | 0.576 | 0.399 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.126 | 0.111 | 0.140 | 0.143 | 0.161 | 0.207 | 0.310 | 0.404 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.048 | 0.083 | 0.113 | 0.140 | 0.150 | 0.197 | 0.214 | 0.266 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.079 | 0.104 | 0.116 | 0.132 | 0.149 | 0.194 | 0.272 | 0.231 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.035 | 0.082 | 0.116 | 0.150 | 0.165 | 0.212 | 0.217 | 0.291 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.076 | 0.088 | 0.118 | 0.167 | 0.181 | 0.198 | 0.173 | 0.201 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 6.7.2.8. Irish Sea plaice: New stock weights-at-age modified to include discard element (kg) (unsmoothed from 1995, bold).**

Irish Sea plaice, 2011 WGCSE, COMBSEX, PLUSGROUP, NEW stock weights (modified to inc. disc element).

1 4 DB 6/5/2011

2004–2010 (not smoothed)

1 14

1

| 0.084 | 0.148 | 0.215 | 0.249 | 0.317 | 0.506 | 0.495 | 0.497 | 0.76 | 0.751 | 0.817 | 1.693 | 2 | 2.327 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.122 | 0.139 | 0.198 | 0.228 | 0.266 | 0.326 | 0.567 | 0.449 | 0.543 | 0.184 | 0.913 | 0.974 | 0.807 | 0.982 |
| 0.133 | 0.135 | 0.171 | 0.228 | 0.285 | 0.357 | 0.392 | 0.481 | 0.585 | 0.554 | 0.838 | 1.415 | 1.139 | 1.277 |
| 0.052 | 0.099 | 0.151 | 0.213 | 0.289 | 0.34 | 0.334 | 0.621 | 0.53 | 0.9 | 0.846 | 0.976 | 0.878 | 1.016 |
| 0.082 | 0.117 | 0.143 | 0.181 | 0.27 | 0.355 | 0.321 | 0.564 | 0.7 | 0.833 | 1.122 | 0.43 | 1.32 | 0 |
| 0.036 | 0.092 | 0.155 | 0.21 | 0.262 | 0.32 | 0.396 | 0.465 | 0.524 | 0.571 | 0.591 | 0.76 | 0.576 | 0.475 |
| 0.077 | 0.094 | 0.145 | 0.19 | 0.229 | 0.248 | 0.216 | 0.358 | 0.53 | 0.56 | 0.509 | 0.882 | 1.908 | 1.04 |

**Table 6.7.3.1. Irish Sea plaice: Final AP output and diagnostics.**

note: (1) model takes log(Ftrend #) as input;

(2) The log.recruitments 1–8 merely provide initial cohorts for each entry in the numbers-at-age matrix.

Age range for fishery selectivity: 1 to 8

Age range for discard fraction: 1 to 5

Age range for UK-BTS: 1 to 6

| Mon May 09 13:02:24 2011 | |
|---|---|
| | |
| SEL_MODEL | TV |
| DISC_MODEL | PTVS |
| INCL_EGG | FALSE |
| INCL_RELBIO | TRUE |
| INCL_PLUSGROUP_NIGFS | TRUE |
| EST_SD_BIO | TRUE |
| firstoptMETHOD | SANN |
| mainMETHOD | BFGS |
| BFGS_MAXIT | 800 |
| BFGS_RELTOL | 1.00E-20 |
| n.tries for uncertainty | 1000 |
| | |
| eigenvalues Hessian positive? | FALSE |
| negative log.likelihood | 95.47752 |
| negative log.likelihood Landings | -9.07453 |
| negative log.likelihood Discards | 34.79614 |
| negative log.likelihood UK-BTS | 2.80479 |
| negative log.likelihood NI-GFSs | 66.95113 |
| AIC | 348.955 |
| Nparameters | 79 |
| Nobservations | 344 |
| | |
| **Final parameter values** | |
| Ftrend 1 | 0.798147 |
| Ftrend 2 | 0.676198 |
| Ftrend 3 | 0.565213 |
| Ftrend 4 | 0.411871 |
| Ftrend 5 | 0.442478 |
| Ftrend 6 | 0.340938 |
| Ftrend 7 | 0.253528 |
| Ftrend 8 | 0.189975 |
| Ftrend 9 | 0.183881 |
| Ftrend 10 | 0.202133 |
| Ftrend 11 | 0.176607 |
| Ftrend 12 | 0.138986 |
| Ftrend 13 | 0.198322 |
| Ftrend 14 | 0.169943 |

| | |
|---|---|
| Ftrend 15 | 0.196883 |
| Ftrend 16 | 0.17729 |
| Ftrend 17 | 0.197655 |
| Ftrend 18 | 0.210536 |
| sel.C 1 | 3.583611 |
| sel.C 2 | 6.98169 |
| sel.C 3 | -4.65117 |
| sel.C 4 | 0.580445 |
| sel.C 5 | -0.65433 |
| sel.C 6 | 1.369824 |
| sel.C 7 | -0.83792 |
| sel.C 8 | -0.10498 |
| logrecruitment 1 | 21.53691 |
| logrecruitment 2 | 19.9775 |
| logrecruitment 3 | 18.41378 |
| logrecruitment 4 | 16.88014 |
| logrecruitment 5 | 16.23729 |
| logrecruitment 6 | 14.97629 |
| logrecruitment 7 | 13.33269 |
| logrecruitment 8 | 10.9786 |
| logrecruitment 9 | 10.62659 |
| logrecruitment 10 | 10.52677 |
| logrecruitment 11 | 10.66514 |
| logrecruitment 12 | 10.75553 |
| logrecruitment 13 | 10.45032 |
| logrecruitment 14 | 10.32543 |
| logrecruitment 15 | 10.59831 |
| logrecruitment 16 | 10.60356 |
| logrecruitment 17 | 10.69511 |
| logrecruitment 18 | 10.4286 |
| logrecruitment 19 | 10.70252 |
| logrecruitment 20 | 10.40553 |
| logrecruitment 21 | 10.55078 |
| logrecruitment 22 | 10.75297 |
| logrecruitment 23 | 10.23463 |
| logrecruitment 24 | 10.26391 |
| Logrecruitment 25 | 10.49985 |
| Catchability 1 | 6.625515 |
| sel.U 1 | -15.164 |
| sel.U 2 | -14.8346 |
| sel.U 3 | -16.4949 |
| sel.U 4 | -16.396 |
| b1 | 7.033246 |
| b2 | -1.46547 |
| b3 | 0.838829 |
| b4 | -2.01049 |

| | |
|---|---|
| b5 | 0.190955 |
| b6 | 0.316053 |
| b7 | -0.06121 |
| b8 | 0.592242 |
| b9 | 0.014284 |
| b10 | 0.034889 |
| b11 | 0.038156 |
| b12 | -0.02182 |
| sds.land1 | -2.37169 |
| sds.land2 | -1.6943 |
| sds.land3 | 3.358717 |
| sds.disc1 | -0.64355 |
| sds.disc2 | -1.38535 |
| sds.disc3 | 1.439733 |
| sds.tun1 | -2.0092 |
| sds.tun2 | 1.699316 |
| sds.tun3 | -0.16963 |
| sds.biotun1 | 0.987188 |
| sds.biotun2 | -23.9996 |

**Table 6.7.3.2. Irish Sea plaice: Estimated landed numbers-at-age (thousands).**

| L | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 47 | 31 | 26 | 23 | 25 | 14 | 9 | 8 | 7 | 7 | 4 | 3 | 2 | 1 | 1 | 0 | 0 | 0 |
| 2 | 1281 | 936 | 754 | 660 | 1005 | 873 | 530 | 368 | 444 | 408 | 313 | 151 | 205 | 87 | 78 | 53 | 21 | 13 |
| 3 | 1542 | 2239 | 1650 | 1254 | 1699 | 1831 | 1660 | 1121 | 1061 | 1475 | 1141 | 850 | 753 | 627 | 368 | 251 | 211 | 78 |
| 4 | 1255 | 1500 | 1914 | 1213 | 1340 | 1210 | 1311 | 1267 | 1102 | 1155 | 1292 | 926 | 1240 | 674 | 794 | 375 | 349 | 309 |
| 5 | 522 | 675 | 777 | 909 | 869 | 660 | 611 | 710 | 882 | 860 | 716 | 706 | 880 | 685 | 502 | 466 | 304 | 311 |
| 6 | 535 | 272 | 346 | 365 | 626 | 394 | 288 | 262 | 361 | 476 | 354 | 253 | 453 | 350 | 385 | 232 | 293 | 192 |
| 7 | 370 | 242 | 131 | 164 | 269 | 324 | 207 | 155 | 172 | 257 | 257 | 157 | 190 | 191 | 180 | 141 | 99 | 107 |
| 8 | 178 | 145 | 102 | 55 | 109 | 128 | 161 | 109 | 104 | 132 | 159 | 139 | 156 | 114 | 151 | 111 | 110 | 72 |
| 9+ | 123 | 129 | 87 | 91 | 118 | 208 | 125 | 101 | 76 | 74 | 94 | 99 | 121 | 131 | 50 | 58 | 47 | 58 |

**Table 6.7.3.3. Irish Sea plaice: Estimated discarded numbers-at-age (thousands).**

| D | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30 558 | 19 284 | 15 324 | 13 655 | 15 879 | 9487 | 6421 | 6505 | 6367 | 7434 | 4927 | 5036 | 4757 | 4176 | 4809 | 1864 | 1403 | 1157 |
| 2 | 17 108 | 9992 | 6781 | 5258 | 7477 | 6383 | 4013 | 3033 | 4201 | 4662 | 4543 | 2944 | 5606 | 3526 | 4970 | 5527 | 3806 | 4301 |
| 3 | 3412 | 3834 | 2306 | 1507 | 1853 | 1909 | 1746 | 1254 | 1329 | 2185 | 2105 | 2060 | 2528 | 3074 | 2782 | 3073 | 4429 | 2953 |
| 4 | 160 | 205 | 286 | 203 | 258 | 274 | 358 | 428 | 471 | 640 | 951 | 926 | 1728 | 1340 | 2309 | 1635 | 2329 | 3242 |
| 5 | 0 | 0 | 1 | 2 | 3 | 6 | 11 | 27 | 64 | 115 | 170 | 283 | 572 | 692 | 752 | 995 | 883 | 1176 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 6.7.3.4. Irish Sea plaice: Estimated population numbers-at-age (thousands).**

| Age | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 58 606 | 41 216 | 37 301 | 42 836 | 46 888 | 34 556 | 30 498 | 40 067 | 40 278 | 44 140 | 33 813 | 44 468 | 33 042 | 38 207 | 46 769 | 27 851 | 28 679 | 36 310 |
| 2 | 35 487 | 23 400 | 18 498 | 18 717 | 25 172 | 26 683 | 21 736 | 21 013 | 29 418 | 29 735 | 32 159 | 25 356 | 34 703 | 24 834 | 29 960 | 36 958 | 22 949 | 24 115 |
| 3 | 10 694 | 14 300 | 10 538 | 9354 | 11 053 | 14 378 | 16 859 | 15 012 | 15 442 | 21 727 | 21 610 | 23 959 | 19 580 | 25 321 | 18 631 | 21 830 | 27 536 | 16 759 |
| 4 | 3759 | 4852 | 7001 | 5641 | 5707 | 6475 | 9243 | 11 755 | 11 083 | 11 450 | 15 832 | 16 116 | 18 515 | 14 284 | 18 980 | 13 565 | 16 239 | 20 063 |
| 5 | 1384 | 2008 | 2707 | 4147 | 3674 | 3563 | 4349 | 6630 | 8833 | 8351 | 8469 | 11 934 | 12 553 | 13 633 | 10 776 | 13 919 | 10 142 | 11 887 |
| 6 | 1250 | 739 | 1149 | 1672 | 2823 | 2440 | 2535 | 3272 | 5188 | 6945 | 6490 | 6679 | 9654 | 9768 | 10 796 | 8379 | 10 972 | 7880 |
| 7 | 801 | 608 | 401 | 695 | 1140 | 1917 | 1793 | 1978 | 2656 | 4262 | 5711 | 5423 | 5685 | 8136 | 8335 | 9213 | 7213 | 9455 |
| 8 | 385 | 364 | 313 | 233 | 462 | 758 | 1395 | 1396 | 1609 | 2194 | 3538 | 4824 | 4663 | 4864 | 7036 | 7223 | 8038 | 6305 |
| 9+ | 266 | 325 | 266 | 386 | 502 | 1228 | 1081 | 1295 | 1176 | 1227 | 2097 | 3408 | 3617 | 5555 | 2337 | 3765 | 3403 | 5077 |

**Table 6.7.3.5. Irish Sea plaice: Estimated fishing mortality-at-age.**

| Age | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.798 | 0.681 | 0.570 | 0.412 | 0.444 | 0.344 | 0.253 | 0.189 | 0.183 | 0.197 | 0.168 | 0.128 | 0.166 | 0.123 | 0.115 | 0.074 | 0.053 | 0.034 |
| 2 | 0.789 | 0.678 | 0.562 | 0.407 | 0.440 | 0.339 | 0.250 | 0.188 | 0.183 | 0.199 | 0.174 | 0.139 | 0.195 | 0.167 | 0.197 | 0.174 | 0.194 | 0.210 |
| 3 | 0.670 | 0.594 | 0.505 | 0.374 | 0.415 | 0.322 | 0.241 | 0.183 | 0.179 | 0.197 | 0.173 | 0.138 | 0.195 | 0.168 | 0.197 | 0.176 | 0.197 | 0.213 |
| 4 | 0.507 | 0.464 | 0.404 | 0.309 | 0.351 | 0.278 | 0.212 | 0.166 | 0.163 | 0.182 | 0.163 | 0.130 | 0.186 | 0.162 | 0.190 | 0.171 | 0.192 | 0.208 |
| 5 | 0.508 | 0.438 | 0.362 | 0.265 | 0.289 | 0.220 | 0.164 | 0.125 | 0.121 | 0.132 | 0.117 | 0.092 | 0.131 | 0.113 | 0.132 | 0.118 | 0.132 | 0.142 |
| 6 | 0.600 | 0.492 | 0.383 | 0.263 | 0.267 | 0.188 | 0.128 | 0.089 | 0.077 | 0.075 | 0.060 | 0.041 | 0.051 | 0.039 | 0.039 | 0.030 | 0.029 | 0.026 |
| 7 | 0.667 | 0.544 | 0.424 | 0.288 | 0.288 | 0.197 | 0.130 | 0.087 | 0.071 | 0.066 | 0.049 | 0.031 | 0.036 | 0.025 | 0.023 | 0.016 | 0.015 | 0.012 |
| 8 | 0.669 | 0.543 | 0.424 | 0.288 | 0.287 | 0.197 | 0.131 | 0.087 | 0.071 | 0.066 | 0.049 | 0.031 | 0.036 | 0.025 | 0.023 | 0.016 | 0.015 | 0.012 |
| 9+ | 0.669 | 0.543 | 0.424 | 0.288 | 0.287 | 0.197 | 0.131 | 0.087 | 0.071 | 0.066 | 0.049 | 0.031 | 0.036 | 0.025 | 0.023 | 0.016 | 0.015 | 0.012 |

**Table 6.7.3.6. Irish Sea plaice: Update AP stock summary. Uncertainty analysis: modelled median values from 1000 bootstrap simulations (50th percentile) with 5th (lower) and 95th (upper) percentiles indicating the 90% CI for: spawning–stock biomass (SSB, tonnes), mean fishing mortality (F) for ages 3–6, discard tonnage (D) and recruitment (R, 000s).**

| Year | SSB (t) lower | SSB (t) med | SSB (t) upper | F lower | F med | F upper | D (t) lower | D (t) med | D (t) upper | R (000s) lower | R (000s) med | R (000s) upper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 3631 | 6650 | 9203 | 0.477 | 0.562 | 0.661 | 2794 | 4655 | 7284 | 42 145 | 58 355 | 80 174 |
| 1994 | 3865 | 5990 | 7897 | 0.421 | 0.501 | 0.613 | 2230 | 3218 | 4605 | 32 170 | 41 079 | 53 007 |
| 1995 | 4276 | 6217 | 7865 | 0.331 | 0.407 | 0.496 | 1730 | 2374 | 3299 | 29 740 | 37 237 | 45 718 |
| 1996 | 5123 | 7082 | 9011 | 0.234 | 0.297 | 0.366 | 1374 | 1872 | 2500 | 35 619 | 42 726 | 51 476 |
| 1997 | 5763 | 7681 | 9694 | 0.263 | 0.334 | 0.438 | 1816 | 2396 | 3161 | 39 586 | 46 547 | 56 097 |
| 1998 | 7067 | 9372 | 12 004 | 0.191 | 0.252 | 0.331 | 1351 | 1822 | 2472 | 29 062 | 34 409 | 40 933 |
| 1999 | 7894 | 10 675 | 13 828 | 0.137 | 0.181 | 0.238 | 906 | 1246 | 1645 | 25 570 | 30 361 | 36 110 |
| 2000 | 9134 | 12 319 | 15 922 | 0.107 | 0.141 | 0.188 | 828 | 1091 | 1441 | 33 988 | 39 761 | 47 409 |
| 2001 | 11 920 | 15 986 | 20 570 | 0.102 | 0.134 | 0.184 | 949 | 1251 | 1665 | 34 339 | 40 132 | 47 330 |
| 2002 | 14 101 | 18 675 | 23 773 | 0.106 | 0.142 | 0.186 | 1114 | 1512 | 1933 | 37 831 | 43 977 | 51 208 |
| 2003 | 16 896 | 22 351 | 28 444 | 0.098 | 0.127 | 0.164 | 1033 | 1363 | 1743 | 29 132 | 33 742 | 38 893 |
| 2004 | 17 602 | 22 922 | 28 958 | 0.079 | 0.100 | 0.132 | 973 | 1212 | 1501 | 38 513 | 44 246 | 51 412 |
| 2005 | 19 007 | 24 338 | 30 506 | 0.104 | 0.136 | 0.173 | 1361 | 1839 | 2253 | 28 064 | 32 862 | 39 520 |
| 2006 | 19 984 | 25 592 | 32 115 | 0.093 | 0.118 | 0.150 | 1163 | 1614 | 2029 | 31 872 | 37 945 | 46 034 |
| 2007 | 19 109 | 24 352 | 30 130 | 0.108 | 0.138 | 0.180 | 1130 | 1393 | 1704 | 38 215 | 46 324 | 57 779 |
| 2008 | 19 800 | 25 277 | 31 697 | 0.088 | 0.119 | 0.157 | 1040 | 1418 | 1779 | 22 660 | 28 064 | 35 010 |
| 2009 | 18 816 | 23 957 | 29 889 | 0.099 | 0.133 | 0.182 | 1069 | 1370 | 1664 | 22 222 | 28 690 | 36 994 |
| 2010 | 18 724 | 24 095 | 30 508 | 0.105 | 0.147 | 0.207 | 1256 | 1598 | 2078 | 27 295 | 36 373 | 48 674 |

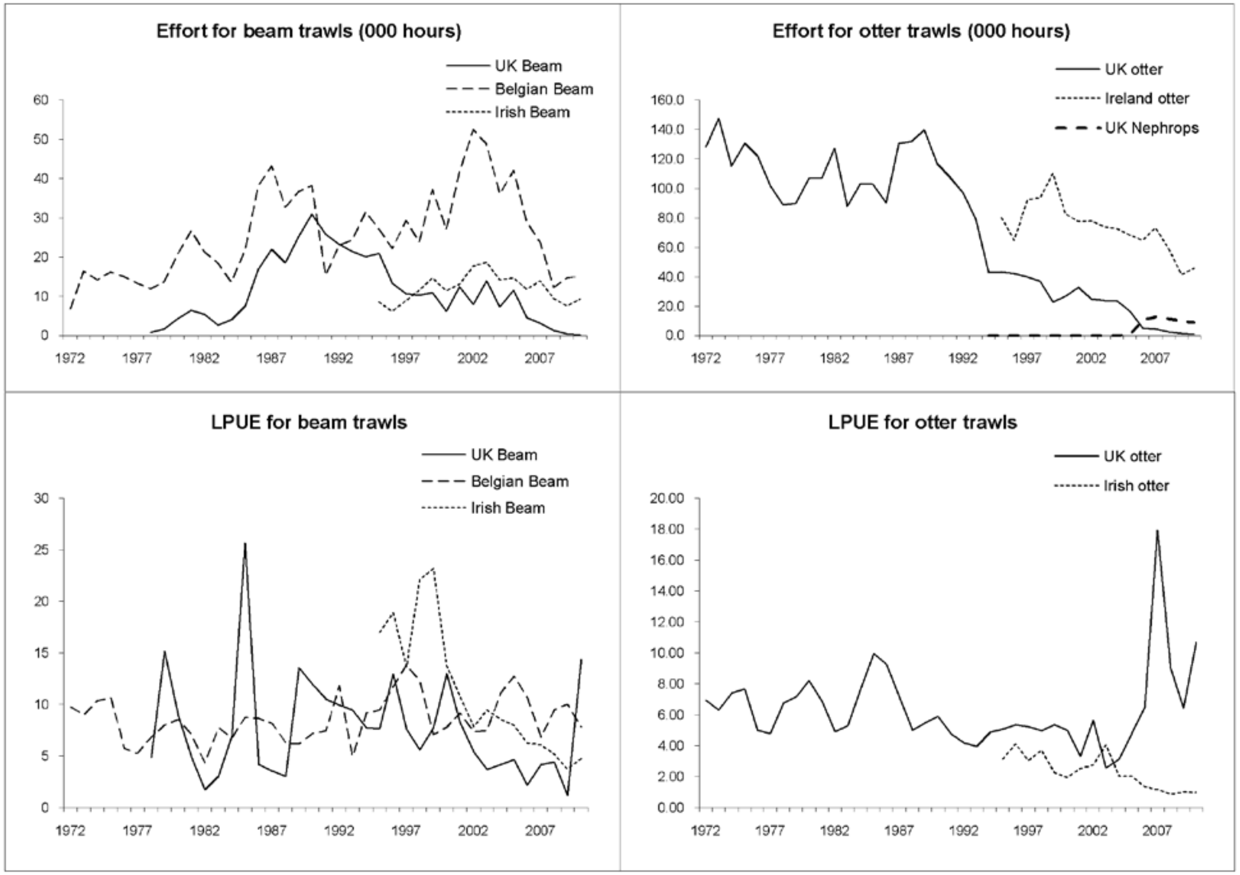



**Figure 6.7.2.1. Irish Sea plaice: Effort and lpue for commercial fleets (note addition of effort by UK *Nephrops* trawlers).**

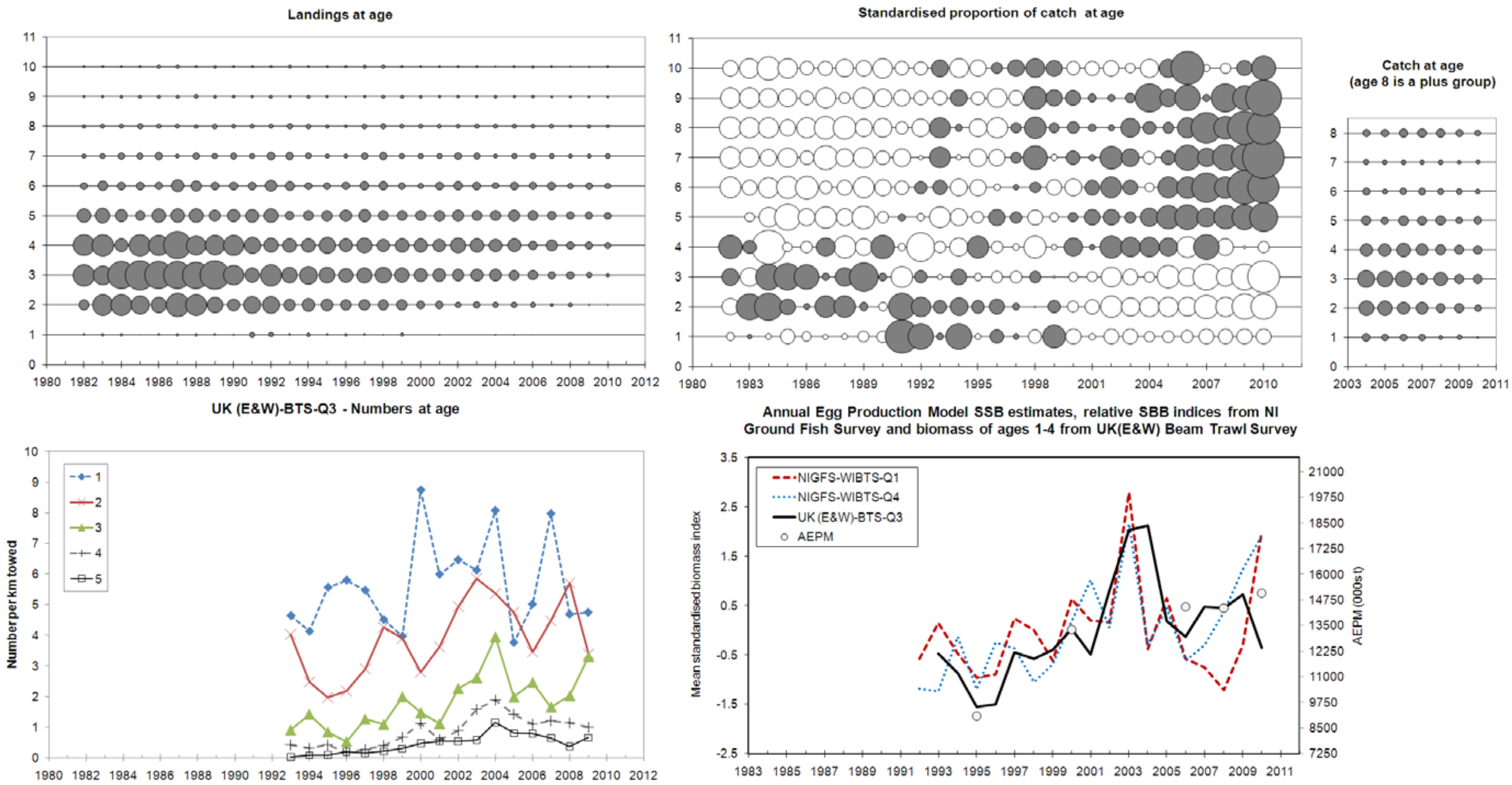



**Figure 6.7.2.2. Catch and survey data: raw landings-at-age data (top left), mean standardized proportion at age (top centre, grey bubbles are positive values and white bubbles are negative); raw catch-at-age data (discards plus landings, topright); UK(E&W)-BTS-Q3 (extended area) cpue (bottom left); standardized indices of SBB (bottom right) derived from NIGFS-WIBTS and also shown biomass of ages 1–4 from UK(E&W)-BTS-Q3 (extended area) and the SSB estimates from the Annual Egg Production Methods (circles, bottom right). Mean standardized proportion-at-age = [ (proportion-at-age in year) – mean(proportion-at-age over all years) ] / STDEV(proportion-at-age over all years).**

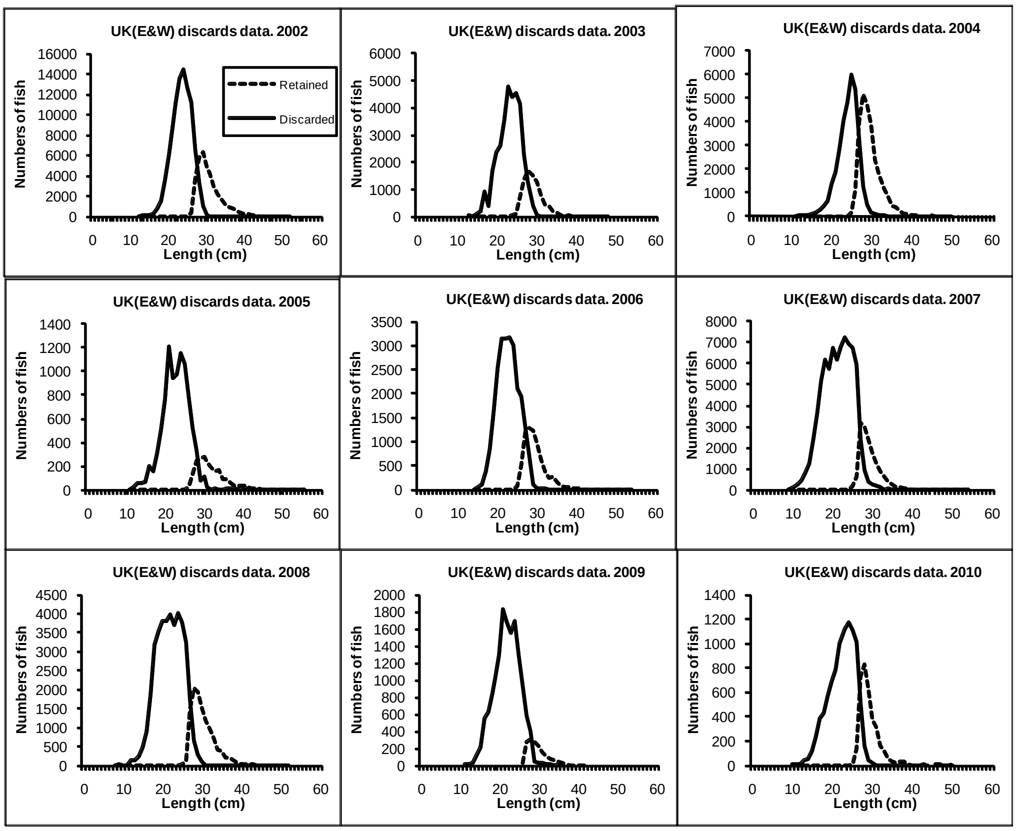



**Figure 6.7.2.3. Length distributions of discarded and retained catches from UK(E&W).**

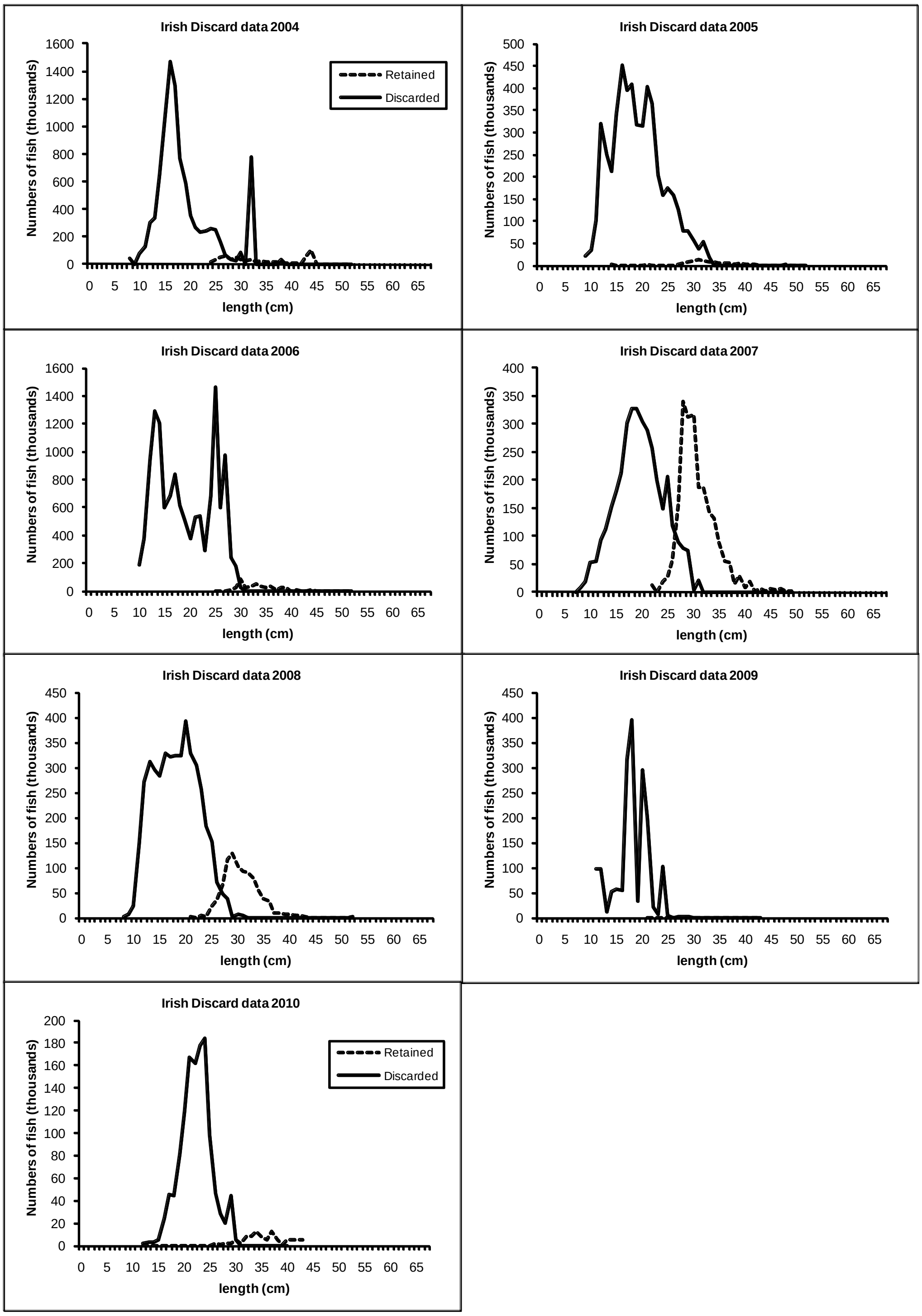



**Figure 6.7.2.4. Length distributions of discarded and retained catches from Ireland.**

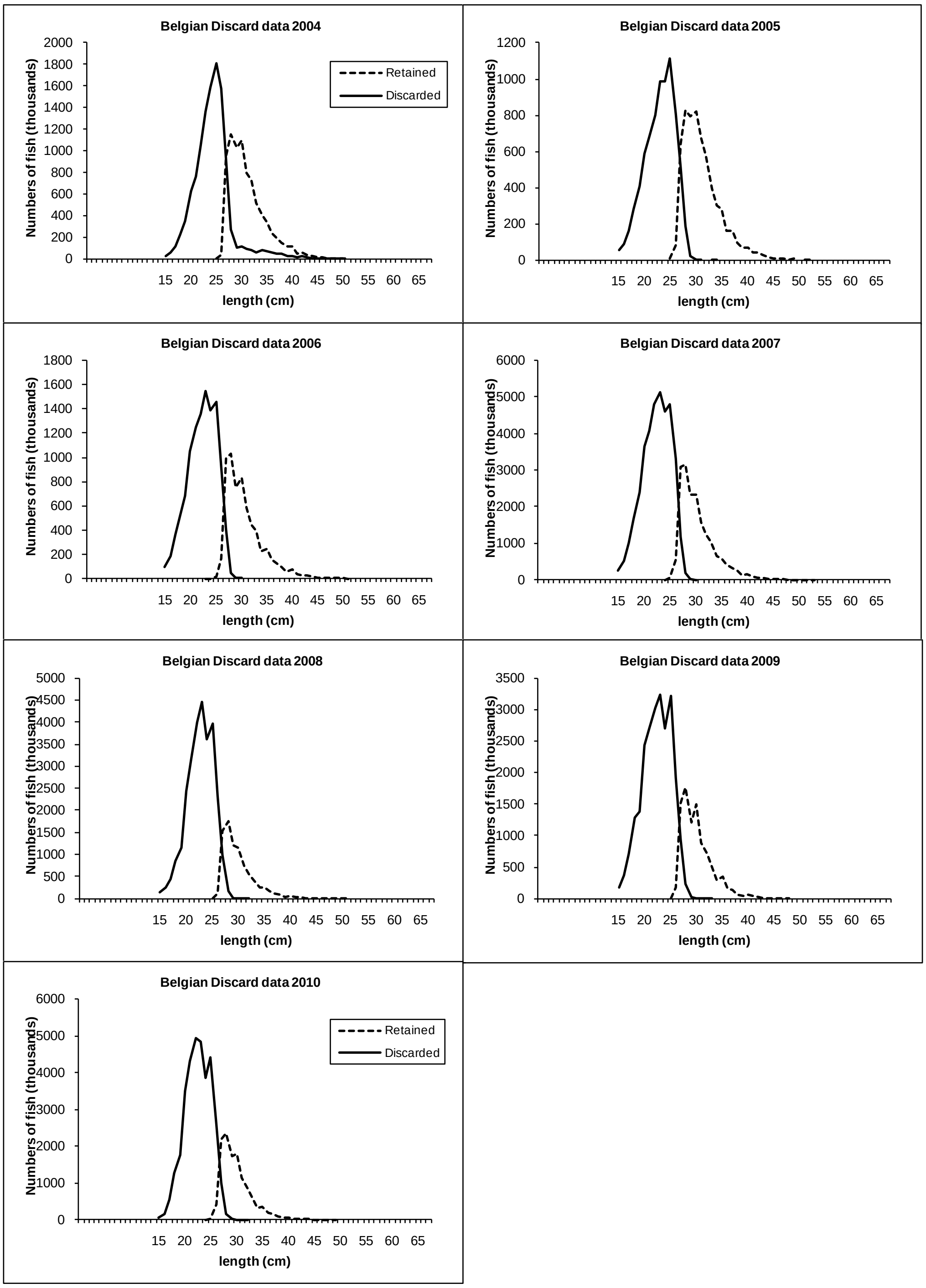



**Figure 6.7.2.5. Length distributions of discarded and retained catches from Belgium.**

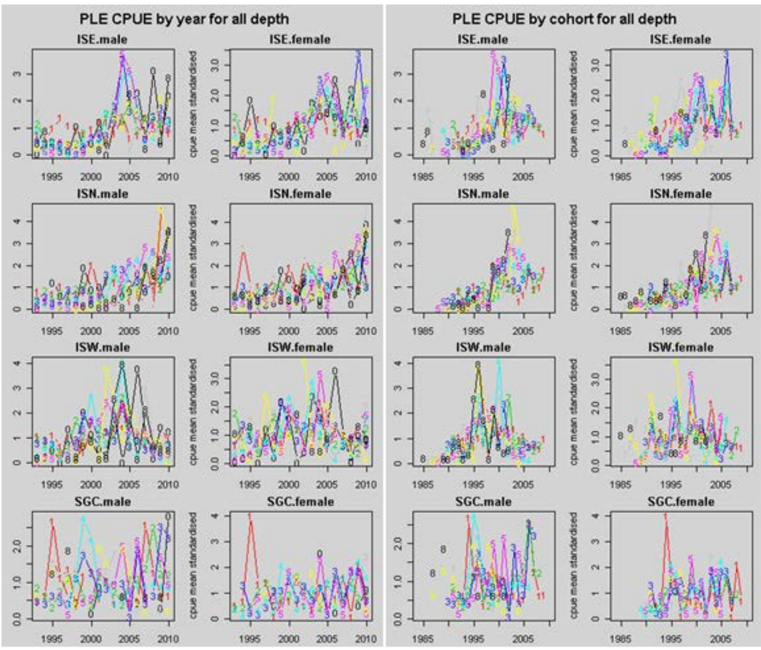



**Figure 6.7.2.6. UK (E&W)-BTS-Q3 mean standardized cpue by age by year and by year class. Mean standardized by age = cpue age i / mean(cpue age i over all years).**

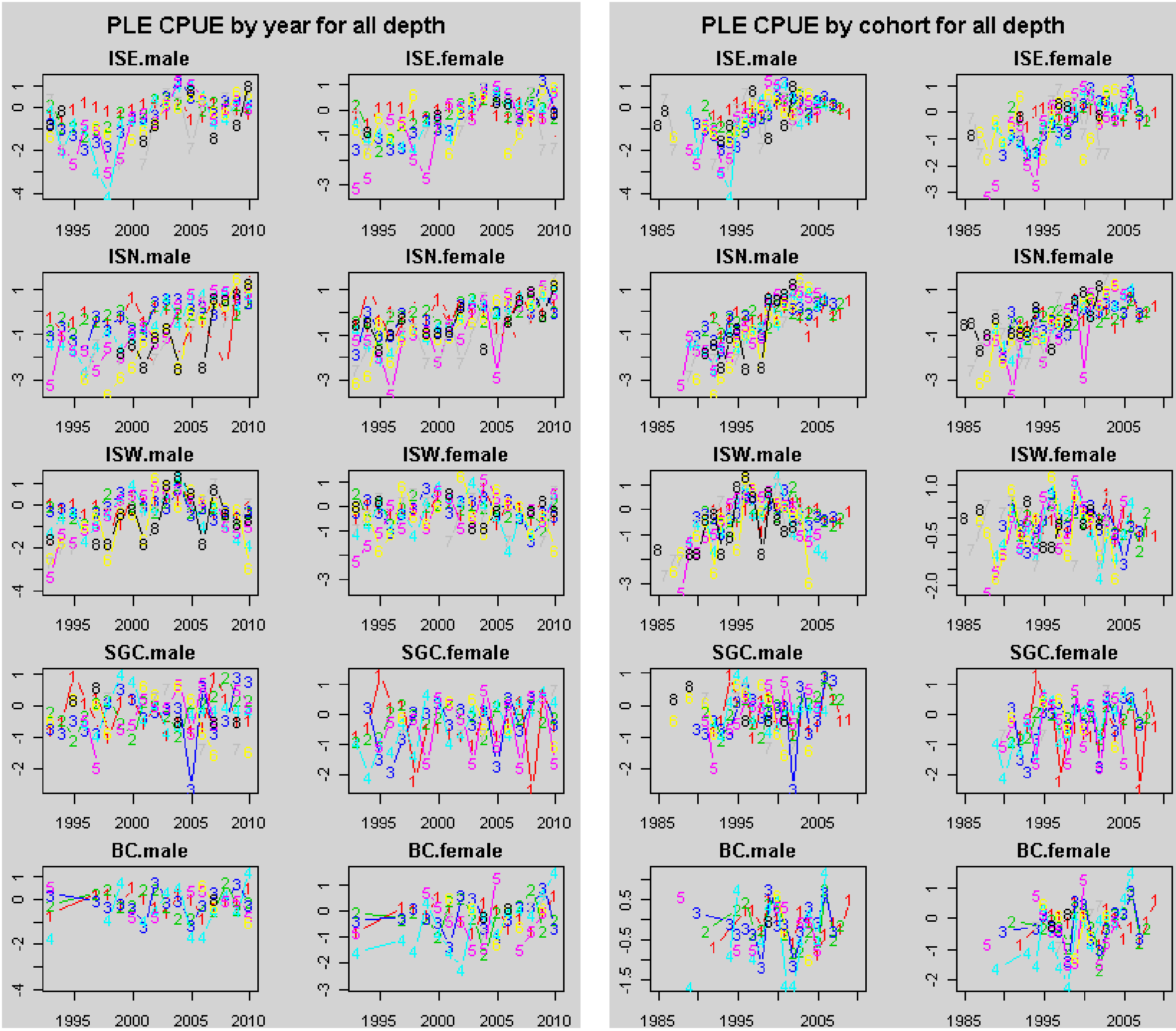



**Figure 6.7.2.6. continued. log( mean standardized cpue) by age for UK (E&W)-BTS-Q3 by year and by year class. Mean standardization by age as in Figure 6.7.2.5.**

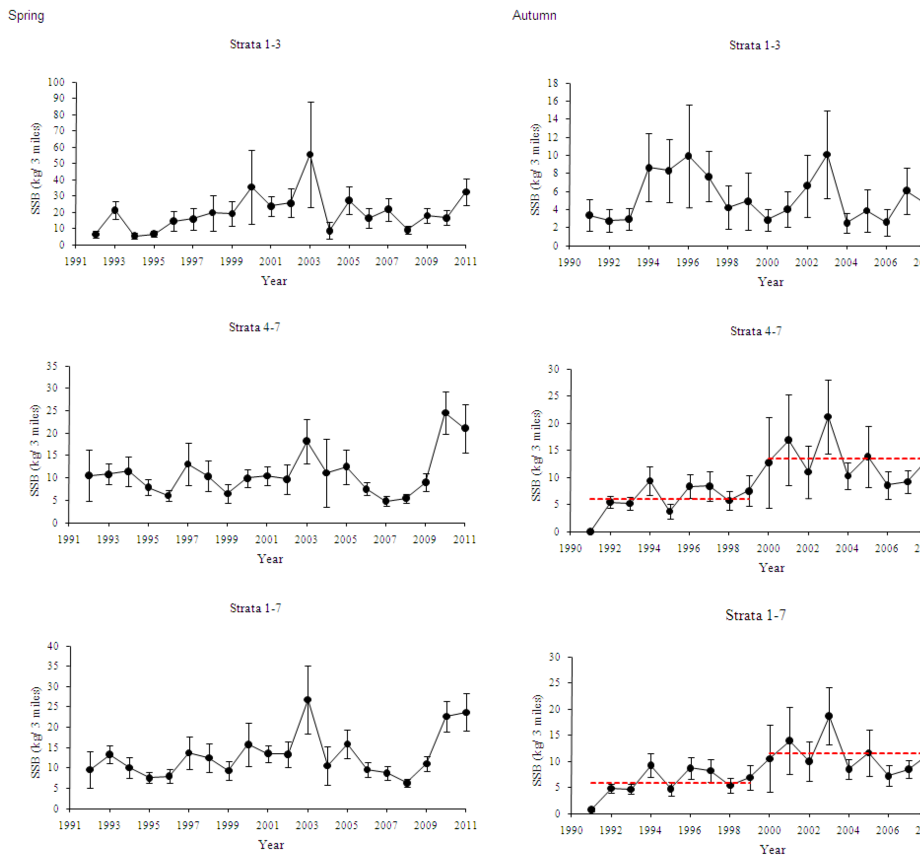



**Figure 6.7.2.7. Northern Irish groundfish survey SSB indices split into spring (left hand panels) and autumn (right hand panels) sampling by western strata (1–3), eastern strata (4–7) and total survey area (strata 1–7) with confidence intervals (± 1 standard error, vertical lines) and mean biomass (kg/3 miles, dashed horizontal lines) for periods identified by statistical breakpoint analysis (see WGCSE 2010).**

Note the different scale on the y-axis in the top-left panel.

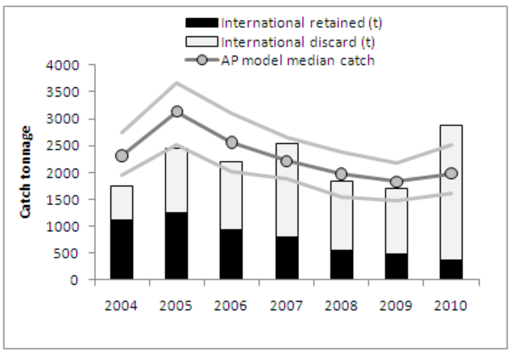



**Figure 6.7.2.8. Plaice in VIIa: WG raised international catch tonnage vs. AP model estimates with uncertainty bounds.**

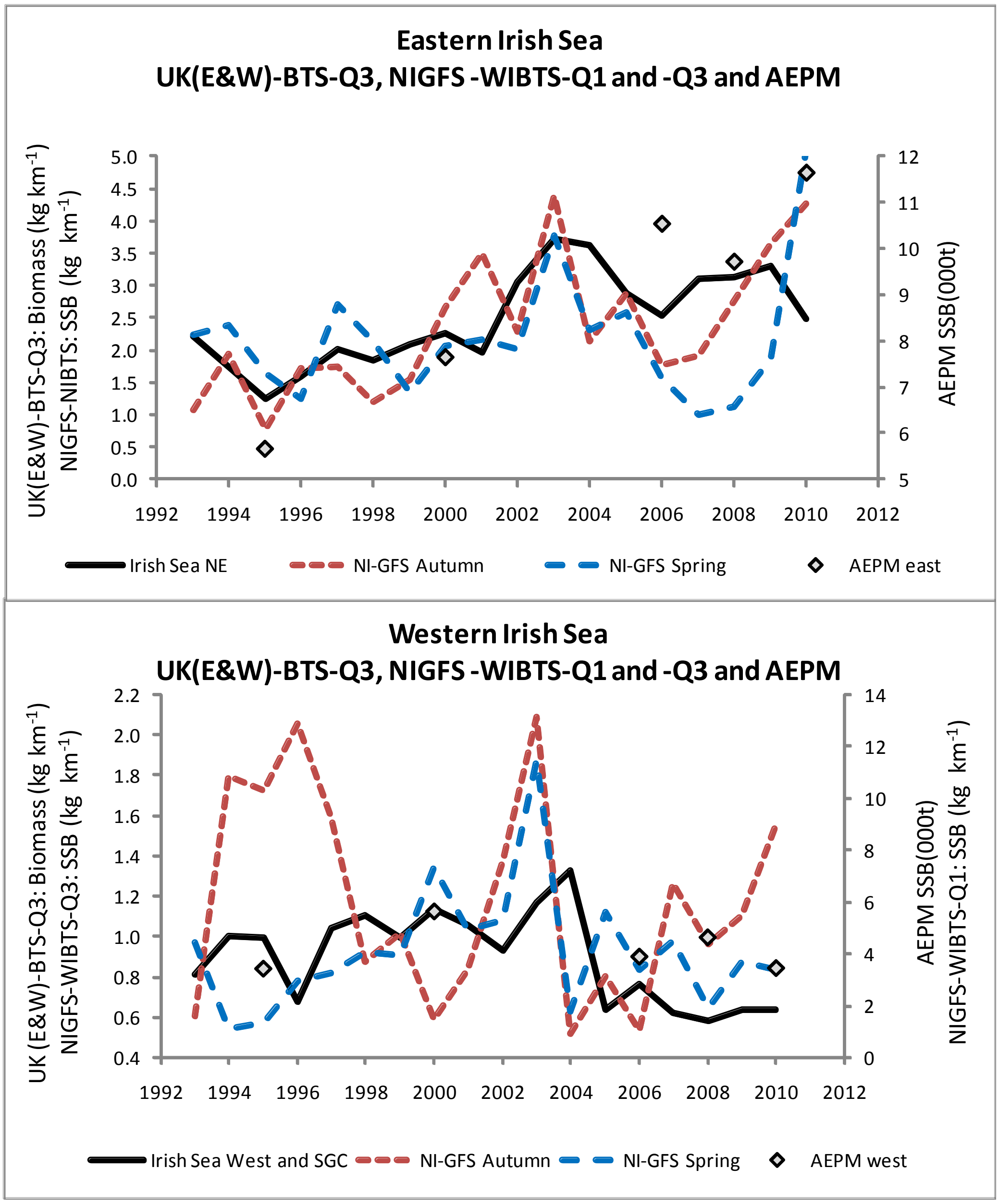



**Figure 6.7.2.9. Trends in SSB indices (kg per km towed) from the UK (E&W)-BTS-Q3 (black line) and the NIGFS-WIBTS-Q1 and -Q3 (blue and red dashed lines respectively) in the eastern Irish Sea (top) and the western and southern Irish Sea (bottom). Also shown (grey diamonds, right axis) are the estimates of SSB from the Annual Egg Production Method (AEPM) from Armstrong *et al.* (2011).**

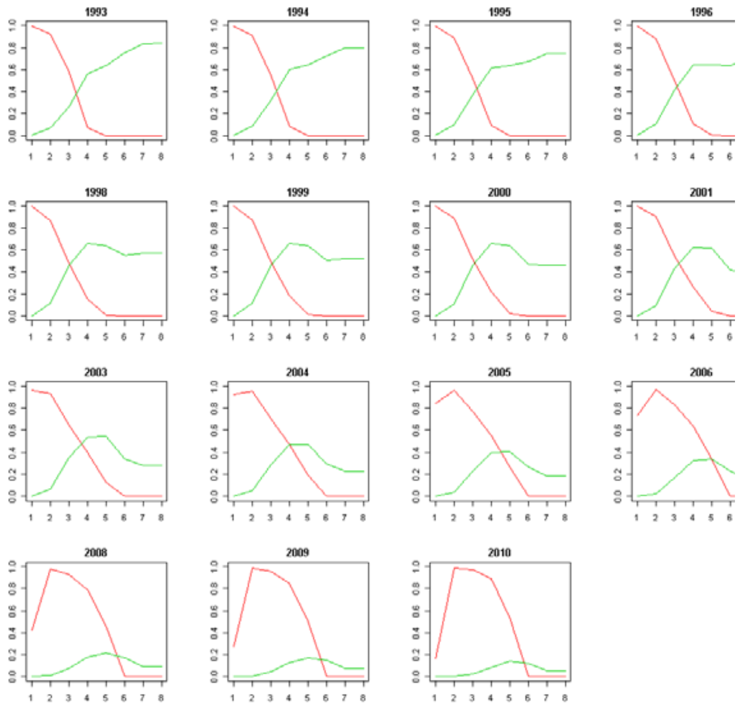



**Figure 6.7.2.10. Selectivity of the fishery split into the landed (green) and discarded (red) components as estimated by the AP model.**

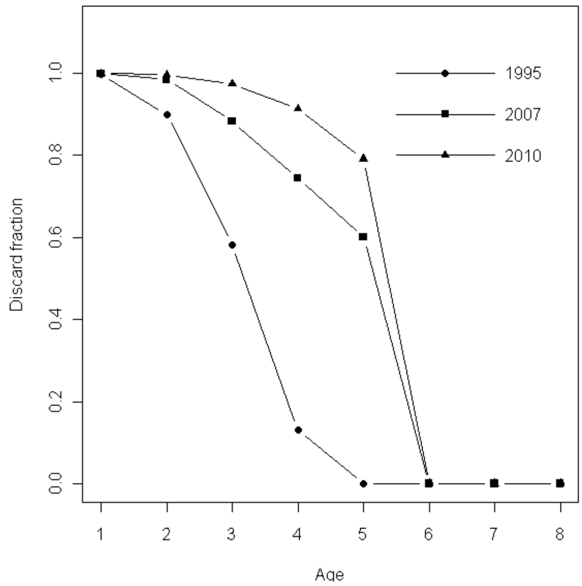



**Figure 6.7.2.11. Change in the discard fraction at age over time as estimated by the AP model.**

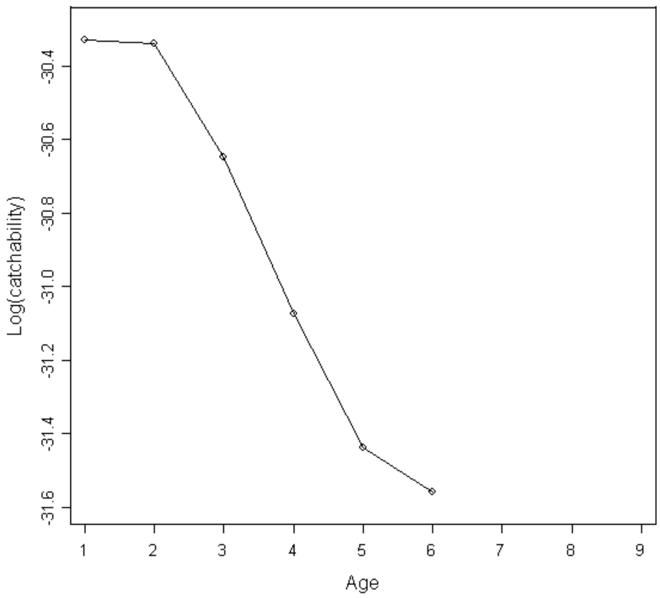



**Figure 6.7.2.12. Log-catchability for the UK (E&W)-BTS-Q3 extended index as estimated by the AP model.**

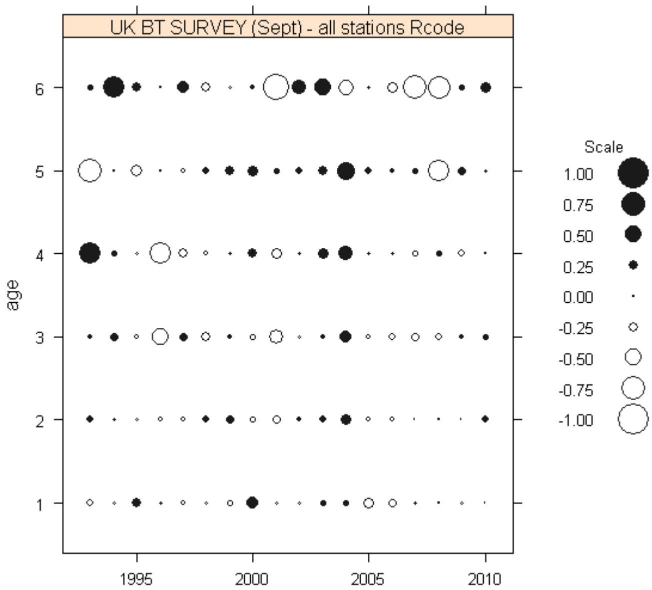



**Figure 6.7.2.13. Residual plot (left) for the UK (E&W)-BTS-Q3extended area index.**

Bubbles are log(observed)–log(expected). Expected values were estimated by the AP model.

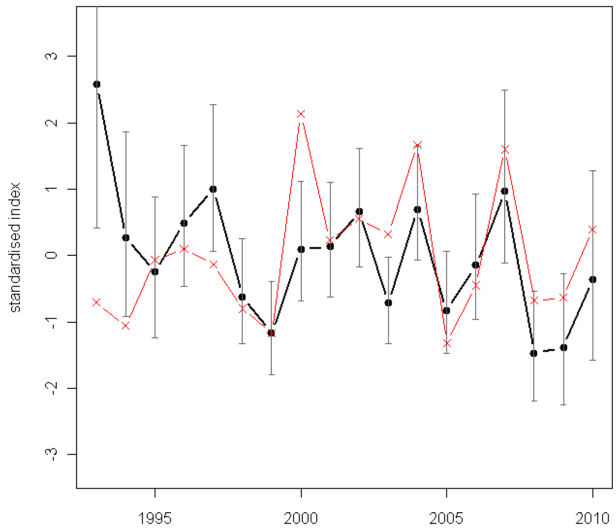



**Figure 6.7.2.14. Age 1 index from the UK (E&W)-BTS-Q3extended area index (red and crosses) and recruitment (black and circles) estimated by the AP model.**

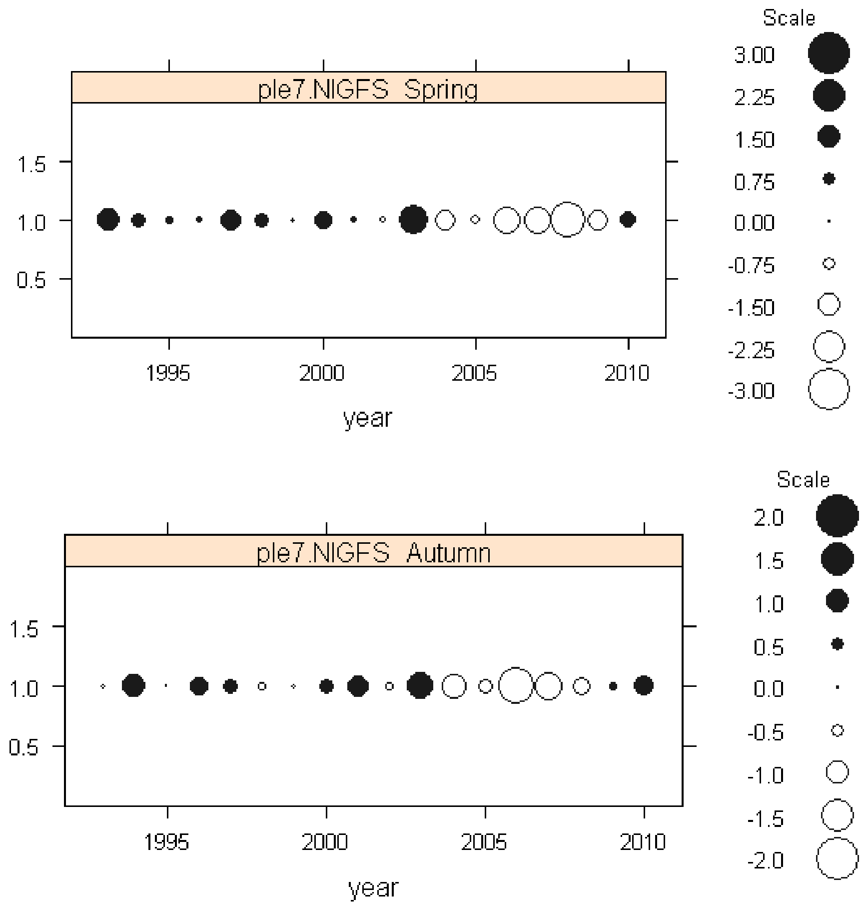
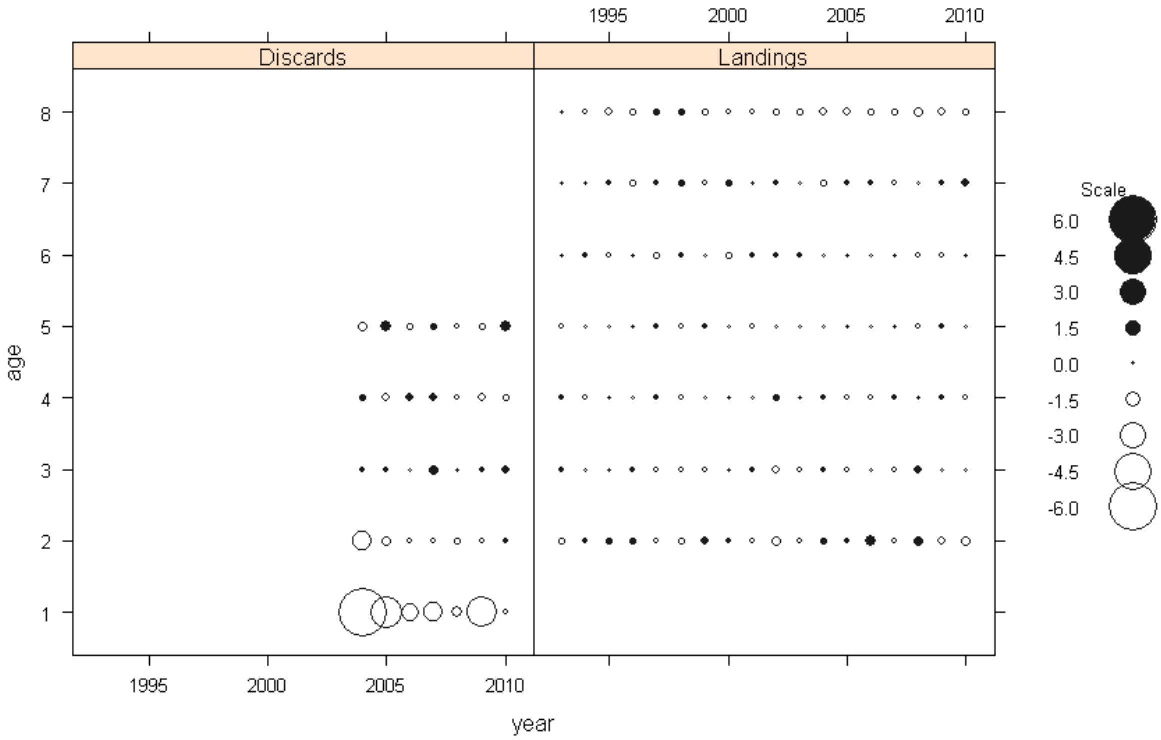



**Figure 6.7.2.15. Residual plots for the NIGFS-WIBTS-Q1 (top) and -Q4 (bottom).**

Bubbles are (observed mean standardized SSB)–(expected mean standardized SSB). Expected values were estimated by the AP model.



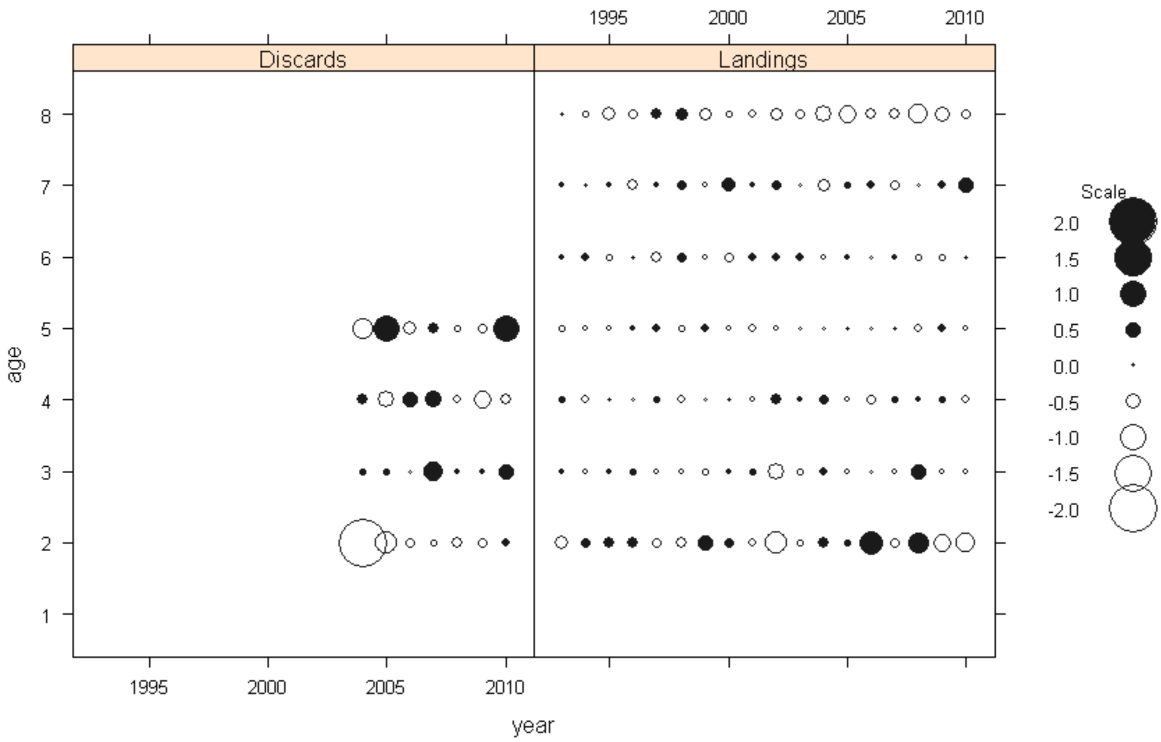




**Figure 6.7.2.16. Residual plots for discards (left) and landings (right) with (bottom) and without (top) bubbles drawn for age 1. Bubbles are log(observed)–log(expected). Expected values were estimated by the AP model.**

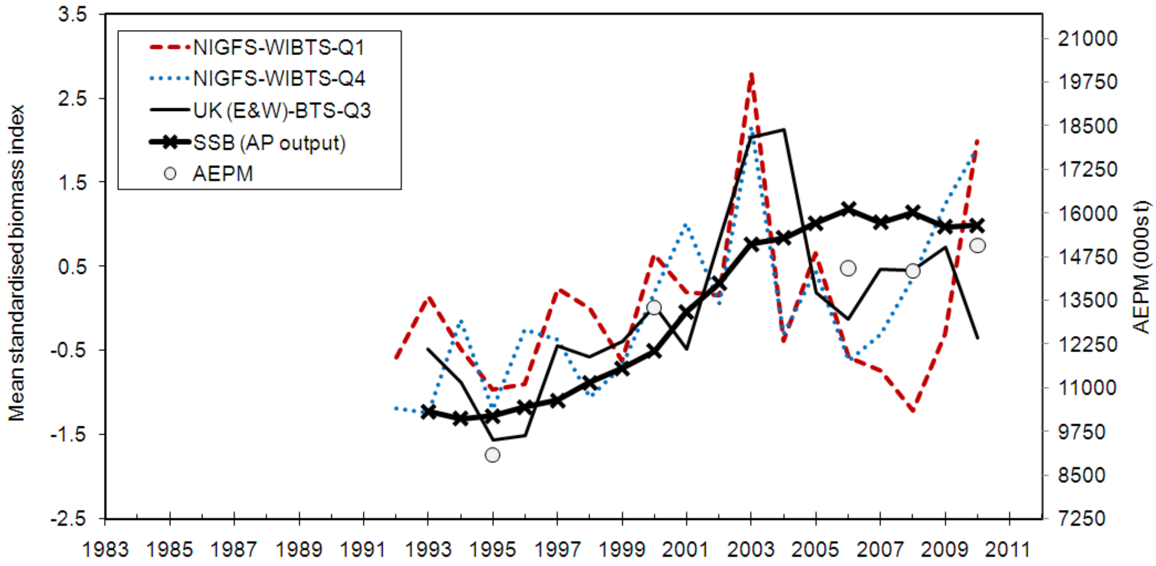



**Figure 6.7.2.17. AP model estimates of mean standardized SSB (black line) overlain with standardized NI-GFS in spring (blue) and autumn (green) relative SSB indices, standardized biomass (ages 1–4) from the UK(E&W)-BTS (grey line) and AEPM SSB index (circles, right axis).**

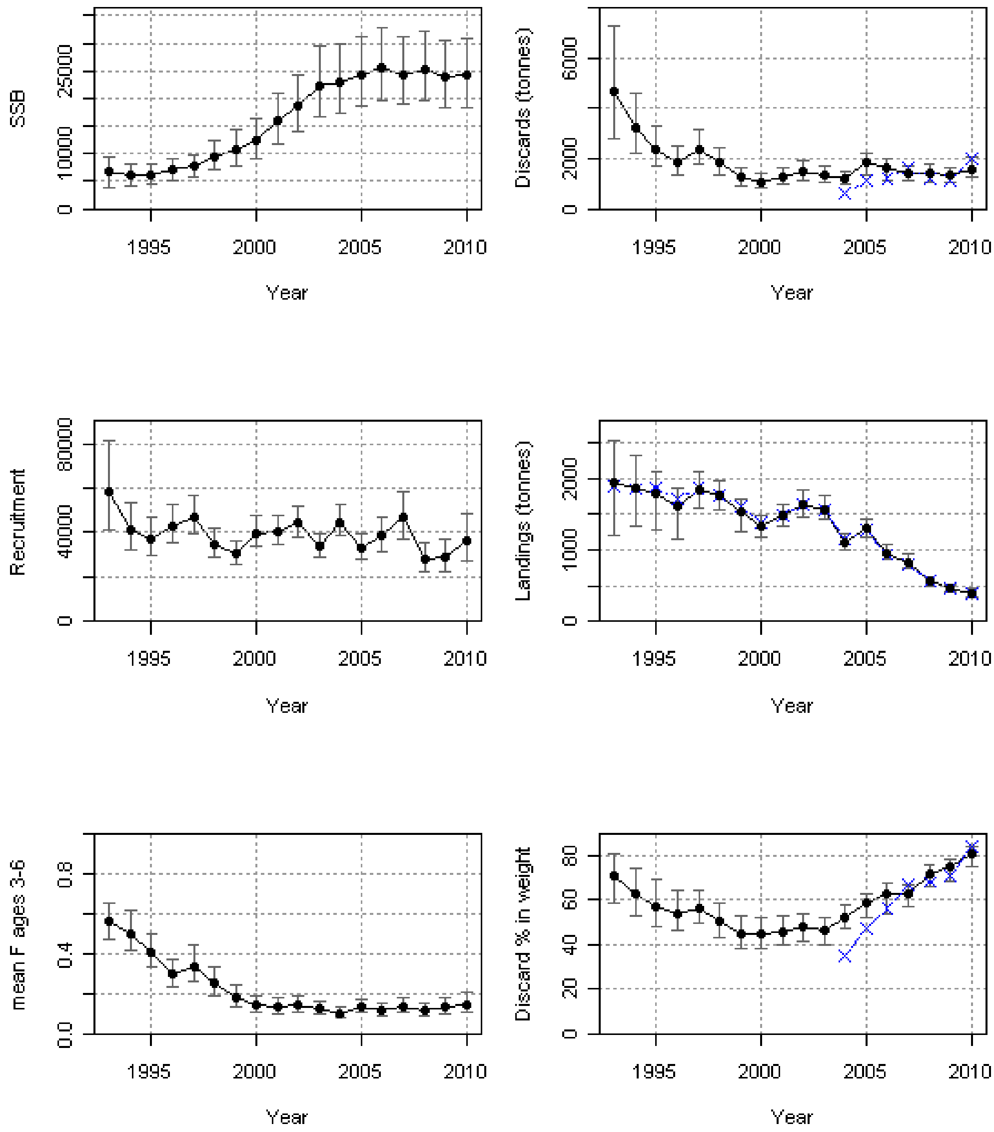



**Figure 6.7.2.18. Modelled SSB (tonnes, top left), recruitment (thousands, centre left), $F_{bar}$ (ages 3–6, bottom left) discard tonnage (top right), landed tonnage (centre right) and % discarded by weight (bottom right). Modelled using the AP model. Raw data shown in blue with crosses.**

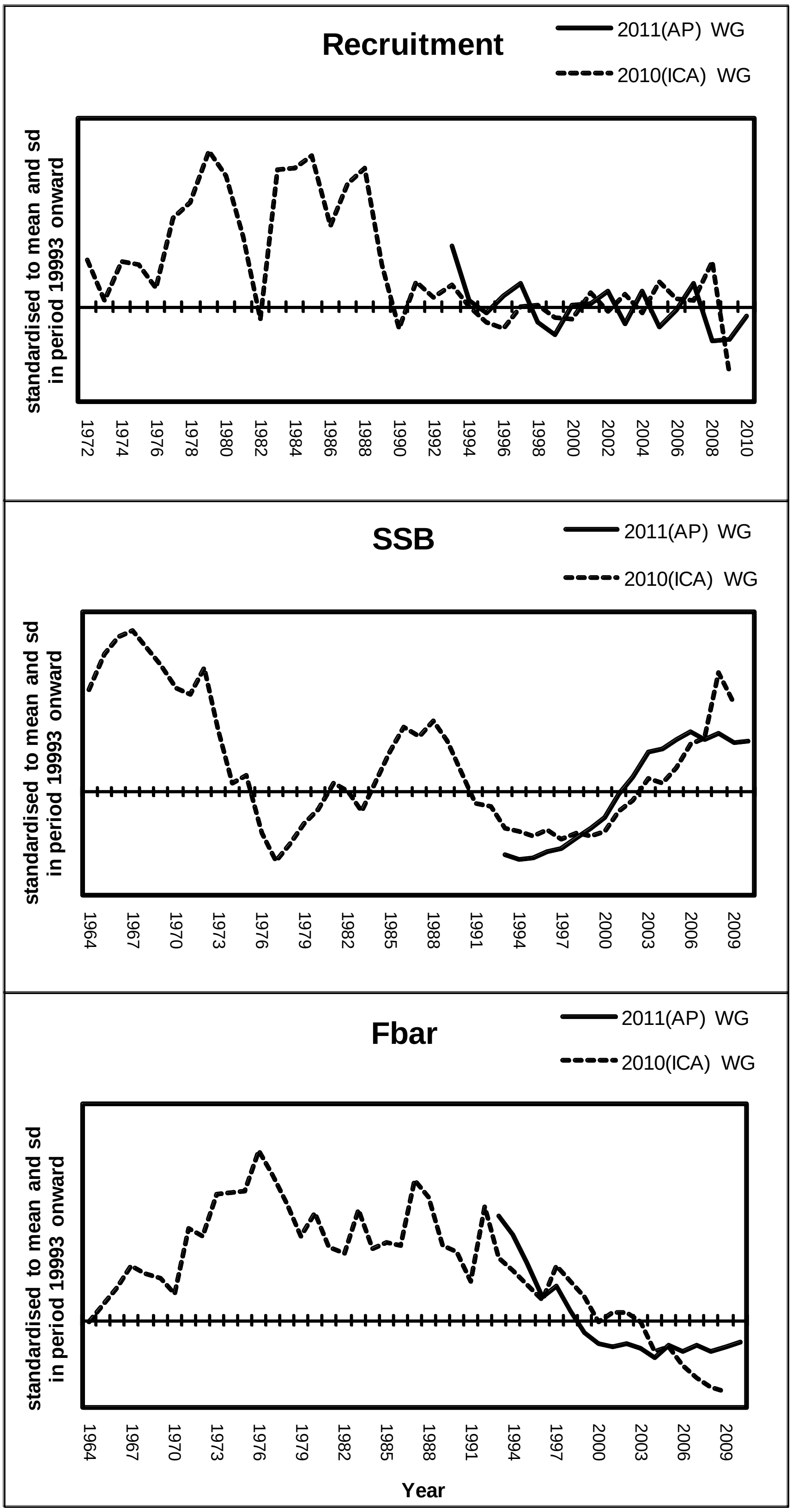



**Figure 6.7.2.19. Comparison of recruitment (age 1), SSB and $F_{bar}$(ages 3–6) between 2010 (WGCSE 2010, ICA model) and 2011 (WGCSE 2011, AP model) assessments.**

## 6.8 Sole in Division VIIa (Irish Sea)

### Type of assessment in 2011

This assessment is an update assessment with the assessment settings agreed at the benchmark meeting (WKFLAT 2011) in February 2011.

Given the improved performance of the assessment with regards to the retrospective pattern and the overall consistency, WKFLAT recommended the following changes to the 2010 assessment.

- The use of a combined age–length key by pooling the raw data of the three main countries (Belgium, UK and Ireland);
- Mean catch weights taken from the combined age–weight key;
- Mean stock weights derived from the mean catch weights by cohort interpolation (Rivard weight calculator);
- The UK march survey (UK(E&W)-BTS-Q1) was omitted from the assessment;
- No taper weighting applied instead of the linear time weighting (over 20 years);
- Catchability independent of age for ages >= 4 instead of ages >= 7.

### ICES advice applicable to 2010

*In 2010 ICES classifies the stock as suffering reduced reproductive capacity and at risk of being harvested unsustainably.*

#### ICES advice applicable to 2010

***Single-stock exploitation boundaries***

*Considering the options in the outlook for 2010, ICES advises on the basis of exploitation boundaries in relation to precautionary limits that no fishing of sole should take place in the Irish Sea in 2010.*

### ICES advice applicable to 2011

*In 2011 the stock status was presented as follows:*

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Above | Above | Above |
| $F_{PA}/F_{lim}$ | Between | Between | Below |
| **Spawning-stock biomass (SSB)** | **2008** | **2009** | **2010** |
| MSY $B_{trigger}$ | Below | Below | Below |
| $B_{PA}/B_{lim}$ | Below | Below | Below |

**ICES advice applicable to 2011**

***MSY approach***

*Following the transition scheme towards the ICES MSY framework implies fishing mortality of (0.8*F(2010)) + (0.2*(FMSY*0.55) = 0.24 for 2011. This results in landings of 390 t in 2011. This is expected to lead to an SSB of 2200 in 2012.*

***PA approach***

*Given the low SSB and low recruitment since 2000, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach. ICES recommends a closure of the fishery in 2011 and a recovery plan should be developed and implemented as a prerequisite to reopening the fishery.*

### Technical comments made by the Review Group (RGCS)

1 ) RCT3 input file has wrong data from March BTS compared with Table 6.8.6. This series should be removed from RCT as it has no input to recent year-class forecasts.
2 ) The short-term forecast uses an $F_{sq}$ that predicts landings of 439 t in 2010, larger than the TAC of 402 t, and likely to be overoptimistic given the 65% TAC uptake in 2009 and the dramatic effort reduction in fleets taking sole in recent years.

The UK(E&W)-BTS-Q1 survey was cancelled from the European survey programme after 1999 and therefore does not provide information to the recent year-class estimates. WKFLAT 2011 decided to omit the UK(E&W)-BTS-Q1 survey from the assessment. In line with that the UK(E&W)-BTS-Q1 series was also excluded from the RCT3 run, as suggested by the review group.

The predictions from the unscaled *status quo* forecast for 2010 are indeed very optimistic considering the decline in fishing mortality and effort in the last three years. Given the downward trend in F over the last three years, ACOM decided to use the F pattern observed over the last three years, rescaled to the final year F (2009). This $F_{sq}$ results in landings of 386 t for 2010, which is more in line with the 2010 TAC of 402 t.

## 6.8.1 General

#### Stock description and management units

The sole fisheries in the Irish Sea are managed by TAC (see text tables below) and technical measures, with the assessment area corresponding to the stock area. Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). In addition beam trawlers, fishing with mesh sizes equal to or greater than 80 mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Council Regulation (EC) N°254/2002 and the Stock Annex.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the western and eastern Irish Sea. Since then, closure has been mainly in the western part whereas the sole fishery takes place mainly in the eastern part of the Irish Sea. No direct impact on the sole stock is expected from this closure.

For 2009 Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The areas are Kattegat, part of IIIa not covered by Skaggerak and Kattegat, ICES Zone IV, EC waters of ICES Zone IIa, ICES Zone VIId, ICES Zone VIIa, ICES Zone VIa and EC waters of ICES Zone Vb. The grouping of fishing gear concerned are: bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≥100 mm)–TR2 (≥70 and <100 mm)–TR3 (≥16 and <32 mm); Beam trawl of mesh size: BT1 (≥120 mm)–BT2 (≥80 and <120 mm); gillnets excluding trammelnets: GN1; trammelnets: GT1 and longlines: LL1.

For 2010 and 2011, Council Regulation (EC) N°53/2010 and Council Regulation (EC) N°57/2011 were updates of the Council Regulation (EC) N°43/2009 with new allocations, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009. (see Section 1.2.1 for complete list).

### Management applicable to 2010 and 2011

*TAC 2010*

| **Species:** Common sole *Solea solea* | | **Zone:** VIIa (SOL/07A.) |
|---|---|---|
| Belgium | 186 | |
| France | 2 | |
| Ireland | 73 | |
| The Netherlands | 58 | |
| United Kingdom | 83 | |
| EU | 402 | |
| TAC | 402 | Analytical TAC |

*TAC 2011*

| **Species:** Common sole *Solea solea* | | **Zone:** VIIa (SOL/07A.) |
|---|---|---|
| Belgium | 179 | |
| France | 2 | |
| Ireland | 73 | |
| The Netherlands | 56 | |
| United Kingdom | 80 | |
| EU | 390 | |
| TAC | 390 | Analytical TAC |

### Fishery in 2010

A full description of the fishery is provided in the Stock Annex, Section A2.

The Working Group estimated the total international landings at 275 t in 2010 (Table 6.8.1), which is about 32% below the 2010 TAC (402 t) and also 30% below last year's forecast of 390 t.

The main countries fishing for Irish Sea sole are Belgium and Ireland.

The Belgian beam trawl effort has declined since 2002, however in 2010 it remains stable at around the lowest level in the time-series. The Irish beam trawl effort has increased slightly in 2010 following a decline since 2003. The Irish otter trawl effort has also increased a little in 2010 however it is still comparable with the historically lowest value reported in 2009.

#### Landings

An overview of the landings data provided and used by the WG is shown in Table 6.8.1. The landings reached a level of 2800 t in the mid-1980s due to good recruitments in 1982–1984, but then subsequently dropped to a lowest of 818 t in 2000 (Table 6.8.12). After a small increase to 1090 t at the beginning of the 2000s, the landings have fallen to under 350 t in the last three years.

The WG estimated the total international landings at 275 t in 2010 (Table 6.8.1), of which 79% (215 t) was landed by Belgium, 17% (47 t) by Ireland, 2% (7 t) by the UK (England & Wales) and the remainder by Northern Ireland, Scotland, Isle of Man and France. These landing-figures are the lowest in the time-series, corresponding to an international uptake of only 68% of the agreed TAC in 2010 (402 t).

The working group estimate of the 2009 landings was slightly revised upwards due to minor (0.4%) revisions of the landings by France, Isle of Man and Scotland, and had a negligible impact on the assessment results.

There is no accurate information on the level of misreporting, but given the partial uptake (50–70%) of the agreed TAC in recent years, misreporting is not considered a problem for this stock (Table 6.8.1).

#### Data

Quarterly age compositions for 2010 were available from the countries that take the major part of the international landings (98%) (Belgium, UK (E&W) and Ireland). The raw age data were combined for the three countries without weighting. The combined ALK was applied to the raised length distribution of the national catches to obtain a combined age distribution.  This distribution was applied to the landings from France, Northern Ireland, Isle of Man and Scotland to obtain the catch numbers-at-age for 2010 (Table 6.8.2). Annual length distributions of the three major countries involved are given in Table 6.8.3.

Sampling levels for the countries providing age data are given in Table 2.1.

Catch weights-at-age for 2010 were taken from the combined age–weight key (Table 6.8.4).

Stock weights-at-age for 2010 were derived from the mean catch weights by cohort interpolation to the first of January (Rivard weight calculator) (Table 6.8.5).

Further details on raising methods are given in the stock annex.

This year, the combined age data (calculated outside InterCatch) as well as the landings from Northern Ireland, Scotland, Isle of Man and France were uploaded to InterCatch. It should be noted that the international age distribution is uploaded as "BE" as no international country code is available in InterCatch at present.

### Discards

The available discard data indicate that discarding is not a major problem in the Irish Sea sole fishery. Discard rates (Table 6.8.6) in the various fisheries targeting sole are generally less than 8% in weight (and often even smaller than 2%). For 2010 discard rates from the beam trawl fleets are 4% for Belgium and 5% for Ireland. The discard rates for the Irish fleets were derived from the Irish length distributions and the combined length–weight relationship.

Length distributions of retained and discarded catches of sole for 2010 from samples taken on board Belgian (beam trawl), UK (all gears) and Irish (beam and otter trawl) vessels are given in Figure 6.8.1a–c . It should be noted that the number of sampled trips is low.

### Biological

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years, details of which can be found in the Stock Annex Section B2.

### Surveys

Cpue and effort-series were available from the UK (E&W) September beam trawl survey (UK(E&W)-BTS-Q3) (1988–2010) and the UK (E&W) March beam trawl survey (UK(E&W)-BTS-Q1) (1993–1998) (Tables 6.8.7 and Figure 6.8.2c). From 2006 until 2010 the two UK beam trawl surveys have been used as tuning indices in the Irish Sea sole assessments. In this year's assessment the March survey (UK(E&W)-BTS-Q1) was omitted as recommended by WKFLAT 2011. The cpue from the UK(E&W)-BTS-Q3 has fluctuated since the beginning of the time-series (1988) between 90 and 200 kg/100 km fished. Since 2000 is has dropped gradually to the lowest value in 2010 (28 kg/100 km fished).

Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

### Commercial cpue

Commercial cpue and effort data were available for Belgian beam trawlers, UK (E&W) beam and otter trawlers and Irish otter and beam trawlers. Minor revisions have been made to the Belgian cpue series for 2006 and 2009 because of a change in the data extraction procedure. The cpue and effort-series from Irish beam and otter trawlers have also slightly been revised for the recent years (2006–2009).

Trends in cpue and effort are given in Table 6.8.7 and Figure 6.8.2-3.

Effort from both Belgian and UK commercial beam trawl fleets increased from the early seventies until the beginning of the nineties. Since then UK beam trawl effort has shown a continuing declining trend. In contrast, the Belgian beam trawl effort has shown a fluctuating pattern. After the decline in the early nineties, it reached its highest level in 2002 and decreased again afterwards. For the three last years, it remained at around the lowest level in the time-series. The effort of the Irish beam trawlers show a slow decline since 2003 back to the levels of the mid-nineties. In 2008 all beam trawl fleets showed a substantial reduction in effort compared to 2007. The effort from the UK otter trawlers remained stable until the beginning of the nineties. Since then the UK otter trawl effort has continuously declined and is now at the lowest level in 2010. The Irish otter trawlers have also shown a marked reduction in effort since 1999.

Cpue for both UK and Belgian beam trawlers was at a high level in the late seventies and early eighties but since early 2000s, cpue for these fleets has fluctuated at a lower level. Since 2007 there has been a small increase in cpue. Irish beam trawl cpue shows a declining trend over the whole time-series. The cpue of both Irish and UK otter trawlers show a decline over the whole time-series.

#### Historical stock development

In 2010, the Irish Sea sole assessment was based on XSA with two survey tuning indices (UK(E&W)-BTS-Q3 and UK(E&W)-BTS-Q1 (Table 6.8.8). The UK(E&W)-BTS-Q1 indices only provides information for years 1993 up to 99 and therefore no longer contributes to the final survivor estimates. At WKFLAT 2011, the exclusion of the UK(E&W)-BTS-Q1 from the assessment was investigated and it was found that there was little effect on the catchability residuals and the retrospective pattern showed a slight improvement. WKFLAT 2011 therefore decided to omit this survey from the assessment.

### 6.8.2 Stock assessment

#### Data screening

The age range for the analysis was 2–8+.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. The logcatch ratios for the fully recruited ages (4–7) did not show any patterns or large residuals. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.5), mean q model for all ages, full time-series and untapered), using the UK(E&W)-BTS-Q3 data (available in ICES files). The log-catchability residual pattern showed no trends and no year effects.

At the Benchmark meeting (WKFLAT 2011), tuning indices of UK(E&W)-BTS-Q3 were examined for inconsistencies using SURBA version 3.0. This analysis showed good cohort tracking and consistency between ages for year-class strength (see WKFLAT 2011 report).

#### Final update assessment

The model settings for the final assessment are summarized below (parameters were changed in 2011 following Benchmark conclusions).

| | | |
|---|---|---|
| Assessment Year | :2010 | :2011 |
| Assmnt Model | :XSA | :XSA |
| Fleets | : | : |
| Bel Beam Trawl | : omitted | :omitted |
| UK Trawl | :omitted | :omitted |
| UK Sept BTS | :1988–2009 2–7 | :1988–2010 2–7 |
| UK Mar BTS | :1993–1999 2–7 | :**omitted** |

| | | |
|---|---|---|
| Time-series Wts | :linear 20 yrs | :**no taper weighting** |
| Power Model | : none | :none |
| Q plateau | :7 | :**4** |
| Shk se | :1.5 | :1.5 |
| Shk age-yr | : 5 yrs 3 ages | : 5 yrs 3 ages |
| Pop Shk se | : 0.3 | : 0.3 |
| Prior Wting | : none | : none |
| Plusgroup | : 8 | : 8 |
| $F_{bar}$ | : 4–7 | : 4–7 |

The final XSA output is given in Table 6.8.9 (diagnostics), Table 6.8.10 (fishing mortalities) and Table 6.8.11 (stock numbers). Log-catchability residuals for the final assessment are given in Figure 6.8.4. A summary of the XSA results is given in Table 6.8.12 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 6.8.5. Retrospective patterns for the final run are shown in Figure 6.8.6.

The survivor estimates and fishing mortality estimates are almost entirely determined by the UK(E&W)-BTS-Q3 survey as it gets a high weighting (>96%) at all ages.

The recommendations from WKFLAT 2011 have resolved the retrospective pattern seen in the previous assessment where there was a downwards revision of SSB. Fishing mortality has a slightly improved retrospective pattern. The recruitment levels appear to be consistently estimated throughout the retrospective period.

#### Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figure 6.8.7.

With the addition of the 2010 data and the changes made at WKFLAT 2011, estimates of fishing mortality and SSB were revised slightly. In last year's assessment, fishing mortality and SSB for 2009 were estimated to be 0.28 and 1183 t respectively; this year's estimates for 2009 are 0.36 and 1130 t, an upward revision of 28% for F and a downward revision of 4% for SSB. The estimated recruitment by XSA in 2009 (2397 thousand fish) was revised downward by 11% in 2010 (2144 thousand fish).

Recruitment trends are very similar, whereas the historical estimates of F show a slight underestimation compared to the 2010 WG assessment. The SSB estimates from the updated assessment are somewhat overestimated for the earlier part of the time-series, but are comparable in the recent years.

#### State of the stock

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Table 6.8.12 and Figure 6.8.5. Since the late eighties the landings of Irish Sea sole have been declining to the lowest level of the time-series (275 t) in 2010. SSB has been at a higher level until the late eighties. Since then SSB has been fluctuating around $B_{pa}$ and since 2005 it dropped below $B_{lim}$. In 2009 SSB declined to the lowest estimate of the time-series (1130 t). High fishing mortalities were observed during the late eighties until the mid nineties. Thereafter fishing mortality declined to a level fluctuating around $F_{lim}$ and since 2007 to around $F_{pa}$. The decline in F is supported by a reduction in effort observed for the Belgian beam trawlers, UK (E&W) beam and otter trawlers and Irish otter trawlers. Since 2001 recruitment has been well below the mean (6331 thousand fish) and the 2010 recruitment (year class 2008) is estimated to be the lowest in the time-series (834 thousand fish).

### 6.8.3 Short-term projections

#### Estimating year-class abundance

The 2008 year class is now estimated at 834 thousand fish at age 2, which is 66% lower than the RCT3-value (2489 thousand fish) used in last year's forecast. The current estimate of the 2008 year class is solely coming from the UK(E&W)-BTS-Q3 and this survey has the lowest catch numbers in the time-series for age 2 in 2010 (59 fish).

The 2009 year class (age 2 in 2011) was estimated using RCT3 (input in Table 6.8.13, output in Table 6.8.14). The RCT3 estimate (1679 thousand fish) was used as it incorporates additional information of age 1 fish from the UK(E&W)-BTS-Q3 survey that is not included in the XSA.

The long-term GM (5216 thousand fish) recruitment was assumed for the 2010 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarized as follows:

| Year class | XSA | GM 70-08 | RCT3 |
|---|---|---|---|
| 2008 | 834 | 5216 | - |
| 2009 | - | 5216 | 1679 |
| 2010 & 2011 | - | 5216 | |

The input for the short-term catch predictions and sensitivity analysis is given in Table 6.8.15. Fishing mortality was calculated as the mean of 2008–2010. Catch and stock weights-at-age were also averages for the years 2008–2010. Population numbers at the start of 2011 for ages 3 and older were taken from the XSA output.

The short-term management option table is given in Table 6.8.16, a detailed output is presented in Table 6.8.17. A short-term forecast plot is shown in Figure 6.8.8.

Assuming *status quo* F, implies a catch of around 323 t in 2011 (the agreed TAC is 390 t) and 320 t in 2012. Assuming *status quo* F will result in a SSB of 1371 t in 2012 and 1716 t in 2013.

Assuming *status quo* F, the proportional contributions of recent year classes to the predicted landings and SSB are given in Table 6.8.17. Given the low stock size, predictions become more dependent on the assumed incoming recruitment. The RCT3 value and the assumed GM recruitment accounts for about 11% and 29% respectively of the landings in 2012 and about 5% and 45 % respectively of the 2013 SSB.

Results of a sensitivity analysis are presented in Figure 6.8.9 (probability profiles). The approximate 90% confidence intervals of the expected *status quo* yield in 2012 are 220 t and 450 t. There is about 85% probability that at current fishing mortality SSB will fall below $B_{lim}$ (2200 t in 2012).

### 6.8.4 MSY explorations

Investigations for possible $F_{MSY}$ candidates for this stock were carried out at last year's WGCSE. ACOM adopted an $F_{MSY}$ value of 0.16, based on stochastic simulations using a Ricker model (PLOTMSY program). $B_{trigger}$ was set to the $B_{pa}$ value of 3100 t.

### 6.8.5 Biological reference points

#### Precautionary approach reference points

Biological reference points are:

| | | |
|---|---|---|
| $\mathbf{B}_{lim}$ = 2200 t | Basis: $\mathbf{B}_{lim}$=$\mathbf{B}_{loss}$ | Changed in ACFM 2007 (from 2800 to 2200 t). The lowest observed spawning stock, fol lowed by an increase in SSB. |
| $\mathbf{B}_{pa}$ = 3100t | Basis: $\mathbf{B}_{pa}$ ~ $\mathbf{B}_{lim}$ * 1.4 | Changed in ACFM 2007 (from 3800 to 3100 t). |
| $\mathbf{F}_{lim}$=0.4 | Basis: $\mathbf{F}_{lim}$=$\mathbf{F}_{loss}$ | Although poorly defined, based that there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above-average recruitment. |
| $\mathbf{F}_{pa}$=0.3 | Basis: $\mathbf{F}_{pa}$ be set at 0.30. | This F is considered to have a high probabili ty of avoiding $\mathbf{F}_{lim}$. |
| $\mathbf{F}_{max}$=0.55 | | Using MFDP program and PLOTMSY pro gram. |
| $\mathbf{F}_{MSY}$=0.16 | | Using PLOTMSY program. |

#### Yield-per-recruit analysis

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2011, are given in Table 6.8.19 and Figure 6.8.8. Current fishing mortality (0.31) is well above $F_{MSY}$ (0.16). $F_{max}$ is calculated by this year's assessment to 0.55, but was considered to be not well defined given flat yield-per-recruit curve.

### 6.8.6 Management plans

No management plan is currently in place for Irish Sea sole.

### 6.8.7 Uncertainties and bias in assessment and forecast

#### Sampling

The major fleets fishing for Irish Sea sole are sampled. Sampling is considered to be at a reasonable level. Under the DCF there is an initiative to coordinate sampling across the three countries involved in the fishery. One of the problems in this assessment may well be the quality of historic catch-at-age data (before the introduction of the combined age distribution in 2000).

#### Landings

There is no reliable information on the accuracy of the landing statistics. Nevertheless, the total TAC uptake since 2006 was only in the range of 50–70%. In this context, misreporting is not considered to be a major problem in recent years.

#### Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from recent years indicates that discarding ranges by weight vary between 0 and 8%.

#### Effort

There are no indications of Irish Sea sole fisheries misreporting effort. Effort in beam trawl fisheries that target sole has declined substantially in the last few years.

#### Surveys

The UK(E&W)-BTS-Q3 survey appears to track year-class strength well. As previously investigated, this tuning fleet is also consistent in estimating year-class strength of the same year class at different ages. Therefore the Working Group had confidence in using the UK(E&W)-BTS-Q3 survey as the only tuning fleet. The bias problem in the assessment may be the result of the precise survey and less precise catch-at-age data.

#### Model formulation

At present XSA is used to assess Irish Sea sole. In the WG of 2007 the model settings were changed which had a considerable impact on the estimates of SSB and fishing mortality. Due to these major revisions, ACFM changed the biomass reference points at its meeting of 2007. In the next two update assessments (2008–2009) no major changes were apparent. In this year's assessment the settings were changed according to the outcome of the WKFLAT 2011.

### 6.8.8 Recommendations for next benchmark

There are no recommendations for the next benchmark at present (sole Irish Sea was benchmarked in February 2011).

### 6.8.9 Management considerations

There is no apparent stock–recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 6.8.10).

SSB in 2010 is estimated to be well below $B_{lim}$. Recruitment-at-age 2 has been well below average since 2001, and in 2010 is estimated to be the lowest in the time-series. XSA indicates that fishing mortality has fallen over the last couple of years (as did effort for most fleets fishing for Irish Sea sole), and is now just below $F_{pa}$.

It is not possible for the stock to reach $B_{pa}$ in one year. A management plan for effort reduction that can be phased in over a number of years and implemented in conjunction with technical conservation measures should be considered.

Given the successive recent low recruitment, predictions become more dependent on the assumed incoming recruitment and 45% of the predicted SSB in 2013 is based on that assumption. The GM (70–08) recruitment used for year classes 2010 and 2011 may be an optimistic assumption given the consecutive low recruitments in recent years.

Sole is caught in a mixed fishery with other flatfish as well as gadoids. Information from observer trips indicates that discarding of sole is relatively low.

**Table 6.8.1. Sole in VIIa. Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings. Last year's landings are preliminary.**

| Year | Belgium | France | Ireland | Netherlands | UK (E+W) | UK (Isle of Man) | UK (N. Ireland)[1] | UK (Scotland) | Officially reported | Unallocated | Total used by WG | TAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 793 | 12 | 27 | 281 | 258 | - | 46 | 11 | 1428 | 0 | 1428 | |
| 1974 | 664 | 54 | 28 | 320 | 218 | - | 23 | - | 1307 | 0 | 1307 | |
| 1975 | 805 | 59 | 24 | 234 | 281 | - | 24 | 15 | 1442 | -1 | 1441 | |
| 1976 | 674 | 72 | 74 | 381 | 195 | - | 49 | 18 | 1463 | 0 | 1463 | |
| 1977 | 566 | 39 | 84 | 227 | 160 | - | 49 | 21 | 1146 | 1 | 1147 | |
| 1978 | 453 | 65 | 127 | 177 | 189 | - | 57 | 30 | 1098 | 8 | 1106 | |
| 1979 | 779 | 48 | 134 | 247 | 290 | - | 47 | 42 | 1587 | 27 | 1614 | |
| 1980 | 1002 | 41 | 229 | 169 | 367 | - | 44 | 68 | 1920 | 21 | 1941 | |
| 1981 | 884 | 13 | 167 | 186 | 311 | - | 41 | 45 | 1647 | 20 | 1667 | |
| 1982 | 669 | 9 | 161 | 138 | 277 | - | 31 | 44 | 1329 | 9 | 1338 | |
| 1983 | 544 | 3 | 203 | 224 | 219 | - | 33 | 29 | 1255 | -86 | 1169 | |
| 1984 | 425 | 10 | 187 | 113 | 230 | - | 38 | 17 | 1020 | 38 | 1058 | |
| 1985 | 589 | 9 | 180 | 546 | 269 | - | 36 | 28 | 1657 | -511 | 1146 | |
| 1986 | 930 | 17 | 235 | - | 637 | 1 | 50 | 46 | 1916 | 79 | 1995 | |
| 1987 | 987 | 5 | 312 | - | 599 | 3 | 72 | 63 | 2041 | 767 | 2808 | 2100 |
| 1988 | 915 | 11 | 366 | - | 507 | 1 | 47 | 38 | 1885 | 114 | 1999 | 1750 |
| 1989 | 1010 | 5 | 155 | - | 613 | 2 | . | 38 | 1823 | 10 | 1833 | 1480 |
| 1990 | 786 | 2 | 170 | - | 569 | 10 | . | 39 | 1576 | 7 | 1583 | 1500 |
| 1991 | 371 | 3 | 198 | - | 581 | 44 | . | 26 | 1223 | -11 | 1212 | 1500 |
| 1992 | 531 | 11 | 164 | - | 477 | 14 | . | 37 | 1234 | 25 | 1259 | 1350 |
| 1993 | 495 | 8 | 98 | - | 338 | 4 | . | 28 | 971 | 52 | 1023 | 1000 |
| 1994 | 706 | 7 | 226 | - | 409 | 5 | . | 14 | 1367 | 7 | 1374 | 1500 |
| 1995 | 675 | 5 | 176 | - | 424 | 12 | . | 8 | 1300 | -34 | 1266 | 1300 |
| 1996 | 533 | 5 | 133 | 149 | 194 | 4 | . | 5 | 1023 | -21 | 1002 | 1000 |
| 1997 | 570 | 3 | 130 | 123 | 189 | 5 | . | 7 | 1027 | -24 | 1003 | 1000 |
| 1998 | 525 | 3 | 134 | 60 | 161 | 3 | . | 9 | 895 | 16 | 911 | 900 |
| 1999 | 469 | <1 | 120 | 46 | 165 | 1 | . | 8 | 810 | 53 | 863 | 900 |
| 2000 | 493 | 3 | 135 | 60 | 133 | 1 | . | 8 | 833 | -15 | 818 | 1080 |
| 2001 | 674 | 4 | 135 | - | 195 | + | . | 4 | 1012 | 41 | 1053 | 1100 |
| 2002 | 817 | 4 | 96 | - | 165 | + | . | 3 | 1085 | 5 | 1090 | 1100 |
| 2003 | 687 | 4 | 103 | - | 217 | + | . | 3 | 1014 | 0 | 1014 | 1010 |
| 2004 | 527 | 1 | 77 | - | 106 | + | . | 1 | 712 | -3 | 709 | 800 |
| 2005 | 662 | 3 | 85 | - | 103 | + | . | 1 | 854 | 1 | 855 | 960 |
| 2006 | 419 | 1 | 85 | - | 69 | + | . | 2 | 576 | -7 | 569 | 960 |
| 2007 | 305 | 1 | 115 | - | 66 | <1 | . | 4 | 491 | 1 | 492 | 820 |
| 2008 | 216 | 1 | 66 | - | 37 | n/a | . | n/a | 320 | 12 | 332 | 669 |
| 2009 | 257 | n/a | 47 | - | 19 | 1 | . | 1 | 325 | 0 | 325 | 502 |
| 2010 | 217 | <1 | 47 | - | 12 | <1 | . | n/a | 277 | -2 | 275 | 402 |

**[1] 1989 onwards: N. Ireland included with England & Wales.**

# Table 6.8.2 - Sole in VIIa. Catch numbers at age (in thousands)

| Age/Year | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|
| 2 | 29 | 113 | 31 | 368 | 25 |
| 3 | 895 | 434 | 673 | 363 | 891 |
| 4 | 1009 | 2097 | 730 | 2195 | 576 |
| 5 | 467 | 1130 | 1537 | 557 | 1713 |
| 6 | 1457 | 232 | 537 | 815 | 383 |
| 7 | 289 | 878 | 172 | 267 | 422 |
| +gp | 2537 | 1887 | 1500 | 1143 | 971 |
| TOTALNUM | 6683 | 6771 | 5180 | 5708 | 4981 |
| TONSLAND | 1785 | 1882 | 1450 | 1428 | 1307 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 |

| Age/Year | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 262 | 29 | 221 | 65 | 108 | 187 | 70 | 8 | 37 |
| 3 | 733 | 375 | 416 | 958 | 1027 | 939 | 580 | 346 | 165 |
| 4 | 2386 | 1332 | 1292 | 649 | 3433 | 1968 | 1668 | 1241 | 998 |
| 5 | 539 | 2330 | 774 | 1009 | 829 | 3055 | 1480 | 1298 | 758 |
| 6 | 842 | 247 | 1066 | 442 | 637 | 521 | 1640 | 711 | 757 |
| 7 | 157 | 544 | 150 | 638 | 326 | 512 | 114 | 641 | 416 |
| +gp | 1006 | 739 | 648 | 587 | 620 | 1145 | 865 | 397 | 709 |
| TOTALNUM | 5925 | 5596 | 4567 | 4348 | 6980 | 8327 | 6417 | 4642 | 3840 |
| TONSLAND | 1441 | 1463 | 1147 | 1106 | 1614 | 1941 | 1667 | 1338 | 1169 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| Age/Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 651 | 154 | 141 | 189 | 32 | 179 | 564 | 1317 | 363 |
| 3 | 786 | 1601 | 3336 | 3348 | 444 | 771 | 1185 | 1270 | 2433 |
| 4 | 380 | 1086 | 3467 | 4105 | 4752 | 775 | 986 | 841 | 918 |
| 5 | 610 | 343 | 961 | 3185 | 2102 | 3978 | 598 | 300 | 556 |
| 6 | 343 | 334 | 235 | 844 | 1310 | 1178 | 2319 | 226 | 190 |
| 7 | 424 | 164 | 277 | 307 | 203 | 552 | 592 | 1173 | 156 |
| +gp | 557 | 739 | 848 | 808 | 516 | 255 | 466 | 459 | 929 |
| TOTALNUM | 3751 | 4421 | 9265 | 12786 | 9359 | 7688 | 6710 | 5586 | 5545 |
| TONSLAND | 1058 | 1146 | 1995 | 2808 | 1999 | 1833 | 1583 | 1212 | 1259 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| Age/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 83 | 122 | 132 | 60 | 789 | 167 | 301 | 178 | 240 |
| 3 | 543 | 1342 | 920 | 469 | 713 | 1728 | 1069 | 908 | 1438 |
| 4 | 1966 | 1069 | 1444 | 1188 | 474 | 466 | 1258 | 909 | 822 |
| 5 | 559 | 1578 | 737 | 741 | 710 | 256 | 297 | 601 | 717 |
| 6 | 251 | 394 | 1010 | 430 | 408 | 315 | 115 | 150 | 511 |
| 7 | 199 | 133 | 179 | 509 | 258 | 191 | 136 | 55 | 80 |
| +gp | 686 | 524 | 350 | 347 | 531 | 423 | 232 | 258 | 272 |
| TOTALNUM | 4287 | 5162 | 4772 | 3744 | 3883 | 3546 | 3408 | 3059 | 4080 |
| TONSLAND | 1023 | 1374 | 1266 | 1002 | 1003 | 911 | 863 | 818 | 1053 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| Age/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 148 | 436 | 295 | 536 | 111 | 171 | 99 | 92 | 21 |
| 3 | 927 | 824 | 850 | 1052 | 666 | 356 | 354 | 414 | 333 |
| 4 | 1618 | 965 | 337 | 626 | 645 | 348 | 191 | 333 | 231 |
| 5 | 738 | 794 | 363 | 271 | 202 | 243 | 196 | 146 | 176 |
| 6 | 573 | 302 | 300 | 314 | 112 | 86 | 157 | 132 | 65 |
| 7 | 253 | 217 | 137 | 279 | 150 | 41 | 56 | 127 | 71 |
| +gp | 216 | 344 | 178 | 368 | 377 | 298 | 210 | 162 | 157 |
| TOTALNUM | 4473 | 3882 | 2460 | 3446 | 2263 | 1543 | 1263 | 1406 | 1054 |
| TONSLAND | 1090 | 1014 | 709 | 855 | 569 | 492 | 332 | 325 | 275 |
| SOPCOF % | 100 | 100 | 101 | 100 | 101 | 100 | 100 | 100 | 100 |

**Table 6.8.3. Sole in VIIa. Annual lenght distributions by country (2010).**

| Length (cm) | UK (England & Wales) All gears | Belgium All gears | Ireland All gears |
|---|---|---|---|
| 20 | | | 55 |
| 21 | | 22 | 277 |
| 22 | | 6038 | 666 |
| 23 | 59 | 40876 | 888 |
| 24 | 763 | 86324 | 2996 |
| 25 | 587 | 134522 | 3495 |
| 26 | 1702 | 107873 | 6602 |
| 27 | 1291 | 102855 | 11319 |
| 28 | 1174 | 92239 | 13371 |
| 29 | 1115 | 60263 | 14481 |
| 30 | 1350 | 56234 | 12539 |
| 31 | 587 | 41552 | 11374 |
| 32 | 1291 | 38274 | 9432 |
| 33 | 763 | 28285 | 7823 |
| 34 | 1232 | 21166 | 6103 |
| 35 | 469 | 18716 | 6325 |
| 36 | 646 | 12788 | 4883 |
| 37 | 587 | 10593 | 5770 |
| 38 | 352 | 8420 | 4272 |
| 39 | 587 | 4621 | 2497 |
| 40 | 587 | 4577 | 1942 |
| 41 | 352 | 2338 | 1997 |
| 42 | 117 | 1972 | 1609 |
| 43 | 587 | 919 | 721 |
| 44 | 293 | 698 | 555 |
| 45 | 176 | 612 | 499 |
| 46 | 117 | 94 | 111 |
| 47 | | 169 | 333 |
| 48 | | 29 | 111 |
| 49 | | 51 | 0 |
| 50 | | 51 | 55 |
| 51 | | | 55 |
| 52 | | | |
| 53 | | | |
| 54 | | | |
| 55 | | | |
| 56 | | | |
| 57 | | | |
| 58 | | | |
| 59 | | | |
| 60 | | | |
| Total | 16784 | 883171 | 133156 |

## Table 6.8.4 - Sole in VIIa. Catch weights at age (kg)

| Age/Year | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|
| 2 | 0.13 | 0.152 | 0.126 | 0.151 | 0.138 |
| 3 | 0.153 | 0.178 | 0.164 | 0.178 | 0.174 |
| 4 | 0.178 | 0.204 | 0.201 | 0.204 | 0.209 |
| 5 | 0.204 | 0.23 | 0.237 | 0.23 | 0.241 |
| 6 | 0.232 | 0.257 | 0.272 | 0.256 | 0.272 |
| 7 | 0.26 | 0.284 | 0.306 | 0.283 | 0.301 |
| +gp | 0.3769 | 0.4194 | 0.4169 | 0.3918 | 0.3956 |
| SOPCOF % | 1 | 0.9997 | 1.0004 | 0.9999 | 1 |

| Age/Year | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.13 | 0.12 | 0.085 | 0.093 | 0.134 | 0.146 | 0.162 | 0.112 | 0.189 |
| 3 | 0.172 | 0.161 | 0.146 | 0.147 | 0.165 | 0.169 | 0.183 | 0.171 | 0.212 |
| 4 | 0.21 | 0.2 | 0.202 | 0.197 | 0.199 | 0.193 | 0.207 | 0.225 | 0.238 |
| 5 | 0.244 | 0.239 | 0.251 | 0.243 | 0.234 | 0.219 | 0.234 | 0.275 | 0.266 |
| 6 | 0.275 | 0.276 | 0.293 | 0.286 | 0.271 | 0.247 | 0.264 | 0.321 | 0.298 |
| 7 | 0.303 | 0.313 | 0.33 | 0.326 | 0.311 | 0.275 | 0.296 | 0.362 | 0.332 |
| +gp | 0.3671 | 0.4574 | 0.387 | 0.4294 | 0.4507 | 0.3801 | 0.452 | 0.4564 | 0.4577 |
| SOPCOF % | 0.9999 | 0.9996 | 0.9996 | 0.9997 | 0.9997 | 1.0007 | 1.0002 | 1.0002 | 0.9997 |

| Age/Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.191 | 0.144 | 0.122 | 0.135 | 0.111 | 0.125 | 0.135 | 0.133 | 0.149 |
| 3 | 0.225 | 0.189 | 0.164 | 0.164 | 0.147 | 0.163 | 0.162 | 0.172 | 0.177 |
| 4 | 0.257 | 0.231 | 0.203 | 0.196 | 0.183 | 0.201 | 0.192 | 0.208 | 0.207 |
| 5 | 0.288 | 0.272 | 0.241 | 0.231 | 0.218 | 0.237 | 0.227 | 0.241 | 0.239 |
| 6 | 0.318 | 0.31 | 0.277 | 0.268 | 0.252 | 0.271 | 0.265 | 0.272 | 0.274 |
| 7 | 0.347 | 0.346 | 0.311 | 0.308 | 0.286 | 0.304 | 0.307 | 0.3 | 0.31 |
| +gp | 0.4085 | 0.4296 | 0.4071 | 0.4615 | 0.4188 | 0.3887 | 0.414 | 0.3452 | 0.3788 |
| SOPCOF % | 0.9998 | 0.9994 | 0.9994 | 0.9998 | 0.999 | 1.0001 | 1.0004 | 0.9995 | 0.9992 |

| Age/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.102 | 0.175 | 0.129 | 0.156 | 0.154 | 0.187 | 0.179 | 0.14 | 0.175 |
| 3 | 0.156 | 0.198 | 0.182 | 0.193 | 0.197 | 0.209 | 0.217 | 0.189 | 0.18 |
| 4 | 0.205 | 0.227 | 0.232 | 0.228 | 0.237 | 0.234 | 0.252 | 0.25 | 0.271 |
| 5 | 0.248 | 0.261 | 0.277 | 0.263 | 0.275 | 0.263 | 0.285 | 0.311 | 0.293 |
| 6 | 0.285 | 0.301 | 0.318 | 0.296 | 0.311 | 0.295 | 0.314 | 0.368 | 0.326 |
| 7 | 0.318 | 0.346 | 0.356 | 0.327 | 0.345 | 0.331 | 0.341 | 0.428 | 0.42 |
| +gp | 0.3701 | 0.5093 | 0.4507 | 0.4104 | 0.4068 | 0.4399 | 0.3992 | 0.5042 | 0.438 |
| SOPCOF % | 0.9994 | 1.0007 | 0.9998 | 1.0003 | 1.0015 | 1 | 1.0005 | 0.9981 | 1 |

| Age/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.162 | 0.16 | 0.17 | 0.16 | 0.179 | 0.172 | 0.148 | 0.141 | 0.166 |
| 3 | 0.172 | 0.187 | 0.219 | 0.203 | 0.194 | 0.224 | 0.189 | 0.195 | 0.193 |
| 4 | 0.211 | 0.247 | 0.289 | 0.256 | 0.224 | 0.296 | 0.248 | 0.229 | 0.266 |
| 5 | 0.283 | 0.294 | 0.338 | 0.286 | 0.297 | 0.36 | 0.279 | 0.279 | 0.285 |
| 6 | 0.328 | 0.342 | 0.371 | 0.312 | 0.293 | 0.38 | 0.291 | 0.277 | 0.321 |
| 7 | 0.333 | 0.326 | 0.383 | 0.326 | 0.318 | 0.429 | 0.386 | 0.261 | 0.308 |
| +gp | 0.3746 | 0.415 | 0.4436 | 0.3515 | 0.3494 | 0.4785 | 0.3919 | 0.2767 | 0.3354 |
| SOPCOF % | 1.003 | 1.0015 | 1.0141 | 0.9996 | 1.0057 | 0.9989 | 0.9963 | 0.9993 | 1.0009 |

## Table 6.8.5 - Sole in VIIa. Stock weights at age (kg)

| Age/Year | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|
| 2 | 0.13 | 0.152 | 0.126 | 0.151 | 0.138 |
| 3 | 0.153 | 0.178 | 0.164 | 0.178 | 0.174 |
| 4 | 0.178 | 0.204 | 0.201 | 0.204 | 0.209 |
| 5 | 0.204 | 0.23 | 0.237 | 0.23 | 0.241 |
| 6 | 0.232 | 0.257 | 0.272 | 0.256 | 0.272 |
| 7 | 0.26 | 0.284 | 0.306 | 0.283 | 0.301 |
| +gp | 0.377 | 0.419 | 0.417 | 0.392 | 0.396 |

| Age/Year | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.13 | 0.12 | 0.085 | 0.093 | 0.134 | 0.146 | 0.162 | 0.112 | 0.189 |
| 3 | 0.172 | 0.161 | 0.146 | 0.147 | 0.165 | 0.169 | 0.183 | 0.171 | 0.212 |
| 4 | 0.21 | 0.2 | 0.202 | 0.197 | 0.199 | 0.193 | 0.207 | 0.225 | 0.238 |
| 5 | 0.244 | 0.239 | 0.251 | 0.243 | 0.234 | 0.219 | 0.234 | 0.275 | 0.266 |
| 6 | 0.275 | 0.276 | 0.293 | 0.286 | 0.271 | 0.247 | 0.264 | 0.321 | 0.298 |
| 7 | 0.303 | 0.313 | 0.33 | 0.326 | 0.311 | 0.275 | 0.296 | 0.362 | 0.332 |
| +gp | 0.367 | 0.457 | 0.387 | 0.429 | 0.451 | 0.380 | 0.452 | 0.456 | 0.458 |

| Age/Year | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.191 | 0.144 | 0.122 | 0.135 | 0.111 | 0.125 | 0.135 | 0.133 | 0.149 |
| 3 | 0.225 | 0.189 | 0.164 | 0.164 | 0.147 | 0.163 | 0.162 | 0.172 | 0.177 |
| 4 | 0.257 | 0.231 | 0.203 | 0.196 | 0.183 | 0.201 | 0.192 | 0.208 | 0.207 |
| 5 | 0.288 | 0.272 | 0.241 | 0.231 | 0.218 | 0.237 | 0.227 | 0.241 | 0.239 |
| 6 | 0.318 | 0.31 | 0.277 | 0.268 | 0.252 | 0.271 | 0.265 | 0.272 | 0.274 |
| 7 | 0.347 | 0.346 | 0.311 | 0.308 | 0.286 | 0.304 | 0.307 | 0.3 | 0.31 |
| +gp | 0.409 | 0.430 | 0.407 | 0.462 | 0.419 | 0.389 | 0.414 | 0.345 | 0.379 |

| Age/Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.102 | 0.175 | 0.129 | 0.156 | 0.154 | 0.187 | 0.179 | 0.124 | 0.151 |
| 3 | 0.156 | 0.198 | 0.182 | 0.193 | 0.197 | 0.209 | 0.217 | 0.158 | 0.159 |
| 4 | 0.205 | 0.227 | 0.232 | 0.228 | 0.237 | 0.234 | 0.252 | 0.23 | 0.226 |
| 5 | 0.248 | 0.261 | 0.277 | 0.263 | 0.275 | 0.263 | 0.285 | 0.303 | 0.271 |
| 6 | 0.285 | 0.301 | 0.318 | 0.296 | 0.311 | 0.295 | 0.314 | 0.345 | 0.318 |
| 7 | 0.318 | 0.346 | 0.356 | 0.327 | 0.345 | 0.331 | 0.341 | 0.41 | 0.393 |
| +gp | 0.370 | 0.509 | 0.451 | 0.410 | 0.407 | 0.440 | 0.399 | 0.530 | 0.450 |

| Age/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.145 | 0.144 | 0.15 | 0.144 | 0.152 | 0.156 | 0.134 | 0.129 | 0.158 |
| 3 | 0.174 | 0.174 | 0.187 | 0.186 | 0.177 | 0.2 | 0.181 | 0.17 | 0.165 |
| 4 | 0.195 | 0.207 | 0.232 | 0.237 | 0.213 | 0.24 | 0.236 | 0.208 | 0.228 |
| 5 | 0.277 | 0.249 | 0.289 | 0.288 | 0.276 | 0.284 | 0.288 | 0.263 | 0.256 |
| 6 | 0.31 | 0.311 | 0.331 | 0.325 | 0.289 | 0.336 | 0.324 | 0.278 | 0.3 |
| 7 | 0.33 | 0.327 | 0.362 | 0.348 | 0.315 | 0.354 | 0.383 | 0.276 | 0.292 |
| +gp | 0.397 | 0.383 | 0.419 | 0.383 | 0.348 | 0.419 | 0.424 | 0.319 | 0.305 |

**Table 6.8.6. Sole in VIIa. Discard rates for the main fleets operational in the Irish Sea (Belgian, UK and Irish beam trawl, UK otter trawl, UK and Irish *Nephrops* trawl).**

| Country | Gear | Landings (t) | Ratio discarded /catch | years | Landings (t) 2010 | Ratio discarded /catch 2010 |
|---|---|---|---|---|---|---|
| BEL | TBB | 716 | 0.05 | 2007–2009 | 209 | 0.04 |
| UK | TBB | 284 | 0.08 | 2002,2005–2007 | 1.703 | n/a |
| | OTB | 61 | 0.05 | 2002–2009 | 1.025 | 0.00 |
| | TWIN OTB | 4 | 0.01 | 2003,2004,2007 | 0.014 | n/a |
| | NEPH OTB | 25 | 0.08 | 2003,2006–2009 | 3.327 | 0.05 |
| | TWIN NEPH | 6 | 0.02 | 2002,2003,2008 | 0.501 | n/a |
| IRL | TBB | 427 | 0.02 | 2003–2009 | 38.3 | 0.05 |
| | NEPH OTB | 16 | 0.56* | 2003–2009 | 9.0 | 0.29* |

*** It should be noted that the 56% discard rate for the year range 2003–2009 and 29% discard rate for 2010 of the Irish *Nephrops* fleet only accounts for respectively 0.4% and 3.3% of the total international landings. n/a=not available.**

**Table 6.8.7 - Sole in VIIa**. Effort and CPUE series.

| | CPUE | | | | | | | Effort | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Belgium[1] | UK(E&W)[3] | | UK[5] | | Ireland | | Belgium[2] | UK(E&W)[4] | | Ireland[6] | |
| | beam | beam | otter | beam survey | | otter | beam | beam | beam | otter | otter | beam |
| Year | Whole year | Whole year | Whole year | Sept | March | Whole year | Whole year | Whole year | Whole year | Whole year | Whole Year | Whole Year |
| 1972 | - | - | 1.06 | - | - | - | - | - | - | 128.4 | - | - |
| 1973 | - | - | 1.06 | - | - | - | - | - | - | 147.6 | - | - |
| 1974 | - | - | 1.09 | - | - | - | - | - | - | 115.2 | - | - |
| 1975 | 21.4 | - | 1.39 | - | - | - | - | 28.4 | - | 130.7 | - | - |
| 1976 | 23.1 | - | 0.94 | - | - | - | - | 24.9 | - | 122.3 | - | - |
| 1977 | 19.8 | - | 0.80 | - | - | - | - | 22.1 | - | 101.9 | - | - |
| 1978 | 18.1 | 34.32 | 1.04 | - | - | - | - | 17.5 | 0.9 | 89.1 | - | - |
| 1979 | 33.4 | 32.01 | 1.43 | - | - | - | - | 20.4 | 1.7 | 89.9 | - | - |
| 1980 | 28.2 | 31.70 | 1.01 | - | - | - | - | 32.0 | 4.3 | 107.0 | - | - |
| 1981 | 22.2 | 21.32 | 0.75 | - | - | - | - | 36.5 | 6.4 | 107.1 | - | - |
| 1982 | 22.0 | 29.94 | 0.53 | - | - | - | - | 26.5 | 5.5 | 127.2 | - | - |
| 1983 | 13.9 | 37.31 | 0.57 | - | - | - | - | 28.7 | 2.8 | 88.1 | - | - |
| 1984 | 22.5 | 16.24 | 0.71 | - | - | - | - | 17.5 | 4.1 | 103.1 | - | - |
| 1985 | 20.6 | 17.34 | 0.56 | - | - | - | - | 27.0 | 7.4 | 102.9 | - | - |
| 1986 | 19.1 | 19.23 | 0.84 | - | - | - | - | 44.5 | 17.0 | 90.3 | - | - |
| 1987 | 17.7 | 14.82 | 0.77 | - | - | - | - | 51.6 | 22.0 | 130.6 | - | - |
| 1988 | 21.3 | 11.81 | 0.46 | 158.7 | - | - | - | 38.2 | 18.6 | 132.0 | - | - |
| 1989 | 21.9 | 9.17 | 0.70 | 145.9 | - | - | - | 42.2 | 25.3 | 139.5 | - | - |
| 1990 | 17.5 | 9.52 | 0.61 | 190.1 | - | - | - | 42.4 | 31.0 | 117.1 | - | - |
| 1991 | 18.7 | 10.43 | 1.12 | 170.5 | - | - | - | 17.1 | 25.8 | 107.3 | - | - |
| 1992 | 19.2 | 9.50 | 1.02 | 158.3 | - | - | - | 25.1 | 23.4 | 96.8 | - | - |
| 1993 | 20.0 | 7.60 | 0.54 | 97.3 | 104.7 | - | - | 23.9 | 21.5 | 78.9 | - | - |
| 1994 | 19.1 | 11.76 | 0.74 | 107.7 | 91.9 | | - | 32.5 | 20.1 | 43.0 | - | - |
| 1995 | 18.1 | 14.96 | 0.95 | 89.5 | 79.3 | 0.38 | 12.69 | 28.6 | 20.9 | 43.1 | 80.3 | 8.64 |
| 1996 | 17.7 | 9.44 | 0.53 | 86.8 | - | 0.25 | 14.94 | 23.2 | 13.3 | 42.2 | 64.8 | 6.26 |
| 1997 | 16.6 | 10.49 | 0.73 | 151.2 | 63.3 | 0.23 | 8.53 | 30.7 | 10.8 | 39.9 | 92.2 | 9.86 |
| 1998 | 19.0 | 8.42 | 0.48 | 140.8 | 89.3 | 0.38 | 7.77 | 24.7 | 10.4 | 36.9 | 93.5 | 11.58 |
| 1999 | 19.5 | 9.94 | 0.60 | 107.3 | - | 0.29 | 9.22 | 22.7 | 11.0 | 22.9 | 110.3 | 14.67 |
| 2000 | 15.5 | 12.90 | 0.44 | 122.6 | - | 0.29 | 8.49 | 26.0 | 6.3 | 27.0 | 82.7 | 11.42 |
| 2001 | 15.0 | 11.72 | 0.15 | 96.9 | - | 0.38 | 7.86 | 36.8 | 12.5 | 32.8 | 77.5 | 13.13 |
| 2002 | 15.0 | 16.73 | 1.48 | 76.0 | - | 0.32 | 4.67 | 47.0 | 8.0 | 24.8 | 77.9 | 17.67 |
| 2003 | 14.8 | 13.20 | 0.15 | 88.6 | - | 0.34 | 4.20 | 43.6 | 14.0 | 23.9 | 73.9 | 18.70 |
| 2004 | 15.4 | 13.86 | 0.17 | 98.9 | - | 0.14 | 4.31 | 32.0 | 7.4 | 23.5 | 72.5 | 14.19 |
| 2005 | 16.7 | 9.14 | 0.19 | 48.9 | - | 0.16 | 4.70 | 37.5 | 11.4 | 16.7 | 68.3 | 14.67 |
| 2006 | 15.2 | 7.83 | 0.52 | 52.6 | - | 0.16 | 6.00 | 24.6 | 4.6 | 5.2 | 66.2 | 12.22 |
| 2007 | 13.7 | 16.38 | 0.42 | 53.0 | - | 0.37 | 6.37 | 19.4 | 3.2 | 4.4 | 74.1 | 14.18 |
| 2008 | 19.5 | 15.25 | 0.30 | 50.7 | - | 0.20 | 6.08 | 9.6 | 1.3 | 2.7 | 58.8 | 9.54 |
| 2009 | 20.2 | 18.88 | 0.22 | 45.8 | - | 0.28 | 4.53 | 11.1 | 0.5 | 1.5 | 42.8 | 7.59 |
| 2010* | 18.0 | 13.90 | 0.44 | 27.8 | - | 0.20 | 4.09 | 11.1 | 0.2 | 1.0 | 45.5 | 9.42 |

All CPUE values in Kg/hr except UK beam survey (Kg/100 km)

[1]Kg/000'hr

[2]000' hours fishing

[3]Kg/000'hr fished (GRT corrected > 40' vessels)

[4]000'hours fished (GRT corrected > 40' vessels)

[5]Kg/100km fished

[6] 000'hours

* Provisional

## Table 6.8.8 - Sole in VIIa. Tuning series (values in bold are used in the assessment)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BE-CBT** | | Belgium Commercial Beam trawl (Effort = Corrected formula) | | | | | | | | | | |
| | 1975 | 2005 | | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | | |
| | 4 | 14 | | | | | | | | | | |
| 12.3 | | 1045 | 275 | 393 | 69 | 105 | 94 | 61 | 72 | 11 | 15 | 64 |
| 11.8 | | 568 | 1066 | 80 | 263 | 64 | 58 | 35 | 5 | 56 | 5 | 5 |
| 10.7 | | 434 | 307 | 509 | 76 | 93 | 45 | 23 | 20 | 2 | 35 | 32 |
| 9.9 | | 169 | 304 | 155 | 258 | 41 | 90 | 12 | 29 | 12 | 7 | 17 |
| 11.2 | | 1455 | 510 | 323 | 193 | 162 | 37 | 36 | 9 | 41 | 0 | 0 |
| 16.7 | | 958 | 1644 | 296 | 268 | 247 | 210 | 30 | 64 | 31 | 14 | 7 |
| 22.6 | | 909 | 721 | 998 | 62 | 92 | 44 | 161 | 13 | 92 | 10 | 8 |
| 19.5 | | 451 | 608 | 378 | 394 | 52 | 64 | 11 | 29 | 24 | 5 | 0 |
| 20.5 | | 259 | 310 | 394 | 238 | 216 | 44 | 38 | 28 | 49 | 3 | 26 |
| 12 | | 107 | 204 | 143 | 188 | 91 | 121 | 2 | 1 | 4 | 14 | 0 |
| 19.6 | | 606 | 171 | 186 | 99 | 150 | 125 | 83 | 27 | 13 | 4 | 23 |
| 38 | | 1531 | 468 | 138 | 135 | 90 | 104 | 69 | 69 | 20 | 8 | 21 |
| 43.2 | | 1527 | 881 | 297 | 167 | 69 | 39 | 54 | 59 | 40 | 13 | 9 |
| 30.5 | | 2027 | 1012 | 480 | 21 | 33 | 37 | 34 | 42 | 35 | 0 | 7 |
| 34 | | 376 | 2423 | 751 | 250 | 59 | 15 | 9 | 2 | 14 | 0 | 1 |
| 36.1 | | 307 | 223 | 1263 | 276 | 142 | 13 | 9 | 11 | 11 | 8 | 5 |
| 13.8 | | 253 | 78 | 60 | 588 | 115 | 40 | 16 | 1 | 1 | 11 | 3 |
| 23.9 | | 298 | 330 | 68 | 40 | 203 | 93 | 36 | 12 | 0 | 0 | 0 |
| 24.5 | | 862 | 253 | 149 | 89 | 79 | 160 | 66 | 77 | 0 | 0 | 0 |
| 31 | | 680 | 786 | 164 | 103 | 39 | 117 | 58 | 19 | 15 | 0 | 7 |
| 26.2 | | 729 | 366 | 410 | 52 | 27 | 6 | 28 | 15 | 6 | 11 | 3 |
| 21.6 | | 537 | 334 | 241 | 219 | 53 | 13 | 11 | 14 | 9 | 7 | 2 |
| 28.5 | | 270 | 376 | 180 | 162 | 134 | 28 | 27 | 15 | 9 | 8 | 1 |
| 23.3 | | 248 | 146 | 142 | 89 | 73 | 62 | 20 | 20 | 9 | 10 | 3 |
| 21.7 | | 693 | 199 | 65 | 50 | 37 | 21 | 17 | 9 | 6 | 4 | 6 |
| 18.6 | | 685 | 220 | 107 | 31 | 15 | 33 | 13 | 7 | 9 | 0.6 | 8 |
| 30.5 | | 600 | 284 | 248 | 39 | 35 | 44 | 33 | 1 | 3 | 0.2 | 4 |
| 38.6 | | 1138 | 814 | 349 | 109 | 30 | 9 | 2 | 1 | 1 | 1 | 0 |
| 24.45 | | 724 | 436 | 196 | 84 | 20 | 7 | 2 | 1 | 0 | 2 | 1 |
| 25.58 | | 313 | 197 | 159 | 47 | 12 | 11 | 6 | 3 | 0 | 0 | 0 |
| 32.15 | | 505 | 342 | 156 | 71 | 87 | 9 | 7 | 1 | 13 | 2 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **UK(E&W)-BTS-Q3** | | | September beam trawl survey | | | | | | | |
| | 1988 | 2010 | | | | | | | | |
| | 1 | 1 | 0.75 | 0.85 | | | | | | |
| | 1 | 9 | | | | | | | | |
| 100.062 | | 118 | **196** | **180** | **410** | **76** | **40** | **4** | 0 | 4 |
| 129.71 | | 218 | **304** | **180** | **74** | **284** | **56** | **32** | 8 | 6 |
| 128.969 | | 1712 | **534** | **122** | **42** | **88** | **194** | **40** | 20 | 6 |
| 123.78 | | 148 | **1286** | **122** | **26** | **16** | **14** | **55** | 19 | 7 |
| 129.525 | | 220 | **309** | **657** | **142** | **34** | **22** | **7** | 75 | 17 |
| 131.192 | | 83 | **330** | **143** | **211** | **40** | **17** | **7** | 16 | 36 |
| 124.892 | | 60 | **408** | **203** | **73** | **132** | **49** | **11** | 13 | 6 |
| 126.004 | | 246 | **154** | **253** | **110** | **30** | **67** | **12** | 5 | 5 |
| 126.004 | | 886 | **126** | **32** | **76** | **46** | **23** | **31** | 8 | 2 |
| 126.004 | | 1158 | **577** | **72** | **24** | **55** | **27** | **16** | 30 | 7 |
| 126.004 | | 539 | **716** | **292** | **18** | **6** | **24** | **23** | 5 | 18 |
| 126.004 | | 385 | **293** | **255** | **203** | **29** | **8** | **26** | 5 | 6 |
| 126.004 | | 354 | **464** | **147** | **219** | **91** | **13** | **2** | 13 | 6 |
| 126.004 | | 91 | **284** | **192** | **65** | **96** | **64** | **6** | 3 | 12 |
| 126.004 | | 205 | **61** | **121** | **126** | **42** | **79** | **49** | 2 | 1 |
| 126.004 | | 242 | **210** | **51** | **97** | **81** | **40** | **43** | 26 | 1 |
| 126.004 | | 406 | **240** | **119** | **27** | **77** | **45** | **41** | 17 | 19 |
| 122.298 | | 53 | **165** | **69** | **25** | **13** | **35** | **25** | 4 | 6 |
| 126.004 | | 107 | **110** | **90** | **45** | **36** | **9** | **16** | 15 | 10 |
| 126.004 | | 125 | **93** | **49** | **57** | **41** | **11** | **4** | 6 | 12 |
| 122.298 | | 126 | **125** | **60** | **21** | **43** | **23** | **6** | 2 | 9 |
| 126.004 | | 57 | **150** | **68** | **39** | **23** | **30** | **12** | 7 | 1 |
| 126.004 | | 25 | **59** | **73** | **37** | **16** | **5** | **10** | 9 | 3 |

## Table 6.8.8 - Sole in VIIa. Continued (values in bold are used in the assessment)

**UK(E&W)-BTS-Q1** March beam trawl survey

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1999 | | | | | | | | |
| | 1 | 1 | 0.15 | 0.25 | | | | | | |
| | 1 | 9 | | | | | | | | |
| 126.931 | | 18 | 337 | 147 | 332 | 73 | 15 | 17 | 10 | 41 |
| 115.442 | | 8 | 354 | 208 | 69 | 151 | 51 | 14 | 11 | 9 |
| 126.189 | | 24 | 96 | 186 | 140 | 30 | 104 | 27 | 10 | 8 |
| 134.343 | | 651 | 114 | 49 | 110 | 78 | 32 | 54 | 10 | 12 |
| 121.742 | | 130 | 417 | 33 | 17 | 69 | 23 | 11 | 46 | 17 |
| 130.081 | | 47 | 421 | 330 | 39 | 19 | 48 | 27 | 12 | 37 |
| 130.822 | | 45 | 227 | 284 | 177 | 14 | 4 | 34 | 12 | 7 |

**UK(E&W)-CBT** UK Commercial Beam trawl

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 2008 | | | | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | | | | |
| | 2 | 14 | | | | | | | | | | | | |
| 25.838 | | 267 | 426 | 212 | 84 | 58 | 218 | 53 | 34 | 4 | 1 | 2 | 1 | 0 |
| 23.399 | | 36 | 460 | 176 | 68 | 37 | 32 | 121 | 34 | 38 | 3 | 1 | 0 | 0 |
| 21.503 | | 11 | 74 | 355 | 98 | 36 | 48 | 25 | 34 | 13 | 22 | 5 | 2 | 4 |
| 20.145 | | 24 | 228 | 150 | 234 | 87 | 17 | 25 | 19 | 42 | 10 | 17 | 1 | 0 |
| 20.392 | | 47 | 239 | 231 | 130 | 199 | 55 | 11 | 22 | 5 | 34 | 10 | 11 | 3 |
| 13.32 | | 0 | 13 | 109 | 98 | 49 | 100 | 37 | 9 | 8 | 6 | 14 | 8 | 3 |
| 10.76 | | 0 | 111 | 50 | 81 | 58 | 24 | 46 | 34 | 12 | 12 | 0 | 8 | 1 |
| 10.386 | | 43 | 219 | 40 | 28 | 49 | 31 | 12 | 22 | 11 | 9 | 2 | 1 | 0 |
| 11.016 | | 53 | 115 | 134 | 12 | 15 | 25 | 10 | 9 | 14 | 9 | 0 | 1 | 2 |
| 6.275 | | 16 | 90 | 84 | 82 | 9 | 6 | 10 | 5 | 5 | 7 | 2 | 1 | 1 |
| 12.495 | | 33 | 184 | 100 | 145 | 107 | 12 | 4 | 17 | 12 | 10 | 6 | 4 | 2 |
| 8.017 | | 4 | 63 | 152 | 50 | 79 | 47 | 5 | 4 | 6 | 3 | 1 | 1 | 1 |
| 13.996 | | 28 | 63 | 178 | 149 | 78 | 52 | 72 | 7 | 5 | 8 | 3 | 7 | 14 |
| 7.396 | | 54 | 61 | 29 | 43 | 25 | 12 | 10 | 5 | 1 | 1 | 4 | 0 | 1 |
| 11.406 | | 10 | 81 | 44 | 16 | 45 | 37 | 17 | 10 | 17 | 3 | 0 | 3 | 3 |
| 4.649 | | 7 | 28 | 33 | 11 | 5 | 10 | 12 | 7 | 9 | 5 | 2 | 0 | 1 |
| 3.197 | | 22 | 20 | 34 | 17 | 6 | 1 | 7 | 7 | 6 | 3 | 2 | 1 | 1 |
| 1.302 | | 1 | 11 | 5 | 7 | 12 | 1 | 2 | 4 | 3 | 4 | 0 | 3 | 1 |

**UK(E&W)-C0T** UK Commercial Otter trawl

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 2010 | | | | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | | | | |
| | 2 | 14 | | | | | | | | | | | | |
| 107.3 | | 265 | 155 | 63 | 29 | 19 | 71 | 20 | 11 | 2 | 0 | 1 | 1 | 1 |
| 96.8 | | 16 | 224 | 69 | 22 | 16 | 10 | 36 | 10 | 10 | 1 | 0 | 0 | 0 |
| 78.9 | | 9 | 27 | 77 | 19 | 3 | 7 | 4 | 5 | 1 | 2 | 0 | 0 | 0 |
| 43 | | 4 | 66 | 34 | 50 | 20 | 3 | 4 | 4 | 7 | 1 | 2 | 0 | 0 |
| 43.1 | | 17 | 50 | 34 | 15 | 24 | 7 | 1 | 2 | 0 | 2 | 1 | 1 | 0 |
| 42.2 | | 2 | 5 | 18 | 12 | 7 | 12 | 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| 39.9 | | 14 | 15 | 7 | 14 | 9 | 3 | 7 | 3 | 1 | 1 | 0 | 1 | 0 |
| 36.9 | | 5 | 24 | 5 | 3 | 5 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 |
| 22.8 | | 5 | 15 | 12 | 2 | 0 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 27 | | 2 | 12 | 9 | 8 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 32.9 | | 3 | 10 | 6 | 8 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24.8 | | 0 | 8 | 16 | 3 | 5 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 23.9 | | 1 | 2 | 6 | 4 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23.5 | | 3 | 5 | 3 | 4 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 16.7 | | 2 | 4 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 5.2 | | 1 | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 4.4 | | 1 | 1 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2.7 | | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.54 | | 0 | 0 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0 | 0 | 0.1 | 0 | 0 | 0 |
| 1.03 | | 0 | 0 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0 | 0.1 | 0.1 | 0 |

**IR-COT** Irish Commercial Otter trawl

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2005 | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | |
| | 2 | 10 | | | | | | | | | |
| 70682 | | 6.8 | 17.7 | 25.5 | 9.2 | 25.8 | 3.6 | 0.8 | 1.5 | 1.9 | 1995 |
| 58166 | | 0 | 5.7 | 12.9 | 12.7 | 4.7 | 4.7 | 2.2 | 0.2 | 0 | 1996 |
| 75029 | | 27.8 | 10.2 | 4.1 | 9.2 | 6.4 | 3.5 | 3.9 | 1 | 0.2 | 1997 |
| 81073 | | 5.5 | 40.7 | 14.7 | 6.6 | 12.3 | 5.4 | 2.7 | 4.1 | 1 | 1998 |
| 93221 | | 26.6 | 36.8 | 30.9 | 5.1 | 3.8 | 5.3 | 2.4 | 0.5 | 1.2 | 1999 |
| 64320 | | 1.6 | 13.2 | 13.4 | 11 | 3.4 | 1.1 | 1 | 0.4 | 0 | 2000 |
| 77541 | | 0.2 | 6.1 | 18.6 | 18.6 | 10.8 | 2.1 | 4.1 | 1.3 | 0.3 | 2001 |
| 39996 | | 20.3 | 20 | 30.2 | 16.4 | 8.2 | 2.9 | 2.4 | 1.4 | 0.5 | 2002 |
| 73854 | | 0.9 | 35.9 | 21.7 | 9.8 | 3.3 | 0.5 | 0.8 | 0.2 | 0.2 | 2003 |
| 72507 | | 9 | 15.1 | 4.1 | 3.2 | 1.9 | 1.6 | 0.3 | 0.2 | 0.1 | 2004 |
| ################################################################################## | | | | | | | | | | | |
| 31142 | | 4 | 1.7 | 1.6 | 1.6 | 0.6 | 0.1 | 0 | 0 | 0 | 2005 |
| ################################################################################## | | | | | | | | | | | |

Please note the 2005 data is based only on Q3 and Q4 data and has not been raised to annual effort.
It should not be included as part of this time series.

## Table 6.8.9 - Sole in VIIa. Diagnostics

Lowestoft VPA Version 3.1

12/05/2011 14:14

Extended Survivors Analysis

IRISH SEA SOLE 2011 WG COMBSEX PLUSGROUP.

CPUE data from file sol7atun.txt

Catch data for 41 years. 1970 to 2010. Ages 2 to 8.

| Fleet | First year | Last year | First age | Last age | Alpha | Beta |
|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3□ | 1988 | 2010 | 2 | 7 | 0.75 | 0.85 |

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 22 iterations

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Regression weights | | | | | | | | | | |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.056 | 0.069 | 0.161 | 0.087 | 0.203 | 0.09 | 0.101 | 0.054 | 0.046 | 0.027 |
| 3 | 0.277 | 0.281 | 0.575 | 0.473 | 0.446 | 0.371 | 0.409 | 0.278 | 0.294 | 0.209 |
| 4 | 0.303 | 0.505 | 0.467 | 0.432 | 0.678 | 0.48 | 0.3 | 0.356 | 0.406 | 0.237 |
| 5 | 0.249 | 0.433 | 0.441 | 0.285 | 0.655 | 0.425 | 0.296 | 0.245 | 0.448 | 0.346 |
| 6 | 0.273 | 0.288 | 0.281 | 0.263 | 0.378 | 0.549 | 0.286 | 0.283 | 0.232 | 0.326 |
| 7 | 0.45 | 0.188 | 0.15 | 0.178 | 0.37 | 0.278 | 0.351 | 0.272 | 0.346 | 0.169 |

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XSA population numbers (Thousands)

| YEAR | AGE 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 2001 | 4.65E+03 | 6.25E+03 | 3.30E+03 | 3.42E+03 | 2.25E+03 | 2.32E+02 |
| 2002 | 2.35E+03 | 3.98E+03 | 4.29E+03 | 2.21E+03 | 2.41E+03 | 1.55E+03 |
| 2003 | 3.08E+03 | 1.98E+03 | 2.72E+03 | 2.34E+03 | 1.29E+03 | 1.63E+03 |
| 2004 | 3.70E+03 | 2.37E+03 | 1.01E+03 | 1.54E+03 | 1.36E+03 | 8.84E+02 |
| 2005 | 3.06E+03 | 3.07E+03 | 1.34E+03 | 5.93E+02 | 1.05E+03 | 9.49E+02 |
| 2006 | 1.35E+03 | 2.26E+03 | 1.78E+03 | 6.14E+02 | 2.79E+02 | 6.50E+02 |
| 2007 | 1.87E+03 | 1.12E+03 | 1.41E+03 | 9.96E+02 | 3.63E+02 | 1.46E+02 |
| 2008 | 1.99E+03 | 1.53E+03 | 6.70E+02 | 9.47E+02 | 6.70E+02 | 2.47E+02 |
| 2009 | 2.14E+03 | 1.71E+03 | 1.05E+03 | 4.25E+02 | 6.71E+02 | 4.57E+02 |
| 2010 | 8.34E+02 | 1.85E+03 | 1.15E+03 | 6.32E+02 | 2.46E+02 | 4.81E+02 |

Estimated population abundance at 1st Jan 2011

| | | | | | |
|---|---|---|---|---|---|
| 0.00E+00 | 7.34E+02 | 1.36E+03 | 8.22E+02 | 4.05E+02 | 1.60E+02 |

Taper weighted geometric mean of the VPA populations:

| | | | | | |
|---|---|---|---|---|---|
| 4.88E+03 | 4.47E+03 | 3.29E+03 | 2.02E+03 | 1.22E+03 | 7.25E+02 |

Standard error of the weighted Log(VPA populations) :

| | | | | | | |
|---|---|---|---|---|---|---|
| | 0.7294 | 0.6947 | 0.7523 | 0.7671 | 0.7736 | 0.7516 |
| 1 | | | | | | |

Log catchability residuals.

Fleet : UK (E&W)-BTS-Q3

| Age | 1988 | 1989 | 1990 |
|---|---|---|---|
| 2 | 0.02 | 0.01 | 0.38 |
| 3 | 0.6 | 0.37 | -0.12 |
| 4 | 0.09 | 0.16 | -0.17 |
| 5 | -0.32 | 0.05 | 1.04 |
| 6 | -0.18 | -0.2 | 0.33 |
| 7 | -0.1 | 0.07 | 0.16 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.48 | -0.07 | -0.3 | 0.13 | 0.17 | -0.3 | 0.05 | 0.39 | -0.18 | -0.02 |
| 3 | -0.3 | 0.47 | -0.27 | -0.04 | 0.29 | -0.66 | -0.07 | 0.09 | -0.02 | -0.22 |
| 4 | -0.84 | 0.52 | -0.02 | -0.2 | 0.13 | -0.18 | -0.07 | -0.68 | 0.36 | 0.37 |
| 5 | -0.55 | 0.04 | -0.27 | 0.09 | -0.51 | -0.17 | 0.08 | -0.68 | 0.4 | -0.09 |
| 6 | -0.16 | 0.21 | -0.04 | 0.54 | 0 | -0.14 | -0.14 | -0.27 | 0.4 | 0.18 |
| 7 | -0.23 | -0.21 | -0.14 | 0.17 | -0.39 | -0.19 | 0.24 | 0.18 | 0.17 | -0.16 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | -0.07 | -0.91 | 0.13 | 0.02 | -0.05 | 0.25 | -0.24 | -0.01 | 0.06 | 0.06 |
| 3 | -0.22 | -0.23 | -0.16 | 0.43 | -0.37 | 0.11 | 0.24 | 0.05 | 0.05 | -0.03 |
| 4 | -0.42 | 0.14 | 0.3 | -0.01 | -0.14 | -0.03 | 0.29 | 0.11 | 0.29 | 0.01 |
| 5 | -0.11 | -0.35 | 0.25 | 0.49 | 0 | 0.77 | 0.31 | 0.4 | 0.7 | -0.14 |
| 6 | -0.08 | 0.08 | 0.01 | 0.06 | 0.19 | 0.27 | -0.01 | 0.15 | 0.34 | -0.37 |
| 7 | -0.03 | -0.04 | -0.26 | 0.33 | -0.05 | -0.22 | -0.05 | -0.21 | -0.1 | -0.48 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Mean Log q | -7.4384 | -7.7953 | -8.0184 | -8.0184 | -8.0184 | -8.0184 |
| S.E(Log q) | 0.2847 | 0.3014 | 0.3277 | 0.4416 | 0.2378 | 0.2162 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 0.9 | 1.25 | 7.52 | 0.87 | 23 | 0.25 | -7.44 |
| 3 | 0.97 | 0.289 | 7.8 | 0.79 | 23 | 0.3 | -7.8 |
| 4 | 0.94 | 0.612 | 8.01 | 0.85 | 23 | 0.31 | -8.02 |
| 5 | 1.15 | -1.134 | 8.05 | 0.73 | 23 | 0.5 | -7.96 |
| 6 | 1.03 | -0.535 | 8 | 0.93 | 23 | 0.24 | -7.97 |
| 7 | 0.98 | 0.367 | 8.05 | 0.94 | 23 | 0.21 | -8.09 |
| 1 | | | | | | | |

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 776 | 0.3 | 0 | 0 | 1 | 0.961 | 0.025 |
| F shrinkage mean | 192 | 1.5 | | | | 0.039 | 0.099 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 734 | 0.29 | 0.28 | 2 | 0.944 | 0.027 |

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 1381 | 0.215 | 0.043 | 0.2 | 2 | 0.975 | 0.206 |
| F shrinkage mean | 729 | 1.5 | | | | 0.025 | 0.361 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1359 | 0.21 | 0.08 | 3 | 0.366 | 0.209 |

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Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 836 | 0.183 | 0.018 | 0.1 | 3 | 0.978 | 0.233 |
| F shrinkage mean | 391 | 1.5 | | | | 0.022 | 0.445 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 822 | 0.18 | 0.07 | 4 | 0.369 | 0.237 |

Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2005

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 407 | 0.175 | 0.12 | 0.68 | 4 | 0.971 | 0.344 |
| F shrinkage mean | 325 | 1.5 | | | | 0.029 | 0.415 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 405 | 0.18 | 0.1 | 5 | 0.592 | 0.346 |

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Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2004

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 161 | 0.167 | 0.19 | 1.13 | 5 | 0.975 | 0.326 |
| F shrinkage mean | 149 | 1.5 | | | | 0.025 | 0.347 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 160 | 0.17 | 0.17 | 6 | 1.001 | 0.326 |

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4

Year class = 2003

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK (E&W)-BTS-Q3 | 372 | 0.146 | 0.163 | 1.11 | 6 | 0.984 | 0.167 |
| F shrinkage mean | 190 | 1.5 | | | | 0.016 | 0.304 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 368 | 0.15 | 0.15 | 7 | 1.039 | 0.169 |

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Table 6.8.10 - Sole in VIIa. Fishing mortality

| Age/Year | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0083 | 0.0117 | 0.0103 | 0.0299 | 0.0045 | 0.0421 | 0.0079 | 0.0148 | 0.0076 | 0.0129 | 0.0395 |
| 3 | 0.1196 | 0.148 | 0.0809 | 0.1436 | 0.0847 | 0.1575 | 0.0704 | 0.135 | 0.0743 | 0.1426 | 0.1332 |
| 4 | 0.2956 | 0.3988 | 0.3518 | 0.3621 | 0.3157 | 0.3032 | 0.4193 | 0.3255 | 0.2866 | 0.3645 | 0.3925 |
| 5 | 0.4445 | 0.5545 | 0.5057 | 0.4394 | 0.4722 | 0.4844 | 0.4816 | 0.4072 | 0.4036 | 0.6323 | 0.5666 |
| 6 | 0.4292 | 0.3671 | 0.493 | 0.4873 | 0.5435 | 0.3973 | 0.3793 | 0.3752 | 0.3816 | 0.4261 | 0.9481 |
| 7 | 0.3909 | 0.4416 | 0.4517 | 0.431 | 0.4453 | 0.3962 | 0.4281 | 0.3704 | 0.3583 | 0.4759 | 0.6384 |
| +gp | 0.3909 | 0.4416 | 0.4517 | 0.431 | 0.4453 | 0.3962 | 0.4281 | 0.3704 | 0.3583 | 0.4759 | 0.6384 |
| FBAR 4-7 | 0.39 | 0.4405 | 0.4506 | 0.43 | 0.4442 | 0.3953 | 0.4271 | 0.3696 | 0.3575 | 0.4747 | 0.6364 |

| Age/Year | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0164 | 0.0034 | 0.007 | 0.0448 | 0.0099 | 0.0062 | 0.0584 | 0.0095 | 0.0435 | 0.1103 | 0.1135 |
| 3 | 0.1486 | 0.095 | 0.0809 | 0.18 | 0.133 | 0.272 | 0.1767 | 0.1698 | 0.2943 | 0.393 | 0.3427 |
| 4 | 0.3282 | 0.4761 | 0.3821 | 0.2413 | 0.3584 | 0.4161 | 0.5536 | 0.3612 | 0.4415 | 0.661 | 0.4741 |
| 5 | 0.5101 | 0.4066 | 0.5304 | 0.3773 | 0.3178 | 0.5474 | 0.7421 | 0.5421 | 0.515 | 0.6411 | 0.3783 |
| 6 | 0.6019 | 0.4359 | 0.3906 | 0.4306 | 0.3249 | 0.3331 | 1.2288 | 0.6935 | 0.59 | 0.5691 | 0.4705 |
| 7 | 0.4817 | 0.441 | 0.4358 | 0.3507 | 0.3346 | 0.4336 | 0.8457 | 1.0286 | 0.6274 | 0.5916 | 0.5597 |
| +gp | 0.4817 | 0.441 | 0.4358 | 0.3507 | 0.3346 | 0.4336 | 0.8457 | 1.0286 | 0.6274 | 0.5916 | 0.5597 |
| FBAR 4-7 | 0.4805 | 0.4399 | 0.4347 | 0.35 | 0.3339 | 0.4325 | 0.8425 | 0.6563 | 0.5435 | 0.6157 | 0.4707 |

| Age/Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0789 | 0.014 | 0.0242 | 0.0712 | 0.0253 | 0.1006 | 0.0247 | 0.0603 | 0.0267 | 0.0558 | 0.0686 |
| 3 | 0.2815 | 0.1459 | 0.2892 | 0.2285 | 0.3423 | 0.4094 | 0.2961 | 0.1947 | 0.2323 | 0.2768 | 0.2811 |
| 4 | 0.3953 | 0.343 | 0.4182 | 0.5089 | 0.4562 | 0.6087 | 0.4548 | 0.3247 | 0.2257 | 0.3034 | 0.505 |
| 5 | 0.5856 | 0.3949 | 0.451 | 0.5035 | 0.4721 | 0.481 | 0.6936 | 0.5202 | 0.2263 | 0.2494 | 0.4334 |
| 6 | 0.3884 | 0.5061 | 0.4736 | 0.516 | 0.5483 | 0.4575 | 0.3608 | 0.687 | 0.4795 | 0.2727 | 0.2879 |
| 7 | 0.6132 | 0.797 | 0.4875 | 0.3626 | 0.4717 | 0.6622 | 0.3568 | 0.2324 | 0.7382 | 0.4504 | 0.1882 |
| +gp | 0.6132 | 0.797 | 0.4875 | 0.3626 | 0.4717 | 0.6622 | 0.3568 | 0.2324 | 0.7382 | 0.4504 | 0.1882 |
| FBAR 4-7 | 0.4956 | 0.5103 | 0.4576 | 0.4728 | 0.4871 | 0.5524 | 0.4665 | 0.4411 | 0.4174 | 0.3189 | 0.3536 |

| Age/Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | FBAR 07-09 |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.1612 | 0.0874 | 0.2033 | 0.0905 | 0.1009 | 0.0537 | 0.0462 | 0.0268 | 0.0422 |
| 3 | 0.5745 | 0.4731 | 0.4464 | 0.3705 | 0.4089 | 0.2784 | 0.2942 | 0.2095 | 0.2607 |
| 4 | 0.4674 | 0.4322 | 0.6781 | 0.4801 | 0.2998 | 0.3561 | 0.4061 | 0.2369 | 0.333 |
| 5 | 0.4406 | 0.2847 | 0.6547 | 0.4246 | 0.2965 | 0.2453 | 0.4483 | 0.3462 | 0.3466 |
| 6 | 0.2815 | 0.2629 | 0.3781 | 0.5488 | 0.2862 | 0.2829 | 0.2319 | 0.3262 | 0.2803 |
| 7 | 0.1504 | 0.1779 | 0.3696 | 0.2778 | 0.3507 | 0.2725 | 0.3458 | 0.1686 | 0.2623 |
| +gp | 0.1504 | 0.1779 | 0.3696 | 0.2778 | 0.3507 | 0.2725 | 0.3458 | 0.1686 | |
| FBAR 4-7 | 0.335 | 0.2894 | 0.5202 | 0.4328 | 0.3083 | 0.2892 | 0.358 | 0.2695 | |

## Table 6.8.11 - Sole in VIIa. Stock numbers at age (start of year, in thousands)

| Age/Year | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3695 | 10178 | 3186 | 13136 | 5872 | 6682 | 3858 | 15776 | 9045 | 8860 | 5077 |
| 3 | 8349 | 3316 | 9102 | 2863 | 11536 | 5289 | 5797 | 3463 | 14065 | 8122 | 7914 |
| 4 | 4145 | 6703 | 2587 | 7596 | 2237 | 9591 | 4089 | 4888 | 2738 | 11815 | 8373 |
| 5 | 1368 | 2791 | 4071 | 1647 | 4785 | 1476 | 6408 | 2433 | 3194 | 1860 | 7425 |
| 6 | 4389 | 794 | 1450 | 2221 | 960 | 2700 | 823 | 3582 | 1465 | 1930 | 894 |
| 7 | 939 | 2586 | 498 | 802 | 1235 | 505 | 1642 | 509 | 2227 | 905 | 1141 |
| +gp | 8212 | 5534 | 4321 | 3418 | 2829 | 3221 | 2222 | 2193 | 2042 | 1714 | 2538 |
| TOTAL | 31098 | 31902 | 25215 | 31673 | 29453 | 29463 | 24838 | 32845 | 34776 | 35206 | 31380 |

| Age/Year | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 4511 | 2476 | 5582 | 15623 | 16437 | 24165 | 3503 | 3547 | 4425 | 5678 | 12905 |
| 3 | 4416 | 4015 | 2232 | 5015 | 13517 | 14728 | 21732 | 2989 | 3179 | 3834 | 4802 |
| 4 | 6267 | 3444 | 3304 | 1863 | 3790 | 10708 | 10151 | 16479 | 2283 | 2143 | 2342 |
| 5 | 3894 | 4084 | 1936 | 2040 | 1324 | 2397 | 6391 | 5281 | 10390 | 1328 | 1001 |
| 6 | 3813 | 2116 | 2461 | 1031 | 1266 | 872 | 1254 | 2753 | 2779 | 5618 | 833 |
| 7 | 313 | 1890 | 1238 | 1507 | 606 | 828 | 565 | 332 | 1245 | 1394 | 2877 |
| +gp | 2368 | 1166 | 2102 | 1973 | 2723 | 2524 | 1477 | 837 | 572 | 1091 | 1120 |
| TOTAL | 25583 | 19190 | 18854 | 29052 | 39664 | 56220 | 45074 | 32218 | 24873 | 21086 | 25479 |

| Age/Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 5029 | 6295 | 5361 | 2019 | 2529 | 8663 | 7195 | 5405 | 7098 | 4648 | 2348 |
| 3 | 10424 | 4205 | 5617 | 4735 | 1701 | 2231 | 7088 | 6351 | 4604 | 6253 | 3977 |
| 4 | 2956 | 7118 | 3288 | 3806 | 3409 | 1093 | 1341 | 4770 | 4730 | 3302 | 4290 |
| 5 | 1319 | 1801 | 4570 | 1958 | 2070 | 1955 | 538 | 770 | 3120 | 3415 | 2208 |
| 6 | 621 | 664 | 1098 | 2634 | 1071 | 1168 | 1093 | 243 | 414 | 2251 | 2408 |
| 7 | 358 | 381 | 362 | 619 | 1423 | 560 | 669 | 690 | 111 | 232 | 1551 |
| +gp | 2119 | 1304 | 1421 | 1206 | 986 | 1146 | 1477 | 1174 | 516 | 785 | 1321 |
| TOTAL | 22824 | 21768 | 21718 | 16976 | 13169 | 16816 | 19401 | 19402 | 20592 | 20886 | 18099 |

| Age/Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | GM ST 70-08 | AM ST 70-08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3078 | 3705 | 3063 | 1349 | 1872 | 1991 | 2144 | 834 | 0 | 5216 | 6561 |
| 3 | 1982 | 2371 | 3071 | 2261 | 1115 | 1531 | 1708 | 1852 | 734 | 4687 | 5887 |
| 4 | 2717 | 1010 | 1336 | 1778 | 1413 | 670 | 1049 | 1151 | 1359 | 3478 | 4476 |
| 5 | 2343 | 1540 | 593 | 614 | 996 | 947 | 425 | 632 | 822 | 2164 | 2776 |
| 6 | 1294 | 1364 | 1049 | 279 | 363 | 670 | 671 | 246 | 405 | 1287 | 1654 |
| 7 | 1634 | 884 | 949 | 650 | 146 | 247 | 457 | 481 | 160 | 742 | 955 |
| +gp | 2586 | 1146 | 1248 | 1629 | 1056 | 923 | 581 | 1062 | 1180 | | |
| TOTAL | 15634 | 12019 | 11309 | 8561 | 6960 | 6980 | 7033 | 6258 | 4661 | | |

# Table 6.8.12 - Sole in VIIa. Summary

| | RECRUITS Age 2 | TOTALBIO | TOTSPBIO | LANDING: | YIELD/SSB | FBAR 4- 7 |
|---|---|---|---|---|---|---|
| 1970 | 3695 | 7133 | 6437 | 1785 | 0.2773 | 0.39 |
| 1971 | 10178 | 7406 | 6222 | 1882 | 0.3025 | 0.4405 |
| 1972 | 3186 | 5727 | 5011 | 1450 | 0.2894 | 0.4506 |
| 1973 | 13136 | 6555 | 5123 | 1428 | 0.2787 | 0.43 |
| 1974 | 5872 | 6190 | 5069 | 1307 | 0.2579 | 0.4442 |
| 1975 | 6682 | 6230 | 5360 | 1441 | 0.2688 | 0.3953 |
| 1976 | 3858 | 5503 | 4890 | 1463 | 0.2992 | 0.4271 |
| 1977 | 15776 | 5511 | 4491 | 1147 | 0.2554 | 0.3696 |
| 1978 | 9045 | 6246 | 5093 | 1106 | 0.2171 | 0.3575 |
| 1979 | 8860 | 6891 | 5687 | 1614 | 0.2838 | 0.4747 |
| 1980 | 5077 | 6433 | 5517 | 1941 | 0.3518 | 0.6364 |
| 1981 | 4511 | 5917 | 5173 | 1667 | 0.3223 | 0.4805 |
| 1982 | 2476 | 4757 | 4340 | 1338 | 0.3083 | 0.4399 |
| 1983 | 5582 | 4936 | 4111 | 1169 | 0.2844 | 0.4347 |
| 1984 | 15623 | 6835 | 4632 | 1058 | 0.2284 | 0.35 |
| 1985 | 16437 | 7930 | 5688 | 1146 | 0.2015 | 0.3339 |
| 1986 | 24165 | 9641 | 7036 | 1995 | 0.2835 | 0.4325 |
| 1987 | 3503 | 8695 | 7279 | 2808 | 0.3858 | 0.8425 |
| 1988 | 3547 | 6139 | 5654 | 1999 | 0.3535 | 0.6563 |
| 1989 | 4425 | 5347 | 4790 | 1833 | 0.3826 | 0.5435 |
| 1990 | 5678 | 4469 | 3795 | 1583 | 0.4171 | 0.6157 |
| 1991 | 12905 | 4658 | 3345 | 1212 | 0.3623 | 0.4707 |
| 1992 | 5029 | 4605 | 3581 | 1259 | 0.3516 | 0.4956 |
| 1993 | 6295 | 3997 | 3356 | 1023 | 0.3048 | 0.5103 |
| 1994 | 5361 | 5169 | 4219 | 1374 | 0.3257 | 0.4576 |
| 1995 | 2019 | 4149 | 3700 | 1266 | 0.3421 | 0.4728 |
| 1996 | 2529 | 3223 | 2849 | 1002 | 0.3517 | 0.4871 |
| 1997 | 8663 | 3593 | 2620 | 1003 | 0.3828 | 0.5524 |
| 1998 | 7195 | 4476 | 3200 | 911 | 0.2847 | 0.4665 |
| 1999 | 5405 | 4547 | 3507 | 863 | 0.2461 | 0.4411 |
| 2000 | 7098 | 4103 | 3294 | 818 | 0.2483 | 0.4174 |
| 2001 | 4648 | 4528 | 3764 | 1053 | 0.2798 | 0.3189 |
| 2002 | 2346 | 4263 | 3814 | 1090 | 0.2858 | 0.3536 |
| 2003 | 3078 | 3861 | 3458 | 1014 | 0.2933 | 0.335 |
| 2004 | 3705 | 2930 | 2441 | 709 | 0.2904 | 0.2894 |
| 2005 | 3063 | 2649 | 2197 | 855 | 0.3892 | 0.5202 |
| 2006 | 1349 | 2007 | 1749 | 569 | 0.3254 | 0.4328 |
| 2007 | 1872 | 1753 | 1491 | 492 | 0.3299 | 0.3083 |
| 2008 | 1991 | 1678 | 1422 | 332 | 0.2334 | 0.2892 |
| 2009 | 2144 | 1394 | 1130 | 325 | 0.2876 | 0.358 |
| 2010 | 834 | 1400 | 1218 | 275 | 0.2257 | 0.2695 |
| 2011 | 1679 [1] | 1472 [2] | 1276 [2] | | | 0.3056 [3] |
| Arith. Mean | 6313 | 4963 | 4092 | 1234 | 0.3022 | 0.4437 |
| 0 Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | |

[1] RCT3

[2] Forecast

[3] Mean F 2008-2010

# Table 6.8.13 – Sole in VIIa. Input to RCT3

XSA = XSA estimates at age 2
S2= abundance indices at age 2 from UK(E&W)-BTS-Q3
S1= abundance indices at age 1 from UK(E&W)-BTS-Q3
Irish Sea sole recruits - age 2

| | | | |
|---|---|---|---|
| 2 | 40 | 2 | |
| 1970 | 3186 | -11 | -11 |
| 1971 | 13136 | -11 | -11 |
| 1972 | 5872 | -11 | -11 |
| 1973 | 6682 | -11 | -11 |
| 1974 | 3858 | -11 | -11 |
| 1975 | 15776 | -11 | -11 |
| 1976 | 9045 | -11 | -11 |
| 1977 | 8860 | -11 | -11 |
| 1978 | 5077 | -11 | -11 |
| 1979 | 4511 | -11 | -11 |
| 1980 | 2476 | -11 | -11 |
| 1981 | 5582 | -11 | -11 |
| 1982 | 15623 | -11 | -11 |
| 1983 | 16437 | -11 | -11 |
| 1984 | 24165 | -11 | -11 |
| 1985 | 3503 | -11 | -11 |
| 1986 | 3547 | 196 | -11 |
| 1987 | 4425 | 304 | 118 |
| 1988 | 5678 | 534 | 218 |
| 1989 | 12905 | 1286 | 1712 |
| 1990 | 5029 | 309 | 148 |
| 1991 | 6295 | 330 | 220 |
| 1992 | 5361 | 408 | 83 |
| 1993 | 2019 | 154 | 60 |
| 1994 | 2529 | 126 | 246 |
| 1995 | 8663 | 577 | 886 |
| 1996 | 7195 | 716 | 1158 |
| 1997 | 5405 | 293 | 539 |
| 1998 | 7098 | 464 | 385 |
| 1999 | 4648 | 284 | 354 |
| 2000 | 2346 | 61 | 91 |
| 2001 | 3078 | 210 | 205 |
| 2002 | 3705 | 240 | 242 |
| 2003 | 3063 | 165 | 406 |
| 2004 | 1349 | 110 | 53 |
| 2005 | 1872 | 93 | 107 |
| 2006 | 1991 | 125 | 125 |
| 2007 | -11 | 150 | 126 |
| 2008 | -11 | 59 | 57 |
| 2009 | -11 | -11 | 25 |

S2
S1

# Table 6.8.14 - Sole in VIIa.

Analysis by RCT3 ver3.1 of data from file :

S7ARCT.TXT

Irish Sea sole recruits - age 2

Data for 2 surveys over 40 years : 1970 - 2009

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2008

| | I-----------Regression----------I | | | | | I-----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| S2 | .84 | 3.66 | .23 | .867 | 21 | 4.09 | 7.08 | .270 | .719 |
| S1 | .80 | 3.97 | .49 | .601 | 20 | 4.06 | 7.20 | .559 | .168 |
| | | | | | | VPA Mean = | 8.55 | .682 | .113 |

Yearclass = 2009

| | I-----------Regression----------I | | | | | I-----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| S2 | | | | | | | | | |
| S1 | .80 | 3.97 | .49 | .601 | 20 | 3.26 | 6.56 | .598 | .566 |
| | | | | | | VPA Mean = | 8.55 | .682 | .434 |

| Year Class | Weighted Average Prediction | Log WAP | Int Std Error | Ext Std Error | Var Ratio | VPA | Log VPA |
|---|---|---|---|---|---|---|---|
| 2008 | 1433 | 7.27 | .23 | .33 | 2.02 | | |
| **2009** | **1679** | **7.43** | **.45** | **.99** | **4.81** | | |

## Table 6.8.15 - Sole in VIIa
## Input for catch forecast and Fmsy analysis

Input: F mean 08-10 not rescaled to F2010
Catch and stock weights are mean 08-10
Recruits age 2 in 2012 and 2013 GM (70-08)

| Label | Value | CV | Label | Value | CV |
|---|---|---|---|---|---|
| Number at age | | | Weight in the stock | | |
| N2 | 1679 | 0.99 | WS2 | 0.140 | 0.11 |
| N3 | 734 | 0.29 | WS3 | 0.172 | 0.05 |
| N4 | 1359 | 0.21 | WS4 | 0.224 | 0.06 |
| N5 | 822 | 0.18 | WS5 | 0.269 | 0.06 |
| N6 | 405 | 0.28 | WS6 | 0.301 | 0.08 |
| N7 | 160 | 0.17 | WS7 | 0.317 | 0.18 |
| N8 | 1180 | 0.15 | WS8 | 0.349 | 0.19 |
| H.cons selectivity | | | Weight in the HC catch | | |
| sH2 | 0.042 | 0.33 | WH2 | 0.152 | 0.09 |
| sH3 | 0.261 | 0.17 | WH3 | 0.192 | 0.02 |
| sH4 | 0.333 | 0.26 | WH4 | 0.248 | 0.07 |
| sH5 | 0.347 | 0.29 | WH5 | 0.281 | 0.01 |
| sH6 | 0.280 | 0.17 | WH6 | 0.296 | 0.08 |
| sH7 | 0.262 | 0.34 | WH7 | 0.318 | 0.20 |
| sH8 | 0.262 | 0.34 | WH8 | 0.335 | 0.17 |
| Natural mortality | | | Proportion mature | | |
| M2 | 0.1 | 0.1 | MT2 | 0.38 | 0.1 |
| M3 | 0.1 | 0.1 | MT3 | 0.71 | 0.1 |
| M4 | 0.1 | 0.1 | MT4 | 0.97 | 0.1 |
| M5 | 0.1 | 0.1 | MT5 | 0.98 | 0.1 |
| M6 | 0.1 | 0.1 | MT6 | 1 | 0 |
| M7 | 0.1 | 0.1 | MT7 | 1 | 0 |
| M8 | 0.1 | 0.1 | MT8 | 1 | 0 |
| Relative effort in HC fihery | | | Year effect for natural mortality | | |
| HF11 | 1 | 0.1 | K10 | 1 | 0.1 |
| HF12 | 1 | 0.1 | K11 | 1 | 0.1 |
| HF13 | 1 | 0.1 | K12 | 1 | 0.1 |
| Recruitment in 2012 and 2013 | | | | | |
| R12 | 5216 | 0.75 | | | |
| R13 | 5216 | 0.75 | | | |

# Table 6.8.16 Sole in VIIa - Management option table

MFDP version 1a
Run: Sole7A1
IRISH SEA SOLE,2011 WG
Time and date: 18:47 12/05/2011
Fbar age range: 4-7

| 2011 Biomass | SSB | FMult | FBar | Landings |
|---|---|---|---|---|
| 1472 | 1276 | 1.0000 | 0.3056 | 323 |

| 2012 Biomass | SSB | FMult | FBar | Landings | 2013 Biomass | SSB |
|---|---|---|---|---|---|---|
| 1906 | 1371 | 0.0000 | 0.0000 | 0 | 2737 | 2036 |
| . | 1371 | 0.1000 | 0.0306 | 36 | 2699 | 2000 |
| . | 1371 | 0.2000 | 0.0611 | 71 | 2663 | 1965 |
| . | 1371 | 0.3000 | 0.0917 | 105 | 2627 | 1931 |
| . | 1371 | 0.4000 | 0.1222 | 138 | 2593 | 1898 |
| . | 1371 | 0.5000 | 0.1528 | 171 | 2560 | 1865 |
| . | 1371 | 0.6000 | 0.1833 | 202 | 2527 | 1834 |
| . | 1371 | 0.7000 | 0.2139 | 233 | 2495 | 1803 |
| . | 1371 | 0.8000 | 0.2445 | 263 | 2464 | 1774 |
| . | 1371 | 0.9000 | 0.2750 | 292 | 2434 | 1745 |
| . | 1371 | 1.0000 | 0.3056 | 320 | 2405 | 1716 |
| . | 1371 | 1.1000 | 0.3361 | 348 | 2376 | 1689 |
| . | 1371 | 1.2000 | 0.3667 | 375 | 2348 | 1662 |
| . | 1371 | 1.3000 | 0.3972 | 401 | 2321 | 1636 |
| . | 1371 | 1.4000 | 0.4278 | 427 | 2295 | 1611 |
| . | 1371 | 1.5000 | 0.4584 | 452 | 2269 | 1587 |
| . | 1371 | 1.6000 | 0.4889 | 476 | 2244 | 1563 |
| . | 1371 | 1.7000 | 0.5195 | 500 | 2219 | 1539 |
| . | 1371 | 1.8000 | 0.5500 | 523 | 2195 | 1517 |
| . | 1371 | 1.9000 | 0.5806 | 545 | 2172 | 1494 |
| . | 1371 | 2.0000 | 0.6111 | 567 | 2150 | 1473 |

Input units are thousands and kg - output in tonnes

| | | | | | | |
|---|---|---|---|---|---|---|
| Fmult corresponding to Fpa = 1.0 | | | | | | |
| . | 1371 | 1 | 0.3056 | 320 | 2405 | 1716 |
| Fmult corresponding to FMSY = 0.524 | | | | | | |
| . | 1371 | 0.524 | 0.1601 | 178 | 2552 | 1858 |
| Fmult corresponding to FHCR-MSY = 0.229 | | | | | | |
| . | 1371 | 0.229 | 0.07 | 81 | 2653 | 1955 |
| Fmult corresponding to FHCR-MSY transition = 0.622 | | | | | | |
| . | 1371 | 0.622 | 0.1901 | 209 | 2520 | 1827 |

Bpa = 3100 t

# Table 6.8.17 Sole in VIIa. Detailed results

MFDP version 1a
Run: Sole7A1
Time and date: 18:55 12/05/2011
Fbar age range: 4-7

**Year: 2011** F multiplier: 1 Fbar: 0.3056

| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0422 | 66 | 10 | 1679 | 236 | 638 | 90 | 638 | 90 |
| 3 | 0.2607 | 161 | 31 | 734 | 126 | 521 | 90 | 521 | 90 |
| 4 | 0.3330 | 367 | 91 | 1359 | 304 | 1318 | 295 | 1318 | 295 |
| 5 | 0.3466 | 230 | 65 | 822 | 221 | 806 | 217 | 806 | 217 |
| 6 | 0.2803 | 94 | 28 | 405 | 122 | 405 | 122 | 405 | 122 |
| 7 | 0.2623 | 35 | 11 | 160 | 51 | 160 | 51 | 160 | 51 |
| 8 | 0.2623 | 260 | 87 | 1180 | 412 | 1180 | 412 | 1180 | 412 |
| Total | | 1213 | 323 | 6339 | 1472 | 5028 | 1276 | 5028 | 1276 |

**Year: 2012** F multiplier: 1 Fbar: 0.3056

| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0422 | 205 | 31 | 5216 | 732 | 1982 | 278 | 1982 | 278 |
| 3 | 0.2607 | 319 | 61 | 1456 | 251 | 1034 | 178 | 1034 | 178 |
| 4 | 0.3330 | 138 | 34 | 512 | 115 | 496 | 111 | 496 | 111 |
| 5 | 0.3466 | 246 | 69 | 881 | 237 | 864 | 232 | 864 | 232 |
| 6 | 0.2803 | 123 | 36 | 526 | 158 | 526 | 158 | 526 | 158 |
| 7 | 0.2623 | 61 | 19 | 277 | 88 | 277 | 88 | 277 | 88 |
| 8 | 0.2623 | 205 | 69 | 933 | 326 | 933 | 326 | 933 | 326 |
| Total | | 1298 | 320 | 9801 | 1906 | 6112 | 1371 | 6112 | 1371 |

**Year: 2013** F multiplier: 1 Fbar: 0.3056

| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0422 | 205 | 31 | 5216 | 732 | 1982 | 278 | 1982 | 278 |
| 3 | 0.2607 | 990 | 190 | 4524 | 778 | 3212 | 553 | 3212 | 553 |
| 4 | 0.3330 | 274 | 68 | 1015 | 227 | 985 | 221 | 985 | 221 |
| 5 | 0.3466 | 93 | 26 | 332 | 89 | 325 | 87 | 325 | 87 |
| 6 | 0.2803 | 131 | 39 | 564 | 170 | 564 | 170 | 564 | 170 |
| 7 | 0.2623 | 79 | 25 | 360 | 114 | 360 | 114 | 360 | 114 |
| 8 | 0.2623 | 185 | 62 | 842 | 294 | 842 | 294 | 842 | 294 |
| Total | | 1959 | 442 | 12853 | 2405 | 8270 | 1716 | 8270 | 1716 |

Input units are thousands and kg - output in tonnes

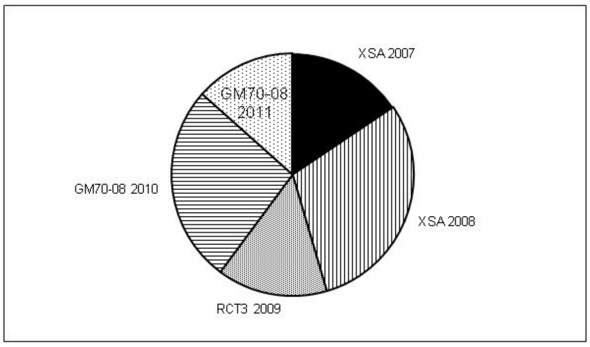
**Table 6.8.18** **Sole VIIa**
**Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes**

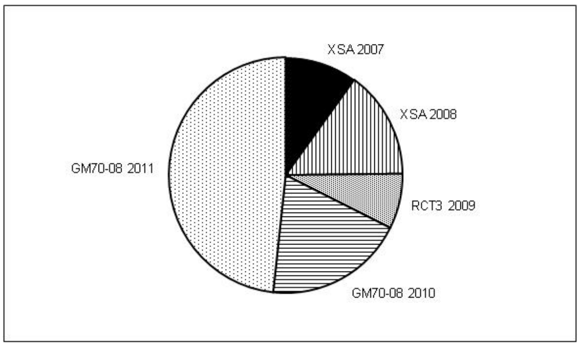
| Year-class | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Stock No. (thousands) of 2 year-olds | 2144 | 834 | 1679 | 5216 | 5216 |
| Source | XSA | XSA | RCT3 | GM70-08 | GM70-08 |
| Status Quo F: | | | | | |
| % in 2011 landings | 20.1 | 28.2 | 9.6 | 3.1 | - |
| % in 2012 landings | 11.3 | 21.6 | 10.7 | 19.1 | 9.7 |
| % in 2011 SSB | 17.0 | 23.1 | 7.0 | 7.0 | - |
| % in 2012 SSB | 11.5 | 16.9 | 8.1 | 13.0 | 20.3 |
| % in 2013 SSB | 6.6 | 9.9 | 5.1 | 12.9 | 32.2 |

GM : geometric mean recruitment

**Sole VIIa : Year-class % contribution to**

**a ) 2012 landings** **b ) 2013 SSB**




| XSA | XSA | RCT3 | GM70-08 | GM70-08 |
|---|---|---|---|---|
| 2007 | 2008 | 2009 | 2010 | 2011 |

## Table 6.8.19 - Sole in VIIa Yield per recruit summary table

MFYPR version 2a
Run: S7A_Y
Time and date: 18:14 12/05/2011
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 10.5083 | 3.0875 | 9.5866 | 2.9458 | 9.5866 | 2.9458 |
| 0.1000 | 0.0306 | 0.2005 | 0.0590 | 8.5059 | 2.4006 | 7.5869 | 2.2596 | 7.5869 | 2.2596 |
| 0.2000 | 0.0611 | 0.3310 | 0.0953 | 7.2028 | 1.9572 | 6.2864 | 1.8168 | 6.2864 | 1.8168 |
| 0.3000 | 0.0917 | 0.4225 | 0.1192 | 6.2901 | 1.6494 | 5.3763 | 1.5095 | 5.3763 | 1.5095 |
| 0.4000 | 0.1222 | 0.4900 | 0.1355 | 5.6171 | 1.4247 | 4.7059 | 1.2853 | 4.7059 | 1.2853 |
| 0.5000 | 0.1528 | 0.5417 | 0.1471 | 5.1017 | 1.2543 | 4.1929 | 1.1155 | 4.1929 | 1.1155 |
| 0.6000 | 0.1833 | 0.5826 | 0.1554 | 4.6952 | 1.1213 | 3.7888 | 0.9830 | 3.7888 | 0.9830 |
| 0.7000 | 0.2139 | 0.6156 | 0.1616 | 4.3671 | 1.0152 | 3.4629 | 0.8774 | 3.4629 | 0.8774 |
| 0.8000 | 0.2445 | 0.6429 | 0.1661 | 4.0970 | 0.9288 | 3.1951 | 0.7915 | 3.1951 | 0.7915 |
| 0.9000 | 0.2750 | 0.6657 | 0.1695 | 3.8712 | 0.8574 | 2.9715 | 0.7205 | 2.9715 | 0.7205 |
| 1.0000 | 0.3056 | 0.6850 | 0.1721 | 3.6797 | 0.7976 | 2.7822 | 0.6612 | 2.7822 | 0.6612 |
| 1.1000 | 0.3361 | 0.7017 | 0.1740 | 3.5156 | 0.7469 | 2.6201 | 0.6109 | 2.6201 | 0.6109 |
| 1.2000 | 0.3667 | 0.7161 | 0.1754 | 3.3734 | 0.7035 | 2.4799 | 0.5679 | 2.4799 | 0.5679 |
| 1.3000 | 0.3972 | 0.7287 | 0.1764 | 3.2490 | 0.6660 | 2.3576 | 0.5308 | 2.3576 | 0.5308 |
| 1.4000 | 0.4278 | 0.7399 | 0.1771 | 3.1394 | 0.6333 | 2.2500 | 0.4985 | 2.2500 | 0.4985 |
| 1.5000 | 0.4584 | 0.7498 | 0.1776 | 3.0422 | 0.6047 | 2.1546 | 0.4703 | 2.1546 | 0.4703 |
| 1.6000 | 0.4889 | 0.7587 | 0.1779 | 2.9553 | 0.5793 | 2.0696 | 0.4453 | 2.0696 | 0.4453 |
| 1.7000 | 0.5195 | 0.7667 | 0.1780 | 2.8772 | 0.5569 | 1.9933 | 0.4232 | 1.9933 | 0.4232 |
| 1.8000 | 0.5500 | 0.7739 | 0.1781 | 2.8067 | 0.5368 | 1.9246 | 0.4035 | 1.9246 | 0.4035 |
| 1.9000 | 0.5806 | 0.7805 | 0.1781 | 2.7427 | 0.5187 | 1.8623 | 0.3858 | 1.8623 | 0.3858 |
| 2.0000 | 0.6111 | 0.7866 | 0.1780 | 2.6843 | 0.5024 | 1.8056 | 0.3698 | 1.8056 | 0.3698 |

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(4-7) | 1.0000 | 0.3056 |
| FMax | 1.8056 | 0.5517 |
| F0.1 | 0.5769 | 0.1763 |
| F35%SPR | 0.561 | 0.1714 |

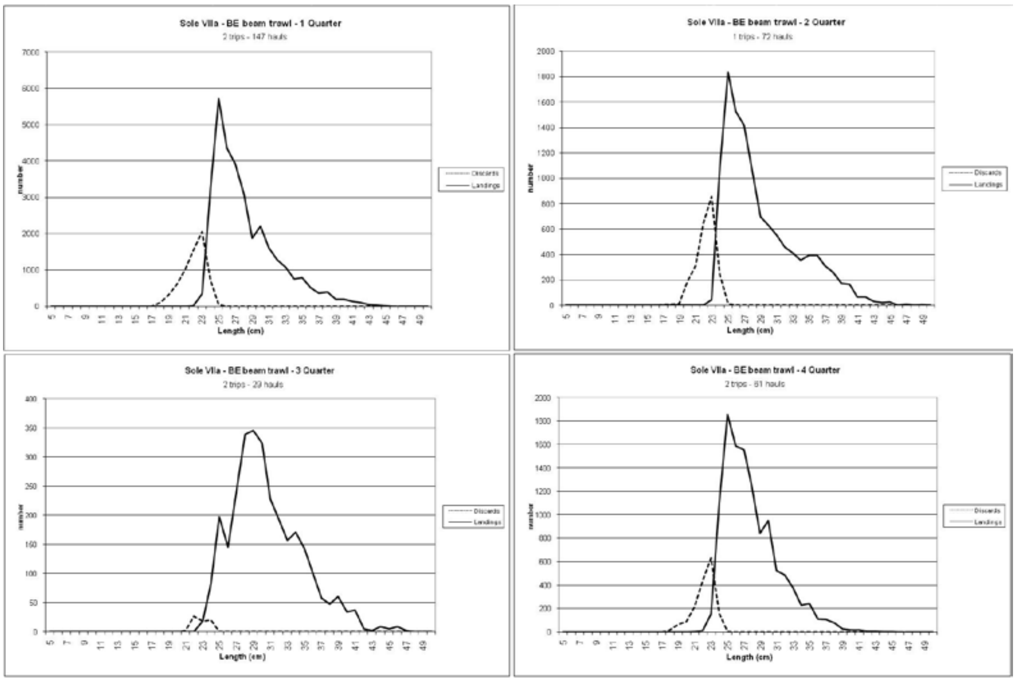



Figure 6.8.1a. Sole VIIa-BE Length distributions of discarded and retained fish from discard sampling studies.

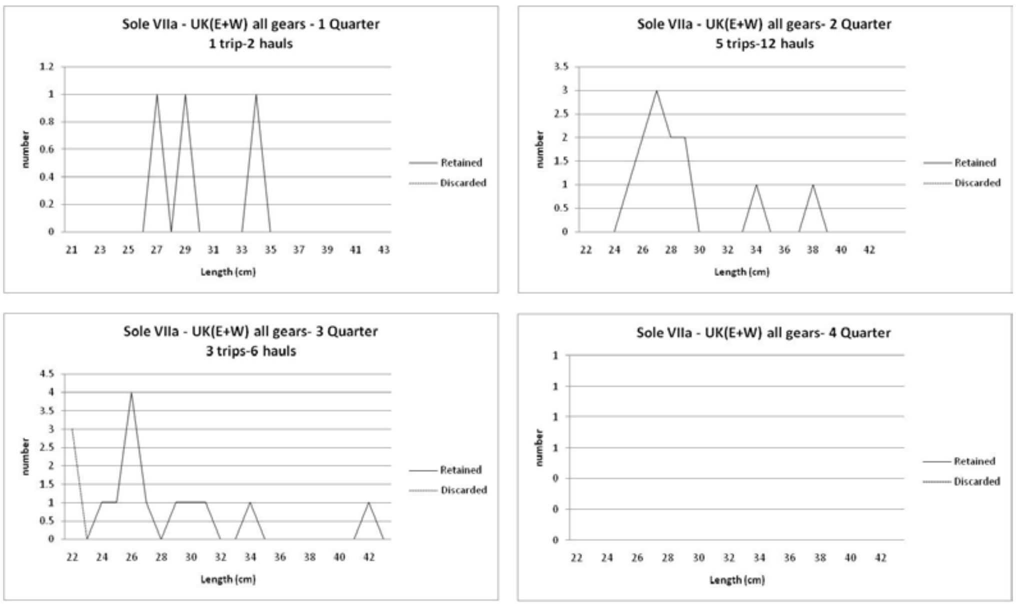



Figure 6.8.1b. Sole VIIa-UK Length distributions of discarded and retained fish from discard sampling studies.

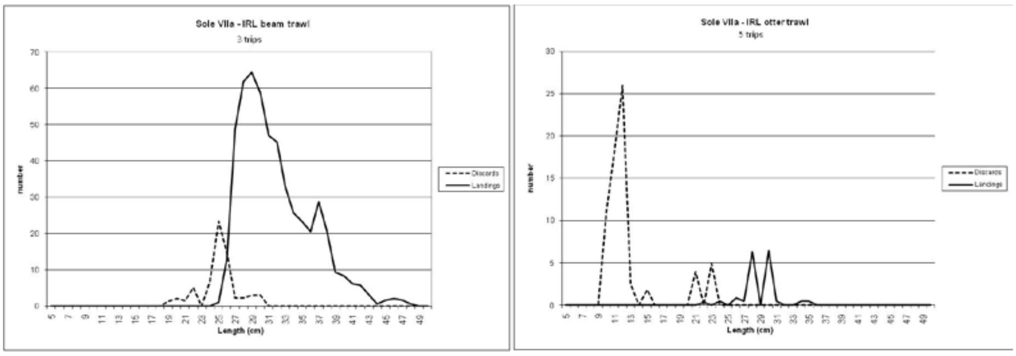


**Figure 6.8.1c. Sole VIIa-IRL Length distributions of discarded and retained fish from discard sampling studies.**

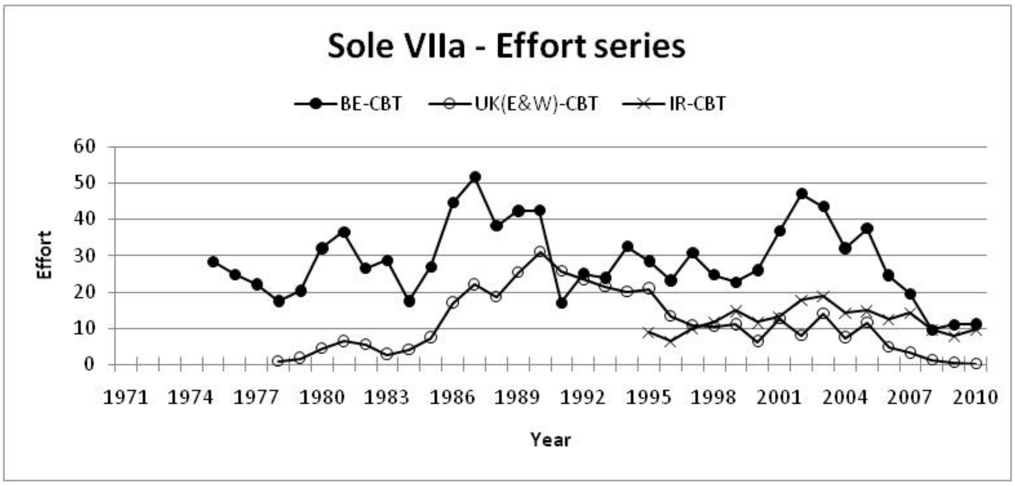



Figure 6.8.2a. Sole in VIIa. Effort series.

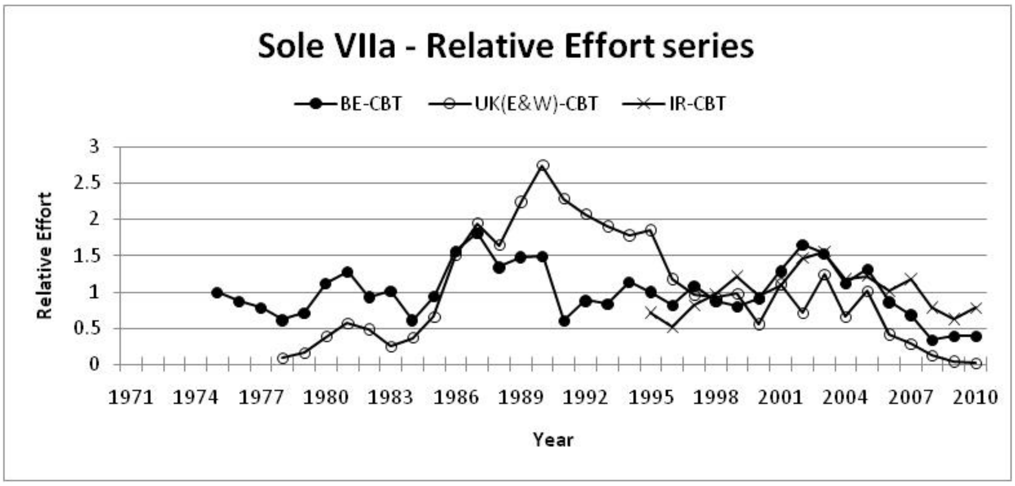



Figure 6.8.2b. Sole in VIIa. Relative effort series.

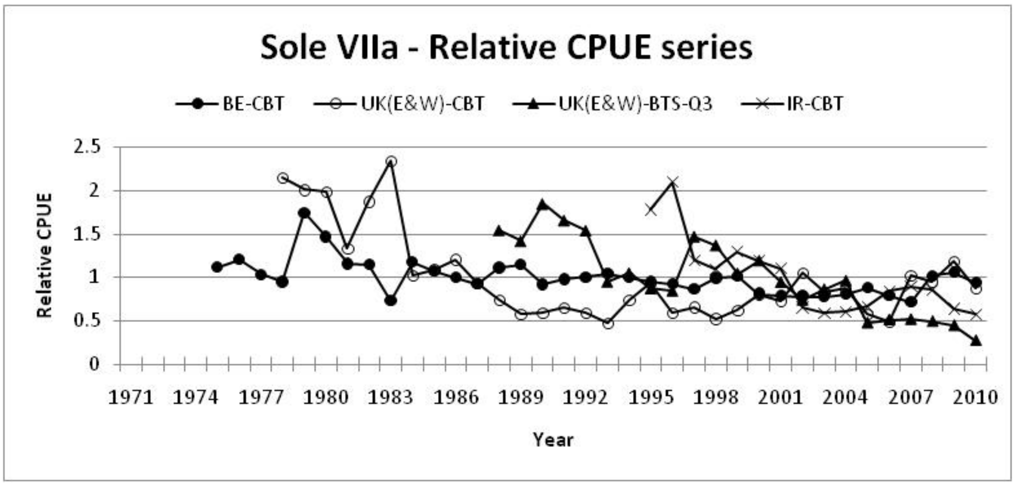



Figure 6.8.2c. Sole in VIIa. Relative cpue series.

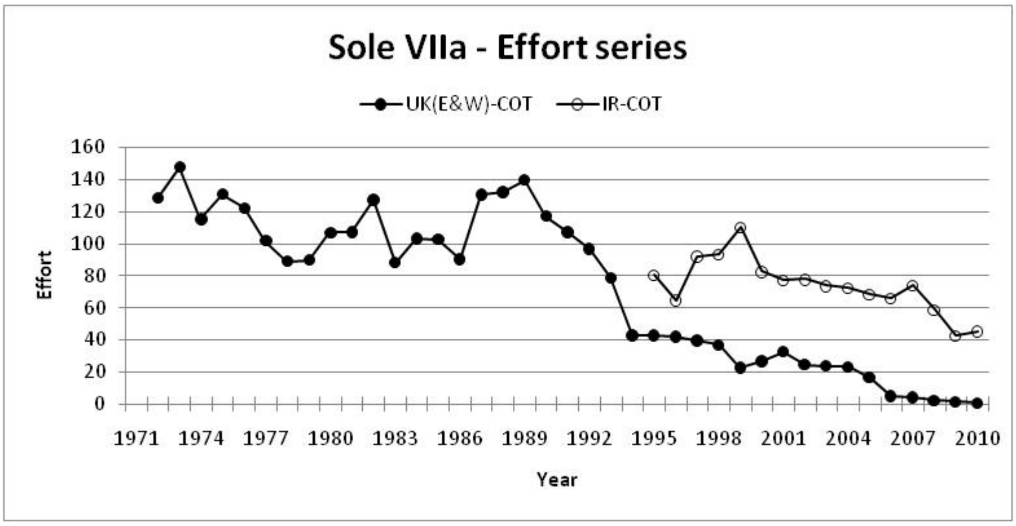



**Figure 6.8.3a. Sole in VIIa. Effort series.**

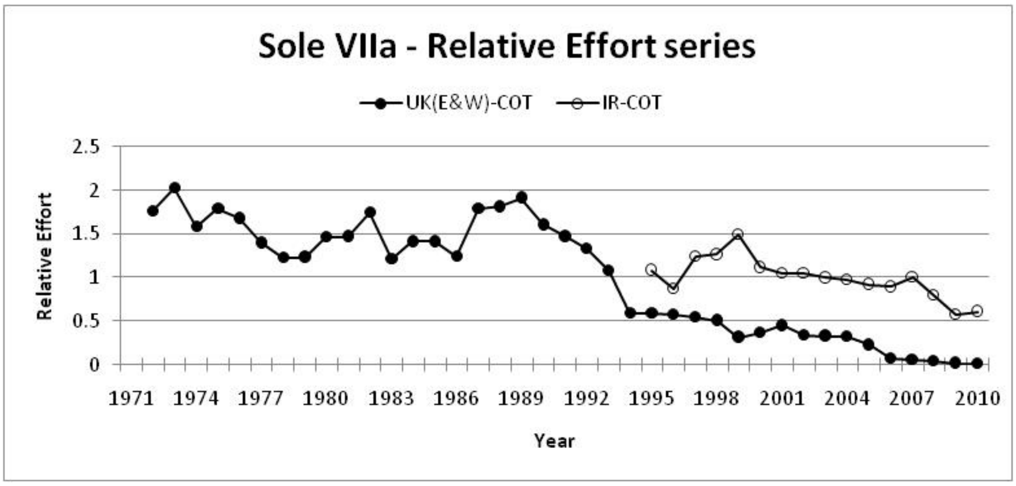



**Figure 6.8.3b. Sole in VIIb. Relative effort series.**

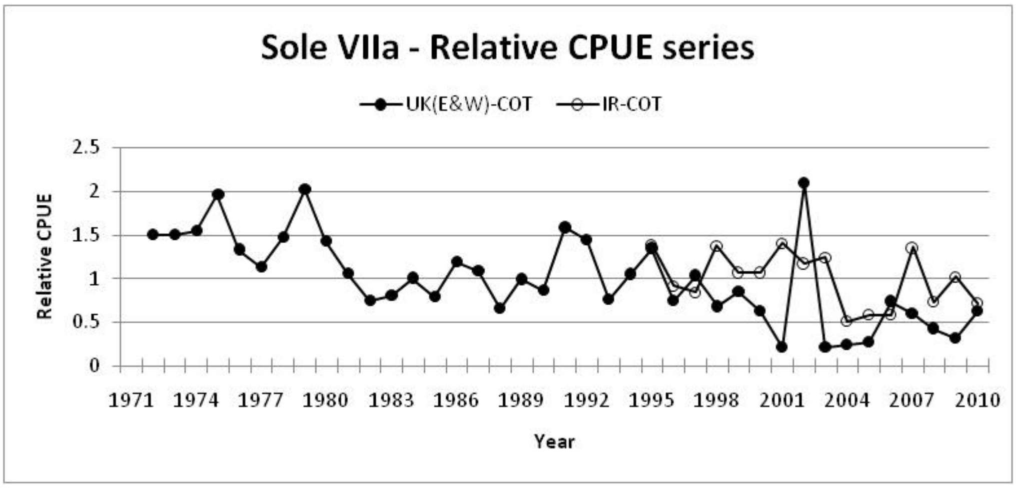
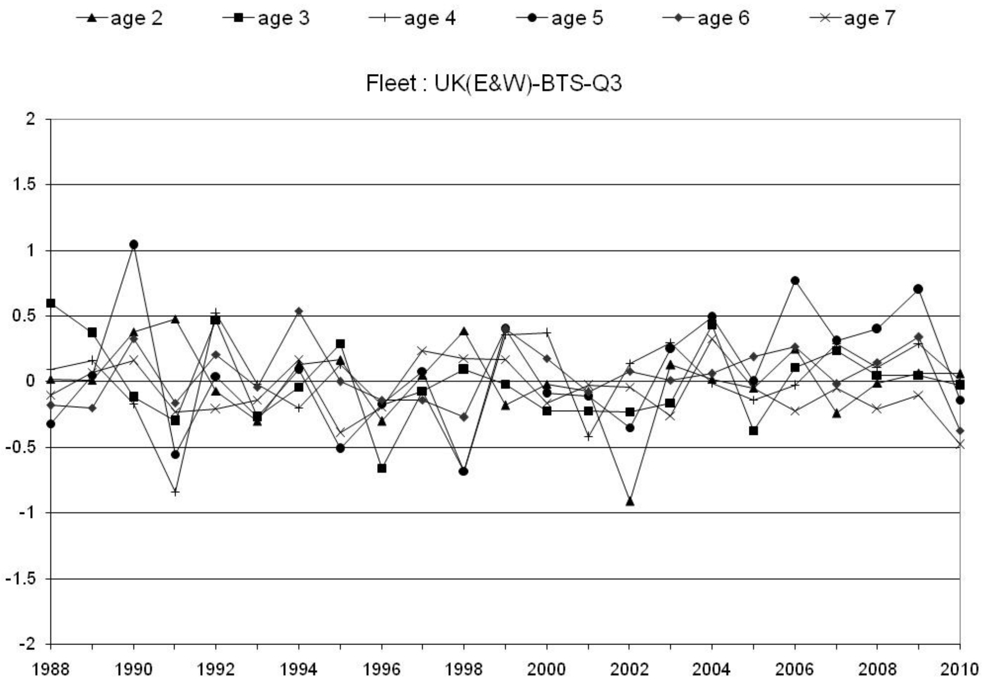



**Figure 6.8.3c. Sole in VIIa. Relative cpue series.**



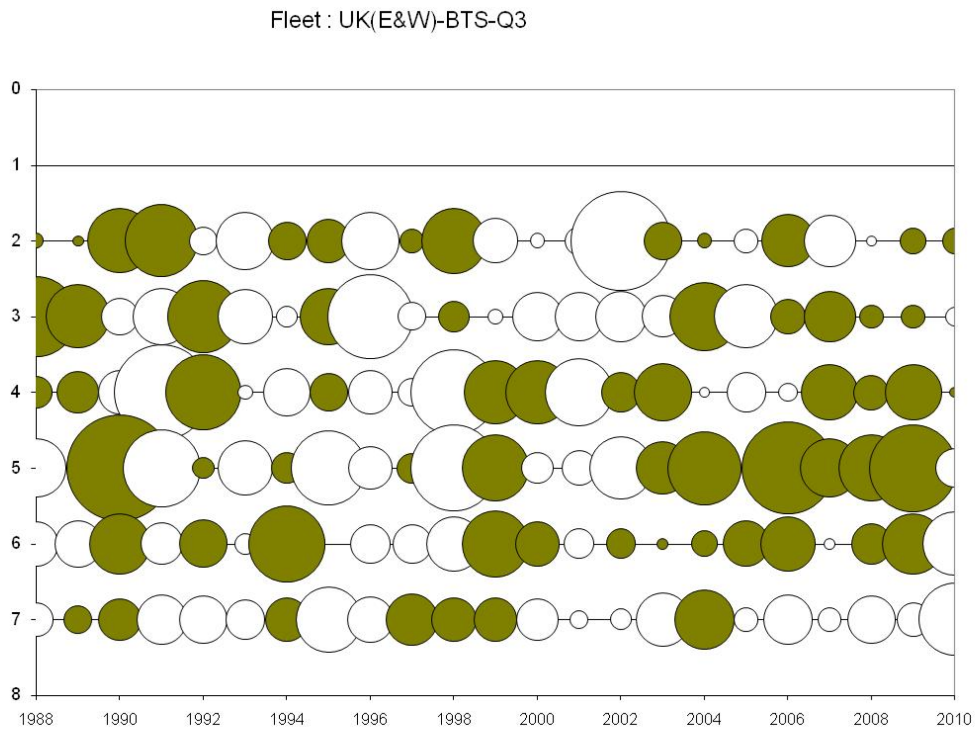




**Figure 6.8.4. VIIa Sole log-catchability residual plots. Final XSA.**

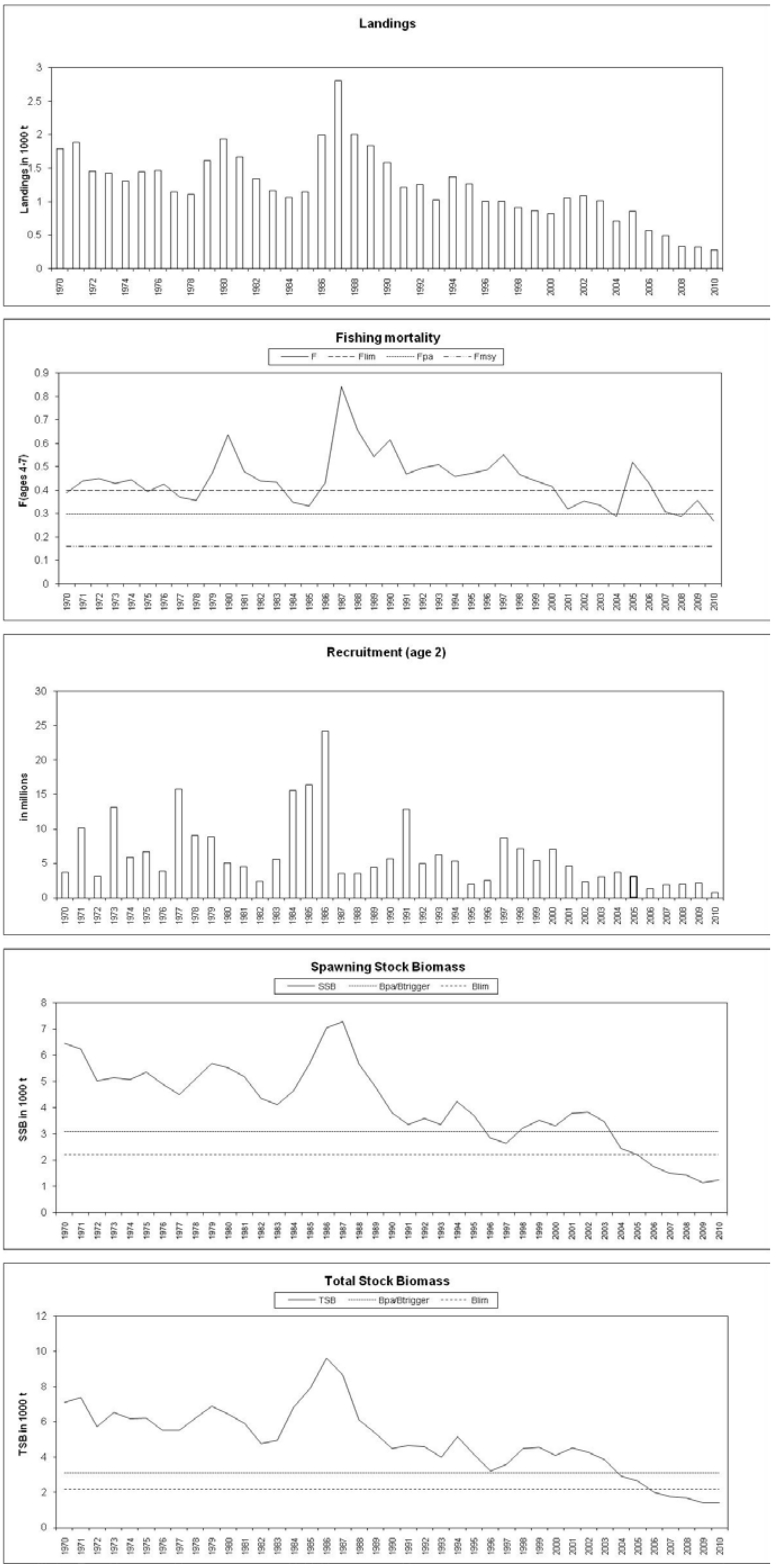



**Figure 6.8.5. Sole in VIIa. Summary plots.**

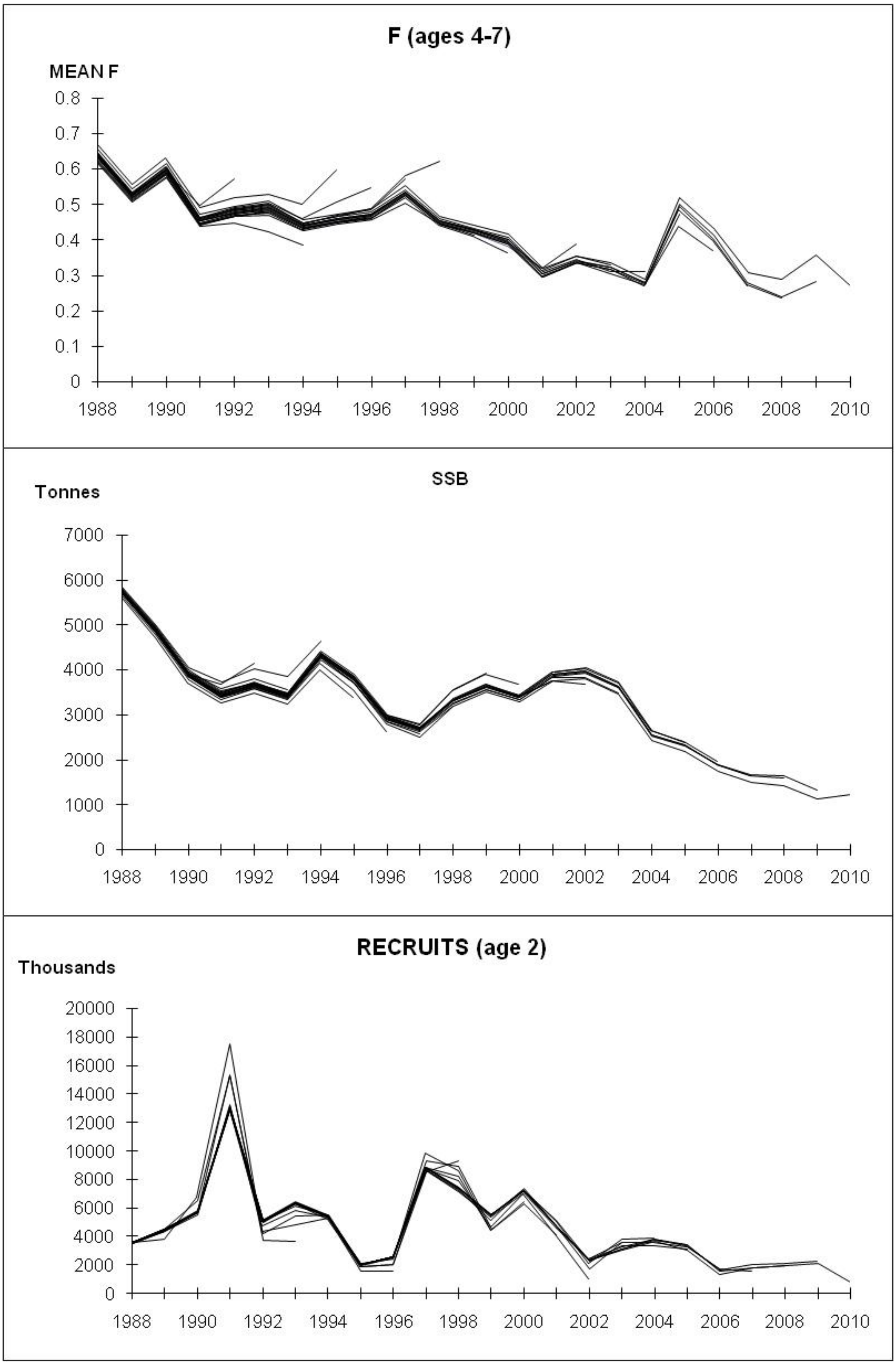



**Figure 6.8.6. Sole VIIa retrospective XSA analyses (shrinkage SE=1.5).**

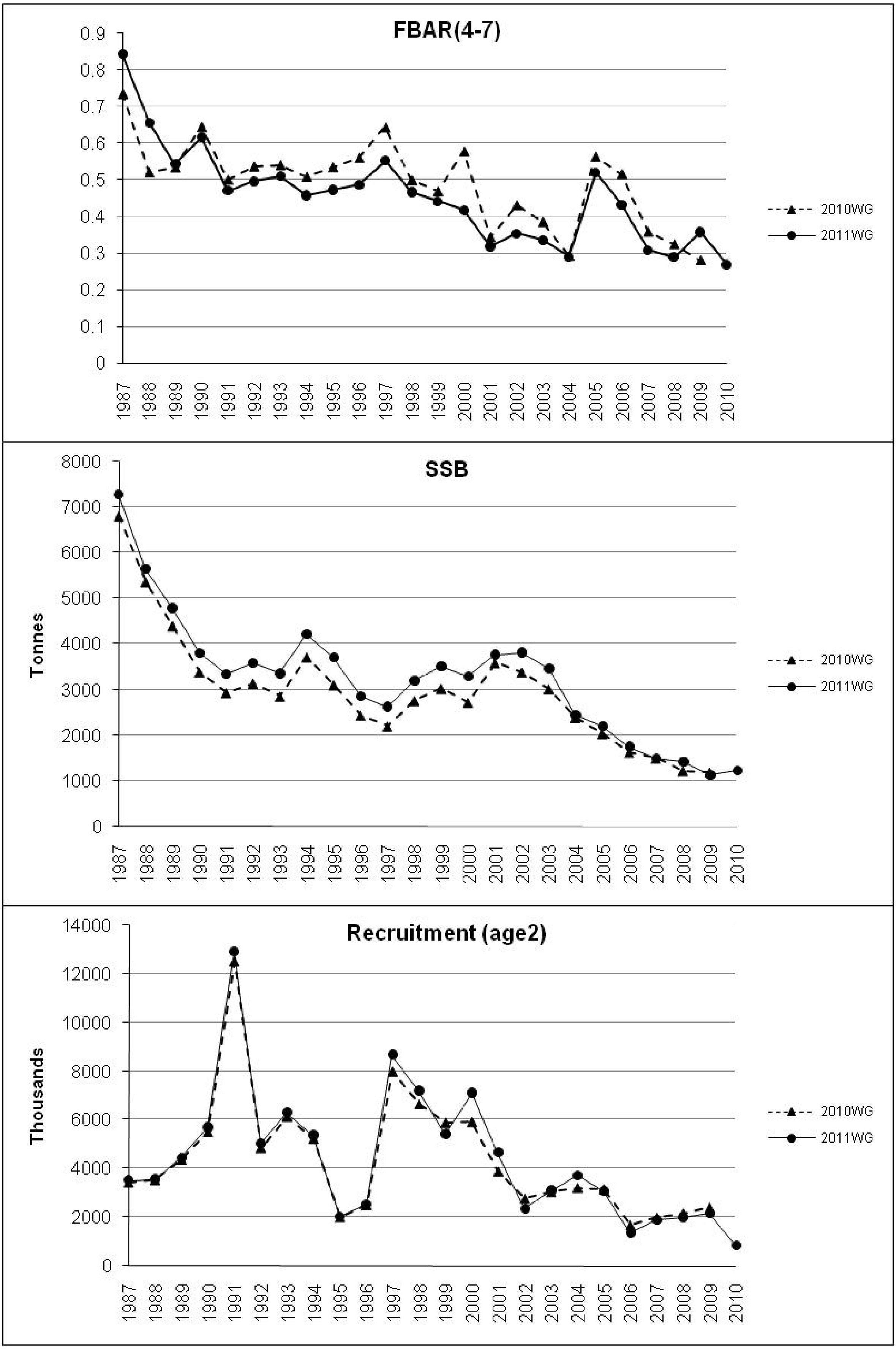
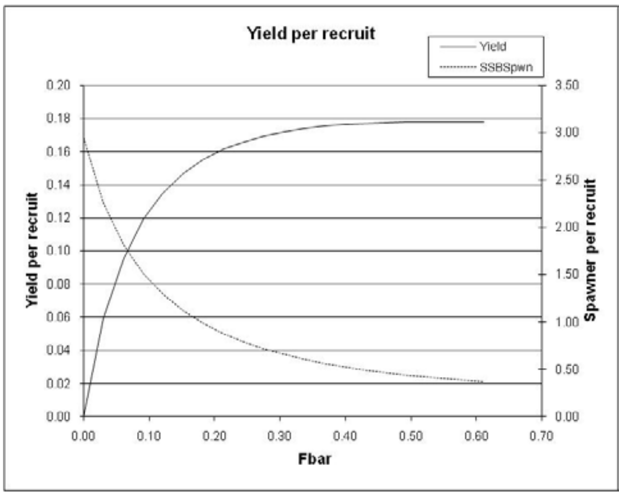
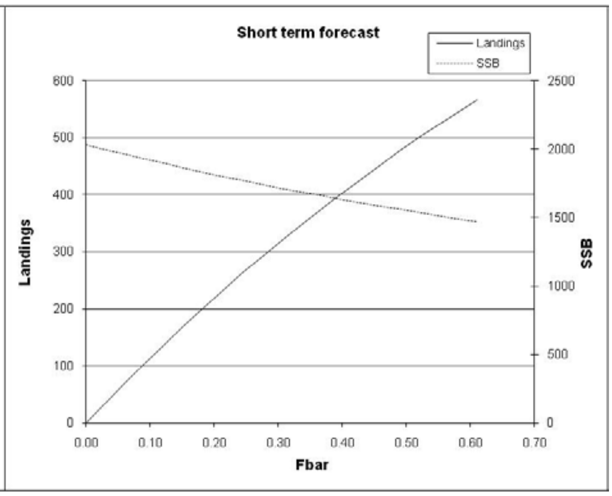



**Figure 6.8.7. Sole VIIa comparison with last year's assessment.**




MFYPR version 2a
Run: S7A_Y
Time and date: 18:47 12/05/2011

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(4-7) | 1.0000 | 0.3056 |
| FMax | 1.8056 | 0.5517 |
| F0.1 | 0.5769 | 0.1763 |
| F35%SPR | 0.5610 | 0.1714 |

MFDP version 1a
Run: Sole7A1
IRISH SEA SOLE,2011 WG
Time and date: 18:47 12/05/2011
Fbar age range: 4-7

Input units are thousands and kg - output in tonnes

**Figure 6.8.8. Sole in VIIa. Yield-per-recruit and short-term forecast plots.**

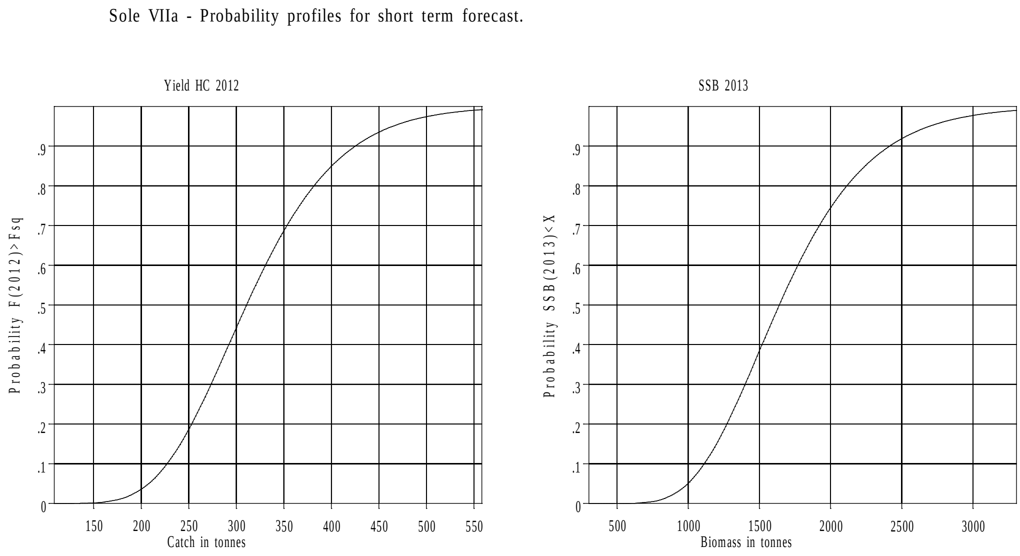



**Figure 6.8.9. Sole VIIa-probability profiles for short-term forecast.**


**Figure 6.8.10. Sole VIIa. Stock–recruitment plot.**

## 7.1 Celtic Sea overview

There is no overview.

## 7.2 Cod in Division VIIe–k (Celtic Sea)

### Type of assessment in 2010

#### Trends analysis

For Celtic Sea cod, the Benchmark Workshop WKROUND 2009 concluded that more work was required before this stock could be benchmarked. The Review Group of WGCSE 2009 added that shortcomings of the data and reconstruction of datasets should be completed in order to continue using an aged based assessment in future.

The recommendations made by WKROUND 2009 were:

- Improvement of the quality of assessment input data, of documentation on data correction in the Stock Annex and data integration and fishery description at regional level through a regional database.
- Evaluation of sampling levels by fleet required to get precise discard estimates for stock assessment. The RG concurred with the conclusion drawn by the Benchmark that cooperative projects with industry on self sampling, and reference fleets, etc should be developed to obtain better estimates of discards. Datasets obtained through fishers science partnerships should be used to complement those discard data collected by fishery observers.
- Estimates of "true landings" as reported landings data and landings equivalents since 2003 are thought to be underestimated.
- International coordination on maturity sampling as there is evidence that maturity has changed for this stock. A directed survey might be needed.
- Improvement on knowledge of stock structure and migration behaviour.
- Reduction of noise in the data from the surveys.

Solutions to those recommendations have been suggested by WGCSE in 2010. Some effort to improve the knowledge of this stock is currently done through survey and industry–science partnerships with new data already available which will be scrutinized during next benchmark in 2012. Those initiatives are summarized later in this section.

The Review Group of WGCSE 2010 noted that the specific TOR for VIIe–k cod was in 2010 to perform an update assessment (as opposed to SALY). The WG last year followed the WKROUND advice not to perform an analytical assessment due to catch uncertainties .The Review Group noted that *"this unfortunately precludes any presentation of long-term trends in SSB, F and recruitment other than the separable VPA recruitment series presented, and it is not possible to see if the addition of new data has affected the WKROUND conclusions. This leaves a critical cod stock with very little quantitative advice on stock status."* This year, an exploratory XSA has been carried out. The used data includes the extra years of corrected data for highgrading and misreporting since 2008.

### ICES advice applicable to 2010

*"ICES advises on the basis of precautionary considerations that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reduction."*

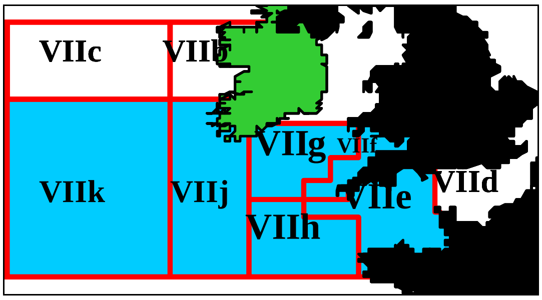
### ICES advice applicable to 2011

*"ICES advises that catches of cod should be reduced although it is not possible to determine the appropriate scale of such reduction."*

## 7.2.1 General

#### Stock description and management units

The 2011 TAC was set for ICES Areas VIIb–c, VIIe–k, VIII, IX, X, and CECAF 34.1.1(1), excluding VIId. This is more representative of the stock area than in the previous years as the cod population in VIId is more relevant to the North Sea population but landings from VIIbc are not included in the assessment area (see Section 7.3 for these).




**Red Boxes-TAC/Management Areas** **Blue Shading-Assessment Area.**

Management applicable since 2009.

**TAC 2010**

| Species: Cod *Gadus morhua* | | Zone: VIIb, VIIc, VIIe-k, VIII, IX and X; EU waters of CECAF 34.1.1 (COD/7XAD34) |
|---|---|---|
| Belgium | 167 | |
| France | 2 735 | |
| Ireland | 825 | |
| The Netherlands | 1 | |
| United Kingdom | 295 | |
| EU | 4 023 | |
| TAC | 4 023 | Analytical TAC |

**TAC 2011**

| Species: Cod *Gadus morhua* | | Zone: VIIb, VIIc, VIIe-k, VIII, IX and X; EU waters of CECAF 34.1.1 (COD/7XAD34) |
|---|---|---|
| Belgium | 167 | |
| France | 2 735 | |
| Ireland | 825 | |
| The Netherlands | 1 | |
| United Kingdom | 295 | |
| EU | 4 023 | |
| TAC | 4 023 | Analytical TAC<br>Article 13 of this Regulation applies. |

### Fishery in 2010

Landings data used by the WG are shown in Table 7.2.1. The French landings have been revised upward for 2009 from 2027 t to 2080 t. French landings data for 2009 were updated and are considered preliminary for 2010 with minor revisions expected for WGCSE 2012. No revision was required for Ireland, UK, Netherlands and Belgium.

International landings have decreased in 2009 and 2010 to around 3200 t after the 2007 peak of 4200 t, which corresponded to approximately half of the average (8200 t) of the time-series. They are now close to their lowest historical values. Since 1988, French landings accounted for ~70% of the international landings and they have declined to around 59% of the total in the last three years. French landings indicate that only 68% of the national quota has been taken. This is mainly related to 1) decommissioning of a substantial number of vessels since 2009; 2) low fish market prices for cod landings which led the vessels to direct their fishing effort towards other demersal species (e.g. haddock).

Irish landings accounted on average at 14% but more recently ~30%. UK and Belgium have contributed on average to 9% and 2%.

There is no information on the absolute level of misreporting for this stock but there is evidence that misreporting has increased from 2002 when quotas became restrictive with a maximum in 2008. Misreporting has decreased since then. Irish landings data in some years have been corrected for area misreporting into the southern rectangles of VIIa. These misreporting estimates are summarized in table below.

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Mis alloc (t) | 108 | 54 | 103 | 527 | 558 | 193 | 143 |

French landings have been corrected with highgrading estimates from 2003 to 2005. The method used to estimate the highgraded component is described in WD#1 of the WG SSDS 2006. For smaller length classes, a scaling of French numbers-at-length based on UK length frequencies or UK number-at-length has been used to estimate length compositions of the French component of highgrading. The accuracy of this method is unknown but it probably underestimates the highgrading levels for those years. Unfortunately, the sampling level of total catch at sea in that period was too poor to get an estimate of the level of bias.

This method was not applied from 2006 onward because highgrading was also observed in the UK landings. Instead, self sampling data obtained in 2008–2009 have been used to estimate the French highgrading level, assuming that the discarding practices in 2006–2007 were the same as those observed in 2008 for the main self-sampled fleet. Applying this method back to 2003 was considered inappropriate. The representatives of Fishermen Organisations at WKROUND 2009 indicated that the discarding level was probably not the same in earlier years as highgrading practices are linked to the level of the TAC. The whole method has been described in the WD#17 of WKROUND 2009.

The estimates of highgrading by year are slightly revised when annual landings statistics are updated. In 2011, the time-series of estimates is:

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| HG (t) | 210 | 148 | 74 | 432 | 592 | 322 | 25 | 7 |

In 2009 and 2010, the low estimate of highgrading is likely to be related to the French vessels not being restricted by quota because of the decommissioning plan and the reports of effort directed towards more profitable species.

Both assumed Irish area misreporting and French highgrading estimates since 2003 in percentages of the landings are summarized in the table below:

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| % | 3 | 7 | 4 | 14 | 23 | 22 | 7 | 5 |

Highgrading also occurred in the UK catches in 2007–2008 but given the low level of landings, it has not been estimated.

The MLS of the Belgian landings is currently set at 50 cm since 2008.

### Fishery-science partnerships

#### *French self-sampling programme*

In 2009, the French self-sampling programme has been extended to several "métiers". The programme is voluntary under the auspices of the main Fishermen Organization P.M.A (Pêcheurs de Manche et Atlantique). In 2009, six otter trawlers have participated, providing data for métiers targeting either gadoids (OTB or OTTPD), *Nephrops* (OTTLN) or benthic species such as monkfish, megrim, rays , john dory (OTB or OTTPB). In 2010, four otter trawlers have participated. 38 trips were sampled in 2008, 86 in 2009 and 43 in 2010; summarized in the text tables below. Many trips of the métier targeting benthic species of fish have been sampled though its contribution to the cod catches or landings is generally small. The reasons are both the voluntary basis of the programme and the shorter duration of the trips of that métier, seven days at sea instead of 12–14 days for the other métiers.

| Gear Code | Q1 | Q2 | Q3 | Q4 | Total | Métier | 2009 |
|---|---|---|---|---|---|---|---|
| OTBPB | 7 | 15 | 14 | 7 | 43 | BENTH= OTBPB+OTTPB | |
| OTBPD | 6 | 5 | | | 11 | GADI= OTBPD+OTTPD | |
| OTTLN | 1 | 3 | 1 | | 5 | *NEPH*= OTTLN | |
| OTTPB | 1 | | 3 | 2 | 6 | | |
| OTTPD | 8 | 6 | 5 | 4 | 23 | | |
| Total | 23 | 29 | 23 | 13 | 88 | | |
| **Gear Code** | **Q1** | **Q2** | **Q3** | **Q4** | **Total** | **Métier** | **2010** |
| OTBPB | 9 | 11 | 5 | | 25 | BENTH= OTBPB+OTTPB | |
| OTBPD | 4 | 6 | 3 | | 13 | GADI= OTBPD+OTTPD | |
| OTCRU | | | 5 | | 5 | *NEPH*= OTTLN | |
| Total | 13 | 17 | 13 | | 43 | | |

| Gear code | Q1 | Q2 | Q3 | Q4 | Total | Métier |
|---|---|---|---|---|---|---|
| | | | | | | |
| 2009 | | | | | | |
| OTDEF | 22 | 26 | 22 | 13 | 83 | Otter trawl targeting gadoids |
| OTCRU | 1 | 3 | 1 | | 5 | Otter trawl targeting *nephrops* |
| Total | 23 | 29 | 23 | 13 | 88 | |
| | | | | | | |
| 2010 | | | | | | |
| OTDEF | 13 | 17 | 8 | | 38 | Otter trawl targeting gadoids |
| OTCRU | | | 5 | | 5 | Otter trawl targeting *nephrops* |
| Total | 13 | 17 | 13 | | 43 | |

Several métiers can be fished during a single trip by changing fishing grounds (from fish to *Nephrops* for instance). Métiers have been identified by targeted species indicated by the skippers for each haul carried out.

During 2009, 2883 hauls have been sampled from 6022 carried out in the trips involved in the self-sampling programme. The sampling level for the Gadoid métier has fluctuated between 34 and 49% of hauls carried out. There is no sampling in the first quarter from the *Nephrops* trawlers because the methodology was more difficult and more time consuming to use in hauls where fish and *Nephrops* were always mixed. Results were better during the *Nephrops* season (Q2&3) and poor in quarter 4 because of the heavy sea conditions. The number of hauls carried out and sampled is indicated in the text table below.

| Métier | Q1 | Q2 | Q3 | Q4 | Total 2009 |
|---|---|---|---|---|---|
| BENTH Total | 925 | 960 | 669 | 307 | 2861 |
| BENTH sampled | 231 | 559 | 501 | 266 | 1557 |
| GADI Total | 1147 | 1164 | 446 | 294 | 3051 |
| GADI sampled | 393 | 545 | 189 | 145 | 1272 |
| *NEPH* Total | 31 | 45 | 34 | 3* | 110 |
| *NEPH* sampled | 0 | 29 | 24 | 1 | 54 |
| three hauls targeting *Nephrops* in a GADI trip | | | | | |
| **Métier** | **Q1** | **Q2** | **Q3** | **Q4** | **Total 2010** |
| BENTH Total | 321 | 454 | 179 | - | 954 |
| BENTH sampled | 172 | 432 | 178 | - | 782 |
| GADI Total | 207 | 275 | 140 | - | 622 |
| GADI sampled | 83 | 249 | 140 | - | 472 |
| *NEPH* Total | - | - | 219 | - | 219 |
| *NEPH* sampled | - | - | 217 | - | 217 |

In 2010, 1471 hauls catching cod have been sampled from 1795 hauls carried out.

Retained and discarded part of the catch will have been scrutinized in each haul sampled. Overall 17 215 cod have been measured in 2009, 15 310 belonging to the retained part and 1905 to the discarded part. In 2010, 12381 cod have been measured, 9709 in the retained part and 2672 in the discarded part of the catch.

Since 2010, sampling data are provided by the Professional Organization (P.M.A) in a database currently located at Ifremer/Lorient.

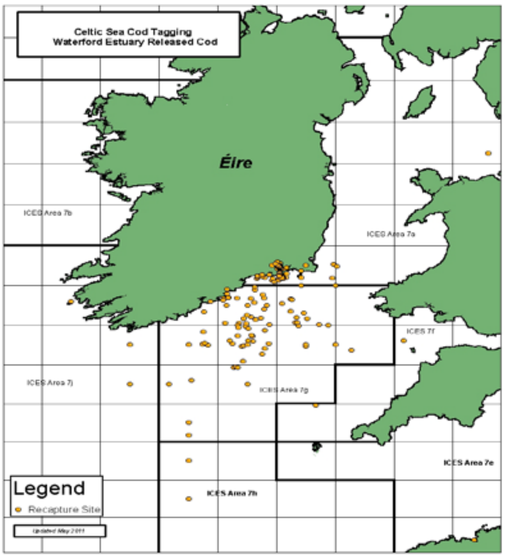
Motivation of the crew or the vessel owners could remain a problem in future. The reasons are that 1) the effort of the industry to provide more biological data is not linked with incentives in setting TAC and quotas, 2) there has been in 2009 and after a pragmatic fit between the quota set and the fleet effort by change of métier or decommissioning which led to an under-consumption of the agreed quota. In addition, the reduction of personnel among scientific staff which used to manage or deal with the data flows from the industry adds additional problems to have the information made available in time for the working group.

#### *Ireland-UK tagging programme in the Irish and Celtic Seas*

The tagging programme focuses on both nursery areas and spawning aggregations of cod in the Irish and Celtic Seas, and involves conventional (plastic) tags and sophisticated electronic data storage tags. The programme in the Celtic Sea commenced in 2007 and is ongoing. The main objectives are to examine the movements of cod in relation to closed areas and in respect to stock mixing; to determine fine-scale movements and behaviour of cod during spawning; to examine vertical distribution (in relation to catchability) and thermal experiences (in relation to gonad development). Results of tagging work to date was presented to ICES ASC in 2009 (Bendall *et al.*, 2009). These results describe fundamental features of cod spatial ecology in the Irish and Celtic Sea, such as the location of feeding and spawning grounds (and the migratory pathways between them), the seasonality of migration and habitat occupation and the potential impact upon substock structure. Recaptures to date of juvenile cod tagged in the south of VIIa (Waterford estuary) shows that the majority of recaptures have occurred in VIIg mainly (O'Cuaig, pers. comm.)

During March 2010 the Marine Institute in conjunction with the Irish South & East Fishermen's Organisation tagged and released a further 2110 cod in the Celtic Sea Ecoregion. Of these, 242 cod were adult cod released on the offshore spawning grounds while the rest (1868) were juvenile cod caught and released in the nursery grounds of Waterford Estuary. This brings the total Celtic Sea Cod released to date by the Marine Institute to 9098. Currently the overall recapture rate stands at 10.9%. The higher recapture rate of 13.3% associated with the offshore released fish is expected as these fish are in an area of higher fishing effort.

The recapture positions associated with the juvenile cod confirms the need to include some of VIIa South Cod in any analysis of the Celtic Sea Cod stock. The map below illustrates the recapture positions to date.




Preliminary results from the DST (data storage tag) returns show that the cod migrate in a clockwise pattern from the spring-spawning area to the summer feeding grounds to the east (The Smalls) before returning the spawning area of initial release. This pattern is the pattern that local fishers would have suggested from their own experience of working with the stock.

While no further tagging was carried out by the Marine Institute in 2011 due to funding constraints it is hoped that more will be carried out in future. As returns to date show that cod can be recaptured up to three years after initial release 2011 will continue to gather data for this project.

#### *Irish industry-science partnership quarter 1 cod survey*

ICES (2009) notes that "given the uncertainty in the landings, the surveys represent the main source of information for estimating the historical trends in the stock." However, the current IBTS survey is conducted in quarter 4 when the stock is widely dispersed resulting in poor ability to track abundance due to low catch rates. ICES notes that "changing the surveys' design or programming additional stations are not thought to be relevant solutions, given the implications on other survey objectives" and ICES (2009) conclude that "adding a survey in quarter 1 would be the best solution, in order to monitor both the concentration of fish and the maturity during the spawning period." In recognition of this advice, the Marine Institute and the Federation of Irish Fishermen, in 2010 initiated an annual Q1 fishery-independent survey for

Celtic Sea Cod. The survey uses a commercial vessel and a dedicated survey trawl specification, based on a commercial design and in accordance with the criteria laid down in ICES Study Group on Survey Trawl Standardization (SGSST, 2009). The survey stations (Figure 7.2.1) are based on both Irish and foreign fleet VMS and/or logbook data. Using the VMS and logbook data, the Celtic Sea has been divided into areas of low, medium and high commercial catches and the survey sites have been randomly selected within these three categories (survey strata) with around 50% of the effort in the high areas and 30 and 20% in the medium and low (Figure 7.2.1).

The first of such surveys was carried out by the Marine Institute from 14–23 March 2010 and is the first in an annual series that aims to track the abundance of Celtic Sea cod by targeting them when they are aggregated for spawning. The survey will provide fishery independent data on the relative abundance of adult and juvenile cod which will form a 'time-series' that will allow interannual variation in abundance, biomass, recruitment and mortality to be assessed. This type of information can be used on its own to provide an estimate of stock size and overall mortality or as a 'tuning index' to drive the ICES stock assessment.

The average catch rates for the entire survey area were 30.1 cod per $km^2$ and 25.3 kg per $km^2$. There was no significant difference in catch rates between the random scientific stations and the stations selected by industry. Catches were dominated by small, young individuals and 80% were one year old. Higher catches were found inside the Celtic Sea Conservation Area although there was no difference found in the maturity pattern. Growth rate in the survey area was rapid and higher than for other cod stocks. The combination of good recruitment and fast growth provides an opportunity for high yields to be taken by the fishing industry in this area.

The survey should be considered primarily as a starting point in a time-series that provides an index of abundance to facilitate the assessment of the cod stock in the Celtic Sea. However, to provide a crude approximation of the size of the cod stock, the data from the survey (cod/$km^2$ caught) was raised to the entire area. However, this assumes that all cod in the trawl path were caught (100% catchability), which in practice is unlikely, therefore the stock size estimate given is likely to be an underestimate. For this work to fulfil its potential it is critical that the survey is combined with a programme to obtain better commercial catch data on the weight and age structure of landings and discards.

#### Landings

Tables 7.2.2 and 7.2.3 show the annual length structure of the landings per métier and country and the catch numbers-at-age respectively.

It is noticeable that this stock has always been composed of a few age classes. The catch number-at-age table (Table 7.2.3) shows the catch-was mainly composed of age 2 over the period 2005–2008. In 2009 the proportion of 2 year old fish is comparatively low and ages 3, 4, and 5 are higher than those observed since 2005. In 2010 year class 2009 (age 1) represents 40% of the total number of landed fish. This is the strongest recruitment since 2000. Age 2 represented 30% of the total number of landed fish.

#### Discards

Table 7.2.4 and Figure 7.2.2a–d show the length structure of landings and discards per country and quarter with a split by métier for France. French information is split into self-sampling (Figure 7.2.2d) and on-board observer programmes. It is noticeable that the majority of the cod discarded result from the highgrading behaviour, for

France and UK. Discarding of undersized individuals is at low level for all countries. Comparisons with last year's report show the landings/discards pattern is strongly variable between fleets and years. This year, discards for the French fleets have substantially changed from last year. In 2009, age 1 individuals (30–45 cm) were mainly discarded. In 2010, most of them were landed. Discards in UK and Irish fleets were substantial for age 1 individuals and shows well the 2009 year class. The discard pattern in 2010 has not changed from 2009 with most individuals below 40–45 cm being discarded. Discards were also available from Belgium. For these fleets, the modal distribution of discards was around 30 cm. Due to the MLS being set at 50 cm for Belgium, discards occur well above 35 cm while relatively low in numbers.

#### Biological

Catch in numbers-at-age (Figure 7.2.3) and stock weights are given respectively in Tables 7.2.5 and 7.2.6. The final year estimates are consistent with the recent historical values.

Natural mortality, percentage of F before spawning and maturity ogive remained unchanged and are described in the Stock Annex. Celtic Sea cod are very fast growing and early maturing compared with more northern cod stocks.

#### Surveys

Tables 7.2.7 present the survey dataseries.

Internal consistency of the two ongoing surveys both part of DCF IBTS Q4 (FR-EVHOE & IR-GFS7gj combined) has been explored using SURBA software. The number of fish sampled during those surveys remains low as those species are not specifically targeted. The raw abundance indices (number of individuals caught per 30 minutes tow) of FR-EVHOE have been provided to the WG. WGCSE in 2010 estimated that indices have an average CV of around 25% and have changed since 2002 within the confidence intervals.

Figure 7.2.4a summarizes the single fleet analysis for FR-EVHOE. The tracking of recruitment is well defined for the relatively good YC 1996, 1999 and 2000, and poor YC 2001 and 2002, especially at age 1. The weakness seems to be in-between year consistency especially for the older ages. The log residuals show a low level of noise, resulting from the recurrent low catch rates.

Figure 7.2.4b represents the single fleet analysis for IR-GFS7gj. The short time-series prevents conclusions on the consistency, but the tracking of recent year classes is consistent with FR-EVHOE except for the 2007 YC.

For both surveys, year class 2009 provides a strong signal indicating a strong recruitment.

Figure 7.2.4c represents SURBA model estimates of mean Z for the three single fleets. Each time-series of Z fluctuates within the magnitude of the uncertainty, resulting in non-robust general trends. Moreover, SURBA is known to provide poor estimates of parameters for the most recent years. As a result, no clear trend can be seen from the surveys.

Overall, no clear trend of change in mortality can be derived from any of the survey indices.

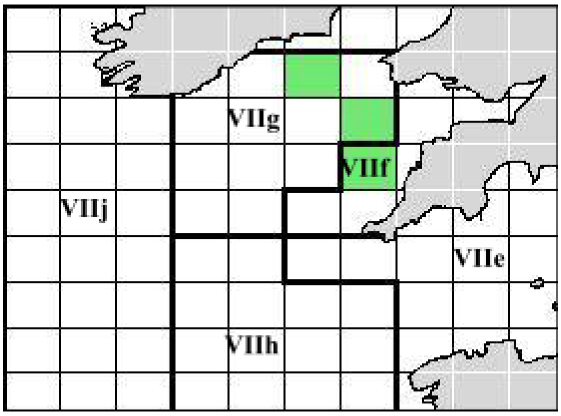
Figure 7.2.4d represents SURBA model estimates for recruitment for both separate and combined surveys. All indices suggest a strong recruitment for year class 2009.

**Commercial cpue**

Tables 7.2.8a, b and c show the series of landings, fishing effort and lpue dataseries for four French fleets, three UK fleets and eight Irish fleets. Figure 7.2.5a and b show their trends. French catch and effort data for 2009 were not available at the time of the meeting. A general decrease in the lpue trend is observed in almost all series between 1990 and 2004, where the TAC began to be constraining. From that point, the lpues seemed to stabilize, or even to increase if highgrading is taken into account.

Different features are observed in the effort time-series. The métiers showing the highest levels of cod directed effort have decreased significantly in the last 5–10 years. Irish otter shows an increasing trend over the period, the majority of this effort is directed towards *Nephrops*.

A special effort has been made during the 2009 WG to combine international landings and effort datasets and produce historical distribution maps. These maps are respectively composed of France, UK, Ireland and Belgium landings (Figure 7.2.6), France and Ireland efforts (Figure 7.2.7) and lpue (Figure 7.2.8). The data are not corrected for misreporting or highgrading. The main outcome of these maps is the shrinking of the geographical area of the stock over the years. This is particularly visible in the distribution of the landings (Figure 7.2.6). The perceived decrease of landings over time is to be regarded with caution given the recent levels of misreporting and highgrading. The rectangles temporarily closed (30E4, 31E4 and 32E3) since 2005 were clearly among the most important in terms of lpue.




**Green: Trevose closed areas.**

### 7.2.2 Stock assessment

Model used: None.

No analytical assessment was carried out on this stock in 2008 and 2009, following the recommendations from WKROUND 2009 and the lack of revision of the available datasets.

An exploratory analysis on the MSY approach was performed last year following the guidelines defined during WKFRAME using the YPR software (http://nft.nefsc.noaa.gov/). YPR has been used to explore the expected yield under equilibrium conditions, of growth, maturity and natural mortality, for a given or assumed fishery pattern, across a range of exploitation levels. With a natural mortality of M=0.2, assuming a fishing mortality between 0.82 and 0.85, the fishing mortality appeared twice above the value of $F_{max}$ and three times the value of $F_{0.1}$ and $F_{40\%}$. These $F_{max}$ and $F_{0.1}$ estimates are very much in line with those obtained from historical XSA assessments for this stock (see previous WGSSDS reports). Fishing mortality from historical XSA assessments have been well above $F_{max.}$ and in line with those obtained here.

### Exploratory XSA

This year, following the recommendations of the Review Group of WGCSE 2010, considering better estimates of misreporting and highgrading that have been made available to the Working Group since WKROUND 2009, an exploratory assessment using XSA has been carried out based on revised landings to include misreporting and highgrading.

The model parameters used prior its abandon at WKROUND 2009 were reused as follow:

| | | | |
|---|---|---|---|
| Catch data range | | | 1971–2010 |
| Age range | | | 1–7+ |
| Commercial tuning-series | | | |
| | FR GADOIDSQ2+3+4 | | 1983–2008 |
| | FR-*NEPHROPS* | | 1987–2008 |
| | UK-WECOT | | 1989–2010 |
| | IR-7JG-OT combined | | 1995–2008 |
| | | | |
| | | | |
| Scientific Surveys | | | |
| | UK-WCGFS | | 1992–2004 |
| | FR-EVHOE | | 1997–2010 |
| | IR-GFSgj | | 2003–2010 |
| Taper | | No | |
| Age s catch dep. Stock size | | None | |
| q plateau | | | 5 |
| F shrinkage se | | | 1 |
| Year range | | | 5 |
| age range | | | 3 |
| age range of mean F | | | 2–5 |

The tuning indices used are in Table 7.2.9. Diagnostics tables are in Tables 7.2.10–7.2.13.

Summary plots (Figure 7.2.9) from the exploratory XSA show that fishing mortality has declined since 2005 to levels close to those around the years 1985–1990. This pattern is consistent with the overall observed decrease of fishing effort in recent years. Recruitment is the highest since 1987. This also consistent with the strong recruitment of year class 2009 observed by surveys and samplings at sea and at fish market. SSB seems to have increased since 2005 and appears to be at stable levels around the period 2007–2010. These results should be considered with caution considering this analysis does not include discards which have been variable between years and fleets.

In summary, this exploratory analysis suggests that F has decreased, SSB is stable and recruitment is high. This is consistent at least for F and recruitment with the available information.

Diagnostics show for survivors at age 1 that signals are rather similar between the French and Irish surveys. FR-EVHOE has higher standard errors than IR-GFS. Both surveys contribute explains 67% of the signal. Indices from UK-WECOT and IR-7GJ-OTB are rather consistent although those indices are based from distinct areas (respectively VIIe and VIIgj).

Diagnostics show for survivors at age 2 that the signal is equally driven by surveys and commercial indices. Indices from both surveys are again rather similar. Commercial indices have more differences between them.

For older ages, the signal is less driven by surveys than by commercial indices. UK-WECOT and IR-7GJ-OTB mainly drive the assessment. The weight of the French Fleet is lower due to the constraints at quarter 1 with the closure of the Trevose Box. They however gain more relative weight for ages 5 and 6.

The assessment appears to be driven at low ages by surveys (with a large number of young fish) and at higher ages by commercial indices which target bigger fish. Survey do not specifically target cod and especially older cod therefore the number of older individuals is rather lower adding noises to the assessment for older ages (3+ years and old fish). Another exploratory assessment has been made based only on FR-EVHOE and IR-GFSgj surveys (Figure 7.2.10 and Table 7.2.14). The outputs are similar to the previous assessment. This highlights that the assessment is mostly driven by the survey indices. Considering that older fish are rarely caught during surveys, some further development (e.g. for the benchmark in 2012) may include combining lower age indices from surveys to higher age class from commercial fleets.

A retrospective analysis has been carried out back to 2001 (Figure 7.2.11) with a limited set of indices excluding fleets with too short time-series. The following fleets were kept:

- FR-GADOIDQ2+3+4
- FR-*NEPHROPS*
- UK-WECOT(E+W)
- IR-7J-OT
- UK-WCGFS
- FR-EVHOE

Recruitment and spawning-stock biomass tend to be slightly underestimated. $F_{bar}$ (2–5) is slightly overestimated. The differences might be attributed with the uncertainties regarding the changes in discards practices. Overall, retrospective pattern does not appear to be substantial and the trends observed appear similar to those observed in past assessment (e.g. WGSSDS, 2008).

### 7.2.3 Short-term projections

No short-term projections were carried out.

### 7.2.4 Medium-term projection

No medium-term projections were carried out.

### 7.2.5 Biological reference points

WKROUND 2009 has suggested that, unless there is an investigation on the possible change in the maturity ogive, there was no solid reason to change the biological reference points. The biological reference points are then recalled below:

| Ref. point | ACFM 1998 | WG 1999* | ACFM 1999 | WG 2004 | ACFM 2004 |
|---|---|---|---|---|---|
| $F_{lim}$ | 0.90 ($F_{loss}$ WG98) | 0.90 (history WG99) | 0.90 (history WG99) | | 0.90 (history WG99) |
| $F_{pa}$ | 0.68 (5th perc $F_{loss}$ WG98) | 0.65 ($F_{lim}$*0.72) | 0.68 (5th perc $F_{loss}$ WG98) | | 0.68 (5th perc $F_{loss}$ WG98) |
| $B_{lim}$ | 4500 t ($B_{loss}$ =B76 WG98) | 5400 t($B_{loss}$=B76 WG99) | 5400 t ($B_{loss}$=B76 WG99) | 6300 t ($B_{loss}$=B76 WG04) | 6300 t ($B_{loss}$=B76 WG04) |
| $B_{pa}$ | 8000 t ($B_{lim}$*1.65) | 9000 t ($B_{lim}$*1.65) | 10 000 t (history) | Reject – no SR relation | 8800 t ($B_{pa}$ = $B_{lim}$ * 1.4) |

### 7.2.6 Management plans

A long-term management plan has been under discussion for this stock and an effort based management system in the Celtic Sea (VIIfg) is being discussed by member states and the EC.

### 7.2.7 Uncertainties and bias in assessment and forecast

The assessment of this stock is impaired by a strong uncertainty in the level of catches, especially since the TAC became constraining from 2003 onward. For this reason, and until a more reliable information is available, WKROUND 2009 concluded that the current assessment procedure treating catch numbers as unbiased was no longer appropriate. Surveys lack robust trends mainly due to their low catch rates.

### 7.2.8 Recommendation for next benchmark

This stock should be benchmarked with the other WGCSE cod stocks in January 2012.

| | | |
|---|---|---|
| Cod VIIe–k | WKROUND 2009 concluded that more work is required before Celtic Sea cod can be benchmarked successfully. WGCSE 2010 reviewed the available infromation and several improvements have occurred since WKROUND. There is now a time-series of self-sampling highgrading estimates. Discard and misreporting rates appear to have changed between years and fleets. Historical time-series of discards are required in order to include discards into the assessment.<br>There is evidence from sampling on the Irish “biological survey” that maturity has changed for this stock. WKROUND 2009 found that the use of new estimates increase SSB by up to 20% which is significant and warrants future sampling to obtain improved estimates of maturity-at age. If new information is available for the next benchmark (e.g from the Irish Celtic Sea cod survey), the use of new ogive should be investigated. | Expert Group members |

| | | |
|---|---|---|
| | WKROUND 2009 considered the use of other models than XSA (B-Adapt, SAMS). Due to time constraints and lack of data, analysis have been preliminary during WKROUND. Further work is needed to investigate the suitability of those models and to identify the proper settings to use for assessment. | Modelling experts |
| | There is a growing body of new tagging information (e.g. Irish tagging studies) that may prove useful to assess stock structure and possible mortality rate. | Tagging experts |
| | There is a new dedicated survey for the stock that need to be considered and the two other IBTS survey-series should be examined to see if a combined index might be possible. | Survey experts |
| | Ultimately the Benchmark should aim to develop an assessment and advice framework for the provision of MSY and precautionary advice form the information available. | |

### 7.2.9 Management considerations

Fishing mortality from historical assessments have been well above potential $F_{msy}$ proxies for this stock. It is not possible to determine current fishing mortality rates due uncertain catch-at-age data and surveys. This was also the case last year when ICES advised "that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reduction".

The geographical range of the stock appears to have contracted significantly according to the international landings and lpue distribution maps. This stock has had a very truncated age structure with age 2 fish having been the most numerous in landings over many years. The historical dynamics of Celtic Sea cod have been "recruitment driven", i.e. the stock increased in the past in response to good recruitments and decreased rapidly during times of poor recruitment. Recruitment in recent years has been poor except for the strong year class 2009 which represented 40% of landings in number in 2010. Fishing mortality should be reduced in the longer term to maximize the contributions of recruitment to future SSB and yield and will result in reduced risk to the stock.

Cod in Divisions VIIe–k are caught in a range of fisheries including gadoid trawlers, *Nephrops* trawlers, otter trawlers, beam trawlers, and gillnetters. Other commercial species that are caught by these fisheries include haddock, whiting, *Nephrops*, plaice, sole, anglerfish, hake, megrim, and elasmobranchs.

In the recent past there have been indications of an underreporting of cod landings in some fleets. The introduction of the buyers and sellers legislation in the UK and Ireland may have reduced this, but may also have increased discards. Measures aimed at reducing discarding and improving the fishing pattern should be encouraged. These might include spatial and temporal changes in fishing practices or technical measures. These measures would need to be evaluated in the context of other species caught in mixed fisheries.

The exclusion of ICES Division VIId in the TAC area since 2009 makes the management area more in line with the boundaries of the stock as the stock is VIId is considered as an extension of the cod population in the North Sea.

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008 and 43/2009) with the objective of reducing fishing mortality on cod. At an annual resolution, maps of international effort distribution do not show evidence that this closure has redistributed effort of otter trawlers to other areas.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French otter trawlers has been declining since 1999 and a decommissioning plan has occurred in 2008 and a new plan is ongoing since 2009. A consequence of the Trevose closure is that a part of the effort displayed by the French otter trawlers in the three rectangles before or after the closure has been reported to the allowed area where the catch of mixed species (mainly gadoids) is still profitable, particularly in the rectangles neighbouring the closed area (rectangles 32E4, 32E2, 31E2, 31E3, 30E3, 29E3, 29E4) or in a more distant and still shallower rectangle 31E1. Another part of the effort is displayed in the rectangles 29E1, 28E1, meaning that this effort is then targeting *Nephrops*, monkfish, megrim, *Nephrops* and elasmobranch. Overall, a part of the French bottom trawlers has not changed their activity with the closed period and continue to target gadoid fish in the neighbouring rectangles of the closed area. Another part of them target benthic species (anglerfish, megrim and john dory) in more distant rectangles 28E1, 29E1.

Irish otter trawl effort in VIIg,j has been stable over the last five years. During this period there has been a fleet modernisation and several decommissioning schemes in Ireland both within the national whitefish fleet and beam trawl fleet.

### 7.2.10 References

Bendall, V., O Cuaig, M, Schön, P-J., Hetherington, S., Armstrong, M., Graham, N., and Righton, D. 2009. Spatio-temporal dynamics of Atlantic cod (*Gadus morhua*) in the Irish and Celtic Seas: results from a collaborative tagging programme ICES CM 2009/J:06.

Cochran, W.G. 1977. Sampling Technics. J. Wiley and Sons. 428 p.

**Table 7.2.1. Nominal landings of Cod in Divisions VII e–k used by the Working Group.**

| Year | Belgium | France | Ireland | UK | Others | Total | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1971 | | | | | | 5782 | | | | | | |
| 1972 | | | | | | 4737 | | | | | | |
| 1973 | | | | | | 4015 | | | | | | |
| 1974 | | | | | | 2898 | | | | | | |
| 1975 | | | | | | 3993 | | | | | | |
| 1976 | | | | | | 4818 | | | | | | |
| 1977 | | | | | | 3058 | | | | | | |
| 1978 | | | | | | 3647 | | | | | | |
| 1979 | | | | | | 4650 | | | | | | |
| 1980 | | | | | | 7243 | | | | | | |
| 1981 | | | | | | 10596 | | | | | | |
| 1982 | | | | | | 8766 | | | | | | |
| 1983 | | | | | | 9641 | | | | | | |
| 1984 | | | | | | 6631 | | | | | | |
| 1985 | | | | | | 8317 | | | | | | |
| 1986 | | | | | | 10475 | | | | | | |
| 1987 | | | | | | 10228 | | | | | | |
| 1988 | 554 | 13863 | 1480 | 1292 | 2 | 17191 | | | | | | |
| 1989 | 910 | 15801 | 1860 | 1223 | 15 | 19809 | | | | | | |
| 1990 | 621 | 9383 | 1241 | 1346 | 158 | 12749 | | | | | | |
| 1991 | 303 | 6260 | 1659 | 1094 | 20 | 9336 | | | | | | |
| 1992 | 195 | 7120 | 1212 | 1207 | 13 | 9747 | | | | | | |
| 1993 | 391 | 8317 | 766 | 945 | 6 | 10425 | | | | | | |
| 1994 | 398 | 7692 | 1616 | 906 | 8 | 10620 | | | | | | |
| 1995 | 400 | 8321 | 1946 | 1034 | 8 | 11709 | | | | | | |
| 1996 | 552 | 8981 | 1982 | 1166 | 0 | 12680 | | | | | | |
| 1997 | 694 | 8662 | 1513 | 1166 | 0 | 12035 | | | | | | |
| 1998 | 528 | 8096 | 1718 | 1089 | 0 | 11431 | French highgrading based on UK data | | WKROUND 2009 HG based on 2008 FR self sampling data | | WGCSE 2011 HG based on 2009–2010 FR self sampling data | |
| 1999 | 326 | 5488 | 1883 | 897 | 0 | 8594 | | | | | | |
| 2000 | 208 | 4281 | 1302 | 744 | 0 | 6535 | | | | | | |
| 2001 | 347 | 6033 | 1091 | 838 | 0 | 8309 | | | | | | |
| 2002 | 555 | 7368 | 694 | 618 | 0 | 9235 | **HG FR** | **Total** | **HG FR** | **Total** | **HG FR** | **Total** |
| 2003 | 136 | 5222 | 517 | 346 | 0 | 6221 | 210 | 6431 | | | | |
| 2004 | 153 | 2425 | 663 | 282 | 0 | 3523 | 148 | 3671 | | | | |
| 2005 | 186 | 1623 | 870 | 309 | 0 | 2988 | 74 | 3062 | | | | |
| 2006 | 103 | 1896 | 959 | 368 | 0 | 3326 | | | 432 | 3758 | | |
| 2007 | 108 | 2509 | 1210 | 412 | 0 | 4239 | | | 592 | 4831 | | |
| 2008 | 65 | 2064 | 1221 | 289 | 0 | 3639 | | | 322 | 3961 | | |
| 2009 | 49 | 2080 | 870 | 264 | 0 | 3263 | | | | | 25 | 3288 |
| 2010* | 51 | 1853 | 1034 | 289 | 2 | 3229 | | | | | 7 | 3236 |

**(*) provisional for 2010.**

**Scaled landings 1971–1987 (SSDS WG 1999).**

**Table 7.2.2. Cod in Divisions VIIe–k. 2010 Landings in numbers-at-length (cm).**

| | France VIIe–k | France VIIe–k | France VIIe–k | UK VII e–k | UK VII e–k | Ireland |
|---|---|---|---|---|---|---|
| | Otter Trawl *Nephrops* | Otter Trawl Demersal fish | Miscellaneous gear | Beam trawl | All bar beam trawl | VIIg,j |
| Length | FR-Otter Trawl *Neph* VIIek | FR-Otter Trawl Demersal VIIek | FR-Misc gear VIIek | UK Beam Trawl VIIek | UK Bar Beam Trawl VIIek | IRL VIIek (all gear) |
| 24 | | | | | | |
| 25 | | | | | | |
| 26 | 4 | 112 | | | | 148 |
| 27 | | 224 | | | | 148 |
| 28 | | 336 | | | 126 | 0 |
| 29 | | 673 | | | | 296 |
| 30 | 13 | 730 | 10 | | | 1144 |
| 31 | | 224 | | | 126 | 1400 |
| 32 | | 271 | | | | 3871 |
| 33 | 5 | 575 | | | | 5043 |
| 34 | 17 | 722 | 26 | | 832 | 3804 |
| 35 | 1354 | 9119 | 26 | 5 | 738 | 9574 |
| 36 | 1466 | 13383 | 52 | 24 | 3551 | 12304 |
| 37 | 1408 | 16687 | 52 | 75 | 3542 | 16047 |
| 38 | 1280 | 19628 | 78 | 55 | 6747 | 14130 |
| 39 | 1107 | 18399 | 208 | 174 | 5767 | 14231 |
| 40 | 981 | 18352 | 208 | 152 | 6052 | 15819 |
| 41 | 891 | 23547 | 182 | 222 | 3620 | 13486 |
| 42 | 842 | 26279 | 796 | 272 | 6747 | 13091 |
| 43 | 545 | 25844 | 443 | 372 | 1441 | 12417 |
| 44 | 551 | 20378 | 234 | 597 | 4448 | 13716 |
| 45 | 465 | 25025 | 629 | 535 | 1087 | 11874 |
| 46 | 469 | 17737 | 189 | 745 | 1069 | 13277 |
| 47 | 481 | 17451 | 52 | 678 | 977 | 12151 |
| 48 | 436 | 14856 | 376 | 687 | 1860 | 10938 |
| 49 | 529 | 11465 | | 923 | 2064 | 9865 |
| 50 | 553 | 12873 | 375 | 954 | 2254 | 9895 |
| 51 | 566 | 11853 | 1583 | 1077 | 1772 | 7593 |
| 52 | 403 | 11532 | 596 | 782 | 823 | 9214 |
| 53 | 659 | 10482 | 122 | 522 | 2244 | 9795 |
| 54 | 558 | 10130 | 685 | 563 | 569 | 8892 |
| 55 | 547 | 7461 | 23 | 624 | 525 | 7960 |
| 56 | 570 | 10473 | 632 | 466 | 472 | 8147 |
| 57 | 463 | 8027 | 214 | 412 | 463 | 8138 |
| 58 | 650 | 13548 | 122 | 1100 | 663 | 5698 |
| 59 | 528 | 10283 | 302 | 411 | 611 | 6996 |

| | **France VIIe–k** | **France VIIe–k** | **France VIIe–k** | **UK VII e–k** | **UK VII e–k** | **Ireland** |
|---|---|---|---|---|---|---|
| | Otter Trawl *Nephrops* | Otter Trawl Demersal fish | Miscellaneous gear | Beam trawl | All bar beam trawl | VIIg,j |
| Length | FR-Otter Trawl *Neph* VIIek | FR-Otter Trawl Demersal VIIek | FR-Misc gear VIIek | UK Beam Trawl VIIek | UK Bar Beam Trawl VIIek | IRL VIIek (all gear) |
| 60 | 569 | 9761 | 435 | 403 | 571 | 7802 |
| 61 | 599 | 12771 | 223 | 331 | 583 | 5051 |
| 62 | 548 | 8323 | 175 | 313 | 558 | 5223 |
| 63 | 447 | 10644 | 493 | 346 | 457 | 4474 |
| 64 | 419 | 9890 | 124 | 465 | 565 | 5777 |
| 65 | 346 | 7397 | 364 | 397 | 740 | 3345 |
| 66 | 370 | 10806 | 234 | 292 | 616 | 4086 |
| 67 | 319 | 7996 | 122 | 256 | 1024 | 3566 |
| 68 | 220 | 7551 | 74 | 266 | 661 | 3285 |
| 69 | 199 | 5798 | 428 | 143 | 827 | 3790 |
| 70 | 207 | 7599 | 301 | 281 | 957 | 3050 |
| 71 | 309 | 6642 | 9 | 212 | 609 | 3693 |
| 72 | 293 | 4980 | 196 | 209 | 702 | 2464 |
| 73 | 191 | 4237 | 252 | 294 | 804 | 3276 |
| 74 | 208 | 8600 | 233 | 257 | 539 | 2453 |
| 75 | 134 | 4191 | 174 | 122 | 662 | 2534 |
| 76 | 467 | 6086 | 76 | 288 | 558 | 2144 |
| 77 | 346 | 6480 | 268 | 273 | 654 | 2772 |
| 78 | 301 | 4316 | 340 | 268 | 618 | 2618 |
| 79 | 214 | 4633 | 709 | 185 | 746 | 3414 |
| 80 | 189 | 4547 | 257 | 170 | 1069 | 1649 |
| 81 | 151 | 5385 | 438 | 263 | 828 | 2296 |
| 82 | 248 | 3792 | 650 | 201 | 1304 | 2898 |
| 83 | 226 | 2576 | 177 | 211 | 857 | 2461 |
| 84 | 303 | 5754 | 363 | 181 | 1143 | 2429 |
| 85 | 262 | 5216 | 549 | 169 | 586 | 3278 |
| 86 | 160 | 4732 | 583 | 148 | 726 | 2073 |
| 87 | 157 | 3806 | 23 | 124 | 561 | 2004 |
| 88 | 337 | 5151 | 724 | 207 | 996 | 2677 |
| 89 | 316 | 4760 | 529 | 211 | 446 | 2513 |
| 90 | 142 | 4406 | 56 | 109 | 487 | 2303 |
| 91 | 333 | 3736 | 61 | 80 | 651 | 2096 |
| 92 | 180 | 4025 | 464 | 124 | 697 | 2019 |
| 93 | 194 | 2723 | 353 | 85 | 371 | 1954 |
| 94 | 91 | 2834 | 79 | 59 | 350 | 2098 |
| 95 | 175 | 2425 | 33 | 99 | 277 | 1374 |
| 96 | 136 | 2489 | 55 | 85 | 237 | 1309 |
| 97 | 160 | 1667 | | 59 | 279 | 1591 |

| | France VIIe-k | France VIIe-k | France VIIe-k | UK VII e-k | UK VII e-k | Ireland |
|---|---|---|---|---|---|---|
| | Otter Trawl *Nephrops* | Otter Trawl Demersal fish | Miscellaneous gear | Beam trawl | All bar beam trawl | VIIg,j |
| Length | FR-Otter Trawl *Neph* VIIek | FR-Otter Trawl Demersal VIIek | FR-Misc gear VIIek | UK Beam Trawl VIIek | UK Bar Beam Trawl VIIek | IRL VIIek (all gear) |
| 98 | 116 | 3472 | 33 | 34 | 172 | 1079 |
| 99 | 89 | 962 | 28 | 60 | 244 | 1407 |
| 100 | 105 | 1499 | | 39 | 99 | 1240 |
| 101 | 181 | 1442 | | 44 | 40 | 744 |
| 102 | 90 | 2351 | 334 | 28 | 78 | 401 |
| 103 | 17 | 1086 | 259 | 34 | 66 | 437 |
| 104 | 160 | 743 | | 34 | 112 | 274 |
| 105 | 108 | 774 | | 45 | | 230 |
| 106 | 24 | 658 | | 18 | 24 | 265 |
| 107 | 7 | 633 | 56 | 24 | 27 | 80 |
| 108 | 9 | 489 | | 35 | 30 | 66 |
| 109 | | 1324 | 33 | 18 | | 168 |
| 110 | 8 | 981 | | 4 | 14 | 0 |
| 111 | | 282 | | 0 | 9 | 0 |
| 112 | 14 | 43 | | 0 | 9 | 0 |
| 113 | 14 | 34 | | 4 | 2 | 88 |
| 114 | 5 | | | 0 | | 0 |
| 115 | 2 | 280 | | 0 | | 26 |
| 116 | | | | 8 | | 32 |
| 117 | 8 | | | | | |
| 118 | | | | | | |
| 119 | | | | | | |
| 120 | 2 | | | | | |
| 121 | | | | | | |
| 122 | | | | | | |
| 123 | | | | | | |
| 124 | | | | | | |
| 125 | | | | | | |
| | | | | | | |
| Total | 29 765 | 624 456 | 19 586 | 21 041 | 87 431 | 411 477 |
| Tw | 83.7 | 1691.0 | 78.3 | 65.663 | 207.569 | 1034 |
| Mean length | 57.6 | 574.1 | 9898.6 | 61.1 | 694.3 | 54.5 |
| Mean Weight | 2.812 | 2.708 | 3.998 | 3.121 | 2.374 | 2.513 |

**Table 7.2.3. Cod in Divisions VIIe–k (Celtic Sea). Catch numbers-at-age. Area reallocation (IRL 2004 to 2010) and highgrading (FR 2003–2010) included.**

Run title : Cod in Divisions VIIe-k,WGCSE11,index file
At 5/05/2011 15:18

Table 1 Catch numbers-at-age Numbers*10**-3

| YEAR, | 1971, | 1972, | 1973, | 1974, | 1975, | 1976, | 1977, | 1978, | 1979, | 1980, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | 725, | 4, | 332, | 1, | 673, | 51, | 25, | 197, | 438, | 609, |
| 2, | 461, | 774, | 239, | 224, | 136, | 1456, | 416, | 497, | 357, | 1213, |
| 3, | 557, | 110, | 346, | 40, | 185, | 61, | 236, | 129, | 263, | 285, |
| 4, | 96, | 205, | 60, | 118, | 61, | 107, | 15, | 116, | 68, | 175, |
| 5, | 35, | 45, | 74, | 38, | 105, | 11, | 60, | 20, | 104, | 52, |
| 6, | 17, | 26, | 17, | 37, | 20, | 22, | 2, | 34, | 19, | 55, |
| +gp, | 11, | 17, | 11, | 36, | 33, | 7, | 17, | 20, | 32, | 14, |
| 0 TOTALNUM, | 1902, | 1181, | 1079, | 494, | 1213, | 1715, | 771, | 1013, | 1281, | 2403, |
| TONSLAND, | 5782, | 4737, | 4015, | 2898, | 3993, | 4818, | 3059, | 3647, | 4650, | 7243, |
| SOPCOF %, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, |

Table 1 Catch numbers-at-age Numbers*10**-3

| YEAR, | 1981, | 1982, | 1983, | 1984, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | 315, | 76, | 1285, | 737, | 726, | 651, | 2741, | 1830, | 666, | 360, |
| 2, | 3086, | 1157, | 529, | 1210, | 1245, | 1303, | 946, | 5443, | 2639, | 846, |
| 3, | 811, | 888, | 540, | 134, | 465, | 673, | 448, | 320, | 2483, | 1006, |
| 4, | 153, | 169, | 424, | 97, | 61, | 254, | 250, | 133, | 149, | 663, |
| 5, | 41, | 36, | 77, | 94, | 40, | 30, | 62, | 46, | 77, | 79, |
| 6, | 20, | 19, | 21, | 22, | 47, | 31, | 20, | 21, | 18, | 21, |
| +gp, | 12, | 5, | 11, | 5, | 15, | 17, | 15, | 8, | 11, | 16, |
| 0 TOTALNUM, | 4438, | 2350, | 2887, | 2299, | 2599, | 2959, | 4482, | 7801, | 6043, | 2991, |
| TONSLAND, | 10597, | 8766, | 9641, | 6631, | 8317, | 10475, | 10228, | 17191, | 19809, | 12749, |
| SOPCOF %, | 100, | 101, | 100, | 100, | 101, | 100, | 98, | 100, | 100, | 99, |

Table 1 Catch numbers-at-age Numbers*10**-3

| YEAR, | 1991, | 1992, | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | 1377, | 1434, | 274, | 1340, | 823, | 617, | 1184, | 639, | 496, | 1693, |
| 2, | 1034, | 2601, | 2371, | 692, | 3320, | 2248, | 1870, | 2545, | 1141, | 464, |
| 3, | 229, | 329, | 928, | 1199, | 310, | 1199, | 951, | 641, | 756, | 419, |
| 4, | 330, | 64, | 79, | 258, | 284, | 134, | 297, | 254, | 158, | 169, |
| 5, | 203, | 70, | 24, | 27, | 73, | 95, | 48, | 99, | 59, | 44, |
| 6, | 48, | 53, | 19, | 10, | 13, | 43, | 22, | 36, | 36, | 17, |
| +gp, | 14, | 17, | 16, | 17, | 5, | 4, | 6, | 8, | 14, | 14, |
| 0 TOTALNUM, | 3235, | 4568, | 3711, | 3543, | 4828, | 4340, | 4378, | 4222, | 2660, | 2820, |
| TONSLAND, | 9336, | 9747, | 10425, | 10620, | 11709, | 12681, | 12035, | 11431, | 8594, | 6536, |
| SOPCOF %, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, |

Table 1 Catch numbers-at-age Numbers*10**-3

| YEAR, | 2001, | 2002, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | 1091, | 210, | 103, | 341, | 295, | 368, | 491, | 123, | 161, | 532, |
| 2, | 2373, | 2069, | 556, | 298, | 664, | 994, | 1245, | 769, | 281, | 434, |
| 3, | 136, | 883, | 827, | 175, | 138, | 249, | 409, | 312, | 324, | 122, |
| 4, | 98, | 64, | 217, | 168, | 52, | 25, | 60, | 101, | 96, | 91, |
| 5, | 70, | 33, | 15, | 59, | 45, | 14, | 9, | 24, | 37, | 42, |
| 6, | 19, | 12, | 9, | 8, | 11, | 13, | 4, | 4, | 10, | 9, |
| +gp, | 19, | 11, | 7, | 7, | 2, | 5, | 4, | 4, | 2, | 2, |
| 0 TOTALNUM, | 3806, | 3282, | 1734, | 1056, | 1207, | 1668, | 2222, | 1337, | 911, | 1313, |
| TONSLAND, | 8308, | 9236, | 6420, | 3672, | 3062, | 3776, | 4830, | 3961, | 3292, | 3229, |
| SOPCOF %, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 100, | 77, |

1

**Table 7.2.4a. Cod in Divisions VIIe–k. Length structure of landings and discards from sampling by UK.**

**UK - Sampled data raised to trips sampled.**

| Length | Q1 | Q1 | Q2 | Q2 | Q3 | Q3 | Q4 | Q4 |
|---|---|---|---|---|---|---|---|---|
| (cm) | Retained | Discarded | Retained | Discarded | Retained | Discarded | Retained | Discarded |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 20 | 0 | 14 | 0 | 20 | 0 | 0 | 0 | 0 |
| 21 | 0 | 4 | 0 | 37 | 0 | 0 | 0 | 0 |
| 22 | 0 | 28 | 0 | 66 | 0 | 0 | 0 | 0 |
| 23 | 0 | 31 | 0 | 49 | 0 | 1 | 0 | 0 |
| 24 | 0 | 48 | 0 | 79 | 0 | 1 | 0 | 0 |
| 25 | 0 | 42 | 0 | 69 | 0 | 10 | 0 | 0 |
| 26 | 0 | 63 | 0 | 48 | 0 | 6 | 0 | 0 |
| 27 | 0 | 84 | 0 | 62 | 0 | 15 | 0 | 5 |
| 28 | 0 | 36 | 0 | 63 | 0 | 3 | 0 | 9 |
| 29 | 0 | 41 | 0 | 62 | 0 | 43 | 0 | 11 |
| 30 | 0 | 39 | 0 | 33 | 0 | 28 | 0 | 10 |
| 31 | 1 | 53 | 0 | 20 | 0 | 13 | 0 | 25 |
| 32 | 0 | 19 | 0 | 13 | 0 | 56 | 0 | 35 |
| 33 | 0 | 10 | 0 | 16 | 0 | 30 | 0 | 41 |
| 34 | 0 | 6 | 1 | 15 | 0 | 84 | 0 | 75 |
| 35 | 0 | 13 | 0 | 10 | 3 | 38 | 1 | 62 |
| 36 | 0 | 0 | 0 | 19 | 4 | 42 | 12 | 50 |
| 37 | 0 | 3 | 1 | 13 | 2 | 17 | 22 | 11 |
| 38 | 1 | 12 | 2 | 4 | 3 | 12 | 21 | 14 |
| 39 | 0 | 0 | 0 | 2 | 6 | 24 | 52 | 13 |
| 40 | 1 | 3 | 0 | 0 | 6 | 25 | 27 | 5 |
| 41 | 1 | 2 | 0 | 4 | 3 | 6 | 38 | 4 |
| 42 | 4 | 2 | 0 | 10 | 4 | 0 | 23 | 6 |
| 43 | 2 | 0 | 0 | 0 | 3 | 1 | 28 | 8 |
| 44 | 2 | 0 | 0 | 0 | 1 | 0 | 20 | 4 |
| 45 | 5 | 0 | 0 | 0 | 4 | 0 | 18 | 3 |
| 46 | 7 | 3 | 0 | 0 | 4 | 0 | 23 | 3 |
| 47 | 5 | 5 | 0 | 0 | 1 | 0 | 19 | 20 |
| 48 | 2 | 1 | 0 | 0 | 3 | 0 | 9 | 5 |
| 49 | 4 | 1 | 0 | 1 | 1 | 0 | 9 | 7 |
| 50 | 6 | 5 | 0 | 0 | 0 | 4 | 17 | 20 |
| 51 | 3 | 6 | 2 | 1 | 1 | 0 | 10 | 9 |
| 52 | 1 | 10 | 0 | 1 | 1 | 0 | 8 | 9 |
| 53 | 1 | 5 | 1 | 2 | 0 | 1 | 5 | 11 |

| Length | Q1 | Q1 | Q2 | Q2 | Q3 | Q3 | Q4 | Q4 |
|---|---|---|---|---|---|---|---|---|
| (cm) | Retained | Discarded | Retained | Discarded | Retained | Discarded | Retained | Discarded |
| 54 | 4 | 7 | 0 | 9 | 0 | 0 | 8 | 1 |
| 55 | 3 | 2 | 6 | 4 | 1 | 0 | 4 | 1 |
| 56 | 3 | 11 | 3 | 3 | 2 | 0 | 3 | 3 |
| 57 | 4 | 3 | 3 | 5 | 1 | 1 | 2 | 2 |
| 58 | 2 | 4 | 2 | 2 | 0 | 0 | 6 | 0 |
| 59 | 3 | 2 | 3 | 4 | 3 | 0 | 1 | 0 |
| 60 | 2 | 3 | 1 | 2 | 2 | 2 | 4 | 0 |
| 61 | 0 | 5 | 3 | 2 | 1 | 1 | 0 | 0 |
| 62 | 0 | 5 | 3 | 0 | 1 | 0 | 2 | 0 |
| 63 | 1 | 1 | 0 | 1 | 1 | 2 | 3 | 1 |
| 64 | 1 | 4 | 1 | 0 | 4 | 1 | 2 | 0 |
| 65 | 0 | 4 | 0 | 2 | 1 | 0 | 2 | 0 |
| 66 | 0 | 3 | 0 | 2 | 1 | 0 | 3 | 0 |
| 67 | 0 | 5 | 1 | 2 | 1 | 4 | 1 | 0 |
| 68 | 0 | 3 | 0 | 2 | 1 | 1 | 3 | 0 |
| 69 | 4 | 5 | 1 | 5 | 0 | 2 | 5 | 1 |
| 70 | 1 | 11 | 0 | 1 | 2 | 0 | 5 | 0 |
| 71 | 0 | 7 | 0 | 0 | 0 | 0 | 6 | 1 |
| 72 | 2 | 13 | 2 | 0 | 2 | 1 | 2 | 0 |
| 73 | 0 | 15 | 0 | 1 | 1 | 0 | 6 | 1 |
| 74 | 3 | 15 | 0 | 5 | 0 | 3 | 2 | 1 |
| 75 | 0 | 17 | 1 | 0 | 2 | 0 | 3 | 0 |
| 76 | 1 | 7 | 0 | 1 | 0 | 1 | 1 | 1 |
| 77 | 0 | 10 | 1 | 1 | 0 | 0 | 1 | 1 |
| 78 | 1 | 5 | 2 | 2 | 0 | 0 | 6 | 0 |
| 79 | 1 | 5 | 3 | 2 | 0 | 0 | 7 | 0 |

**Table 7.2.4a. Continued.**

| Length (cm) | Q1 Retained | Q1 Discarded | Q2 Retained | Q2 Discarded | Q3 Retained | Q3 Discarded | Q4 Retained | Q4 Discarded |
|---|---|---|---|---|---|---|---|---|
| 80 | 0 | 5 | 0 | 0 | 0 | 0 | 3 | 1 |
| 81 | 0 | 6 | 1 | 1 | 0 | 0 | 0 | 1 |
| 82 | 3 | 5 | 1 | 1 | 1 | 0 | 2 | 1 |
| 83 | 1 | 8 | 1 | 1 | 1 | 0 | 4 | 1 |
| 84 | 3 | 6 | 1 | 0 | 0 | 1 | 6 | 0 |
| 85 | 2 | 3 | 0 | 2 | 0 | 0 | 3 | 2 |
| 86 | 4 | 1 | 1 | 1 | 0 | 0 | 8 | 1 |
| 87 | 2 | 5 | 1 | 2 | 1 | 0 | 1 | 2 |
| 88 | 3 | 4 | 3 | 2 | 1 | 0 | 4 | 1 |
| 89 | 3 | 1 | 2 | 1 | 1 | 0 | 2 | 2 |
| 90 | 11 | 1 | 1 | 1 | 5 | 0 | 3 | 1 |
| 91 | 2 | 0 | 0 | 1 | 1 | 0 | 2 | 3 |
| 92 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 1 |
| 93 | 5 | 0 | 0 | 1 | 0 | 0 | 5 | 2 |
| 94 | 4 | 1 | 0 | 0 | 0 | 0 | 4 | 2 |
| 95 | 5 | 0 | 0 | 1 | 0 | 0 | 2 | 2 |
| 96 | 9 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 97 | 1 | 0 | 0 | 2 | 0 | 0 | 5 | 0 |
| 98 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| 99 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| 100 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 101 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 102 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 103 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 104 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 105 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 106 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 |
| 107 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 108 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 109 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 111 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 112 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 113 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | | | | | | | | |
| Total N | 149 | 682 | 62 | 556 | 90 | 478 | 513 | 513 |
| Trips sampled | 32 | | 22 | | 29 | | 12 | |

**Table 7.2.4b. Cod in Divisions VIIe–k. Length structure of landings and discards from sampling by Ireland in 2010. No of Trips= 40, No. of hauls = 473. Raised (using trips as variable).**

| Frequency ('000) | | | Frequency ('000) | | |
|---|---|---|---|---|---|
| Length (cm) | Discards | Retained Catch | Length (cm) | Discards | Retained Catch |
| 14 | 2.15 | 0.00 | 61 | 0.00 | 5.37 |
| 15 | 3.51 | 0.00 | 62 | 0.00 | 7.98 |
| 16 | 0.00 | 0.00 | 63 | 0.00 | 5.35 |
| 17 | 2.15 | 0.00 | 64 | 0.00 | 7.29 |
| 18 | 4.01 | 0.00 | 65 | 0.00 | 2.34 |
| 19 | 3.22 | 0.00 | 66 | 0.00 | 6.82 |
| 20 | 12.70 | 0.00 | 67 | 0.00 | 5.07 |
| 21 | 11.35 | 0.00 | 68 | 0.00 | 4.79 |
| 22 | 37.69 | 0.00 | 69 | 0.00 | 4.74 |
| 23 | 65.53 | 0.00 | 70 | 0.00 | 3.95 |
| 24 | 37.17 | 0.00 | 71 | 0.00 | 3.60 |
| 25 | 116.90 | 0.00 | 72 | 0.00 | 3.65 |
| 26 | 102.28 | 0.00 | 73 | 0.00 | 4.90 |
| 27 | 155.92 | 0.00 | 74 | 0.00 | 0.73 |
| 28 | 143.76 | 0.00 | 75 | 0.00 | 2.91 |
| 29 | 251.17 | 3.20 | 76 | 0.00 | 2.08 |
| 30 | 125.70 | 0.00 | 77 | 0.00 | 1.65 |
| 31 | 100.68 | 0.00 | 78 | 0.00 | 3.94 |
| 32 | 97.41 | 0.74 | 79 | 0.00 | 2.36 |
| 33 | 128.88 | 2.10 | 80 | 0.00 | 1.80 |
| 34 | 146.22 | 3.48 | 81 | 0.00 | 0.82 |
| 35 | 63.64 | 3.60 | 82 | 0.00 | 0.73 |
| 36 | 92.09 | 8.68 | 83 | 0.00 | 1.08 |
| 37 | 30.01 | 11.48 | 84 | 0.00 | 1.98 |
| 38 | 37.45 | 10.07 | 85 | 0.00 | 1.58 |
| 39 | 48.77 | 11.43 | 86 | 0.00 | 0.19 |
| 40 | 4.98 | 11.80 | 87 | 0.00 | 0.36 |
| 41 | 0.00 | 11.07 | 88 | 0.00 | 0.36 |
| 42 | 0.00 | 11.53 | 89 | 0.00 | 0.31 |
| 43 | 0.00 | 11.71 | 90 | 0.00 | 1.53 |
| 44 | 0.00 | 11.01 | 91 | 0.00 | 0.00 |
| 45 | 0.00 | 8.01 | 92 | 0.00 | 1.09 |
| 46 | 0.00 | 10.01 | 93 | 0.00 | 1.12 |
| 47 | 0.00 | 5.12 | 94 | 0.00 | 0.31 |
| 48 | 0.00 | 8.19 | 95 | 0.00 | 0.63 |
| 49 | 0.00 | 7.51 | 96 | 0.00 | 0.36 |
| 50 | 0.00 | 9.40 | 97 | 0.00 | 0.31 |
| 51 | 0.00 | 4.55 | 98 | 0.00 | 0.99 |
| 52 | 0.00 | 12.21 | 99 | 0.00 | 0.99 |
| 53 | 0.00 | 13.07 | 100 | 0.00 | 1.17 |
| 54 | 0.00 | 10.64 | 101 | 0.00 | 0.00 |
| 55 | 0.00 | 12.31 | 102 | 0.00 | 0.00 |
| 56 | 0.00 | 8.07 | 103 | 0.00 | 0.63 |
| 57 | 0.00 | 5.82 | 104 | 0.00 | 0.31 |
| 58 | 0.00 | 3.81 | 105 | 0.00 | 0.00 |
| 59 | 0.00 | 4.57 | 106 | 0.00 | 0.00 |
| 60 | 0.00 | 7.44 | 107 | 0.00 | 0.00 |
| | | | 108 | 0.00 | 0.27 |

**Table 7.2.4c. Cod in Divisions VIIe–k 2010. Length structure of French landings and discards from the self-sampling Programme. Sampling data raised by landing ratio to the total catch of the fleet targeting *Nephrops*.**

| | Q1 | Q1 | Q2 | Q2 | Q3 | Q3 |
|---|---|---|---|---|---|---|
| Length | Discarded | Retained | Discarded | Retained | Discarded | Retained |
| 15 | 0 | 0 | 54 | 0 | 0 | 0 |
| 16 | 0 | 0 | 54 | 0 | 0 | 0 |
| 17 | 0 | 0 | 108 | 0 | 0 | 0 |
| 18 | 0 | 0 | 217 | 0 | 0 | 0 |
| 19 | 0 | 0 | 271 | 0 | 0 | 0 |
| 20 | 0 | 0 | 596 | 0 | 0 | 0 |
| 21 | 0 | 0 | 217 | 0 | 0 | 0 |
| 22 | 0 | 0 | 705 | 0 | 258 | 0 |
| 23 | 0 | 0 | 813 | 0 | 0 | 0 |
| 24 | 0 | 0 | 380 | 0 | 258 | 0 |
| 25 | 0 | 0 | 434 | 0 | 258 | 0 |
| 26 | 0 | 0 | 325 | 107 | 516 | 0 |
| 27 | 0 | 0 | 325 | 215 | 1032 | 0 |
| 28 | 0 | 0 | 380 | 322 | 1548 | 0 |
| 29 | 0 | 0 | 163 | 645 | 1548 | 0 |
| 30 | 0 | 0 | 813 | 537 | 4129 | 0 |
| 31 | 0 | 0 | 325 | 215 | 2065 | 0 |
| 32 | 0 | 0 | 434 | 157 | 1548 | 103 |
| 33 | 0 | 0 | 217 | 113 | 774 | 206 |
| 34 | 0 | 0 | 380 | 282 | 1290 | 409 |
| 35 | 0 | 0 | 596 | 1174 | 4645 | 7178 |
| 36 | 0 | 0 | 0 | 1969 | 516 | 7886 |
| 37 | 0 | 328 | 380 | 2379 | 774 | 10177 |
| 38 | 0 | 716 | 108 | 2365 | 258 | 9752 |
| 39 | 0 | 0 | 54 | 2041 | 258 | 9849 |
| 40 | 0 | 526 | 0 | 1473 | 0 | 10892 |
| 41 | 0 | 2258 | 0 | 1571 | 0 | 11238 |
| 42 | 0 | 1921 | 0 | 1150 | 0 | 15311 |
| 43 | 0 | 2147 | 0 | 1053 | 0 | 13838 |
| 44 | 0 | 2763 | 0 | 793 | 0 | 8554 |
| 45 | 0 | 3976 | 0 | 157 | 0 | 10936 |
| 46 | 0 | 3068 | 0 | 277 | 0 | 8519 |
| 47 | 0 | 4120 | 0 | 723 | 0 | 5982 |
| 48 | 0 | 2896 | 0 | 925 | 0 | 5111 |
| 49 | 0 | 3003 | 0 | 906 | 0 | 3146 |
| 50 | 0 | 4818 | 0 | 2443 | 0 | 3397 |
| 51 | 0 | 2940 | 0 | 2865 | 0 | 2512 |
| 52 | 0 | 2612 | 0 | 4229 | 0 | 2540 |
| 53 | 0 | 3457 | 0 | 3751 | 0 | 1478 |
| 54 | 0 | 1952 | 0 | 3088 | 0 | 2377 |

| | Q1 | Q1 | Q2 | Q2 | Q3 | Q3 |
|---|---|---|---|---|---|---|
| Length | Discarded | Retained | Discarded | Retained | Discarded | Retained |
| 55 | 0 | 1216 | 0 | 2773 | 0 | 1547 |
| 56 | 0 | 2028 | 0 | 4538 | 0 | 2612 |
| 57 | 0 | 832 | 0 | 3101 | 0 | 2413 |
| 58 | 0 | 1012 | 0 | 4015 | 0 | 5060 |
| 59 | 0 | 465 | 0 | 3867 | 0 | 3501 |
| 60 | 0 | 539 | 0 | 2552 | 0 | 5076 |
| 61 | 0 | 494 | 0 | 4055 | 0 | 5446 |
| 62 | 0 | 86 | 0 | 1989 | 0 | 3323 |
| 63 | 0 | 189 | 0 | 2095 | 0 | 5492 |
| 64 | 0 | 349 | 0 | 1554 | 0 | 3871 |
| 65 | 0 | 232 | 0 | 730 | 0 | 5152 |
| 66 | 0 | 211 | 0 | 1273 | 0 | 5724 |
| 67 | 0 | 365 | 0 | 1197 | 0 | 2425 |
| 68 | 0 | 681 | 0 | 194 | 0 | 2974 |
| 69 | 0 | 670 | 0 | 279 | 0 | 2161 |
| 70 | 0 | 796 | 0 | 623 | 0 | 2719 |
| 71 | 0 | 760 | 0 | 481 | 0 | 4138 |
| 72 | 0 | 927 | 0 | 752 | 0 | 2216 |
| 73 | 0 | 337 | 0 | 1241 | 0 | 1022 |
| 74 | 0 | 758 | 0 | 1533 | 0 | 5221 |
| 75 | 0 | 921 | 0 | 945 | 0 | 1332 |
| 76 | 0 | 566 | 0 | 602 | 0 | 2946 |
| 77 | 0 | 1190 | 0 | 1039 | 0 | 2732 |
| 78 | 0 | 784 | 0 | 710 | 0 | 2388 |
| 79 | 0 | 916 | 0 | 1002 | 0 | 2138 |

**Table 7.2.4c. Continued.**

| | Q1 | Q1 | Q2 | Q2 | Q3 | Q3 |
|---|---|---|---|---|---|---|
| Length | Discarded | Retained | Discarded | Retained | Discarded | Retained |
| 80 | 0 | 768 | 0 | 1344 | 0 | 1659 |
| 81 | 0 | 1360 | 0 | 1347 | 0 | 1939 |
| 82 | 0 | 928 | 0 | 1206 | 0 | 1010 |
| 83 | 0 | 983 | 0 | 707 | 0 | 367 |
| 84 | 0 | 1649 | 0 | 967 | 0 | 1543 |
| 85 | 0 | 2093 | 0 | 1937 | 0 | 679 |
| 86 | 0 | 2032 | 0 | 1108 | 0 | 686 |
| 87 | 0 | 194 | 0 | 1304 | 0 | 996 |
| 88 | 0 | 2106 | 0 | 1240 | 0 | 1050 |
| 89 | 0 | 1452 | 0 | 1270 | 0 | 729 |
| 90 | 0 | 695 | 0 | 1252 | 0 | 895 |
| 91 | 0 | 1522 | 0 | 1084 | 0 | 491 |
| 92 | 0 | 955 | 0 | 1468 | 0 | 941 |
| 93 | 0 | 889 | 0 | 894 | 0 | 313 |
| 94 | 0 | 1055 | 0 | 757 | 0 | 650 |
| 95 | 0 | 733 | 0 | 582 | 0 | 691 |
| 96 | 0 | 193 | 0 | 711 | 0 | 1034 |
| 97 | 0 | 753 | 0 | 455 | 0 | 34 |
| 98 | 0 | 485 | 0 | 751 | 0 | 256 |
| 99 | 0 | 172 | 0 | 102 | 0 | 348 |
| 100 | 0 | 398 | 0 | 557 | 0 | 134 |
| 101 | 0 | 514 | 0 | 178 | 0 | 576 |
| 102 | 0 | 398 | 0 | 61 | 0 | 555 |
| 103 | 0 | 261 | 0 | 331 | 0 | 373 |
| 104 | 0 | 184 | 0 | 335 | 0 | 31 |
| 105 | 0 | 21 | 0 | 176 | 0 | 341 |
| 106 | 0 | 0 | 0 | 476 | 0 | 31 |
| 107 | 0 | 277 | 0 | 211 | 0 | 0 |
| 108 | 0 | 259 | 0 | 109 | 0 | 106 |
| 109 | 0 | 184 | 0 | 67 | 0 | 309 |
| 110 | 0 | 0 | 0 | 228 | 0 | 0 |
| 111 | 0 | 0 | 0 | 67 | 0 | 203 |
| 112 | 0 | 0 | 0 | 0 | 0 | 0 |
| 113 | 0 | 0 | 0 | 0 | 0 | 33 |
| 114 | 0 | 0 | 0 | 0 | 0 | 0 |
| 115 | 0 | 198 | 0 | 74 | 0 | 0 |
| 116 | 0 | 0 | 0 | 0 | 0 | 0 |
| 117 | 0 | 0 | 0 | 0 | 0 | 0 |
| 118 | 0 | 0 | 0 | 0 | 0 | 0 |
| 119 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120 | 0 | 0 | 0 | 0 | 0 | 0 |
| Number of trips | 13 | | 17 | | 8 | |
| Number of sampled hauls | 255 | | 681 | | 318 | |
| Number of total hauls | 528 | | 729 | | 319 | |

**Table 7.2.4d. Cod in Divisions VIIe–k. Length structure of French landings and discards from on-board observer programme. Otter trawlers targeting demersal fish.**

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_DEF | | | | | OT_DEF | | | |
| Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 20 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 22 | 0 | 1 | 0 | 0 |
| 23 | 0 | 0 | 0 | 0 | 23 | 1 | 0 | 1 | 1 |
| 24 | 0 | 0 | 0 | 0 | 24 | 4 | 1 | 0 | 2 |
| 25 | 0 | 0 | 0 | 0 | 25 | 3 | 5 | 1 | 1 |
| 26 | 0 | 1 | 0 | 0 | 26 | 5 | 6 | 2 | 2 |
| 27 | 0 | 2 | 0 | 0 | 27 | 10 | 11 | 4 | 1 |
| 28 | 0 | 3 | 0 | 0 | 28 | 5 | 13 | 3 | 3 |
| 29 | 0 | 6 | 0 | 0 | 29 | 5 | 19 | 16 | 7 |
| 30 | 0 | 5 | 0 | 2 | 30 | 1 | 29 | 13 | 5 |
| 31 | 0 | 2 | 0 | 0 | 31 | 2 | 23 | 26 | 8 |
| 32 | 0 | 2 | 1 | 0 | 32 | 0 | 26 | 24 | 11 |
| 33 | 0 | 1 | 2 | 1 | 33 | 3 | 21 | 31 | 8 |
| 34 | 0 | 4 | 3 | 0 | 34 | 1 | 18 | 34 | 8 |
| 35 | 0 | 12 | 41 | 1 | 35 | 1 | 19 | 12 | 5 |
| 36 | 0 | 21 | 46 | 9 | 36 | 0 | 14 | 15 | 2 |
| 37 | 2 | 27 | 60 | 13 | 37 | 0 | 12 | 10 | 3 |
| 38 | 4 | 25 | 58 | 24 | 38 | 0 | 10 | 8 | 2 |
| 39 | 0 | 23 | 70 | 27 | 39 | 0 | 8 | 11 | 1 |
| 40 | 3 | 20 | 76 | 28 | 40 | 0 | 0 | 14 | 0 |
| 41 | 14 | 20 | 75 | 42 | 41 | 0 | 0 | 7 | 2 |
| 42 | 18 | 15 | 111 | 35 | 42 | 0 | 0 | 4 | 0 |
| 43 | 16 | 15 | 108 | 38 | 43 | 0 | 0 | 9 | 0 |
| 44 | 23 | 13 | 71 | 43 | 44 | 0 | 0 | 1 | 0 |
| 45 | 35 | 4 | 89 | 53 | 45 | 0 | 0 | 3 | 2 |
| 46 | 30 | 6 | 70 | 38 | 46 | 0 | 0 | 5 | 0 |
| 47 | 36 | 14 | 52 | 47 | 47 | 0 | 0 | 1 | 1 |
| 48 | 33 | 17 | 46 | 49 | 48 | 0 | 0 | 1 | 1 |
| 49 | 28 | 17 | 34 | 38 | 49 | 0 | 0 | 0 | 0 |
| 50 | 39 | 30 | 37 | 17 | 50 | 0 | 0 | 0 | 0 |
| 51 | 29 | 29 | 19 | 27 | 51 | 0 | 0 | 0 | 0 |
| 52 | 23 | 35 | 23 | 14 | 52 | 0 | 0 | 1 | 0 |
| 53 | 30 | 31 | 12 | 15 | 53 | 0 | 1 | 0 | 0 |
| 54 | 16 | 24 | 14 | 18 | 54 | 0 | 0 | 0 | 0 |
| 55 | 9 | 23 | 13 | 11 | 55 | 0 | 0 | 0 | 0 |
| 56 | 16 | 34 | 16 | 6 | 56 | 0 | 0 | 0 | 0 |
| 57 | 6 | 30 | 19 | 11 | 57 | 0 | 0 | 0 | 0 |
| 58 | 10 | 35 | 35 | 16 | 58 | 0 | 0 | 0 | 0 |
| 59 | 4 | 30 | 22 | 11 | 59 | 0 | 0 | 0 | 0 |

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_DEF | | | | | OT_DEF | | | |
| Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 60 | 4 | 21 | 36 | 9 | 60 | 0 | 0 | 0 | 0 |
| 61 | 5 | 37 | 33 | 10 | 61 | 0 | 1 | 0 | 0 |
| 62 | 3 | 20 | 27 | 17 | 62 | 0 | 0 | 2 | 0 |
| 63 | 3 | 19 | 33 | 16 | 63 | 0 | 0 | 0 | 0 |
| 64 | 7 | 17 | 25 | 22 | 64 | 0 | 0 | 0 | 0 |
| 65 | 4 | 10 | 35 | 11 | 65 | 0 | 0 | 0 | 0 |
| 66 | 6 | 13 | 29 | 25 | 66 | 0 | 0 | 0 | 0 |
| 67 | 5 | 11 | 14 | 20 | 67 | 0 | 0 | 0 | 0 |
| 68 | 8 | 3 | 17 | 21 | 68 | 0 | 0 | 0 | 0 |
| 69 | 9 | 4 | 10 | 20 | 69 | 0 | 0 | 0 | 0 |
| 70 | 15 | 8 | 17 | 16 | 70 | 0 | 0 | 0 | 0 |
| 71 | 12 | 6 | 19 | 7 | 71 | 0 | 0 | 0 | 0 |
| 72 | 12 | 10 | 11 | 6 | 72 | 0 | 0 | 0 | 0 |
| 73 | 5 | 12 | 7 | 8 | 73 | 0 | 0 | 0 | 0 |
| 74 | 9 | 18 | 21 | 9 | 74 | 0 | 0 | 0 | 0 |
| 75 | 11 | 11 | 11 | 8 | 75 | 0 | 0 | 0 | 0 |
| 76 | 8 | 11 | 14 | 10 | 76 | 0 | 0 | 0 | 0 |
| 77 | 10 | 15 | 13 | 10 | 77 | 0 | 0 | 0 | 0 |
| 78 | 10 | 10 | 13 | 2 | 78 | 0 | 0 | 0 | 0 |
| 79 | 8 | 12 | 13 | 5 | 79 | 0 | 0 | 0 | 0 |

**Table 7.2.4d. Continued.**

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_DEF | | | | | OT_DEF | | | |
| Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | Length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 80 | 8 | 13 | 10 | 6 | 80 | 0 | 0 | 0 | 0 |
| 81 | 9 | 15 | 13 | 5 | 81 | 0 | 0 | 0 | 0 |
| 82 | 9 | 14 | 7 | 6 | 82 | 0 | 0 | 0 | 0 |
| 83 | 9 | 7 | 5 | 7 | 83 | 0 | 0 | 0 | 0 |
| 84 | 10 | 8 | 8 | 7 | 84 | 0 | 0 | 0 | 0 |
| 85 | 19 | 17 | 8 | 3 | 85 | 0 | 0 | 0 | 0 |
| 86 | 13 | 14 | 7 | 6 | 86 | 0 | 0 | 0 | 0 |
| 87 | 3 | 17 | 11 | 10 | 87 | 0 | 0 | 0 | 0 |
| 88 | 17 | 12 | 7 | 4 | 88 | 0 | 1 | 0 | 0 |
| 89 | 12 | 15 | 9 | 9 | 89 | 0 | 0 | 0 | 0 |
| 90 | 9 | 15 | 6 | 7 | 90 | 0 | 0 | 0 | 0 |
| 91 | 10 | 15 | 7 | 7 | 91 | 0 | 0 | 0 | 0 |
| 92 | 11 | 16 | 11 | 5 | 92 | 0 | 0 | 0 | 0 |
| 93 | 9 | 10 | 6 | 5 | 93 | 0 | 0 | 0 | 0 |
| 94 | 10 | 11 | 9 | 4 | 94 | 0 | 0 | 0 | 0 |
| 95 | 6 | 8 | 8 | 4 | 95 | 0 | 0 | 0 | 0 |
| 96 | 3 | 9 | 12 | 5 | 96 | 0 | 0 | 0 | 0 |
| 97 | 8 | 8 | 1 | 3 | 97 | 0 | 0 | 0 | 0 |
| 98 | 6 | 9 | 5 | 9 | 98 | 0 | 0 | 0 | 0 |
| 99 | 2 | 2 | 4 | 2 | 99 | 0 | 0 | 0 | 0 |
| 100 | 4 | 9 | 3 | 2 | 100 | 0 | 0 | 0 | 0 |
| 101 | 6 | 4 | 8 | 2 | 101 | 0 | 0 | 0 | 0 |
| 102 | 4 | 2 | 4 | 3 | 102 | 0 | 0 | 0 | 0 |
| 103 | 3 | 5 | 2 | 1 | 103 | 0 | 0 | 0 | 0 |
| 104 | 1 | 5 | 1 | 2 | 104 | 0 | 0 | 0 | 0 |
| 105 | 1 | 3 | 3 | 2 | 105 | 0 | 0 | 0 | 0 |
| 106 | 0 | 5 | 1 | 1 | 106 | 0 | 0 | 0 | 0 |
| 107 | 2 | 3 | 0 | 1 | 107 | 0 | 0 | 0 | 0 |
| 108 | 4 | 2 | 1 | 0 | 108 | 0 | 0 | 0 | 0 |
| 109 | 1 | 1 | 2 | 1 | 109 | 0 | 0 | 0 | 0 |
| 110 | 0 | 1 | 0 | 3 | 110 | 0 | 0 | 0 | 0 |
| 111 | 0 | 1 | 1 | 0 | 111 | 0 | 0 | 0 | 0 |
| 112 | 0 | 0 | 0 | 1 | 112 | 0 | 0 | 0 | 0 |
| 113 | 0 | 0 | 1 | 0 | 113 | 0 | 0 | 0 | 0 |
| 114 | 0 | 0 | 0 | 0 | 114 | 0 | 0 | 0 | 0 |
| 115 | 1 | 1 | 0 | 0 | 115 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Number of fish | 788 | 1121 | 1802 | 1019 | | 41 | 239 | 259 | 76 |
| Number of hauls | 252 | 451 | 579 | 490 | | 252 | 451 | 579 | 490 |

**Table 7.2.4e. Cod in Divisions VIIe–k. Length structure of French landings and discards from on-board observer programme. Otter trawlers targeting *Nephrops*.**

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_CRU | | | | | OT_CRU | | | |
| length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 20 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 3 | 1 |
| 22 | 0 | 0 | 0 | 0 | 22 | 0 | 2 | 2 | 0 |
| 23 | 0 | 0 | 0 | 0 | 23 | 0 | 3 | 1 | 0 |
| 24 | 0 | 0 | 0 | 0 | 24 | 1 | 5 | 3 | 0 |
| 25 | 0 | 0 | 0 | 0 | 25 | 1 | 5 | 1 | 0 |
| 26 | 0 | 0 | 0 | 1 | 26 | 1 | 9 | 3 | 0 |
| 27 | 0 | 0 | 0 | 0 | 27 | 2 | 14 | 8 | 2 |
| 28 | 0 | 0 | 0 | 0 | 28 | 3 | 14 | 8 | 3 |
| 29 | 0 | 0 | 0 | 0 | 29 | 0 | 22 | 15 | 3 |
| 30 | 0 | 0 | 2 | 0 | 30 | 1 | 18 | 25 | 4 |
| 31 | 0 | 0 | 0 | 0 | 31 | 0 | 20 | 30 | 9 |
| 32 | 0 | 0 | 0 | 0 | 32 | 0 | 18 | 27 | 8 |
| 33 | 0 | 0 | 1 | 0 | 33 | 0 | 21 | 32 | 9 |
| 34 | 0 | 0 | 1 | 0 | 34 | 0 | 9 | 44 | 4 |
| 35 | 0 | 0 | 512 | 3 | 35 | 0 | 9 | 18 | 1 |
| 36 | 0 | 1 | 548 | 2 | 36 | 0 | 6 | 14 | 1 |
| 37 | 0 | 1 | 508 | 3 | 37 | 0 | 4 | 17 | 1 |
| 38 | 0 | 0 | 483 | 9 | 38 | 0 | 6 | 10 | 2 |
| 39 | 0 | 1 | 395 | 7 | 39 | 0 | 3 | 5 | 3 |
| 40 | 0 | 2 | 336 | 11 | 40 | 0 | 2 | 3 | 1 |
| 41 | 1 | 6 | 267 | 23 | 41 | 0 | 2 | 5 | 0 |
| 42 | 2 | 3 | 211 | 25 | 42 | 0 | 2 | 3 | 0 |
| 43 | 3 | 2 | 119 | 33 | 43 | 0 | 0 | 0 | 0 |
| 44 | 2 | 7 | 90 | 38 | 44 | 0 | 0 | 1 | 0 |
| 45 | 7 | 4 | 68 | 26 | 45 | 0 | 0 | 0 | 0 |
| 46 | 2 | 9 | 39 | 34 | 46 | 0 | 0 | 0 | 0 |
| 47 | 14 | 3 | 29 | 24 | 47 | 0 | 0 | 0 | 0 |
| 48 | 8 | 5 | 25 | 25 | 48 | 0 | 0 | 0 | 0 |
| 49 | 11 | 8 | 13 | 16 | 49 | 0 | 0 | 0 | 0 |
| 50 | 11 | 7 | 16 | 7 | 50 | 0 | 0 | 0 | 0 |
| 51 | 12 | 9 | 17 | 12 | 51 | 0 | 0 | 0 | 0 |
| 52 | 5 | 7 | 21 | 7 | 52 | 0 | 0 | 0 | 0 |
| 53 | 5 | 18 | 22 | 5 | 53 | 0 | 0 | 0 | 0 |
| 54 | 4 | 12 | 27 | 3 | 54 | 0 | 0 | 0 | 0 |
| 55 | 5 | 12 | 19 | 3 | 55 | 0 | 0 | 0 | 0 |
| 56 | 3 | 16 | 33 | 0 | 56 | 0 | 0 | 0 | 0 |
| 57 | 6 | 13 | 23 | 6 | 57 | 0 | 0 | 0 | 0 |
| 58 | 9 | 19 | 47 | 2 | 58 | 0 | 0 | 0 | 0 |

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_CRU | | | | | OT_CRU | | | |
| length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 59 | 2 | 13 | 45 | 4 | 59 | 0 | 0 | 0 | 0 |
| 60 | 2 | 20 | 51 | 3 | 60 | 0 | 0 | 0 | 0 |
| 61 | 1 | 12 | 56 | 5 | 61 | 0 | 0 | 0 | 0 |
| 62 | 1 | 13 | 46 | 4 | 62 | 0 | 0 | 0 | 0 |
| 63 | 2 | 9 | 45 | 7 | 63 | 0 | 0 | 0 | 0 |
| 64 | 0 | 7 | 39 | 9 | 64 | 0 | 0 | 0 | 0 |
| 65 | 1 | 8 | 43 | 10 | 65 | 0 | 0 | 0 | 0 |
| 66 | 3 | 7 | 27 | 13 | 66 | 0 | 0 | 0 | 0 |
| 67 | 1 | 6 | 25 | 8 | 67 | 0 | 0 | 0 | 0 |
| 68 | 3 | 3 | 25 | 6 | 68 | 0 | 0 | 0 | 0 |
| 69 | 5 | 1 | 27 | 12 | 69 | 0 | 0 | 0 | 0 |
| 70 | 4 | 3 | 21 | 8 | 70 | 0 | 0 | 0 | 0 |
| 71 | 4 | 4 | 16 | 11 | 71 | 0 | 0 | 0 | 0 |
| 72 | 2 | 9 | 7 | 6 | 72 | 0 | 0 | 0 | 0 |
| 73 | 5 | 3 | 2 | 7 | 73 | 0 | 0 | 0 | 0 |
| 74 | 2 | 6 | 5 | 6 | 74 | 0 | 0 | 0 | 0 |
| 75 | 2 | 4 | 5 | 2 | 75 | 0 | 0 | 0 | 0 |
| 76 | 7 | 11 | 10 | 5 | 76 | 0 | 0 | 0 | 0 |
| 77 | 3 | 7 | 11 | 4 | 77 | 0 | 0 | 0 | 0 |
| 78 | 4 | 7 | 10 | 3 | 78 | 0 | 0 | 0 | 0 |
| 79 | 2 | 5 | 5 | 1 | 79 | 0 | 0 | 0 | 0 |

**Table 7.2.4e. Continued.**

| | Retained | | | | | Discarded | | | |
|---|---|---|---|---|---|---|---|---|---|
| | OT_CRU | | | | | OT_CRU | | | |
| length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 | length (cm) | 2010 - Q1 | 2010 - Q2 | 2010 - Q3 | 2010 - Q4 |
| 80 | 3 | 3 | 5 | 3 | 80 | 0 | 0 | 0 | 0 |
| 81 | 2 | 2 | 13 | 3 | 81 | 0 | 0 | 0 | 0 |
| 82 | 5 | 4 | 11 | 1 | 82 | 0 | 0 | 0 | 0 |
| 83 | 1 | 7 | 10 | 4 | 83 | 0 | 0 | 0 | 0 |
| 84 | 1 | 11 | 16 | 2 | 84 | 0 | 0 | 0 | 0 |
| 85 | 4 | 4 | 10 | 2 | 85 | 0 | 0 | 0 | 0 |
| 86 | 2 | 4 | 7 | 5 | 86 | 0 | 0 | 0 | 0 |
| 87 | 3 | 3 | 11 | 1 | 87 | 0 | 0 | 0 | 0 |
| 88 | 4 | 9 | 7 | 4 | 88 | 0 | 0 | 0 | 0 |
| 89 | 2 | 7 | 13 | 4 | 89 | 0 | 0 | 0 | 0 |
| 90 | 1 | 5 | 8 | 3 | 90 | 0 | 0 | 0 | 0 |
| 91 | 0 | 9 | 10 | 5 | 91 | 0 | 0 | 0 | 0 |
| 92 | 2 | 4 | 11 | 3 | 92 | 0 | 0 | 0 | 0 |
| 93 | 1 | 6 | 14 | 2 | 93 | 0 | 0 | 0 | 0 |
| 94 | 0 | 2 | 10 | 1 | 94 | 0 | 0 | 0 | 0 |
| 95 | 3 | 4 | 5 | 3 | 95 | 0 | 0 | 0 | 0 |
| 96 | 1 | 4 | 5 | 3 | 96 | 0 | 0 | 0 | 0 |
| 97 | 1 | 3 | 3 | 6 | 97 | 0 | 0 | 0 | 0 |
| 98 | 2 | 2 | 7 | 1 | 98 | 0 | 0 | 0 | 0 |
| 99 | 1 | 3 | 2 | 2 | 99 | 0 | 0 | 0 | 0 |
| 100 | 2 | 1 | 5 | 1 | 100 | 0 | 0 | 0 | 0 |
| 101 | 2 | 2 | 6 | 2 | 101 | 0 | 0 | 0 | 0 |
| 102 | 1 | 2 | 6 | 2 | 102 | 0 | 0 | 0 | 0 |
| 103 | 0 | 1 | 4 | 1 | 103 | 0 | 0 | 0 | 0 |
| 104 | 3 | 3 | 2 | 1 | 104 | 0 | 0 | 0 | 0 |
| 105 | 2 | 2 | 0 | 2 | 105 | 0 | 0 | 0 | 0 |
| 106 | 1 | 0 | 0 | 0 | 106 | 0 | 0 | 0 | 0 |
| 107 | 0 | 1 | 0 | 1 | 107 | 0 | 0 | 0 | 0 |
| 108 | 0 | 0 | 1 | 1 | 108 | 0 | 0 | 0 | 0 |
| 109 | 0 | 0 | 0 | 0 | 109 | 0 | 0 | 0 | 0 |
| 110 | 0 | 0 | 3 | 0 | 110 | 0 | 0 | 0 | 0 |
| 111 | 0 | 0 | 0 | 0 | 111 | 0 | 0 | 0 | 0 |
| 112 | 0 | 1 | 0 | 0 | 112 | 0 | 0 | 0 | 0 |
| 113 | 0 | 1 | 0 | 0 | 113 | 0 | 0 | 0 | 0 |
| 114 | 0 | 0 | 1 | 0 | 114 | 0 | 0 | 0 | 0 |
| 115 | 0 | 0 | 1 | 0 | 115 | 0 | 0 | 0 | 0 |
| 116 | 0 | 0 | 0 | 0 | 116 | 0 | 0 | 0 | 0 |
| 117 | 0 | 0 | 1 | 0 | 117 | 0 | 0 | 0 | 0 |
| 118 | 0 | 0 | 0 | 0 | 118 | 0 | 0 | 0 | 0 |
| 119 | 0 | 0 | 0 | 0 | 119 | 0 | 0 | 0 | 0 |
| 120 | 0 | 0 | 1 | 0 | 120 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Number of fish | 216 | 433 | 4602 | 528 | | 9 | 194 | 278 | 52 |
| Number of hauls | 53 | 154 | 156 | 191 | | 53 | 154 | 156 | 191 |

**Table 7.2.4f. Cod in Divisions VIIe–k. Length structure of Belgium landings and discards from on-board observer programme.**

| | Quarter 1 | | Quarter 2 | | Quarter 3 | | Quarter 4 | |
|---|---|---|---|---|---|---|---|---|
| | Discards | Landings | Discards | Landings | Discards | Landings | Discards | Landings |
| Length | 2 trips | | 8 trips | | 8 trips | | 4 trips | |
| (cm) | 14 hauls | | 14 hauls | | 16 trips | | 80 hauls | |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| 19 | 2 | 0 | 30 | 0 | 0 | 0 | 0 | 0 |
| 20 | 6 | 0 | 157 | 0 | 0 | 0 | 0 | 0 |
| 21 | 52 | 0 | 238 | 0 | 0 | 0 | 0 | 0 |
| 22 | 58 | 0 | 316 | 0 | 10 | 0 | 0 | 0 |
| 23 | 86 | 0 | 427 | 0 | 14 | 0 | 0 | 0 |
| 24 | 80 | 0 | 377 | 0 | 84 | 0 | 2 | 0 |
| 25 | 120 | 0 | 450 | 0 | 182 | 0 | 4 | 0 |
| 26 | 145 | 0 | 362 | 0 | 153 | 0 | 2 | 0 |
| 27 | 122 | 0 | 360 | 0 | 137 | 0 | 6 | 0 |
| 28 | 97 | 0 | 301 | 0 | 170 | 0 | 12 | 0 |
| 29 | 79 | 0 | 216 | 0 | 113 | 0 | 10 | 0 |
| 30 | 72 | 0 | 227 | 0 | 69 | 0 | 12 | 0 |
| 31 | 46 | 0 | 197 | 0 | 66 | 0 | 14 | 0 |
| 32 | 34 | 0 | 128 | 0 | 58 | 0 | 25 | 0 |
| 33 | 32 | 0 | 96 | 0 | 32 | 0 | 24 | 0 |
| 34 | 25 | 0 | 103 | 0 | 41 | 0 | 47 | 0 |
| 35 | 11 | 0 | 86 | 0 | 34 | 0 | 8 | 0 |
| 36 | 6 | 0 | 50 | 0 | 30 | 0 | 22 | 0 |
| 37 | 12 | 0 | 44 | 0 | 10 | 0 | 30 | 0 |
| 38 | 9 | 0 | 29 | 0 | 18 | 0 | 28 | 0 |
| 39 | 18 | 0 | 8 | 0 | 10 | 0 | 29 | 0 |
| 40 | 9 | 0 | 6 | 0 | 35 | 0 | 20 | 0 |
| 41 | 9 | 0 | 12 | 0 | 12 | 0 | 18 | 0 |
| 42 | 9 | 0 | 10 | 0 | 14 | 0 | 14 | 0 |
| 43 | 11 | 0 | 8 | 0 | 10 | 0 | 12 | 0 |
| 44 | 11 | 0 | 8 | 0 | 12 | 0 | 16 | 0 |

| | Quarter 1 | | Quarter 2 | | Quarter 3 | | Quarter 4 | |
|---|---|---|---|---|---|---|---|---|
| | Discards | Landings | Discards | Landings | Discards | Landings | Discards | Landings |
| Length | 2 trips | | 8 trips | | 8 trips | | 4 trips | |
| (cm) | 14 hauls | | 14 hauls | | 16 trips | | 80 hauls | |
| 45 | 15 | 0 | 25 | 0 | 2 | 0 | 10 | 0 |
| 46 | 4 | 0 | 23 | 0 | 2 | 0 | 8 | 0 |
| 47 | 2 | 0 | 16 | 0 | 6 | 0 | 7 | 0 |
| 48 | 8 | 0 | 23 | 0 | 0 | 0 | 0 | 0 |
| 49 | 4 | 0 | 17 | 0 | 0 | 0 | 4 | 0 |
| 50 | 0 | 11 | 4 | 10 | 0 | 0 | 2 | 2 |
| 51 | 0 | 4 | 4 | 23 | 0 | 4 | 0 | 6 |
| 52 | 0 | 6 | 2 | 10 | 0 | 0 | 0 | 0 |
| 53 | 0 | 14 | 2 | 16 | 0 | 0 | 0 | 6 |
| 54 | 0 | 9 | 2 | 10 | 0 | 2 | 0 | 2 |
| 55 | 0 | 16 | 4 | 8 | 0 | 2 | 0 | 8 |
| 56 | 0 | 7 | 0 | 8 | 0 | 2 | 0 | 2 |
| 57 | 0 | 11 | 2 | 6 | 0 | 6 | 0 | 4 |
| 58 | 0 | 0 | 4 | 6 | 0 | 0 | 0 | 0 |
| 59 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 2 | 10 | 0 | 4 | 0 | 0 |
| 61 | 0 | 7 | 0 | 4 | 0 | 0 | 0 | 0 |
| 62 | 0 | 4 | 2 | 6 | 0 | 2 | 0 | 0 |
| 63 | 0 | 0 | 0 | 12 | 0 | 4 | 0 | 0 |
| 64 | 0 | 2 | 0 | 27 | 0 | 2 | 0 | 0 |
| 65 | 0 | 0 | 2 | 41 | 0 | 0 | 0 | 0 |
| 66 | 0 | 7 | 0 | 0 | 0 | 2 | 0 | 0 |
| 67 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | 2 |
| 68 | 0 | 7 | 0 | 2 | 0 | 0 | 0 | 0 |
| 69 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.2.4f. Continued.**

| | Quarter 1 | | Quarter 2 | | Quarter 3 | | Quarter 4 | |
|---|---|---|---|---|---|---|---|---|
| | Discards | Landings | Discards | Landings | Discards | Landings | Discards | Landings |
| Length | 2 trips | | 8 trips | | 8 trips | | 4 trips | |
| (cm) | 14 hauls | | 14 hauls | | 16 trips | | 80 hauls | |
| 70 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 |
| 73 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 76 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 79 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 94 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 95 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 101 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| Total | 1194 | 149 | 4394 | 210 | 1324 | 32 | 386 | 36 |
| % number | 801 | 3 | 2095 | | 4154 | | 1070 | |

**Table 7.2.5. Cod in Divisions VIIe–k. Catch weight-at-age.**

Run title : Cod in Divisions VIIe-k,WGCSE11,index file
At 5/05/2011 15:18

Table 2 Catch weights-at-age (kg)

| YEAR, | 1971, | 1972, | 1973, | 1974, | 1975, | 1976, | 1977, | 1978, | 1979, | 1980, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .9080, | .9080, | .9080, | .9080, | .9080, | .9080, | .9080, | .9080, | .9080, | .9080, |
| 2, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, | 2.1930, |
| 3, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, | 4.8310, |
| 4, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, | 7.4640, |
| 5, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, | 9.6690, |
| 6, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, | 11.7840, |
| +gp, | 14.8159, | 14.4792, | 14.6675, | 14.9506, | 14.5262, | 15.1279, | 15.7144, | 15.2267, | 14.3395, | 13.8620, |
| 0 SOPCOFAC, | 1.0006, | .9972, | .9982, | .9966, | 1.0011, | 1.0029, | 1.0004, | .9974, | 1.0006, | 1.0003, |

Table 2 Catch weights-at-age (kg)

| YEAR, | 1981, | 1982, | 1983, | 1984, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .9450, | .9450, | .9790, | .9810, | 1.0010, | 1.0540, | .9090, | .9060, | .8440, | .8800, |
| 2, | 1.5490, | 2.2420, | 2.5250, | 2.6450, | 2.6370, | 2.5540, | 2.5040, | 2.1870, | 2.0130, | 2.3000, |
| 3, | 4.3850, | 4.4740, | 4.9610, | 5.2840, | 5.5210, | 5.3980, | 5.2640, | 5.3180, | 4.7060, | 4.6240, |
| 4, | 7.5650, | 7.7970, | 7.4570, | 7.8280, | 8.0820, | 7.4400, | 8.0890, | 7.9970, | 7.6380, | 7.1880, |
| 5, | 9.0600, | 10.2500, | 9.9650, | 9.7580, | 10.4070, | 10.7820, | 10.4470, | 10.6490, | 9.4380, | 9.0450, |
| 6, | 12.7500, | 12.4650, | 12.0100, | 11.6720, | 11.4690, | 12.3960, | 13.5740, | 12.4860, | 12.9170, | 11.7130, |
| +gp, | 14.7237, | 15.4408, | 16.4710, | 15.3396, | 14.3697, | 13.5580, | 15.3490, | 14.6217, | 13.3935, | 14.8144, |
| 0 SOPCOFAC, | 1.0002, | 1.0146, | 1.0006, | .9984, | 1.0092, | 1.0000, | .9844, | .9997, | 1.0003, | .9900, |

Table 2 Catch weights-at-age (kg)

| YEAR, | 1991, | 1992, | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .9050, | .8150, | .8710, | .8740, | .8060, | .7870, | .7710, | .8530, | .9930, | .8630, |
| 2, | 2.1350, | 1.9160, | 2.0430, | 2.0000, | 1.9730, | 1.8770, | 2.0390, | 1.8960, | 2.0980, | 2.5410, |
| 3, | 4.9870, | 4.9160, | 4.5080, | 4.4920, | 4.5890, | 4.6390, | 4.5160, | 4.4610, | 4.4950, | 4.6290, |
| 4, | 6.7380, | 7.3590, | 6.8660, | 7.9260, | 7.5600, | 6.9970, | 7.3890, | 6.8810, | 7.3260, | 7.0420, |
| 5, | 8.8650, | 9.7440, | 8.4310, | 10.0920, | 9.7500, | 9.8540, | 9.7190, | 9.3290, | 8.9450, | 9.5020, |
| 6, | 10.8090, | 11.4980, | 10.9420, | 12.2120, | 11.1520, | 11.4070, | 11.8200, | 11.2160, | 11.2550, | 10.6600, |
| +gp, | 14.1344, | 12.6295, | 12.3344, | 14.0578, | 14.0814, | 12.3707, | 14.3670, | 14.0713, | 14.6309, | 12.1360, |
| 0 SOPCOFAC, | 1.0000, | 1.0000, | 1.0009, | 1.0000, | .9999, | 1.0000, | 1.0006, | 1.0012, | 1.0017, | .9995, |

Table 2 Catch weights-at-age (kg)

| YEAR, | 2001, | 2002, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .7940, | .7570, | .8890, | .8840, | .7760, | .7890, | .7720, | .8470, | .9230, | .8530, |
| 2, | 2.0290, | 1.8800, | 1.8440, | 2.1770, | 2.1180, | 1.7930, | 1.6570, | 1.8040, | 2.3840, | 2.2260, |
| 3, | 5.1120, | 4.7280, | 4.2740, | 4.5430, | 3.9070, | 4.7160, | 4.2760, | 4.5410, | 4.2480, | 4.7890, |
| 4, | 7.8580, | 6.7640, | 6.6670, | 7.0730, | 6.1680, | 7.4040, | 7.4630, | 7.1640, | 6.7210, | 7.2850, |
| 5, | 9.8320, | 9.3600, | 9.5060, | 9.4350, | 9.1940, | 9.1860, | 9.6970, | 9.2290, | 8.8950, | 9.9750, |
| 6, | 11.4230, | 10.7740, | 11.0640, | 10.8020, | 11.5440, | 11.6460, | 11.8630, | 11.0950, | 10.5840, | 11.9480, |
| +gp, | 13.8977, | 13.1661, | 12.1431, | 12.8979, | 10.0370, | 12.3902, | 12.8190, | 13.3042, | 10.3420, | .0000, |
| 0 SOPCOFAC, | .9991, | .9996, | .9992, | 1.0014, | 1.0020, | 1.0005, | 1.0011, | 1.0026, | .9989, | .7715, |

1

**Table 7.2.6. Cod in Divisions VIIe–k. Stock weight-at-age = 1st quarter values.**

Run title : Cod in Divisions VIIe-k,WGCSE11,index file
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Table 3 Stock weights-at-age (kg)

| YEAR, | 1971, | 1972, | 1973, | 1974, | 1975, | 1976, | 1977, | 1978, | 1979, | 1980, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .6620, | .6620, | .6620, | .6620, | .6620, | .6620, | .6620, | .6620, | .6620, | .6620, |
| 2, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, | 1.7090, |
| 3, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, | 4.4440, |
| 4, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, | 7.3210, |
| 5, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, | 9.5290, |
| 6, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, | 11.6050, |
| +gp, | 14.5404, | 14.1778, | 14.3755, | 14.5822, | 14.2402, | 14.8683, | 15.3589, | 14.9079, | 14.0056, | 13.5130, |

Table 3 Stock weights-at-age (kg)

| YEAR, | 1981, | 1982, | 1983, | 1984, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .4600, | .7040, | .4460, | .5120, | .5810, | .5280, | .5220, | .9060, | .8440, | .6130, |
| 2, | 1.5490, | 1.4880, | 1.9450, | 1.9510, | 2.0700, | 1.9020, | 1.9470, | 1.6210, | 1.4630, | 1.7740, |
| 3, | 2.2840, | 3.8760, | 4.4670, | 4.9280, | 5.3330, | 5.2860, | 4.8770, | 4.8870, | 4.5140, | 4.3900, |
| 4, | 7.8060, | 7.4070, | 7.3530, | 7.4330, | 8.3760, | 7.3820, | 7.9460, | 7.7770, | 7.6150, | 7.1860, |
| 5, | 10.5440, | 9.6240, | 9.7520, | 9.5520, | 10.8510, | 10.6890, | 10.3080, | 10.3020, | 9.4380, | 8.4860, |
| 6, | 11.4390, | 12.3160, | 11.2230, | 12.1800, | 11.5850, | 12.3930, | 14.4190, | 11.7860, | 12.6920, | 10.7030, |
| +gp, | 14.6123, | 15.7394, | 17.4511, | 15.2018, | 14.9743, | 14.4820, | 15.4457, | 13.4600, | 14.1533, | 14.6578, |

Table 3 Stock weights-at-age (kg)

| YEAR, | 1991, | 1992, | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .5390, | .6630, | .7030, | .6050, | .6120, | .6730, | .4700, | .4210, | .7780, | .5610, |
| 2, | 1.5380, | 1.3180, | 1.3850, | 1.7540, | 1.4440, | 1.2830, | 1.4100, | 1.3140, | 1.5420, | 1.6960, |
| 3, | 4.7910, | 4.6000, | 4.2780, | 4.1890, | 4.3460, | 4.4710, | 4.0790, | 4.3400, | 4.2520, | 4.2230, |
| 4, | 6.5240, | 6.5580, | 6.5740, | 7.7200, | 7.4520, | 6.7470, | 7.1120, | 6.6760, | 7.1260, | 6.6270, |
| 5, | 8.6310, | 9.3420, | 8.0660, | 9.7220, | 9.1400, | 9.8770, | 9.0440, | 9.3030, | 8.7000, | 9.3260, |
| 6, | 10.6720, | 11.2850, | 10.8150, | 12.1010, | 10.6460, | 11.4240, | 11.1560, | 11.1720, | 11.1420, | 10.5050, |
| +gp, | 13.8090, | 12.4660, | 12.1295, | 13.9081, | 14.0514, | 12.8480, | 13.7300, | 12.8280, | 15.2226, | 11.4651, |

Table 3 Stock weights-at-age (kg)

| YEAR, | 2001, | 2002, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1, | .6300, | .3520, | .4820, | .5910, | .5880, | .7030, | .7220, | .8690, | .9380, | .8190, |
| 2, | 1.4550, | 1.2570, | 1.3270, | 1.2580, | 1.6880, | 1.2160, | 1.3990, | 1.4490, | 1.6290, | 1.4240, |
| 3, | 4.9040, | 4.4520, | 4.1110, | 4.0530, | 4.0750, | 4.2330, | 3.7940, | 4.1880, | 3.8650, | 4.3730, |
| 4, | 7.8720, | 7.0460, | 6.6010, | 6.7590, | 5.9450, | 6.8190, | 6.9900, | 6.8960, | 6.5570, | 6.9840, |
| 5, | 10.1920, | 9.4000, | 9.1830, | 9.3720, | 9.0180, | 8.8950, | 9.8090, | 8.8810, | 8.9850, | 9.8910, |
| 6, | 11.6130, | 10.6140, | 10.6350, | 10.1580, | 11.3330, | 11.4870, | 12.2730, | 11.5430, | 10.5670, | 11.6630, |
| +gp, | 13.8257, | 13.6879, | 12.5877, | 12.6100, | 11.4870, | 11.6694, | 14.8977, | 12.7292, | 12.9810, | .0000, |

**Table 7.2.7. Cod in Divisions VIIe–k. Series of surveys indices scrutinized at WGCSE.**

```
Cod in Divisions VIIe-k, tuning fleets,WGCSE11

102
FR-EVHOE Groundfish  Oct-Nov survey in VIIf,g,h,j, numbers per 30 mn

1997    2010
1       1       0.75    1
1       6
1       0.213   0.095   0.246   0.117   0.048   0
1       0.212   0.52    0.207   0.045   0.045   0
1       0.155   0.184   0.283   0.015   0.03    0.015
1       1.046   0.041   0.118   0.064   0.013   0
1       0.716   0.18    0.029   0.038   0.018   0.007
1       0.033   0.313   0.148   0       0.015   0
1       0.052   0.041   0.142   0.061   0.008   0
1       0.066   0.144   0.072   0.122   0.046   0
1       0.255   0.12    0.055   0       0.026   0
1       0.125   0.139   0       0.048   0.045   0
1       0.321   0.206   0.117   0.033   0       0
1       0.217   0.141   0.117   0.096   0       0
1       0.237   0.092   0.132   0.078   0       0.023
1       1.805   0.210   0.028   0.094   0       0

IR-GFS-7GJ combined: Irish Grounfish Survey (IBTS 4th Qrt)- Cod number per 1h

2003    2010
1       1       0.79    0.92
1       5
1       0.45    0.52    0.53    0.15    0
1       0.64    0.21    0.07    0.04    0.04
1       2.87    0.28    0.11    0       0
1       1.36    0.46    0.06    0       0
1       1.88    0.65    0.21    0.06    0
1       0.36    0.98    0.24    0.03    0
1       1.16    0.14    0.17    0.03    0
1       10.09   0.82    0.02    0.07    0
```

**Table 7.2.8a. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue.**

| | France | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fr gadoid trawlers VIIfgh | | | Fr *Nephrops* trawlers VIIfgh | | | Fr Otter trawlers VIIe-k | | | Fr Otter trawlers VII e | | |
| Year | Landings | Effort | lpue | Landings | Effort | lpue | Landings | Effort | lpue | Landings | Effort | lpue |
| 1978 | Q2+Q3+Q4 for | | | Q2+Q3+Q4 for | | | | | | | | |
| 1979 | consistency with | | | consistency with | | | includes Fr gadoid trawlers and | | | | | |
| 1980 | box closure | | | box closure | | | Fr *Nephrops* trawlers | | | | | |
| 1981 | during Q1 2005 | | | during Q1 2005 | | | | | | | | |
| 1982 | and Feb–March 2006 to 2008 | | | and Feb–March 2006 to 2008 | | | | | | | | |
| 1983 | 1453 | 75.0 | 19.4 | 630 | 190.5 | 3.3 | 5443 | 904.3 | 6.0 | 472 | 210.6 | 2.2 |
| 1984 | 2002 | 60.6 | 33.1 | 671 | 170.5 | 3.9 | 4881 | 654.9 | 7.5 | 189 | 118.4 | 1.6 |
| 1985 | 1667 | 73.4 | 22.7 | 1023 | 150.7 | 6.8 | 6262 | 847.6 | 7.4 | 351 | 154.1 | 2.3 |
| 1986 | 2086 | 85.3 | 24.5 | 774 | 132.6 | 5.8 | 8046 | 932.0 | 8.6 | 431 | 220.4 | 2.0 |
| 1987 | 2804 | 107.8 | 26.0 | 778 | 145.7 | 5.3 | 8215 | 886.0 | 9.3 | 835 | 167.6 | 5.0 |
| 1988 | 6243 | 184.4 | 33.9 | 1726 | 144.1 | 12.0 | 13739 | 963.6 | 14.3 | 1320 | 199.4 | 6.6 |
| 1989 | 5171 | 166.3 | 31.1 | 1496 | 157.7 | 9.5 | 15715 | 1066.0 | 14.7 | 983 | 217.4 | 4.5 |
| 1990 | 3045 | 155.2 | 19.6 | 1138 | 206.3 | 5.5 | 9018 | 1073.3 | 8.4 | 383 | 198.6 | 1.9 |
| 1991 | 2096 | 127.1 | 16.5 | 690 | 186.2 | 3.7 | 5878 | 1013.2 | 5.8 | 335 | 177.7 | 1.9 |
| 1992 | 2304 | 133.0 | 17.3 | 1223 | 226.2 | 5.4 | 6709 | 1060.6 | 6.3 | 325 | 179.1 | 1.8 |
| 1993 | 2566 | 155.5 | 16.5 | 1236 | 205.3 | 6.0 | 8302 | 1095.6 | 7.6 | 295 | 238.4 | 1.2 |
| 1994 | 1725 | 121.8 | 14.2 | 1245 | 225.1 | 5.5 | 7353 | 959.7 | 7.7 | 306 | 185.1 | 1.7 |
| 1995 | 2598 | 128.2 | 20.3 | 1606 | 200.5 | 8.0 | 8248 | 1010.8 | 8.2 | 520 | 215.2 | 2.4 |
| 1996 | 2455 | 123.0 | 20.0 | 1450 | 181.6 | 8.0 | 8667 | 954.6 | 9.1 | 460 | 188.5 | 2.4 |
| 1997 | 2830 | 168.2 | 16.8 | 1246 | 152.6 | 8.2 | 8307 | 1057.5 | 7.9 | 584 | 258.3 | 2.3 |
| 1998 | 1707 | 139.3 | 12.3 | 805 | 111.1 | 7.2 | 5765 | 743.383* | 7.76* | 150* | 28.2* | 5.33* |
| 1999 | 1271 | 138.8 | 9.2 | 546 | 114.6 | 4.8 | 5445 | 1047.3 | 5.2 | 647 | 298.4 | 2.2 |
| 2000 | 938 | 115.3 | 8.1 | 711 | 125.3 | 5.7 | 4254 | 1051.9 | 4.0 | 542 | 312.5 | 1.7 |
| 2001 | 1911 | 138.5 | 13.8 | 916 | 141.7 | 6.5 | 5957 | 1010.4 | 5.9 | 584 | 281.3 | 2.1 |
| 2002 | 2412 | 121.8 | 19.8 | 1083 | 147.6 | 7.3 | 7389 | 974.8 | 7.6 | 654 | 317.4 | 2.1 |
| 2003 | 1110 | 92.0 | 12.1 | 972 | 169.9 | 5.7 | 5157 | 1025.7 | 5.0 | 619 | 366.2 | 1.7 |
| 2004 | 469 | 83.1 | 5.6 | 462 | 128.2 | 3.6 | 2379 | 952.1 | 2.4 | 193 | 353.6 | 0.5 |
| 2005 | 483 | 79.1 | 6.1 | 343 | 113.3 | 3.0 | 1577 | 874.2 | 1.7 | 239 | 333.9 | 0.7 |
| 2006 | 430 | 55.6 | 7.7 | 376 | 108.3 | 3.5 | 1834 | 866.8 | 2.1 | 359 | 334.8 | 1.1 |
| 2007 | 678 | 63.4 | 10.7 | 509 | 85.1 | 6.0 | 2438 | 805.7 | 3.0 | 445 | 311.5 | 1.4 |
| 2008 | 496 | 54.0 | 9.2 | 445 | 78.1 | 5.7 | 1958 | 655.3 | 3.0 | 399 | 242.5 | 1.6 |
| 2009<br>2010 | Incomplete datasets/not usable | | | | | | | | | | | |

**Units: landings in Tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.**

| | Fr gadoid trawlers VIIfgh | | | Fr Nephrops trawlers VIIfgh | | | Fr Otter trawlers VIIe-k | | |
|---|---|---|---|---|---|---|---|---|---|
| | Landings | Effort | lpue | Landings | Effort | lpue | Landings | Effort | lpue |
| FR- Highgrading input | | | | | | | | | |
| 2003 | 1155 | 92.0 | 12.6 | 1011 | 169.9 | 6.0 | 5367 | 1025.7 | 5.2 |
| 2004 | 498 | 83.1 | 6.0 | 491 | 128.2 | 3.8 | 2527 | 952.1 | 2.7 |
| 2005 | 506 | 79.1 | 6.4 | 359 | 113.3 | 3.2 | 1651 | 874.2 | 1.9 |
| 2006 | 548 | 55.6 | 9.8 | 465 | 108.3 | 4.3 | 2229 | 866.8 | 2.6 |
| 2007 | 886 | 63.4 | 14.0 | 630 | 85.1 | 7.4 | 2995 | 805.7 | 3.7 |
| 2008 | 591 | 54.0 | 11.0 | 534 | 78.1 | 6.8 | 2284 | 655.3 | 3.5 |
| 2009<br>2010 | Incomplete datasets/not usable | | | | | | | | |

**Table 7.2.8b. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue. Units: landings in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.**

| | UK (England + Wales) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | UK Otter trawlers VIIe–k | | | UK Beam trawlers VIIe-–k | | | UK Otter trawlers VIIe | | |
| Year | Landings | Effort | Lpue | Landings | Effort | Lpue | Landings | Effort | Lpue |
| 1972 | 355 | 117.1 | 3.0 | | | | 80 | 64.6 | 1.2 |
| 1973 | 223 | 118.5 | 1.9 | | | | 58 | 69.5 | 0.8 |
| 1974 | 192 | 91.6 | 2.1 | | | | 55 | 50.1 | 1.1 |
| 1975 | 136 | 100.3 | 1.4 | | | | 38 | 54.7 | 0.7 |
| 1976 | 97 | 88.2 | 1.1 | | | | 32 | 56.1 | 0.6 |
| 1977 | 119 | 88.5 | 1.3 | | | | 78 | 55.4 | 1.4 |
| 1978 | 116 | 83.2 | 1.4 | 6 | 24.7 | 0.3 | 70 | 48.8 | 1.4 |
| 1979 | 130 | 73.5 | 1.8 | 14 | 44.0 | 0.3 | 74 | 49.9 | 1.5 |
| 1980 | 228 | 85.6 | 2.7 | 39 | 76.7 | 0.5 | 84 | 50.0 | 1.7 |
| 1981 | 324 | 104.3 | 3.1 | 63 | 87.6 | 0.7 | 76 | 46.9 | 1.6 |
| 1982 | 362 | 104.7 | 3.5 | 84 | 115.0 | 0.7 | 65 | 38.5 | 1.7 |
| 1983 | 163 | 82.1 | 2.0 | 84 | 135.3 | 0.6 | 73 | 52.6 | 1.4 |
| 1984 | 237 | 86.7 | 2.7 | 129 | 131.5 | 1.0 | 77 | 52.9 | 1.5 |
| 1985 | 249 | 90.3 | 2.8 | 145 | 152.5 | 1.0 | 64 | 57.7 | 1.1 |
| 1986 | 233 | 84.7 | 2.8 | 164 | 135.7 | 1.2 | 80 | 49.5 | 1.6 |
| 1987 | 221 | 84.3 | 2.6 | 246 | 177.1 | 1.4 | 96 | 45.1 | 2.1 |
| 1988 | 270 | 89.1 | 3.0 | 248 | 194.9 | 1.3 | 155 | 53.4 | 2.9 |
| 1989 | 186 | 84.1 | 2.2 | 230 | 198.2 | 1.2 | 105 | 54.7 | 1.9 |
| 1990 | 314 | 99.5 | 3.2 | 307 | 207.6 | 1.5 | 128 | 53.1 | 2.4 |
| 1991 | 243 | 76.7 | 3.2 | 258 | 203.2 | 1.3 | 84 | 40.8 | 2.0 |
| 1992 | 232 | 86.4 | 2.7 | 256 | 196.1 | 1.3 | 81 | 39.9 | 2.0 |
| 1993 | 181 | 61.9 | 2.9 | 220 | 208.4 | 1.1 | 43 | 39.2 | 1.1 |
| 1994 | 79 | 53.7 | 1.5 | 174 | 220.0 | 0.8 | 41 | 38.8 | 1.1 |
| 1995 | 115 | 52.3 | 2.2 | 239 | 243.1 | 1.0 | 55 | 35.5 | 1.5 |
| 1996 | 120 | 60.5 | 2.0 | 303 | 260.8 | 1.2 | 59 | 30.5 | 1.9 |
| 1997 | 149 | 66.7 | 2.2 | 299 | 264.8 | 1.1 | 79 | 33.3 | 2.4 |
| 1998 | 119 | 62.1 | 1.9 | 265 | 254.6 | 1.0 | 62 | 29.8 | 2.1 |
| 1999 | 90 | 98.4 | 0.9 | 257 | 251.4 | 1.0 | 47 | 27.5 | 1.7 |
| 2000 | 111 | 104.1 | 1.1 | 187 | 259.0 | 0.7 | 52 | 30.5 | 1.7 |
| 2001 | 110 | 85.3 | 1.3 | 256 | 272.7 | 0.9 | 59 | 31.9 | 1.8 |
| 2002 | 80 | 83.0 | 1.0 | 130 | 249.5 | 0.5 | 34 | 28.3 | 1.2 |
| 2003 | 58 | 72.3 | 0.8 | 103 | 282.1 | 0.4 | 24 | 25.1 | 1.0 |
| 2004 | 44 | 75.7 | 0.6 | 96 | 273.9 | 0.3 | 15 | 25.6 | 0.6 |
| 2005 | 41 | 76.4 | 0.5 | 102 | 270.3 | 0.4 | 17 | 21.1 | 0.8 |
| 2006 | 55 | 83.3 | 0.7 | 91 | 252.0 | 0.4 | 13 | 21.1 | 0.6 |
| 2007 | 49 | 87.6 | 0.6 | 111 | 239.9 | 0.5 | 22 | 22.4 | 1.0 |
| 2008 | 49 | 71.2 | 0.7 | 71 | 216.9 | 0.3 | 24 | 19.9 | 1.2 |
| 2009 | 27 | 73.8 | 0.4 | 67 | 190.9 | 0.4 | 13 | 21.4 | 0.6 |
| 2010 | 31 | 77.6 | 0.4 | 65 | 195.9 | 0.3 | 15 | 26.1 | 0.6 |

**Table 7.2.8c. Cod in Divisions VIIe–k. Time-series of landings, effort and lpue. Units: landings in tonnes live weight, Effort in 000s hours fished, lpue in Kg/hour fished.**

| | IRELAND | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ir Otter trawlers VIIg | | | Ir Beam trawlers VIIg | | | Ir Scottish seiners VIIg | | | Ir Gillnet VIIg | | |
| Year | Landings | Effort | Lpue | Landings | Effort | Lpue | Landings | Effort | Lpue | Landings | Effort | Lpue |
| 1995 | 429.9 | 63.6 | 6.8 | 85.8 | 20.8 | 4.1 | 111.27 | 6.43 | 17.3 | 114.92 | | |
| 1996 | 569.3 | 60.0 | 9.5 | 112.6 | 26.8 | 4.2 | 164.87 | 9.73 | 16.9 | 338.84 | | |
| 1997 | 401.9 | 65.1 | 6.2 | 131.5 | 28.3 | 4.7 | 215.24 | 16.13 | 13.3 | 52.81 | | |
| 1998 | 450.6 | 72.3 | 6.2 | 166.9 | 35.3 | 4.7 | 264.14 | 14.94 | 17.7 | 87.32 | | |
| 1999 | 300.9 | 51.7 | 5.8 | 190.6 | 40.9 | 4.7 | 64.59 | 8.01 | 8.1 | 211.92 | | |
| 2000 | 279.4 | 60.6 | 4.6 | 180.6 | 37.0 | 4.9 | 106.04 | 9.90 | 10.7 | 157.03 | | |
| 2001 | 339.5 | 69.4 | 4.9 | 96.6 | 39.7 | 2.4 | 111.09 | 16.33 | 6.8 | 107.99 | | |
| 2002 | 213.0 | 77.7 | 2.7 | 57.9 | 31.6 | 1.8 | 70.84 | 20.86 | 3.4 | 34.13 | | |
| 2003 | 167.4 | 86.8 | 1.9 | 57.1 | 49.3 | 1.2 | 38.07 | 20.91 | 1.8 | 31.17 | | |
| 2004 | 190.2 | 97.0 | 2.0 | 74.3 | 54.9 | 1.4 | 54.86 | 19.38 | 2.8 | 60.65 | | |
| 2005 | 294.9 | 124.4 | 2.4 | 118.7 | 49.6 | 2.4 | 66.13 | 14.81 | 4.5 | 77.697 | | |
| 2006 | 390.0 | 119.2 | 3.3 | 128.6 | 60.5 | 2.1 | 90.98 | 14.79 | 6.2 | 63.73 | | |
| 2007 | 323.0 | 136.5 | 2.4 | 96.2 | 55.9 | 1.7 | 58.52 | 15.82 | 3.7 | 85.44 | | |
| 2008 | 349.9 | 125.8 | 2.8 | 85.4 | 37.2 | 2.3 | 55.59 | 11.65 | 4.8 | 91.07 | | |
| 2009 | 405.9 | 137.1 | 3.0 | 74.4 | 38.0 | 2.0 | 34.63 | 8.19 | 4.2 | 86.16 | | |
| 2010 | 523.8 | 140.6 | 3.7 | 94.7 | 40.2 | 2.4 | 54.30 | 9.69 | 5.6 | 77.46 | | |

| | IRELAND | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ir Otter trawlers VIIj | | | Ir Beam trawlers VIIj | | | Ir Scottish seiners VIIj | | | Ir Gillnet VIIj | | |
| Year | Landings | Effort | Lpue | Landings | Effort | Lpue | Landings | Effort | Lpue | Landings | Effort | Lpue |
| 1995 | 338.5 | 93.7 | 3.6 | 0.0 | 0.2 | 0.2 | 75.52 | 5.26 | 14.4 | 179.57 | | |
| 1996 | 326.4 | 70.2 | 4.6 | 8.7 | 1.5 | 5.9 | 124.55 | 8.15 | 15.3 | 64.96 | | |
| 1997 | 352.8 | 83.2 | 4.2 | 3.4 | 1.8 | 1.9 | 115.81 | 10.73 | 10.8 | 45.47 | | |
| 1998 | 262.7 | 89.6 | 2.9 | 19.2 | 5.2 | 3.7 | 103.37 | 6.61 | 15.6 | 59.13 | | |
| 1999 | 76.7 | 40.6 | 1.9 | 27.5 | 7.4 | 3.7 | 9.57 | 1.41 | 6.8 | 24.01 | | |
| 2000 | 95.5 | 64.6 | 1.5 | 21.2 | 6.9 | 3.1 | 23.71 | 3.49 | 6.8 | 13.98 | | |
| 2001 | 140.7 | 67.7 | 2.1 | 10.4 | 3.0 | 3.5 | 27.95 | 4.42 | 6.3 | 12.69 | | |
| 2002 | 150.1 | 90.4 | 1.7 | 5.4 | 3.1 | 1.7 | 24.65 | 8.87 | 2.8 | 12.23 | | |
| 2003 | 74.4 | 111.3 | 0.7 | 8.8 | 9.0 | 1.0 | 14.72 | 9.15 | 1.6 | 6.17 | | |
| 2004 | 36.1 | 92.0 | 0.4 | 2.5 | 2.2 | 1.2 | 11.57 | 9.18 | 1.3 | 4.21 | | |
| 2005 | 40.6 | 73.9 | 0.5 | 4.7 | 2.4 | 1.9 | 17.76 | 6.09 | 2.9 | 3.30 | | |
| 2006 | 42.7 | 65.9 | 0.6 | 2.0 | 1.5 | 1.3 | 15.64 | 5.33 | 2.9 | 7.18 | | |
| 2007 | 39.0 | 80.5 | 0.5 | 7.8 | 2.4 | 3.3 | 9.83 | 3.51 | 2.8 | 6.50 | | |
| 2008 | 33.5 | 66.5 | 0.5 | 2.6 | 1.1 | 2.3 | 9.46 | 2.84 | 3.3 | 6.66 | | |
| 2009 | 26.6 | 73.1 | 0.4 | 4.7 | 2.8 | 1.7 | 8.90 | 3.33 | 2.7 | 7.52 | | |
| 2010 | 51.9 | 85.3 | 0.6 | 1.7 | 1.0 | 1.7 | 17.04 | 4.35 | 3.9 | 7.86 | | |

**Table 7.2.9. Cod in Divisions VIIe–k. Tuning indices used for exploratory XSA.**

Cod in Divisions VIIe-k, tuning fleets,WGCSE09

109
FR-GADOIDQ2+3+4 trawlers in VIIfgh (effort hours fished, n° individuals)

1983 2008
1 1 0.25 1
1 7

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 74992 | 260899 | 98470 | 83167 | 51148 | 8708 | 2115 | 702 | 572 | 104 | 0 |
| 60554 | 264776 | 384489 | 34198 | 25074 | 19906 | 5260 | 935 | 437 | 0 | 0 |
| 73397 | 164991 | 240550 | 91883 | 13287 | 7830 | 9379 | 1514 | 913 | 0 | 0 |
| 85302 | 148440 | 222666 | 130804 | 49043 | 8106 | 5991 | 4158 | 40 | 0 | 0 |
| 107781 | 1316826 | 279848 | 110620 | 18501 | 7118 | 1708 | 1275 | 810 | 69 | 0 |
| 184408 | 611840 | 2024182 | 84860 | 41087 | 8973 | 5934 | 559 | 178 | 1109 | 0 |
| 166279 | 207852 | 813228 | 548423 | 29672 | 15390 | 5014 | 1389 | 784 | 526 | 0 |
| 155175 | 138846 | 311610 | 222389 | 124462 | 16526 | 6539 | 744 | 99 | 99 | 0 |
| 127064 | 362141 | 301828 | 35757 | 53178 | 34282 | 8598 | 1315 | 1087 | 0 | 0 |
| 132970 | 607817 | 492100 | 68181 | 9279 | 8984 | 5550 | 1371 | 89 | 0 | 0 |
| 155514 | 109856 | 674880 | 92481 | 17324 | 4642 | 4335 | 2188 | 633 | 134 | 0 |
| 121829 | 266023 | 117323 | 153569 | 30545 | 4085 | 1183 | 1013 | 369 | 0 | 0 |
| 128219 | 154493 | 617967 | 54352 | 54795 | 18932 | 4101 | 360 | 1064 | 0 | 0 |
| 123025 | 129647 | 526800 | 179949 | 18438 | 12552 | 4950 | 835 | 0 | 0 | 0 |
| 168156 | 154549 | 489043 | 185037 | 56522 | 12127 | 8228 | 1443 | 180 | 0 | 0 |
| 139326 | 131195 | 401923 | 81432 | 23640 | 9972 | 3497 | 908 | 753 | 262 | 131 |
| 138767 | 71952 | 142275 | 93463 | 22704 | 6301 | 4502 | 1186 | 1229 | 0 | 141 |
| 115310 | 340457 | 77158 | 33382 | 16050 | 3556 | 1798 | 1272 | 198 | 128 | 0 |
| 138521 | 297665 | 563912 | 19119 | 11523 | 8243 | 2818 | 1230 | 531 | 0 | 0 |
| 121794 | 65876 | 637726 | 168485 | 13416 | 4586 | 1956 | 409 | 958 | 417 | 272 |
| 91951 | 20159 | 158283 | 130617 | 31516 | 1855 | 1498 | 744 | 151 | 66 | 0 |
| 83130 | 32301 | 50715 | 33878 | 13601 | 5483 | 524 | 51 | 0 | 0 | 47 |
| 79120 | 24413 | 119375 | 8391 | 5027 | 6992 | 2273 | 281 | 55 | 195 | 0 |
| 55637 | 81151 | 145045 | 20670 | 2832 | 1422 | 1002 | 599 | 0 | 0 | 0 |
| 63360 | 114102 | 212783 | 61307 | 10796 | 1715 | 558 | 667 | 205 | 46 | 0 |
| 50415 | 18989 | 92047 | 25440 | 9205 | 2448 | 358 | 141 | 256 | 0 | 4 |

FR-NEPHROPS trawlers in VIIfgh (effort in hours fished, n° individuals)

1987 2008
1 1 0 1
1 7

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 191020 | 171757 | 81278 | 52746 | 23485 | 6513 | 3474 | 2209 | 572 | 0 | 0 |
| 172625 | 65228 | 505300 | 58116 | 18370 | 4627 | 2818 | 462 | 272 | 448 | 0 |
| 180285 | 34563 | 188872 | 192486 | 20017 | 10775 | 2101 | 1149 | 212 | 150 | 0 |
| 230684 | 21416 | 89684 | 91512 | 58839 | 7705 | 3522 | 1244 | 59 | 0 | 0 |
| 226146 | 75858 | 112496 | 25967 | 28891 | 14338 | 3934 | 1735 | 958 | 0 | 0 |
| 278998 | 111808 | 343353 | 57068 | 7023 | 9674 | 6450 | 1780 | 0 | 0 | 0 |
| 270056 | 8018 | 329369 | 114425 | 14046 | 2239 | 3051 | 2477 | 624 | 174 | 0 |
| 260993 | 252260 | 72275 | 124690 | 27001 | 4607 | 998 | 1276 | 112 | 0 | 0 |
| 240953 | 68020 | 496186 | 35291 | 33012 | 13081 | 2259 | 630 | 277 | 0 | 0 |
| 220922 | 55213 | 312231 | 123538 | 15095 | 10286 | 4442 | 1069 | 0 | 0 | 0 |
| 188417 | 66023 | 246609 | 100660 | 26480 | 6035 | 2803 | 379 | 0 | 0 | 0 |
| 155789 | 21185 | 199640 | 62447 | 22498 | 9037 | 2518 | 526 | 293 | 88 | 0 |
| 151470 | 30026 | 126600 | 50043 | 11822 | 3977 | 3592 | 479 | 454 | 0 | 0 |
| 194560 | 182011 | 46785 | 59385 | 22741 | 5160 | 1237 | 1394 | 376 | 0 | 0 |
| 171813 | 181989 | 288579 | 11628 | 12475 | 6849 | 2298 | 1209 | 548 | 0 | 0 |
| 172969 | 17408 | 295819 | 85715 | 6785 | 4737 | 1475 | 1051 | 192 | 47 | 47 |
| 200830 | 8630 | 76748 | 157290 | 41895 | 3331 | 1985 | 2252 | 390 | 0 | 0 |
| 161277 | 42683 | 48862 | 31193 | 29642 | 9297 | 1325 | 533 | 572 | 0 | 135 |
| 149785 | 23764 | 90000 | 11083 | 5094 | 10502 | 1972 | 102 | 33 | 16 | 0 |
| 137118 | 43216 | 144234 | 30017 | 4441 | 2430 | 3705 | 1090 | 189 | 0 | 0 |
| 102160 | 55030 | 140834 | 57818 | 10360 | 2225 | 1057 | 743 | 210 | 30 | 0 |
| 96987 | 22944 | 109279 | 42109 | 18589 | 5933 | 1333 | 950 | 366 | 76 | 0 |

UK-WECOT(E+W)Otter trawlers inVIIe, effort in 000's hours, numbers-at-age in 000's

1988 2010
1 1 0 1
1 6

| | | | | | | |
|---|---|---|---|---|---|---|
| 53.402 | 59.047 | 38.995 | 0.728 | 0.178 | 0.076 | 0.194 |
| 54.707 | 3.49 | 12.604 | 11.944 | 0.835 | 0.75 | 0 |
| 53.05 | 4.783 | 3.591 | 11.303 | 5.755 | 1.245 | 0 |
| 40.789 | 27.281 | 3.388 | 1.789 | 2.664 | 2.547 | 1.022 |
| 39.909 | 14.758 | 29.177 | 1.993 | 0.636 | 0.468 | 0.923 |
| 39.174 | 0.73 | 10.494 | 3.703 | 0.25 | 0.141 | 0.102 |
| 38.768 | 18.196 | 1.402 | 3.165 | 1.208 | 0.166 | 0.063 |
| 35.453 | 10.755 | 24.948 | 1.959 | 0.647 | 0.098 | 0.013 |
| 30.541 | 4.259 | 14.297 | 4.475 | 0.42 | 0.095 | 0.103 |
| 33.281 | 30.644 | 7.783 | 4.526 | 1.656 | 0.462 | 0.27 |
| 29.802 | 3.832 | 13.999 | 3.394 | 1.297 | 0.317 | 0.102 |
| 27.516 | 2.297 | 3.100 | 6.927 | 0.865 | 0.247 | 0.136 |
| 30.493 | 19.065 | 2.024 | 1.858 | 1.946 | 0.526 | 0.305 |
| 31.900 | 7.723 | 16.722 | 1.026 | 0.365 | 0.622 | 0.107 |
| 28.346 | 1.151 | 8.922 | 3.165 | 0.136 | 0.135 | 0.059 |
| 25.052 | 0.312 | 2.679 | 3.268 | 0.536 | 0.046 | 0.024 |
| 25.584 | 1.005 | 1.019 | 0.872 | 0.793 | 0.189 | 0.035 |
| 21.129 | 0.750 | 4.031 | 0.423 | 0.213 | 0.170 | 0.083 |
| 21.058 | 0.605 | 2.934 | 1.011 | 0.054 | 0.061 | 0.022 |
| 22.352 | 2.266 | 4.208 | 1.965 | 0.250 | 0.022 | 0.026 |
| 19.860 | 1.979 | 4.415 | 1.649 | 0.459 | 0.079 | 0.015 |
| 21.412 | 0.360 | 1.575 | 1.103 | 0.224 | 0.086 | 0.018 |
| 26.062 | 3.662 | 0.952 | 0.942 | 0.425 | 0.112 | 0.033 |

IR-7J-OT Irish otter trawlers in VIIj, effort in 000s hours, N in 000s

**Table 7.2.9. Continued.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1995 | 2008 | | | | | | |
| 1 | 1 | 0 | 1 | | | | |
| 1 | 6 | | | | | | |
| 93.642 | 30.597 | 121.744 | 9.697 | 7.883 | 0.505 | 0.222 | 0.044 |
| 70.226 | 23.109 | 54.566 | 49.072 | 5.6 | 1.197 | 0.787 | 0 |
| 83.171 | 26.433 | 69.525 | 30.08 | 8.289 | 0.997 | 0.115 | 0 |
| 89.61 | 17.685 | 77.44 | 10.809 | 7.534 | 2.833 | 1.147 | 0.236 |
| 40.61 | 0.992 | 9.714 | 7.894 | 2.783 | 0.394 | 0.187 | 0.099 |
| 78.499 | 21.299 | 6.65 | 5.494 | 3.23 | 0.982 | 0.267 | 0.102 |
| 83.84 | 21.418 | 51.569 | 2.569 | 1.76 | 0.428 | 0.107 | 0 |
| 90.446 | 10.898 | 44.185 | 10.786 | 1.392 | 0.22 | 0.109 | 0 |
| 118.809 | 1.935 | 8.802 | 11.822 | 0.884 | 0.218 | 0.026 | 0 |
| 91.957 | 6.154 | 6.154 | 11.877 | 1.622 | 0.859 | 0.054 | 0 |
| 73.919 | 10.613 | 10.613 | 12.326 | 3.143 | 0.739 | 0.382 | 0.19 |
| 65.346 | 23.346 | 23.346 | 14.377 | 1.983 | 0.394 | 0.179 | 0.031 |
| 80.485 | 9.898 | 9.898 | 16.569 | 1.588 | 0.187 | 0 | 0 |
| 66.349 | 0.597 | 13.715 | 1.998 | 0.329 | 0.062 | 0 | 0 |

IR-7G-OT Irish otter trawlers in VIIg, effort in 000s hours, N in 000s

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 2008 | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | |
| 1 | 7 | | | | | | | | | |
| 96.991 | 40.668 | 21.027 | 12.303 | 6.798 | 1.908 | 0.401 | 0.115 | 0 | 0 | 0 |
| 124.395 | 80.602 | 50.632 | 24.284 | 11.276 | 3.76 | 0.646 | 0.236 | 0.038 | 0 | 0 |
| 118.364 | 29.629 | 108.106 | 37.295 | 2.458 | 0.977 | 1.106 | 0 | 0.121 | 0 | 0 |
| 131.323 | 15.307 | 62.794 | 37.138 | 6.312 | 1.011 | 0.499 | 0.036 | 0.036 | 0 | 0 |
| 129.313 | 3.078 | 69.57 | 35.902 | 8.996 | 1.839 | 0.46 | 0.113 | 0.098 | 0.071 | 0.015 |

IR-7GJ-OTB Irish otter trawlers in VIIg,j aggregated effort in 000s hours, N in 000s

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2004 | 2010 | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | |
| 1 | 7 | | | | | | | |
| 188.948 | 46.822 | 32.904 | 13.925 | 7.657 | 1.962 | 0.401 | 0.000 | |
| 198.31466 | 91.215 | 62.957 | 27.427 | 12.015 | 4.143 | 0.836 | 0.000 | |
| 183.70985 | 52.974 | 122.483 | 39.278 | 2.852 | 1.156 | 1.136 | 0.000 | |
| 211.80805 | 25.205 | 79.363 | 38.727 | 6.499 | 1.011 | 0.499 | 0.000 | |
| 195.6619167 | | 3.675 | 83.285 | 37.900 | 9.324 | 1.901 | 0.460 | 0.000 |
| 207.6318667 | | 27.572 | 22.824 | 44.433 | 14.834 | 6.863 | 1.518 | 0.120 |
| 140.6473333 | | 90.502 | 71.353 | 16.454 | 13.196 | 6.519 | 2.869 | 0.719 |

UK-WCGFS West Coast March survey, effort in mn towed, numbers *10**2, final survey in 2004

| | | | | | |
|---|---|---|---|---|---|
| 1992 | 2004 | | | | |
| 1 | 1 | 0.15 | 0.25 | | |
| 1 | 5 | | | | |
| 3774 | 2800 | 7100 | 400 | 200 | 200 |
| 3602 | 500 | 7250 | 4850 | 1230 | 100 |
| 1915 | 7400 | 600 | 3180 | 1130 | 300 |
| 3439 | 11200 | 14520 | 880 | 1400 | 700 |
| 3695 | 1300 | 6800 | 8500 | 1000 | 800 |
| 3826 | 3700 | 3200 | 3400 | 700 | 100 |
| 3744 | 1800 | 2500 | 2000 | 700 | 500 |
| 3823 | 200 | 1500 | 300 | 400 | 100 |
| 4092 | 3000 | 0 | 410 | 200 | 200 |
| 3700 | 1450 | 1100 | 1000 | 100 | 100 |
| 3387 | 200 | 5450 | 2960 | 430 | 100 |
| 2326 | 0 | 579 | 3154 | 410 | 100 |
| 1689 | 1400 | 0 | 200 | 1000 | 200 |

FR-EVHOE Groundfish  Oct-Nov survey in VIIf,g,h,j, numbers per 30 mn

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1997 | 2010 | | | | | | |
| 1 | 1 | 0.75 | 1 | | | | |
| 1 | 6 | | | | | | |
| 1 | 0.213 | 0.095 | 0.246 | 0.117 | 0.048 | 0 | 1997 |
| 1 | 0.212 | 0.52 | 0.207 | 0.045 | 0.045 | 0 | 1998 |
| 1 | 0.155 | 0.184 | 0.283 | 0.015 | 0.03 | 0.015 | 1999 |
| 1 | 1.046 | 0.041 | 0.118 | 0.064 | 0.013 | 0 | 2000 |
| 1 | 0.716 | 0.18 | 0.029 | 0.038 | 0.018 | 0.007 | 2001 |
| 1 | 0.033 | 0.313 | 0.148 | 0 | 0.015 | 0 | 2002 |
| 1 | 0.052 | 0.041 | 0.142 | 0.061 | 0.008 | 0 | 2003 |
| 1 | 0.066 | 0.144 | 0.072 | 0.122 | 0.046 | 0 | 2004 |
| 1 | 0.255 | 0.12 | 0.055 | 0 | 0.026 | 0 | 2005 |
| 1 | 0.125 | 0.139 | 0 | 0.048 | 0.045 | 0 | 2006 |
| 1 | 0.321 | 0.206 | 0.117 | 0.033 | 0 | 0 | 2007 |
| 1 | 0.217 | 0.141 | 0.117 | 0.096 | 0 | 0 | 2008 |
| 1 | 0.237 | 0.092 | 0.132 | 0.078 | 0 | 0.023 | 2009 |
| 1 | 1.805 | 0.210 | 0.028 | 0.094 | 0 | 0 | 2010 |

**Table 7.2.9. Continued.**

IR-GFSgj Irish Groundfish Survey (IBTS 4th Qtr) - VIIg-VIIjcombined Cod number-at-age (Effort Standardized to 1hr)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | |
| 1 | 6 | | | | | | | |
| 1 | 0.45 | 0.52 | 0.53 | 0.15 | 0.00 | 0.00 | 0.00 | 2003 |
| 1 | 0.64 | 0.21 | 0.07 | 0.04 | 0.04 | 0.00 | 0.00 | 2004 |
| 1 | 2.87 | 0.28 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 2005 |
| 1 | 1.36 | 0.46 | 0.06 | 0.00 | 0.00 | 0.03 | 0.00 | 2006 |
| 1 | 1.88 | 0.65 | 0.21 | 0.06 | 0.00 | 0.00 | 0.00 | 2007 |
| 1 | 0.36 | 0.98 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 2008 |
| 1 | 1.16 | 0.14 | 0.17 | 0.03 | 0.00 | 0.00 | 0.00 | 2009 |
| 1 | 10.09 | 0.82 | 0.02 | 0.07 | 0.00 | 0.00 | 0.00 | 2010 |

IR-GFSg Irish Groundfish Survey (IBTS 4th Qtr) - VIIg Cod number-at-age (Interim indices for new Celtic Explorer series)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | | |
| 0 | 7 | | | | | | | | |
| 832 | 0 | 6 | 10 | 10 | 4 | 0 | 0 | 0 | 2003 |
| 980 | 6 | 16 | 6 | 2 | 1 | 1 | 0 | 0 | 2004 |
| 845 | 2 | 29 | 8 | 1 | 0 | 0 | 0 | 0 | 2005 |
| 1046 | 1 | 38 | 11 | 2 | 0 | 0 | 1 | 0 | 2006 |
| 1168 | 0 | 50 | 16 | 7 | 2 | 0 | 0 | 0 | 2007 |
| 1139 | 0 | 10 | 25 | 6 | 1 | 0 | 0 | 0 | 2008 |
| 1018 | 4 | 32 | 4 | 5 | 1 | 0 | 0 | 0 | 2009 |
| 1381 | 1 | 286 | 27 | 1 | 1 | 0 | 0 | 0 | 2010 |

IR-GFSj Irish Groundfish Survey (IBTS 4th Qtr) - VIIj Cod number-at-age (Interim indices for new Celtic Explorer series)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | | |
| 0 | 7 | | | | | | | | |
| 780 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 2003 |
| 720 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2004 |
| 881 | 0 | 27 | 0 | 1 | 0 | 0 | 0 | 0 | 2005 |
| 901 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2006 |
| 874 | 0 | 7 | 3 | 0 | 0 | 0 | 0 | 0 | 2007 |
| 873 | 0 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 2008 |
| 747 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2009 |
| 1021 | 4 | 59 | 3 | 0 | 1 | 0 | 0 | 0 | 2010 |

**Table 7.2.10. Cod in Divisions VIIe–k. XSA diagnostics.**

```
Lowestoft VPA Version 3.1

   7/06/2011  14:00

 Extended Survivors Analysis

 Cod in Divisions VIIe-k,WGCSE11,index file

 cpue data from file fleets.txt

 Catch data for  40 years. 1971 to 2010. Ages  1 to   7.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FR-GADOIDQ2+3+4 traw,   1983, 2010,   1,     6,   .250,  1.000
 FR-NEPHROPS trawlers,   1987, 2010,   1,     6,   .000,  1.000
 UK-WECOT(E+W)Ottertr,   1989, 2010,   1,     6,   .000,  1.000
 IR-7J-OT Irish otter,   1995, 2010,   1,     6,   .000,  1.000
 IR-7G-OT Irish otter,   2004, 2010,   1,     6,   .000,  1.000
 IR-7GJ-OTB Irish ott,   2004, 2010,   1,     6,   .000,  1.000
 UK-WCGFS West Coast ,   1992, 2010,   1,     5,   .150,   .250
 FR-EVHOE Groundfish ,   1997, 2010,   1,     6,   .750,  1.000
 IR-GFS-7GJ combined:,   2003, 2010,   1,     6,   .790,   .920
 IR-GFS: Irish Ground,   2003, 2010,   0,     6,   .790,   .920
 IR-GFS: Irish Ground,   2003, 2010,   0,     6,   .790,   .920


 Time-series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    5


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   1.000

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting applied :
      Fleet  Weight
      FR-GADOI  1.00
      FR-NEPHR  1.00
      UK-WECOT  1.00
      IR-7J-OT   .00
      IR-7G-OT   .00
      IR-7GJ-O  1.00
      UK-WCGFS  1.00
      FR-EVHOE  1.00
      IR-GFS-7  1.00
      IR-GFS:    .00
      IR-GFS:    .00

 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00226

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6
 Iteration 29,  .0511,  .4332,  .8247,  .4208,  .3655,  .1236
 Iteration 30,  .0511,  .4331,  .8242,  .4205,  .3646,  .1233


1


 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000



 Fishing mortalities
    Age,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010

      1,  .227,  .172,  .140,  .210,  .121,  .139,  .229,  .169,  .101,  .051
      2,  .916,  .891,  .938,  .758,  .809,  .750,  .958,  .679,  .722,  .433
      3,  .726, 1.143, 1.210,  .911, 1.027,  .845,  .823,  .677,  .693,  .824
      4,  .867,  .949, 1.025,  .877,  .777,  .505,  .496,  .487,  .452,  .420
      5, 1.243,  .838,  .603,  .899,  .615,  .488,  .341,  .376,  .330,  .365
      6, 1.034,  .726,  .574,  .775,  .403,  .357,  .248,  .249,  .265,  .123


1
 XSA population numbers (Thousands)

                               AGE
 YEAR ,           1,            2,            3,            4,            5,            6,

 2001 ,    5.94E+03, 4.37E+03, 2.91E+02, 1.87E+02, 1.09E+02, 3.26E+01,
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 2002 , | 1.47E+03, | 3.88E+03, | 1.43E+03, | 1.15E+02, | 6.43E+01, | 2.57E+01, |
| 2003 , | 8.71E+02, | 1.01E+03, | 1.30E+03, | 3.74E+02, | 3.66E+01, | 2.28E+01, |
| 2004 , | 1.99E+03, | 6.20E+02, | 3.23E+02, | 3.18E+02, | 1.10E+02, | 1.64E+01, |
| 2005 , | 2.87E+03, | 1.32E+03, | 2.38E+02, | 1.06E+02, | 1.08E+02, | 3.66E+01, |
| 2006 , | 3.13E+03, | 2.08E+03, | 4.82E+02, | 6.96E+01, | 4.01E+01, | 4.79E+01, |
| 2007 , | 2.65E+03, | 2.23E+03, | 8.06E+02, | 1.70E+02, | 3.44E+01, | 2.01E+01, |
| 2008 , | 8.74E+02, | 1.72E+03, | 7.01E+02, | 2.90E+02, | 8.46E+01, | 2.00E+01, |
| 2009 , | 1.84E+03, | 6.04E+02, | 7.16E+02, | 2.92E+02, | 1.46E+02, | 4.75E+01, |
| 2010 , | 1.18E+04, | 1.36E+03, | 2.40E+02, | 2.93E+02, | 1.52E+02, | 8.58E+01, |

Estimated population abundance at 1st Jan 2011

| | | | | | | |
|---|---|---|---|---|---|---|
| , | 0.00E+00, | 9.18E+03, | 7.25E+02, | 8.63E+01, | 1.58E+02, | 8.66E+01, |

Taper weighted geometric mean of the VPA populations:

| | | | | | | |
|---|---|---|---|---|---|---|
| , | 3.09E+03, | 1.99E+03, | 7.63E+02, | 2.85E+02, | 1.11E+02, | 4.59E+01, |

Standard error of the weighted Log(VPA populations) :

| | | | | | | |
|---|---|---|---|---|---|---|
| , | .8134, | .7597, | .7221, | .5953, | .5954, | .6260, |

1

Log-catchability residuals.

Fleet : FR-GADOIDQ2+3+4 traw

| Age , | 1983, | 1984, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990 |
|---|---|---|---|---|---|---|---|---|
| 1 , | .81, | 1.01, | .46, | .41, | .69, | .14, | .40, | -.11 |
| 2 , | .20, | .78, | -.02, | -.01, | .13, | -.08, | -.06, | .42 |
| 3 , | .41, | .45, | .29, | .48, | .32, | -.53, | .12, | .11 |
| 4 , | .09, | .48, | .21, | .80, | -.20, | -.11, | -.51, | .16 |
| 5 , | -.12, | .22, | -.16, | .38, | -.14, | -.16, | .12, | -.04 |
| 6 , | .03, | .21, | -.20, | .01, | -.65, | .05, | .35, | .26 |

| Age , | 1991, | 1992, | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 , | .05, | .49, | -.21, | -.43, | -.68, | -.55, | -.96, | -.23, | -.01, | .16 |
| 2 , | .30, | -.28, | -.24, | -.67, | -.23, | -.06, | -.11, | -.32, | -.72, | -.27 |
| 3 , | -.09, | .21, | -.71, | -.07, | -.39, | .03, | .04, | -.23, | -.22, | -.51 |
| 4 , | .42, | -.20, | -.04, | -.24, | .29, | -.32, | -.06, | -.25, | -.07, | -.40 |
| 5 , | .49, | .03, | .14, | -.22, | .33, | .19, | -.05, | -.37, | -.09, | -.52 |
| 6 , | .74, | -.10, | .22, | .28, | .61, | .15, | .51, | .21, | .00, | .14 |

| Age , | 2001, | 2002, | 2003, | 2004, | 2005, | 2006, | 2007, | 2008, | 2009, | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 , | -.01, | -.02, | -.42, | -.64, | -1.29, | .19, | .62, | .13, | 99.99, | 99.99 |
| 2 , | -.07, | .29, | .55, | -.10, | .07, | .13, | .44, | -.08, | 99.99, | 99.99 |
| 3 , | -.61, | .34, | .50, | .47, | -.50, | -.06, | .38, | -.22, | 99.99, | 99.99 |
| 4 , | -.38, | .42, | .43, | -.23, | -.14, | -.10, | .21, | -.26, | 99.99, | 99.99 |
| 5 , | .18, | .02, | -.18, | .08, | .22, | -.10, | .02, | -.27, | 99.99, | 99.99 |
| 6 , | .19, | .02, | .07, | -.44, | .06, | -.71, | -.62, | -.83, | 99.99, | 99.99 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age , | 1, | 2, | 3, | 4, | 5, | 6 |
|---|---|---|---|---|---|---|
| Mean Log q, | -7.6535, | -6.2434, | -6.4854, | -6.6922, | -6.8380, | -6.8380, |
| S.E(Log q), | .5529, | .3406, | .3786, | .3256, | .2345, | .3952, |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age, | Slope , | t-value , | Intercept, | RSquare, | No Pts, | Reg s.e, | Mean Q |
|---|---|---|---|---|---|---|---|
| 1, | .90, | .724, | 7.71, | .68, | 26, | .50, | -7.65, |
| 2, | 1.11, | -.960, | 6.08, | .77, | 26, | .38, | -6.24, |
| 3, | .92, | .809, | 6.51, | .80, | 26, | .35, | -6.49, |
| 4, | .94, | .658, | 6.63, | .82, | 26, | .31, | -6.69, |
| 5, | .89, | 1.578, | 6.61, | .90, | 26, | .20, | -6.84, |
| 6, | .90, | .826, | 6.52, | .75, | 26, | .36, | -6.82, |

1

Fleet : FR-NEPHROPS trawlers

| Age , | 1983, | 1984, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990 |
|---|---|---|---|---|---|---|---|---|
| 1 , | 99.99, | 99.99, | 99.99, | 99.99, | -.27, | -.39, | .15, | -.72 |
| 2 , | 99.99, | 99.99, | 99.99, | 99.99, | -.54, | -.27, | -.48, | -.13 |
| 3 , | 99.99, | 99.99, | 99.99, | 99.99, | -.18, | .00, | -.25, | -.40 |
| 4 , | 99.99, | 99.99, | 99.99, | 99.99, | .09, | -.12, | -.25, | -.33 |
| 5 , | 99.99, | 99.99, | 99.99, | 99.99, | -.24, | -.19, | .23, | -.62 |
| 6 , | 99.99, | 99.99, | 99.99, | 99.99, | .07, | -.05, | -.05, | -.17 |

| Age , | 1991, | 1992, | 1993, | 1994, | 1995, | 1996, | 1997, | 1998, | 1999, | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 , | -.44, | -.30, | -1.72, | .41, | -.47, | -.33, | -.28, | -.52, | .65, | .65 |
| 2 , | -.16, | -.26, | -.37, | -.76, | .03, | -.04, | .19, | -.04, | .19, | -.18 |
| 3 , | -.21, | .07, | -.27, | -.28, | -.62, | -.17, | .07, | .15, | -.18, | .30 |
| 4 , | -.14, | -.53, | -.10, | -.44, | -.18, | -.40, | -.25, | .22, | -.14, | .11 |
| 5 , | -.45, | -.11, | -.59, | -.28, | -.09, | -.07, | -.27, | -.03, | -.13, | -.11 |
| 6 , | -.14, | -.18, | -.12, | -.16, | -.05, | -.04, | -.11, | .21, | .21, | -.25 |

```
 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 ,   .93,  -.05,  -.39,   .63,  -.29,   .32,  1.07,  1.33, 99.99, 99.99
    2 ,   .16,   .29,   .15,   .34,   .28,   .36,   .65,   .59, 99.99, 99.99
    3 ,  -.50,   .07,   .65,   .52,  -.08,   .22,   .65,   .46, 99.99, 99.99
    4 ,   .16,   .06,   .59,   .57,  -.07,   .19,   .44,   .53, 99.99, 99.99
    5 ,   .26,   .25,   .22,   .49,   .58,   .14,   .43,   .58, 99.99, 99.99
    6 ,   .30,  -.04,   .16,   .39,  -.10,   .33,   .18,   .47, 99.99, 99.99


Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time


  Age ,        1,         2,         3,         4,         5,         6
Mean Log q,   -9.3603,   -7.5172,   -7.4390,   -7.5298,   -7.5399,   -7.5399,
S.E(Log q),     .6967,     .3625,     .3551,     .3266,     .3510,     .2113,


Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 1,    1.18,    -.784,      9.57,     .48,     22,     .83,   -9.36,
 2,    1.14,   -1.137,      7.47,     .76,     22,     .41,   -7.52,
 3,    1.09,    -.722,      7.49,     .78,     22,     .39,   -7.44,
 4,    1.11,    -.880,      7.73,     .77,     22,     .36,   -7.53,
 5,    1.23,   -1.470,      8.23,     .66,     22,     .42,   -7.54,
 6,    1.16,   -1.507,      8.11,     .82,     22,     .23,   -7.50,
1


Fleet : UK-WECOT(E+W)Ottertr

 Age  ,  1983,  1984,  1985,  1986,  1987,  1988,  1989,  1990
    1 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.14,   .06
    2 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.48,  -.37
    3 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.51,   .30
    4 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,  -.64,   .41
    5 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99,   .41,   .68
    6 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99


 Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
    1 ,  1.06,   .43, -1.38,   .50,   .41,  -.10,  1.50,   .25,   .60,  1.06
    2 ,  -.44,   .73,  -.37, -1.29,   .46,   .36,  -.02,   .47,  -.30,   .05
    3 ,   .16,  -.02,  -.45,  -.72,  -.27,  -.18,   .03,   .22,   .87,   .01
    4 ,   .78,   .61,  -.61,  -.05,  -.60,  -.41,   .30,   .61,   .54,  1.10
    5 ,  1.19,   .46,   .23,  -.04, -1.42, -1.12,   .54,  -.08,   .45,  1.11
    6 ,  1.87,  1.48,   .06,   .64, -1.64,  -.17, -1.37,   .31,   .30,  1.86


 Age  ,  2001,  2002,  2003,  2004,  2005,  2006,  2007,  2008,  2009,  2010
    1 ,   .27,  -.14,  -.82,  -.47,  -.97, -1.26,   .21,  1.27, -1.29, -1.05
    2 ,   .51,   .11,   .39,  -.18,   .65,  -.15,   .17,   .48,   .44, -1.20
    3 ,   .08,  -.10,   .18,   .11,  -.06,   .03,   .11,   .13,  -.36,   .43
    4 ,  -.09,  -.45,  -.10,   .38,   .31,  -.75,  -.18,   .01,  -.80,  -.38
    5 ,  1.20,   .16,  -.33,   .08,   .07,  -.02, -1.01,  -.50, -1.05, -1.01
    6 ,   .57,   .20,  -.52,   .25,   .34, -1.27,  -.35,  -.78, -1.53, -1.77


Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time


  Age ,        1,         2,         3,         4,         5,         6
Mean Log q,  -10.1703,   -9.0280,   -8.7653,   -9.1230,   -9.1928,   -9.1928,
S.E(Log q),     .8557,     .5492,     .3398,     .5460,     .7655,    1.0989,


Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 1,     .77,    1.178,      9.71,     .57,     22,     .66,  -10.17,
 2,     .88,     .783,      8.87,     .69,     22,     .49,   -9.03,
 3,    1.19,   -1.683,      9.14,     .81,     22,     .39,   -8.77,
 4,     .81,    1.323,      8.45,     .70,     22,     .43,   -9.12,
 5,     .85,     .605,      8.51,     .45,     22,     .66,   -9.19,
 6,     .97,     .064,      9.10,     .21,     20,    1.09,   -9.27,
1


Fleet : IR-7J-OT Irish otter

 Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
    1 , 99.99, 99.99, 99.99, 99.99,   .22,   .50,   .18,   .40,  -.89,  -.04
    2 , 99.99, 99.99, 99.99, 99.99,   .51,   .31,   .69,   .51,  -.11,  -.27
    3 , 99.99, 99.99, 99.99, 99.99,  -.27,   .75,   .38,  -.35,  -.02,  -.48
    4 , 99.99, 99.99, 99.99, 99.99,   .30,   .73,   .37,   .65,   .70,   .03
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | -.81 | .52 | .34 | .96 | .47 | .73 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | .17 | .97 | -.89 | 1.57 | .17 | .72 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .06 | .68 | -.81 | -.20 | .16 | .99 | .14 | -1.40 | 99.99 | 99.99 |
| 2 | .10 | -.02 | -.54 | -.23 | -.20 | .23 | -.82 | -.16 | 99.99 | 99.99 |
| 3 | -.60 | -.66 | -.72 | .81 | 1.42 | .92 | .33 | -1.51 | 99.99 | 99.99 |
| 4 | -.11 | .10 | -1.78 | -.81 | 1.12 | 1.09 | -.23 | -2.15 | 99.99 | 99.99 |
| 5 | -.19 | -.57 | -.39 | .26 | .23 | .66 | -.21 | -2.00 | 99.99 | 99.99 |
| 6 | -.46 | -.40 | -2.05 | -.65 | .56 | -.37 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Mean Log q | -9.9086 | -8.4637 | -8.1349 | -8.4981 | -9.1363 | -9.1363 |
| S.E(Log q) | .6471 | .4233 | .8030 | .9858 | .7762 | .9655 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | .66 | 2.426 | 9.24 | .81 | 14 | .36 | -9.91 |
| 2 | .72 | 3.004 | 8.25 | .90 | 14 | .24 | -8.46 |
| 3 | 1.51 | -1.005 | 8.90 | .24 | 14 | 1.21 | -8.13 |
| 4 | 2.05 | -1.167 | 11.64 | .09 | 14 | 1.99 | -8.50 |
| 5 | .80 | .643 | 8.19 | .45 | 14 | .63 | -9.14 |
| 6 | .47 | 1.863 | 6.24 | .56 | 12 | .41 | -9.19 |

1

Fleet : IR-7G-OT Irish otter

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | 99.99 | .92 | .95 | -.08 | -.64 | -1.14 | 99.99 | 99.99 |
| 2 | 99.99 | 99.99 | 99.99 | .09 | -.02 | .31 | -.32 | -.06 | 99.99 | 99.99 |
| 3 | 99.99 | 99.99 | 99.99 | -.21 | .58 | .28 | -.35 | -.30 | 99.99 | 99.99 |
| 4 | 99.99 | 99.99 | 99.99 | -.29 | 1.02 | -.15 | -.20 | -.37 | 99.99 | 99.99 |
| 5 | 99.99 | 99.99 | 99.99 | .00 | .33 | -.03 | -.01 | -.28 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | .29 | -.44 | -.14 | -.23 | -.29 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Mean Log q | -9.1869 | -7.6050 | -7.1322 | -7.6369 | -8.1315 | -8.1315 |
| S.E(Log q) | .9305 | .2294 | .4085 | .5752 | .2182 | .3313 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | .50 | 1.148 | 8.42 | .64 | 5 | .45 | -9.19 |
| 2 | 1.11 | -.409 | 7.64 | .81 | 5 | .29 | -7.60 |
| 3 | 2.43 | -1.899 | 8.55 | .37 | 5 | .77 | -7.13 |
| 4 | 1.76 | -.962 | 9.56 | .35 | 5 | 1.02 | -7.64 |
| 5 | .91 | .437 | 7.79 | .89 | 5 | .22 | -8.13 |
| 6 | 1.42 | -.962 | 10.40 | .64 | 5 | .40 | -8.29 |

1

Fleet : IR-7GJ-OTB Irish ott

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | 99.99 | .62 | .82 | .28 | -.40 | -1.07 | .03 | -.28 |
| 2 | 99.99 | 99.99 | 99.99 | .13 | .00 | .25 | -.31 | -.03 | -.31 | .27 |
| 3 | 99.99 | 99.99 | 99.99 | -.36 | .61 | .27 | -.40 | -.27 | -.19 | .33 |
| 4 | 99.99 | 99.99 | 99.99 | -.43 | .98 | -.02 | -.36 | -.42 | .01 | .24 |
| 5 | 99.99 | 99.99 | 99.99 | -.35 | .19 | -.18 | -.24 | -.35 | .28 | .64 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | -.21 | -.42 | 99.99 | 99.99 | .12 | .26 |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Mean Log q | -9.4092 | -7.8677 | -7.5197 | -8.0054 | -8.3986 | -8.3986 |
| S.E(Log q) | .6502 | .2395 | .3963 | .5019 | .3791 | .3144 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | .84 | .524 | 9.17 | .69 | 7 | .58 | -9.41 |
| 2 | .95 | .279 | 7.83 | .85 | 7 | .25 | -7.87 |
| 3 | 2.17 | -2.293 | 9.17 | .44 | 7 | .66 | -7.52 |
| 4 | 1.58 | -1.094 | 9.60 | .42 | 7 | .78 | -8.01 |
| 5 | .72 | 1.740 | 7.29 | .88 | 7 | .24 | -8.40 |
| 6 | .64 | 1.294 | 6.81 | .86 | 4 | .18 | -8.46 |

1

Fleet : UK-WCGFS West Coast

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | -.21 | -.68 | 1.28 | 1.47 | -.49 | .22 | .22 | -1.25 | -.14 |
| 2 | 99.99 | .38 | .39 | -.36 | .97 | .46 | -.04 | -.50 | -.34 | 99.99 |
| 3 | 99.99 | -.88 | .60 | .65 | -.28 | .94 | .27 | .13 | -1.93 | -1.12 |
| 4 | 99.99 | -.35 | 1.23 | .72 | .31 | .43 | -.57 | -.17 | -.45 | -1.35 |
| 5 | 99.99 | -.39 | -.06 | 1.28 | .59 | .75 | -1.10 | .11 | -.85 | -.17 |
| 6 | No data for this fleet at this age | | | | | | | | | |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -.59 | -1.09 | 99.99 | 1.25 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 2 | -1.35 | .45 | -.06 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 3 | .66 | .32 | .87 | -.23 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 4 | -1.40 | .64 | -.19 | 1.15 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | -.88 | -.35 | .55 | .52 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Mean Log q | -8.9561 | -8.0222 | -7.4564 | -7.2239 | -7.1322 |
| S.E(Log q) | .9213 | .6306 | .8641 | .8441 | .7160 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | .61 | 1.575 | 8.71 | .63 | 12 | .53 | -8.96 |
| 2 | .74 | .968 | 8.04 | .61 | 11 | .47 | -8.02 |
| 3 | .72 | 1.000 | 7.29 | .54 | 13 | .62 | -7.46 |
| 4 | 1.10 | -.192 | 7.39 | .24 | 13 | .97 | -7.22 |
| 5 | 1.16 | -.318 | 7.54 | .27 | 13 | .86 | -7.13 |

1

Fleet : FR-EVHOE Groundfish

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.86 | -.15 | .40 | .71 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.94 | .60 | .15 | -.48 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .17 | .35 | .54 | .20 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .08 | -.28 | -1.24 | .02 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .19 | -.11 | .27 | -.69 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.01 | 99.99 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .46 | -1.27 | -.32 | -.85 | .06 | -.72 | .47 | 1.13 | .41 | .54 |
| 2 | -.60 | .05 | -.59 | 1.00 | .10 | -.26 | .25 | -.12 | .54 | .30 |
| 3 | -.67 | -.27 | -.16 | .30 | .44 | 99.99 | -.21 | -.19 | -.08 | -.42 |
| 4 | .02 | 99.99 | -.06 | .67 | 99.99 | .93 | -.34 | .18 | -.06 | .09 |
| 5 | -.18 | -.19 | -.46 | .45 | -.36 | 1.08 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | -.10 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .04 | 99.99 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Mean Log q | -9.1081 | -8.5263 | -7.7390 | -7.5929 | -7.2665 | -7.2665 |
| S.E(Log q) | .7096 | .5356 | .3618 | .5306 | .5120 | .0785 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1, | .92, | .337, | 9.01, | .59, | 14, | .68, | -9.11, |
| 2, | 1.36, | -1.229, | 8.91, | .49, | 14, | .71, | -8.53, |
| 3, | .91, | .669, | 7.62, | .82, | 13, | .34, | -7.74, |
| 4, | 1.57, | -1.225, | 8.74, | .31, | 12, | .82, | -7.59, |
| 5, | 1.21, | -.488, | 7.86, | .40, | 10, | .65, | -7.27, |
| 6, | .86, | 1.103, | 6.80, | .98, | 3, | .06, | -7.29, |

1

Fleet : IR-GFS-7GJ combined:

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | -.10 | -.52 | .54 | -.28 | .29 | -.31 | .06 | .32 |
| 2 | 99.99 | 99.99 | .56 | -.01 | -.44 | -.44 | .01 | .44 | -.42 | .29 |
| 3 | 99.99 | 99.99 | .84 | -.05 | .81 | -.66 | .06 | .21 | -.14 | -1.08 |
| 4 | 99.99 | 99.99 | 1.09 | -.19 | 99.99 | 99.99 | .52 | -.72 | -.76 | .06 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age , | 1, | 2, | 3, | 4, | 5, | 6 |
|---|---|---|---|---|---|---|
| Mean Log q, | -7.1728, | -7.1633, | -7.4411, | -7.8683, | .0000, | .0000, |
| S.E(Log q), | .3656, | .4066, | .6575, | .7198, | .0000, | .0000, |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1, | .82, | 1.418, | 7.28, | .91, | 8, | .28, | -7.17, |
| 2, | .94, | .191, | 7.16, | .64, | 8, | .41, | -7.16, |
| 3, | .71, | 1.012, | 7.09, | .67, | 8, | .47, | -7.44, |
| 4, | 1.06, | -.039, | 7.99, | .11, | 6, | .85, | -7.87, |
| 5, | .00, | .000, | .00, | .00, | 0, | .00, | .00, |
| 6, | .00, | .000, | .00, | .00, | 0, | .00, | .00, |

1

Fleet : IR-GFS: Irish Ground

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | -.38 | -.33 | -.03 | -.05 | .36 | -.16 | .31 | .29 |
| 2 | 99.99 | 99.99 | .48 | .14 | -.14 | -.54 | -.17 | .32 | -.31 | .23 |
| 3 | 99.99 | 99.99 | .74 | .11 | -.03 | -.41 | .20 | .08 | .01 | -.70 |
| 4 | 99.99 | 99.99 | 1.35 | -.16 | 99.99 | 99.99 | .66 | -.55 | -.48 | -.81 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age , | 1, | 2, | 3, | 4, | 5, | 6 |
|---|---|---|---|---|---|---|
| Mean Log q, | -11.0280, | -10.8428, | -11.1334, | -11.5662, | .0000, | .0000, |
| S.E(Log q), | .2923, | .3471, | .4274, | .8340, | .0000, | .0000, |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1, | .82, | 1.845, | 10.45, | .95, | 8, | .21, | -11.03, |
| 2, | 1.15, | -.468, | 11.40, | .62, | 8, | .42, | -10.84, |
| 3, | .67, | 2.595, | 9.49, | .91, | 8, | .21, | -11.13, |
| 4, | 1.11, | -.061, | 12.19, | .08, | 6, | 1.03, | -11.57, |
| 5, | .00, | .000, | .00, | .00, | 0, | .00, | .00, |
| 6, | .00, | .000, | .00, | .00, | 0, | .00, | .00, |

1

Fleet : IR-GFS: Irish Ground

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | .71 | -1.08 | 1.57 | -.72 | .40 | -.48 | -1.13 | .73 |
| 2 | 99.99 | 99.99 | .46 | 99.99 | 99.99 | -.57 | -.03 | .28 | 99.99 | -.14 |
| 3 | 99.99 | 99.99 | -.03 | 99.99 | .70 | 99.99 | 99.99 | -.67 | 99.99 | 99.99 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

```
 Mean log-catchability and standard error of ages with catchability
 independent of year-class strength and constant w.r.t. time


    Age ,         1,          2,          3,          4,          5,          6
 Mean Log q,  -12.7457,  -12.3684,  -11.9041,      .0000,      .0000,      .0000,
 S.E(Log q),     .9910,     .3986,     .6864,      .0000,      .0000,      .0000,



 Regression statistics :


 Ages with q independent of year-class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  1,     .75,     .696,     11.51,     .57,      8,     .78,  -12.75,
  2,    4.43,   -1.411,     29.45,     .05,      5,    1.58,  -12.37,
  3,    2.10,    -.871,     17.95,     .39,      3,    1.54,  -11.90,
  4,     .00,     .000,       .00,     .00,      0,     .00,     .00,
  5,     .00,     .000,       .00,     .00,      0,     .00,     .00,
  6,     .00,     .000,       .00,     .00,      0,     .00,     .00,
1

 Terminal year survivor and F summaries :

 Age  1   Catchability constant w.r.t. time and dependent on age

 Year class = 2009

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-NEPHROPS trawlers,         1.,   .000,       .000,    .00,   0,  .000,     .000
 UK-WECOT(E+W)Ottertr,      3228.,   .875,       .000,    .00,   1,  .101,     .139
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,      6944.,   .695,       .000,    .00,   1,  .160,     .067
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,     15790.,   .735,       .000,    .00,   1,  .143,     .030
 IR-GFS-7GJ combined:,     12682.,   .388,       .000,    .00,   1,  .514,     .037
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,      2922.,   1.00,,,,                        .081,     .152

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      9185.,       .28,      .29,    5,   1.039,   .051



1
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2008

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-NEPHROPS trawlers,         1.,   .000,       .000,    .00,   0,  .000,     .000
 UK-WECOT(E+W)Ottertr,       213.,   .473,       .039,    .08,   2,  .124,    1.045
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,       914.,   .276,       .082,    .30,   2,  .369,     .358
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,      1016.,   .443,       .053,    .12,   2,  .140,     .327
 IR-GFS-7GJ combined:,       856.,   .289,       .114,    .39,   2,  .324,     .378
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,       325.,   1.00,,,,                        .044,     .792

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       725.,       .17,      .18,    9,   1.087,   .433


1
 Age  3   Catchability constant w.r.t. time and dependent on age

 Year class = 2007

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,        98.,   .563,       .000,    .00,   1,  .030,     .752
 FR-NEPHROPS trawlers,       324.,   .712,       .000,    .00,   1,  .019,     .293
 UK-WECOT(E+W)Ottertr,       139.,   .294,       .131,    .45,   3,  .239,     .585
 IR-7J-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,        81.,   .247,       .296,   1.20,   3,  .272,     .859
 UK-WCGFS West Coast ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,        75.,   .303,       .367,   1.21,   3,  .217,     .904
 IR-GFS-7GJ combined:,        49.,   .285,       .229,    .80,   3,  .170,    1.176
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,       .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,        87.,   1.00,,,,                        .053,     .822

 Weighted prediction :
```

```
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        86.,       .14,      .14,   15,   1.013,   .824


1
 Age  4   Catchability constant w.r.t. time and dependent on age

 Year class = 2006

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,       172.,   .297,      .295,    .99,   2,  .072,     .392
 FR-NEPHROPS trawlers,       310.,   .330,      .181,    .55,   2,  .059,     .236
 UK-WECOT(E+W)Ottertr,       120.,   .280,      .152,    .54,   4,  .223,     .521
 IR-7J-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,       158.,   .251,      .114,    .45,   4,  .251,     .419
 UK-WCGFS West Coast ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,       159.,   .288,      .076,    .27,   4,  .212,     .417
 IR-GFS-7GJ combined:,       188.,   .310,      .122,    .39,   4,  .142,     .364
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,       113.,   1.00,,,,                       .040,     .548

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       158.,       .13,      .07,   21,    .549,   .420


1
 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 2005

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,        87.,   .263,      .211,    .80,   3,  .101,     .362
 FR-NEPHROPS trawlers,       142.,   .270,      .067,    .25,   3,  .101,     .237
 UK-WECOT(E+W)Ottertr,        55.,   .285,      .264,    .93,   5,  .196,     .522
 IR-7J-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,       113.,   .246,      .205,    .84,   5,  .332,     .291
 UK-WCGFS West Coast ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,        76.,   .294,      .099,    .34,   4,  .141,     .405
 IR-GFS-7GJ combined:,        66.,   .330,      .221,    .67,   4,  .088,     .456
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,        70.,   1.00,,,,                       .041,     .433

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        87.,       .12,      .10,   25,    .796,   .365


1
 Age  6   Catchability constant w.r.t. time and age (fixed at the value for age)  5

 Year class = 2004

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 FR-GADOIDQ2+3+4 traw,        55.,   .230,      .204,    .89,   4,  .155,     .138
 FR-NEPHROPS trawlers,       105.,   .232,      .088,    .38,   4,  .153,     .075
 UK-WECOT(E+W)Ottertr,        38.,   .300,      .315,   1.05,   6,  .132,     .192
 IR-7J-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7G-OT Irish otter,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-7GJ-OTB Irish ott,        73.,   .215,      .115,    .53,   6,  .399,     .106
 UK-WCGFS West Coast ,         1.,   .000,      .000,    .00,   0,  .000,     .000
 FR-EVHOE Groundfish ,        60.,   .297,      .112,    .38,   4,  .080,     .126
 IR-GFS-7GJ combined:,        51.,   .323,      .291,    .90,   4,  .053,     .148
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000
 IR-GFS: Irish Ground,         1.,   .000,      .000,    .00,   0,  .000,     .000

   F shrinkage mean  ,        11.,   1.00,,,,                       .028,     .541

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        62.,       .11,      .10,   29,    .906,   .123


1
1
```

**Table 7.2.11. Cod in Divisions VIIe–k. Fishing mortality-at-age.**

Table 8 Fishing mortality (F) at age

| YEAR | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.3018 | 0.0078 | 0.249 | 0.0022 | 0.2123 | 0.0481 | 0.0163 | 0.1381 | 0.1214 | 0.0888 |
| 2 | 0.809 | 0.6151 | 0.8558 | 0.2653 | 0.4592 | 0.981 | 0.6742 | 0.5077 | 0.3971 | 0.5741 |
| 3 | 0.7095 | 0.451 | 0.6237 | 0.3239 | 0.3659 | 0.3846 | 0.4005 | 0.4534 | 0.5578 | 0.645 |
| 4 | 0.6013 | 0.6242 | 0.4775 | 0.4473 | 1.2461 | 0.3741 | 0.1518 | 0.3506 | 0.461 | 0.9338 |
| 5 | 0.3938 | 0.6387 | 0.4815 | 0.6414 | 0.9494 | 0.7885 | 0.3721 | 0.3106 | 0.6159 | 0.792 |
| 6 | 0.573 | 0.5761 | 0.5318 | 0.4744 | 0.8628 | 0.5199 | 0.31 | 0.374 | 0.5494 | 0.7983 |
| +gp | 0.573 | 0.5761 | 0.5318 | 0.4744 | 0.8628 | 0.5199 | 0.31 | 0.374 | 0.5494 | 0.7983 |
| 0 FBAR 2- 5 | 0.6284 | 0.5822 | 0.6096 | 0.4195 | 0.7551 | 0.6321 | 0.3997 | 0.4056 | 0.508 | 0.7362 |

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.1096 | 0.0646 | 0.3678 | 0.2089 | 0.2308 | 0.2532 | 0.2022 | 0.2839 | 0.351 | 0.1635 |
| 2 | 0.8544 | 0.7329 | 0.8371 | 0.7161 | 0.6529 | 0.8421 | 0.7161 | 0.7839 | 0.8632 | 1.0569 |
| 3 | 1.0031 | 0.6433 | 0.9579 | 0.5195 | 0.6756 | 0.9368 | 0.8093 | 0.5662 | 1.0878 | 1.0167 |
| 4 | 0.9015 | 0.5789 | 0.7475 | 0.4345 | 0.476 | 1.0326 | 1.2175 | 0.6014 | 0.5676 | 1.0264 |
| 5 | 0.5832 | 0.5456 | 0.5733 | 0.3581 | 0.3203 | 0.456 | 0.7747 | 0.7649 | 0.875 | 0.6829 |
| 6 | 0.8379 | 0.5944 | 0.7278 | 0.3149 | 0.3052 | 0.4422 | 0.6356 | 0.6617 | 0.7964 | 0.6273 |
| +gp | 0.8379 | 0.5944 | 0.7278 | 0.3149 | 0.3052 | 0.4422 | 0.6356 | 0.6617 | 0.7964 | 0.6273 |
| 0 FBAR 2- 5 | 0.8355 | 0.6252 | 0.7789 | 0.507 | 0.5312 | 0.8169 | 0.8794 | 0.6791 | 0.8484 | 0.9457 |

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.2284 | 0.2305 | 0.1428 | 0.1809 | 0.1574 | 0.154 | 0.222 | 0.2427 | 0.4165 | 0.3004 |
| 2 | 0.9755 | 0.8961 | 0.7415 | 0.6417 | 0.9163 | 0.8413 | 0.9578 | 1.0573 | 0.9137 | 0.8925 |
| 3 | 0.9693 | 1.0278 | 0.9994 | 1.1357 | 0.6778 | 1.0836 | 1.1448 | 1.1158 | 1.1443 | 1.1084 |
| 4 | 1.2268 | 0.8176 | 0.7474 | 0.8744 | 0.9453 | 0.7171 | 0.8954 | 1.1997 | 0.9619 | 0.878 |
| 5 | 1.108 | 0.9794 | 0.8663 | 0.6237 | 0.6596 | 1.0297 | 0.6138 | 0.8907 | 1.0728 | 0.7982 |
| 6 | 1.298 | 1.0408 | 0.8014 | 1.2083 | 0.7116 | 1.1146 | 0.7117 | 1.4977 | 1.0165 | 1.1299 |
| +gp | 1.298 | 1.0408 | 0.8014 | 1.2083 | 0.7116 | 1.1146 | 0.7117 | 1.4977 | 1.0165 | 1.1299 |
| 0 FBAR 2- 5 | 1.0699 | 0.9302 | 0.8386 | 0.8189 | 0.7997 | 0.9179 | 0.9029 | 1.0659 | 1.0232 | 0.9193 |

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.2268 | 0.1725 | 0.1401 | 0.2096 | 0.1206 | 0.139 | 0.2292 | 0.1692 | 0.1014 | 0.0511 |
| 2 | 0.9157 | 0.891 | 0.9383 | 0.7584 | 0.809 | 0.7497 | 0.9582 | 0.679 | 0.7221 | 0.4331 |
| 3 | 0.7256 | 1.1428 | 1.2103 | 0.9115 | 1.0271 | 0.8452 | 0.8234 | 0.677 | 0.6935 | 0.8242 |
| 4 | 0.8669 | 0.9487 | 1.0246 | 0.8775 | 0.7766 | 0.5054 | 0.4958 | 0.487 | 0.4522 | 0.4205 |
| 5 | 1.2425 | 0.838 | 0.6032 | 0.8991 | 0.6155 | 0.4879 | 0.3413 | 0.3763 | 0.3295 | 0.3646 |
| 6 | 1.0336 | 0.7256 | 0.5744 | 0.7751 | 0.4033 | 0.3568 | 0.2478 | 0.2495 | 0.2646 | 0.1233 |
| +gp | 1.0336 | 0.7256 | 0.5744 | 0.7751 | 0.4033 | 0.3568 | 0.2478 | 0.2495 | 0.2646 | 0.1233 |
| 0 FBAR 2- 5 | 0.9377 | 0.9551 | 0.9441 | 0.8616 | 0.807 | 0.647 | 0.6547 | 0.5548 | 0.5493 | 0.5106 |

**Table 7.2.12. Cod in Divisions VIIe–k. Stock numbers-at-age.**

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 3075 | 565 | 1665 | 500 | 3888 | 1201 | 1713 | 1688 | 4233 | 7925 |
| 2 | 919 | 1862 | 459 | 1063 | 408 | 2574 | 937 | 1380 | 1204 | 3069 |
| 3 | 1212 | 335 | 824 | 160 | 667 | 211 | 790 | 391 | 680 | 663 |
| 4 | 235 | 488 | 175 | 362 | 95 | 379 | 118 | 433 | 203 | 319 |
| 5 | 119 | 105 | 214 | 89 | 189 | 22 | 213 | 83 | 250 | 105 |
| 6 | 43 | 66 | 46 | 108 | 38 | 60 | 8 | 120 | 50 | 111 |
| +gp | 28 | 42 | 29 | 104 | 62 | 19 | 70 | 70 | 83 | 28 |
| 0 TOTAL | 5630 | 3464 | 3411 | 2385 | 5348 | 4467 | 3850 | 4166 | 6703 | 12219 |

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 3355 | 1343 | 4614 | 4320 | 3892 | 3217 | 16551 | 8184 | 2486 | 2638 |
| 2 | 5937 | 2461 | 1031 | 2615 | 2870 | 2530 | 2045 | 11071 | 5044 | 1433 |
| 3 | 1415 | 2069 | 968 | 366 | 1046 | 1223 | 892 | 818 | 4139 | 1742 |
| 4 | 285 | 425 | 890 | 304 | 178 | 436 | 392 | 325 | 380 | 1142 |
| 5 | 103 | 95 | 195 | 345 | 161 | 91 | 127 | 95 | 146 | 176 |
| 6 | 39 | 47 | 45 | 90 | 198 | 96 | 47 | 48 | 36 | 50 |
| +gp | 23 | 12 | 23 | 20 | 63 | 52 | 35 | 18 | 22 | 37 |
| 0 TOTAL | 11156 | 6452 | 7767 | 8060 | 8408 | 7644 | 20089 | 20558 | 12254 | 7219 |

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 7454 | 7698 | 2275 | 8950 | 6244 | 4778 | 6573 | 3278 | 1609 | 7212 |
| 2 | 1834 | 4857 | 5005 | 1615 | 6115 | 4367 | 3354 | 4310 | 2105 | 869 |
| 3 | 408 | 566 | 1623 | 1952 | 696 | 2003 | 1542 | 1054 | 1226 | 691 |
| 4 | 516 | 127 | 166 | 489 | 513 | 289 | 555 | 402 | 283 | 320 |
| 5 | 335 | 124 | 46 | 64 | 167 | 163 | 116 | 186 | 99 | 88 |
| 6 | 73 | 91 | 38 | 16 | 28 | 71 | 48 | 51 | 62 | 28 |
| +gp | 21 | 29 | 32 | 26 | 11 | 6 | 13 | 11 | 24 | 22 |
| 0 TOTAL | 10641 | 13490 | 9184 | 13113 | 13775 | 11678 | 12199 | 9291 | 5408 | 9230 |

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 5941 | 1465 | 871 | 1993 | 2870 | 3133 | 2649 | 874 | 1845 | 11804 |
| 2 | 4373 | 3877 | 1009 | 620 | 1323 | 2083 | 2232 | 1724 | 604 | 1365 |
| 3 | 291 | 1433 | 1302 | 323 | 238 | 482 | 806 | 701 | 716 | 240 |
| 4 | 187 | 115 | 374 | 318 | 106 | 70 | 170 | 290 | 292 | 293 |
| 5 | 109 | 64 | 37 | 110 | 108 | 40 | 34 | 85 | 146 | 152 |
| 6 | 33 | 26 | 23 | 16 | 37 | 48 | 20 | 20 | 48 | 86 |
| +gp | 32 | 23 | 18 | 14 | 7 | 18 | 20 | 20 | 9 | 19 |
| 0 TOTAL | 10965 | 7004 | 3633 | 3394 | 4688 | 5874 | 5931 | 3713 | 3659 | 13958 |

**Table 7.2.13. Cod in Divisions VIIe–k. XSA Summary table.**

| | RECRUITS | TOTALBIO | TOTSPBIO | LANDINGS | YIELD/SSB | FBAR 2- 5 |
|---|---|---|---|---|---|---|
| | Age 1 | | | | | |
| 1971 | 3075 | 12742 | 8928 | 5782 | 0.6476 | 0.6284 |
| 1972 | 565 | 10984 | 8225 | 4737 | 0.5759 | 0.5822 |
| 1973 | 1665 | 9815 | 7668 | 4015 | 0.5236 | 0.6096 |
| 1974 | 500 | 9127 | 7411 | 2898 | 0.391 | 0.4195 |
| 1975 | 3888 | 10062 | 6628 | 3993 | 0.6024 | 0.7551 |
| 1976 | 1201 | 10096 | 6301 | 4818 | 0.7646 | 0.6321 |
| 1977 | 1713 | 10314 | 7687 | 3059 | 0.398 | 0.3997 |
| 1978 | 1688 | 11621 | 8617 | 3647 | 0.4232 | 0.4056 |
| 1979 | 4233 | 13488 | 8934 | 4650 | 0.5205 | 0.508 |
| 1980 | 7925 | 18428 | 9436 | 7243 | 0.7676 | 0.7362 |
| 1981 | 3355 | 18058 | 10329 | 10597 | 1.026 | 0.8355 |
| 1982 | 1343 | 17453 | 13011 | 8766 | 0.6737 | 0.6252 |
| 1983 | 4614 | 17745 | 13443 | 9641 | 0.7172 | 0.7789 |
| 1984 | 4320 | 16078 | 10361 | 6631 | 0.64 | 0.507 |
| 1985 | 3892 | 20249 | 13534 | 8317 | 0.6145 | 0.5312 |
| 1986 | 3217 | 19104 | 13405 | 10475 | 0.7814 | 0.8169 |
| 1987 | 16551 | 22616 | 10764 | 10228 | 0.9502 | 0.8794 |
| 1988 | 8184 | 33674 | 14616 | 17191 | 1.1761 | 0.6791 |
| 1989 | 2486 | 33202 | 23970 | 19809 | 0.8264 | 0.8484 |
| 1990 | 2638 | 22592 | 17856 | 12749 | 0.714 | 0.9457 |
| 1991 | 7454 | 16116 | 9888 | 9336 | 0.9442 | 1.0699 |
| 1992 | 7698 | 17475 | 8069 | 9747 | 1.2079 | 0.9302 |
| 1993 | 2275 | 17729 | 10923 | 10425 | 0.9544 | 0.8386 |
| 1994 | 8950 | 21382 | 12912 | 10620 | 0.8225 | 0.8189 |
| 1995 | 6244 | 21480 | 11611 | 11709 | 1.0084 | 0.7997 |
| 1996 | 4778 | 22230 | 14295 | 12681 | 0.8871 | 0.9179 |
| 1997 | 6573 | 19808 | 12740 | 12035 | 0.9446 | 0.9029 |
| 1998 | 3278 | 16739 | 11123 | 11431 | 1.0277 | 1.0659 |
| 1999 | 1609 | 13644 | 9593 | 8594 | 0.8958 | 1.0232 |
| 2000 | 7212 | 11929 | 6457 | 6536 | 1.0122 | 0.9193 |
| 2001 | 5941 | 14933 | 7021 | 8308 | 1.1833 | 0.9377 |
| 2002 | 1465 | 13776 | 9402 | 9236 | 0.9824 | 0.9551 |
| 2003 | 871 | 10380 | 8275 | 6420 | 0.7758 | 0.9441 |
| 2004 | 1993 | 6791 | 4817 | 3672 | 0.7623 | 0.8616 |
| 2005 | 2870 | 6988 | 3768 | 3062 | 0.8126 | 0.807 |
| 2006 | 3133 | 8371 | 4325 | 3776 | 0.873 | 0.647 |
| 2007 | 2649 | 10160 | 5863 | 4830 | 0.8238 | 0.6547 |
| 2008 | 874 | 9426 | 6621 | 3961 | 0.5982 | 0.5548 |
| 2009 | 1845 | 9327 | 6503 | 3292 | 0.5062 | 0.5493 |
| 2010 | 11804 | 17449 | 6317 | 3229 | 0.5112 | 0.5106 |
| | | | | | | |
| Arith. | | | | | | |
| Mean | 4164 | 15590 | 9791 | 7804 | 0.7817 | 0.7458 |
| 0 Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | |

**Table 7.2.13. Cod in Divisions VIIe–k. Comparison between XSA outputs using all tuning indices and an exploratory run based only on survey indices.**

| Year | Recuits (age 1) | | SSB | | FBAR 2-5 | |
|---|---|---|---|---|---|---|
| | Standard | Survey only | Standard | Survey only | Standard | Survey only |
| | XSA | | XSA | | XSA | |
| 1971 | 3075 | 3075 | 8928 | 8927 | 0.6284 | 0.6285 |
| 1972 | 565 | 565 | 8225 | 8223 | 0.5822 | 0.5824 |
| 1973 | 1665 | 1662 | 7668 | 7665 | 0.6096 | 0.6099 |
| 1974 | 500 | 498 | 7411 | 7404 | 0.4195 | 0.4199 |
| 1975 | 3888 | 3882 | 6628 | 6616 | 0.7551 | 0.7569 |
| 1976 | 1201 | 1197 | 6301 | 6280 | 0.6321 | 0.6346 |
| 1977 | 1713 | 1701 | 7687 | 7645 | 0.3997 | 0.4022 |
| 1978 | 1688 | 1669 | 8617 | 8550 | 0.4056 | 0.4095 |
| 1979 | 4233 | 4143 | 8934 | 8830 | 0.508 | 0.5159 |
| 1980 | 7925 | 7713 | 9436 | 9241 | 0.7362 | 0.7596 |
| 1981 | 3355 | 3256 | 10329 | 9939 | 0.8355 | 0.8911 |
| 1982 | 1343 | 1313 | 13011 | 11993 | 0.6252 | 0.6976 |
| 1983 | 4614 | 4613 | 13443 | 11836 | 0.7789 | 0.9207 |
| 1984 | 4320 | 4313 | 10361 | 8472 | 0.507 | 0.5936 |
| 1985 | 3892 | 3863 | 13534 | 11638 | 0.5312 | 0.587 |
| 1986 | 3217 | 3235 | 13405 | 12472 | 0.8169 | 0.8499 |
| 1987 | 16551 | 16565 | 10764 | 10362 | 0.8794 | 0.8925 |
| 1988 | 8184 | 8180 | 14616 | 14516 | 0.6791 | 0.697 |
| 1989 | 2486 | 2494 | 23970 | 23896 | 0.8484 | 0.8798 |
| 1990 | 2638 | 2635 | 17856 | 17735 | 0.9457 | 0.9307 |
| 1991 | 7454 | 7470 | 9888 | 10048 | 1.0699 | 1.0584 |
| 1992 | 7698 | 7682 | 8069 | 8158 | 0.9302 | 0.926 |
| 1993 | 2275 | 2302 | 10923 | 10947 | 0.8386 | 0.8151 |
| 1994 | 8950 | 8947 | 12912 | 13047 | 0.8189 | 0.8174 |
| 1995 | 6244 | 6256 | 11611 | 11667 | 0.7997 | 0.791 |
| 1996 | 4778 | 4769 | 14295 | 14392 | 0.9179 | 0.9263 |
| 1997 | 6573 | 6559 | 12740 | 12780 | 0.9029 | 0.8825 |
| 1998 | 3278 | 3261 | 11123 | 11265 | 1.0659 | 1.0632 |
| 1999 | 1609 | 1599 | 9593 | 9548 | 1.0232 | 1.0125 |
| 2000 | 7212 | 7230 | 6457 | 6419 | 0.9193 | 0.9544 |
| 2001 | 5941 | 5902 | 7021 | 6789 | 0.9377 | 1.0016 |
| 2002 | 1465 | 1530 | 9402 | 9209 | 0.9551 | 1.0206 |
| 2003 | 871 | 869 | 8275 | 8107 | 0.9441 | 0.9576 |
| 2004 | 1993 | 1976 | 4817 | 4834 | 0.8616 | 0.8241 |
| 2005 | 2870 | 2689 | 3768 | 3885 | 0.807 | 0.7923 |
| 2006 | 3133 | 2998 | 4325 | 4240 | 0.647 | 0.6205 |
| 2007 | 2649 | 2605 | 5863 | 5983 | 0.6547 | 0.7519 |
| 2008 | 874 | 805 | 6621 | 5556 | 0.5548 | 0.7091 |
| 2009 | 1845 | 2022 | 6503 | 5107 | 0.5493 | 0.8127 |
| 2010 | 11804 | 14517 | 6317 | 4504 | 0.5106 | 0.6864 |

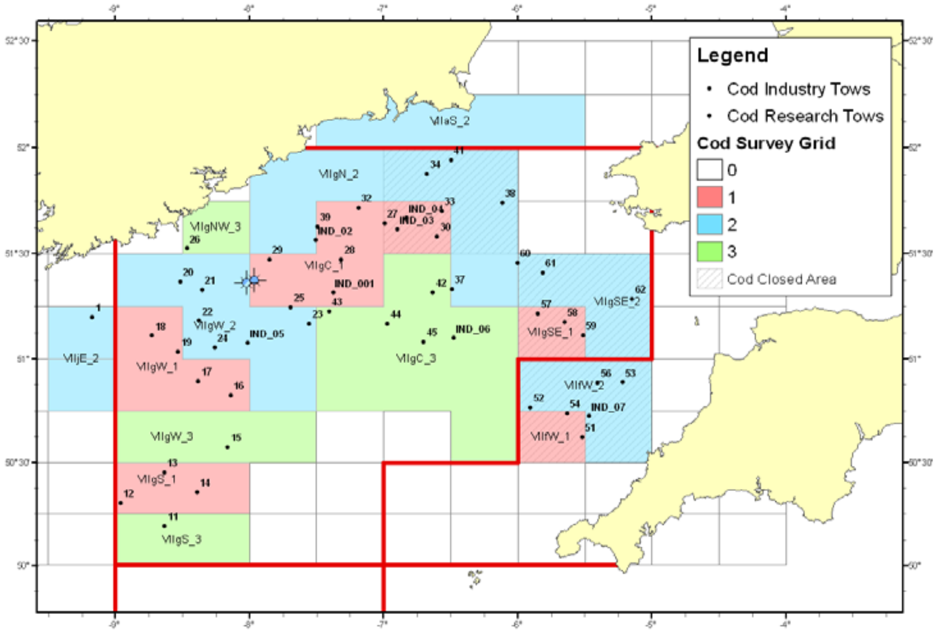
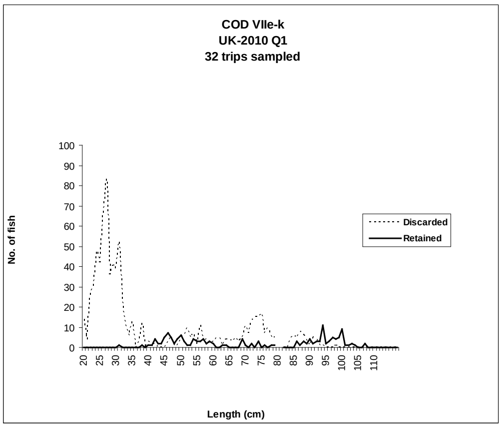
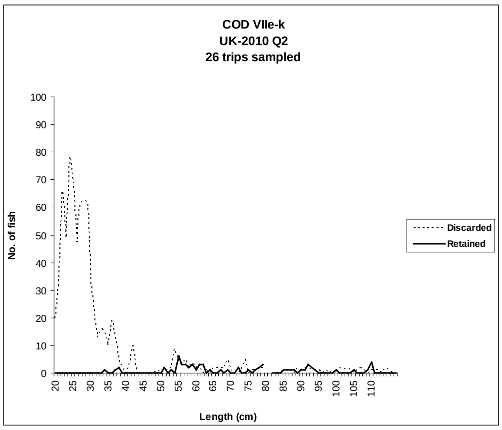
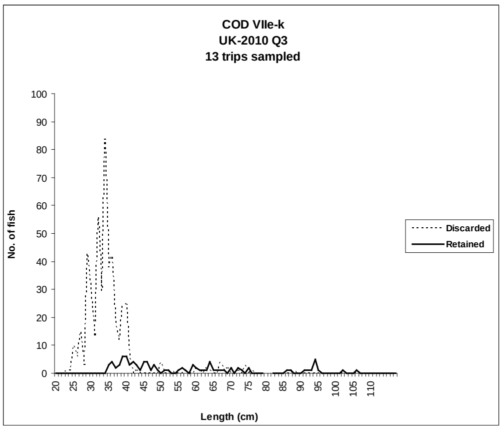
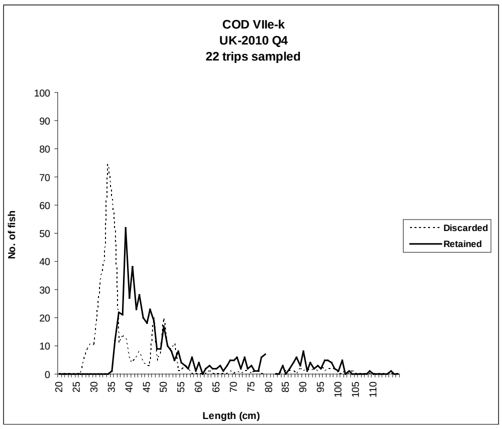



**Figure 7.2.1. Irish industry and science survey. Map of sampled stations.**



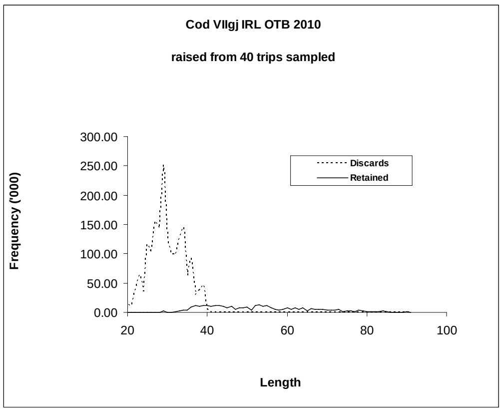




**Figure 7.2.2a. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of UK, Irish discards raised using effort ratio for Irish data, from hauls sampled for UK.**

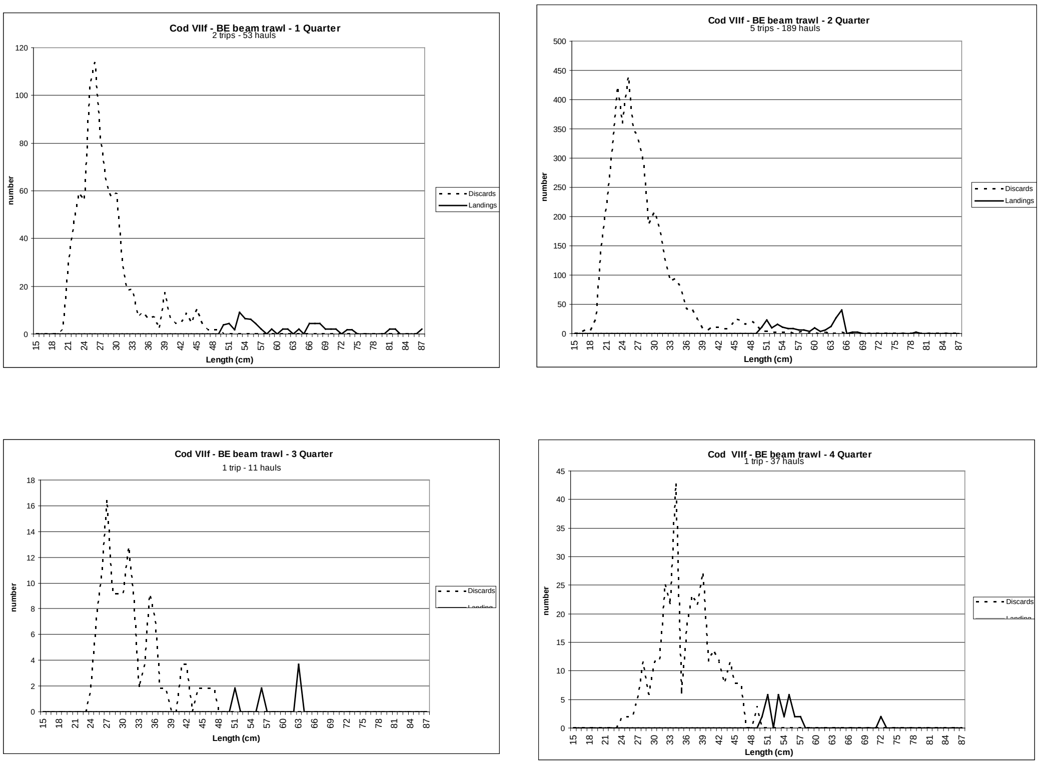



**Figure 7.2.2b. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of Belgian discards from observers at sea.**

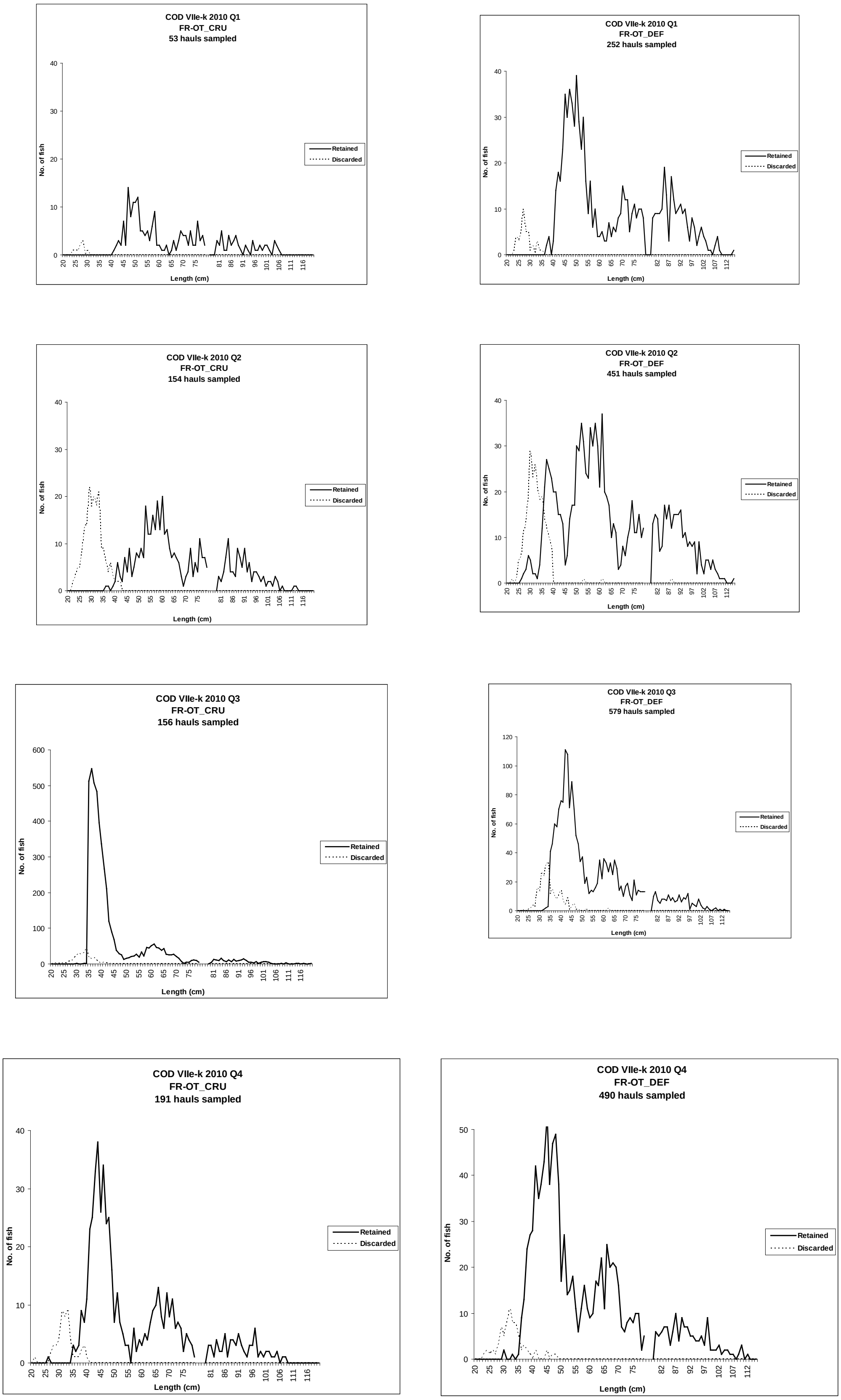
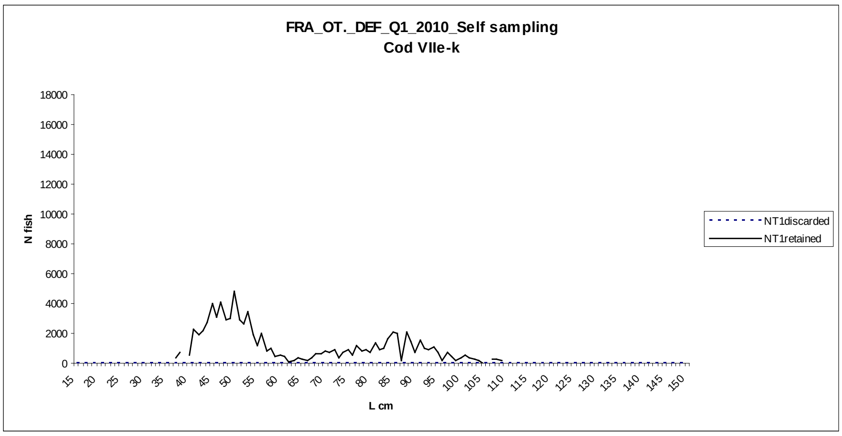
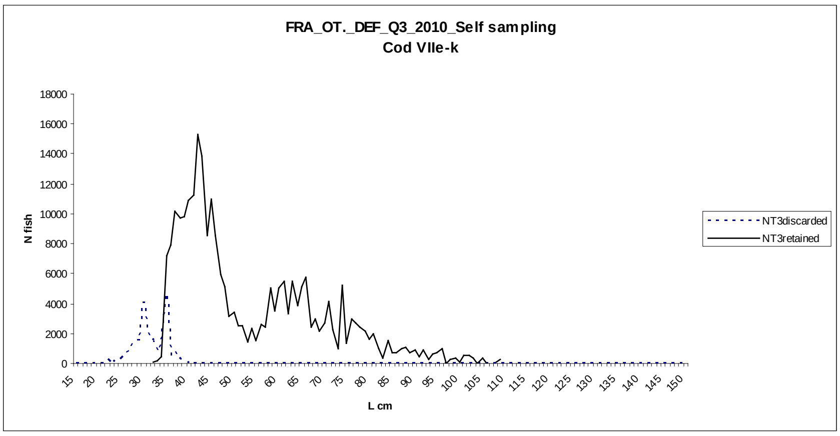



**Figure 7.2.2c. Cod in Divisions VIIe–k. 2010 Quarterly or annual length compositions of French discards from observers at sea.**



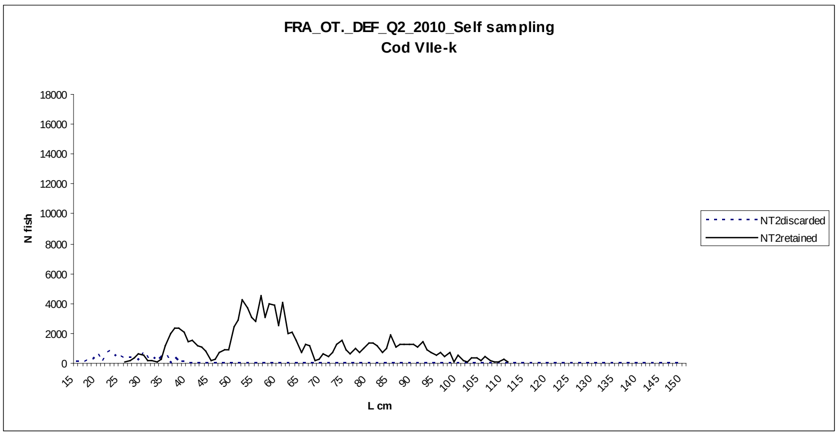




**Figure 7.2.2d. Cod in Divisions VIIe–k. 2009 Quarterly length composition of French landings and discards. Self-sampling programme.**

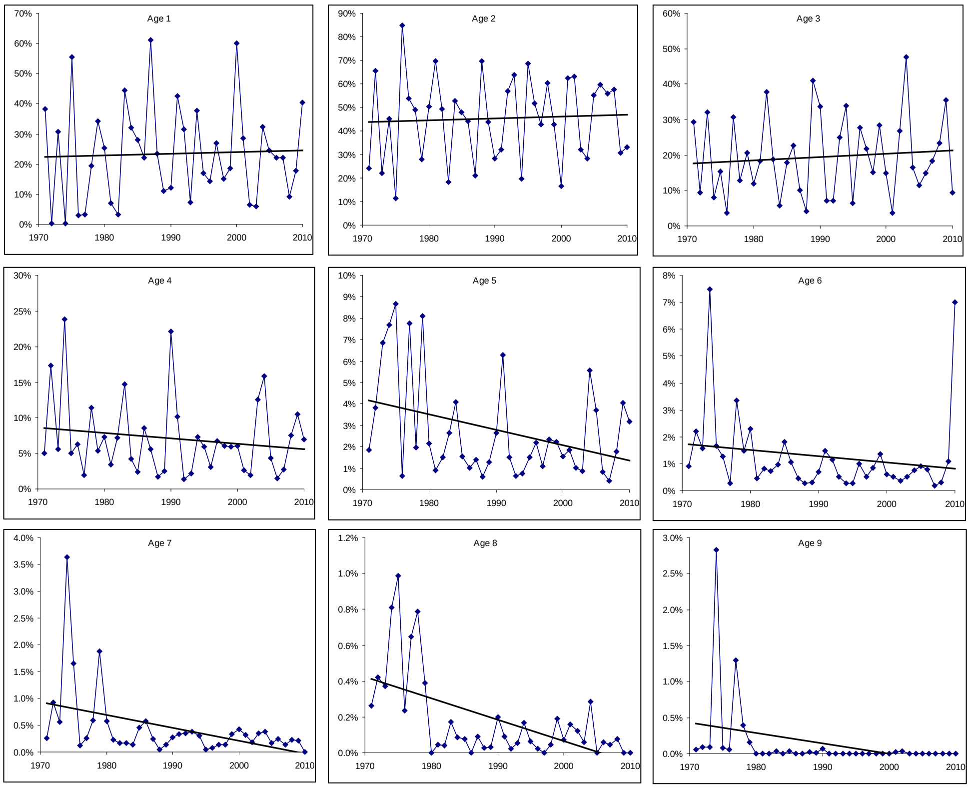



**Figure 7.2.3. Cod in Divisions VIIe–k. Percentage of landings accounted for by each age class in Celtic Sea cod over the time-series.**

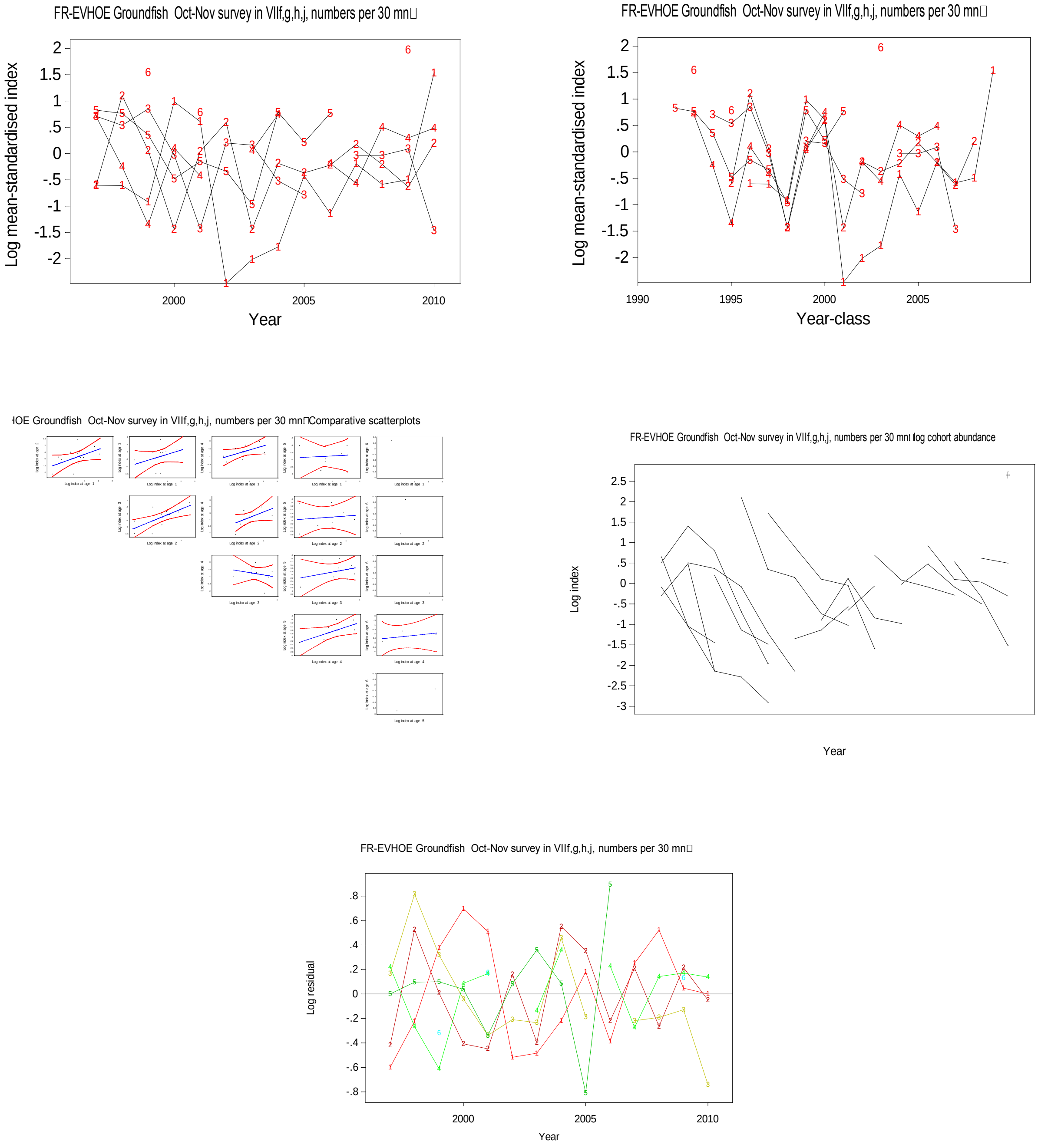



**Figure 7.2.4a. Cod in VII e–k. Diagnostics SURBA v3.0 plots for IBTS Q4 (FR-EVHOE) survey, age groups 1–5. Log mean standardized indices by year and age class, scatterplots, catch curves, and residuals. (Single fleet).**

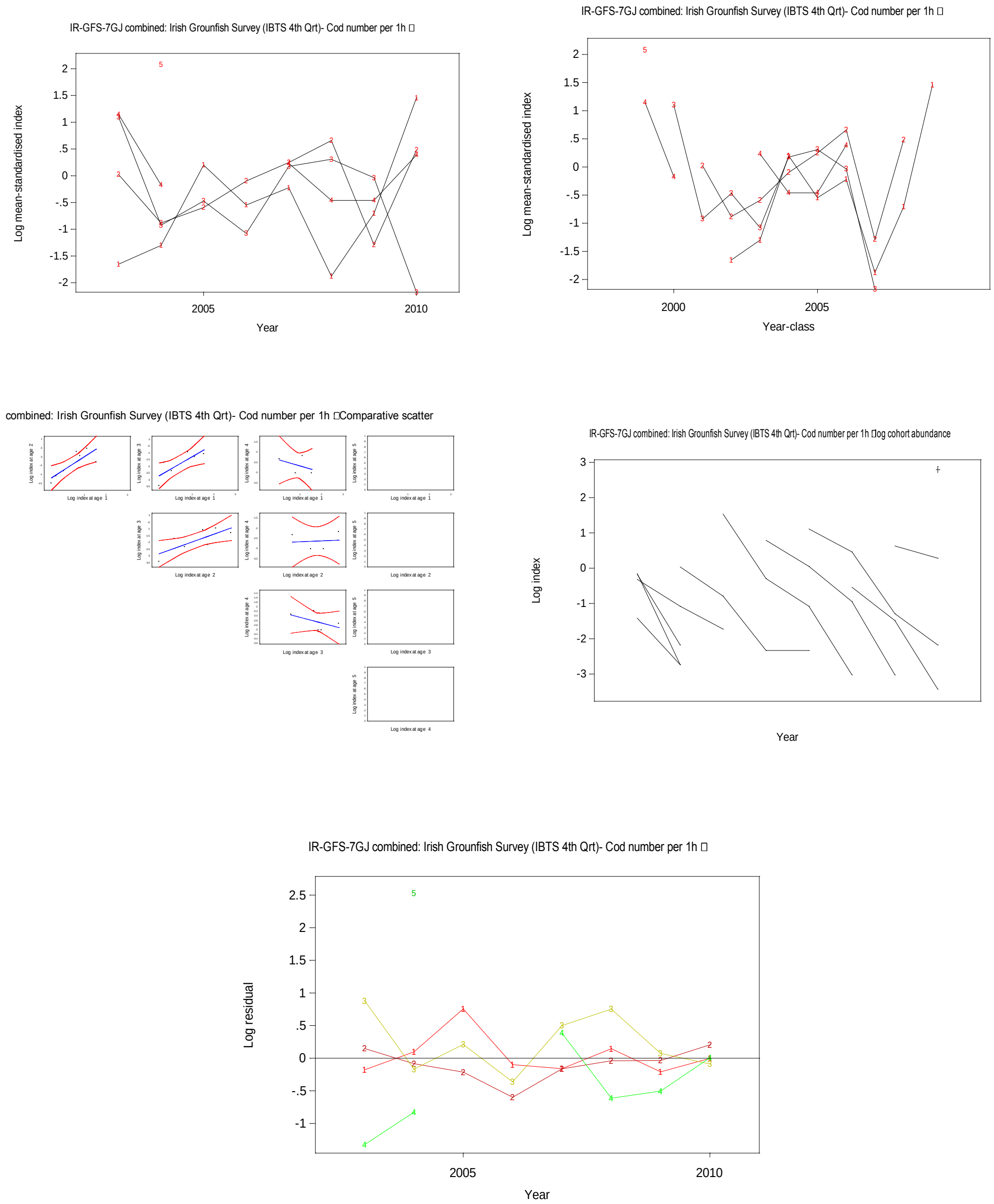
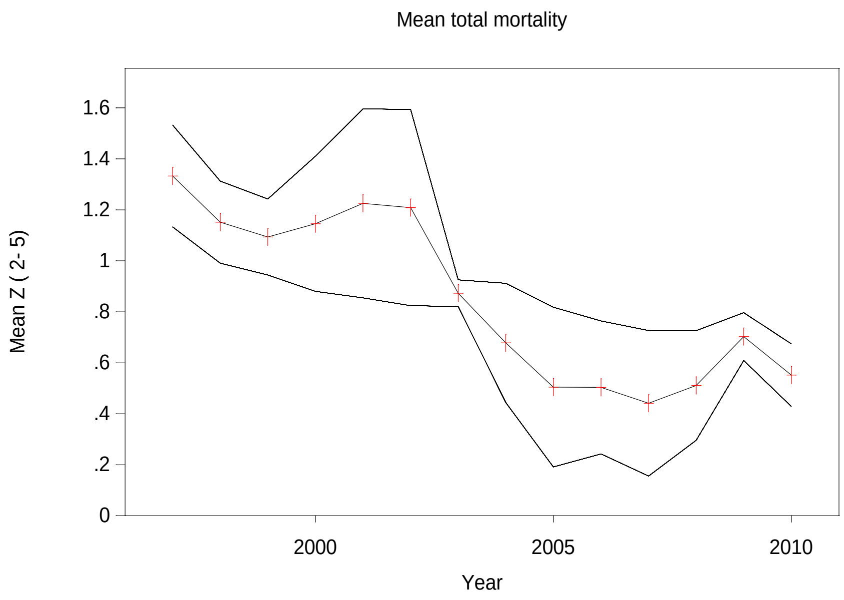
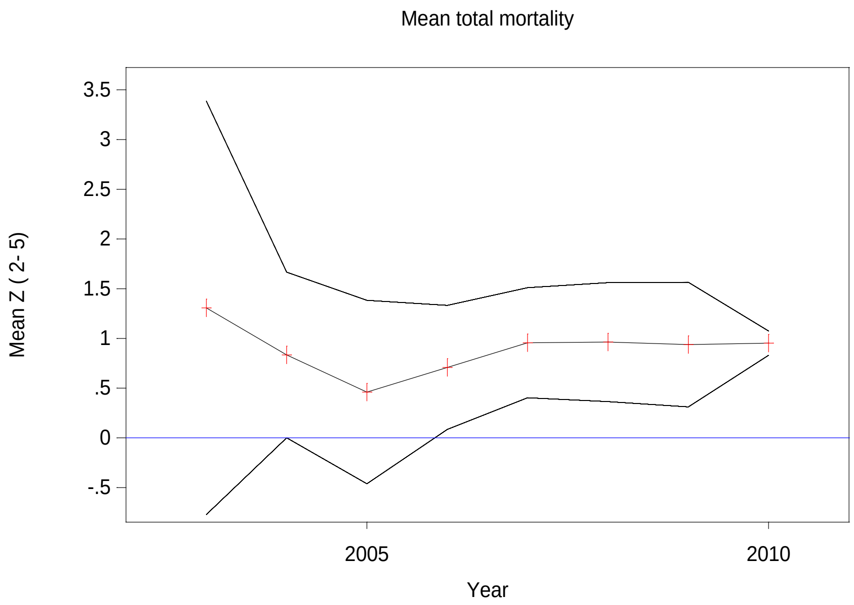



**Figure 7.2.4b. Cod in VII e–k. Diagnostics SURBA v3.0 plots for IBTS Q4 (IR-GFS7gj) survey, age groups 1–5. Log mean standardized indices by year and age class, scatterplots, catch curves, and residuals. (Single fleet).**




**FR-IBTS Q4 – EVHOE survey**




**IR-GFS 7gj survey**

**Figure 7.2.4c. Cod in VII e–k. Trends of relative mean Z. SURBA v3.0 plots for the two surveys used separately.**

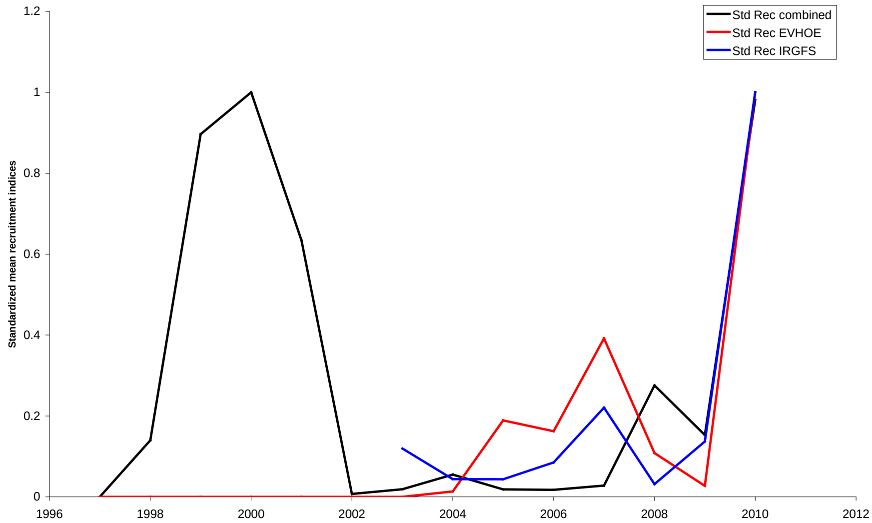
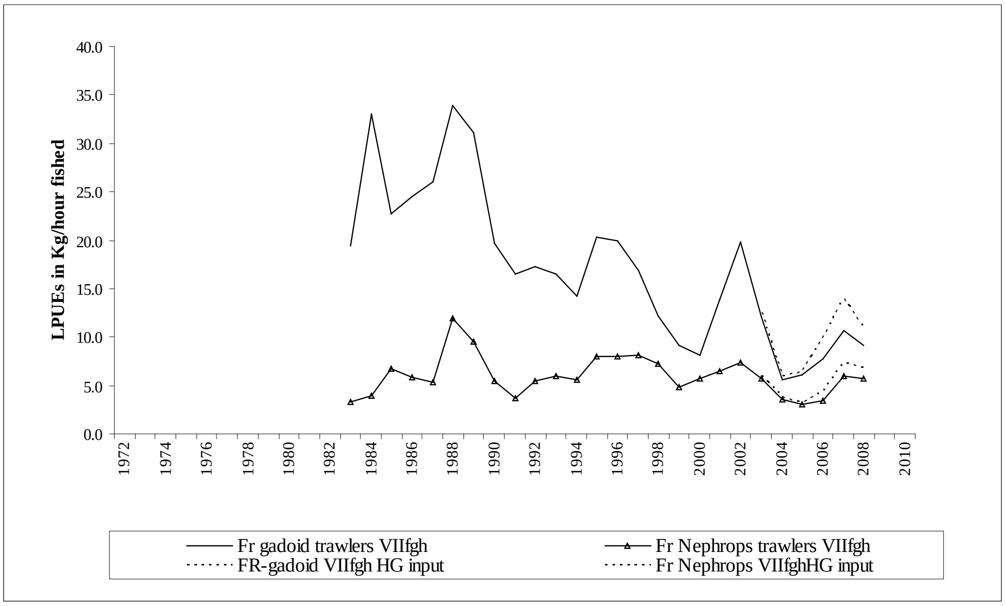



**Figure 7.2.4d. Comparative trends of recruitment estimates from a Surba v3.0. Mean standardized indices for both FR-IBTS Q4 (EVHOE), IR-GFS and combined surveys.**



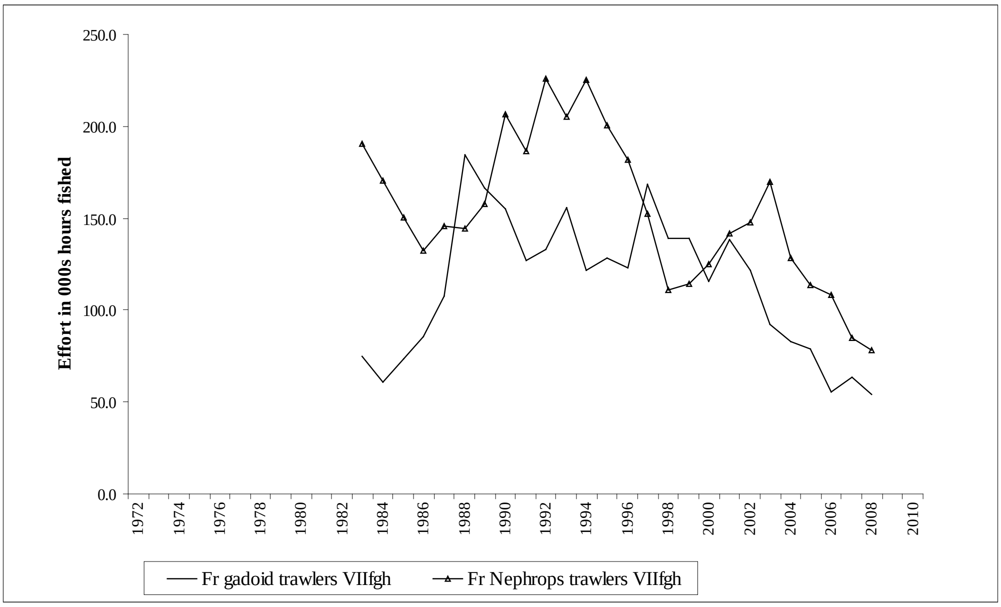
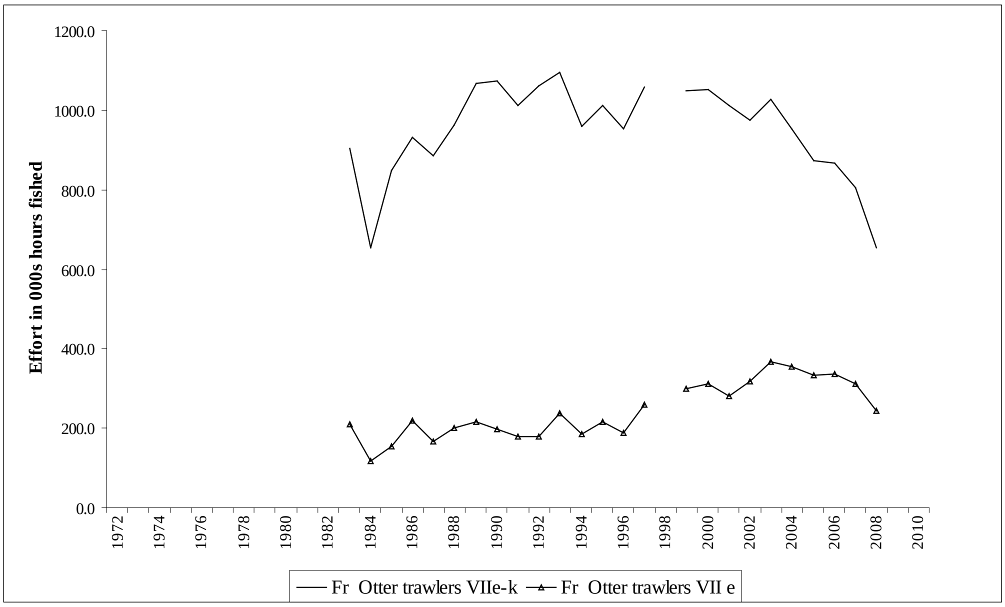




**Figure 7.2.5a. Cod in Divisions VIIe–k. Trends of lpues and effort. French Gadoid trawlers and French *Nephrops* trawlers in VIIfgh.**



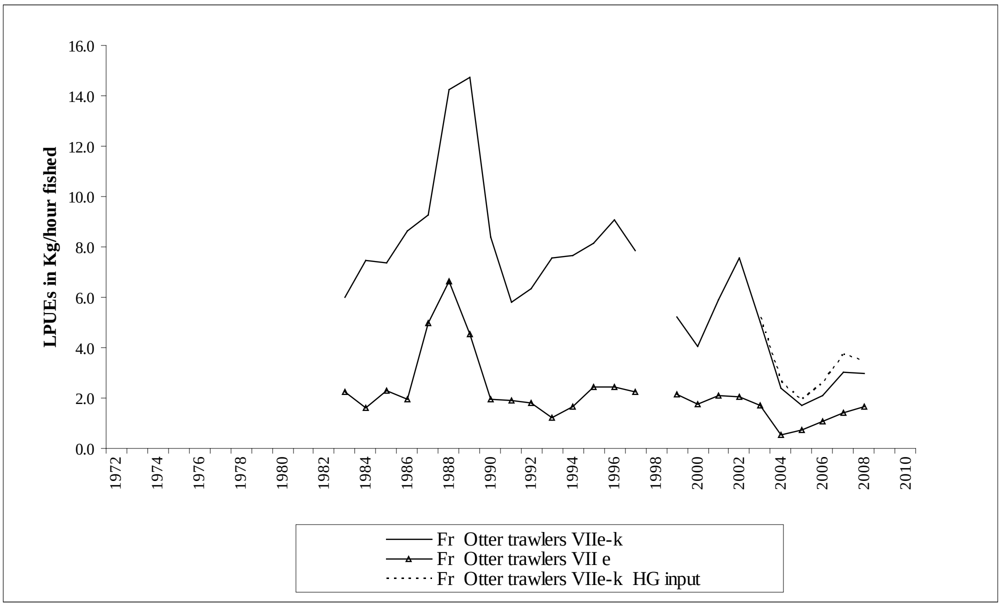
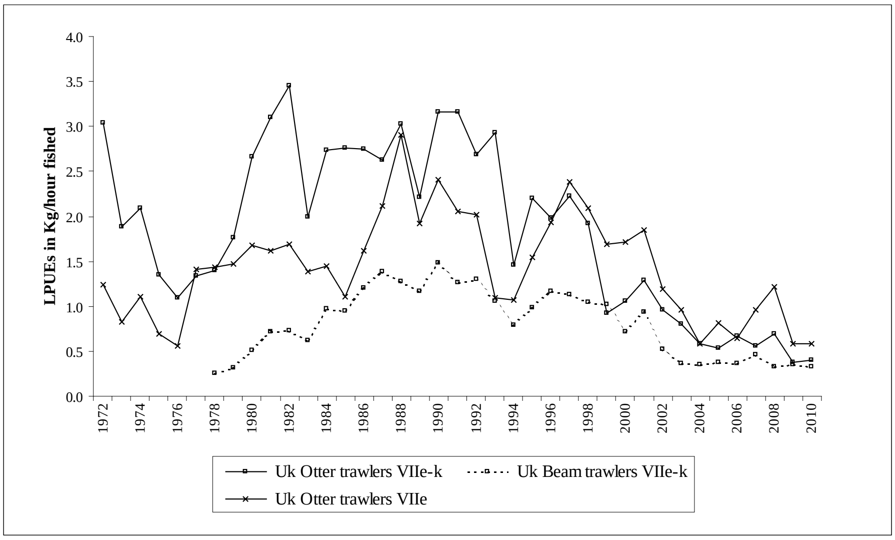




**Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. French otter trawlers in VIIe–k (including Gadoid trawlers and *Nephrops* trawlers in VIIfgh) and French otter trawlers in VIIe.**



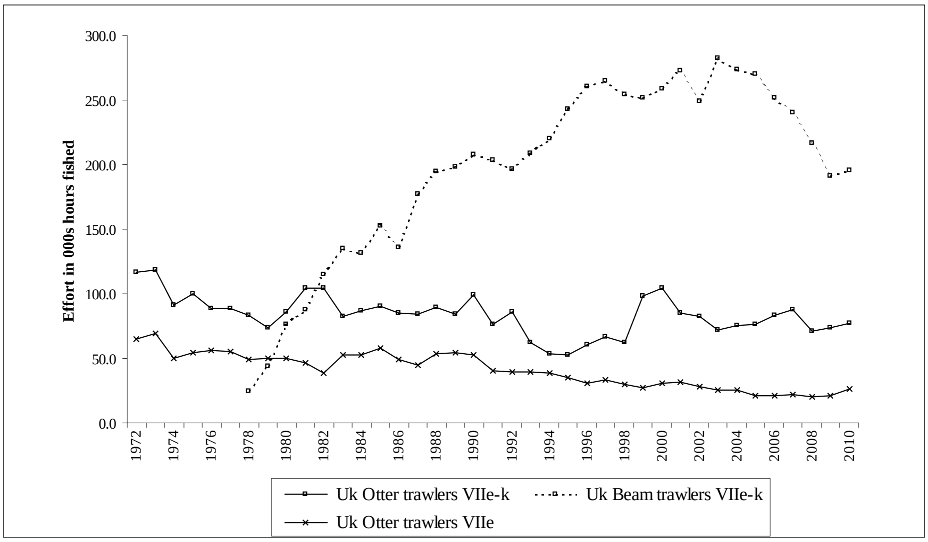
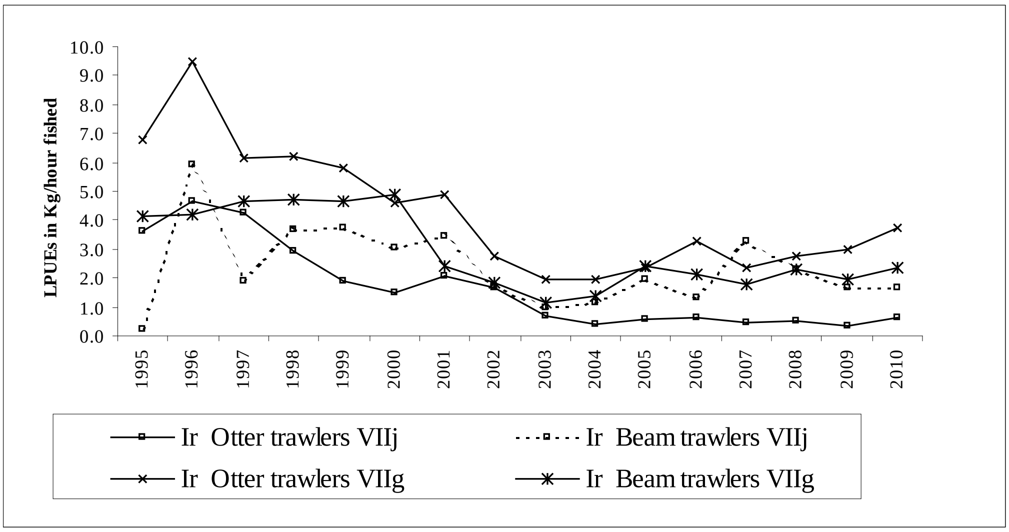




**Figure 7.2.5a. Continued. Cod in Divisions VIIe–k. Trends of lpues and effort. UK otter trawlers in VIIe–k and VIIe, UK beam trawlers in VIIe–k.**



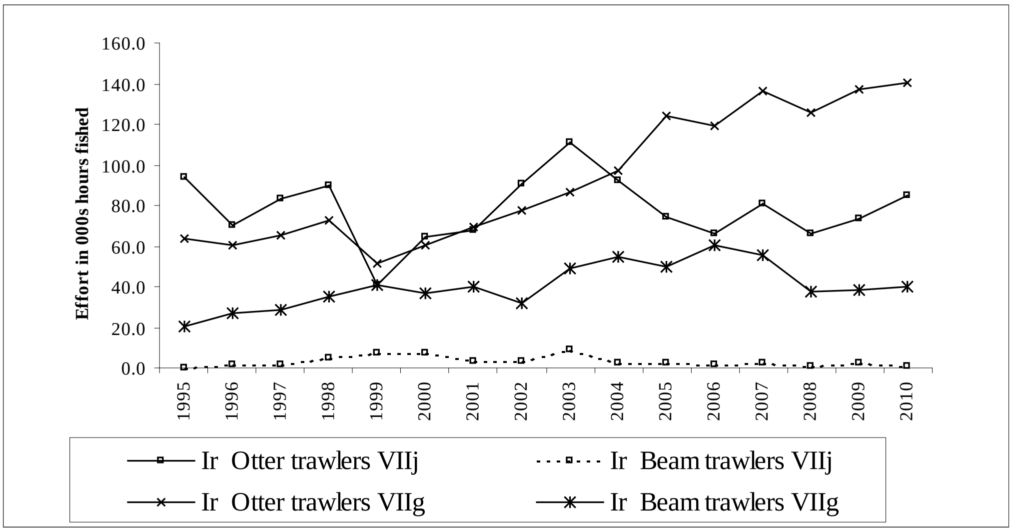
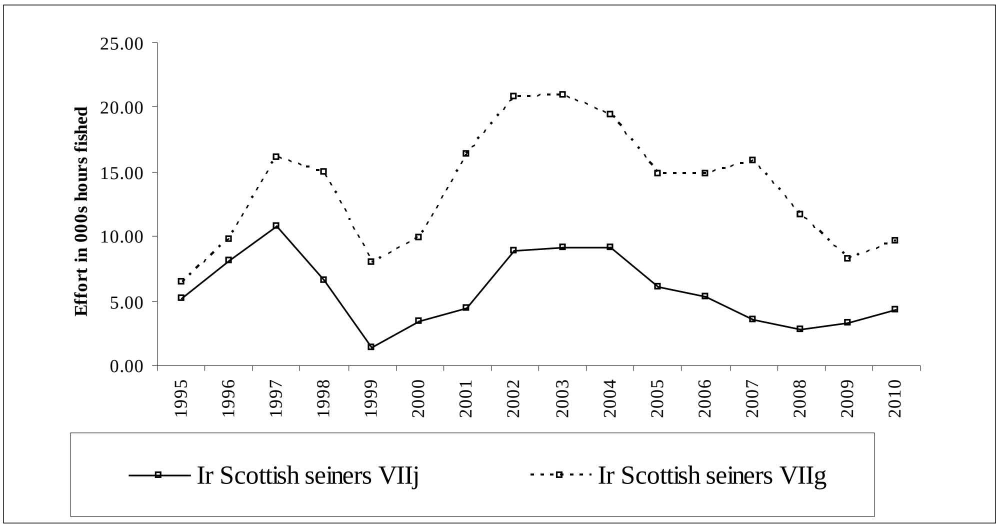




**Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish otter trawlers in VIIg and VIIj, Irish beam trawlers in VIIg and VIIj.**



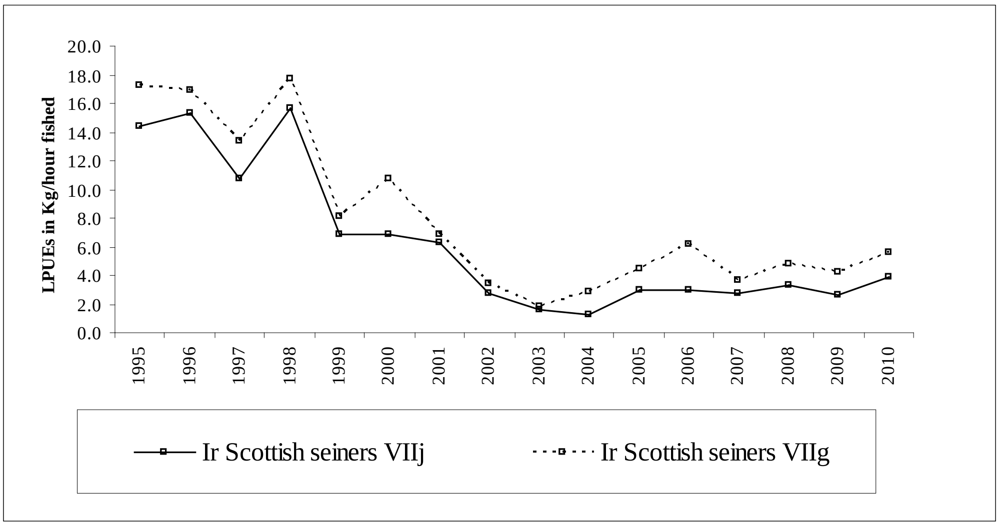




**Figure 7.2.5b. Cod in Divisions VIIe–k. Trends of lpues and effort. Irish Scottish seiners in VIIg and VIIj.**

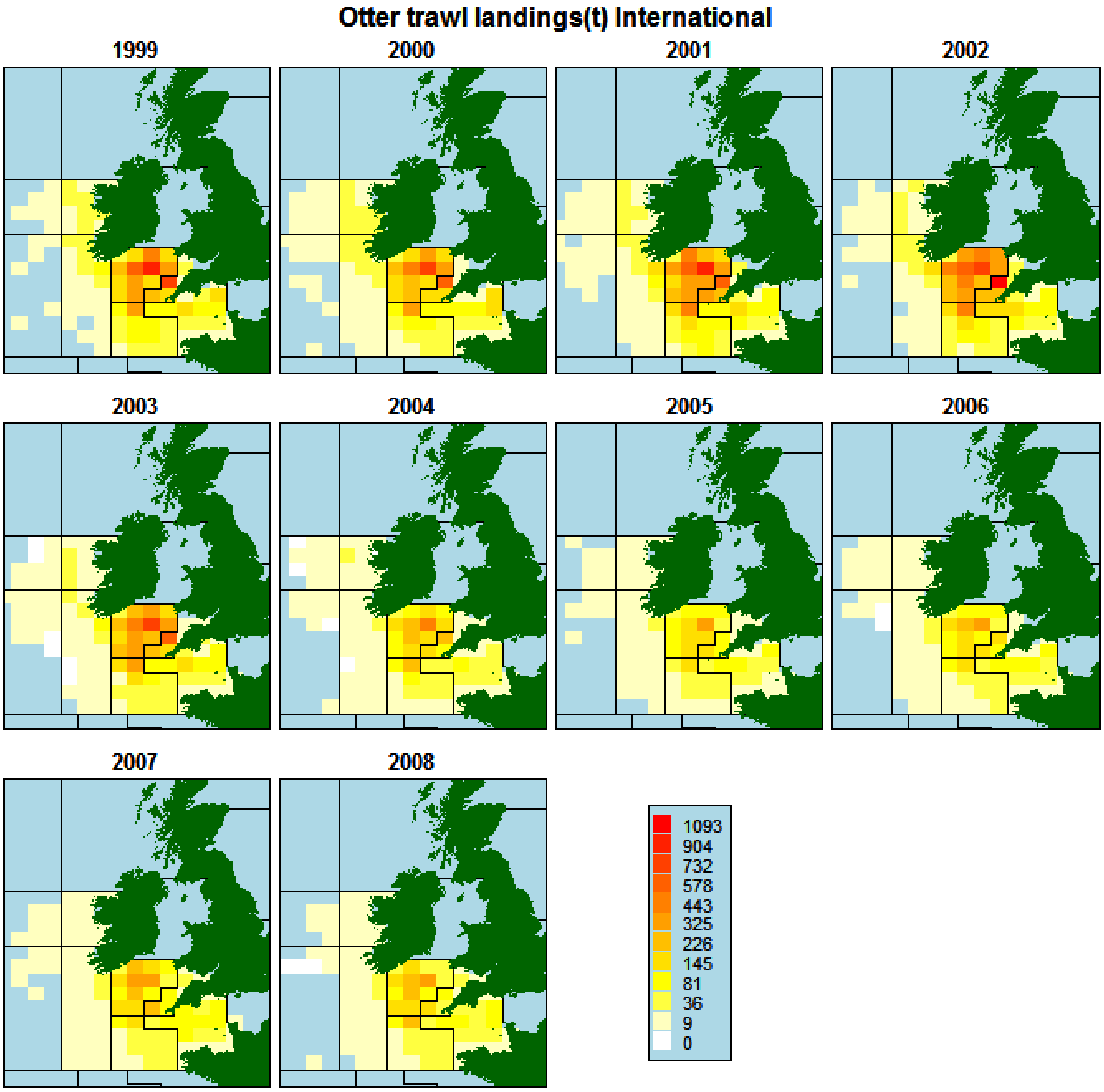



**Figure 7.2.6. Cod in VII e–k. Distribution of landings by otter trawlers in the TAC area.**

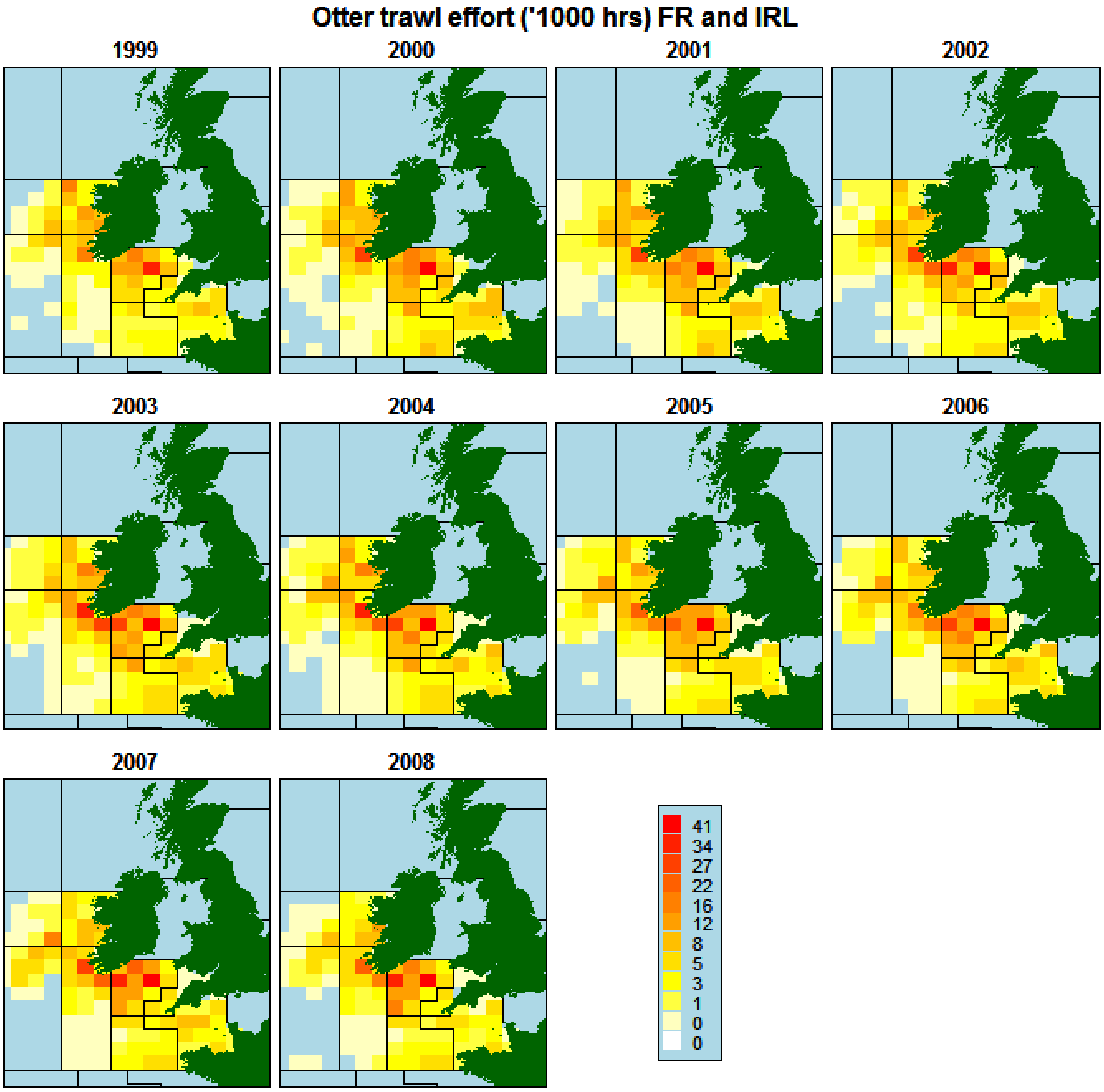



**Figure 7.2.7. Cod in VII e–k. Distribution of effort by French and Irish otter trawlers in the TAC area.**

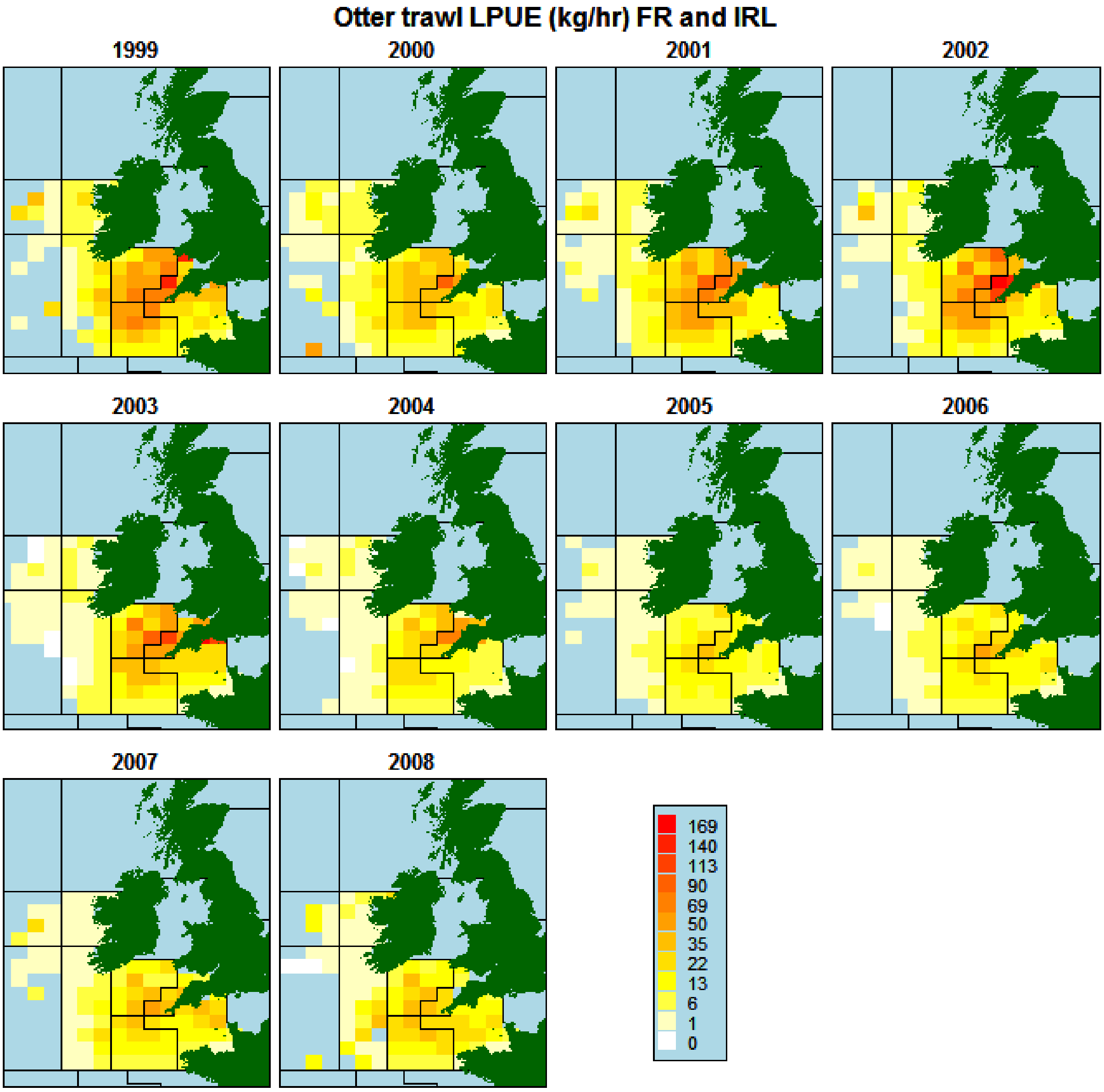



**Figure 7.2.8. Cod in VII e–k. Distribution of lpues by French and Irish otter trawlers in the TAC area.**

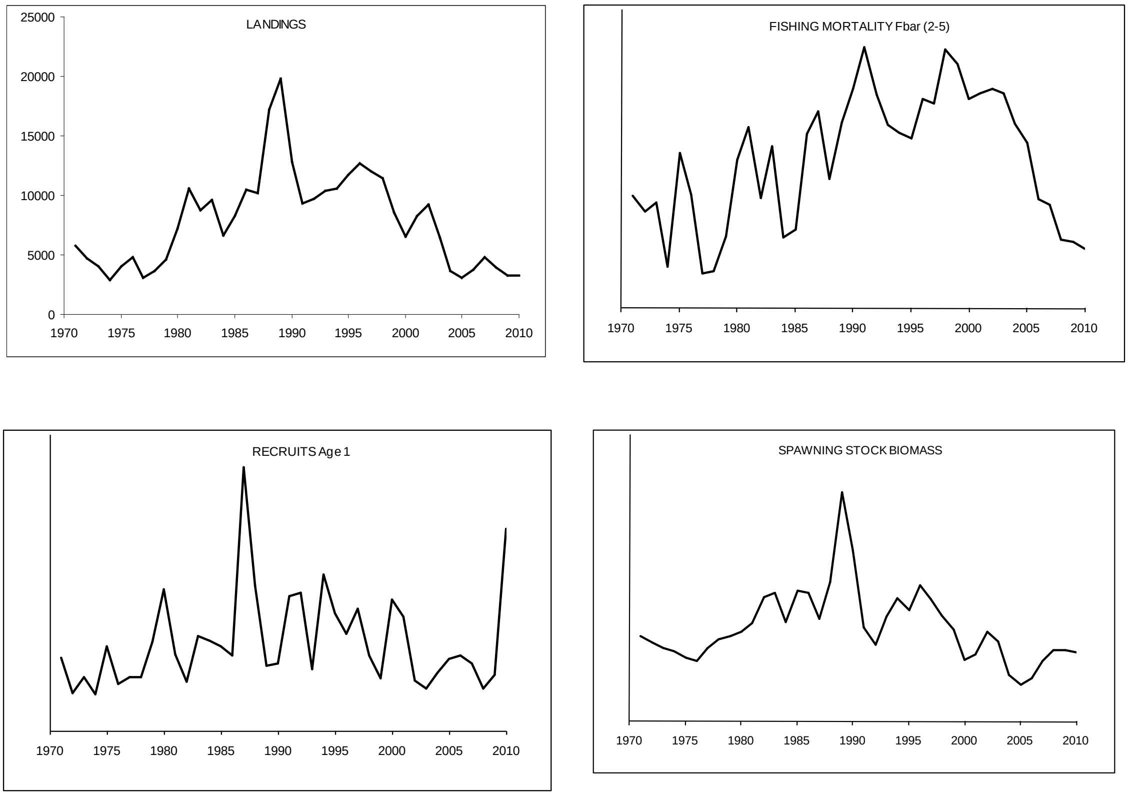



**Figure 7.2.9. Cod in VII e–k. Summary plots. Exploratory XSA.**

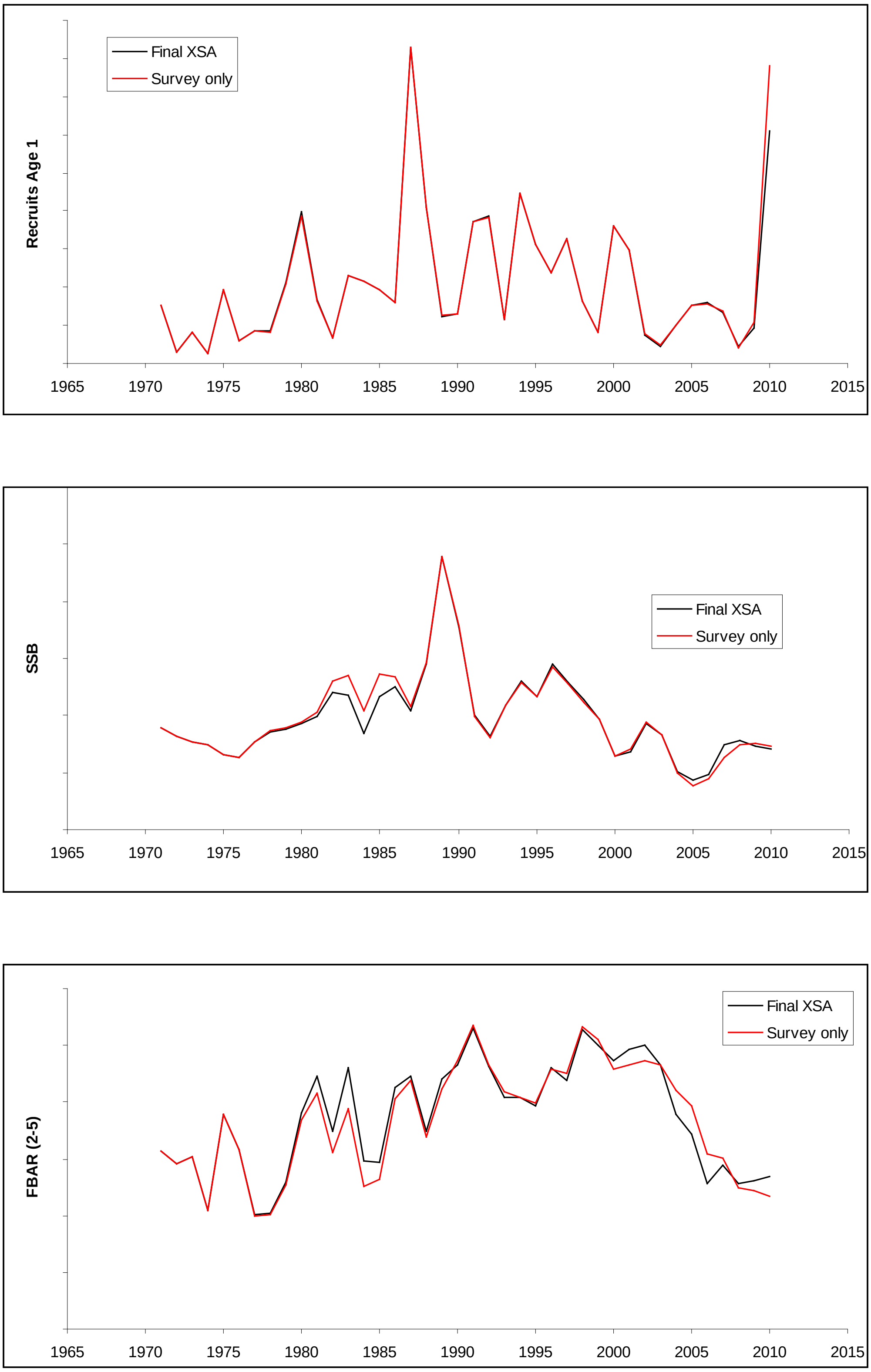



**Figure 7.2.10. Cod in VII e–k. Summary. Exploratory XSA based on survey indices only.**


**Figure 7.2.11. Cod in VIIe–k. Retrospective plots. Exploratory XSA.**

## 7.3 Cod in Divisions VIIb, c

### Type of assessment: No assessment

The nominal landings are given in Table 7.3.1.

**Table 7.3.1. Landings (t) of cod in Division VIIb,c for 1995–2009 as officially reported to ICES.**

| Country | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|
| France | 91 | 115 | 71 | 44 | …[1] | 46 | 38 | 54 |
| Germany | - | - | 3 | - | - | - | - | - |
| Ireland | 282 | 353 | 177 | 234 | 154 | 141 | 107 | 59 |
| Netherlands | - | - | - | - | - | - | + | - |
| Norway | 3 | 1 | 6 | | 11 | +* | 1 | 5 |
| Spain | 6 | 3 | | 6 | 2 | 3 | 1 | 1 |
| UK(E/W/NI) | 25 | 35 | 37 | 25 | 4 | 4 | 2 | 1 |
| UK(Scotland) | 66 | 12 | 7 | 9 | 1 | - | | 1 |
| UK | | | | | | | | |
| **Total** | **473** | **519** | **301** | **318** | **172** | **194** | **150** | **122** |

| Country | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| France | 33 | 13 | 13 | 10 | 18 | 14 | 5 | 17 |
| Germany | | | | | | | | |
| Ireland | 59 | 60 | 32 | 16 | 11 | 18 | 29 | 37 |
| Netherlands | 1 | | | | | | | |
| Norway | | | | 1 | 1 | | | |
| Spain | | | | | | | | |
| UK(E/W/NI) | 8 | | 0 | 1 | 2 | 1 | | 1 |
| UK(Scotland) | 1 | 10 | | 0 | | | | |
| UK | | | | | | | | |
| **Total** | **102** | **83** | **45** | **28** | **32** | **33** | **34** | **55** |

**[1]See VIIg-k.**

## 7.4 Haddock in Divisions VIIb–k

#### Type of assessment in 2011

Update.

#### ICES advice applicable to 2010 and 2011

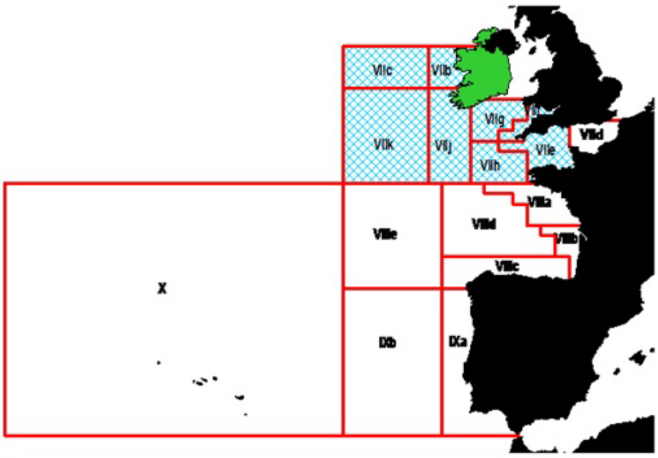
*"Effort should not be allowed to increase, reduce discard rates."*

*"The assessment is indicative of trends only. SSB shows an increasing trend over the time-series. Recruitment is highly variable and in the past the SSB and catches have increased after good recruitment. Recruitment of the 2009 year class appears to be exceptionally good, however it is likely that many of these fish will be discarded before they are of a marketable size."*

### 7.4.1 General

#### Stock description and management units

The basis for the stock assessment Area VIIb–k is described in detail in the Stock Annex. The TAC for haddock is set for the combined areas VIIb–k, VIII, IX and X and EU waters of CECAF 34.1.1. This does not correspond to the stock assessment area (VIIb–k). However, official international landings from VIII, IX and X have been less than 2% of all landings in the TAC area in most years since the TAC was instated.




**Red Boxes-TAC/Management Areas     Blue Shading– Assessment Area.**

#### Management applicable to 2010 and 2011

**TAC Table 2010**

| **Species:** Haddock *Melanogrammus aeglefinus* | | **Zone:** VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1 (HAD/7X7A34) |
|---|---|---|
| Belgium | 129 | |
| France | 7 719 | |
| Ireland | 2 573 | |
| United Kingdom | 1 158 | |
| EU | 11 579 | |
| TAC | 11 579 | Analytical TAC |

**TAC Table 2011**

| **Species:** Haddock *Melanogrammus aeglefinus* | | **Zone:** VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1 (HAD/7X7A34) |
|---|---|---|
| Belgium | 148 | |
| France | 8 877 | |
| Ireland | 2 959 | |
| United Kingdom | 1 332 | |
| EU | 13 316 | |
| TAC | 13 316 | Analytical TAC<br>Article 13 of this Regulation applies. |

Since 2009, a separate TAC is set for VIIa haddock, previously a separate allocation for VIIa existed within the TAC for VII, VIII, IX and X.

Article 13 refers to the closure of the porcupine bank from 1 May to 31 July 2011.

#### Fishery in 2010

The official landings reported to ICES and Working Group estimates of the landings and discards are given in Table 7.4.1. The historic landings are also shown in Figure 7.4.1. Ireland provided minor revisions to the landings figures for 2009. France provided a major update to the landing figures for 2009 (-775 t) due to previous problems with the French database. The 2009 international landings figure of 10 028 t was revised to 9276 t. The 2010 landings were estimated by the WG to be 9 6864 t.

Before 2002, the TAC was well in excess of the landings in the TAC area (Table 7.4.1a). Between 1999 and 2003 the TAC was sequentially reduced and appeared to become restrictive for France in 2003–2004 and Ireland in 2002–2003 and perhaps after (Table 7.4.1b and Figure 7.4.1). (WGSSDS05 provided some qualitative evidence that misreporting was now a problem). During 2005–2008 the TAC was between 11 520 t and 11 579 t and the international landings in the TAC area were less than 70% of the TAC. In 2009 and 2010 the total landings are still below the TAC but the quota appeared to become restrictive again for Ireland and Belgium (but not for France and the UK).

### 7.4.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

### Numbers-at-length

Length compositions of landings were available for haddock landed into Ireland, France and the UK in 2010 (Table 7.4.2; Figure 7.4.2a). Length distributions of the various fleets are quite similar with the exception of the UK beam trawl fleet.

Discard length distributions for 2010 are shown in Figure 7.4.2b. Most of the discarding in 2010 appears to have been fish under the MLS of 30 cm.

### Discard numbers-at-age

Irish otter trawl discard data were raised to the national level using the number of trips as auxiliary variable as described in the Stock Annex (all métiers combined). The numbers of OTB (Otter Bottom Trawl) discard trips by year and métier are given in Table 7.4.3a and the total number of OTB trips is given in Table 7.4.3b. Irish discard data from VIIgj were used to estimate international discards by using the ratio of the international effort in VIIe–k to the Irish effort in VIIgj (Table 7.4.3c). French effort data were not available for 2009 and 2010, therefore the average 2006–2008 effort was assumed for these years.

Figure 7.4.3a shows the Irish discard numbers-at-age and the discard numbers-at-age raised to international levels. Figure 7.4.3b shows the proportions-at-age that are discarded; over the last 10 years 90% of 1-year-olds, 54% of 2-year-olds and 17% of 3-year-olds have been discarded. By number, 70% of the total catch was discarded (45% by weight; average last ten years).

### Landings numbers-at-age

Landings numbers-at-age were raised using the procedure described in the Stock Annex. Landings numbers-at-age are given in Table 7.4.4a, discard numbers-at-age are given in Table 7.4.4b and catch numbers-at-age in Table 7.4.4c. Discards account for a large proportion of the catch numbers up to age 3. Despite uncertainty about the quality of the discard data, it is possible to track strong year classes in both the discards and the landings-at-age matrices.

Mean landings weights-at-age are given in Table 7.4.5a, catch weights-at-age are given in Table 7.4.5b and stock weights are given in Table 7.4.5c. Figure 7.4.4 shows the stock weights-at-age. There appear to be some cyclical trends in the stock-weights-at-age, particularly in the three-year running average weights.

### Biological

The assumptions of natural mortality and maturity are described in the Stock Annex. The maturity ogive used in the assessment is knife-edged at age 2. Irish Q1 survey data from 2004–2009 in VIIbgj (WD 3; WGCSE 2010) suggested a similar maturity ogive for females but also indicated that a significant number of males mature before the age of two.

### Surveys and commercial tuning fleets

The surveys are described in the Stock Annex. Available survey indices and tuning fleet data are given in Table 7.4.6. Survey data tuning-series were made available by Ireland, the UK, and France. Commercial tuning fleets were made available by Ireland; the French tuning fleet data for 2009 and 2010 were not available due to problems with the French logbooks database.

The standardized indices are given by year in Figure 7.4.5a and by cohort in Figure 7.4.5b. In addition to the indices that were used in the assessment, the Irish Groundfish Survey (IGFS–WIBTS- 4Q) indices in VIIb and VIIj are shown.

Figure 7.4.6 shows the standardized recruitment (age 0 and 1) indices for all available current surveys (some of which not used in the assessment). All surveys except the IGFS-WIBTS-Q4(7b) survey indicate that the 2009 recruitment is the highest in the time-series and that the 2010 recruitment is well below average.

#### Commercial lpue

Effort and lpue data are given in Table 7.4.7 and Figure 7.4.7. Lpue has shown an increasing trend in recent years suggesting improved availability of haddock. French effort is unknown but unlikely to have increased over the last two years.

#### Other relevant data

Figure 7.4.1a gives a long-term overview of the landings of haddock which may give some information on availability of haddock before the assessment time-series started, although effort is unknown. The time-series is characterized by a number of peaks with rapid increases in the landings, mostly followed by rapid decreases in landings within a few years, suggesting the fishery was taking advantage of sporadic events of very high recruitment. During the 1960s and 1970s three such peaks in landings occurred where the landings increased from less than 4000 t to 10 000 t or more. During the 1980s and early 1990s, landings were relatively stable around 2000–4000 t. During the mid-1990s the haddock landings increased again to over 10 000 t, mirroring increased landings in the Irish Sea in that period. Since the late 1990s the landings have varied between 7000 and 9000 t

### 7.4.3 Historical stock development

Model used: eXtended Survival Analysis (XSA)

Software used: FLR, VPA95

Exploratory data analysis and the assessment were carried out using FLR under R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0. The final assessment was also run using the Lowestoft VPA95 software.

#### Data screening

The general approach to data screening and analysis was followed in addition to the data exploration tools available in the FLR package FLEDA. The results of the data screening are available in the folder 'Data\Stock\had-7b–k\Exploratory runs' on SharePoint.

One particular exploratory assessment will be highlighted here: The catch numbers-at-age are likely to be estimated with low precision for the youngest ages due to the inclusion of (imprecise) discard data. To investigate the sensitivity of the assessment to the catch numbers at these ages, an assessment run was performed where the catch numbers-at-ages 0, 1 and 2 replaced with zeros. For these ages the total mortality is then assumed to be equal to the natural mortality which was set at 0.7 to account for the fishing mortality. This exploratory assessment showed virtually identical estimates for $F_{bar}$ 3–5 while SSB and recruitment showed very similar trends. This suggests that the trends from the assessment are not very sensitive to the uncertainty in the catch numbers-at-age that is introduced by the inclusion of the discards.

#### Final update assessment

The final assessment was run with the same settings as last year. The only difference is that no data were available for the French commercial tuning fleet (FR7fgGAD) in 2009 and 2010.

Input data types and characteristics:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Caton | Catch in tonnes | 1993–2010 | 0–8+ |
| Canum | Catch-at-age in numbers | 1993–2010 | 0–8+ |
| Weca | Weight-at-age in the catch | 1993–2010 | 0–8+ |
| West | Weight-at-age at spawning time. | 1993–2010 | 0–8+ |
| $M_{prop}$ | Proportion of M before spawning | 1993–2010 | 0–8+ |
| $F_{prop}$ | Proportion of F before spawning | 1993–2010 | 0–8+ |
| $Mat_{prop}$ | Proportion mature-at-age | 1993–2010 | 0–8+ |
| $Nat_{mor}$ | Natural mortality | 1993–2010 | 0–8+ |

A plusgroup of 8+ was used. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA runs. However, catch numbers-at-age 0 were set to zero to avoid spurious F-shrinkage effects at this age.

Model Options:

| Option | Setting |
|---|---|
| Ages catch dep stock size | None |
| Q plateau | 4 |
| Taper | No |
| F shrinkage SE | 1.5 |
| F shrinkage year range | 5 |
| F shrinkage age range | 3 |
| Fleet SE threshold | 0.3 |
| Prior weights | No |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Survey | UK WCGFS | 1996–2004 | Not used |
| Survey | EVHOE-WIBTS-Q4 | 1997–present | 0–5 |
| Survey | IRL-WCGFS | 1999–2002 | Not used |
| Survey | IGFS-WIBTS-Q4 (7g) | 1999–present | 0–5 |
| Survey | IGFS-WIBTS-Q4 (7b) | 2003–present | Not used |
| Survey | IGFS-WIBTS-Q4 (7j) | 2003–present | Not used |
| Commercial | IRL-OTB (7bj) | 1995–present | 2–7 |
| Commercial | FR-GAD | 2002–2008 | 2–6 |

The XSA diagnostics are given in Table 7.4.8a. The estimated fishing mortality is quite variable. The catchability regressions and residuals are given in Figure 7.4.8, the residuals are relatively large and some year effects are apparent. The catchability regression for age 7 is very tight, suggesting that the model adjusts the population numbers at that age to the tuning data. Increasing the fleet SE threshold can prevent this; however the assessment results do not change noticeably when the SE is increased, therefore last year's settings were not changed. The full fishing mortality and stock numbers-at-age tables are given in Table 7.4.8b and 7.4.8c.

The weighting applied to the terminal survivor estimates is shown in Figure 7.4.9. The 2010 cohort takes equal weight from the two surveys. The French Gadoid fleet gets relatively little weight because no 2009–2010 data were available. F-shrinkage does not account for much of the weighting in any of the cohorts.

The retrospective analysis was run back to 2003. The results are shown in Figure 7.4.10. $F_{bar}$ for recent has been revised downwards somewhat in the latest assessment. The estimated high recruitment in 2009 has not been affected by the inclusion of the 2010 data. SSB shows virtually no retrospective change.

#### Comparison with previous assessments

The XSA settings have not changed since 2007. The landings figures for 2009 were revised downwards by 7%. Figure 7.4.11 shows a comparison of the current and last year's assessment. Last year's estimates of $F_{bar}$, SSB, and recruitment have not changed significantly.

#### State of the stock

The state of the stock is not precisely known. However SSB has shown an overall increasing trend over the time-series.

The stock summary is given in Table 7.4.9 and Figure 7.4.11. Following good recruitment in 1999, 2001 and 2002 the SSB and catch increased. Recruitment has also been relatively high in 2007–2008 and exceptionally high in 2009 and the catches have increased since 2008, however most of these increased catches were discarded, mostly because they were under the MLS but possibly also due to restrictive quota.

### 7.4.4 Short-term projections

Short-term projections are presented here for reference only; they are not considered reliable because recruitment of haddock is characterized by sporadic events, therefore the use of geometric mean recruitment (1993–2008) for 2011–2013 provides a very uncertain estimate of future recruitment.

Short-term projections were performed using MFDP1a software.

Recruitment for 2011–2013 was estimated at 38 338 (GM 93-08; thousands). Three year averages were used for F and weights-at-age. Input data for the short-term forecast are given in Table 7.4.10. Landings and discard numbers and weights were supplied separately. Table 7.4.11 gives the management options. Estimates of the relative contribution of recent year classes to the 2012 landings and 2013 SSB are shown in Table 7.4.12. The high recruitment in 2009 accounts for 87% of the projected landings in 2011 and for 60% of the SSB in 2013.

### 7.4.5 MSY evaluation

WGCSE 2010 performed an MSY evaluation. Because haddock stocks are characterized by extreme recruitment events; recruitment modelled from a stock–recruitment (SR) relationship is therefore only a useful concept in the long term. Additionally, the time-series is quite short and there is little information to inform the SR model.

Because the assessment is indicative of trends only, F reference points should only be interpreted in a relative sense.

The stock–recruit relationship of haddock is not well captured by any of the models and the underlying data do not support the provision of absolute estimates of $F_{msy}$. However it is likely that current F is well above any $F_{msy}$ proxy.

### 7.4.6 Biological reference points

#### Precautionary approach reference points

It is not possible to derive precautionary reference points for this stock from the short time-series of information available.

### 7.4.7 Management plans

No management plan for VIIbk haddock has been agreed or proposed.

### 7.4.8 Uncertainties and bias in assessment and forecast

#### Landings

The sampling levels of landings for countries supplying data for 2010 are given in Table 2.1. Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, although the assessment is contingent on the accuracy of the landings statistics.

#### Discards

France and the UK have collected discard data in recent years and WD1 provides a comparison of the French and Irish discarding data. The document concludes that the French fleets do not appear to catch many one-year-olds while the Irish fleets do. Therefore the number of one year olds in the catch-at-age matrix is likely to be overestimated (because this is based on Irish data raised to international effort levels). However, reducing these numbers to 30% of their original value did not affect the assessment trends noticeably except for a small reduction in the recruitment estimates. The French and Irish fleets had similar selection ogives. Therefore it should be possible to include the French discard data in the assessment at the next benchmark, while retaining the use of the Irish-only data for the period for which no French data are available.

The problem remains that the number of discard trips remains small compared to the total number of trips. The level of uncertainty due to the small sample sizes is likely to be high. The cost of increasing discard coverage will be considerable.

Exploratory assessments have shown that SSB estimates are sensitive to the inclusion of young fish (aged 1 and 2) but the absolute estimates of $F_{bar}$ do not change noticeably if the catch numbers of fish aged 2 and less are set to zero. Therefore the uncertainty introduced by the inclusion of discard numbers-at-age is not likely to affect estimates of $F_{bar}$ or trends in recruitment.

#### Surveys

None of the available surveys cover the full assessment area. The EVHOE-WIBTS-Q4 survey covers the southern end of the area (VIIh+f and the southern part of VIIg+j) while the IGFS-WIBTS-Q4 (VIIg) survey only covers VIIj. The IGFS-WIBTS-Q4 (VIIb) and IGFS-WIBTS-Q4 (VIIj) are not currently included but should be considered at the next benchmark.

### 7.4.9 Recommendation for next benchmark

#### Review Group comments

Comments from the Review Group were addressed as far as possible without performing a benchmark assessment. The Stock Annex was amended to take some of the Review Group comments into account.

Regarding the strong 2009 cohort, the review group concluded that: "A key question is where in the Celtic Seas this abundance of small haddock will be located, and hence where would measures to avoid discarding be best targeted. The WG should monitor the distribution of these fish through surveys and observer data and provide managers with this information" This issue is addressed in WD2. The Working Document concludes that juvenile haddock are widely distributed throughout the stock area. However there are some areas where the catch rate of juveniles is particularly high and discard rates are also high (mainly to the west of the Aran grounds in VIIb and the northwest of VIIg). The 2009 year class does not seem to have a different distribution from juveniles in other years. Fishing effort in the areas with large numbers of juveniles is low to moderate which may offer some protection from discarding.

#### Recommendations for future work

The following issues can be explored in preparation for a future benchmark (proposed for 2013).

- The French discard data should be included in the assessment. WD1 indicates that it may be valid to use estimate historic discarding levels from the Irish data and recent discarding levels from Irish and French data. This would require the French discard data to be age-disaggregated and raised to the French fleets. Various methods of raising the discards to national and international level should be explored.
- The two survey tuning fleets (EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 (VIgj)) show very good agreement on the trends in the 0-group (Figure 7.4.6). The new Irish Groundfish Survey in VIIb and VIIj (IGFS-WIBTS-Q4 (VIIb) and (VIIj); not used in the analysis) generally agrees with the other surveys. It is believed that a significant amount of recruitment takes place in VIIb and the north of VIIj, these divisions are not covered by the EVHOE or IGFS-WIBTS-Q4 (VIIg) indices; therefore it would be worth considering including all IRGFS indices at the next benchmark assessment.
- EVHOE tuning fleet data from 1997 to 2000 are based on Irish survey Age–Length Keys. The time-series is now sufficiently long to omit these years.
- The Irish commercial tuning fleets should be split according to target species assemblage. Additionally, vessel-effects may be modelled and/or the spatial location of the fishing activity may be taken into account by making use of VMS data (e.g. Gerritsen, 2011, WD to WKCPUEFFORT).
- The Review Group suggested in 2010 that *"a model that allows for catch by multiple fleets should be developed to account for differences between countries and gear types. The RG suggests that in order to account for numerous fleets a forward projection, statistical catch-at-age model should be considered in the next*

*benchmark assessment, because it may be a more appropriate method than the XSA model due to its increased flexibility. In addition, such a model will allow for error in catch-at-age, which is important for a fishery with such high and uncertain levels of discards. It might also be possible under such a framework to more readily and easily include all the surveys, even those for which sampling has been discontinued."*

### 7.4.10 Management considerations

Management by TAC is inappropriate to this stock because landings, but not catches, are controlled. Haddock are caught in a mixed fishery so TAC management can lead to discarding of over-quota fish in addition to already considerable discarding of undersized fish.

Discarding is a serious problem for this stock; over the last ten years 70% of the catch has been discarded (45% by weight). The TAC has not been restrictive in recent years but since 2009 the national quota of Ireland and Belgium appeared to have become restrictive. The catches are increasing as the 2009 cohort enters the fishery; and despite a moderate increase in TAC in 2011, the quota are likely to become restrictive for all countries resulting in increased levels of discarding.

An analysis of Irish landings and discards by métier (2003–2009 data; Anon, *in prep*) indicates that although the *Nephrops* fleets have very high discarding rates of haddock (>70% by weight), in absolute terms these fleets only contribute 10% of the Irish haddock discards in the Celtic Sea. The demersal OTB and SSC fleets in VIIgj contribute 82% of the haddock discards.

| Métier | Landings (t) | Discards (t) | Discard Rate |
|---|---|---|---|
| OTB VIIg Dem | 7164 | 6007 | 46% |
| SSC VIIgj Dem | 4622 | 6098 | 57% |
| OTB VIIj Dem | 2395 | 1599 | 40% |
| TBB VIIefgh Dem | 1301 | 1358 | 51% |
| OTB VIIgfh *Neph* | 269 | 1202 | 82% |
| OTB VIIj *Neph* | 147 | 393 | 73% |
| OTB VIIf Dem | 106 | 55 | 34% |

**Source Anon (*in prep*).**

Technical measures can reduce discarding and could increase the yield considerably. Improved selectivity on younger ages will reduce discarding and promote stock increase when strong year classes occur. ICES recommends that the minimum mesh size for the demersal fleet should be at least 100 mm with a square mesh panel of at least 110 mm. Technical measures will also benefit other species (particularly whiting) caught in the mixed fishery. However technical measures are also likely to result in reduction in catch rates of marketable fish.

### 7.4.11 References

Anon. *in prep*. Demersal discard atlas; An Overview of Irish Discarding and Potential Solutions.

BIM. 2009. Summary report of Gear Trials to Support Ireland's Submission under Articles 11 & 13 of Reg. 1342/2008. *Nephrops* Fisheries VIIa & VIIb–k. Project 09.SM.T1.01. Bord Iascaigh Mhara (BIM) May 2009.

WD 01. WGCSE. 2011. Discarding of Haddock in VIIb–k; Comparison between the Irish and French discard data 2005–2010.

WD 02. WGCSE. 2011. Distribution of Juvenile Haddock in VIIb–k based on IGFS and EVHOE WIBTS- 4Q surveys.

**Table 7.4.1. (a) Haddock in VIIb–k official landings, the landings used by the working group and the TAC (tonnes). (b) The landings used by the working group, disaggregated by country and the quota (tonnes).**

| (a) | Official landings | | | | | | Un- | Used by WG | | | TAC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Belgium | France | Ireland | UK | Others | Total | allocated | Landings | Discards | Catch | VII - X |
| **1993** | 51 | 1839 | 1262 | 256 | 0 | 3408 | -60 | 3348 | 1193[2] | 4541 | |
| **1994** | 123 | 2788 | 908 | 240 | 17 | 4076 | 55 | 4131 | 1193[2] | 5324 | |
| **1995** | 189 | 2964 | 966 | 266 | 83 | 4468 | 2 | 4470 | 470 | 4941 | 6000 |
| **1996** | 133 | 4527 | 1468 | 439 | 86 | 6653 | 103 | 6756 | 1398 | 8154 | 14000 |
| **1997** | 246 | 6581 | 2789 | 569 | 85 | 10270 | 557 | 10827 | 2104 | 12931 | 14000 |
| **1998** | 142 | 3674 | 2788 | 444 | 312 | 7360 | 308 | 7668 | 355 | 8023 | 20000 |
| **1999** | 51 | 2725 | 2034 | 278 | 159 | 5247 | -365 | 4882 | 620 | 5502 | 22000 |
| **2000** | 90 | 3088 | 3066 | 289 | 123 | 6656 | 755 | 7411 | 6984 | 14395 | 16600 |
| **2001** | 165 | 4842 | 3608 | 422 | 665 | 9702 | -1070 | 8632 | 1941 | 10573 | 12000 |
| **2002** | 132 | 4348 | 2188 | 315 | 106 | 7089 | -686 | 6403 | 7506 | 13909 | 9300 |
| **2003** | 118 | 5781 | 1867 | 393 | 82 | 8241 | -95 | 8146 | 8194 | 16341 | 8185 |
| **2004** | 136 | 6130 | 1715 | 313 | 159 | 8453 | 128 | 8581 | 5350 | 13931 | 9600 |
| **2005** | 167 | 4174 | 2037 | 292 | 197 | 6867 | -219 | 6648 | 2546 | 9194 | 11520 |
| **2006** | 99 | 3190 | 1875 | 274 | 209 | 5647 | -264 | 5383 | 2083 | 7466 | 11520 |
| **2007** | 119 | 4142 | 1930 | 386 | 52 | 6629 | -119 | 6510 | 3243 | 9753 | 11520 |
| **2008** | 108 | 3639 | 1800 | 566 | 121 | 6234 | 815 | 7049 | 9277 | 16326 | 11579 |
| **2009** | 131 | 5419 | 2983 | 716 | 48 | 9297 | -21 | 9276 | 7276 | 16552 | 11579[3] |
| **2010[1]** | 170 | 6249 | 2611 | 850 | 1 | 9881 | -17 | 9864 | 12369 | 22233 | 11579[3] |

[1] preliminary data

[2] No discard data available, the avereage effort for **1995-1999** was used to estimate discards

[3] Applies to VIIb-k, VIII, IX and X

| (b) | Landings used by WG (Quota in brackets) | | | | | |
|---|---|---|---|---|---|---|
| Year | Belgium | France | Ireland | UK | Others | Total |
| **2002** | 134 (103) | 3878 (6200) | 2070 (2067) | 301 (930) | 21 | 6403 (9300) |
| **2003** | 116 (91) | 5960 (5456) | 1667 (1819) | 362 (819) | 41 | 8146 (8185) |
| **2004** | 137 (107) | 6336 (6400) | 1732 (2133) | 303 (960) | 73 | 8581 (9600) |
| **2005** | 165 (128) | 4096 (7680) | 1991 (2560) | 282 (1152) | 20 | 6555 (11520) |
| **2006** | 98 (128) | 3151 (7680) | 1857 (2560) | 262 (1152) | 14 | 5383 (11520) |
| **2007** | 118 (128) | 4073 (7680) | 1925 (2560) | 383 (1152) | 10 | 6510 (11520) |
| **2008** | 109 (129) | 4587 (7719) | 1794 (2573) | 545 (1158) | 14 | 7049 (11579) |
| **2009** | 131 (129) | 5455 (7719) | 2986 (2573) | 703 (1158) | 2 | 9276 (11579) |
| **2010** | 167 (148) | 6267 (8877) | 2609 (2959) | 789 (1332) | 34 | 9864 (13316) |

**Table 7.4.2. Length frequency distributions ('000) of the landings of haddock in VIIb–k in 2010. FR OT_DEF and FR OT_CRU are the French gadoid and *Nephrops* fleets. IRL OTB is the Irish otter trawl fleet, UK trawl includes all trawl gears except beam trawl.**

| | FR OT_DEF VIIfgh | FR OT_CRU VIIfgh | IRL OTB VIIbc | IRL OTB VIIfgh | IRL OTB VIIjk | UK Trawl VIIe-k | UK Beam VIIe-k |
|---|---|---|---|---|---|---|---|
| | Landings | | Landings | Landings | Landings | Landings | Landings |
| Length (cm) | 5992 | 68 | 252 | 1080 | 520 | 666 | 105 |
| 22 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 |
| 23 | 0.0 | 0.0 | 0.1 | 0.0 | 0.4 | 0.0 | 0.0 |
| 24 | 0.1 | 0.0 | 0.1 | 0.8 | 1.4 | 0.0 | 0.0 |
| 25 | 0.0 | 0.0 | 0.1 | 1.2 | 3.6 | 0.0 | 0.0 |
| 26 | 1.6 | 0.0 | 0.1 | 0.8 | 8.2 | 0.0 | 0.0 |
| 27 | 2.9 | 0.0 | 0.1 | 0.8 | 9.6 | 0.5 | 0.0 |
| 28 | 5.0 | 0.1 | 0.8 | 2.1 | 14.6 | 0.5 | 0.0 |
| 29 | 25.1 | 0.2 | 2.0 | 10.6 | 24.0 | 1.6 | 0.0 |
| 30 | 75.3 | 0.5 | 4.5 | 25.5 | 24.9 | 3.8 | 0.1 |
| 31 | 168.0 | 1.2 | 7.0 | 29.3 | 29.8 | 8.8 | 4.4 |
| 32 | 290.5 | 2.1 | 11.9 | 60.4 | 35.5 | 29.5 | 5.4 |
| 33 | 373.7 | 2.2 | 13.6 | 100.4 | 45.2 | 27.6 | 17.5 |
| 34 | 455.5 | 4.3 | 17.1 | 130.3 | 53.8 | 49.4 | 21.7 |
| 35 | 456.0 | 3.7 | 17.9 | 126.1 | 52.3 | 30.8 | 13.7 |
| 36 | 625.6 | 3.5 | 23.4 | 144.3 | 46.0 | 50.0 | 9.5 |
| 37 | 632.9 | 5.5 | 19.9 | 146.0 | 43.6 | 39.7 | 5.7 |
| 38 | 602.7 | 5.0 | 25.1 | 134.2 | 45.2 | 59.3 | 4.9 |
| 39 | 588.6 | 3.9 | 29.0 | 121.6 | 38.8 | 52.3 | 3.2 |
| 40 | 510.3 | 4.2 | 25.4 | 108.8 | 34.3 | 64.6 | 2.5 |
| 41 | 441.9 | 3.5 | 21.0 | 98.4 | 36.3 | 55.4 | 4.3 |
| 42 | 381.0 | 3.5 | 18.5 | 81.0 | 32.1 | 48.5 | 2.8 |
| 43 | 304.5 | 1.8 | 14.9 | 58.1 | 34.2 | 45.8 | 2.9 |
| 44 | 267.9 | 3.2 | 13.4 | 67.7 | 26.7 | 33.7 | 3.7 |
| 45 | 226.7 | 2.2 | 10.4 | 43.8 | 26.2 | 52.6 | 3.0 |
| 46 | 183.4 | 2.4 | 10.1 | 49.9 | 20.7 | 39.8 | 4.5 |
| 47 | 199.2 | 2.5 | 8.4 | 45.9 | 15.2 | 33.7 | 3.6 |
| 48 | 149.8 | 2.0 | 7.4 | 30.5 | 12.1 | 18.0 | 3.1 |
| 49 | 131.1 | 1.4 | 5.7 | 24.6 | 11.3 | 18.3 | 2.4 |
| 50 | 112.6 | 1.8 | 4.4 | 14.4 | 9.6 | 20.1 | 2.9 |
| 51 | 83.0 | 1.6 | 5.1 | 9.7 | 8.1 | 10.2 | 1.8 |
| 52 | 91.6 | 1.4 | 4.1 | 8.9 | 6.6 | 10.6 | 1.6 |
| 53 | 61.7 | 1.1 | 3.1 | 6.2 | 6.5 | 4.2 | 0.7 |
| 54 | 49.0 | 1.2 | 2.9 | 5.1 | 4.8 | 7.0 | 1.4 |
| 55 | 44.1 | 1.2 | 2.9 | 5.5 | 3.9 | 9.2 | 1.2 |
| 56 | 36.2 | 0.8 | 3.3 | 5.3 | 2.8 | 3.3 | 1.0 |
| 57 | 30.0 | 0.6 | 2.5 | 2.3 | 3.7 | 4.7 | 1.0 |
| 58 | 30.7 | 0.5 | 1.5 | 3.2 | 4.9 | 1.3 | 1.2 |
| 59 | 31.6 | 0.5 | 1.6 | 0.6 | 3.1 | 0.9 | 0.5 |
| 60 | 24.6 | 0.7 | 1.3 | 2.0 | 2.4 | 0.9 | 0.8 |
| 61 | 21.4 | 0.6 | 1.2 | 1.3 | 2.2 | 0.8 | 0.7 |
| 62 | 21.7 | 0.5 | 1.1 | 1.7 | 1.7 | 0.7 | 1.0 |
| 63 | 20.2 | 0.4 | 1.1 | 2.0 | 1.4 | 0.8 | 0.6 |
| 64 | 25.0 | 0.4 | 1.0 | 0.9 | 1.2 | 2.5 | 0.7 |
| 65 | 15.2 | 0.3 | 0.8 | 1.1 | 1.4 | 0.4 | 0.6 |
| 66 | 16.3 | 0.2 | 0.3 | 0.6 | 1.1 | 0.4 | 0.4 |
| 67 | 22.2 | 0.3 | 0.6 | 0.7 | 0.6 | 0.1 | 0.1 |
| 68 | 8.7 | 0.2 | 0.2 | 0.3 | 0.9 | 0.2 | 0.1 |
| 69 | 13.0 | 0.1 | 0.1 | 0.3 | 0.5 | 0.3 | 0.2 |
| 70 | 11.6 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.3 |
| 71 | 5.4 | 0.1 | 0.0 | 1.6 | 0.5 | 0.3 | 0.3 |
| 72 | 8.6 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.2 |
| 73 | 5.2 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 0.2 |
| 74 | 3.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| 75 | 5.6 | 0.1 | 0.0 | 0.3 | 0.3 | 0.0 | 0.1 |
| 76 | 2.0 | 0.2 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 |
| 77 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 78 | 0.3 | 0.0 | 0.0 | 0.3 | 0.3 | 0.0 | 0.0 |
| 79 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 80 | 2.9 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| 81 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 82 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 83 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 84 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 85 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 86 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 87 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 7.4.3. Overview of the number of OTB (otter trawl) discard trips, the total number of OTB trips and the raising factor used to raise the Irish discard data to international discards.**

**a). Number of Irish OTB discard trips by year and metier**

| Metier | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OTB VIIb Neph | 1 | 1 | 0 | 5 | 2 | 2 | 1 | 1 | 2 | 1 | 5 | 6 | 4 | 1 | 0 | 6 | 4 | 2 | 44 |
| OTB VIIbc Dem | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 9 |
| OTB VIIck Neph | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 10 |
| OTB VIIg Dem | 3 | 3 | 0 | 0 | 5 | 2 | 1 | 0 | 0 | 0 | 2 | 10 | 7 | 1 | 4 | 2 | 4 | 1 | 45 |
| OTB VIIgfh Neph | 4 | 6 | 0 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 0 | 10 | 4 | 7 | 6 | 54 |
| OTB VIIj Dem | 1 | 1 | 2 | 4 | 0 | 2 | 2 | 0 | 2 | 0 | 7 | 3 | 6 | 1 | 2 | 2 | 2 | 4 | 41 |
| OTB VIIj Neph | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 7 |
| Other gears VIIbk | 1 | 0 | 0 | 1 | 3 | 4 | 0 | 0 | 0 | 0 | 3 | 5 | 3 | 0 | 0 | 1 | 2 | 0 | 23 |
| Total discard trips | 11 | 15 | 2 | 12 | 13 | 12 | 7 | 2 | 6 | 3 | 22 | 28 | 25 | 3 | 19 | 17 | 23 | 13 | 233 |

**b). Total number of Irish OTB trips by year and Division**

| Metier | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OTB VIIb | 1352 | 860 | 949 | 1267 | 1156 | 1192 | 1115 | 941 | 1468 | 1333 | 973 | 788 | 990 | 942 | 903 | 779 | 17008 |
| OTB VIIg | 1834 | 1763 | 1913 | 1979 | 1342 | 1408 | 1474 | 1732 | 1773 | 1891 | 2337 | 2308 | 2825 | 2843 | 2641 | 2706 | 32769 |
| OTB VIIj | 2181 | 1808 | 1916 | 1976 | 838 | 1136 | 1699 | 1756 | 2405 | 2049 | 1675 | 1411 | 2248 | 2157 | 2139 | 2300 | 29694 |
| Total OTB VIIbgj | 5367 | 4431 | 4778 | 5222 | 3336 | 3736 | 4288 | 4429 | 5646 | 5273 | 4985 | 4507 | 6063 | 5942 | 5683 | 5785 | 79471 |

**c). Effort (1000h) and the raising factor used to raise the Irish VIIgj discard data to international discards**

| Fleet | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IRL OTB VIIb | 56* | 56* | 65 | 41 | 50 | 64 | 62 | 63 | 61 | 47 | 64 | 60 | 47 | 40 | 41 | 37 | 38 | 43 | 817 |
| IRL OTB VIIgj | 138* | 132* | 157 | 130 | 148 | 162 | 92 | 125 | 137 | 168 | 198 | 189 | 198 | 185 | 217 | 192 | 210 | 226 | 2376 |
| International VIIe-k** | 413 | 366 | 394 | 361 | 441 | 413 | 397 | 400 | 413 | 428 | 415 | 384 | 376 | 348 | 389 | 334 | 362 | 381 | 5933 |
| Raising Factor (INT 7ek/IRL 7 | 3.00 | 2.78 | 2.50 | 2.77 | 2.97 | 2.55 | 4.31 | 3.19 | 3.01 | 2.54 | 2.09 | 2.03 | 1.90 | 1.88 | 1.79 | 1.74 | 1.72 | 1.69 | 2.50 |

* Average of 1995-99

** Includes IRL OTB VIIgj, FR GAD VIIfgh and UK Trawl VIIe-k

*** assuming average effort 2006-8 for France

**Table 7.4.4. (a) Catch numbers-at-age of haddock in VIIb–k. (b) Landings numbers-at-age. (c) Discard numbers-at-age.**

**a) Haddock VIIbk - Landings numbers at age**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 494 | 3311 | 954 | 815 | 257 | 130 | 130 | 42 | 3 | 0 | #1993 |
| 0 | 1491 | 2934 | 870 | 461 | 297 | 66 | 25 | 63 | 0 | 0 | #1994 |
| 25 | 2237 | 1185 | 1090 | 462 | 581 | 338 | 161 | 44 | 0 | 0 | #1995 |
| 0 | 2399 | 10373 | 1206 | 648 | 260 | 275 | 126 | 71 | 10 | 10 | #1996 |
| 0 | 1581 | 12102 | 3119 | 694 | 580 | 239 | 130 | 33 | 42 | 22 | #1997 |
| 3 | 640 | 3264 | 6199 | 846 | 302 | 252 | 179 | 73 | 56 | 6 | #1998 |
| 0 | 622 | 2585 | 1560 | 1646 | 245 | 80 | 44 | 14 | 3 | 0 | #1999 |
| 28 | 4676 | 2344 | 587 | 535 | 589 | 134 | 23 | 14 | 2 | 0 | #2000 |
| 11 | 3998 | 8036 | 1053 | 282 | 295 | 298 | 51 | 29 | 7 | 0 | #2001 |
| 1 | 872 | 4216 | 3354 | 760 | 39 | 88 | 73 | 19 | 5 | 2 | #2002 |
| 16 | 665 | 8293 | 1998 | 1149 | 112 | 42 | 48 | 41 | 10 | 0 | #2003 |
| 4 | 117 | 5870 | 4540 | 881 | 573 | 50 | 12 | 16 | 3 | 0 | #2004 |
| 0 | 783 | 833 | 4166 | 1884 | 436 | 114 | 4 | 13 | 3 | 0 | #2005 |
| 0 | 831 | 3313 | 1431 | 2106 | 376 | 64 | 7 | 0 | 0 | 0 | #2006 |
| 0 | 653 | 6198 | 2566 | 503 | 827 | 149 | 29 | 3 | 2 | 0 | #2007 |
| 0 | 1528 | 3854 | 4212 | 914 | 216 | 358 | 65 | 11 | 1 | 0 | #2008 |
| 0 | 777 | 6723 | 3304 | 1880 | 475 | 140 | 107 | 24 | 2 | 0 | #2009 |
| 0 | 1235 | 4612 | 5788 | 866 | 472 | 156 | 65 | 53 | 6 | 1 | #2010 |

**b) Haddock VIIbk - Discard numbers at age**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 577 | 3092 | 1488 | 95 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | #1993 |
| 577 | 3092 | 1488 | 95 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | #1994 |
| 12740 | 1620 | 81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #1995 |
| 192 | 4144 | 1497 | 42 | 19 | 6 | 0 | 0 | 0 | 0 | 0 | #1996 |
| 849 | 5795 | 2997 | 228 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | #1997 |
| 423 | 602 | 534 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #1998 |
| 539 | 2759 | 367 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #1999 |
| 3945 | 37367 | 5891 | 247 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | #2000 |
| 1049 | 7294 | 1871 | 196 | 13 | 1 | 0 | 0 | 0 | 0 | 0 | #2001 |
| 11543 | 22260 | 7206 | 901 | 52 | 4 | 0 | 0 | 0 | 0 | 0 | #2002 |
| 11303 | 25087 | 10001 | 395 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | #2003 |
| 1470 | 4365 | 10011 | 1203 | 65 | 79 | 0 | 0 | 0 | 0 | 0 | #2004 |
| 1223 | 3412 | 3020 | 1907 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | #2005 |
| 6091 | 5108 | 656 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #2006 |
| 2173 | 6538 | 4056 | 306 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | #2007 |
| 2659 | 29268 | 8659 | 1017 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | #2008 |
| 5604 | 17296 | 7921 | 285 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | #2009 |
| 525 | 49143 | 8297 | 1287 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #2010 |

**c) Haddock VIIbk - Catch numbers at age**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 585 | 3586 | 4799 | 1049 | 822 | 259 | 130 | 130 | 42 | 3 | 0 | #1993 |
| 577 | 4583 | 4422 | 965 | 468 | 299 | 66 | 25 | 63 | 0 | 0 | #1994 |
| 12766 | 3857 | 1265 | 1090 | 462 | 581 | 338 | 161 | 44 | 0 | 0 | #1995 |
| 192 | 6543 | 11870 | 1248 | 667 | 266 | 275 | 126 | 71 | 10 | 10 | #1996 |
| 849 | 7377 | 15099 | 3348 | 700 | 581 | 239 | 130 | 33 | 42 | 22 | #1997 |
| 425 | 1242 | 3798 | 6232 | 846 | 302 | 252 | 179 | 73 | 56 | 6 | #1998 |
| 539 | 3380 | 2951 | 1567 | 1646 | 245 | 80 | 44 | 14 | 3 | 0 | #1999 |
| 3973 | 42044 | 8234 | 834 | 547 | 589 | 134 | 23 | 14 | 2 | 0 | #2000 |
| 1060 | 11292 | 9908 | 1248 | 294 | 296 | 298 | 51 | 29 | 7 | 0 | #2001 |
| 11544 | 23132 | 11422 | 4255 | 812 | 43 | 88 | 73 | 19 | 5 | 2 | #2002 |
| 11319 | 25752 | 18294 | 2392 | 1299 | 112 | 42 | 48 | 41 | 10 | 0 | #2003 |
| 1474 | 4482 | 15881 | 5742 | 947 | 652 | 50 | 12 | 16 | 3 | 0 | #2004 |
| 1223 | 4194 | 3853 | 6073 | 1962 | 436 | 114 | 4 | 13 | 3 | 0 | #2005 |
| 6091 | 5939 | 3969 | 1431 | 2106 | 376 | 64 | 7 | 0 | 0 | 0 | #2006 |
| 2173 | 7192 | 10254 | 2872 | 508 | 832 | 149 | 29 | 3 | 2 | 0 | #2007 |
| 2659 | 30796 | 12514 | 5229 | 954 | 216 | 358 | 65 | 11 | 1 | 0 | #2008 |
| 5604 | 18073 | 14644 | 3589 | 1914 | 475 | 140 | 107 | 24 | 2 | 0 | #2009 |
| 525 | 50378 | 12909 | 7075 | 866 | 472 | 156 | 65 | 53 | 6 | 1 | #2010 |

**Table 7.4.5. (a) Mean landings weights-at-age. (b) Mean discard weights-at-age. (c) Mean stock weights-at-age (including discards). A 3-year running average was applied to the stock weights.**

**a) Haddock VIIbk - Landings weights at age**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.141 | 0.187 | 0.320 | 0.556 | 0.851 | 1.402 | 1.693 | 2.130 | 2.593 | 2.325 | 0.000 | #1993 |
| 0.000 | 0.321 | 0.537 | 0.869 | 1.167 | 1.428 | 1.990 | 2.399 | 2.673 | 0.000 | 0.000 | #1994 |
| 0.156 | 0.285 | 0.735 | 0.932 | 0.964 | 1.052 | 1.284 | 2.040 | 2.495 | 0.000 | 0.000 | #1995 |
| 0.000 | 0.207 | 0.339 | 0.689 | 1.137 | 1.389 | 1.450 | 1.850 | 2.105 | 1.835 | 1.415 | #1996 |
| 0.000 | 0.321 | 0.442 | 0.863 | 1.237 | 1.417 | 1.453 | 0.965 | 1.451 | 0.706 | 1.570 | #1997 |
| 0.101 | 0.291 | 0.341 | 0.664 | 1.024 | 1.325 | 1.558 | 1.915 | 2.106 | 1.544 | 2.044 | #1998 |
| 0.000 | 0.360 | 0.444 | 0.661 | 1.094 | 1.406 | 2.267 | 2.594 | 2.559 | 1.575 | 0.000 | #1999 |
| 0.160 | 0.437 | 0.918 | 1.392 | 1.709 | 1.826 | 2.308 | 2.486 | 2.213 | 2.449 | 0.000 | #2000 |
| 0.442 | 0.345 | 0.541 | 1.104 | 1.865 | 1.783 | 1.705 | 2.297 | 1.669 | 1.386 | 0.000 | #2001 |
| 0.114 | 0.373 | 0.513 | 0.825 | 1.032 | 1.732 | 1.671 | 1.504 | 1.532 | 1.589 | 1.840 | #2002 |
| 0.282 | 0.347 | 0.520 | 0.883 | 1.242 | 1.429 | 1.800 | 1.705 | 1.589 | 2.143 | 3.045 | #2003 |
| 0.197 | 0.432 | 0.523 | 0.758 | 1.192 | 1.380 | 1.855 | 1.806 | 1.876 | 3.092 | 1.950 | #2004 |
| 0.104 | 0.429 | 0.546 | 0.719 | 1.027 | 1.256 | 1.946 | 2.667 | 1.881 | 2.185 | 2.708 | #2005 |
| 0.000 | 0.349 | 0.482 | 0.545 | 0.938 | 1.486 | 2.118 | 2.619 | 4.022 | 4.019 | 0.000 | #2006 |
| 0.000 | 0.330 | 0.467 | 0.640 | 0.886 | 1.199 | 1.630 | 1.487 | 3.427 | 1.448 | 5.779 | #2007 |
| 0.000 | 0.377 | 0.519 | 0.673 | 0.875 | 1.139 | 1.267 | 1.654 | 1.745 | 2.553 | 2.878 | #2008 |
| 0.000 | 0.349 | 0.553 | 0.701 | 0.999 | 1.310 | 1.544 | 1.646 | 2.449 | 2.204 | 0.000 | #2009 |
| 0.000 | 0.385 | 0.547 | 0.774 | 1.185 | 1.773 | 1.862 | 1.739 | 1.702 | 1.541 | 1.012 | #2010 |

**b) Haddock VIIbk - Discard weights at age**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.074 | 0.184 | 0.384 | 0.538 | 0.305 | 0.329 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1993 |
| 0.074 | 0.184 | 0.384 | 0.538 | 0.305 | 0.329 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1994 |
| 0.095 | 0.282 | 0.165 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1995 |
| 0.056 | 0.166 | 0.452 | 0.468 | 0.548 | 0.825 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1996 |
| 0.081 | 0.144 | 0.374 | 0.636 | 0.246 | 0.487 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1997 |
| 0.069 | 0.244 | 0.359 | 0.502 | 0.254 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1998 |
| 0.057 | 0.176 | 0.356 | 0.548 | 0.163 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #1999 |
| 0.090 | 0.134 | 0.328 | 0.200 | 0.196 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2000 |
| 0.095 | 0.164 | 0.350 | 0.432 | 0.558 | 0.326 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2001 |
| 0.083 | 0.207 | 0.342 | 0.393 | 1.338 | 1.171 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2002 |
| 0.012 | 0.192 | 0.317 | 0.245 | 0.746 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2003 |
| 0.085 | 0.207 | 0.364 | 0.583 | 0.902 | 0.520 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2004 |
| 0.068 | 0.187 | 0.318 | 0.469 | 0.688 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2005 |
| 0.066 | 0.375 | 0.258 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2006 |
| 0.088 | 0.200 | 0.432 | 0.590 | 0.333 | 0.205 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2007 |
| 0.077 | 0.174 | 0.415 | 0.580 | 0.223 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2008 |
| 0.088 | 0.223 | 0.412 | 0.547 | 0.306 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2009 |
| 0.073 | 0.169 | 0.391 | 0.639 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | #2010 |

**c) Haddock VIIbk - Stock weights at age (3-year running average)**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.073 | 0.190 | 0.362 | 0.659 | 0.866 | 1.581 | 2.010 | 2.114 | 3.779 | 2.384 | 2.384 | #1993 |
| 0.080 | 0.252 | 0.441 | 0.766 | 0.956 | 1.536 | 1.864 | 2.142 | 3.403 | 2.473 | 2.473 | #1994 |
| 0.075 | 0.244 | 0.438 | 0.821 | 1.147 | 1.385 | 1.720 | 1.998 | 2.833 | 2.166 | 2.170 | #1995 |
| 0.077 | 0.237 | 0.454 | 0.936 | 1.267 | 1.484 | 1.712 | 1.961 | 2.484 | 1.575 | 2.033 | #1996 |
| 0.068 | 0.172 | 0.343 | 0.805 | 1.235 | 1.421 | 1.676 | 2.044 | 2.542 | 1.037 | 1.368 | #1997 |
| 0.069 | 0.179 | 0.367 | 0.672 | 1.072 | 1.311 | 1.782 | 2.198 | 2.231 | 1.040 | 1.365 | #1998 |
| 0.072 | 0.181 | 0.367 | 0.657 | 1.089 | 1.456 | 2.050 | 2.363 | 2.324 | 1.376 | 1.358 | #1999 |
| 0.080 | 0.184 | 0.435 | 0.797 | 1.339 | 1.691 | 2.224 | 2.373 | 1.934 | 1.560 | 1.560 | #2000 |
| 0.089 | 0.192 | 0.414 | 0.878 | 1.383 | 1.710 | 1.893 | 1.817 | 1.562 | 1.753 | 1.670 | #2001 |
| 0.063 | 0.197 | 0.399 | 0.828 | 1.373 | 1.671 | 1.895 | 1.724 | 1.601 | 2.647 | 2.409 | #2002 |
| 0.060 | 0.203 | 0.366 | 0.728 | 1.199 | 1.556 | 1.944 | 1.386 | 1.610 | 3.145 | 2.409 | #2003 |
| 0.055 | 0.206 | 0.352 | 0.682 | 1.225 | 1.625 | 2.315 | 1.968 | 1.927 | 3.147 | 2.732 | #2004 |
| 0.073 | 0.259 | 0.357 | 0.603 | 1.100 | 1.555 | 2.172 | 2.421 | 2.676 | 3.151 | 2.891 | #2005 |
| 0.074 | 0.260 | 0.369 | 0.580 | 0.982 | 1.448 | 2.110 | 2.564 | 3.343 | 2.752 | 4.182 | #2006 |
| 0.077 | 0.246 | 0.390 | 0.589 | 0.885 | 1.361 | 1.820 | 2.203 | 3.315 | 3.079 | 4.179 | #2007 |
| 0.084 | 0.206 | 0.405 | 0.629 | 0.894 | 1.195 | 1.655 | 1.870 | 3.189 | 2.287 | 3.387 | #2008 |
| 0.079 | 0.194 | 0.402 | 0.644 | 0.950 | 1.306 | 1.546 | 1.824 | 2.615 | 2.087 | 1.783 | #2009 |
| 0.081 | 0.200 | 0.405 | 0.671 | 1.029 | 1.346 | 1.610 | 1.858 | 2.809 | 1.643 | 1.324 | #2010 |

**Table 7.4.6. Tuning data available for haddock in VIIB–k. The tuning data used in the final assessment is highlighted in grey.**

| HADDOCK VIIb–k, WGSSDS 2010, TUNING DATA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113 | | | | | | | | | | | | |
| IRL-OTB (7b) : Irish Otter Trawl in 7B - effort, nos at age per 1000h | | | | | | | | | | | | |
| 1995 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 0 | 10 | | | | | | | | | | | |
| 65.3 | 0 | 0 | 20.5 | 104.3 | 76.1 | 105.3 | 62 | 29.6 | 8.1 | 0 | 0 | #1995 |
| 41.5 | 0 | 19.4 | 93.2 | 30.2 | 30 | 17.9 | 21.5 | 9.4 | 5.1 | 0.8 | 0.8 | #1996 |
| 49.5 | 0 | 8.3 | 195.2 | 116.9 | 29.6 | 31.9 | 19.1 | 13.5 | 4.1 | 5.3 | 8.4 | #1997 |
| 63.5 | 0 | 9.8 | 147.4 | 290.7 | 68.1 | 37.7 | 34.6 | 25 | 9.5 | 8.4 | 0.9 | #1998 |
| 62 | 0 | 0.4 | 193.6 | 225.9 | 190.9 | 49.6 | 12.4 | 6 | 2.3 | 0.7 | 0 | #1999 |
| 57.7 | 0 | 41.3 | 57.2 | 22.2 | 56.8 | 98.5 | 31.2 | 7.5 | 6.9 | 0.7 | 0 | #2000 |
| 60.7 | 0 | 20.2 | 289.1 | 72.8 | 13.9 | 42.5 | 60.4 | 7.4 | 8.2 | 2 | 0 | #2001 |
| 46.8 | 0.3 | 3.9 | 38.9 | 95.2 | 28.6 | 4.3 | 17.3 | 17.6 | 4.8 | 1.3 | 0.6 | #2002 |
| 64 | 0 | 2.2 | 21.7 | 42.2 | 66.8 | 15.1 | 9 | 10.6 | 10.4 | 2.5 | 0.1 | #2003 |
| 60.4 | 0 | 0.6 | 43.7 | 68.3 | 59.8 | 79.6 | 11 | 3.2 | 4.8 | 0.3 | 0.2 | #2004 |
| 47.4 | 0 | 9.7 | 60.8 | 64.4 | 57.4 | 32.7 | 2 | 1.6 | 1 | 0.3 | 0 | #2005 |
| 39.7 | 0 | 20.9 | 120.5 | 108.9 | 50.7 | 7.2 | 9.3 | 0 | 0 | 0 | 0 | #2006 |
| 40.7 | 0 | 0 | 63.5 | 64.9 | 45.3 | 69.5 | 14.9 | 7.9 | 0 | 0 | 0 | #2007 |
| 37.3 | 0 | 0 | 37.6 | 96.6 | 63.3 | 33.3 | 62.4 | 12.2 | 3.1 | 0.2 | 0 | #2008 |
| 37.8 | 0 | 0.1 | 75.1 | 54.3 | 81.3 | 80.5 | 34.4 | 44.3 | 4.7 | 1.3 | 0 | #2009 |
| 43.1 | 0 | 0 | 7.8 | 110.4 | 50.2 | 42.6 | 41.4 | 25.2 | 25.5 | 4.3 | 0.6 | #2010 |
| IRL-OTB (7j) : Irish Otter Trawl in 7J - effort, nos at age per 1000h | | | | | | | | | | | | |
| 1995 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 0 | 10 | | | | | | | | | | | |
| 93.6 | 3.56 | 323.2 | 92.2 | 37.7 | 1.4 | 0.5 | 0 | 0 | 0 | 0 | 0 | #1995 |
| 70.2 | 0 | 146.9 | 464.1 | 24 | 9.9 | 3.2 | 1.6 | 0 | 0 | 0 | 0 | #1996 |
| 83.2 | 0 | 136.4 | 929 | 190.9 | 38.6 | 26.4 | 6.7 | 1.5 | 0 | 0 | 0 | #1997 |
| 89.6 | 0.34 | 69 | 287.7 | 515.6 | 48 | 7.3 | 4.3 | 3 | 1.6 | 0 | 0 | #1998 |
| 40.6 | 0 | 8.5 | 119.2 | 52.1 | 61.2 | 3.2 | 1.6 | 1.8 | 0.6 | 0 | 0 | #1999 |
| 64.1 | 0 | 100.1 | 80.4 | 30.6 | 26.2 | 37 | 4.9 | 0 | 0 | 0 | 0 | #2000 |
| 67.7 | 0.4 | 347.9 | 523 | 62.7 | 21.1 | 10.4 | 6.3 | 1.4 | 0.1 | 0 | 0 | #2001 |
| 90.4 | 0.2 | 38.9 | 495.4 | 322.3 | 36 | 3.9 | 7.3 | 3.2 | 0.6 | 0 | 0 | #2002 |
| 111.3 | 0.7 | 26.6 | 318.3 | 125.7 | 150.1 | 23 | 3.6 | 4.1 | 2.6 | 0 | 0 | #2003 |
| 92 | 0 | 7.8 | 204.5 | 207.1 | 84.4 | 34.4 | 2.4 | 0.8 | 0.6 | 0.3 | 0 | #2004 |
| 73.9 | 0.1 | 2.3 | 32.2 | 207.1 | 152.6 | 61.2 | 9.6 | 0 | 0 | 0 | 0 | #2005 |
| 65.9 | 0 | 32.4 | 117.6 | 111.7 | 222.8 | 44.3 | 5.4 | 0.9 | 0 | 0 | 0 | #2006 |
| 80.5 | 0 | 28.1 | 148.6 | 152.6 | 41.9 | 157.8 | 16.6 | 2.1 | 0.6 | 0 | 0.2 | #2007 |
| 66.5 | 0 | 177.7 | 232.8 | 120.6 | 74.4 | 22.6 | 38.5 | 8.3 | 0.5 | 0 | 0.1 | #2008 |
| 72.5 | 0 | 102 | 577.5 | 105.6 | 52.5 | 38.6 | 34.8 | 20.4 | 3.1 | 0 | 0 | #2009 |
| 85.3 | 0 | 26.8 | 272.5 | 379.6 | 44.3 | 17.4 | 19.2 | 7.7 | 13.4 | 0.9 | 0 | #2010 |
| IRL-OTB (7bj) : Irish Otter Trawl in 7B&J - effort, nos at age per 1000h | | | | | | | | | | | | |
| 1995 | 2010 | | | | | | | | | | | |

| HADDOCK VIIb-k, WGSSDS 2010, TUNING DATA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 0 | 10 | | | | | | | | | | | |
| 158.9 | 3.56 | 323.2 | 112.7 | 142 | 77.6 | 105.8 | 62 | 29.6 | 8.1 | 0 | 0 | #1995 |
| 111.7 | 0 | 166.3 | 557.4 | 54.1 | 39.9 | 21.1 | 23.1 | 9.4 | 5.1 | 0.8 | 0.8 | #1996 |
| 132.7 | 0 | 144.7 | 1124.2 | 307.8 | 68.1 | 58.2 | 25.8 | 15 | 4.1 | 5.3 | 8.4 | #1997 |
| 153.1 | 0.34 | 78.8 | 435.1 | 806.3 | 116.1 | 45.1 | 39 | 28 | 11.2 | 8.4 | 0.9 | #1998 |
| 102.7 | 0 | 8.9 | 312.8 | 277.9 | 252.1 | 52.8 | 13.9 | 7.8 | 3 | 0.7 | 0 | #1999 |
| 121.7 | 0 | 141.3 | 137.6 | 52.8 | 83 | 135.5 | 36.1 | 7.5 | 6.9 | 0.7 | 0 | #2000 |
| 128.4 | 0.4 | 368.1 | 812 | 135.6 | 35 | 52.9 | 66.7 | 8.8 | 8.3 | 2 | 0 | #2001 |
| 137.2 | 0.5 | 42.9 | 534.2 | 417.5 | 64.6 | 8.3 | 24.6 | 20.8 | 5.4 | 1.3 | 0.6 | #2002 |
| 175.2 | 0.7 | 28.8 | 340 | 167.9 | 216.9 | 38.1 | 12.6 | 14.7 | 13 | 2.5 | 0.1 | #2003 |
| 152.4 | 0 | 8.4 | 248.2 | 275.3 | 144.2 | 114 | 13.4 | 4 | 5.4 | 0.6 | 0.2 | #2004 |
| 121.3 | 0.1 | 12.1 | 92.9 | 271.6 | 210.1 | 93.9 | 11.7 | 1.6 | 1 | 0.3 | 0 | #2005 |
| 105.6 | 0 | 53.3 | 238.1 | 220.6 | 273.6 | 51.5 | 14.7 | 0.9 | 0 | 0 | 0 | #2006 |
| 121.2 | 0 | 28.1 | 212 | 217.5 | 87.2 | 227.3 | 31.5 | 10 | 0.6 | 0 | 0.2 | #2007 |
| 103.8 | 0 | 177.7 | 270.4 | 217.2 | 137.7 | 56 | 100.9 | 20.5 | 3.6 | 0.2 | 0.1 | #2008 |
| 110.3 | 0 | 102.1 | 652.6 | 160 | 133.7 | 119.1 | 69.2 | 64.7 | 7.8 | 1.3 | 0 | #2009 |
| 128.3 | 0 | 26.8 | 280.2 | 489.9 | 94.5 | 60 | 60.6 | 32.9 | 38.9 | 5.2 | 0.6 | #2010 |
| IRL-ISCSGFS (7g): Irish Sea Celtic Sea GFS (VIIg; Prime stations only) - effort, nos at age per 30min | | | | | | | | | | | | |
| 1997 | 2002 | | | | | | | | | | | |
| 1 | 1 | 0.8 | 0.9 | | | | | | | | | |
| 0 | 4 | | | | | | | | | | | |
| 1 | 18.9 | 11.7 | 15.2 | 2.4 | 2.4 | #1997 | | | | | | |
| 1 | 241.6 | 23.6 | 5.6 | 0.8 | 0.2 | #1998 | | | | | | |
| 1 | 2465.2 | 6.6 | 0.4 | 0.4 | 0.1 | #1999 | | | | | | |
| 1 | 1191.4 | 710.6 | 0.9 | 0 | 0 | #2000 | | | | | | |
| 1 | 1200.9 | 34.5 | 13.7 | 0 | 0 | #2001 | | | | | | |
| 1 | 560.9 | 119.9 | 8.5 | 2.8 | 0.2 | #2002 | | | | | | |
| IRL-WCGFS : Irish Autumn WCGFS - effort, nos at age per min | | | | | | | | | | | | |
| 1993 | 2002 | | | | | | | | | | | |
| 1 | 1 | 0.75 | 0.79 | | | | | | | | | |
| 0 | 6 | | | | | | | | | | | |
| 1901 | 6647 | 1307 | 86 | 52 | 7 | 6 | 0 | #1993 | | | | |
| 2386 | 47261 | 727 | 111 | 68 | 5 | 7 | 0 | #1994 | | | | |
| 2210 | 239176 | 6136 | 17 | 6 | 2 | 3 | 0 | #1995 | | | | |
| 2248 | 37211 | 9305 | 333 | 141 | 28 | 22 | 0 | #1996 | | | | |
| 2396 | 661 | 8679 | 526 | 249 | 88 | 120 | 0 | #1997 | | | | |
| 2486 | 12340 | 601 | 685 | 451 | 50 | 31 | 0 | #1998 | | | | |
| 2304 | 53123 | 808 | 22 | 66 | 7 | 18 | 0 | #1999 | | | | |
| 2400 | 57484 | 14036 | 28 | 22 | 6 | 22 | 0 | #2000 | | | | |
| 1107 | 45261 | 10419 | 6230 | 209 | 173 | 364 | 302 | #2001 | | | | |
| 1301 | 141437 | 17366 | 2026 | 849 | 7 | 5 | 27 | #2002 | | | | |
| UK-WCGFS 1gp : 7efghj Standardized no <= 26 cm as proxy for 1-gp | | | | | | | | | | | | |
| 1992 | 2001 | | | | | | | | | | | |
| 1 | 1 | 0.15 | 0.25 | | | | | | | | | |

| HADDOCK VIIb-k, WGSSDS 2010, TUNING DATA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | |
| 1 | 1.7 | #1992 | | | | | | | | |
| 1 | 19.8 | #1993 | | | | | | | | |
| 1 | 33.4 | #1994 | | | | | | | | |
| 1 | 20.8 | #1995 | | | | | | | | |
| 1 | 145.9 | #1996 | | | | | | | | |
| 1 | 26.7 | #1997 | | | | | | | | |
| 1 | 7.1 | #1998 | | | | | | | | |
| 1 | 9.3 | #1999 | | | | | | | | |
| 1 | 19.6 | #2000 | | | | | | | | |
| 1 | 15.6 | #2001 | | | | | | | | |
| UK-WCGFS : 7efghj Aged component - effort, nos at age per min | | | | | | | | | | |
| 1998 | 2004 | | | | | | | | | |
| 1 | 1 | 0.15 | 0.25 | | | | | | | |
| 1 | 6 | | | | | | | | | |
| 3744 | 380.3 | 245.8 | 170.3 | 51 | 9.5 | 10.9 | #1998 | Cirolana | | |
| 3823 | 580.2 | 18.5 | 8 | 37.9 | 14.5 | 1 | #1999 | Cirolana | | |
| 4092 | 1639 | 33 | 1.5 | 1.5 | 11.2 | 1 | #2000 | Cirolana | | |
| 3700 | 949.9 | 335.5 | 33.1 | 0 | 1.5 | 4.5 | #2001 | Cirolana | | |
| 3387 | 3995.1 | 317.5 | 100.8 | 13.8 | 2.1 | 0 | #2002 | Cirolana | | |
| 2326 | 13655.1 | 947.1 | 75.3 | 45.7 | 4.6 | 0 | #2003 | Cirolana | | |
| 1689 | 3334.1 | 7174.4 | 410.7 | 56.4 | 18.7 | 4 | #2004 | Cefas Endeavour | | |
| EVHOE-WIBTS-Q4: THALASSA - effort, nos at age per 30min | | | | | | | | | | |
| 1997 | 2010 | | | | | | | | | |
| 1 | 1 | 0.75 | 1 | | | | | | | |
| 0 | 7 | | | | | | | | | |
| 1 | 6.38 | 10.49 | 1.53 | 0.1 | 0.07 | 0 | 0 | 0 | #1997 | |
| 1 | 10.72 | 8.85 | 1.38 | 1.82 | 0.44 | 0.13 | 0 | 0 | #1998 | |
| 1 | 102.68 | 57.65 | 1.7 | 0.58 | 0.32 | 0.16 | 0 | 0 | #1999 | |
| 1 | 26.03 | 15.5 | 0.17 | 0.03 | 0.04 | 0.02 | 0 | 0 | #2000 | |
| 1 | 188.39 | 16.98 | 3.12 | 0.29 | 0.01 | 0 | 0 | 0 | #2001 | |
| 1 | 281.02 | 12.38 | 7.49 | 5.53 | 0.31 | 0 | 0 | 0 | #2002 | |
| 1 | 46.57 | 228.87 | 11.61 | 0.77 | 0.1 | 0.01 | 0 | 0 | #2003 | |
| 1 | 83.49 | 3.25 | 9.52 | 1.24 | 0.11 | 0.03 | 0 | 0 | #2004 | |
| 1 | 111.84 | 26.13 | 1.26 | 2.36 | 0.49 | 0.1 | 0 | 0 | #2005 | |
| 1 | 14.74 | 8.67 | 1.04 | 0.2 | 0.34 | 0.17 | 0 | 0.01 | #2006 | |
| 1 | 101.33 | 8.63 | 2.17 | 0.67 | 0.1 | 0.35 | 0.05 | 0.01 | #2007 | |
| 1 | 83.6 | 27.94 | 1.83 | 0.62 | 0.15 | 0.05 | 0.1 | 0.05 | #2008 | |
| 1 | 396.22 | 15.14 | 4.52 | 0.26 | 0.11 | 0.03 | 0 | 0 | #2009 | |
| 1 | 17.69 | 431.32 | 12.89 | 3.24 | 0.11 | 0.16 | 0 | 0.05 | #2010 | |
| FR-GAD : French Gadoid Trawlers in VIIfgh FU05 - effort, nos at age per 1000h | | | | | | | | | | |
| 2002 | 2008 | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | |
| 1 | 9 | | | | | | | | | |
| 178.7 | 267.5 | 1518.8 | 1435.8 | 17.3 | 5.1 | 3.9 | 1.2 | 0 | 0 | #2002 |

| HADDOCK VIIb–k, WGSSDS 2010, TUNING DATA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 144.2 | 124.8 | 3434.6 | 787.5 | 313 | 9.3 | 2.3 | 0.8 | 0.1 | 0.3 | #2003 | | |
| 119.4 | 0 | 2901.3 | 1909.1 | 219.5 | 102 | 4.5 | 0.1 | 0.1 | 1 | #2004 | | |
| 101 | 284.2 | 256.4 | 1353.4 | 457.6 | 109 | 24.8 | 1 | 4.8 | 0 | #2005 | | |
| 79.2 | 212.5 | 808.2 | 212.2 | 534.1 | 79.3 | 4.9 | 0.1 | 0 | 0 | #2006 | | |
| 83.9 | 69.9 | 2260.4 | 772.9 | 93 | 124.4 | 24.9 | 1.8 | 0.9 | 1.1 | #2007 | | |
| 70 | 415.7 | 1137.3 | 1601.4 | 235.5 | 22.1 | 46.2 | 3.7 | 0.6 | 0 | #2008 | | |
| IGFS-WIBTS-Q4 (7g) : Irish Sea Celtic Sea GFS +Irish Groundfish Survey (IBTS 4th Qtr) - standardized numbers per 10km² | | | | | | | | | | | | |
| 1999 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0.8 | 0.9 | | | | | | | | | |
| 0 | 9 | | | | | | | | | | | |
| 10 | 4894 | 129 | 17 | 17 | 5 | 1 | 0 | 0 | 0 | 0 | #1999 | ISCSGFS |
| 10 | 1549 | 3038 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | #2000 | ISCSGFS |
| 10 | 26150 | 1676 | 122 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | #2001 | ISCSGFS |
| 10 | 14484 | 2402 | 272 | 37 | 3 | 0 | 0 | 3 | 3 | 0 | #2002 | ISCSGFS |
| 10 | 2819 | 6393 | 453 | 11 | 6 | 0 | 0 | 0 | 0 | 0 | #2003 | IBTS Q4 |
| 10 | 11248 | 1853 | 1302 | 78 | 6 | 3 | 0 | 0 | 0 | 0 | #2004 | IBTS Q4 |
| 10 | 12470 | 2204 | 140 | 106 | 16 | 1 | 0 | 0 | 0 | 0 | #2005 | IBTS Q4 |
| 10 | 3387 | 2102 | 240 | 21 | 6 | 2 | 1 | 0 | 0 | 0 | #2006 | IBTS Q4 |
| 10 | 9395 | 795 | 325 | 62 | 2 | 3 | 0 | 0 | 0 | 0 | #2007 | IBTS Q4 |
| 10 | 8871 | 3148 | 109 | 29 | 7 | 0 | 3 | 0 | 0 | 0 | #2008 | IBTS Q4 |
| 10 | 65717 | 1050 | 521 | 35 | 6 | 1 | 0 | 0 | 0 | 0 | #2009 | IBTS Q4 |
| 10 | 2817 | 30977 | 784 | 172 | 11 | 2 | 0 | 0 | 0 | 1 | #2010 | IBTS Q4 |
| IGFS-WIBTS-Q4 (7g) : Irish Groundfish Survey in VIIg (IBTS 4th Qtr) - effort in minutes | | | | | | | | | | | | |
| 2003 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | | | | | |
| 0 | 7 | | | | | | | | | | | |
| 832 | 3042 | 6975 | 489 | 11 | 6 | 0 | 0 | 0 | #2003 | | | |
| 980 | 14567 | 2400 | 1687 | 101 | 7 | 4 | 0 | 0 | #2004 | | | |
| 845 | 15997 | 2594 | 173 | 125 | 20 | 1 | 0 | 0 | #2005 | | | |
| 1046 | 5098 | 3163 | 361 | 32 | 9 | 3 | 1 | 0 | #2006 | | | |
| 1168 | 15557 | 1316 | 539 | 102 | 3 | 4 | 0 | 0 | #2007 | | | |
| 1139 | 12644 | 4487 | 156 | 41 | 9 | 0 | 4 | 0 | #2008 | | | |
| 1018 | 88424 | 1412 | 701 | 47 | 7 | 1 | 0 | 0 | #2009 | | | |
| 1381 | 4538 | 49888 | 1263 | 277 | 17 | 3 | 0 | 1 | #2010 | | | |
| IGFS-WIBTS-Q4 (7j) : Irish Groundfish Survey in VIIj (IBTS 4th Qtr) - effort in minutes | | | | | | | | | | | | |
| 2003 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | | | | | |
| 0 | 7 | | | | | | | | | | | |
| 780 | 4592 | 16281 | 640 | 74 | 20 | 1 | 0 | 0 | #2003 | | | |
| 720 | 5175 | 1620 | 1395 | 44 | 7 | 4 | 1 | 0 | #2004 | | | |
| 881 | 1474 | 1273 | 240 | 286 | 36 | 6 | 2 | 0 | #2005 | | | |
| 901 | 2636 | 262 | 124 | 53 | 50 | 7 | 0 | 0 | #2006 | | | |
| 874 | 22831 | 2116 | 192 | 71 | 20 | 36 | 1 | 0 | #2007 | | | |
| 873 | 14056 | 4934 | 222 | 20 | 15 | 6 | 6 | 3 | #2008 | | | |
| 747 | 56856 | 1476 | 205 | 2 | 1 | 2 | 2 | 1 | #2009 | | | |

| HADDOCK VIIb-k, WGSSDS 2010, TUNING DATA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1021 | 1308 | 27870 | 1906 | 362 | 8 | 5 | 9 | 1 | #2010 | |
| IGFS-WIBTS-Q4 (7b) : Irish Groundfish Survey in VIIb (IBTS 4th Qtr) - effort in minutes | | | | | | | | | | |
| 2003 | 2010 | | | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | | | |
| 0 | 8 | | | | | | | | | |
| 757 | 11834 | 34773 | 2793 | 874 | 313 | 6 | 1 | 2 | 7 | #2003 |
| 728 | 31311 | 2960 | 6688 | 925 | 372 | 196 | 46 | 2 | 1 | #2004 |
| 724 | 3737 | 7082 | 964 | 2299 | 188 | 37 | 5 | 0 | 0 | #2005 |
| 700 | 8823 | 2303 | 2471 | 614 | 421 | 39 | 16 | 7 | 0 | #2006 |
| 734 | 56350 | 2383 | 770 | 747 | 434 | 392 | 26 | 9 | 0 | #2007 |
| 653 | 10948 | 11622 | 398 | 148 | 172 | 98 | 273 | 54 | 4 | #2008 |
| 770 | 46145 | 6349 | 8264 | 258 | 272 | 122 | 165 | 110 | 4 | #2009 |
| 861 | 10253 | 19311 | 2195 | 1754 | 36 | 144 | 123 | 50 | 55 | #2010 |

**Table 7.4.7. Lpue (kg/hour fishing) of haddock and effort (hours fishing) for Irish Otter trawls in VIIb, VIIg and VIIj, the French demersal fleet in VIIfgh and effort only for UK beam and trawl fleets in VIIe–k. Lpue in kg/hour and effort in hours fishing. No Effort data were available for the French fleet in 2009–2010.**

| | IRL OTB VIIb | | IRL OTB VIIg | | IRL OTB VIIj | | FR OTB_DEF VIIfgh | | UK Beam VIIe-k | UK Trawl VIIe-k |
|---|---|---|---|---|---|---|---|---|---|---|
| | LPUE | Effort | LPUE | Effort | LPUE | Effort | LPUE | Effort | Effort | Effort |
| 1983 | | | | | | | 2.18 | 115379 | 135344 | 82054 |
| 1984 | | | | | | | 2.02 | 85790 | 131465 | 86722 |
| 1985 | | | | | | | 2.83 | 92012 | 152487 | 90298 |
| 1986 | | | | | | | 1.64 | 119664 | 135738 | 84748 |
| 1987 | | | | | | | 3.20 | 144186 | 177118 | 84267 |
| 1988 | | | | | | | 7.27 | 221164 | 194882 | 89148 |
| 1989 | | | | | | | 5.28 | 247929 | 198156 | 84140 |
| 1990 | | | | | | | 2.23 | 201349 | 207576 | 99492 |
| 1991 | | | | | | | 1.94 | 179381 | 203196 | 76712 |
| 1992 | | | | | | | 3.74 | 190784 | 196065 | 86397 |
| 1993 | | | | | | | 4.23 | 213508 | 208421 | 61903 |
| 1994 | | | | | | | 7.95 | 181031 | 220023 | 53743 |
| 1995 | 6.47 | 65423 | 1.48 | 63560 | 2.36 | 93688 | 9.12 | 184067 | 243136 | 52270 |
| 1996 | 4.51 | 41496 | 5.36 | 60041 | 3.36 | 70237 | 15.36 | 170141 | 260817 | 60509 |
| 1997 | 5.51 | 49560 | 5.82 | 65105 | 9.12 | 83187 | 19.58 | 226015 | 264814 | 66707 |
| 1998 | 7.00 | 63560 | 4.09 | 72298 | 6.49 | 89610 | 11.62 | 189457 | 254590 | 62114 |
| 1999 | 6.51 | 62047 | 2.34 | 51657 | 4.53 | 40609 | 5.05 | 206601 | 251431 | 98350 |
| 2000 | 5.05 | 62758 | 10.43 | 60604 | 4.68 | 64626 | 8.86 | 170292 | 258962 | 104088 |
| 2001 | 4.92 | 60725 | 8.34 | 69427 | 8.34 | 67659 | 16.39 | 190482 | 272662 | 85338 |
| 2002 | 3.42 | 46793 | 3.28 | 77689 | 6.49 | 90446 | 13.61 | 176678 | 249480 | 83023 |
| 2003 | 2.56 | 63959 | 3.28 | 86791 | 4.34 | 111267 | 22.01 | 144180 | 282097 | 72303 |
| 2004 | 3.13 | 60446 | 3.45 | 96991 | 3.94 | 91957 | 31.41 | 119444 | 273871 | 75681 |
| 2005 | 3.32 | 47399 | 4.42 | 124395 | 4.59 | 73920 | 21.48 | 101027 | 270347 | 76361 |
| 2006 | 3.58 | 39698 | 4.16 | 119227 | 5.07 | 65856 | 17.74 | 79214 | 252001 | 83308 |
| 2007 | 4.73 | 40718 | 4.10 | 136525 | 4.80 | 80485 | 22.62 | 83904 | 239921 | 87683 |
| 2008 | 5.44 | 37338 | 4.57 | 125815 | 5.70 | 66503 | 31.22 | 70044 | 216909 | 71154 |
| 2009 | 6.70 | 37875 | 9.44 | 137115 | 7.91 | 73065 | | | 191047 | 73861 |
| 2010 | 5.18 | 43067 | 7.45 | 140647 | 6.00 | 85253 | | | 195877 | 77559 |

**Table 7.4.8. (a) XSA diagnostics for haddock in VIIb–k, (b) Fishing mortalitiy-at-age and (c) stock numbers-at-age.**

Lowestoft VPA Version 3.1

4/05/2011 14:13

Extended Survivors Analysis

HADDOCK VIIb-k WGCSE 2011 COMBSEX PLUSGROUP

Cpue data from file had7bktu.txt

Catch data for 18 years. 1993 to 2010. Ages 0 to 8.

| Fleet | First | Last | First | Last | Alpha | Beta |
|---|---|---|---|---|---|---|
| | year | year | age | age | | |
| IRL-OTB (7bj) | 1995 | 2010 | 2 | 7 | 0 | 1 |
| EVHOE-WIBTS-Q4 | 1997 | 2010 | 0 | 5 | 0.75 | 1 |
| FR-GAD | 2002 | 2010 | 2 | 6 | 0 | 1 |
| IGFS-WIBTS-Q4 (7g) | 1999 | 2010 | 0 | 5 | 0.8 | 0.9 |

Time-series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 26 iterations

1

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.432 | 0.486 | 0.514 | 0.373 | 0.262 | 0.204 | 0.262 | 0.542 | 0.44 | 0.157 |
| 2 | 0.765 | 1.1 | 0.928 | 0.706 | 0.644 | 0.424 | 0.65 | 1.013 | 0.541 | 0.657 |
| 3 | 0.671 | 0.922 | 0.718 | 0.882 | 0.653 | 0.528 | 0.63 | 0.844 | 0.952 | 0.551 |
| 4 | 0.91 | 1.425 | 0.832 | 0.71 | 0.893 | 0.495 | 0.359 | 0.44 | 0.897 | 0.633 |
| 5 | 0.607 | 0.308 | 0.76 | 1.585 | 0.87 | 0.412 | 0.369 | 0.254 | 0.409 | 0.575 |
| 6 | 0.574 | 0.361 | 0.563 | 0.969 | 1.763 | 0.286 | 0.283 | 0.268 | 0.26 | 0.227 |
| 7 | 0.373 | 0.264 | 0.342 | 0.307 | 0.174 | 0.449 | 0.202 | 0.192 | 0.119 | 0.184 |

1

XSA population numbers (Thousands)

| | AGE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2001 | 8.11E+04 | 3.56E+04 | 2.05E+04 | 2.82E+03 | 5.44E+02 | 7.19E+02 | 7.54E+02 | 1.81E+02 |
| 2002 | 8.65E+04 | 6.64E+04 | 1.89E+04 | 7.81E+03 | 1.18E+03 | 1.79E+02 | 3.21E+02 | 3.48E+02 |
| 2003 | 1.94E+04 | 7.08E+04 | 3.34E+04 | 5.16E+03 | 2.54E+03 | 2.33E+02 | 1.08E+02 | 1.83E+02 |
| 2004 | 2.46E+04 | 1.59E+04 | 3.46E+04 | 1.08E+04 | 2.06E+03 | 9.06E+02 | 8.91E+01 | 5.02E+01 |
| 2005 | 4.34E+04 | 2.01E+04 | 8.97E+03 | 1.40E+04 | 3.67E+03 | 8.29E+02 | 1.52E+02 | 2.77E+01 |
| 2006 | 4.21E+04 | 3.55E+04 | 1.27E+04 | 3.85E+03 | 5.97E+03 | 1.23E+03 | 2.85E+02 | 2.14E+01 |
| 2007 | 9.94E+04 | 3.45E+04 | 2.37E+04 | 6.79E+03 | 1.86E+03 | 2.98E+03 | 6.68E+02 | 1.75E+02 |
| 2008 | 6.86E+04 | 8.14E+04 | 2.17E+04 | 1.01E+04 | 2.96E+03 | 1.06E+03 | 1.69E+03 | 4.12E+02 |
| 2009 | 4.69E+05 | 5.61E+04 | 3.87E+04 | 6.46E+03 | 3.57E+03 | 1.56E+03 | 6.76E+02 | 1.06E+03 |
| 2010 | 1.74E+04 | 3.84E+05 | 2.96E+04 | 1.85E+04 | 2.04E+03 | 1.19E+03 | 8.50E+02 | 4.26E+02 |

Estimated population abundance at 1st Jan 2011

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.00E+00 | 1.42E+04 | 2.69E+05 | 1.26E+04 | 8.72E+03 | 8.88E+02 | 5.49E+02 | 5.55E+02 |

Taper weighted geometric mean of the VPA populations:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 4.22E+04 | 3.47E+04 | 1.61E+04 | 5.66E+03 | 2.16E+03 | 9.32E+02 | 4.19E+02 | 1.92E+02 |

Standard error of the weighted Log(VPA populations) :

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.9134 | 0.9078 | 0.6391 | 0.6389 | 0.52 | 0.6577 | 0.7664 | 0.9987 |

1

Log-catchability residuals.

Fleet : IRL-OTB (7bj) : Iris

| Age | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | |
| 1 | No data for this fleet at this age | | | | | |
| 2 | -0.31 | 0.63 | 0.64 | 0.79 | 1.48 | -0.27 |
| 3 | -0.36 | -0.71 | 0.45 | 0.58 | 0.99 | 0.04 |
| 4 | -0.59 | -1.02 | -0.16 | 0.08 | 0.51 | 0.09 |
| 5 | 0.13 | -1.04 | -0.06 | 0.2 | 0.5 | 0.53 |
| 6 | 0.42 | -0.24 | -0.43 | 0.41 | 0.24 | 0.64 |
| 7 | 0.01 | -0.13 | 0.02 | 0.32 | 0.07 | 0 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 0.75 | 0.48 | -0.86 | -1.16 | -0.59 | 0.05 | -0.73 | -0.1 | -0.05 | -0.73 |
| 3 | 0.27 | 0.42 | -0.41 | -0.45 | -0.58 | 0.58 | -0.09 | -0.25 | -0.12 | -0.37 |
| 4 | 0.34 | 0.31 | 0.28 | 0.17 | 0.27 | 0.02 | -0.16 | 0.03 | -0.06 | -0.11 |
| 5 | 0.35 | -0.32 | 0.9 | 1.1 | 0.94 | -0.11 | 0.33 | 0.07 | 0.45 | -0.05 |
| 6 | 0.52 | 0.21 | 0.48 | 1.04 | 0.9 | 0.04 | -0.19 | 0.2 | 0.67 | 0.14 |
| 7 | -0.17 | -0.08 | 0 | 0.12 | -0.03 | -0.09 | -0.03 | -0.02 | 0.09 | 0.2 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Mean Log q | -8.3858 | -7.7598 | -7.4341 | -7.4341 | -7.4341 | -7.4341 |
| S.E(Log q) | 0.7343 | 0.494 | 0.3757 | 0.5847 | 0.5188 | 0.1256 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 1.86 | -1.681 | 7.21 | 0.21 | 16 | 1.29 | -8.39 |
| 3 | 1.24 | -0.989 | 7.54 | 0.55 | 16 | 0.61 | -7.76 |
| 4 | 1.03 | -0.141 | 7.43 | 0.67 | 16 | 0.4 | -7.43 |
| 5 | 1.06 | -0.276 | 7.21 | 0.61 | 16 | 0.58 | -7.19 |
| 6 | 1.36 | -2.359 | 7.51 | 0.75 | 16 | 0.48 | -7.12 |
| 7 | 0.97 | 1.067 | 7.35 | 0.99 | 16 | 0.12 | -7.42 |
| 1 | | | | | | | |

Fleet : EVHOE-WIBTS-Q4: THAL

| Age | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| 0 | 99.99 | 99.99 | -0.57 | -0.96 | -0.02 | -0.7 |
| 1 | 99.99 | 99.99 | 0.18 | 0.56 | 1.55 | -0.36 |
| 2 | 99.99 | 99.99 | -1.03 | 0.05 | 1.03 | -1.89 |
| 3 | 99.99 | 99.99 | -1.53 | 0.66 | 0.47 | -1.51 |
| 4 | 99.99 | 99.99 | -0.32 | 1.38 | 0.29 | -0.99 |
| 5 | 99.99 | 99.99 | 99.99 | 1.24 | 1.07 | -1.73 |
| 6 | No data for this fleet at this age | | | | | |
| 7 | No data for this fleet at this age | | | | | |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.66 | 1 | 0.69 | 1.04 | 0.76 | -1.23 | -0.16 | 0.01 | -0.35 | -0.16 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.11 | -1.01 | 1.87 | -1.01 | 0.74 | -0.98 | -0.91 | -0.35 | -0.68 | 0.5 |
| 2 | 0.07 | 1.31 | 1.03 | 0.61 | -0.12 | -0.85 | -0.54 | -0.31 | -0.39 | 1.02 |
| 3 | 0.01 | 2.16 | 0.42 | 0.3 | 0.49 | -0.8 | -0.07 | -0.36 | -0.68 | 0.44 |
| 4 | -1.03 | 2.07 | -0.34 | -0.14 | 0.93 | -0.26 | -0.44 | -0.43 | -0.53 | -0.2 |
| 5 | 99.99 | 99.99 | -0.31 | 0.14 | 0.81 | 0.55 | 0.35 | -0.67 | -1.43 | 0.66 |
| 6 | No data for this fleet at this age | | | | | | | | | |
| 7 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Mean Log q | -6.5496 | -6.9831 | -8.0164 | -8.4316 | -8.9028 | -8.9028 |
| S.E(Log q) | 0.7337 | 0.9442 | 0.928 | 0.9555 | 0.8861 | 0.9902 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 0.95 | 0.236 | 6.76 | 0.66 | 14 | 0.72 | -6.55 |
| 1 | 1.04 | -0.149 | 6.82 | 0.48 | 14 | 1.03 | -6.98 |
| 2 | 0.94 | 0.146 | 8.12 | 0.33 | 14 | 0.91 | -8.02 |
| 3 | 0.6 | 1.825 | 8.57 | 0.64 | 14 | 0.53 | -8.43 |
| 4 | 0.91 | 0.217 | 8.8 | 0.35 | 14 | 0.84 | -8.9 |
| 5 | 1.55 | -0.71 | 9.9 | 0.16 | 11 | 1.57 | -8.84 |
| 1 | | | | | | | |

Fleet : FR-GAD : French Gado

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 99.99 | -0.22 | 0.17 | 0.06 | -0.87 | 0.08 | 0.52 | 0.26 | 99.99 | 99.99 |
| 3 | 99.99 | -0.06 | -0.12 | 0.28 | -0.25 | -0.62 | 0.09 | 0.69 | 99.99 | 99.99 |
| 4 | 99.99 | -1.82 | 0.29 | 0.28 | 0.68 | 0.43 | -0.27 | 0.41 | 99.99 | 99.99 |
| 5 | 99.99 | -1.62 | -0.86 | 0.68 | 0.73 | 0.06 | -0.45 | -1.02 | 99.99 | 99.99 |
| 6 | 99.99 | -2.44 | -1.58 | -0.35 | 1.28 | -1.32 | -0.6 | -0.74 | 99.99 | 99.99 |
| 7 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Mean Log q | -6.9073 | -6.3059 | -6.8851 | -6.8851 | -6.8851 |
| S.E(Log q) | 0.4438 | 0.4143 | 0.8532 | 0.9657 | 1.464 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 0.62 | 2.143 | 8.06 | 0.86 | 7 | 0.22 | -6.91 |
| 3 | 0.67 | 1.444 | 7.19 | 0.79 | 7 | 0.25 | -6.31 |
| 4 | 0.43 | 2.885 | 7.43 | 0.84 | 7 | 0.25 | -6.89 |
| 5 | 0.69 | 1.258 | 7.04 | 0.77 | 7 | 0.59 | -7.24 |
| 6 | 1.18 | -0.303 | 8.07 | 0.37 | 7 | 1.49 | -7.71 |
| 1 | | | | | | | |

Fleet : IGFS-WIBTS-Q4 (7g) :

| Age | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| 0 | 99.99 | 99.99 | 99.99 | 99.99 | -0.9 | -1.35 |
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | -2.02 | 0.52 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | -1.03 | -1.26 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | -0.14 | 99.99 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | -0.54 | 99.99 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | -0.68 | 99.99 |
| 6 | No data for this fleet at this age | | | | | |
| 7 | No data for this fleet at this age | | | | | |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.85 | 0.2 | 0.05 | 1.2 | 0.74 | -0.54 | -0.38 | -0.06 | 0.02 | 0.16 |
| 1 | 0.1 | -0.12 | 0.82 | 0.95 | 0.8 | 0.13 | -0.76 | 0 | -0.82 | 0.4 |
| 2 | -0.62 | 0.55 | 0.34 | 1.18 | 0.25 | 0.25 | 0.12 | -0.58 | 0.01 | 0.78 |
| 3 | -0.26 | 0.06 | -0.91 | 0.45 | 0.3 | -0.13 | 0.47 | -0.51 | 0.22 | 0.42 |
| 4 | 99.99 | 0.74 | 0.16 | 0.27 | 0.83 | -0.97 | -1.02 | -0.17 | -0.12 | 0.82 |
| 5 | 99.99 | 99.99 | 99.99 | 1.14 | -0.47 | -0.57 | -1.08 | 99.99 | -1.5 | -0.39 |
| 6 | No data for this fleet at this age | | | | | | | | | |
| 7 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Mean Log q | -4.1161 | -4.9196 | -5.9907 | -6.7659 | -7.6399 | -7.6399 |
| S.E(Log q) | 0.7289 | 0.8546 | 0.7336 | 0.4397 | 0.6952 | 0.9897 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 1.15 | -0.499 | 3.12 | 0.54 | 12 | 0.87 | -4.12 |
| 1 | 0.84 | 0.595 | 5.83 | 0.6 | 12 | 0.74 | -4.92 |
| 2 | 0.6 | 2.124 | 7.54 | 0.74 | 12 | 0.38 | -5.99 |
| 3 | 0.73 | 1.706 | 7.33 | 0.82 | 11 | 0.29 | -6.77 |
| 4 | 3.14 | -1.422 | 7.08 | 0.05 | 10 | 2.07 | -7.64 |
| 5 | 7.01 | -1.28 | 14.47 | 0.01 | 7 | 5.49 | -8.15 |
| 1 | | | | | | | |

Terminal year survivor and F summaries :

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 2010

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| IRL-OTB (7bj) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| EVHOE-WIBTS-Q4 | 12058 | 0.759 | 0 | 0 | 1 | 0.499 | 0 |
| FR-GAD | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IGFS-WIBTS-Q4 (7g) | 16763 | 0.759 | 0 | 0 | 1 | 0.501 | 0 |
| F shrinkage mean | 0 | 1.5 | | | | 0 | 0 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 14220 | 0.54 | 0.16 | 2 | 0.307 | 0 |

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| IRL-OTB (7bj) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| EVHOE-WIBTS-Q4 | 260865 | 0.6 | 0.414 | 0.69 | 2 | 0.441 | 0.161 |
| FR-GAD | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IGFS-WIBTS-Q4 (7g) | 321859 | 0.577 | 0.19 | 0.33 | 2 | 0.476 | 0.132 |
| F shrinkage mean | 111009 | 1.5 | | | | 0.082 | 0.344 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 268698 | 0.4 | 0.21 | 5 | 0.528 | 0.157 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 1 | | | | | | | |
| Age 2 Catchability constant w.r.t. time and dependent on age | | | | | | | |
| | | | | | | | |
| Year class = 2008 | | | | | | | |
| | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 6050 | 0.757 | 0 | 0 | 1 | 0.191 | 1.075 |
| EVHOE-WIBTS-Q4 | 15870 | 0.52 | 0.474 | 0.91 | 3 | 0.315 | 0.552 |
| FR-GAD | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IGFS-WIBTS-Q4 (7g) | 14857 | 0.472 | 0.454 | 0.96 | 3 | 0.4 | 0.58 |
| | | | | | | | |
| F shrinkage mean | 12487 | 1.5 | | | | 0.094 | 0.66 |
| | | | | | | | |
| Weighted prediction : | | | | | | | |
| | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | |
| at end of year | s.e | s.e | | Ratio | | | |
| 12567 | 0.32 | 0.25 | 8 | 0.778 | 0.657 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Age 3 Catchability constant w.r.t. time and dependent on age | | | | | | | |
| | | | | | | | |
| Year class = 2007 | | | | | | | |
| | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 6422 | 0.433 | 0.13 | 0.3 | 2 | 0.325 | 0.692 |
| EVHOE-WIBTS-Q4 | 8658 | 0.504 | 0.213 | 0.42 | 4 | 0.173 | 0.554 |
| FR-GAD | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IGFS-WIBTS-Q4 (7g) | 11381 | 0.352 | 0.15 | 0.43 | 4 | 0.451 | 0.446 |
| | | | | | | | |
| F shrinkage mean | 5975 | 1.5 | | | | 0.051 | 0.728 |
| | | | | | | | |
| Weighted prediction : | | | | | | | |
| | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | |
| at end of year | s.e | s.e | | Ratio | | | |
| 8720 | 0.24 | 0.11 | 11 | 0.471 | 0.551 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 1 | | | | | | | |
| Age 4 Catchability constant w.r.t. time and dependent on age | | | | | | | |
| | | | | | | | |
| Year class = 2006 | | | | | | | |
| | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 797 | 0.321 | 0.004 | 0.01 | 3 | 0.52 | 0.685 |
| EVHOE-WIBTS-Q4 | 574 | 0.58 | 0.171 | 0.29 | 5 | 0.126 | 0.861 |
| FR-GAD | 1145 | 0.474 | 0 | 0 | 1 | 0.039 | 0.521 |
| IGFS-WIBTS-Q4 (7g) | 1294 | 0.381 | 0.238 | 0.62 | 5 | 0.264 | 0.473 |
| | | | | | | | |
| F shrinkage mean | 908 | 1.5 | | | | 0.052 | 0.622 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Weighted prediction : | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | |
| at end of year | s.e | s.e | | Ratio | | | |
| 888 | 0.22 | 0.1 | 15 | 0.456 | 0.633 | | |
| Age 5 Catchability constant w.r.t. time and age (fixed at the value for age) 4 | | | | | | | |
| Year class = 2005 | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 502 | 0.317 | 0.07 | 0.22 | 4 | 0.479 | 0.615 |
| EVHOE-WIBTS-Q4 | 632 | 0.572 | 0.273 | 0.48 | 6 | 0.145 | 0.516 |
| FR-GAD | 1038 | 0.339 | 0.077 | 0.23 | 2 | 0.099 | 0.345 |
| IGFS-WIBTS-Q4 (7g) | 425 | 0.409 | 0.131 | 0.32 | 6 | 0.218 | 0.696 |
| F shrinkage mean | 719 | 1.5 | | | | 0.06 | 0.466 |
| Weighted prediction : | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | |
| at end of year | s.e | s.e | | Ratio | | | |
| 549 | 0.22 | 0.09 | 19 | 0.416 | 0.575 | | |
| 1 | | | | | | | |
| Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 4 | | | | | | | |
| Year class = 2004 | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 640 | 0.267 | 0.083 | 0.31 | 5 | 0.544 | 0.199 |
| EVHOE-WIBTS-Q4 | 329 | 0.468 | 0.369 | 0.79 | 6 | 0.108 | 0.357 |
| FR-GAD | 649 | 0.327 | 0.094 | 0.29 | 3 | 0.137 | 0.197 |
| IGFS-WIBTS-Q4 (7g) | 538 | 0.335 | 0.36 | 1.07 | 6 | 0.18 | 0.233 |
| F shrinkage mean | 181 | 1.5 | | | | 0.033 | 0.577 |
| Weighted prediction : | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | |
| at end of year | s.e | s.e | | Ratio | | | |
| 555 | 0.18 | 0.12 | 21 | 0.681 | 0.227 | | |
| Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 4 | | | | | | | |
| Year class = 2003 | | | | | | | |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| IRL-OTB (7bj) | 360 | 0.203 | 0.114 | 0.56 | 6 | 0.72 | 0.151 |
| EVHOE-WIBTS-Q4 | 182 | 0.473 | 0.189 | 0.4 | 6 | 0.063 | 0.281 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FR-GAD | 146 | 0.333 | 0.141 | 0.42 | 4 | 0.107 | 0.339 | |
| IGFS-WIBTS-Q4 (7g) | 210 | 0.335 | 0.269 | 0.8 | 5 | 0.091 | 0.246 | |
| | | | | | | | | |
| F shrinkage mean | 95 | 1.5 | | | | 0.02 | 0.482 | |
| | | | | | | | | |
| Weighted prediction : | | | | | | | | |
| | | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | | |
| at end of year | s.e | s.e | | Ratio | | | | |
| 290 | 0.16 | 0.1 | 22 | 0.647 | 0.184 | | | |

**b) Haddock VIIbk – Fishing mortality (F) at age**

| | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Fbar 2-5 |
| 1993 | 0.000 | 0.289 | 0.823 | 0.349 | 0.493 | 0.326 | 0.648 | 0.493 | 0.493 | 0.498 |
| 1994 | 0.000 | 0.571 | 0.703 | 0.376 | 0.258 | 0.333 | 0.128 | 0.241 | 0.241 | 0.418 |
| 1995 | 0.000 | 0.158 | 0.300 | 0.367 | 0.311 | 0.592 | 0.789 | 0.520 | 0.520 | 0.392 |
| 1996 | 0.000 | 0.177 | 1.035 | 0.548 | 0.403 | 0.296 | 0.628 | 0.791 | 0.791 | 0.570 |
| 1997 | 0.000 | 0.578 | 0.785 | 0.981 | 0.694 | 0.749 | 0.475 | 0.703 | 0.703 | 0.802 |
| 1998 | 0.000 | 0.196 | 0.678 | 0.919 | 0.723 | 0.750 | 0.894 | 0.811 | 0.811 | 0.768 |
| 1999 | 0.000 | 0.218 | 0.987 | 0.671 | 0.666 | 0.470 | 0.449 | 0.369 | 0.369 | 0.699 |
| 2000 | 0.000 | 1.050 | 1.292 | 0.870 | 0.524 | 0.534 | 0.513 | 0.222 | 0.222 | 0.805 |
| 2001 | 0.000 | 0.432 | 0.765 | 0.671 | 0.910 | 0.607 | 0.574 | 0.373 | 0.373 | 0.738 |
| 2002 | 0.000 | 0.486 | 1.100 | 0.922 | 1.425 | 0.308 | 0.361 | 0.264 | 0.264 | 0.939 |
| 2003 | 0.000 | 0.514 | 0.928 | 0.718 | 0.832 | 0.760 | 0.563 | 0.342 | 0.342 | 0.809 |
| 2004 | 0.000 | 0.373 | 0.706 | 0.882 | 0.710 | 1.585 | 0.969 | 0.307 | 0.307 | 0.971 |
| 2005 | 0.000 | 0.262 | 0.644 | 0.653 | 0.893 | 0.870 | 1.763 | 0.174 | 0.174 | 0.765 |
| 2006 | 0.000 | 0.204 | 0.424 | 0.528 | 0.495 | 0.412 | 0.286 | 0.450 | 0.450 | 0.465 |
| 2007 | 0.000 | 0.262 | 0.650 | 0.630 | 0.359 | 0.369 | 0.283 | 0.202 | 0.202 | 0.502 |
| 2008 | 0.000 | 0.542 | 1.013 | 0.844 | 0.440 | 0.254 | 0.268 | 0.192 | 0.192 | 0.638 |
| 2009 | 0.000 | 0.440 | 0.541 | 0.952 | 0.897 | 0.409 | 0.260 | 0.119 | 0.119 | 0.700 |
| 2010 | 0.000 | 0.157 | 0.657 | 0.551 | 0.633 | 0.575 | 0.227 | 0.185 | 0.185 | 0.604 |
| Fbar Catch | 0.000 | 0.379 | 0.737 | 0.782 | 0.656 | 0.413 | 0.251 | 0.165 | | |
| Fbar Land | 0.000 | 0.038 | 0.400 | 0.667 | 0.638 | 0.407 | 0.251 | 0.165 | | |
| Fbar Disc | 0.000 | 0.341 | 0.337 | 0.115 | 0.018 | 0.006 | 0.000 | 0.000 | | |

c) Haddock VIIbk - Stock numbers-at-age (start of year) ('1000)

| | Age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
| 1993 | 14226 | 15782 | 9459 | 3936 | 2334 | 1030 | 301 | 369 | 127 | 47565 |
| 1994 | 35562 | 11647 | 9677 | 3402 | 2273 | 1167 | 609 | 129 | 324 | 64790 |
| 1995 | 54599 | 29116 | 5389 | 3921 | 1913 | 1438 | 685 | 439 | 119 | 97618 |
| 1996 | 22676 | 44702 | 20348 | 3268 | 2224 | 1148 | 651 | 255 | 181 | 95453 |
| 1997 | 9432 | 18566 | 30678 | 5919 | 1546 | 1218 | 699 | 285 | 210 | 68551 |
| 1998 | 23281 | 7722 | 8525 | 11455 | 1817 | 632 | 471 | 356 | 265 | 54524 |
| 1999 | 87316 | 19061 | 5198 | 3543 | 3740 | 722 | 244 | 158 | 60 | 120043 |
| 2000 | 43475 | 71488 | 12547 | 1586 | 1483 | 1572 | 369 | 128 | 88 | 132738 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 81123 | 35594 | 20487 | 2822 | 544 | 719 | 754 | 181 | 127 | 142352 |
| 2002 | 86450 | 66418 | 18925 | 7808 | 1181 | 179 | 321 | 348 | 123 | 181753 |
| 2003 | 19426 | 70779 | 33447 | 5159 | 2543 | 233 | 108 | 183 | 193 | 132071 |
| 2004 | 24586 | 15904 | 34648 | 10831 | 2060 | 906 | 89 | 50 | 79 | 89153 |
| 2005 | 43402 | 20129 | 8966 | 13998 | 3672 | 829 | 152 | 28 | 110 | 91287 |
| 2006 | 42110 | 35535 | 12685 | 3854 | 5965 | 1231 | 285 | 21 | 0 | 101687 |
| 2007 | 99367 | 34477 | 23720 | 6795 | 1861 | 2978 | 668 | 175 | 30 | 170070 |
| 2008 | 68578 | 81355 | 21720 | 10142 | 2964 | 1064 | 1686 | 412 | 76 | 187996 |
| 2009 | 468851 | 56147 | 38742 | 6459 | 3572 | 1564 | 676 | 1056 | 256 | 577322 |
| 2010 | 17368 | 383862 | 29616 | 18469 | 2041 | 1193 | 850 | 426 | 392 | 454218 |
| 2011 | 0 | 14220 | 268698 | 12567 | 8720 | 888 | 549 | 555 | 557 | 306753 |
| GM93-09 | 38338 | 28995 | 14651 | 5215 | 2100 | 889 | 389 | 164 | | |

**Table 7.4.9. Stock Summary for haddock in VIIb–k.**

| | Recruits | | | | | Yield/ | Fbar 2-5 |
|---|---|---|---|---|---|---|---|
| Year | age 0 | TotBio | SSB | Landings | Discards | SSB | Lan+Dis |
| 1993 | 14226 | 15555 | 11519 | 3348 | 1193 | 0.291 | 0.498 |
| 1994 | 35562 | 19131 | 13352 | 4131 | 1193 | 0.309 | 0.418 |
| 1995 | 54599 | 23440 | 12200 | 4470 | 470 | 0.366 | 0.392 |
| 1996 | 22676 | 31202 | 18860 | 6756 | 1398 | 0.358 | 0.570 |
| 1997 | 9432 | 24865 | 21029 | 10827 | 2104 | 0.515 | 0.802 |
| 1998 | 23281 | 18657 | 15670 | 7668 | 355 | 0.489 | 0.768 |
| 1999 | 87316 | 20091 | 10359 | 4882 | 620 | 0.471 | 0.699 |
| 2000 | 43475 | 29263 | 12646 | 7411 | 6984 | 0.586 | 0.805 |
| 2001 | 81123 | 28973 | 14911 | 8632 | 1941 | 0.579 | 0.738 |
| 2002 | 86450 | 35930 | 17387 | 6403 | 7506 | 0.368 | 0.939 |
| 2003 | 19426 | 35793 | 20251 | 8146 | 8194 | 0.402 | 0.809 |
| 2004 | 24586 | 28716 | 24081 | 8581 | 5350 | 0.356 | 0.971 |
| 2005 | 43402 | 26111 | 17711 | 6555 | 2546 | 0.370 | 0.765 |
| 2006 | 42110 | 27673 | 15271 | 5383 | 2083 | 0.352 | 0.465 |
| 2007 | 99367 | 36862 | 20695 | 6510 | 3243 | 0.315 | 0.502 |
| 2008 | 68578 | 45421 | 22897 | 7049 | 9277 | 0.308 | 0.638 |
| 2009 | 468851 | 76761 | 28810 | 9276 | 7276 | 0.322 | 0.700 |
| 2010 | 17368 | 109630 | 31343 | 9864 | 12369 | 0.315 | 0.604 |
| GM93-08 | 38338 | | | | | | |

**Table 7.4.10. Input values for short-term forecast (.prd).**

MFDP version 1a
Run: mfdp
Time and date: 09:41 05/05/2011
Fbar age range (Total) : 2-5
Fbar age range Fleet 1 : 2-5

2011

| Age | N | M | Mat | PF | PM | SWt |
|---|---|---|---|---|---|---|
| 0 | 38338 | 0.2 | 0 | 0 | 0 | 8.13E-02 |
| 1 | 14220 | 0.2 | 0 | 0 | 0 | 0.2 |
| 2 | 268698 | 0.2 | 1 | 0 | 0 | 0.405 |
| 3 | 12567 | 0.2 | 1 | 0 | 0 | 0.651 |
| 4 | 8720 | 0.2 | 1 | 0 | 0 | 0.954333 |
| 5 | 888 | 0.2 | 1 | 0 | 0 | 1.266667 |
| 6 | 549 | 0.2 | 1 | 0 | 0 | 1.578667 |
| 7 | 555 | 0.2 | 1 | 0 | 0 | 1.818333 |
| 8 | 557 | 0.2 | 1 | 0 | 0 | 2.756667 |

CATCH

| Age | Sel | CWt | DSel | DCWt |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 7.93E-02 |
| 1 | 1.65E-02 | 0.195333 | 0.36299 | 0.188667 |
| 2 | 0.266362 | 0.457 | 0.47507 | 0.406 |
| 3 | 0.693101 | 0.697667 | 0.114892 | 0.588667 |
| 4 | 0.676601 | 1.006667 | 1.23E-02 | 0.176333 |
| 5 | 0.394884 | 1.407333 | 0 | 0 |
| 6 | 0.210039 | 1.557667 | 0 | 0 |
| 7 | 0.127029 | 1.679667 | 0 | 0 |
| 8 | 0.128635 | 1.983 | 0 | 0 |

2012

| Age | N | M | Mat | PF | PM | SWt |
|---|---|---|---|---|---|---|
| 0 | 38338 | 0.2 | 0 | 0 | 0 | 8.13E-02 |
| 1 | . | 0.2 | 0 | 0 | 0 | 0.2 |
| 2 | . | 0.2 | 1 | 0 | 0 | 0.405 |
| 3 | . | 0.2 | 1 | 0 | 0 | 0.651 |
| 4 | . | 0.2 | 1 | 0 | 0 | 0.954333 |
| 5 | . | 0.2 | 1 | 0 | 0 | 1.266667 |
| 6 | . | 0.2 | 1 | 0 | 0 | 1.578667 |
| 7 | . | 0.2 | 1 | 0 | 0 | 1.818333 |
| 8 | . | 0.2 | 1 | 0 | 0 | 2.756667 |

CATCH

| Age | Sel | CWt | DSel | DCWt |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 7.93E-02 |
| 1 | 1.65E-02 | 0.195333 | 0.36299 | 0.188667 |
| 2 | 0.266362 | 0.457 | 0.47507 | 0.406 |
| 3 | 0.693101 | 0.697667 | 0.114892 | 0.588667 |
| 4 | 0.676601 | 1.006667 | 1.23E-02 | 0.176333 |
| 5 | 0.394884 | 1.407333 | 0 | 0 |
| 6 | 0.210039 | 1.557667 | 0 | 0 |
| 7 | 0.127029 | 1.679667 | 0 | 0 |
| 8 | 0.128635 | 1.983 | 0 | 0 |

2013

| Age | N | M | Mat | PF | PM | SWt |
|---|---|---|---|---|---|---|
| 0 | 38338 | 0.2 | 0 | 0 | 0 | 8.13E-02 |
| 1 | . | 0.2 | 0 | 0 | 0 | 0.2 |
| 2 | . | 0.2 | 1 | 0 | 0 | 0.405 |
| 3 | . | 0.2 | 1 | 0 | 0 | 0.651 |
| 4 | . | 0.2 | 1 | 0 | 0 | 0.954333 |
| 5 | . | 0.2 | 1 | 0 | 0 | 1.266667 |
| 6 | . | 0.2 | 1 | 0 | 0 | 1.578667 |
| 7 | . | 0.2 | 1 | 0 | 0 | 1.818333 |
| 8 | . | 0.2 | 1 | 0 | 0 | 2.756667 |

CATCH

| Age | Sel | CWt | DSel | DCWt |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 7.93E-02 |
| 1 | 1.65E-02 | 0.195333 | 0.36299 | 0.188667 |
| 2 | 0.266362 | 0.457 | 0.47507 | 0.406 |
| 3 | 0.693101 | 0.697667 | 0.114892 | 0.588667 |
| 4 | 0.676601 | 1.006667 | 1.23E-02 | 0.176333 |
| 5 | 0.394884 | 1.407333 | 0 | 0 |
| 6 | 0.210039 | 1.557667 | 0 | 0 |
| 7 | 0.127029 | 1.679667 | 0 | 0 |
| 8 | 0.128635 | 1.983 | 0 | 0 |

Input units are thousands and kg - output in tonnes

**Table 7.4.11. Management options table (.prm).**

MFDP version 1a
Run: mfdp
Time and date: 09:41 05/05/2011
Fbar age range (Total) : 2-5
Fbar age range Fleet 1 : 2-5

| 2011 | | | | | | |
|---|---|---|---|---|---|---|
| | | "CATCH" | Landings | | Discards | |
| Biomass | SSB | FMult | FBar | Yield | FBar | Yield |
| 135824 | 129862 | 1 | 0.5077 | 29730 | 0.1506 | 34864 |

| 2012 | | | | | | | 2013 | |
|---|---|---|---|---|---|---|---|---|
| | | "CATCH" | Landings | | Discards | | | |
| Biomass | SSB | FMult | FBar | Yield | FBar | Yield | Biomass | SSB |
| 93416 | 84020 | 0 | 0 | 0 | 0 | 0 | 118692 | 109296 |
| . | 84020 | 0.1 | 0.0508 | 5003 | 0.0151 | 945 | 111100 | 101704 |
| . | 84020 | 0.2 | 0.1015 | 9644 | 0.0301 | 1827 | 104065 | 94670 |
| . | 84020 | 0.3 | 0.1523 | 13950 | 0.0452 | 2650 | 97548 | 88152 |
| . | 84020 | 0.4 | 0.2031 | 17945 | 0.0602 | 3420 | 91507 | 82111 |
| . | 84020 | 0.5 | 0.2539 | 21652 | 0.0753 | 4140 | 85908 | 76512 |
| . | 84020 | 0.6 | 0.3046 | 25094 | 0.0903 | 4813 | 80718 | 71322 |
| . | 84020 | 0.7 | 0.3554 | 28290 | 0.1054 | 5442 | 75904 | 66509 |
| . | 84020 | 0.8 | 0.4062 | 31259 | 0.1205 | 6031 | 71441 | 62045 |
| . | 84020 | 0.9 | 0.457 | 34016 | 0.1355 | 6583 | 67300 | 57904 |
| . | 84020 | 1 | 0.5077 | 36578 | 0.1506 | 7099 | 63459 | 54063 |
| . | 84020 | 1.1 | 0.5585 | 38960 | 0.1656 | 7583 | 59894 | 50498 |
| . | 84020 | 1.2 | 0.6093 | 41174 | 0.1807 | 8037 | 56585 | 47189 |
| . | 84020 | 1.3 | 0.6601 | 43234 | 0.1957 | 8463 | 53513 | 44117 |
| . | 84020 | 1.4 | 0.7108 | 45149 | 0.2108 | 8862 | 50661 | 41265 |
| . | 84020 | 1.5 | 0.7616 | 46932 | 0.2259 | 9237 | 48011 | 38615 |
| . | 84020 | 1.6 | 0.8124 | 48592 | 0.2409 | 9589 | 45550 | 36154 |
| . | 84020 | 1.7 | 0.8632 | 50137 | 0.256 | 9920 | 43262 | 33867 |
| . | 84020 | 1.8 | 0.9139 | 51577 | 0.271 | 10231 | 41136 | 31740 |
| . | 84020 | 1.9 | 0.9647 | 52919 | 0.2861 | 10523 | 39159 | 29763 |
| . | 84020 | 2 | 1.0155 | 54169 | 0.3011 | 10798 | 37321 | 27925 |

Input units are thousands and kg - output in tonnes

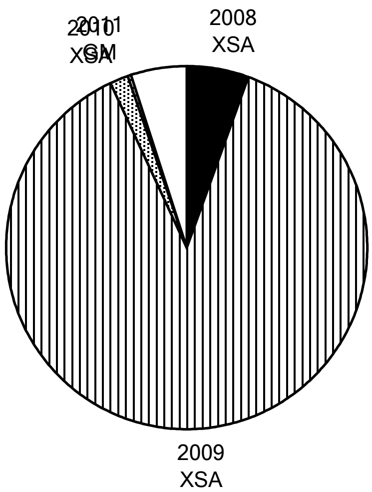
**Table 7.4.12. Haddock VIIb–k. Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes.**

| Year-class | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Stock No. (thousands) of 0 year-olds | 68578 | 468851 | 17368 | 38338 | 38338 |
| Source | XSA | XSA | XSA | GM | GM |
| Status Quo F: | | | | | |
| % in 2011 landings | 12.9 | 71.3 | 0.1 | 0.0 | - |
| % in 2012 | 5.7 | 87.3 | 1.7 | 0.2 | 0.0 |
| % in 2011 SSB | 6.3 | 83.8 | 0.0 | 0.0 | - |
| % in 2012 SSB | 3.7 | 85.5 | 6.5 | 0.0 | 0.0 |
| % in 2013 SSB | 2.9 | 59.8 | 4.9 | 27.5 | 0.0 |

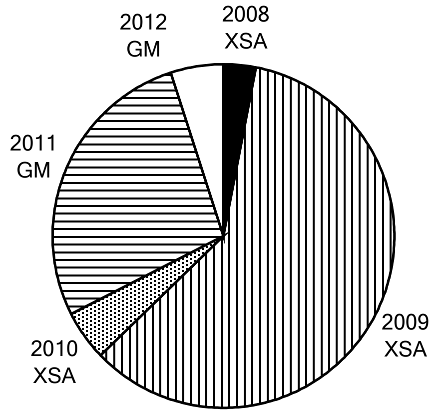
MR : mean recruitment

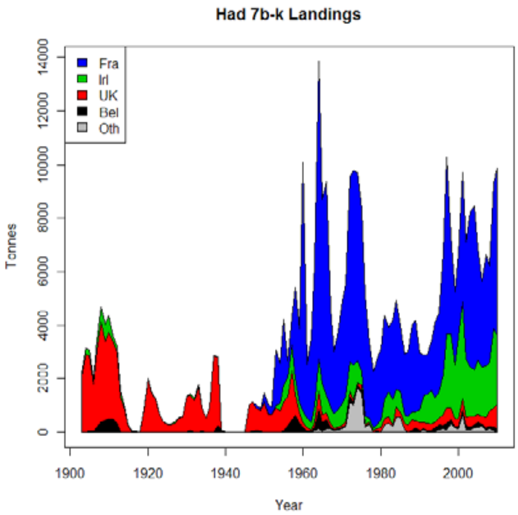
**Haddock in VIIb-k : Year-class % contribution to**

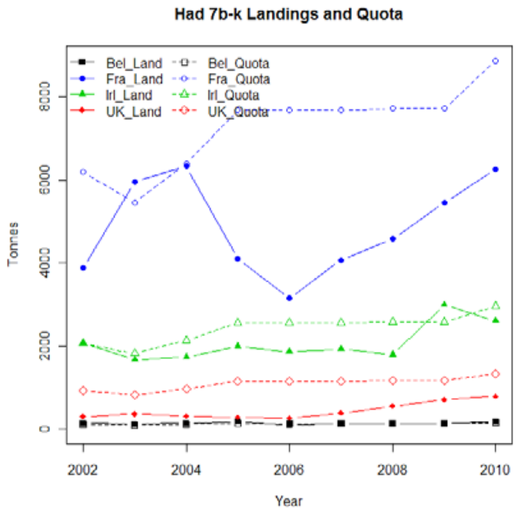
**a ) 2012 landings**




**b ) 2013 SSB**






**(a)** **(b)**

**Figure 7.4.1. a) Official ICES landings of haddock in VIIb–k by country and the TAC. Historical data may not be complete for all countries. b) Recent working group landings and quota by country.**

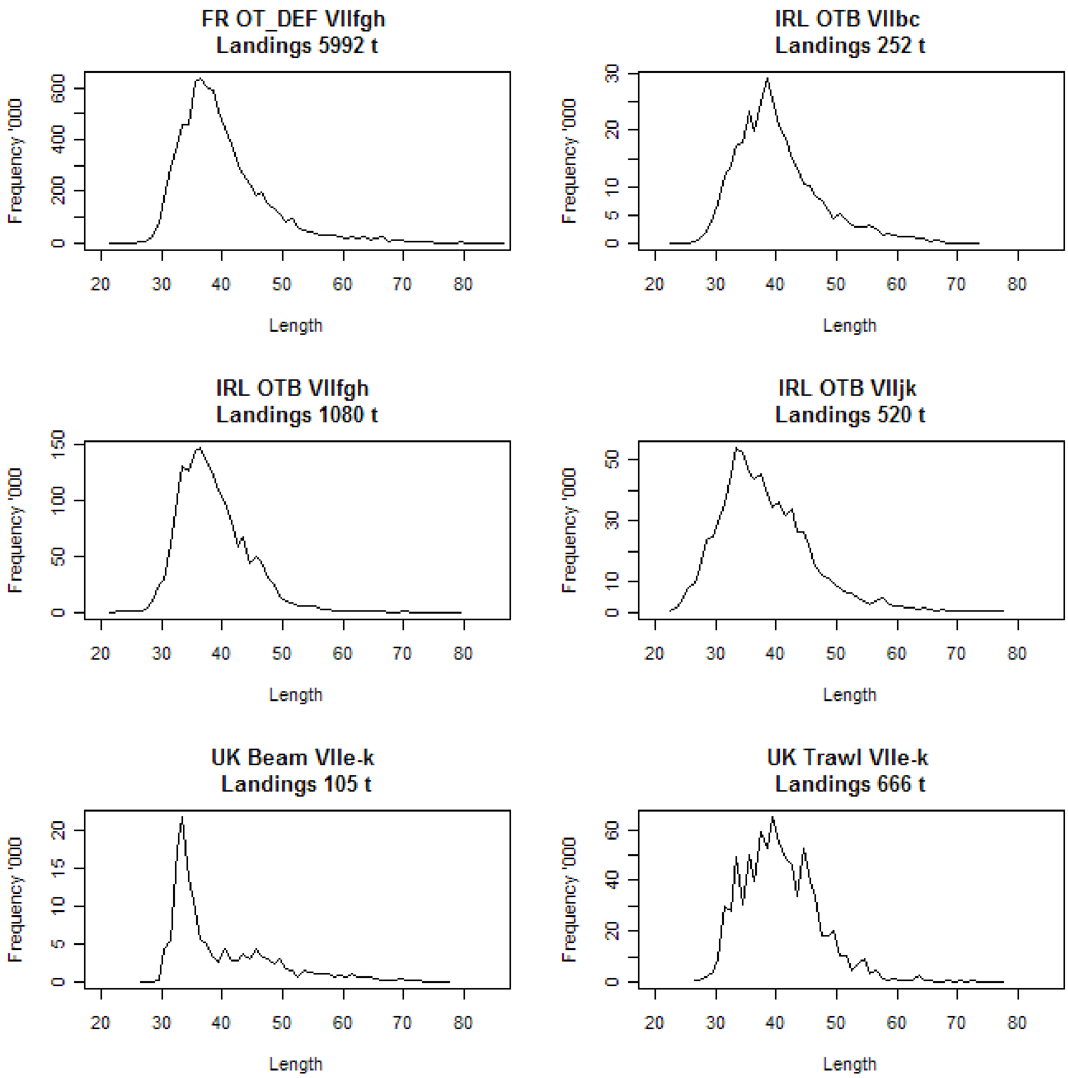



**Figure 7.4.2a. Length distributions of the landings of haddock in VIIb–k in 2010. FR OT_DEF is the French demersal fleet; IRL OTB is the Irish otter trawl fleet; UK beam is the UK beam trawl fleet and UK trawl consists of all other UK trawls.**

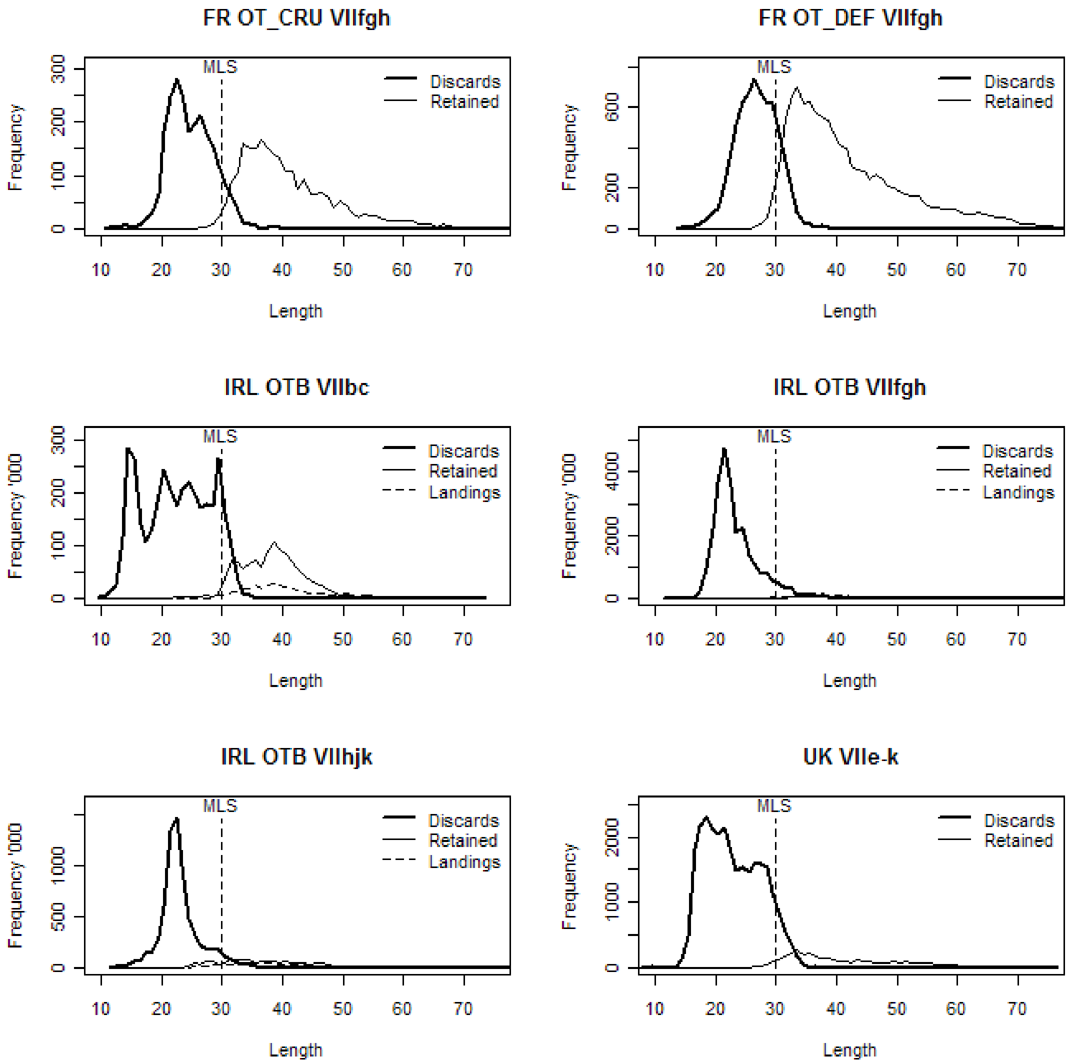



**Figure 7.4.2b. Length distributions of discards and the retained catch of haddock in VIIb–k in 2010. FR OT_CRU is the French otter trawl *Nephrops* fleet; FR OT_DEF is the French otter trawl demersal fleet; IRL OTB is the Irish otter trawl fleet; all UK fleets were combined. Irish data were raised to total numbers, the length distributions of the landings (from port sampling) is given for comparison.**

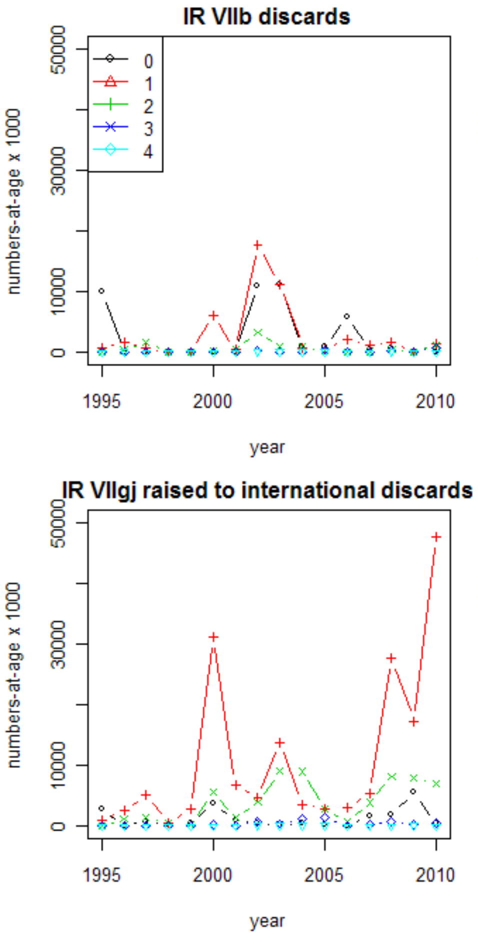



**Figure7.4.3a. Numbers-at-age of Irish Discards of haddock in VIIb and VIIgj. The Irish discards in VIIgj were raised to international levels using effort as auxiliary variable.**

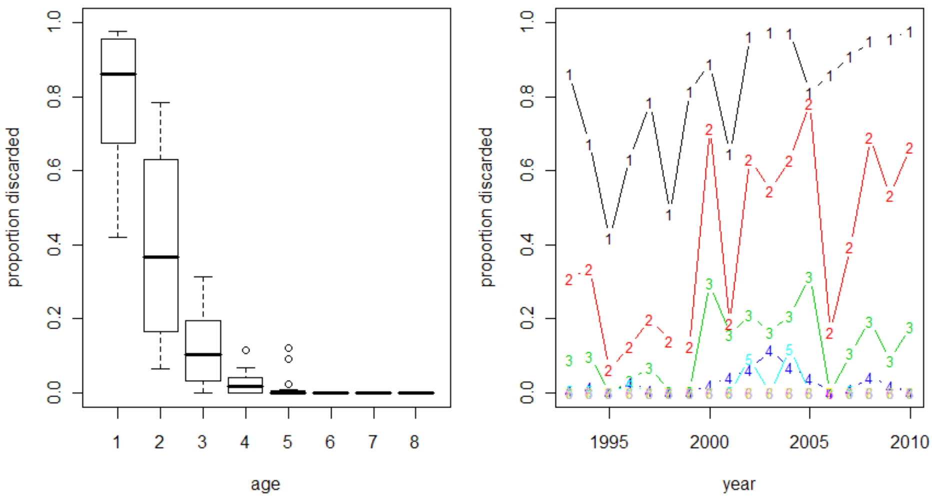



**Figure7.4.3b. Proportion of discards of haddock in VIIb–k by age (left) and year (right).**

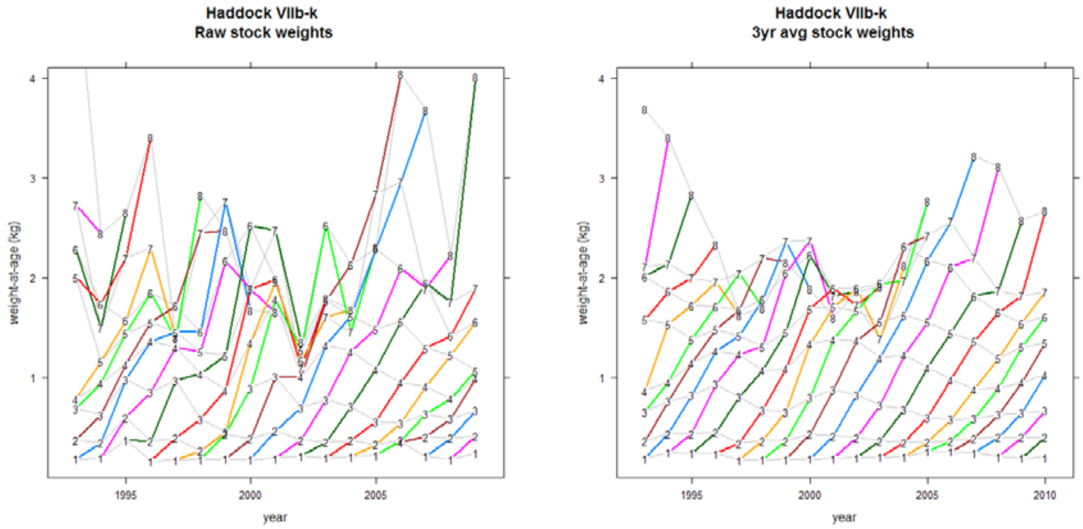



**Figure7.4.4. Raw stock weights-at-age (left) and the tree-year running average stock weights (left).**

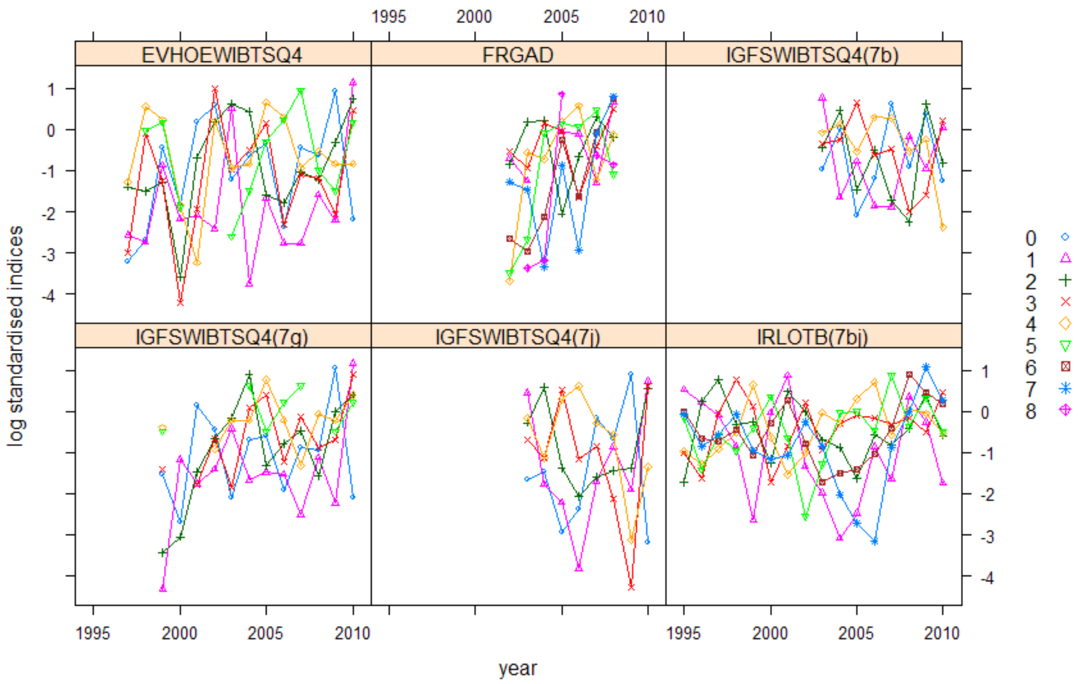



**Figure 7.4.5a. Log standardized indices of tuning fleets by year. The IGFSWIBTSQ4(7b) and IGFSWIBTSQ4(7j) fleets were not used in the assessment. See Stock Annex for a description of the fleets.**

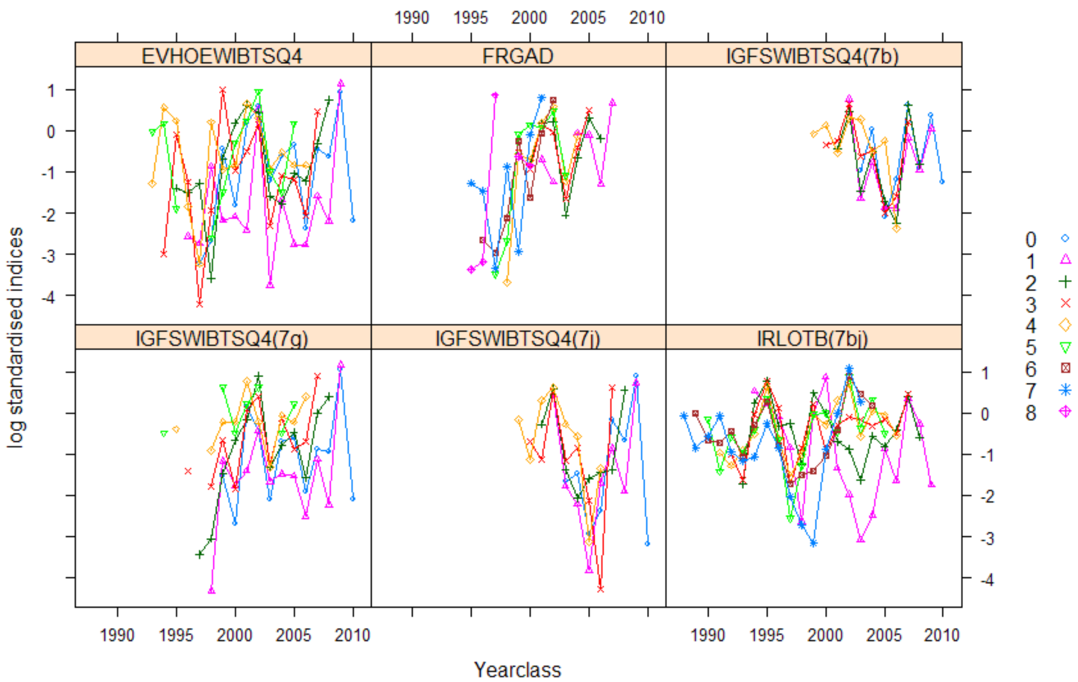



**Figure 7.4.5b. Log standardized indices of tuning fleets by year class. The IGFSWIBTSQ4(7b) and IGFSWIBTSQ4(7j) fleets were not used in the assessment. See Stock Annex for a description of the fleets.**

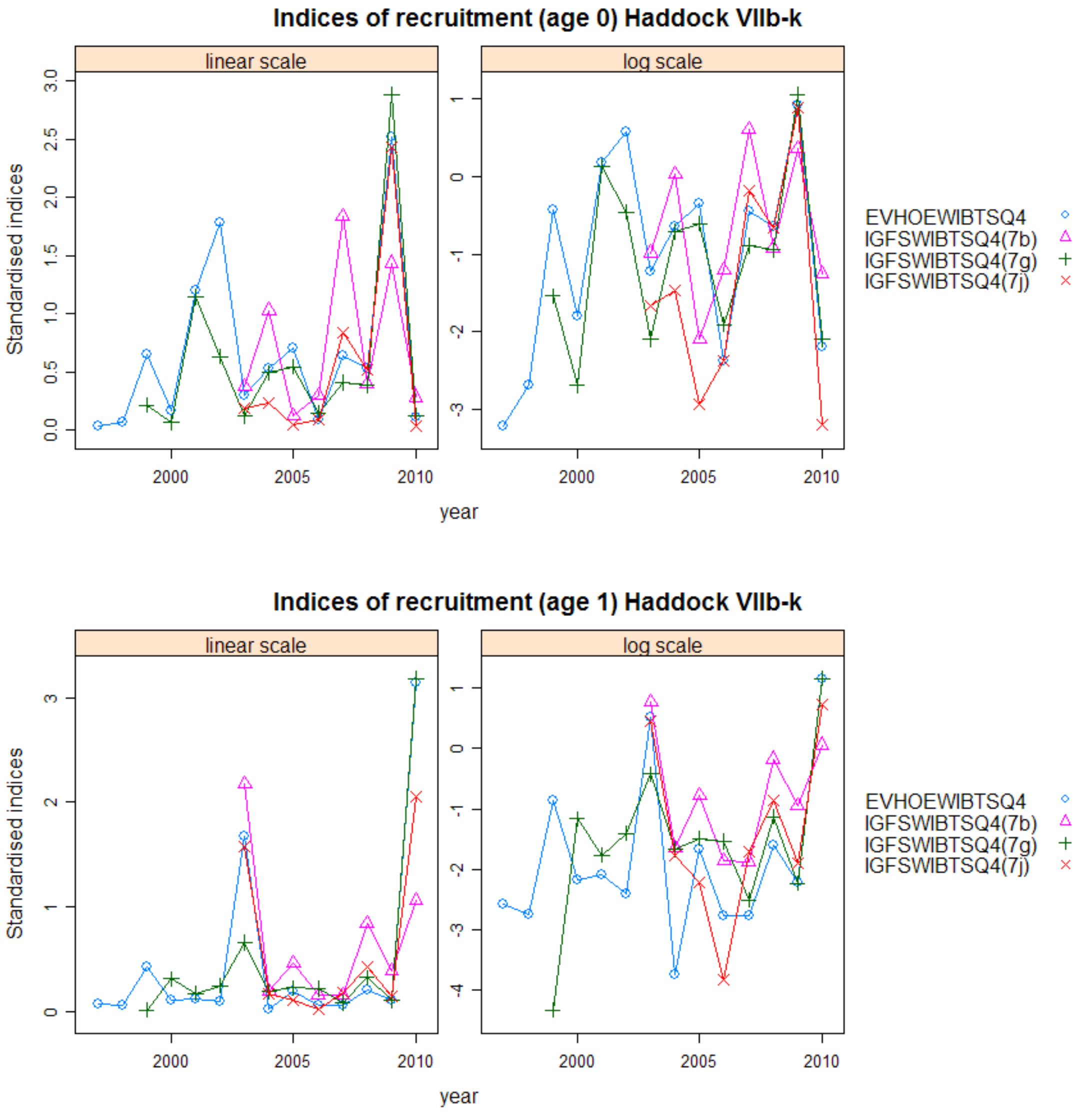



**Figure 7.4.6. Survey indices of recruitment-at-age 0 and 1, presented on a linear and log scale. The EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4-(7g) were used as tuning fleets. The other fleets are currently not used.**

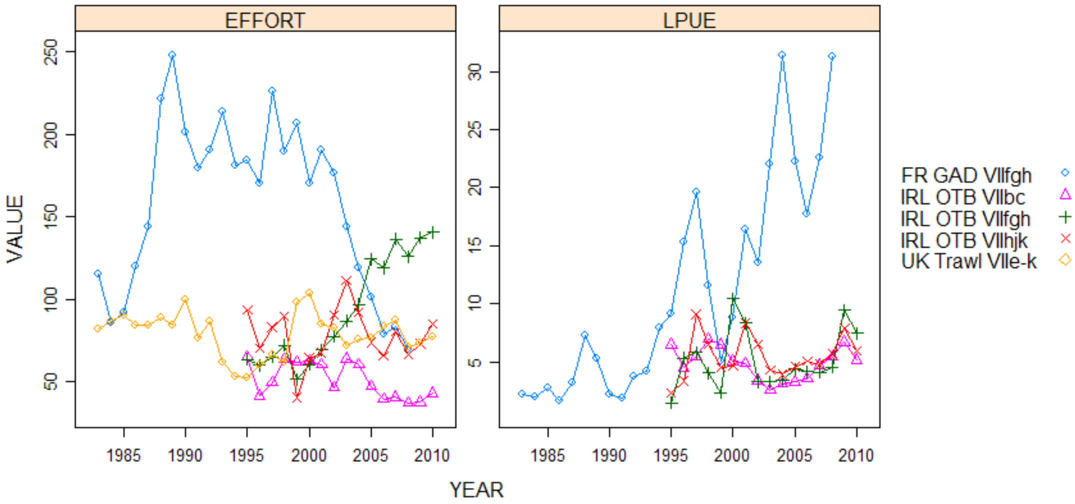



**Figure 7.4.7. Effort ('1000h) of the Irish otter trawl fleets, the French gadoid fleet and for UK trawl fleet and lpue (kg/h) for the Irish and French fleets.**

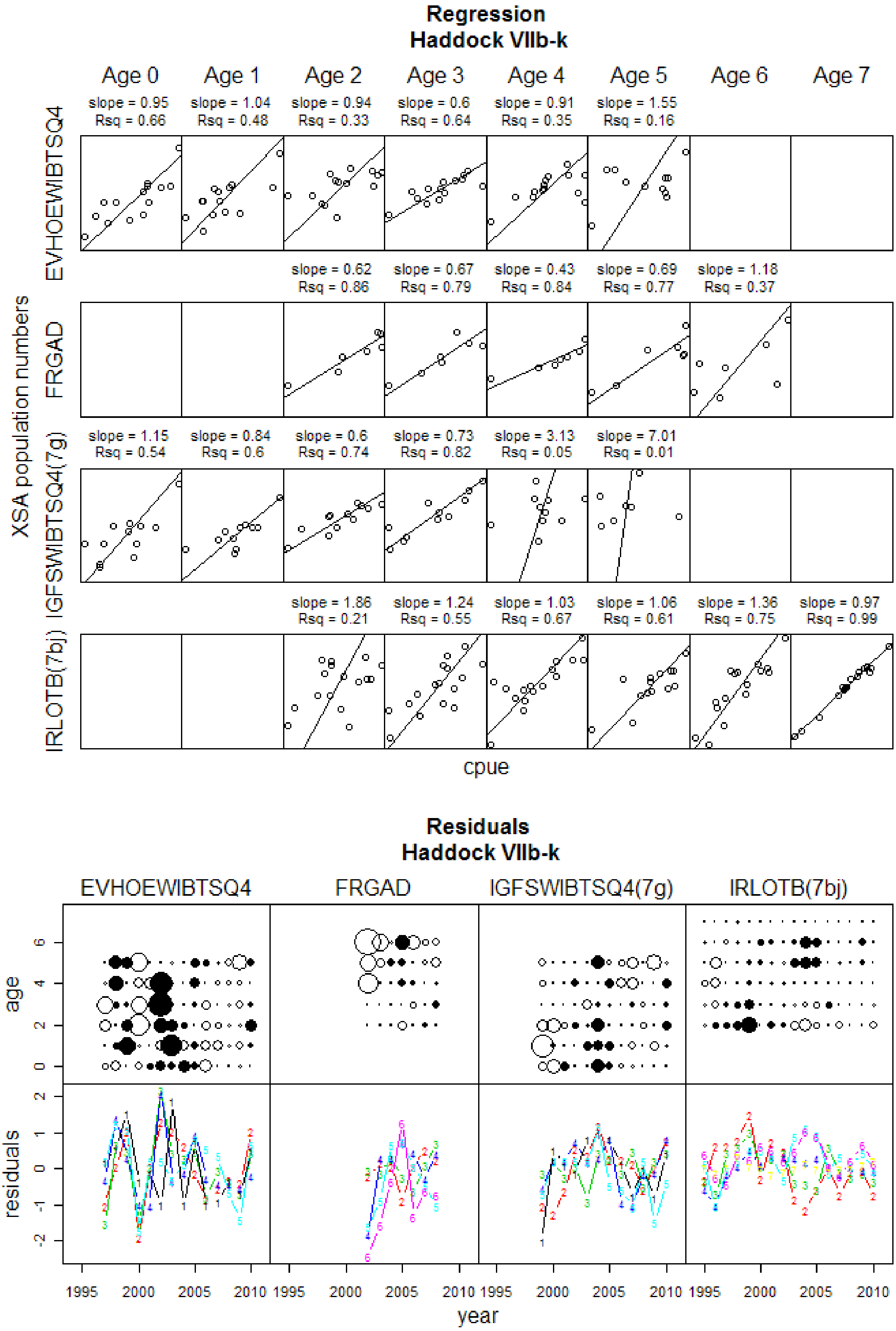



**Figure 7.4.8. Log-catchability regressions and residual plots of the tuning fleets used in the assessment.**

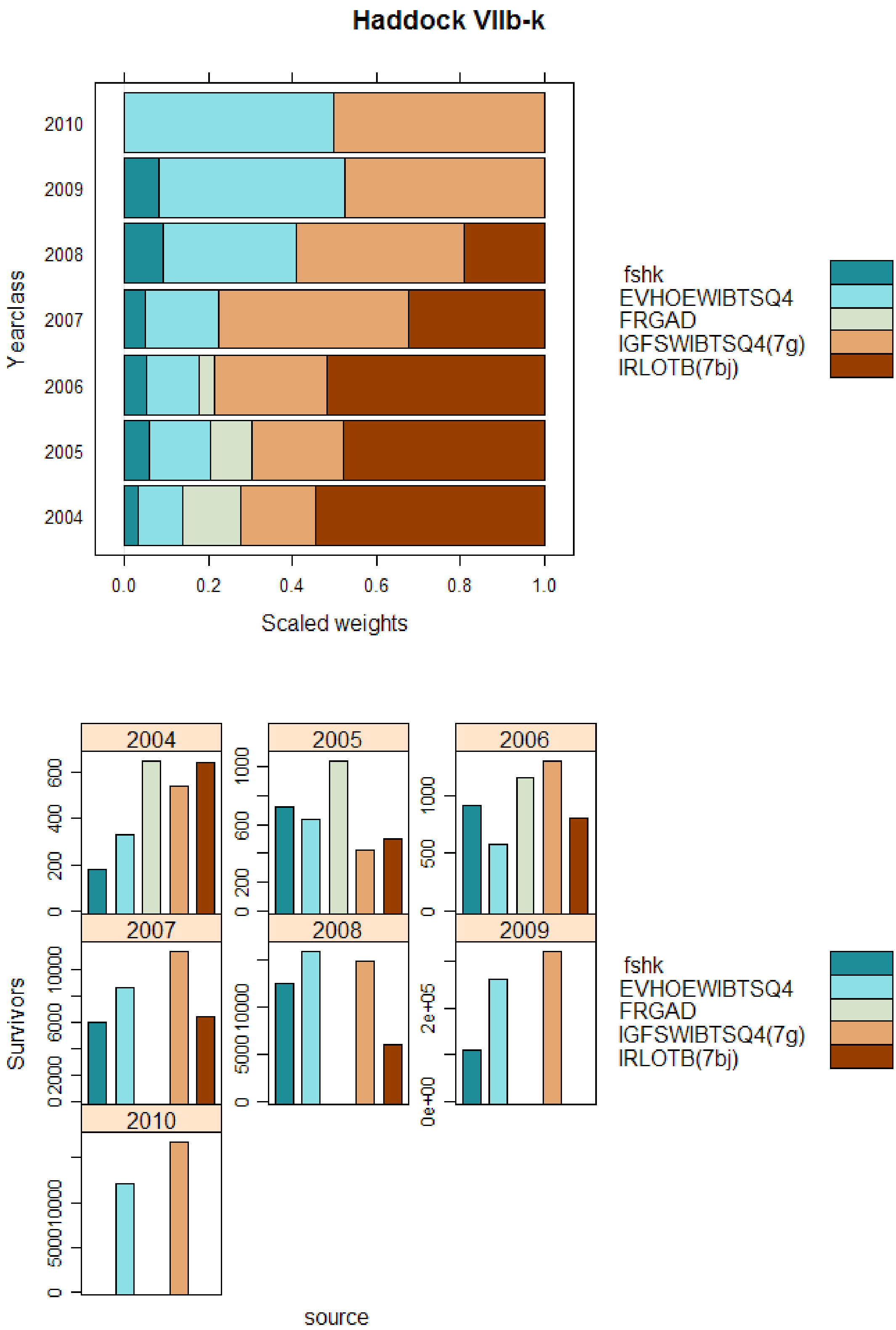



**Figure 7.4.9. Scaled weights and survivor estimates (by year class) of the tuning fleets used in the assessment.**

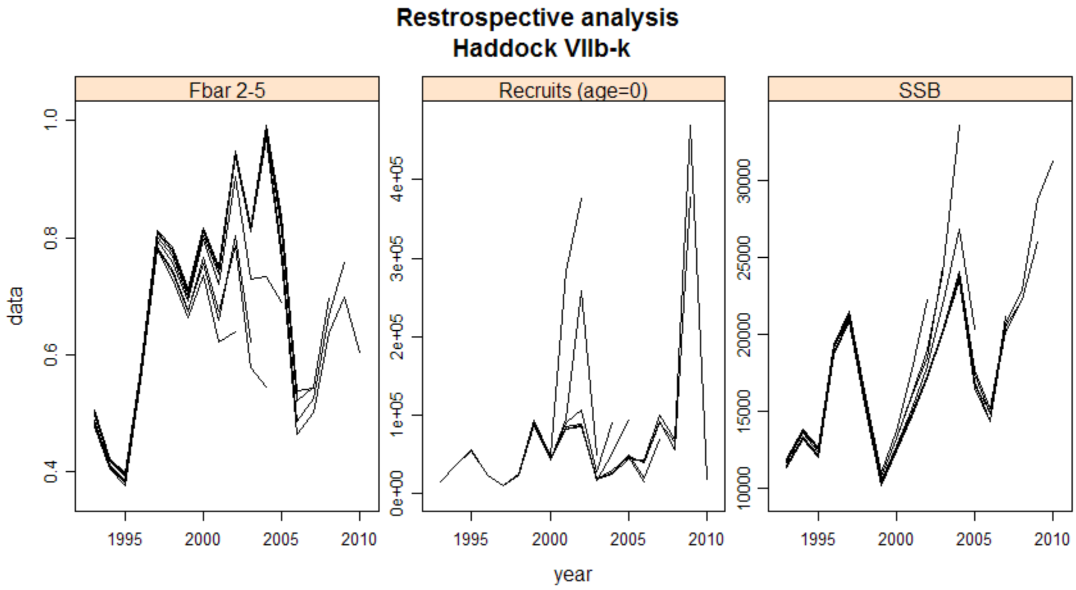



**Figure 7.4.10. Retrospective XSA analysis.**

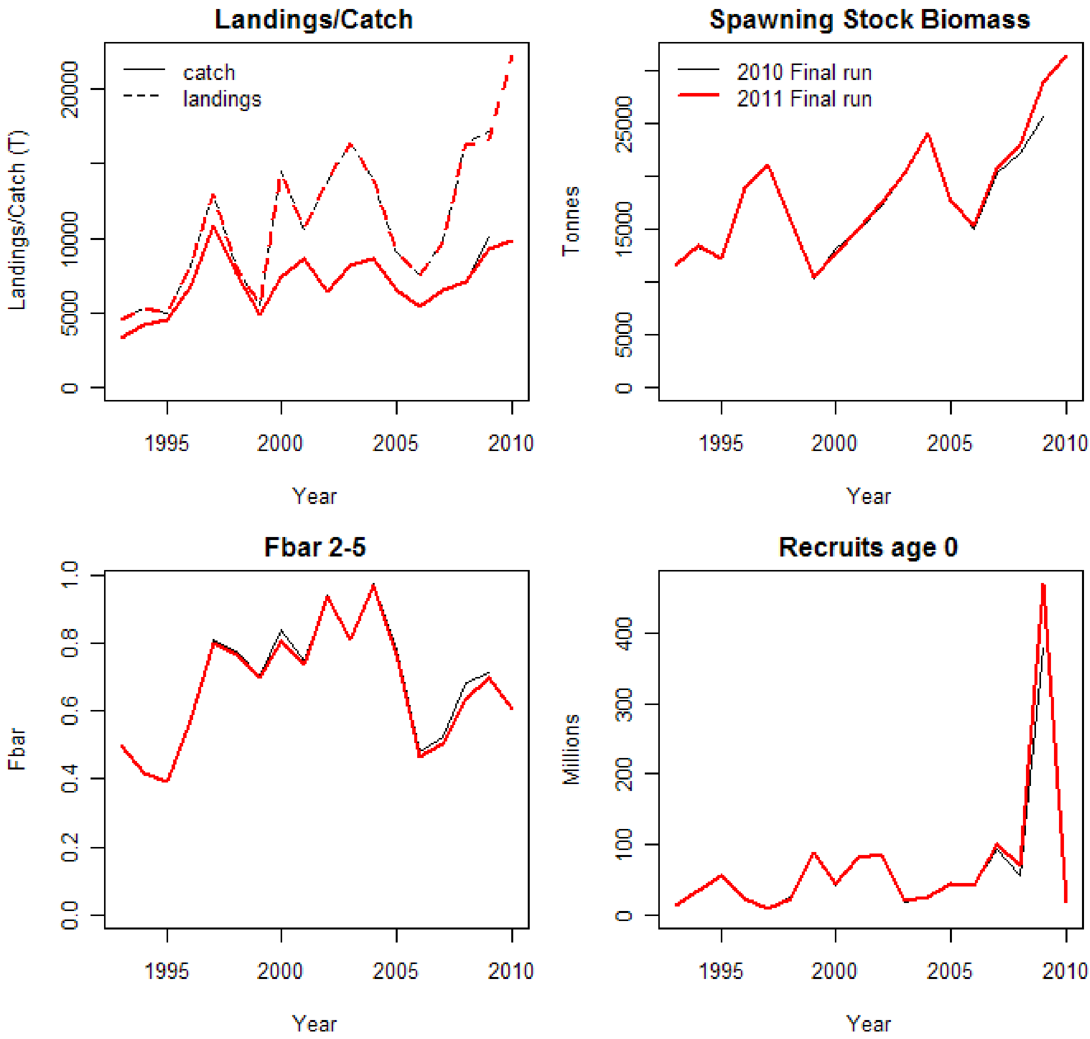



**Figure 7.4.11. Stock summary plot. The thin black line represents last year's assessment, the thick red line represents the current assessment.**

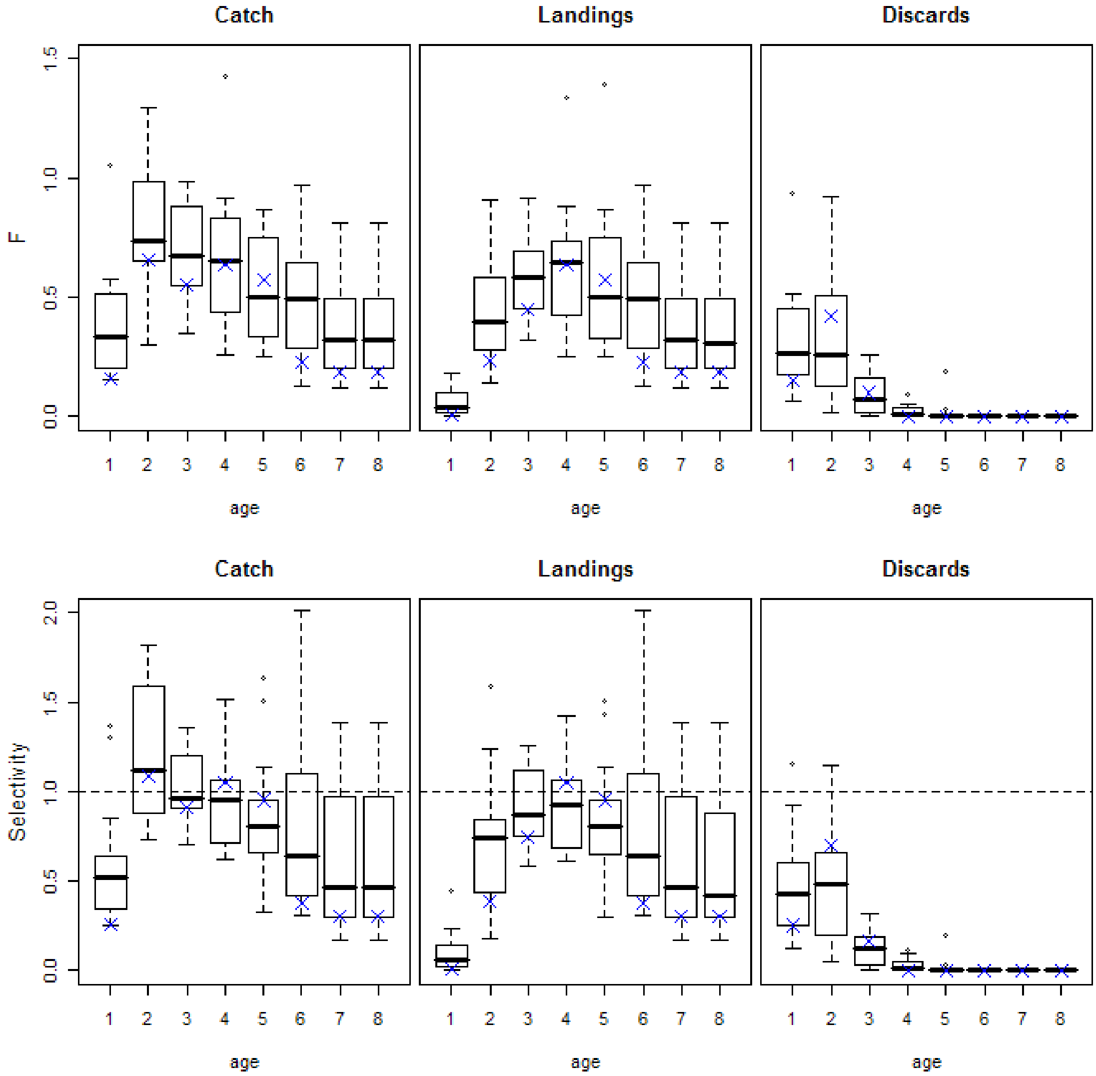



**Figure 7.4.12. Fishing mortality and selectivity-at-age, the blue crosses represent the most recent year. F was separated into a landings and discards component using the proportion of the catch numbers that were discarded for each age and year. Selectivity was estimated by dividing the F matrix by the catch $F_{bar}$ 2–5 for each year.**

## 7.5 *Nephrops* in Division VIIb (Aran Grounds, FU17)

### Type of assessment in 2011

UWTV based assessment using WK*NEPH* 2009 protocol as described in the Stock Annex. This year long-term reference points have been examined for this stock. Further description on the background is presented in Section 7.5.2.

### ICES advice applicable to 2010

#### June 2009

*"Advises on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Ratio for Nephrops fisheries should be less than the lower bound of $F_{0.1}$ ranges for similar stocks (8%).This corresponds to landings of no more than 505 t for the Aran Grounds stock."*

Advice was reopened in November after the 2009 UWTV survey results were available.

#### November 2009

*"ICES recommends that on the basis of exploitation boundaries in relation to high long-term yield and low risk of depletion of production potential that the Harvest Ratio for Nephrops fisheries should be less than the lower bound of $F_{0.1}$ ranges for similar stocks (8%). This corresponds to landings of no more than 704 t for the Aran Grounds stock."*

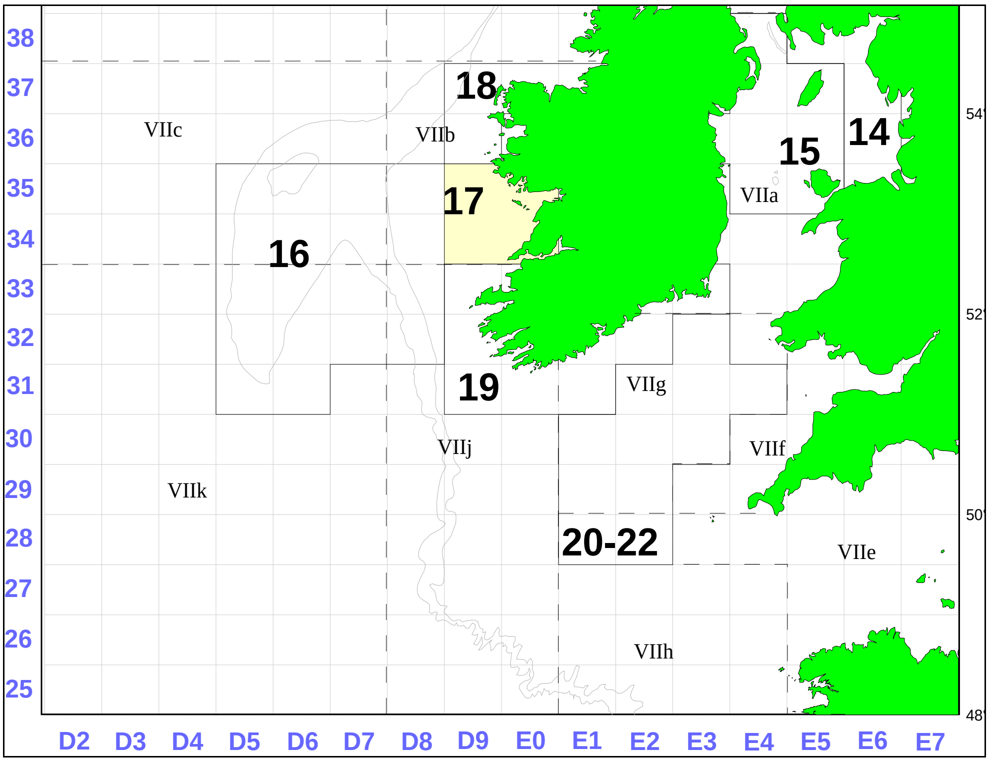
### ICES advice applicable to 2011

*"Following the ICES MSY framework implies harvest ratio of 10.5%, resulting in landings of 950 t."*

### 7.5.1 General

#### Stock description and management units

The Aran Grounds *Nephrops* stock (FU17) covers ICES rectangles 34–35 D9–E0 within VIIb. This stock is included as part of the TAC Area VII *Nephrops* which includes the following stocks: Irish Sea East and West (FU14, FU15), Porcupine Bank (FU16), northwestern Irish Coast (FU18), southeastern and southwestern Irish Coast (FU19) and the Celtic Sea (FU20–22).




The TAC is set for Subarea VII which does not correspond to the stock area (FU 17 is shaded light yellow). There is no evidence that the individual functional units belong to the same stock. The 2011 TAC is 21 759 t, 3% less than the 2010 TAC. No FU17 specific restrictions in TAC apply thus, up to 100% of the Area VII TAC could, in theory be taken within FU17.

### Management applicable to 2010 and 2011

**TAC in 2010**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 346 | |
| France | 5 455 | |
| Ireland | 8 273 | |
| United Kingdom | 7 358 | |
| EU | 22 432 | |
| TAC | 22 432 | Analytical TAC |

**TAC in 2011**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 306 ([1]) | |
| France | 5 291 ([1]) | |
| Ireland | 8 025 ([1]) | |
| United Kingdom | 7 137 ([1]) | |
| EU | 21 759 ([1]) | |
| TAC | 21 759 ([1]) | Analytical TAC |

([1]) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

| | |
|---|---|
| Spain | 75 |
| France | 305 |
| Ireland | 463 |
| United Kingdom | 411 |
| EU | 1 254 |

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VIIIa, VIIIb, VIIId and VIIIe (NEP/8ABDE.) |
|---|---|---|
| Spain | 234 | |
| France | 3 665 | |
| EU | 3 899 | |
| TAC | 3 899 | Analytical TAC |

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VIIIc (NEP/08C.) |
|---|---|---|
| Spain | 87 | |
| France | 4 | |
| EU | 91 | |
| TAC | 91 | Analytical TAC |

The MLS implemented by EC is set at 25 mm CL i.e. 8.5 cm total length and this regulation is applied by the Irish and UK fleets whereas a more restrictive regulation adopted by the French Producers' Organisations (35 mm CL i.e. 11.5 cm total length) is applied by the French trawlers.

### Ecosystem aspects

This section is detailed in Stock Annex.

### Fishery description

Since 1996 the Republic of Ireland fleet had over 99% of the landings from this FU. A description of the fleet is given in the Stock Annex. 53 Irish trawlers reported landings from this FU in 2010. This is about a 43% increase compared with the number of vessels reporting in 2009. In addition, 28 of these vessels reported landings in excess of 10 t. The majority of these vessels are based in the port of Ros-a-Mhíl. Vessel lengths range from 13 to 38 m and engine power ranges from 120–870 kW (See Stock

Annex). The majority of vessels are in the 20–25 m length range and make fishing trips between 3-7 days in duration. The majority of the landings are made with 80 mm mesh.

The majority of the landings come from the grounds to the west and southwest of the Aran Islands known as the 'back of the Aran ground' (See Stock Annex). The fishery on the Aran Grounds operates throughout the year, weather permitting with a seasonal trend (Figure A.2.5).

#### Fishery in 2010

The 2010 landings increased by 60% from those made in 2009 and amounted to 1000 t. The increase is mainly attributable to an increase in fishing effort relative to 2009. In recent years several newer vessels specializing in *Nephrops* fishing have participated periodically in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates.

### 7.5.2 Data

Sampling of landings and discards resumed in 2008 after a break of two years (2006–2007) in the sampling programme. This break was due to non-cooperation with sampling by the fishing industry. Sampling levels in 2010 were good and are detailed in Section 2 (Table 2.1). Historical data availability and quality is reported in the Stock Annex (Section B).

#### Landings

The reported landings time-series is shown in Figure 7.5.1 and Table 7.5.1. The reported Irish landings from FU17 have fluctuated around 800 t in the recent years. There is concern about the accuracy of reported landings statistics for *Nephrops* by Irish vessels due to restrictive quotas and various misreporting practices. The introduction of sales notes and increased control and enforcement since 2007 should improve the accuracy of reported landings data. The TAC was increased in 2007 and 2008 this has led to an increase in reported landings and lpue.

#### Commercial cpue

Effort data for this FU is available from 1995 for the Irish otter trawl *Nephrops* directed fleet. In 2010 this fleet accounted for ~90% of the landings compared with an average of 70% over the time period. These data have not been standardized to take into account vessel or efficiency changes during the time period. Effort has declined between 2003–2006 then increased in 2007 to 2008, dropped again in 2009 then increased in 2010 to levels similar to 2008. (Table 7.5.2.). Landings per unit of effort (lpues) have been fluctuating around an average of 42 kg/hr. Lpue in 2010 was above average at 54 kg/hr (Figure 7.5.2).

#### Discarding

Before 2001 there was no discard sampling and it was thought that *Nephrops* discarding in this fishery was relatively low. Since 2001 discard rates have been estimated using unsorted catch and discards sampling (as described in the Stock Annex). Discard rates range between 14–24% of total catch by weight and 25–40% of total catch by number (Table 7.5.3). Discard rate of females tends to be higher due to the smaller average size and market reasons. There is no information on discard survival rate in this fishery (10% is assumed). No estimates of discards were available in 2006 and 2007 due to the non cooperation of the fishing industry with sampling programmes.

### Biological sampling

The Irish sampling programme resumed in 2008 and since then coverage and intensity has been very good. The mean size of whole *Nephrops* (>35 mm) in Irish landings has remained stable between 1995 and 2000 for both sexes (Figure 7.5.3 and Table 7.5.4). The mean size of *Nephrops* in the catch has remained relatively stable since 2001.

The sex ratio in the landings is slightly male biased (Figure 7.5.4). The proportion of males is high in 2009 due an increased proportion of the landings taken in autumn (see Fishery in 2009 WGCSE Report 2010).

There is no change to other biological parameters as described in the Stock Annex.

### Abundance indices from UWTV surveys

Prior to 2011 there were minor revisions to 2006 to 2008 UWTV data due to the amalgamation of survey data into a SQL server. This amalgamation resulted in some changes to historical abundance estimates although it did not change the overall perception in the trend in the time-series (See Lordan and Doyle, WD05). WK*NEPH* 2009 concluded that this survey could be used as an absolute index of abundance for this stock provided the bias (see text table below) was taken into account (ICES, 2009). This direct use of the survey is in lieu of alternative assessment approaches. These bias sources are not easily estimated and are largely based on expert opinion. In the Aran Grounds the largest source of perceived bias is the "edge effect". The bias correction factor is in line with other stocks with similar density e.g. FU11 = 1.33 and FU12 = 1.32 (ICES, 2009).

| FU | Area | Edge effect | detection rate | species identification | Occupancy | Cumulative bias |
|---|---|---|---|---|---|---|
| 17 | Aran | 1.35 | 0.9 | 1.05 | 1 | 1.3 |

The blanked krigged contour plot and posted point density data are shown in Figure 7.5.5. The krigged contours correspond very well to the observed data. In general the densities are higher towards the western side of the ground rather and there is a notable trend towards lower densities towards the east. Densities and abundance have fluctuated considerably in the time-series (e.g. 0.6–1.4 burrows/$m^2$). The mean density in 2010 is approx 15% increase on 2009 and remains just below the average of the time-series.

The summary statistics from this geostatistical analysis are given in Table 7.5.5 and plotted in Figure 7.5.6. The 2010 estimate of 827 million burrows are around average but the estimates have fluctuated fairly widely since the survey commenced. The estimation variance of the survey as calculated by EVA is very low (CVs in the order <5%). Random stratified estimates are given for the smaller Slyne Head and Galway Bay grounds. Currently the spatial extent of these other grounds not well estimated. The size and contribution to landings of these grounds is small relative to the Aran grounds and these have not been taken into account in the overall abundance estimate or catch options.

### 7.5.3 Assessment

**Summary of Review Group comments on the 2010 assessment**

"The assessment was carried out in accordance with the description in the Stock Annex and the RG found no errors in the assessment.

The assessment approach used by WGCSE 2010 was said to be consistent with that set out in the Stock Annex and WKNEPH (2009). Exploratory SCAs (Separable cohort analysis) were carried out to derive suitable reference points for this stock. The RG could not evaluate the SCA as the input files were not available.

The Stock Annex was very clear and contained good information on ecosystem consideration.

Discard estimates are included in the assessment since 2001 with the exception of 2006–2007 when there was no sampling of landings and discards."

1 ) The combined-sex $F_{MSY}$ proxy harvest-ratios for the *Nephrops* stocks in VIa and VII other than FU17, all tend to be very similar despite the variations in growth rates and discard rates (see table below). The much lower value for FU17 appears to be due to a low value for females (similar to FU15) and a very low value for males (50% lower than FU15). The same growth data are used for FU15 and FU17. The RG asked for the FU17 model inputs to be checked as the $L_{infinity}$ for mature females in the Stock Annex table is given as 50 mm but is claimed to be derived from FU15 and FU16 values which are 56–60 mm. The RG was advised that the LCA was run using the same parameters as for the Irish Sea. A source of the large difference between FU17 and other FUs could therefore be a very different length composition and selectivity pattern for males in the 2008–2009 FU17 data than is obtained for the other stocks. The WG should further explore the reasons for the different $F_{MSY}$ values in FU17, including the quality of the LFDs for landings and discards and the effect of the shift in timing of the fishery in recent years.

| Harvest ratios for different (combined sex) FMSY proxies | | | | Harvest ratios for F35%spr for males and females | | Males and imm. females | | Mature females | | Burrow densities (per m2) |
|---|---|---|---|---|---|---|---|---|---|---|
| FU | F0.1 | Fmax | F35%spr | Male | Female | Linf | K | Linf | K | |
| 11 | 9.8 | 16.9 | 13.3 | 10.5 | 19.2 | 70 | 0.16 | 60 | 0.06 | 0.55 |
| 12 | 9.7 | 16.9 | 13.1 | 9.8 | 21.1 | 66 | 0.16 | 59 | 0.06 | 0.43 |
| 13 | 9.3 | 16.9 | 13.1 | 9.7 | 22.2 | 73 | 0.16 | 60 | 0.06 | 0.8–1.0 |
| 14 | 9.8 | 16.4 | 13.0 | 14.1 | 12.7 | Same as FU15 | | | | 0.25–0.38 |
| 15 | 10.6 | 17.1 | 13.4 | 12.5 | 13.5 | 60 | 0.16 | 56 | 0.10 | ~1.0 |
| 16 | | | | | | 75 | 0.14 | 60 | 0.16 | |
| 17 | 7.2 | 11.1 | 10.5 | 8.4 | 12.8 | 60 | 0.15 | 56* | 0.1 | 0.6–1.4 |
| 20–22 | | | | | | 68 | 0.17 | 49 | 0.10 | 0.23–0.4 |

2 ) The Stock Annex and WKNEPH 2009 should be amended to show the correct Linf of mature females in FU17 (56 mm if derived from FU15). The RG/ADG was advised that the $F_{MSY}$ calculations were done for FU17 using "the same growth inputs as for the Irish Sea".

#### Conclusions

"The RG agrees that the UWTV survey and associated $F_{MSY}$ values represent an appropriate means of providing quantitative management advice. The UWTV is a method susceptible to bias but the WG concludes that the survey estimates are considered fairly precise. The RG agrees that $F_{35\%spr}/F_{max}$ (both giving harvest ratio of 9.7% combined between sexes) is consistent with the approach adopted by WGCSE for choosing $F_{msy}$ proxies for *Nephrops*. This is predicted to deliver an SPR for males of 23% virgin SPR. However the RG still has concerns about the different harvest ratios for males compared to other stocks which should be investigated further. The mean weight in landings and discard rates should also be examined further as they are also key sources of uncertainty.

The bias correction factor needs further investigation including, as suggested by the WG, a precision estimate.

The RG agrees with the WG that management on a FU level would be beneficial."

#### Approach in 2011

The assessment approach used by WGCSE 2011 is consistent with that set out in the Stock Annex and WK*NEPH* (ICES, 2009). Since the most recent three years of sampling data were available, three year averages of mean weighs in the landings and proportions retained in the fishery have been used. This is in line with the procedure for other stocks.

Last year the final SCAs (Separable cohort analysis) used landings and discard length distributions by sex derived from 2008–2009 sampling. Different selection patterns between sexes were included in the model to take into account differences in selection observed in the fishery. Despite this the SCA model fit was not as good as those observed for other stocks with relatively high residuals at length (Figure 7.5.7, ICES, 2010). In response to the RG comments above WGCSE 2011 explored further the SCA inputs for FU17. In order to obtain a more parsimonious model fit to the data the assumed growth and natural mortality parameters needed to be altered. Despite the explorations WGCSE was not in a position to conclude on an alternative SCA analysis for this stock. WGCSE recommend that this is something that should be explored at the next benchmark or through an inter-benchmark process.

#### Comparison with previous assessments

The assessment is based on the same methods and similar data as used in 2010. The stock size is estimated to have increased and harvest ratio has also increased slightly based on the UWTV survey.

#### State of the stock

UWTV abundance estimates suggest that the stock size has fluctuated widely without trend and the 2010 estimate is close to average of the series (geomean: 842 million). Table 7.5.6 summarizes recent harvest ratios for the stock along with other stock parameters. Figure 7.5.6 is the stock summary plot for FU17. Recent harvest rates have fluctuated around 8%, and landing have fluctuated around 850 t.

### 7.5.4 Short-term projections

Catch option table inputs and historical estimates of mean weight in landings and harvest ratios are presented in Table 7.5.6. A three year average (2008–2010) of mean weight in landings and proportion of removals retained was used. Since 2002 mean weight in the landings has varied between 18–27 grs. The estimate harvest ratio has also varied a lot, 3–13% with 2008 being the highest observed.

A prediction of landings for 2012 was made for the Aran Grounds Functional Unit using the approach agreed procedure proposed at WK*NEPH* 2009 and outlined in the Stock Annex. Table 7.5.7 shows landings predictions at various harvest ratios, including those equivalent to fishing within the range of $F_{0.1}$ to $F_{max}$. The $F_{2010}$ (mean F 2008–2010) for the Aran grounds is estimated to close to the $F_{msy\ proxy}$ proposed by ICES.

### 7.5.5 MSY explorations

No new MSY explorations were carried out at WGCSE this year. The results of the final SCA model carried out last year are given in the text table below. The F multipliers required to achieve the potential $F_{msy}$ proxies, the harvest rates that correspond to those multipliers and the resulting level of spawner per recruit as a percentage of the virgin level.

| | | Fbar 20-40mm | | Harvest Rate | % Virgin Spawner per Recruit | |
|---|---|---|---|---|---|---|
| | | Female | Male | | Female | Male |
| $F_{0.1}$ | Comb | 0.06 | 0.17 | 7.2% | 64.3% | 39.4% |
| $F_{0.1}$ | Female | 0.11 | 0.31 | 9.1% | 49.7% | 25.4% |
| $F_{0.1}$ | Male | 0.05 | 0.14 | 6.4% | 68.8% | 44.8% |
| $F_{35}$ | Comb | 0.12 | 0.34 | 10.5% | 47.0% | 23.2% |
| $F_{35\%}$ | Female | 0.55 | 0.19 | 12.8% | 34.9% | 15.0% |
| $F_{35\%}$ | Male | 0.07 | 0.21 | 8.4% | 60.0% | 34.8% |
| $F_{max}$ | Comb | 0.12 | 0.34 | 11.1% | 47.0% | 23.2% |
| $F_{max}$ | Female | 0.56 | 0.19 | 13.0% | 34.5% | 14.8% |
| $F_{max}$ | Male | 0.09 | 0.26 | 9.8% | 54.1% | 29.2% |

This fishery is highly seasonal (see Annex), but the timing of the fishery has varied somewhat in recent years. In 2009 a larger proportion of the landings were taken in autumn leading to a change in sex ratio and size compared with 2008. This coupled with limited time-series of survey data and biological knowledge of the stock suggests that a risk adverse harvest rate would be appropriate.

Compared to other *Nephrops* fisheries in ICES area the absolute population density of this stock is relatively high Figure 6.5.9. This implies that sperm limitation if males are overfished is not likely to be a significant problem. The combined sex $F_{35\%\ SPR}$ would result in >20% males SPR and 47% female SPR. **The WGCSE and RGCSE 2010 concluded that a combined sex $F_{35\%}$ was a suitable $F_{msy\ proxy}$ for this stock. This corresponds to a harvest rate of 10.5%.**

### 7.5.6 Biological reference points

Precautionary reference points have not been defined for *Nephrops* stocks. Given the short time-series of UWTV survey data it is not possible to define an appropriate $B_{trigger}$. The combined sex$F_{35\%}$ SPR is proposed by the WG as proxy for $F_{msy}$.

### 7.5.7 Management strategies

As yet there are no explicit management strategies for this stock but there have been some discussions among the fishing industry and scientists about developing a long-term plan for the management of the Aran fishery. Sustainable utilization of the *Nephrops* stock will form the cornerstone of any management strategy for this fishery.

### 7.5.8 Uncertainties and bias in assessment and forecast

The SCA and YPR analysis carried out by WGCSE 2010 was based on 2008 and 2009 sampling, The fit to the SCA model was problematic, as discussed above, so harvest proxies are likely to be uncertain. The harvest ratio for the combined sex $F_{35\%}$ appears to be conservative relative to other stocks with similar burrow densities as noted by RGCSE 2010.

There are several key uncertainties and bias sources in the method proposed (these are discussed further in WK*NEPH* 2009 (ICES, 2009)). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups WKNEPTV 2007; WKNEPHBID 2008; SGNEPS 2009 (ICES, 2007, 2008, 2009). These recommendations have been retrospectively applied to historical survey estimates this year (Section 5.1) and these are now considered final. Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate but no more precise (*ICES*, 2009). The survey estimates themselves are likely to be fairly precisely estimated given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU17 are largely based on expert opinion. The precision of these cannot yet be characterized. Ultimately there still remains a degree of subjectivity in the production of UWTV indices.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU17 deterministic estimates of the mean weight in the landings and discard rates for 2008 and 2009 have been used since sampling data were not available for the previous two years. Historical data suggest parameters have been variable in the past (Table 7.5.6). In future years the uncertainty in these key parameters should be estimated.

Landings data are assumed to be accurate. Since 2007 the introduction of "buyers and sellers legislation" in Ireland is thought to have improved the accuracy of the reported landings.

Finally, the catch options developed do not have any additional catches for the smaller Slyne or Galway Bay Grounds. This is likely to cause a small (<3%) underestimate in the catch options for FU17 as a whole.

### 7.5.9 Recommendation for next benchmark

This stock was benchmarked in 2009. WK*NEPH* 2009 suggested several areas to be addressed before the next Benchmark. For this stock the inputs to the SCA analysis need further investigation given that growth and natural mortality parameters are assumed from the Irish Sea. Currently there is no recommended time frame for another benchmark but this stock should be benchmarked with other *Nephrops* stocks.

### 7.5.10 Management considerations

The trends from the fishery (landings, effort lpue, mean size, etc.) appear to be relatively stable. Lpues have been relatively high in the last three years. Conversely, the UWTV abundance and mean density estimates show large fluctuations in burrow abundance and harvest rates. This suggests that the *Nephrops* population at current exploitation and recruitment rates is rather dynamic. The generally low apparent harvest rate (9% average) appears to have little impact on observed stock fluctuations. A new survey point should be available after June 2011 which will provide a more up to date prognosis of stock status. The use of the most up to date survey information should be considered for this stock.

In recent years several newer vessels specializing in *Nephrops* fishing have participated in this fishery. These vessels target *Nephrops* on several other grounds within the TAC area and move around to optimize catch rates. Since the introduction of effort management associated with the cod long-term plan (EC 1342/2008) there have been concerns that effort will be displaced towards the Aran and other *Nephrops* grounds where effort control has not been put in place. This did not happen in 2009 as effort declined by 37% due to the decommissioning of several vessels that actively participated in the fishery. Effort increased again in 2010 but harvest rates remained below the $F_{msy}$ target.

### 7.5.11 References

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14.

ICES. 2008. Report of the Workshop and training course on *Nephrops* burrow identification (WKNEPHBID). ICES CM 2008/LRC:03.

ICES. 2009. Report of the Study Group on *Nephrops* Surveys (SGNEPS). ICES CM 2009/LRC: 15, pp 52.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* assessment (WKNEPH). ICES CM 2009/ACOM:33.

ICES. 2010. Report of the Working Group on the Celtic Seas Region (WGCSE) ICES CM 2009/ACOM:09.

**Table 7.5.1. *Nephrops* in FU17 (Aran Grounds). Landings in tonnes by country.**

| Year | France | Rep. of Ireland | UK | Total |
|---|---|---|---|---|
| 1974 | 477 | | | 477 |
| 1975 | 822 | | | 822 |
| 1976 | 131 | | | 131 |
| 1977 | 272 | | | 272 |
| 1978 | 481 | | | 481 |
| 1979 | 452 | | | 452 |
| 1980 | 442 | | | 442 |
| 1981 | 414 | | | 414 |
| 1982 | 210 | | | 210 |
| 1983 | 131 | | | 131 |
| 1984 | 324 | | | 324 |
| 1985 | 207 | | | 207 |
| 1986 | 147 | | 1 | 148 |
| 1987 | 62 | | 0 | 62 |
| 1988 | 14 | 814 | | 828 |
| 1989 | 27 | 317 | 3 | 347 |
| 1990 | 30 | 489 | | 519 |
| 1991 | 11 | 399 | | 410 |
| 1992 | 11 | 361 | 2 | 374 |
| 1993 | 11 | 361 | 0 | 372 |
| 1994 | 18 | 707 | 4 | 729 |
| 1995 | 91 | 774 | 2 | 867 |
| 1996 | 2 | 519 | 7 | 528 |
| 1997 | 2 | 839 | 0 | 841 |
| 1998 | 9 | 1401 | 0 | 1410 |
| 1999 | 0 | 1140 | 0 | 1140 |
| 2000 | 1 | 879 | 0 | 880 |
| 2001 | 1 | 912 | 0 | 913 |
| 2002 | 2 | 1152 | 0 | 1154 |
| 2003 | 0 | 933 | 0 | 933 |
| 2004 | 0 | 525 | 0 | 525 |
| 2005 | 0 | 778 | 0 | 778 |
| 2006 | 0 | 637 | 0 | 637 |
| 2007 | 0 | 913 | 0 | 913 |
| 2008 | 0 | 1050 | 7 | 1057 |
| 2009 | 0 | 625 | 0 | 625 |
| 2010 | 0 | 991 | 9 | 1000 |

**Table 7.5.2.** ***Nephrops*** **in FU 17 (Aran Grounds). Irish effort and lpue for** ***Nephrops*** **directed fleet.**

| | Irish *Nephrops* Directed Fleet | | |
|---|---|---|---|
| Year | Effort (Hrs) | Landings (tonnes) | Lpue (kg/hr) |
| 1995 | 15 306 | 530 | 34.6 |
| 1996 | 9109 | 311 | 34.1 |
| 1997 | 15 763 | 478 | 30.3 |
| 1998 | 21 909 | 926 | 42.3 |
| 1999 | 19 546 | 743 | 38.0 |
| 2000 | 17 131 | 547 | 31.9 |
| 2001 | 18 700 | 600 | 32.1 |
| 2002 | 18 565 | 861 | 46.4 |
| 2003 | 19 922 | 732 | 36.8 |
| 2004 | 12 899 | 381 | 29.5 |
| 2005 | 14 900 | 729 | 45.8 |
| 2006 | 10 798 | 559 | 51.8 |
| 2007 | 13 608 | 815 | 59.9 |
| 2008 | 16 676 | 963 | 57.8 |
| 2009 | 10 620 | 561 | 52.8 |
| 2010 | 16 199 | 875 | 54.0 |

**Table 7.5.3. *Nephrops* in FU17 (Aran Grounds). Landings and discard weight and numbers by year and sex.**

| | Female | | Male | | Both sexes |
|---|---|---|---|---|---|
| Year | Landings (t) | Discards (t) | Landings (t) | Discards (t) | % Discard |
| 2001 | 312 | 109 | 601 | 138 | 21% |
| 2002 | 423 | 96 | 729 | 99 | 14% |
| 2003 | 237 | 89 | 688 | 98 | 17% |
| 2004 | 267 | 71 | 259 | 45 | 18% |
| 2005 | 323 | 106 | 441 | 86 | 20% |
| 2006 | | | | | |
| 2007 | No Sampling | | | | |
| 2008 | 324 | 160 | 726 | 98 | 20% |
| 2009 | 90 | 130 | 726 | 134 | 24% |
| 2010 | 408 | 126 | 593 | 73 | 17% |
| | Female Numbers '000s | | Male Numbers '000s | | Both sexes |
| Year | Landings | Discards | Landings | Discards | % Discard |
| 2001 | 18,665 | 12,161 | 29,949 | 13,250 | 34% |
| 2002 | 23,105 | 9,374 | 31,256 | 8,326 | 25% |
| 2003 | 14,530 | 9,577 | 29,538 | 8,744 | 29% |
| 2004 | 16,109 | 7,068 | 12,930 | 4,282 | 28% |
| 2005 | 20,280 | 11,383 | 21,828 | 8,967 | 33% |
| 2006 | | | | | |
| 2007 | No Sampling | | | | |
| 2008 | 15,697 | 13,223 | 31,184 | 8,350 | 32% |
| 2009 | 3,084 | 7,485 | 20,421 | 8,218 | 40% |
| 2010 | 16,894 | 8,000 | 24,075 | 5,336 | 25% |

**Table 7.5.4. *Nephrops* in FU17 (Aran Grounds). Mean size trends for catches and whole landings by sex.**

| | Catches | | Catches | | Whole Landings | | | |
|---|---|---|---|---|---|---|---|---|
| | <35 mm CL | | >35 mm CL | | <35 mm CL | | >35 mm CL | |
| Year | Males | Females | Males | Females | Males | Females | Males | Females |
| 1995 | na | na | na | na | 32.0 | 31.8 | 38.3 | 37.0 |
| 1996 | na | na | na | na | 31.1 | 32.1 | 37.8 | 37.4 |
| 1997 | na | na | na | na | 31.9 | 32.0 | 37.8 | 37.4 |
| 1998 | na | na | na | na | 31.3 | 31.7 | 38.0 | 37.2 |
| 1999 | na | na | na | na | 31.3 | 32.3 | 38.0 | 37.1 |
| 2000 | na | na | na | na | 32.0 | 31.4 | 38.4 | 36.3 |
| 2001 | 28.9 | 27.5 | 38.0 | 37.3 | na | na | na | na |
| 2002 | 30.7 | 29.1 | 38.2 | 37.2 | na | na | na | na |
| 2003 | 30.5 | 27.4 | 38.2 | 38.0 | na | na | na | na |
| 2004 | 29.3 | 28.3 | 37.3 | 37.5 | na | na | na | na |
| 2005 | 28.9 | 27.7 | 37.8 | 37.2 | na | na | na | na |
| 2006 | No Sampling | | | | | | | |
| 2007 | | | | | | | | |
| 2008 | 27.4 | 29.7 | 36.8 | 37.8 | na | na | na | na |
| 2009 | 30.3 | 28.4 | 38.0 | 37.1 | na | na | na | na |
| 2010 | 30.2 | 29.6 | 38.7 | 37.3 | na | na | na | na |

**Table 7.5.5. *Nephrops* in FU17 (Aran Grounds). Results summary table for geostatistical analysis of UWTV survey.**

| Ground | Year | Number of stations | Mean Density (No./M2) | Domain Area (km2) | Geostatistical abundance estimate (million burrows) | CV on Burrow Estimate |
|---|---|---|---|---|---|---|
| Aran | 2002 | 49 | 0.84 | 943 | 818 | 4% |
| | 2003 | 41 | 1.01 | 943 | 989 | 5% |
| | 2004 | 64 | 1.43 | 943 | 1397 | 3% |
| | 2005 | 70 | 1.09 | 936 | 1063 | 3% |
| | 2006* | 67 | 0.64 | 932 | **616** | 3% |
| | 2007 | 71 | 0.93 | 942 | 906 | 3% |
| | 2008* | 63 | 0.56 | 906 | **536** | 3% |
| | 2009 | 82 | 0.73 | 940 | 718 | 2% |
| | 2010 | 91 | 0.85 | 937 | 827 | 2% |

* Minor data revision due to transfer of data to SQL server

**Results summary table for empirical statistical analysis of UWTV survey**

| Ground | Year | Number of stations | Mean Density (No./M2) | Area Surveyed (m2) | Burrow count | Standard Deviation | 95%CI | CV |
|---|---|---|---|---|---|---|---|---|
| Galway Bay | 2002 | 7 | 1.58 | 1,299 | 2,017 | 0.37 | 0.34 | 9% |
| | 2003 | 3 | 1.60 | 591 | 941 | 0.29 | 0.73 | 11% |
| | 2004 | 9 | 0.73 | 2,312 | 1,625 | 0.42 | 0.32 | 19% |
| | 2005 | 4 | 1.67 | 661 | 1,107 | 0.20 | 0.32 | 6% |
| | 2006 | 3 | 0.98 | 540 | 522 | 0.27 | 0.67 | 16% |
| | 2007 | 5 | 1.14 | 890 | 992 | 0.24 | 0.29 | 9% |
| | 2008 | 10 | 0.42 | 1,907 | 859 | 0.31 | 0.22 | 23% |
| | 2009 | 8 | 0.93 | 1,207 | 1,116 | 0.16 | 0.14 | 6% |
| | 2010 | 10 | 1.61 | 1,284 | 1,757 | 0.43 | 0.31 | 9% |
| Slyne Grounds | 2002 | 5 | 0.85 | 1,216 | 1,027 | 0.19 | 0.23 | 10% |
| | 2003 | 0 | - | - | - | - | - | - |
| | 2004 | 3 | 0.68 | 827 | 531 | 0.27 | 0.66 | 23% |
| | 2005 | 3 | 0.55 | 531 | 294 | 0.05 | 0.13 | 6% |
| | 2006 | 3 | 0.41 | 526 | 210 | 0.20 | 0.49 | 28% |
| | 2007 | 4 | 0.63 | 838 | 547 | 0.31 | 0.49 | 24% |
| | 2008 | 0 | - | - | - | - | - | - |
| | 2009 | 6 | 0.40 | 531 | 144 | 0.22 | 0.23 | 22% |
| | 2010 | 9 | 0.74 | 1,117 | 928 | 0.43 | 0.33 | 20% |

*random stratified estimates are given for the Slyne Head and Galway Bay grounds

**Table 7.5.6. *Nephrops* in FU17 (Aran Grounds). Forecast inputs (bold) and historical estimates of mean weight in landings and harvest ratio. Removals estimated in years with no sampling (shaded) using ratio of removals to landings in adjacent years.**

| Year | Landings in Number (millions) | Discards in Number (millions) | Removals in Number (millions) | Prop Removals Retained | Adjusted Survey (millions) | Harvest Ratio | Landings (t) | Discards (t) | Mean Weight in landings (gr) |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 48.7 | 25.4 | 71.6 | 0.68 | | | 912 | | |
| 2002 | 54.5 | 17.7 | 70.4 | 0.77 | 629 | 11.2% | 1,152 | 192 | 21.2 |
| 2003 | 44.1 | 18.3 | 60.6 | 0.73 | 761 | 8.0% | 933 | 183 | 21.2 |
| 2004 | 29.0 | 11.4 | 39.3 | 0.74 | 1075 | 3.7% | 525 | 112 | 18.1 |
| 2005 | 42.4 | 19.7 | 60.1 | 0.70 | 818 | 7.4% | 778 | 182 | 18.4 |
| 2006 | na | na | 49.5 | na | 474 | 10.4% | 636 | na | na |
| 2007 | na | na | 57.3 | na | 697 | 8.2% | 913 | na | na |
| 2008 | 46.9 | 21.6 | 66.3 | 0.71 | 412 | 16.1% | 1,050 | 245 | 22.4 |
| 2009 | 23.5 | 15.7 | 37.6 | 0.62 | 552 | 6.8% | 625 | 256 | 26.6 |
| 2010 | 41.0 | 13.3 | 53.0 | 0.77 | **636** | 8.3% | 1,000 | 194 | 24.4 |
| Avg 08-10 | | | | **0.70** | | | | | **24.46** |

**na= not available due to non-cooperation with sampling programmes.**

**Shading indicates removal estimated based on combined 2005 and 2008 numbers-at-length scaled appropriately to landings in 2006 and 2007. The commensurate harvest ratio estimate is also shaded.**

**Table 7.5.7.** ***Nephrops*** **in FU 17 (Aran Grounds). Catch option table for 2012.**

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Survey Index (millions) | Retained number (millions) | Landings (tonnes) |
| MSY framework | 10.5% | 636 | 47 | 1,146 |
| $F_{2010}$ | 10.4% | 636 | 46 | 1,134 |
| $F_{0.1\ Combined}$ | 7.2% | 636 | 32 | 786 |
| $F_{max\ Combined}$ | 11.1% | 636 | 50 | 1,212 |
| | 0% | 636 | 0 | 0 |
| | 2% | 636 | 9 | 218 |
| | 4% | 636 | 18 | 437 |
| | 6% | 636 | 27 | 655 |
| | 8% | 636 | 36 | 873 |
| | 10% | 636 | 45 | 1,092 |
| | 12% | 636 | 54 | 1,310 |

| | | Basis |
|---|---|---|
| Landings Mean Weight (Kg) | 0.0245 | Sampling 2008–2010 |
| Survey Overestimate Bias | 1.30 | WKNEPH 2009 |
| Survey Numbers (Millions) | 827 | UWTV Survey 2010 |
| Prop. Retained by the Fishery | 0.70 | Sampling 2008–2010 |

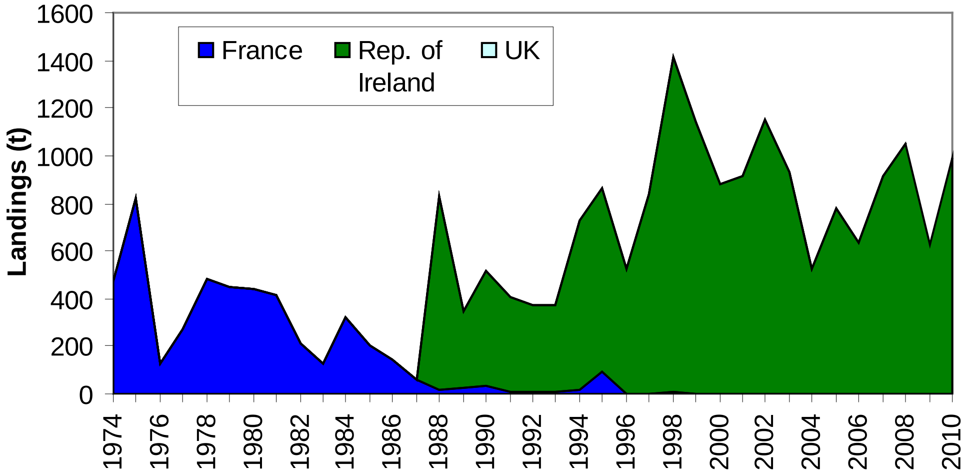



**Figure 7.5.1. *Nephrops* in FU17 (Aran Grounds). Landings in tonnes by country.**

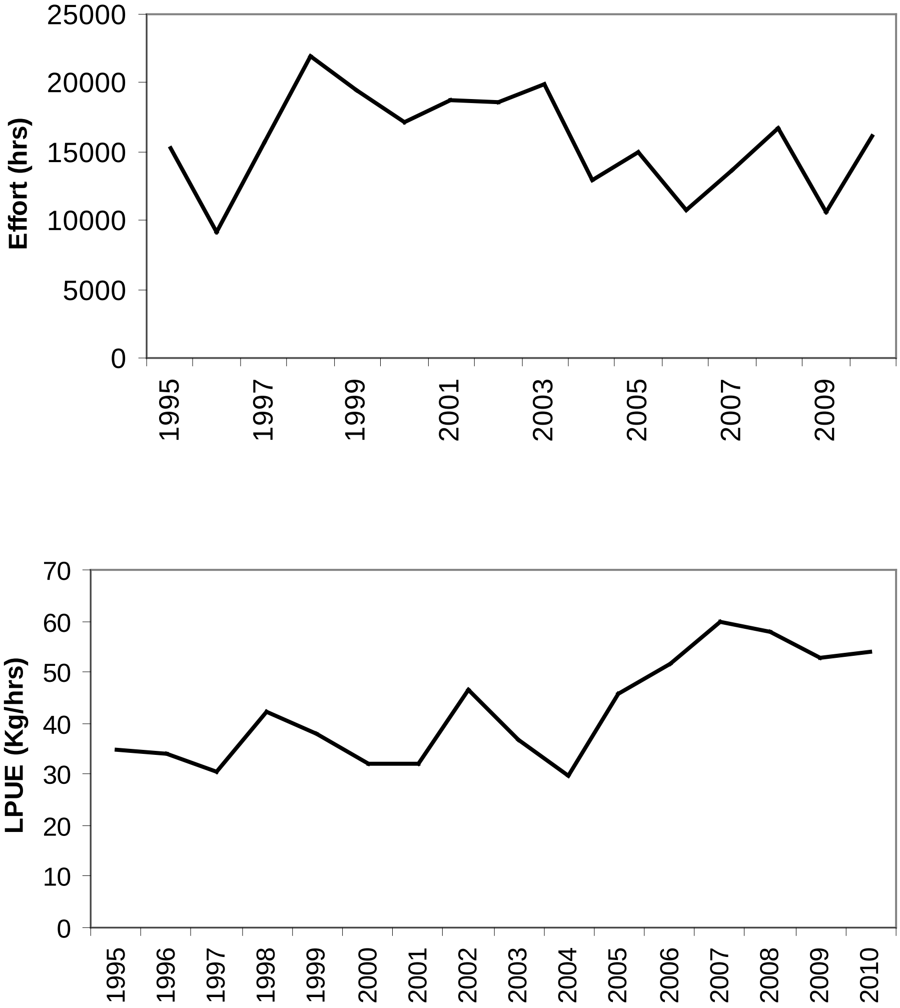



**Figure 7.5.2.** ***Nephrops*** **FU17 Aran Grounds. Irish effort and lpue for** ***Nephrops*** **directed fleet.**

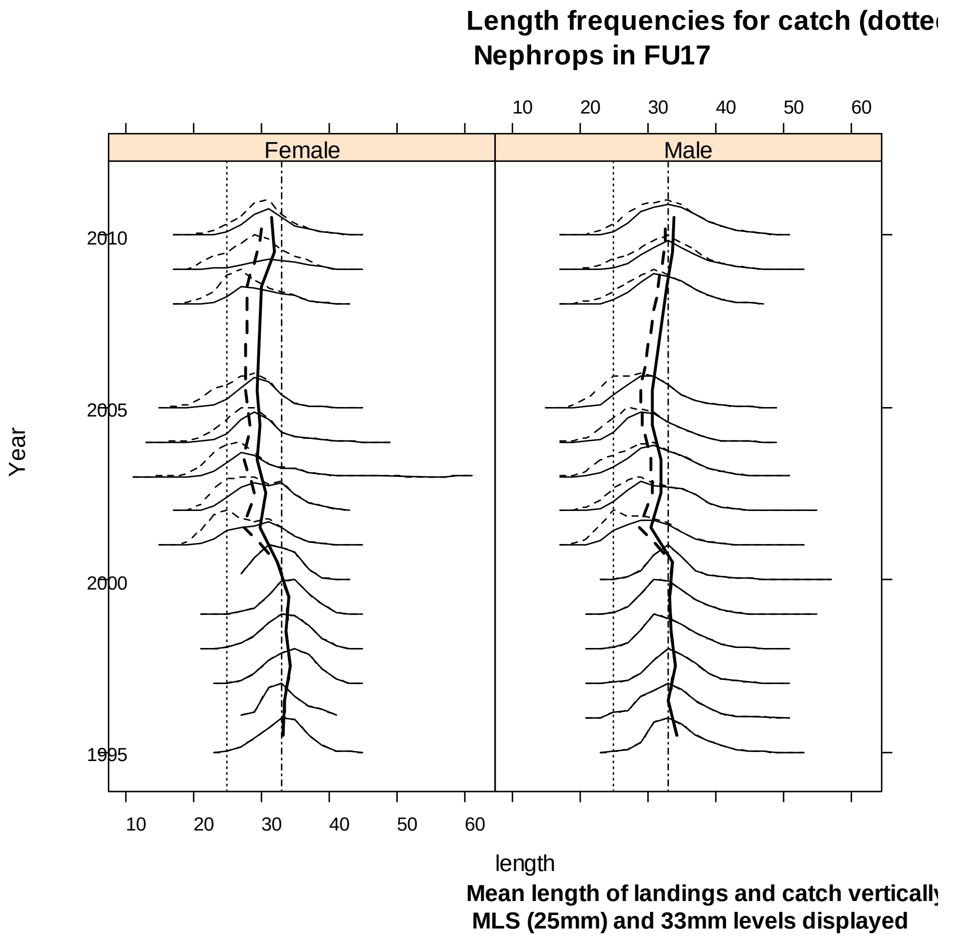



**Figure 7.5.3.** ***Nephrops*** **FU17 Aran Grounds. Length distributions in the catches 2001–2005, 2008–2010 and in the landings 1995–2001.**

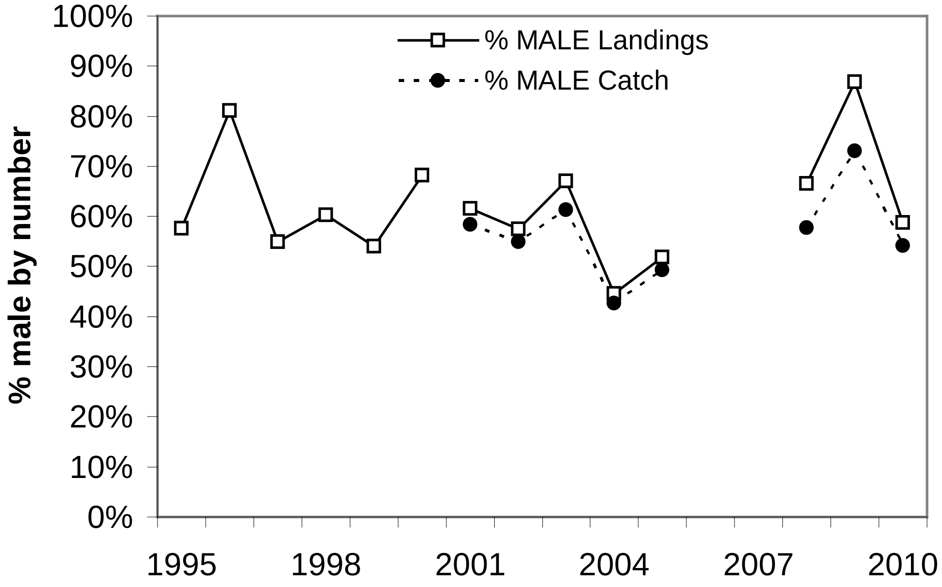



**Figure 7.5.4.** ***Nephrops*** **in FU17 (Aran Grounds). Sex ratio of whole landings (1995–2000), landings (2001–2010) and catch (2001–2010).**

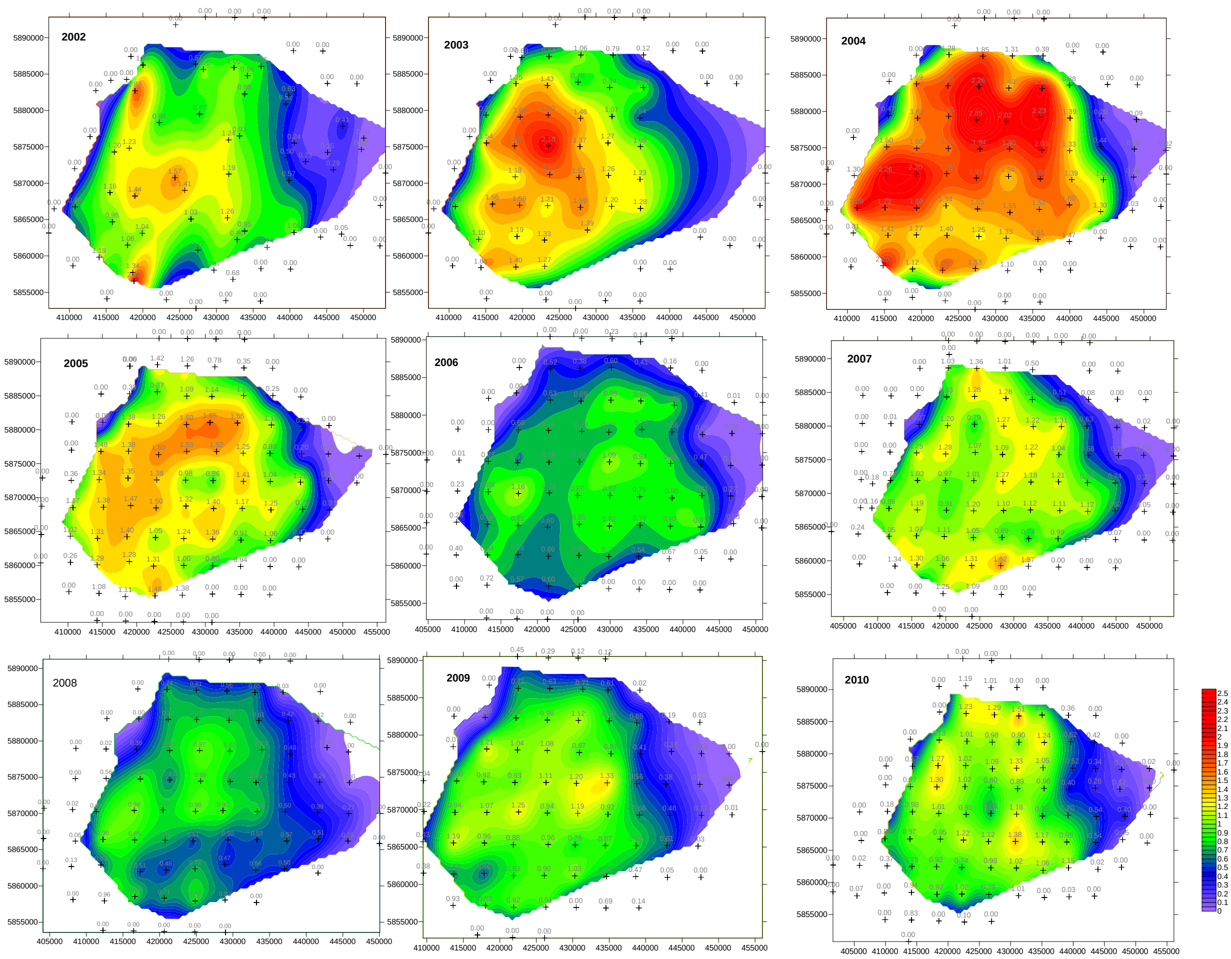



**Figure 7.5.5.** ***Nephrops*** **in FU17 (Aran Grounds). Contour plots of the krigged density estimates for the Aran Ground UWTV surveys from 2002–2010.**

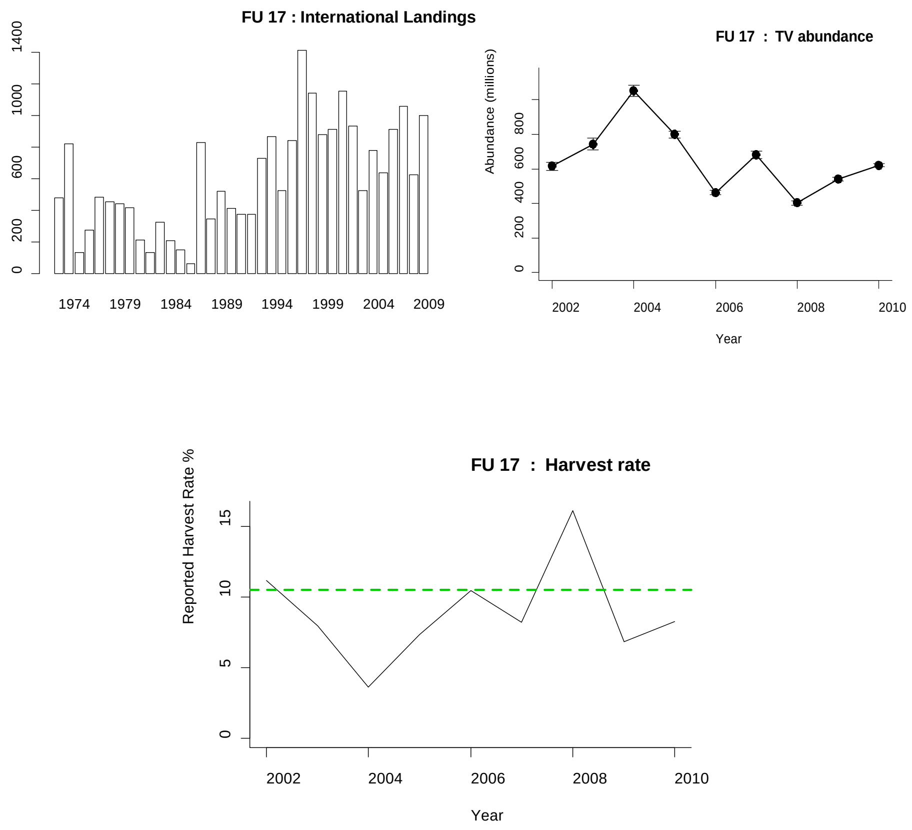



**Figure 7.5.6.** ***Nephrops*** **FU17 Aran Grounds. Stock Summary plots: Landings (tonnes), UWTV abundance (millions) and Harvest Ratio (% dead removed/UWTV abundance).**

## 7.6 *Nephrops* in Division VIIb,c,j,k (Porcupine Bank, FU16)

### Type of assessment in 2011

This year the Working Group updated the fishery information, survey data and other indicators for *Nephrops* in Division VIIbcjk. There has been a deterioration in the sampling information from the landings in recent years due larger proportions of the catches landed in frozen grades. There have been significant changes in fishing practices. The recruit observed in the survey and commercial catches last year has been confirmed by the 2010 survey. The switch towards larger proportions of females in the landings has been reversed in 2010. Mean size in the landings remains high. The stock was over exploited and declining but the new recruitment offers an opportunity to rebuild the stock if exploitation rates can be kept low.

### ICES advice applicable to 2010

*"ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that catches in 2010 should be reduced to the lowest possible level."*

### ICES advice applicable to 2011

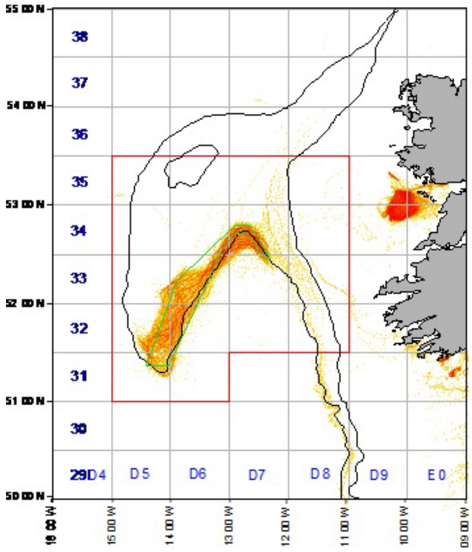
*" MSY approach*

*Catches in 2011 should be reduced to the lowest possible level to allow the incoming recruitment to rebuild the stock."*

### 7.6.1 General

#### Stock description and management units

The TAC area is Subarea VII in 2011 and 'of which' clause has been introduced specifically for the Porcupine Bank. The quota share by country was determined by relative stability for the TAC but discussions are ongoing to develop an alternative allocation scheme. The Functional Unit for assessment includes some parts of the following ICES Divisions VIIb, c, j, and k. The exact stock area is shown on the map below and includes the following ICES Statistical rectangles: 31–35 D5–D6; 32–35 D7–D8.




The FU16 outlined by the red line. The closed area from 01/05/10–31/07/10 and 01/05/11–31/07/11 is shown with a green line. Irish *Nephrops* directed fishing effort between 2006–2009 derived from integrated VMS and logbook information is shown as a heat map.

### Management applicable to 2010 and 2011

**TAC in 2010**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 346 | |
| France | 5 455 | |
| Ireland | 8 273 | |
| United Kingdom | 7 358 | |
| EU | 22 432 | |
| TAC | 22 432 | Analytical TAC |

**TAC in 2011**

| Species: Norway lobster *Nephrops norvegicus* | | Zone: VII (NEP/07.) |
|---|---|---|
| Spain | 1 306 ([1]) | |
| France | 5 291 ([1]) | |
| Ireland | 8 025 ([1]) | |
| United Kingdom | 7 137 ([1]) | |
| EU | 21 759 ([1]) | |
| TAC | 21 759 ([1]) | Analytical TAC |

([1]) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

| | |
|---|---|
| Spain | 75 |
| France | 305 |
| Ireland | 463 |
| United Kingdom | 411 |
| EU | 1 254 |

### Closed area restrictions

A seasonal closed area was introduced in 2010 and is also in place in 2011. The closed area is shown in the map above. The specific coordinates and conditions of the closed area are given below (EC 57/2011).

*Article 13*

**Restrictions on the use of certain fishing opportunities**

1. The fishing opportunities fixed in Annex I for tusk, cod, megrim, anglerfish, haddock, whiting, hake, blue ling, ling, Norway lobster, plaice, pollack, saithe, skates and rays, sole and spurdog in ICES subarea VII or relevant divisions thereof, shall be restricted by the prohibition to fish or retain onboard any such species during the period from 1 May to 31 July 2011 in the Porcupine Bank. The relevant Annex I entries are identified by cross-reference to this Article.

| Point | Latitude | Longitude |
|---|---|---|
| 1 | 52° 27′ N | 12° 19′ W |
| 2 | 52° 40′ N | 12° 30′ W |
| 3 | 52° 47′ N | 12° 39,600′ W |
| 4 | 52° 47′ N | 12° 56′ W |
| 5 | 52° 13,5′ N | 13° 53,830′ W |
| 6 | 51° 22′ N | 14° 24′ W |
| 7 | 51° 22′ N | 14° 03′ W |
| 8 | 52° 10′ N | 13° 25′ W |
| 9 | 52° 32′ N | 13° 07,500′ W |
| 10 | 52° 43′ N | 12° 55′ W |
| 11 | 52° 43′ N | 12° 43′ W |
| 12 | 52° 38,800′ N | 12° 37′ W |
| 13 | 52° 27′ N | 12° 23′ W |
| 14 | 52° 27′ N | 12° 19′ W |

3. By way of derogation from paragraph 1 of this Article, transit through the Porcupine Bank, carrying onboard the species referred to in that paragraph, shall be permitted in accordance with Article 50(3), (4) and (5) of Regulation (EC) No 1224/2009.

The following TCMs are in place for *Nephrops* in VII (excluding VIIa) after EC 850/9 in operation since 2000:

Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Although it is legal to land smaller prawns from this fishery, marketing restrictions imposed by producer organizations in France mean smaller *Nephrops* (< 35 mm CL or 115 mm whole length) are not retained in this fishery.

The mesh size restrictions apply to towed gears in VIIb–k targeting *Nephrops and* are given in Section 7.1. Vessels mainly used 80–99 mm mesh to target *Nephrops* on the Porcupine Bank.

#### Fishery in 2010

Historically *Nephrops* fisheries in this area are very seasonal and rather sporadic, mainly targeting *Nephrops* when available and when weather conditions are good. Total international landings increased by ~10% in 2010 to 917 t (Figure 7.6.1 and Table 7.6.1).

#### Effect of regulations

Landings for the TAC area (Subarea VII) are undershot (Table 7.8.4). UK and Irish national quotas are usually restrictive but uptake by France and Spain is well below their quotas due to changes in relative landings from different FUs within this TAC area (Section 7.1). In the past TACs and quotas applied to the whole of VII. This has not restricted the FU16 fishery. A closed implemented in 2010 and again in 2011 is coincident with a time period where the majority of annual international landings have been taken in recent years (see text table below). The closure is therefore expected to be quite effective at reducing fishing mortality within the closed area. An analysis of VMS effort data in 2010 illustrates that considerable effort was displaced to the part of the *Nephrops* ground not fully covered by the closure (Figure 7.6.2). The closure therefore afforded some protection to the majority of the stock area (~75%). For this part of the stock area fishing effort and mortality will have been reduced at a time of peak female emergence and typically high lpue and landings. The closure will also have inadvertently concentrated effort and fishing mortality ~25% of the stock area not covered by the closure. In August 2010 fishing resumed in the closed part of the ground and catch rates were reported to be high.

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2003–2008 |
|---|---|---|---|---|---|---|---|
| % of annual Int. landings taken May–July | 60% | 53% | 64% | 54% | 67% | 68% | 61% |

### 7.6.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

Length compositions of annual landings are available from Spain (1986–2009), France (1995–2007) and Ireland (1995–2005 and 2008–2010). No sampling was possible in 2006 and 2007 for Ireland due to the withdrawal of cooperation with scientific sampling programmes by the fishing industry. Sampling in Ireland resumed in 2008 but sampling levels have been low (only three samples in 2010). There was no sampling in France in 2008 and 2009 due to low landings. Sampling intensity in Spain was extremely low in 2008 and 2009 (two and five samples) with no sampling in 2010.

Sampling of *Nephrops* in this area is hampered by several factors:

- The remote nature of the fishery.
- Trips are long duration sometimes fishing in multiple areas.
- An increasing proportion of the landings are landed frozen and graded at sea making access to samples problematic.
- There is reluctance from fishermen and processors to allow sampling of landings due to high value of the larger *Nephrops* and the risk of damage to individuals during sampling.

These issues need to be resolved as current sampling intensity is insufficient to get precise and accurate length structure data of the catches. In 2010 data on the grade composition of the landings have been provide for some Irish vessels and this has been used to reconstruct the size distribution of the landings for around 25% of the total landings (see information form industry). Despite the low sampling intensity in recent years, the recent trends in indicators such as length and sex ratio are consistent across all countries and in the survey (Figure 7.6.3).

### Landings

Data on the mean size (carapace length, CL) of male and female *Nephrops* in the landings are available from Spain, France and Ireland (Table 7.6.2, Figure 7.6.3). The longest time-series are from Spain and, prior to 2002, these have been quite stable at between 39 and 43 mm CL for the males, and between 34 and 38 mm CL for the females. Since 2002 there has been an increasing trend in the mean size in the landings. Mean *Nephrops* sizes in French landings also show an increasing trend in both sexes. Mean sizes in the landings of Irish trawlers are more variable but clearly show increasing trend over the last number of years.

Raised frequency distributions of the sampled landings by sex are given in Figure 7.6.4. This also shows significant shift towards larger individuals in the landings since 2002 and few individuals at smaller sizes. The 2009 data for males shows a recruiting year class entering the landings at ~35 mm CL this year class is also apparent in the 2010 data. This is the first time in the time-series a very obvious year-class signal has appeared in the landings–length distributions (though there are possibly other YC appearing at a slightly large size in other years).

It is difficult to extract other useful signals in the length frequency distributions plot, so for males a number of indicators were calculated (Figure 7.6.5). These included a recruitment proxy (% of males <32 mm CL), and percentage of larger individuals (>50 mm CL) in the sampled landings. An exploitation proxy was calculated using the slope of ln(CL) vs. ln(Numbers) between 41–56 mm CL i.e. the slope of downward limb on the Right-Hand-Side of the length frequency distribution (Figure 7.6.6).

These indicators suggest the following: recruitment has fluctuated in the past and recruitment in the last five years (2004 to 2008) has probably been very weak. The recruitment proxy in 2009 and 2010 was around average (note: this conclusion is relatively insensitive to length threshold). The fishery in recent years has exploited a larger proportion of larger individuals than ever before in the time-series. The exploitation proxy shows an increasing trend (i.e. steepness) since the early 2000s. The exploitation proxy in 2010 declined from the highest in the series observed in 2009.

### Discards

There are few historical estimates of discards for this stock. Recent Irish sampling has shown discarding to be minimal mainly limited to small and damaged individuals <5% by number. This situation may well change due to restrictive vessel quotas in 2011.

### Biological

Previous working groups have highlighted stability in sex ratio as an important indicator for *Nephrops* stocks. In the most recent years the sex ratio in the landings and survey catches has been unstable (Figure 7.6.7). The change in sex ratio in the landings is strongly influenced by the re-availability of Irish sampling data since 2007. In the past Irish vessels have tended to land a greater proportion of female *Nephrops* than either the French or Spanish fleet so the situation may be exaggerated somewhat. The fishery-independent survey catches also show larger proportions of females in the catches between 2007–2009. Both the commercial and survey data indicate that sex ratio switched back to a more usual situation in 2010 with males accounting for larger proportions of the catch.

*Nephrops* moult once a year shortly after hatching of eggs in April or May. There is a 24 horr period after moulting when the male *Nephrops* can mate with the female (Farmer, 1974). It has been suggested that insufficient males in the population to mate with the recently moulted females can result in a change in female behaviour whereby unmated females concentrated on feeding and growth instead of reproduction. This so called "sperm limitation" could explain the sex ratio changes observed in the Porcupine *Nephrops* in recent years although this has not been confirmed through sampling. A similar switch to female dominated catches has also been observed in the Farn Deeps in recent years (ICES, 2010). The return to a more usual male dominated sex ratio is a positive sign and may well be linked to maturation of the recent good recruitment (see below). The $L_{50}$ or length at 50% maturity of 30 mm observed during 2010 (WD 03) was very similar to previous observations for Irish catches from this stock (Lordan, unpublished data) albeit slightly higher than the 28.3 mm previously reported for Spanish catches (González Herraiz and Fariña, 2005). If 'sperm limitation' was a problem in 2007 and 2008 this will have an impact on larval production and subsequent recruitment success.

There are no changes to other biological parameters for this stock and they are not relevant to the current trends based assessment.

#### Surveys

The main fishery-independent source of data is from the Spanish Porcupine trawl survey (SpPGFS-WIBTS-Q4). Further information on this survey is provided in the IBTS report (ICES, 2009) and in previous IBTS reports. Catchability of *Nephrops* in trawl surveys is typically an issue due to variable emergence patterns of *Nephrops* from their burrows (ICES, 2007). However, this stock is found in deep water where animals are known to emerge mainly during the day. Survey hauls are only conducted during the day and the survey is scheduled for the same time each year, thus minimizing variability due to seasonal emergence patterns.

Distribution of *Nephrops* catches and biomass in Porcupine surveys between 2001 and 2010 are shown in Figure 7.6.8. There may well be a year effect in 2008 when unusual gear parameters were observed other than that the survey gives consistent a fairly consistent information. The recruitment in 2009 in one particular area of the ground appears to be more widespread (Figure 7.6.8). The stratified abundance estimate and biomass increased significantly in 2010 and are now the highest on the short series (Figure 7.6.9).

The size structure of the catches in the survey shows two things: a much lower mean size than in the commercial fleets and an increasing trend in mean size for both sexes up to 2008 (Table 7.6.2, Figure 7.6.10, WD 03). In 2009 there is large reduction of mean size in both sexes due to a recruiting year class with a modal length at around 27 mm. In 2010 the modal length of this year class increased to ~36 mm significantly faster than previous growth estimates from MIX analysis (Hillis and Geary, 1990).

An Irish Fisheries Science Research Partnership (IFSRP) survey was developed in consultation the Irish fishing industry to obtain data from the closed area in 2010 (see WD 03). Altogether 46 hauls were carried out and the results indicate high cpue for the survey relative to recent observations at that time of year for the Irish fleet. Strong patterns in size and sex ratio were observed spatially over the ground with larger individuals and males becoming more prevalent in catches to the southwest of the ground. The male biased sex ratio and size-at-maturity observed in July 2010 was similar to historical observation for the stock. The size distributions of the catches are very different from the September Spanish survey in the area indicating selectivity differences between the surveys.

#### Commercial cpue

In the past the *Nephrops* fishery on the Porcupine Bank was both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather. Freezing of catches at sea has become increasingly prevalent since 2006 and the fishery now operates throughout the year, mainly targeting larger *Nephrops* in lower volumes. Fishing effort has fluctuated considerably in the recent past in response to availability of *Nephrops*.

Effort and lpue data are generally not standardized, and hence do not take into account vessel capacity, efficiency, seasonality or other factors that may bias perception of lpue and abundance trends over the longer term. These data are presented by country in Table 7.6.3 and Figure 7.6.11. Note: Irish and French effort is in hours and Spanish effort is power adjusted and is reported in thousands of day*BHP/100.

The effort index for the Spanish fleet (all gears) operating in Porcupine shows a steady decline from the 1970s until the early 1990s. Since then Spanish effort has declined more gradually. *Nephrops* lpue data for the Spanish fleet (all gears) shows a general declining trend until 2003. In 2004 and 2005 lpue increased rapidly, probably due to increased targeting of *Nephrops*, before declining again 2006.

Fishing effort for French *Nephrops* vessels[1] has fluctuated widely with peaks in the mid 1980s and through the late 1990s. Effort in 2009 was the lowest in the series. Lpue data for the French fleet in FU16 were high in the 1980s but declined with fluctuations to a series low in 2008.

Fishing effort data for the Irish otter trawl *Nephrops* directed fleet[2]. Increased rapidly over the period 2003–2007 due to increase targeting. Effort remains higher in 2010 than at the start of the series. Lpue has increased a little in 2010.

A detailed analysis of Irish lpue data was carried out in 2011 following discussions with the industry about changing fishing patterns and the accuracy of lpue as an indicator of stock abundance (WD 12). The main conclusion of the analysis was as follows: It remains possible that the long lpue trend is biased in the past and not reflective of stock abundance given the observed differences in size structure throughout the ground. While targeting behaviour and fleet composition has changed significantly over time including vessel, spatial and temporal explanatory variables in the lpue models does not significantly alter the long-term trends. There is an upturn in lpues in 2010 despite the closure of the majority of the area during months with relatively high lpues suggesting that without the closure the lpue increase in 2010 may have been higher.

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[1] where *Nephrops* constituted 10% of the landed value.

[2] A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the landing and effort of this fleet.

#### Information from the fishing industry

A meeting was held prior to WGCSE with some of the main Irish vessels operating in the fishery. The industry view is that the Irish lpue data is biased by changing fishing practices. This was explored by WD 12 and summarized above. The industry opinion was that the size and sex ratio trends in landings data would also be affected by targeting behaviour. The industry expressed a view that the drop in sex ratio in 2009 was exaggerated in ICES statistics compared with their observations. Recent sampling data have been sparse as discussed in Section 7.6.2. In response some vessels gave a detailed breakdown of size grade and sex composition of their landings in 2010 and the first few months of 2011. These data were used to reconstruct size composition of ~25% if the Irish landings in 2010.

These reconstructions proved sensitive to the choice of mean and standard deviation parameters for the normal distributions at each grade. Three different modelling approaches were investigated at WGCSE:

1 ) Using the observed means and standard deviation based on 2011 grade sampling.
2 ) Using the observed means and adjusting standard deviations of the grades to model observed LFD distribution on the 2010 IFSRP survey (WD 03) from grade compositions.
3 ) Using grade midpoints and modelled standard deviations.

Figure 7.6.12 illustrates the differences in different resulting length frequency distributions from the three approaches. The text table below summarizes the impact of these on the stock indicators currently used by WGCSE. All three methods result in a very similar estimate of mean CL and % >= 50 mm. These are significantly different from other samples in 2010. The exploitation and recruitment proxies are slightly more variable but similar to 2010 sampling.

| Method | Mean Carapace Length (mm) | % >=50mm | Recruit Proxy %<32mm | Exploitation Proxy |
|---|---|---|---|---|
| 1 | 36.6 | 4% | 13% | 0.12 |
| 2 | 36.6 | 4% | 10% | 0.11 |
| 3 | 36.3 | 4% | 14% | 0.14 |
| 2010 Sampling | 48.9 | 20% | 10% | 0.15 |

WGCSE concluded that the grade composition of the landings can be used to accurately reconstruct size distributions of the landings provided sampling to assess the parameters of each market sizedgrade carried out in parallel. If the industry can provided a breakdown of grades landed in future this will address a key data deficiency for this stock.

### 7.6.3 Stock assessment

The assessment is based on multiple lines of evidence from several indicators. The available data includes commercial landings compositions for males and females from the main fleets. Catch rates and length distributions from the Spanish Porcupine Bank survey (2001–2010,) along with lpue and effort data for the main fleets.

#### Comparison with previous assessments

The assessment is based on similar indicators to those used in 2010. The additional data shows some improvement in stock status due to a new recruitment to the fishery and survey in 2009 and 2010. The sex ratio has returned to a more usual situation where males account for a larger proportion of commercial and survey catches.

This fishery-independent information from the Spanish survey (SpPGFS-WIBTS-Q4) has proven increasingly important for this stock. The survey indices in abundance and biomass are the highest observed in the series (from 2001).

#### State of the stock

The main state of the stock indicators are shown in Figure 7.6.13. Effort, landings and size distribution indicate that exploitation rate has been high in the last seven years. Survey information indicates that recruitment to the fishery has been very weak between 2004 and 2008 and the stock declined to a low level. The average recruitment observed in the 2009 survey has resulted in increased survey abundance and biomass in 2010. The marked decline in the proportion of males (observed in the catches between 2007–2009) may impair future recruitment in the short term.

Landings per unit of effort (lpue) show a generally declining trend in most fleets over the time-series available and reached their lowest levels in the early 2000s. Since then lpue have been fluctuating. This may reflect longer term declines in stock abundance.

### 7.6.4 Short-term projections

There is no possibility to forecast catches in the short term using the available stock indicators. Recruitment may be impaired in the near future if sperm limitation occurred during 2008 and 2009.

### 7.6.5 MSY explorations

It has not been possible to carry out explorations of MSY targets for this stock but given the recent stock indicators the stock is probably exploited well above MSY levels.

### 7.6.6 Biological reference points

There are no reference points defined or agree for this stock.

### 7.6.7 Management plans

There is no management plan for this stock.

### 7.6.8 Uncertainties and bias in assessment and forecast

Despite the poor recent sampling all size data from the commercial fleets show similar trend towards increasing mean size as does the fishery-independent survey. All information points to poor recruitment prior to 2009 and an increasing reliance of the fishery up to 2009 on larger individuals with a high female component. The situation changed in 2010 with new recruitment entering the fishery.

### 7.6.9 Recommendation for next benchmark

There needs to be improved sampling of catches for this stock. Sampling levels are currently low and several factors complicate sampling (see Section 7.6.2).

In the short term the survey may be the most appropriate method of monitoring stock status. The development of full analytical assessment would require better growth information and an improvement in sampling of catches. Spatially explicit landings and effort data, either by rectangle or at finer resolution by gear from all countries would also be useful.

Currently there are no plans to benchmark this stock before 2013.

### 7.6.10 Management considerations

*Nephrops* on the Porcupine Bank are fished in relatively deep waters over a widespread area where they occur at low abundance. Given the sedentary nature of *Nephrops* populations the closed area as introduced in 2010 can be an appropriate management tool to substantially reduce catches and fishing mortality allowing the stock to recover. An analysis of the spatial dynamics if the fleet during the closure in 2010 shows that the closure was respected and is expected to have been quite effective at reducing fishing mortality for ~70% of the stock area. Some fishing effort during May–July was displaced to the remaining 30% of the stock area not covered by the closure in 2010 in advertently resulting in increased fishing mortality on that component of the stock. The overall impact of the closure is difficult to quantitatively assess.

Productivity of deep-water *Nephrops* stocks is generally lower than that in shelf waters, though individual *Nephrops* grow to relatively large sizes and attain high market prices. Other deep-water *Nephrops* stocks off the Spanish and Portuguese coast have collapsed and have been subject to recovery measures for several years e.g. FU25, 26, 27 and 31. Recruitment in *Nephrops* populations in deep water may be more sporadic than for shelf stocks with strong larval retention mechanizms. This makes these stocks more vulnerable to over exploitation and potential recruitment failure as has been observed on the Porcupine Bank over the last decade. The strong recruitment observed in catches since 2009 offers an opportunity to rebuild this stock.

### 7.6.11 References

González Herraiz, I. and Fariña A.C. 2005. Approach to the realized fecundity of *Nephrops norvegicus* in the Porcupine Bank. ICES CM 2005/Q:24.

ICES. 2007. Report of the Workshop on the use of UWTV surveys for determining abundance in *Nephrops* stocks throughout European waters (WKNEPHTV). ICES CM: 2007/ACFM: 14 Ref: LRC, PGCCDBS.

ICES. 2010. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 5–11 May 2010, ICES Headquarters, Copenhagen. ICES CM 2010/ACOM:13. 1048 pp.

**Table 7.6.1. Porcupine Bank (FU 16): Landings (tonnes) by country, 1965–2010.**

| Year | France | Ireland | Spain | UK E& W | UK Scotland | Total |
|---|---|---|---|---|---|---|
| 1965 | 514 | | | | | 514 |
| 1966 | 0 | | | | | 0 |
| 1967 | 441 | | | | | 441 |
| 1968 | 441 | | | | | 441 |
| 1969 | 609 | | | | | 609 |
| 1970 | 256 | | | | | 256 |
| 1971 | 500 | | 1444 | | | 1944 |
| 1972 | 0 | | 1738 | | | 1738 |
| 1973 | 811 | | 2135 | | | 2946 |
| 1974 | 900 | | 1894 | | | 2794 |
| 1975 | 0 | | 2150 | | | 2150 |
| 1976 | 6 | | 1321 | | | 1327 |
| 1977 | 0 | | 1545 | | | 1545 |
| 1978 | 2 | | 1742 | | | 1744 |
| 1979 | 14 | | 2255 | | | 2269 |
| 1980 | 21 | | 2904 | | | 2925 |
| 1981 | 66 | | 3315 | | | 3381 |
| 1982 | 358 | | 3931 | | | 4289 |
| 1983 | 615 | | 2811 | | | 3426 |
| 1984 | 1067 | | 2504 | | | 3571 |
| 1985 | 1181 | | 2738 | | | 3919 |
| 1986 | 1060 | | 1462 | 69 | | 2591 |
| 1987 | 609 | | 1677 | 213 | | 2499 |
| 1988 | 600 | | 1555 | 220 | | 2375 |
| 1989 | 324 | 350 | 1417 | 24 | | 2115 |
| 1990 | 336 | 169 | 1349 | 41 | | 1895 |
| 1991 | 348 | 170 | 1021 | 101 | | 1640 |
| 1992 | 665 | 311 | 822 | 217 | | 2015 |
| 1993 | 799 | 206 | 752 | 100 | | 1857 |
| 1994 | 1088 | 512 | 809 | 103 | | 2512 |
| 1995 | 1234 | 971 | 579 | 152 | | 2936 |
| 1996 | 1069 | 508 | 471 | 182 | | 2230 |
| 1997 | 1028 | 653 | 473 | 255 | | 2409 |
| 1998 | 879 | 598 | 405 | 273 | | 2155 |
| 1999 | 1047 | 609 | 448 | 185 | | 2290 |
| 2000 | 351 | 227 | 213 | 120 | | 910 |
| 2001 | 425 | 369 | 270 | 158 | | 1222 |
| 2002 | 369 | 543 | 276 | 139 | | 1327 |
| 2003 | 131 | 307 | 333 | 108 | 29 | 908 |
| 2004 | 289 | 494 | 588 | 126 | 28 | 1526 |
| 2005 | 397 | 754 | 799 | 208 | 156 | 2315 |
| 2006 | 462 | 731 | 571 | 201 | 155 | 2120 |
| 2007 | 302 | 1060 | 496 | 146 | 183 | 2186 |
| 2008 | 26 | 562 | 234 | 41 | 138 | 1000 |
| 2009 | 4 | 356 | 294 | 13 | 159 | 825 |
| 2010 | 4 | 579 | 235 | 10 | 90 | 917 |

**Table 7.6.2. Porcupine Bank (FU 16): Mean sizes (mm CL) of male and female *Nephrops* in Spanish, French and Irish landings and the Spanish Porcupine Groundfish survey 1981–2010.**

| | Spain | | Rep. of Ireland | | France | | Porcupine Survey | |
|---|---|---|---|---|---|---|---|---|
| Year | Landings | | Landings | | Landings | | Catch | |
| | Males | Females | Males | Females | Males | Females | Males | Females |
| 1981 | 39.9 | 34.5 | - | - | - | - | - | - |
| 1982 | 40.9 | 34.8 | - | - | - | - | - | - |
| 1983 | 40.8 | 34.0 | - | - | - | - | - | - |
| 1984 | 39.7 | 33.1 | - | - | - | - | - | - |
| 1985 | 38.7 | 33.5 | - | - | - | - | - | - |
| 1986 | 40.7 | 36.4 | - | - | - | - | - | - |
| 1987 | 39.3 | 35.0 | - | - | - | - | - | - |
| 1988 | 40.7 | 38.3 | - | - | - | - | - | - |
| 1989 | 40.5 | 36.8 | - | - | - | - | - | - |
| 1990 | 41.0 | 36.1 | - | - | - | - | - | - |
| 1991 | 39.4 | 34.5 | - | - | - | - | - | - |
| 1992 | 39.2 | 34.1 | - | - | - | - | - | - |
| 1993 | 41.6 | 36.1 | - | - | - | - | - | - |
| 1994 | 40.8 | 36.5 | - | - | - | - | - | - |
| 1995 | 41.3 | 36.6 | 40.7 | 36.5 | 43.2 | 38.3 | - | - |
| 1996 | 41.6 | 35.1 | 34.6 | 35.3 | 41.7 | 38.9 | - | - |
| 1997 | 39.7 | 34.8 | 35.9 | 34.5 | 41.9 | 38.4 | - | - |
| 1998 | 41.1 | 34.6 | 37.2 | 35.6 | 41.9 | 38.4 | - | - |
| 1999 | 41.5 | 35.7 | 36.6 | 33.7 | 43.1 | 39.1 | - | - |
| 2000 | 41.1 | 34.8 | na | na | 45.3 | 40.5 | - | - |
| 2001 | 41.1 | 36.3 | 37.8 | 35.4 | 45.4 | 39.4 | 35.5 | 28.4 |
| 2002 | 39.7 | 35.3 | 36.1 | 38.5 | 45.3 | 40.3 | 37.0 | 31.2 |
| 2003 | 41.4 | 37.8 | 44.5 | 36.2 | 46.2 | 38.9 | 39.2 | 31.4 |
| 2004 | 43.5 | 38.5 | 43.5 | 35.7 | 46.4 | 41.5 | 39.4 | 30.0 |
| 2005 | 43.4 | 38.1 | 46.9 | 40.6 | 45.9 | 41.0 | 44.6 | 33.3 |
| 2006 | 43.9 | 38.0 | na | na | 48.9 | 41.4 | 43.6 | 34.5 |
| 2007 | 43.7 | 41.0 | na | na | 48.3 | 43.8 | 45.4 | 37.4 |
| 2008 | 51.0 | 40.6 | 43.3 | 37.5 | na | na | 48.0 | 38.2 |
| 2009 | 43.0 | 42.7 | 44.1 | 40.1 | na | na | 32.2 | 28.3 |
| 2010 | na | na | 48.9 | 40.4 | na | na | 35.8 | 31.3 |

**Table 7.6.3. Porcupine Bank (FU 16): Landings and effort for the various different fleets exploiting the stock 1971–2010.**

| | Spanish fleet | | | French Nep fleet1 | | | Irish Nep Fleet2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Landings | Effort | Standardized Lpue | Landings | Effort | Lpue (>10%) | Landings | Effort | Lpue |
| Year | Tonnes | day*BHP/100 (x1000) | Kg/day*BHP/100 | Tonnes | ('000's Hrs) | (kg/hr) | Tonnes | ('000's Hrs) | (kg/hr) |
| 1971 | 1444 | 159 | 9 | | | | | | |
| 1972 | 1738 | 188 | 9 | | | | | | |
| 1973 | 2135 | 181 | 12 | | | | | | |
| 1974 | 1894 | 192 | 10 | | | | | | |
| 1975 | 2150 | 229 | 9 | | | | | | |
| 1976 | 1321 | 187 | 7 | | | | | | |
| 1977 | 1545 | 196 | 8 | | | | | | |
| 1978 | 1742 | 166 | 11 | | | | | | |
| 1979 | 2255 | 157 | 14 | | | | | | |
| 1980 | 2904 | 163 | 18 | | | | | | |
| 1981 | 3315 | 143 | 23 | | | | | | |
| 1982 | 3931 | 138 | 29 | | | | | | |
| 1983 | 2811 | 108 | 26 | 615 | 18 | 35 | | | |
| 1984 | 2504 | 114 | 22 | 1067 | 30 | 35 | | | |
| 1985 | 2738 | 115 | 24 | 1181 | 33 | 36 | | | |
| 1986 | 1462 | 95 | 15 | 1060 | 28 | 38 | | | |
| 1987 | 1677 | 105 | 16 | 609 | 24 | 26 | | | |
| 1988 | 1555 | 109 | 14 | 600 | 22 | 27 | | | |
| 1989 | 1417 | 105 | 14 | 324 | 14 | 23 | | | |
| 1990 | 1349 | 96 | 14 | 336 | 15 | 23 | | | |
| 1991 | 1021 | 85 | 12 | 348 | 19 | 18 | | | |
| 1992 | 822 | 59 | 14 | 665 | 32 | 21 | | | |
| 1993 | 752 | 49 | 15 | 799 | 36 | 22 | 206 | | |
| 1994 | 809 | 50 | 16 | 1088 | 38 | 28 | 512 | | |
| 1995 | 579 | 48 | 12 | 1234 | 42 | 30 | 971 | 15 | 41 |
| 1996 | 471 | 43 | 11 | 1069 | 41 | 26 | 508 | 8 | 42 |
| 1997 | 473 | 42 | 11 | 1028 | 41 | 25 | 653 | 11 | 35 |
| 1998 | 405 | 43 | 10 | 879 | 40 | 22 | 598 | 10 | 42 |
| 1999 | 448 | 37 | 12 | 889 | 43 | 21 | 609 | 9 | 35 |
| 2000 | 213 | 30 | 7 | 313 | 23 | 16 | 227 | 2 | 31 |
| 2001 | 270 | 29 | 9 | 366 | 24 | 17 | 369 | 8 | 30 |
| 2002 | 276 | 31 | 9 | 324 | 18 | 22 | 543 | 10 | 38 |
| 2003 | 333 | 38 | 9 | 130 | 7 | 19 | 296 | 7 | 26 |
| 2004 | 588 | 32 | 18 | 232 | 9 | 25 | 494 | 16 | 21 |
| 2005 | 799 | 30 | 27 | 380 | 15 | 26 | 628 | 24 | 30 |
| 2006 | 571 | 39 | 15 | 446 | 22 | 21 | 683 | 28 | 25 |
| 2007 | 496 | 35 | 14 | 297 | 17 | 20 | 977 | 36 | 27 |
| 2008 | 234 | 24 | 10 | 25 | 4 | 7 | 534 | 20 | 26 |
| 2009 | 294 | 26 | 11 | na | na | na | 327 | 12 | 27 |
| 2010 | 235 | 23 | 10 | na | na | na | 555 | 19 | 29 |

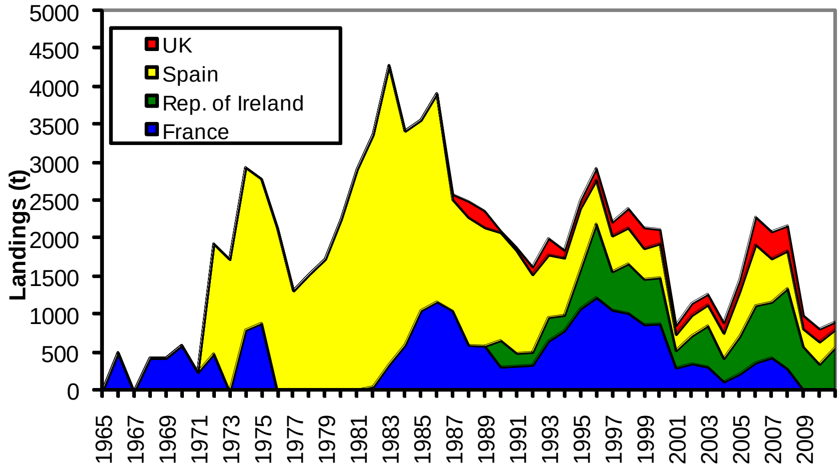



**Figure 7.6.1.** ***Nephrops*** **in FU16 (Porcupine Bank). Landings in tonnes by country.**

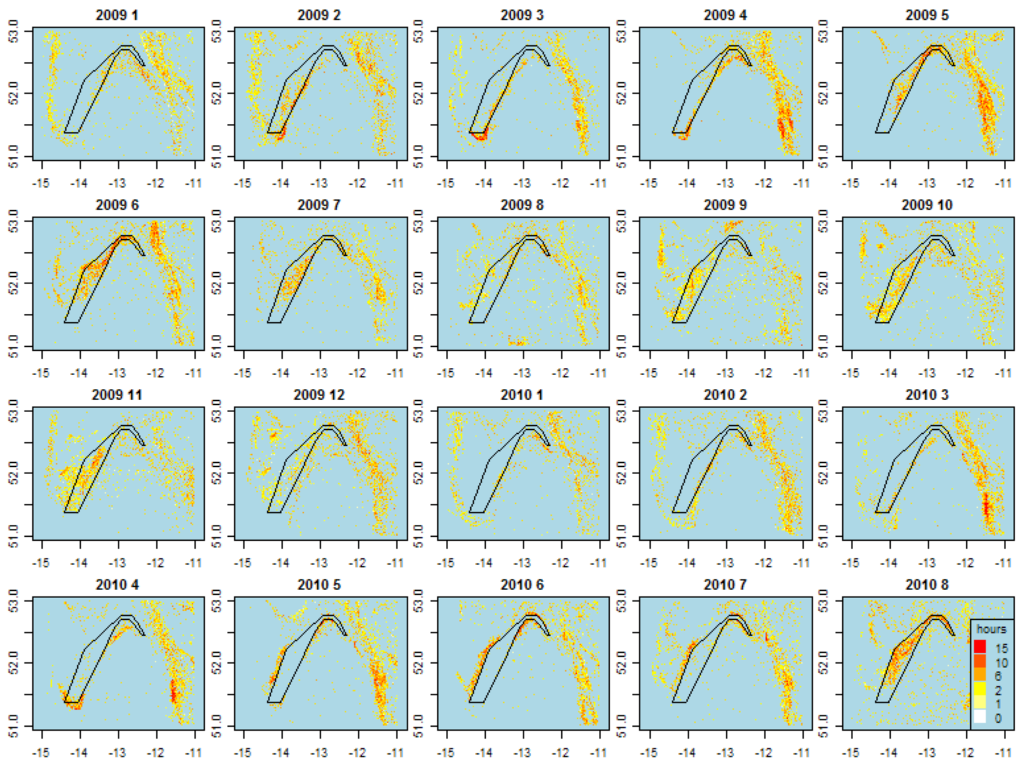



**Figure 7.6.2.** ***Nephrops*** **in FU16 (Porcupine Bank). Fishing activity from VMS by month for all vessels between Jan 2009 and August 2010. The black polygon indicates the closed area a square root effort scale has be used to enhance contrast.**

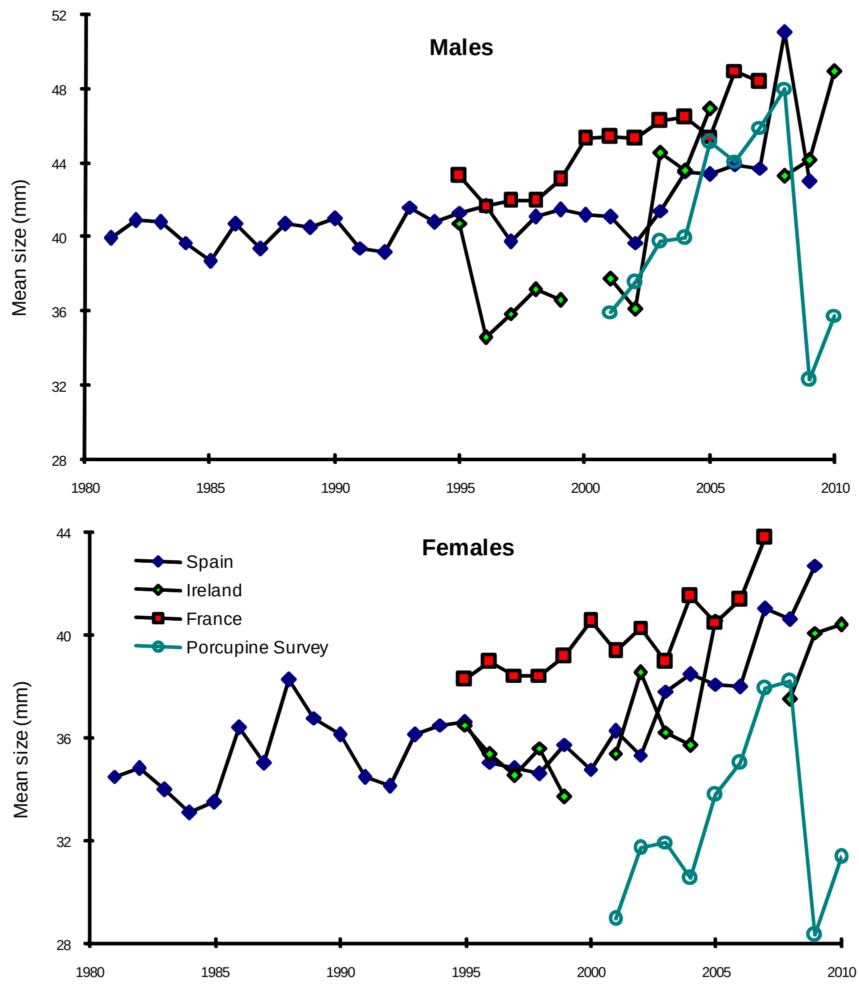



**Figure 7.6.3.** ***Nephrops*** **in FU16 (Porcupine Bank). Landings mean sizes by sex and country and mean size in the catch for the Porcupine survey.**

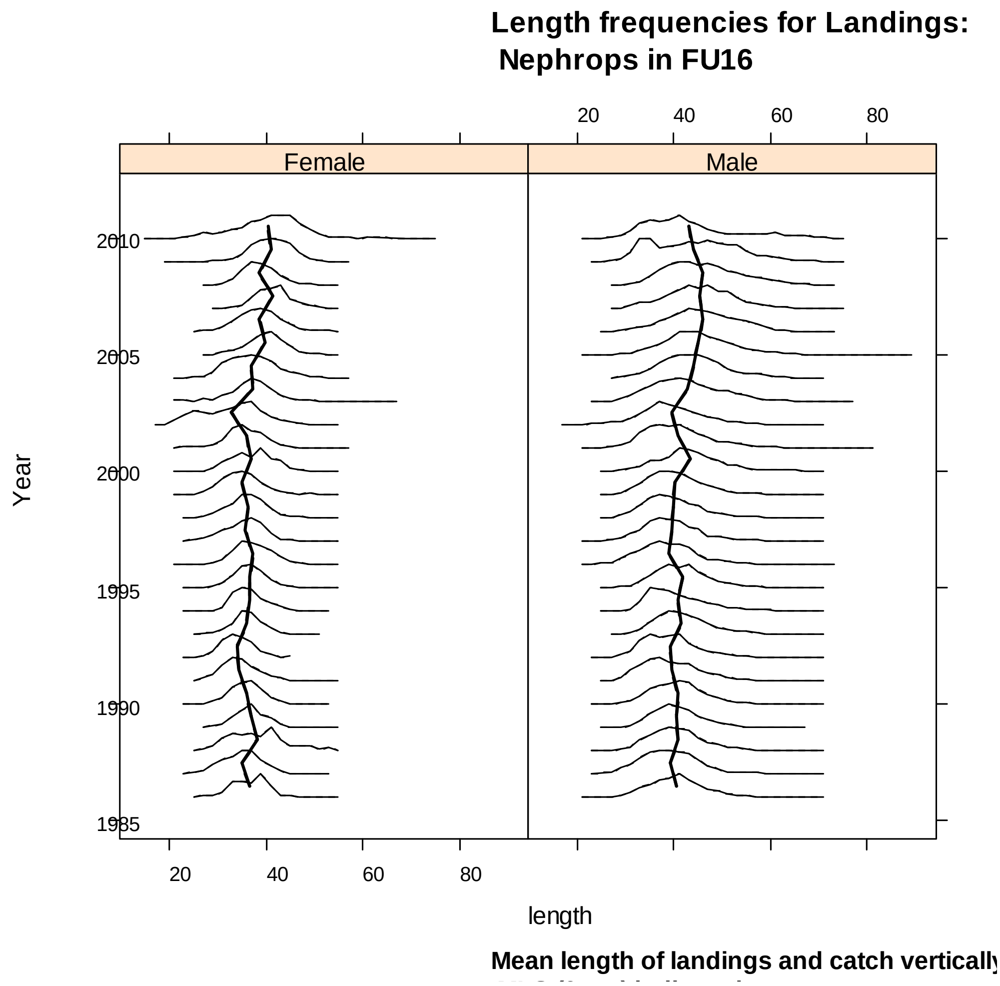



**Figure 7.6.4.** ***Nephrops*** **in FU16 (Porcupine Bank). Female and male landings length distributions.**

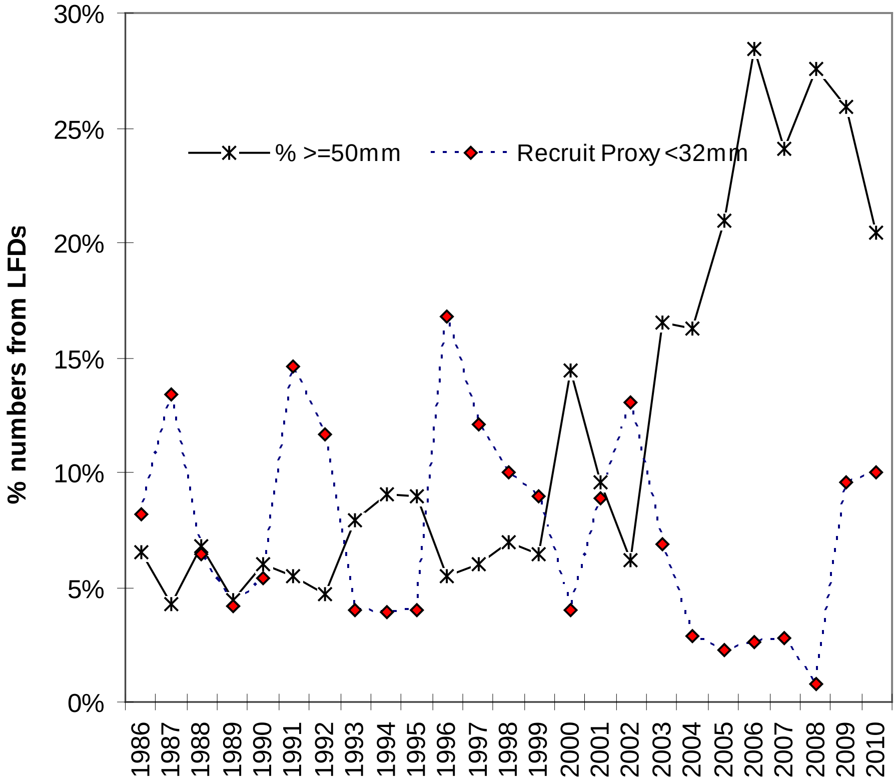



**Figure 7.6.5.** ***Nephrops*** **in FU16 (Porcupine Bank). Trends in the percentages of the sampled male** ***Nephrops*** **landings <32 mm carapace length (a possible recruitment proxy) and >50 mm carapace length.**

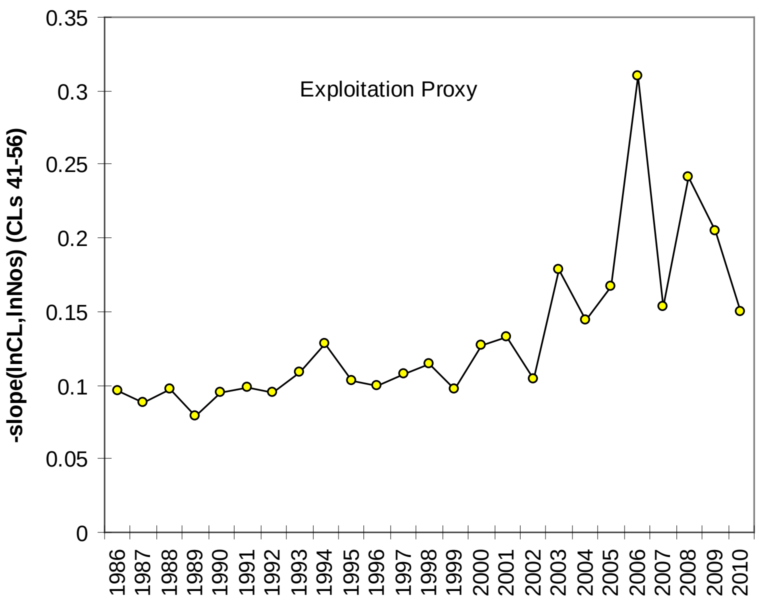



**Figure 7.6.6.** ***Nephrops*** **in FU16 (Porcupine Bank). Trends in an exploitation proxy for this stock. This is derived from the slope of the length frequency for male** ***Nephrops*** **between carapace lengths of 41–56 mm which are considered fully selected in the fishery.**

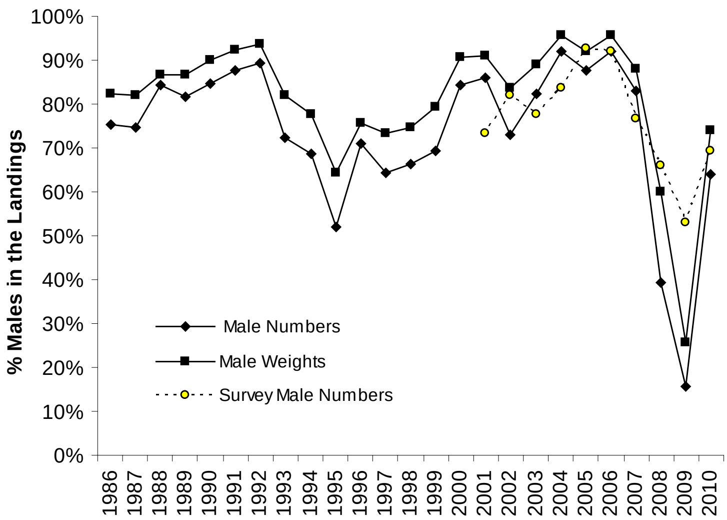



**Figure 7.6.7. *Nephrops* in FU16 (Porcupine Bank). Sex ratio of landings and survey catches.**

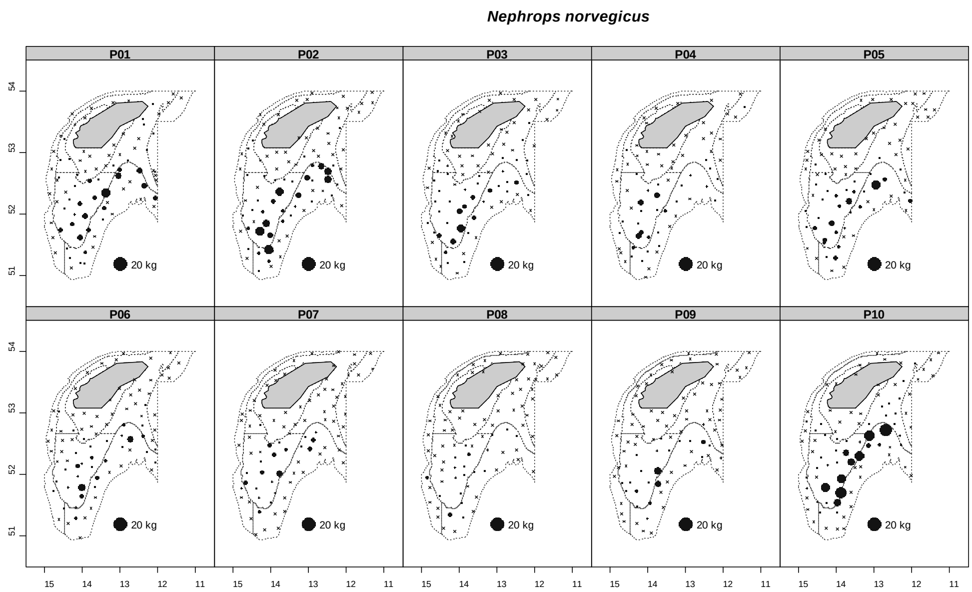



**Figure 7.6.8. *Nephrops* in FU16 (Porcupine Bank). Distribution of *Nephrops norvegicus* catches in Porcupine surveys between 2001 and 2009.**

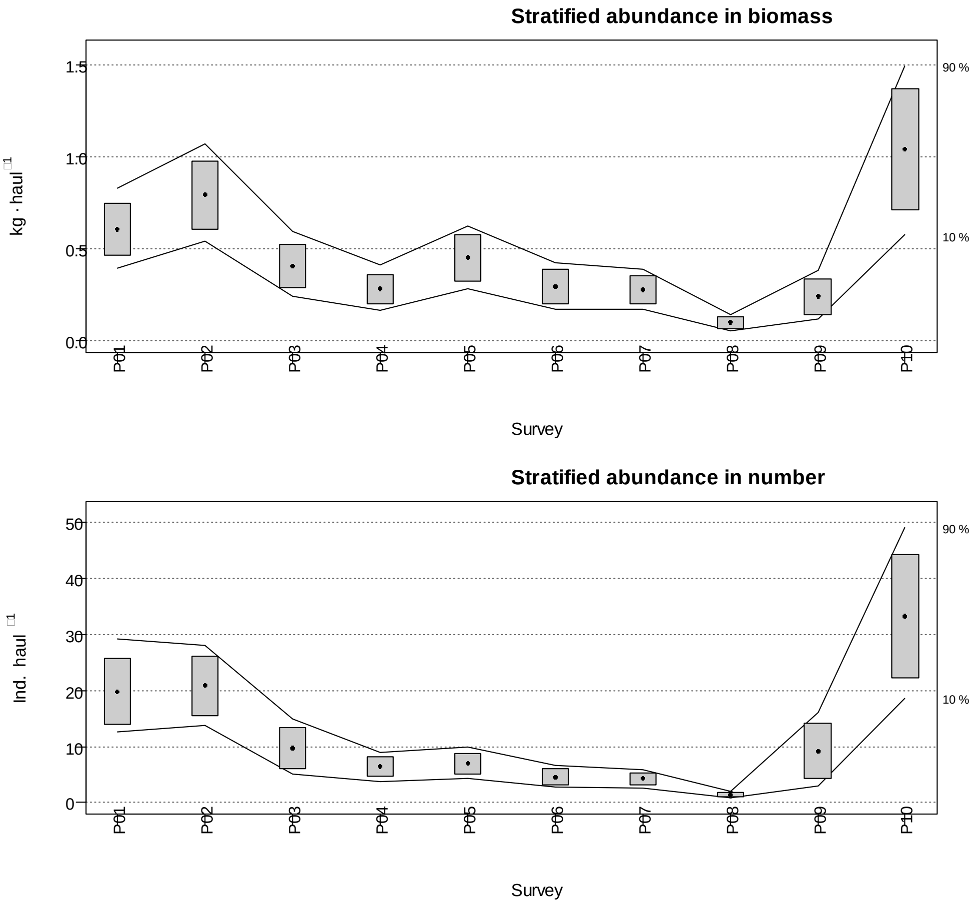



**Figure 7.6.9.** ***Nephrops*** **in FU16 (Porcupine Bank). Changes in** ***Nephrops norvegicus*** **biomass and number stratified indices during Porcupine Survey time-series (2001–2009). Boxes mark parametric standard error of the stratified abundance index. Lines mark bootstrap confidence intervals (**$\alpha$**=0.80, bootstrap iterations=1000).**

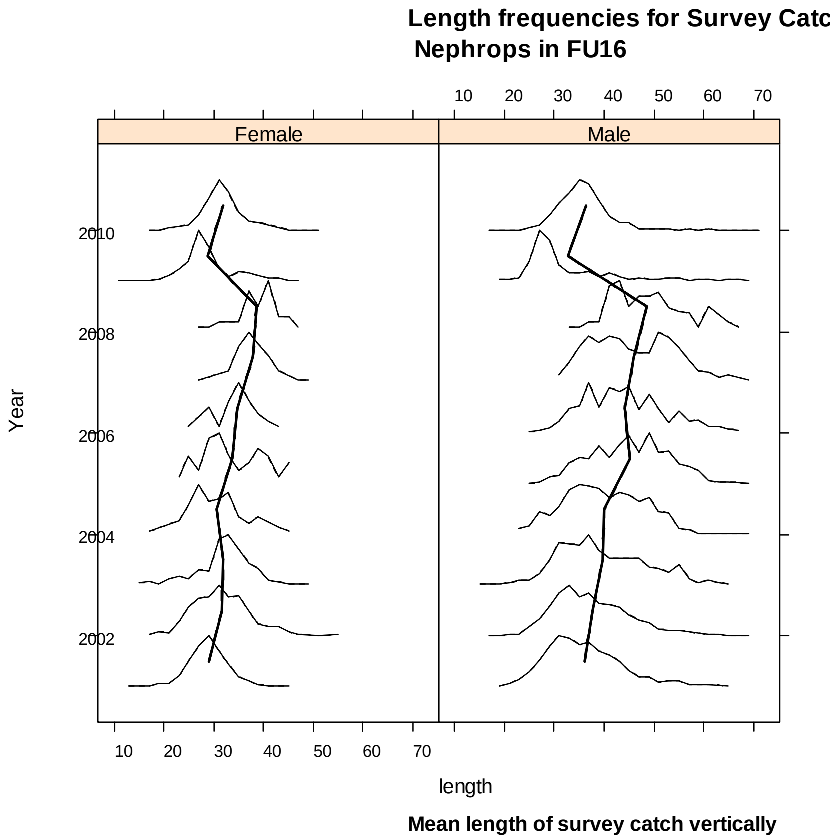
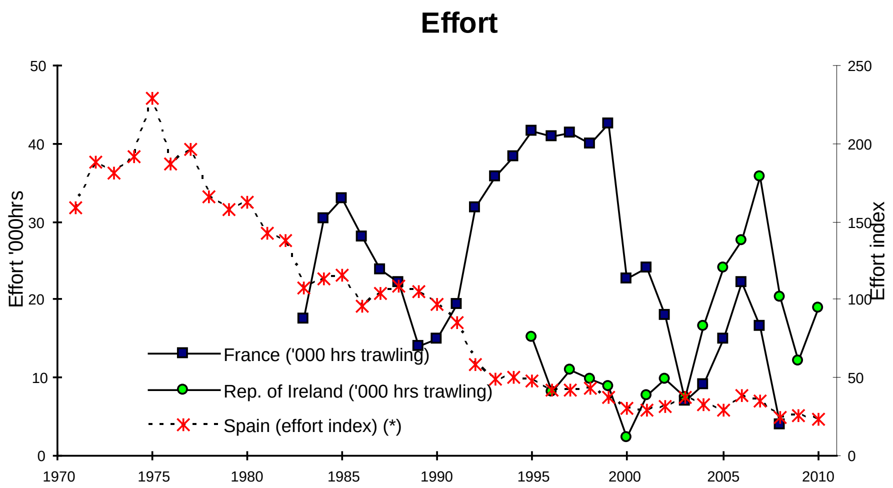



**Figure 7.6.10.** ***Nephrops*** **in FU16 (Porcupine Bank). Female and male Porcupine Survey length distributions.**



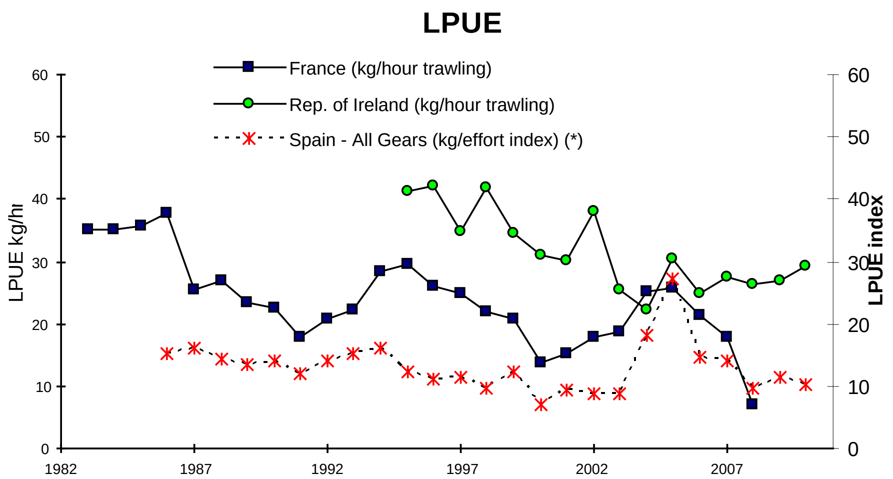




**Figure 7.6.11.** ***Nephrops*** **in FU16 (Porcupine Bank). Effort and lpue trends for fleets. (*) The Spanish effort index is based on a combination of hours at sea and average engine power. Irish and French effort and lpue is unstandardized.**

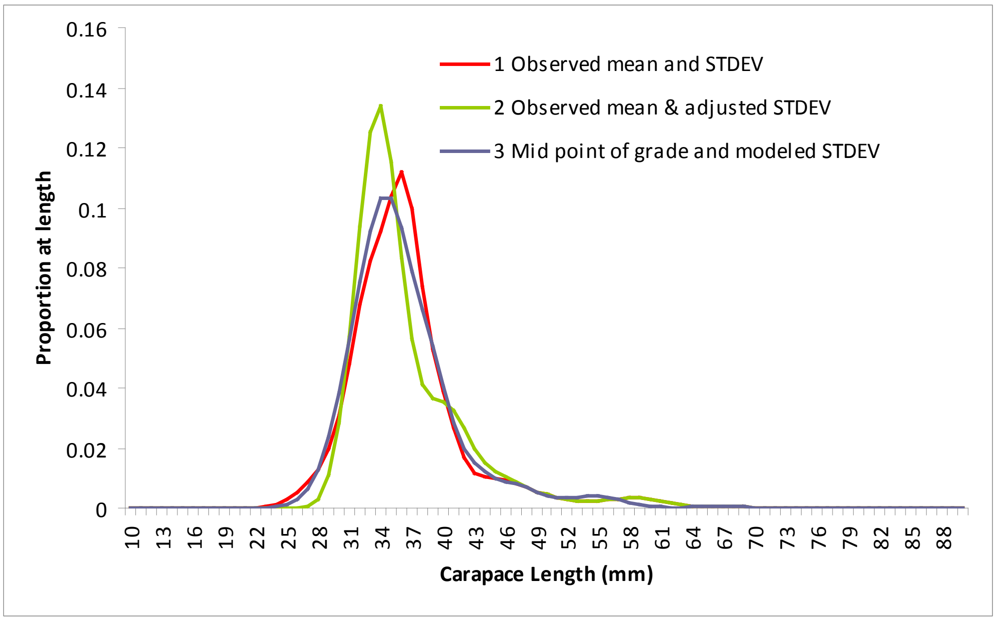



**Figure 7.6.12. *Nephrops* in FU16 (Porcupine Bank). Using commercial grade information from the fishing industry to reconstruct the size distribution of male *Nephrops* landings in 2010 using three alternative methods.**

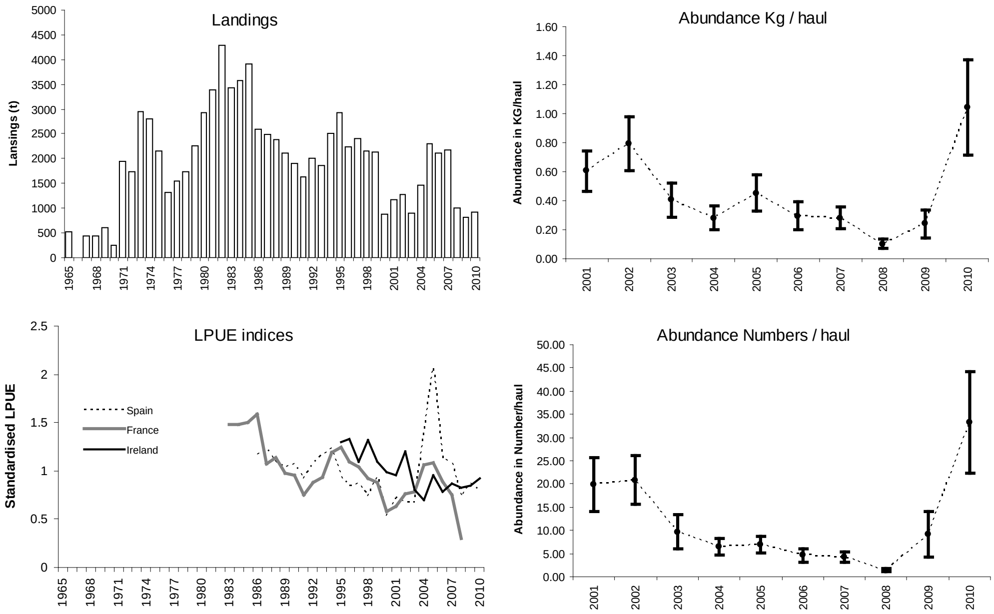



**Figure 7.6.13. *Nephrops* in FU16 (Porcupine Bank). Left: ICES landings over the years (top), standardized lpues by fleet (bottom). Right: Trends over the years in biomass (top, in kg/haul) and abundance (bottom, individuals/haul) from the Spanish Porcupine survey (LHS).**

## 7.7 *Nephrops* in the Celtic Sea (FU20-22)

ICES description VIIfgh

Functional Units Celtic Sea, VIIfgh (FU20–22)

Type of assessment in 2011: This year there was an update of stock trends for FU20–22 in addition the UWTV survey for the Smalls component of the stock are (FU22) was used to evaluate recent harvest rates and provide catch options for that component of the stock.

Overall upwards trend mainly since the early 2000s. Suggested very strong recruitment in 2007, but impossibility to indicate the actual state of the more recent year classes.

### ICES advice in 2010 applicable to 2011 and 2012

**Advice Summary for 2011 and 2012**

| **Management Objective (s)** | **Landings in 2011 and 2012** |
|---|---|
| Transition to an **MSY approach** with caution at low stock size | Reduce landings from recent level |
| Cautiously avoid impaired recruitment (**Precautionary Approach**) | Less than 5 300 t |
| Cautiously avoid impaired recruitment and achieve other objective(s) of a **management plan** (e.g., catch stability) | |

To protect the stock in this Functional Unit, management should be implemented at the Functional Unit level.

*MSY approach*

Considering the stable lpue trend and unknown exploitation status, catches should be reduced from the recent level.

*PA considerations*

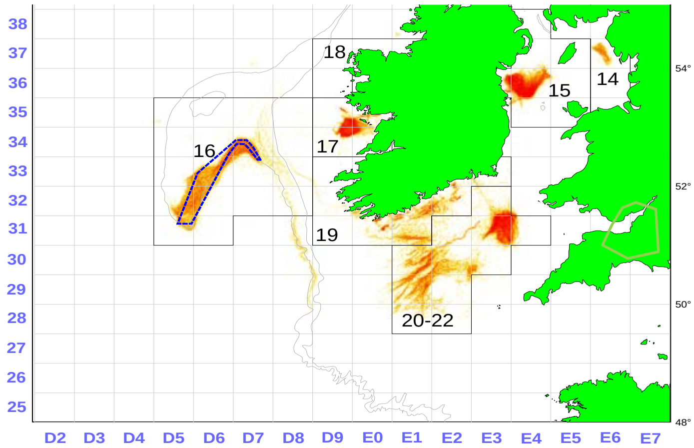
ICES considers that the current fishery does not appear to be detrimental to the stock and recommends that *Nephrops* fisheries should not be allowed to increase relative to recent landings. This corresponds to landings of no more than 5300 t.

### 7.7.1 General

**Stock description and management units.**

The Celtic Sea *Nephrops* stock (FU20–22) is included in the whole ICES Area VII together with Irish Sea East and West [FU14, FU15], Porcupine Bank [FU16], Aran Islands [FU17], Northwest Irish Coast [FU18], southeast and southeest Irish Coast [FU19]. The TAC is set for Subarea VII which does not correspond to the stock area.

Historically FU20–22 is has covered an amalgamation of several spatially distinct mud patches; FU20 NW Labadie, Baltimore and Galley, FU21 Jones and Cockburn and FU22 the Smalls. There is no evidence that the whole exploited area belongs to the same stock or that there are several patches linked in meta-population sense.




**The FUs with TAC VII are shown above together with Irish *Nephrops* directed VMS effort between 2005–2009. The 'Smalls' FU22 covered by the Irish UWTV survey is shown with a green line.**

#### Management applicable in 2010 and 2011

Currently the TAC is set for Subarea VII .The 2011 TAC is 21 759 t, 3% less than the 2009 TAC. This TAC includes many *Nephrops* stocks and this may allow unrestricted catches for stocks under excessive fishing pressure where catches should be limited.

The MLS implemented by EC is set at 25 mm CL i.e. 8.5 cm total length and this regulation is applied by the Irish and UK fleets whereas a more restrictive regulation adopted by the French Producers' Organisations (35 mm CL i.e. 11.5 cm total length) is applied by the French trawlers.

In application of the Council Regulation (EC) N° 1459/1999, June 24th 1999, modifying the regulation (EC) N° 850/98 of the Council for the conservation of fishery resources through technical measures for the protection of juveniles, the French minimum mesh size of codend was set at 100 mm in January 2000 whereas the Irish mesh size was maintained at 80 mm.

**TAC in 2010**

| Species: | Norway lobster *Nephrops norvegicus* | Zone: | VII (NEP/07.) |
|---|---|---|---|
| Spain | 1 346 | | |
| France | 5 455 | | |
| Ireland | 8 273 | | |
| United Kingdom | 7 358 | | |
| EU | 22 432 | | |
| TAC | 22 432 | | Analytical TAC |

**TAC in 2011**

| Species: | Norway lobster *Nephrops norvegicus* | Zone: | VII (NEP/07.) |
|---|---|---|---|
| Spain | 1 306 (1) | | |
| France | 5 291 (1) | | |
| Ireland | 8 025 (1) | | |
| United Kingdom | 7 137 (1) | | |
| EU | 21 759 (1) | | |
| TAC | 21 759 (1) | | Analytical TAC |

(1) Of which no more than the following quotas may be taken in VII (Porcupine Bank – Unit 16) (NEP/*07U16):

| | |
|---|---|
| Spain | 75 |
| France | 305 |
| Ireland | 463 |
| United Kingdom | 411 |
| EU | 1 254 |

### Ecosystem aspects

This section is detailed in Stock Annex.

### Fishery description

France, and Ireland are the main countries involved in the FU20–22 *Nephrops* fishery.

In 2010 49 French trawlers landed *Nephrops* from FU20–22 (74 in 2009 and 88 in 2008). Of these, 25 exceeded landings of 10 t representing around 92% of French landings; among them, seven vessels exceeded 50 t and accounted for 42% of the total. In 2010, 65 Irish vessels reported landings from FU20–22 (79 in 2009). Of these, 60 vessels (54 in 2009) reported landings in excess of 10 t accounting for 99% of the total Irish landings.

A decommissioning programme was in operation in Ireland during 2007 and 2008. Twelve vessels active in the FU20 fishery were decommissioned. These vessels accounted for approximately 18% of the landings in the 2007–2008 period.

In application of the Council Regulation (EC) N° 1459/1999, June 24th 1999, modifying the regulation (EC) N° 850/98 of the Council for the conservation of fishery resources through technical measures for the protection of juveniles, the French minimum mesh size of codend was set at 100 mm in January 2000 whereas the Irish mesh size was maintained at 80 mm.

#### Landings

In 2010, total landings were 4622 tonnes (-14% compared to 2009). Slight revisions of the French and of Irish landings data have been done and presented in the Table below.

| Country | Year | Previous landings (t) | Revised landings (WGCSE 2011) (t) |
|---|---|---|---|
| France | 2009 | 2156 | 2165 |
| Ireland | 2003 | 1388 | 1389 |
| | 2004 | 1627 | 1629 |
| | 2005 | 2391 | 2387 |
| | 2006 | 1864 | 1848 |
| | 2007 | 3213 | 3214 |

Landings are reported mainly by France and the Republic of Ireland (Figure 7.7.1; Table 7.7.1). The contribution of French landings has gradually decreased from 80–90% at the end of 1980s to 50–60% at the beginning of 2000s. Since 2007, French landings declined to almost 25% of the total reported quantities (Table 7.7.1): in 2010, French contribution in the total landings reached the historically lowest level, whereas Irish landings increased by 9%. The overall fishing profile remains typically seasonal (Table 7.7.2) with the majority of landings coming from the 2nd and 3rd quarters.

#### Uptake of quotas

There is no specific TAC for the FU20–22 *Nephrops;* thus, the question should be examined for the whole Subarea VII. For the two main fleets operating in the Celtic Sea, the total harvested quantities on VII remained below the allowed quotas. In 2010, 5455 t were allocated to France whereas actual French landings were 2217 t almost exclusively i.e. 98% coming from the Celtic Sea. In 2010, 8273 t were allocated to the Republic of Ireland and the uptake of quota was of 98% (38% of the national landings coming from the Celtic Sea). For 2010 there was no advice and ICES recommended as for 2009 to not exceed 5300 t of landings coming: the total harvested quantity was 4622 t (3110 t Ireland, 1112 t France, 343 t England/Wales/Northern Ireland, 57 t Scotland).

#### Discards

The increasing practice of tailing *Nephrops* by the French trawlers may affect the total discard rate of this fleet. Hence, method for discard derivation applied since 2006 on LFD French dataset for years with no sampling on board is not currently used for the assessment. The Irish discard rate seems to have decreased for the last three years after some higher values in the second half of 2000s mainly explained by positive signal of recruitments as for 2007.

### 7.7.2 Data

#### Landings

Landings information by country (France and Ireland) is given in the Stock Annex. All data are presented in Figures 7.7.2 and 7.7.3, Tables 7.7.3 to 7.7.11, 7.7.12, 7.7.13 and 7.7.14a. The Table 7.7.15 provides information on mean size of landings by year and country.

Length frequency distributions (LFD) differ significantly between the two countries. The two ogives of selectivity through meshes are different because of different meshes. The mean size in the French landings has increased since the beginning of

2000s (coincidently with mesh regulations), whereas it remained almost stable in the Irish landings.

In recent years, the decline in mean sizes observed in 2007 and 2008 may be due to a strong year class which was also apparent in the 2006 Irish UWTV survey.

Since 2009, the WGCSE has pointed out a significantly increasing proportion of tailed individuals present in French landings (Figure 7.7.4) whereas this proportion was already high for Irish trawlers. For 2005–2010, tailed *Nephrops* were comprised between 11 to 20% of the French landings when it was less than 5% before. This is linked to increasing fuel prices with larger proportions of tailed individuals retained to compensate this loss according to the French industry.

By the end of 2007, tailed *Nephrops* could not be sampled at auction and, as the sampling on board remains difficult to apply routinely due to long trip duration by the French trawlers, the problem was partially tackled by apportioning tailed individuals to the smallest category of landings at auction. Since the end of 2007, new biometric relationships established during the EVHOE survey have been used (Stock Annex): this allows fitting CL vs. 2nd abdominal segment of tail by sex.

The length distribution of *Nephrops* tailed in the French landings for years 2008–2010 were estimated by two ways: one using the extrapolations from tails to CL, the other apportioning tails to the small category as for previous years (Table 7.7.13; Figures 7.7.5 to 7.7.7). Results for 2009 are respectively 48 and 39 million *Nephrops*. It should be noted that 19% of individuals are smaller than the French Producers' Organization MLS (11.5 cm/35 mm CL) and the sex ratios are respectively 10% and 3%. In 2010, this method provides respectively 23 and 18 million individuals (+23%), 20% of them were smaller than the French Producers' Organization MLS and the sex ratios are respectively 14.5% and 3.5%. As indicated in the Table 7.7.15, the mean size of French landings for years 2008–2010 decreases at around 2.5–5.5 mm CL by sex when tails are involved by sampling. However, the mean CL remains larger than the Irish one. Before WGCSE 2009, the size composition was overestimated when raised to the composition of entire individuals and, therefore, the total number of landed *Nephrops* was underestimated.

### Discards

#### Sampling

The available dataset is detailed in the Stock Annex. Additional French dataset was also acquired in 2005, but it involves in only two quarters (Q3 and Q4; Stock Annex). Data sampled in 2009 (14 trips, 199 hauls during three quarters) cannot yet be integrated in the assessment. In 2010, the French DCF plan (12 validated trips, 108 hauls in four quarters) provided yearly estimates for discards. As for landings, the Irish discard sampling began in 2002. Thus, there is no common dataset on discards between French and Irish fleets (lack of information of the Irish sampling programme for 2005-Q3, 2005-Q4, 2006-Q4, 2007-Q2). Available information on complete yearly sets (1997-FR, 2010-FR, 2003-IRL, 2008-IRL, 2009-IRL, 2010-IRL) is given by Figures 7.7.8 to 7.7.10, Tables 7.7.16 and 7.7.17. Tables 7.7.14b,c,d provide discard estimates, total catches and removals for Irish trawlers (using mortality rate of discards equal to 75%: Charuau *et al.*, 1982).

The notable contrast between the retained proportions on board and the spatial heterogeneity of the exploited area prevents direct comparisons of the main fleets. It is not yet possible to estimate if the inter-fleet variability of the discard rate is larger than the interannual one.

Changes in discard rate are a consequence of the strength of recruitments, increase in the MLS (which tends to increase the discards) and the gear selectivity. Other practices as stated above (tailing individuals) may affect discard rate. The relative contribution of each of these four factors remains unknown.

### Back-calculation

As for the main *Nephrops* stocks, the lack of estimation of discards hampers quantitative analysis of recruitment indices, therefore, possibilities of back-calculation for discards were investigated. For a long period, a "proportional derivation" of discards was processed on the FU20–22 *Nephrops* by WGNEPH, but was considered as unreliable because it induces lack of contrast in interannual variations of recruitment (see reports of WGSSDS 2005–2008; WGCSE 2009). An alternative probabilistic approach developed since 2006 on other *Nephrops* stocks (VIIIab; Bay of Biscay; FU23–24) was also applied to the FU20–22. The main concepts of the back-calculation are detailed in Stock Annex.

The increasing proportion of tails probably results of changes in discard practices. Thus, the back-calculation approach used in the past is now considered inappropriate and has been stopped until this stock is benchmarked.

### Surveys

A fishery-independent UWTV survey has been conducted by Ireland since 2006. This survey indicates a stable density of burrow density over the “Smalls” ground FU22 during the last three years (WD10). Figure 7.7.11 shows a consistency between the highest survey indicators in 2006 and the strong lpue values obtained by commercial vessels in the same area in 2007. Around 50% of the recent landings from FU20–22 are caught on the Smalls annually although this percentage does vary (Table 7.7.18).

In FU20–22, the French groundfish survey EVHOE while not focusing on *Nephrops per se* it does provide some indication of the length distributions and the strength of recruitment (Stock Annex). The Irish groundfish survey has been carried out since 2003 giving some information on the length compositions of *Nephrops* catches. The UK bottom-trawl survey occurred on the same area between 1984 and 2004 (see WGSSDS 2006), however, only two sampling stations were surveyed within FU20–22 area.

### Commercial lpue

Thresholds of 10% and 30% of total trip landings composed from *Nephrops* are applied to the French and Irish otter fleets to identify *Nephrops* directed fishing activity.

Effort data are available from 1983 to 2008 for the French *Nephrops* fleet (Table 7.7.19; Figure 7.7.12). In 2009 and 2010, the new registration system of official French statistics changed the way fishing effort is computed. As a consequence, there is no reference to the number of hours for use of a fishing gear and that hampers unbiased estimates while vessels alternate fishing gears and targeted species during the same trip. To circumvent this problem, the WG tested new allocation method to characterize a *Nephrops* trawler based on thresholds of *Nephrops* landings weight with no reference to the other species composing the landings by trip. Estimators based on a simple threshold of 500 kg landed *Nephrops*/trip gave satisfactory results compared to the previous estimators (based on threshold of 10% of landings: Table 7.7.19). The coefficients of correlation for fishing effort and for lpue between previous and current estimators over the years 1999–2008 are respectively equal to 0.96 and 0.98. Thus, estimates of French fishing effort and lpue for 2009 and 2010 (Table 7.7.19; Figure 7.7.12) were calculated in this way.

The WGCSE 2011 investigated the disaggregated lpue series for FU20–21 and FU22 separately in order to evaluate trends between the two areas. The French trawlers represented in Figure 7.7.12 are essentially operating in FU20–21 and are showing very similar patterns as the Irish trawlers in FU20–22. Highest lpues for both series were observed in 2008 and 2009 with a decline in lpue evident in 2010. Recent lpues for FU22 have also been high relative to the remainder of the series and there are indications that the lpue increases occur in FU22 before FU20–21.

French effort has fluctuated with a decreasing trend since 2004 to the lowest observed in 2010. The decrease of the French fishing effort was caused by the reduction of the number of vessels due to decommissioning schemes. Lpue for French trawlers increased between 2007 and 2008, remained stable in 2009 (+22%: 22.6 kg/h in 2008 and 22.7 kg/h in 2009 against 18.5 kg/h for 2007). In 2010, lpue decreased (-27%: 16.9 kg/h).

Effort data, aggregated and spatially separated (FU20–21 and FU22: Smalls ground), are available from 1995 for the Irish otter trawl *Nephrops* directed fleet. These data have not been standardized to take into account vessel or efficiency changes during the time period.

Irish effort has increased over the series with a maximum level in 2007 and 2008. A slight reduction occurred in 2009 although the global fishing effort remained stable in 2010, increasing steeply in FU22 (+36%) and dropping in FU20–21 (-36%). The lpue reached a maximum value in 2008 (60.5 kg/h) in the Smalls ground, decreased by -10% in 2009 and remained stable in 2010 (47.3 kg/h against 48.2). Outside Smalls the lpue was maximized in 2008 and 2009, but decreased by -21% in 2010 (34.4 kg/h against 43.6 kg/h). (Table 7.7.19; Figure 7.7.12). The increase of the Irish fishing effort involves either in the number of fishing vessels or in the number of trips by vessel.

#### Other relevant data

French fishing industry underlined that the increase of lpue series since the end of 1990s may be caused by the change of the global fishing efficiency of the fleet because some old vessels were replaced by more recent ones. Fishing power analysis including spatial distribution will be undertaken on a set of French *Nephrops* trawlers remaining in the fishery for a long period (e.g. 1999–2008; 40 vessels) combining information involving in other substantial species targeted in the Celtic Sea (cod). Furthermore, the problem of the actual size composition of tailed individuals in landings was also debated with Producers' Organisations. The possibility of European regulation such as a *numerus clausus* licence system was also debated. The self-sampling on board on discarded fraction of catches was initiated in the 2nd quarter 2011 with the aim of providing additional information to the DCF sampling dataset.

### 7.7.3 Historical stock development

The stock is considered to be stable at a high level based on long-term indicators (lpue, mean size) and recent UWTV survey data. There have been indications of strong recruitment in recent years (e.g. 2006) as underlined by the Irish UWTV survey in 2006 and by commercial lpue for Irish in 2007 and for French trawlers in 2008 and 2009. Recent harvest rates for the Smalls component suggest the stock is exploited below $F_{msy}$.

#### Comparison with previous assessments

#### New approach : UWTV survey on FU22, trends only on FU20–21

The previous assessment was based on global indicators for the stock e.g. lpue, mean size. Even if there is no possibility for catch-at-age analysis regarding absolute levels of abundance of *Nephrops* in FU20–22, there is usually significant information on the relative stock state.

The French trawlers lpue and cpue series both have indicated a rise in stock abundance since the early 2000s suggesting that recent fishing activity has not been detrimental to the stock. It is noticeable that the French groundfish survey EVHOE, while not focusing on *Nephrops*, had provided in 2007 the highest indices for this species since the beginning of the survey ten years ago is in agreement with observations made by the Irish UWTV survey (WD 10). Trenkel and Rochet (2003) examining indicators in the French EVHOE Celtic Sea survey suggested that *Nephrops* population was increasing during 2000s.

Until 2005, the mean length in the landings had also increased except for 2001 when the smaller size composition suggests a stronger recruitment entry in the fishery. Nevertheless, in 2006 and 2007, mean length in landings for both fleets decreased. This point combined to the former UK survey on this area (suggesting a slight trend of decrease of mean sizes for some sampling reference stations: see WGSSDS 2006) could be induced either by stronger recruitment abundance than previously or by overfishing.

As detailed in the Stock Annex, independent sources of information (EVHOE survey's indices, logistically derived discards for no sampled years) agree that some recent recruiting classes (mainly 2001 and probably 2002 and 2003, mostly 2007) should be of a good level whereas it is still impossible to indicate the actual state of the more recent year classes.

Little or no change in the perception of the state of the stock has to be taken into consideration for the moment.

### 7.7.4 MSY explorations

MSY explorations were carried out for the Smalls component FU22 which represents around ~50% of the total landings from FU20–22 (Table 7.7.18).

In response to the recommendations of WKFRAME (2010), the Bell/Dobby combined sex–length cohort analysis (LCA) model (WKNEPH, 2009) was used to determine Harvest Rates associated with fishing at various potential $F_{MSY}$ proxies i.e. $F_{35\%SPR}$, $F_{0.1}$ and $F_{max}$. This approach was previously applied to all other *Nephrops* stocks with UWTV and catch sampling data. Length distributions for male and female landings and discards were available for Irish sampling from FU22 (Smalls) from 2003–2010.

The length frequency distributions reference period 2008–2010 were used as input to the LCA model. There has been some variations in the LFDs particularly when an apparently strong recruitment entered the fishery in 2007 (Figure 7.7.13). The length distributions in the reference period were very stable. Other LCA inputs such as growth parameters and discard survival were all taken from the stock annex.

| Parameter | Males | Immature Females | Mature females |
|---|---|---|---|
| L□ | 68 | 68 | 49 |
| K | 0.17 | 0.17 | 0.1 |
| Natural Mortality | 0.3 | 0.3 | 0.2 |
| Discard Survival | 25% | 25% | 25% |
| a | 0.000322 | 0.000684 | 0.000684 |
| b | 3.207 | 2.963 | 2.963 |

The $L_{50}$ for female maturity was estimated at 22 mm was based on Irish sampling in FU22 and reported to WKNEPH 2006 (ICES, 2006). Figure 7.7.14 shows the estimated selection pattern and residuals and YPR curves, from the model. The LCA model fit to both landings and discards of both sexes is fairly good. The YPR plot indicates a more domed YPR for females than males. The results of the model in the Table 7.7.20 show the F multipliers required to achieve the potential $F_{MSY}$ proxies; the harvest rates that correspond to those multipliers and the resulting level of spawner-per-recruit as a percentage of the virgin level. The estimate harvest rates are very close to those estimated for several other stocks in VI and VII.

WGCSE took into account the following considerations based on the check list presented in Section 2.2:

- Compared to other *Nephrops* fisheries in the ICES area the population density of FU22 is the moderate ~0.5/m². These moderate densities have been fairly consistent throughout time and space (Figure 7.7.11) with the exception of 2006 when strong recruitment was observed. The time-series of UWTV estimates is short.

- The biological parameters in the Celtic Sea are rather old indicating slightly faster growth in males than in other areas. Natural mortality estimates are assumed in line with other stocks.
- Fishery operates throughout the year but there has been some variability of the seasonality depending on *Nephrops* emergence.
- The observed harvest rate has fluctuated over the time-series but is relatively stable over the most recent years.
- Overall the indicators suggest that the adult stock has been relatively stable or increasing for more than a decade.

Given the above considerations the **WG concluded default proxy of combined sex $F_{35\%Spr}$ is appropriate as an $F_{msy}$ proxy**. **This corresponds to a harvest rate of 10.9%,** in line with several other stocks in the remit of this WG (FU11, 12, 15, 17). Fishing at the combined sex $F_{35\%Spr}$ is predicted to keep the SPR for both sexes >25% and should deliver long-term yield with a low probability of recruitment overfishing. No $B_{trigger}$ can be proposed given the shortness of the UWTV series. Given that the stock in recent years has been at a relatively high level it is likely to be above $B_{trigger}$.

### 7.7.5 Short-term projections

No short-term projection is performed for the whole area of this stock. Projections are only carried out for the Smalls (FU22) component using the method agreed at WKNEPH 2009 and applied for all other stocks with UWTV estimates in VI and VII by WGCSE.

Catch option for 2011 at various harvest rations were calculated using the approach agreed at the Benchmark Workshop (WKNEPH, 2009). Catch options are calculated by applying a bias correction factor to the UWTV survey estimate, using 3 year mean weight in the landings, 3 year mean proportions of the catch retained and harvest ratios at different reference points from an SCA analysis to calculate landings options.

Previously a bias correction factor has not been estimated for FU22 but WD 10 offers a basis to estimate this as follows: The burrow systems are estimated to be of moderate size ~40 cm for most of the area. A field of view (FOV) of ~75 cm on the UWTV survey has been confirmed for most stations using sledge mounted lasers. There may be some random noise in the FOV due to sinking and jumping in poor weather, but this is normally not a major problem in FU22. The FOV is smaller than that used for Scottish stocks (FOV ~1 m) resulting an edge effect bias correction factor of around 1.35 based on the findings of Campbell *et al.* (2009). Burrow system detection rates are thought to be relatively high (0.9). Visibility is generally good; most systems have multiple entrances and are fairly evenly spaced making detection easier. There are some other burrowing macrobenthic species present in FU22 and misidentification is assumed to be in the order of 1.05. Fishing activity in FU22 is intensive and unoccupied burrows are likely to be filled in quickly due to a combination of fishing and hydrodynamic sediment disturbance. As for most other areas the assumption is that all the burrows counted are occupied by a single *Nephrops*. The cumulative bias estimates appropriate to the survey are shown below.

| FU | Area | Edge effect | detection rate | species identification | Occupancy | Cumulative bias |
|---|---|---|---|---|---|---|
| 20–22 | Smalls | 1.35 | 0.9 | 1.05 | 1 | 1.3 |

The inputs to the catch option table are given in Table 7.7.21. Table 7.7.22 shows landings predicted at a range of harvest ratios including those equivalent to fishing at $F_{MSY}$ proxies for the fishery as well as $F_{current} = F_{2010}$. Only the Harvest Rates associated with the combined sex $F_{MSY}$ proxies are identified in the table as they are considered more appropriate to this stock. As for other *Nephrops* stocks the $F_{MSY}$ proxy harvest rate values are considered preliminary and may be modified following further data exploration and analysis.

Table 7.7.18 gives the recent landings from all statistical rectangles within FU20–22. Recent landings for rectangles outside the Smalls i.e. FU 20 and 21 have fluctuated considerably between 1.3 and 3.1 kT. The average landings over the last decade were ~2.6 kT. In the provision of catch options for the whole of the area landings of that order could be added to catch advice for FU22.

### 7.7.6 Biological reference points

There are no biological reference points for FU20–22 *Nephrops* stock.

### 7.7.7 Management plans

No specific management plan exists for this stock.

### 7.7.8 Uncertainties and bias in assessment and forecast

The revision of French landings, fishing effort and lpue over the recent years, underlines the heterogeneous composition of the standard pool of vessels. Currently, misreporting does not seem to be a problem for the stock.

There are several key uncertainties and bias sources in the method used here (these are discussed further in WKNEPH 2009). Various agreed procedures have been put in place to ensure the quality and consistency of the survey estimates following the recommendations of several ICES groups (WKNEPTV 2007, WKNEPHBID 2008, SGNEPS 2009). Ultimately there still remains a degree of subjectivity in the production of UWTV abundance estimates (Marrs *et al.*, 1996). Taking explicit note of the likely biases in the surveys may at least provide an estimate of absolute abundance that was more accurate, but no more precise (WKNEPH 2009). The survey estimates themselves are very precisely estimated (CVs 2–6%) given the homogeneous distribution of burrow density and the modelling of spatial structuring. The cumulative bias estimates for FU22 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterized, but is likely to be lower than that observed in the survey.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings and the discard rates also arise. For FU22 deterministic estimates of the mean weight in the landings and discard rates for 2008–2010 are used although there is some variability of these over time. Particularly when large recruitments are observed in the stock as was the case in 2006 and 2007.

There is a gap of 16 months between the survey and the start of the year for which the assessment is used to set management levels. It is assumed that the stock is in equilibrium during this period (i.e. recruitment and growth balance mortality) although this is rarely the case. The effect of this assumption on realized harvest rates has not been investigated, but remains a key uncertainty.

The quality of landings data is thought to be good and sampling and discard estimates have improving over the time-series.

#### Exploitation pattern and spatial variability

The French and Irish time-series remain different and were provided by applying different exploitation pattern on different areas.

As pointed out by the Table 7.7.18, French and Irish trawlers cover different areas and have presented contrasting features over the last decade. French fleet moved gradually from the "Smalls" Ground (mainly 31E3) to the "Labadie" (30E2): at the end of 1990s, more than 40% of French landings were reported from the "Smalls" area whereas the contribution of this rectangle became minor less than 10% at the end of 2000s. Irish vessels are mainly fishing in the "Smalls" ground (current production of 31E3 equal to 2/3 of the total Irish landings).

#### Heterogeneity of LFDs for landings and discards

The problem of high variability of French landing samples between trips still remains (higher coefficients of variation at auction because of higher heterogeneity of the fished area and of long duration of trips i.e. 12–15 days and, therefore, less availability of samples at auction). Hence, high CV of numbers-at-sizes (20–30%) are usual. In any case, commercial samples can be extended by including the commercial part sampled on board during the DCF plan.

The sampling of tailed individuals in French landings provides valuable information, but underlines the necessity to re-calculate the actual size-composition of discarded individuals under the revised LFDs for landings, before the next benchmark.

While the selectivity parameters are not significantly improved for *Nephrops* trawlers, it appears appropriate to continue the Irish discard plan and to conduct a French one on a yearly basis. For French trawlers, the self-sampling on board initiated recently should provide additional information. It should be interesting to examine the part of decrease of the French discard rate since the early 2000s due to the selectivity improvement from that related to some weak recruiting classes (however, size-composition of landings for 2006 and 2007 may suggest a positive signal for recruitment and 2010s dataset of French sampling on board provided a high discard rate of 54% [65% in 1997] even if data from the 3rd and 4th quarter seem to be unlikely: Figure 7.7.9). Moreover, if the individual growth of this species is faster during the latter period of the compiled time-series, there would be decline of the discarded amounts with no possibility to investigate the actual recruitment level.

### 7.7.9 Recommendation for next benchmark

Many quantitative explorations attempted in recent years for the FU20–22 *Nephrops* stock (e.g. sampling on board, maturity ogive, discard derivation) were handicapped by the overall spatial heterogeneity, by the divergence of exploitation pattern for the two main fleets and by other factors as commercial trip duration.

#### Biological sampling

##### *Auction*

As the French sampling of tailed *Nephrops* on landings at auction has recently been standardized, updated information for LFD and sex ratio was provided in 2010 and should be benchmarked.

##### *On board*

The Irish plan of sampling on board under DCF will continue to provide information on discarded amounts and LFD. For the French trawlers, self-sampling on board is more realistic than during the 1980s–1990s (concentration of a huge proportion of total landings from a small number of vessels; see above § 7.7.1).

##### *Maturity*

Re-estimation of maturity parameters requires a specifically designed experiment which should be commonly organized by France and Ireland under DCF. This point should be discussed during the next RCM North Atlantic at La Rochelle.

#### Back-calculation for missing biological data

*Tails*

The modification of LFD for tailed individuals was extended on the overall period since the tailed fraction became significant by applying probabilistic concepts combined with s-shaped quarterly curves of tailing *Nephrops* vs. size. This has to be validated.

*Discards*

After re-calculating LFD for French landings on recent years, LFD of discards for French trawlers should be carried out for the whole time-series integrating the change of relative selectivity for trawls in 2000 (100 mm replacing 80 mm).

*Dataset on LFD of Irish landings before 2002*

For the years 1995–2002, available series on Irish landings on quarterly basis was not associated to samples on LFD. Despite spatial variability affecting size composition by fleet, the possibility to extrapolate French LFD for this period has to be investigated: before 2000, the same selectivity parameters for trawls should be used (the difference involved in MLS; § 7.7.1).

#### Surveys

*UWTV Irish survey*

The UWTV Irish survey initiated in 2006 can already form the basis for catch options and management advice on the Smalls component of the stock.

#### Commercial fleets

*Stratification of the French fleet*

The existence of official French statistics by vessel and trip (at least for the recent ten years), allows to stratify the whole fleet in order to propose homogeneous pools for commercial tuning fleets. Spatio-temporal variability of fishing power should also be performed aiming to evaluate the effect of different decommissioning plans throughout the time-series. See also general comments on mixed fisheries and allocation of trips to métier.

### 7.7.10 Management considerations

Management for *Nephrops* stocks in the Area VII should be conducted at an appropriate geographic scale (e.g. Functional Unit).

The *Nephrops* fisheries target different areas, and *Nephrops* catches and landings show very different size structures. These fisheries also have differences in non-*Nephrops* bycatch composition. Cod, whiting, and to a lesser extent haddock are the main bycatch species.

Discarding of small *Nephrops* is substantial. The discard rate seems to have notably fluctuated between fleets or years. This shows that trawls currently used to target *Nephrops* are not technically adapted to select marketable *Nephrops*. The calculation of the discard rate may be impacted by the upwards trend of tailed individuals in landings. Discarding of other fish species is also a problem in *Nephrops* fishery.

The French trawlers showed an overall decline in effort and landings during the last decade, mainly explained by decommissioning schemes associated to constraints linked to fuel prices. In a minor degree, Irish fleet also started to be impacted by European decommissioning plans in 2008 and 2009, but there was no new effect in 2010.

Effort of Irish vessels is more directed towards the Smalls ground which has high densities of small *Nephrops*. Currently, French effort is directed towards other grounds such as the Labbadie where the substratum is more heterogeneous and the mean size of *Nephrops* is significantly larger. There have been some changes in the spatial strategies over time. The recent lpues compared between French and Irish fleets in FU20–21 are showing very similar patterns, as are the Irish lpues in the two Areas FU20–21 and FU22. All lpue values over the whole time-series have not been corrected to take into account changing fishing power of fishing practices.

The average landings during 2000s have been stable or ascending up to 2008, and declining more recently. . However, various additional information such as mean sizes in landings, discard rate, abundances provided by UWTV survey suggest that there is little evidence of significant changes in the status of this stock.

### 7.7.11 References

**Charuau A., Morizur Y., Rivoalen J.J. 1982.** Survival of discarded *Nephrops norvegicus* in the Bay of Biscay and in the Celtic Sea. *ICES-CM-1982/B:13*.

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**Table 7.7.1. *Nephrops* FU 20–22 (Celtic Sea). Total and by country nominal landings (t) in Division VIIfgh as used by WG.**

| Year | France | Rep. of Ireland | UK | Other Countries[1] | Total reported | Unallocated | Total |
|---|---|---|---|---|---|---|---|
| 1983 | 3667 | | 65 | | | | |
| 1984 | 3653 | | 36 | | | | |
| 1985 | 3599 | | 3 | | | | |
| 1986 | 2638 | | | | | | |
| 1987 | 3080 | 329 | | | | | |
| 1988 | 2926 | 239 | 1 | | | | |
| 1989 | 3221 | 784 | 13 | | | | |
| 1990 | 3762 | 528 | 14 | | | | |
| 1991 | 2651 | 644 | 13 | | | | |
| 1992 | 3415 | 750 | 84 | | | | |
| 1993 | 3815 | 770 | 47 | 0 | 4632 | -274 | 4358 |
| 1994 | 3658 | 1415 | 42 | 2 | 5117 | -274 | 4843 |
| 1995 | 3803 | 1575 | 100 | 2 | 5480 | -282 | 5198 |
| 1996 | 3363 | 1377 | 77 | 2 | 4819 | -217 | 4602 |
| 1997 | 2589 | 1552 | 59 | 4 | 4204 | -213 | 3991 |
| 1998 | 2241 | 1619 | 48 | 1 | 3909 | -90 | 3819 |
| 1999 | 2078 | 824 | 38 | 0 | 2940 | -78 | 2862 |
| 2000 | 2848 | 1793 | 44 | 1 | 4686 | -44 | 4642 |
| 2001 | 2626 | 2123 | 19 | 1 | 4769 | -33 | 4736 |
| 2002 | 3154 | 1496 | 15 | 8 | 4673 | -50 | 4623 |
| 2003 | 3595 | 1389 | 19 | N/A | 5003 | 0 | 5003 |
| 2004 | 2605 | 1629 | 36 | N/A | 4270 | 0 | 4270 |
| 2005 | 2502 | 2387 | 53 | N/A | 4942 | 0 | 4942 |
| 2006 | 2368 | 1848 | 32 | N/A | 4248 | 0 | 4248 |
| 2007 | 2033 | 3214 | 47 | 6 | 5300 | 0 | 5300 |
| 2008 | 2348 | 3411 | 242 | N/A | 6001 | 0 | 6001 |
| 2009 | 2165 | 2844 | 378 | N/A | 5387 | 0 | 5387 |
| 2010 | 1112 | 3110 | 400 | N/A | 4565 | 0 | 4622 |

**[1]Other countries include Belgium.**

**Table 7.7.2. *Nephrops* FU 20–22 (Celtic Sea). Nominal landings (t) by quarter in Division VIIfgh as used by WG.**

| | French trawlers | | | | | Irish trawlers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | Q1 | Q2 | Q3 | Q4 | Total | Q1 | Q2 | Q3 | Q4 | Total |
| 1987 | 759 | 941 | 972 | 409 | 3080 | | | | | 329 |
| 1988 | 547 | 1065 | 683 | 631 | 2926 | | | | | 239 |
| 1989 | 411 | 1493 | 838 | 480 | 3221 | | | | | 784 |
| 1990 | 482 | 1765 | 1229 | 287 | 3762 | | | | | 528 |
| 1991 | 500 | 1245 | 518 | 388 | 2652 | | | | | 644 |
| 1992 | 681 | 992 | 1064 | 678 | 3415 | | | | | 750 |
| 1993 | 972 | 1598 | 742 | 504 | 3815 | | | | | 770 |
| 1994 | 541 | 1303 | 1052 | 762 | 3658 | | | | | 1415 |
| 1995 | 693 | 1631 | 876 | 604 | 3803 | 193 | 1137 | 109 | 136 | 1575 |
| 1996 | 674 | 1437 | 728 | 523 | 3363 | 268 | 714 | 330 | 66 | 1377 |
| 1997 | 460 | 1028 | 683 | 417 | 2589 | 249 | 971 | 196 | 136 | 1552 |
| 1998 | 642 | 881 | 456 | 262 | 2241 | 351 | 952 | 264 | 52 | 1619 |
| 1999 | 479 | 447 | 606 | 546 | 2078 | 214 | 184 | 105 | 321 | 824 |
| 2000 | 598 | 1261 | 743 | 246 | 2848 | 420 | 1154 | 149 | 71 | 1793 |
| 2001 | 422 | 879 | 667 | 658 | 2626 | 456 | 843 | 317 | 508 | 2123 |
| 2002 | 479 | 1211 | 823 | 641 | 3154 | 167 | 557 | 408 | 363 | 1496 |
| 2003 | 533 | 1401 | 1187 | 474 | 3595 | 203 | 519 | 479 | 190 | 1389 |
| 2004 | 496 | 981 | 677 | 452 | 2605 | 234 | 686 | 341 | 367 | 1629 |
| 2005 | 628 | 909 | 537 | 428 | 2502 | 491 | 1390 | 233 | 272 | 2387 |
| 2006 | 486 | 1024 | 563 | 295 | 2368 | 354 | 965 | 232 | 297 | 1848 |
| 2007 | 294 | 966 | 423 | 350 | 2033 | 416 | 1331 | 415 | 1051 | 3214 |
| 2008 | 450 | 794 | 681 | 424 | 2348 | 493 | 1589 | 600 | 728 | 3411 |
| 2009 | 543 | 886 | 493 | 244 | 2165 | 933 | 1186 | 529 | 197 | 2844 |
| 2010 | 298 | 379 | 312 | 122 | 1112 | 1122 | 1335 | 343 | 309 | 3110 |

**Table 7.7.3. *Nephrops* in VIIfgh. Length distribution of landings by country in 2002. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

- The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).
- The Irish data reported from the whole MA M (See Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | 1 | | | 1 | |
| 18 | | | | | | | | | | | 1 | | | 1 | |
| 19 | | | 4 | | | 5 | | | | | 2 | 24 | | 2 | 33 |
| 20 | | | 13 | | | 6 | | | | | 3 | 126 | | 3 | 145 |
| 21 | | | 37 | | | 4 | | | | | 5 | 172 | | 5 | 213 |
| 22 | | 1 | 72 | | | 17 | | | | | 7 | 564 | | 8 | 653 |
| 23 | | 1 | 124 | | 1 | 85 | | | 6 | | 12 | 1124 | | 13 | 1340 |
| 24 | | 2 | 236 | | 1 | 136 | | | 67 | 81 | 78 | 1804 | 81 | 81 | 2243 |
| 25 | | 3 | 421 | | 2 | 216 | | | 75 | | 30 | 1533 | | 35 | 2245 |
| 26 | | 5 | 538 | | 4 | 245 | | 1 | 182 | | 47 | 1495 | | 57 | 2459 |
| 27 | | 10 | 778 | | 7 | 326 | | 2 | 202 | | 75 | 1110 | | 94 | 2417 |
| 28 | | 17 | 760 | 83 | 71 | 577 | | 5 | 607 | | 120 | 1516 | 83 | 213 | 3459 |
| 29 | 21 | 48 | 639 | | 22 | 776 | | 11 | 470 | | 289 | 1220 | 21 | 369 | 3104 |
| 30 | 41 | 88 | 510 | | 39 | 741 | | 23 | 1125 | 242 | 613 | 1107 | 283 | 763 | 3483 |
| 31 | 47 | 339 | 589 | | 70 | 1075 | | 51 | 1685 | 242 | 667 | 1284 | 289 | 1125 | 4632 |
| 32 | 132 | 399 | 565 | | 125 | 1199 | | 110 | 1558 | 242 | 626 | 1002 | 375 | 1260 | 4325 |
| 33 | 140 | 433 | 453 | 83 | 283 | 1624 | 37 | 266 | 1551 | 404 | 694 | 995 | 664 | 1676 | 4624 |
| 34 | 236 | 511 | 419 | 122 | 801 | 1654 | 165 | 791 | 1455 | 404 | 718 | 753 | 927 | 2822 | 4281 |
| 35 | 366 | 612 | 326 | 540 | 1436 | 1654 | 401 | 1427 | 1152 | 678 | 857 | 782 | 1985 | 4332 | 3913 |
| 36 | 503 | 693 | 256 | 995 | 2001 | 1376 | 1125 | 1745 | 599 | 601 | 777 | 512 | 3223 | 5217 | 2742 |
| 37 | 648 | 767 | 221 | 1541 | 2247 | 1361 | 706 | 1359 | 711 | 823 | 914 | 412 | 3718 | 5288 | 2705 |
| 38 | 797 | 832 | 198 | 1603 | 2131 | 1156 | 1603 | 1761 | 580 | 1146 | 1096 | 526 | 5150 | 5821 | 2460 |
| 39 | 847 | 827 | 198 | 2230 | 2404 | 820 | 1463 | 1504 | 341 | 824 | 849 | 270 | 5364 | 5584 | 1628 |
| 40 | 1078 | 963 | 116 | 2901 | 2690 | 907 | 1466 | 1320 | 313 | 1618 | 1388 | 270 | 7063 | 6361 | 1606 |
| 41 | 817 | 730 | 47 | 2757 | 2381 | 380 | 1028 | 896 | 249 | 1377 | 1156 | 171 | 5978 | 5163 | 847 |
| 42 | 1114 | 926 | 140 | 2365 | 1929 | 322 | 1186 | 958 | 207 | 669 | 578 | 156 | 5334 | 4391 | 825 |
| 43 | 509 | 434 | 12 | 2070 | 1598 | 249 | 781 | 629 | 129 | 836 | 671 | 85 | 4196 | 3332 | 474 |
| 44 | 604 | 493 | 47 | 1003 | 794 | 234 | 1076 | 837 | 129 | 771 | 625 | 28 | 3454 | 2749 | 438 |
| 45 | 352 | 288 | 23 | 1157 | 882 | 132 | 605 | 476 | 74 | 612 | 527 | 71 | 2727 | 2174 | 300 |
| 46 | 144 | 122 | | 467 | 371 | 132 | 893 | 692 | 37 | 306 | 281 | 14 | 1811 | 1466 | 183 |
| 47 | 179 | 150 | | 345 | 302 | 15 | 470 | 371 | 97 | 247 | 238 | 14 | 1241 | 1061 | 126 |
| 48 | 78 | 68 | 23 | 472 | 390 | 102 | 422 | 331 | 55 | 175 | 161 | 14 | 1147 | 949 | 195 |
| 49 | 87 | 74 | 12 | 133 | 124 | 59 | 202 | 164 | 37 | 55 | 59 | 14 | 477 | 420 | 121 |
| 50 | 73 | 62 | | 242 | 207 | 15 | 158 | 129 | | 87 | 91 | 14 | 560 | 490 | 29 |
| 51 | 48 | 41 | | 166 | 142 | | 126 | 106 | 18 | 95 | 83 | | 435 | 371 | 18 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 52 | 32 | 29 | | 72 | 73 | | 120 | 100 | 18 | 94 | 74 | | 318 | 276 | 18 |
| 53 | 30 | 28 | | 76 | 77 | | 45 | 43 | | 24 | 25 | | 175 | 172 | |
| 54 | 31 | 29 | | 57 | 57 | | 65 | 54 | 18 | 23 | 24 | | 176 | 165 | 18 |
| 55 | 24 | 24 | | 53 | 53 | | 99 | 80 | 18 | 17 | 17 | | 192 | 175 | 18 |
| 56 | 18 | 18 | | 40 | 41 | | 19 | 18 | | 8 | 9 | | 85 | 85 | |
| 57 | 11 | 11 | | 42 | 42 | | 9 | 9 | 18 | 15 | 15 | | 77 | 78 | 18 |
| 58 | 11 | 11 | | 23 | 23 | | 8 | 8 | 18 | | | | 42 | 42 | 18 |
| 59 | 10 | 10 | | 12 | 12 | | 2 | 2 | | 1 | 1 | | 25 | 26 | |
| 60 | 12 | 13 | | 14 | 14 | | 7 | 6 | 18 | 1 | 1 | | 34 | 34 | 18 |
| 61 | 3 | 3 | | 18 | 18 | | 7 | 7 | | 1 | 1 | | 28 | 28 | |
| 62 | 4 | 4 | | 20 | 21 | | 1 | 1 | | 1 | 1 | | 26 | 26 | |
| 63 | 2 | 2 | | | | | 1 | 1 | | 8 | 8 | | 11 | 11 | |
| 64 | 2 | 2 | | | | | | | | 1 | 1 | | 2 | 2 | |
| 65 | 2 | 2 | | | | | 1 | 1 | | | | | 3 | 3 | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | 1 | 1 | | | | | 1 | 1 | | | | | 2 | 2 | |
| 69 | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 9056 | 10 126 | 7774 | 21 703 | 23 884 | 17 600 | 14 293 | 16 297 | 13 821 | 12 732 | 14 516 | 19 184 | 57 783 | 64 823 | 58 378 |

**Table 7.7.4. *Nephrops* in VIIfgh. Length distribution of landings by country in 2003. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | 2 | | | | | | | | | 2 |
| 19 | | | | | | 10 | | | | | | | | | 10 |
| 20 | | | 124 | | | 26 | | | 71 | | | 49 | | | 270 |
| 21 | | | 556 | | | 72 | | | 271 | | 1 | 172 | | 1 | 1071 |
| 22 | | | 567 | | | 169 | | | 399 | | 1 | 198 | | 1 | 1333 |
| 23 | | | 1452 | | | 319 | | | 596 | | 1 | 211 | | 2 | 2578 |
| 24 | | | 446 | | 1 | 848 | | 1 | 608 | | 2 | 239 | | 4 | 2141 |
| 25 | | | 150 | | 1 | 1110 | | 1 | 737 | | 3 | 477 | | 6 | 2474 |
| 26 | | | 2334 | | 3 | 1836 | | 3 | 1072 | | 5 | 586 | | 11 | 5827 |
| 27 | | | 321 | | 5 | 1894 | | 6 | 1644 | | 8 | 514 | | 19 | 4372 |
| 28 | | 1 | 1675 | | 9 | 1967 | | 12 | 2065 | | 13 | 948 | | 35 | 6654 |
| 29 | | 1 | 450 | | 16 | 1895 | | 25 | 2331 | | 20 | 901 | | 63 | 5578 |
| 30 | | 2 | 372 | | 29 | 1744 | | 52 | 2545 | | 31 | 445 | | 115 | 5106 |
| 31 | 25 | 23 | 831 | | 54 | 1682 | | 107 | 1906 | 25 | 66 | 828 | 50 | 250 | 5247 |
| 32 | | 7 | 1002 | 47 | 133 | 1796 | 211 | 370 | 1810 | 99 | 257 | 1307 | 357 | 767 | 5915 |
| 33 | | 13 | 548 | 47 | 215 | 2035 | | 1152 | 1360 | 99 | 273 | 437 | 146 | 1653 | 4380 |
| 34 | | 24 | 428 | 328 | 1228 | 1565 | 739 | 2297 | 1374 | 124 | 427 | 477 | 1191 | 3975 | 3845 |
| 35 | 77 | 188 | 238 | 516 | 1412 | 1293 | 1689 | 3101 | 868 | 496 | 756 | 240 | 2778 | 5457 | 2639 |
| 36 | 75 | 310 | 190 | 563 | 1534 | 856 | 1901 | 2690 | 510 | 545 | 812 | 254 | 3083 | 5345 | 1809 |
| 37 | 298 | 494 | 190 | 1220 | 1892 | 639 | 1478 | 2008 | 378 | 595 | 776 | 233 | 3591 | 5169 | 1441 |
| 38 | 323 | 533 | 285 | 1313 | 1794 | 492 | 2649 | 2548 | 391 | 694 | 774 | 206 | 4979 | 5649 | 1374 |
| 39 | 497 | 666 | 95 | 1360 | 1691 | 359 | 2745 | 2356 | 434 | 694 | 703 | 137 | 5297 | 5415 | 1026 |
| 40 | 828 | 915 | | 2224 | 2200 | 158 | 1496 | 1296 | 179 | 620 | 616 | 158 | 5168 | 5027 | 495 |
| 41 | 1024 | 1022 | 48 | 2499 | 2268 | 257 | 2217 | 1691 | 219 | 942 | 790 | 69 | 6683 | 5771 | 592 |
| 42 | 1044 | 978 | 95 | 2385 | 2054 | 197 | 1409 | 1078 | 223 | 697 | 593 | 34 | 5535 | 4703 | 549 |
| 43 | 1096 | 959 | 48 | 2478 | 2024 | 228 | 1224 | 925 | 112 | 737 | 582 | 27 | 5535 | 4490 | 415 |
| 44 | 761 | 660 | | 1734 | 1410 | 80 | 1472 | 1100 | 96 | 501 | 401 | 27 | 4467 | 3570 | 203 |
| 45 | 751 | 627 | | 1532 | 1242 | 70 | 1229 | 974 | 20 | 459 | 364 | 21 | 3971 | 3206 | 110 |
| 46 | 462 | 389 | 48 | 1692 | 1365 | 50 | 1193 | 931 | 20 | 312 | 270 | 14 | 3659 | 2954 | 131 |
| 47 | 298 | 267 | | 1008 | 858 | 20 | 391 | 336 | 120 | 243 | 218 | 27 | 1941 | 1679 | 167 |
| 48 | 308 | 274 | | 674 | 588 | 10 | 313 | 286 | 60 | 204 | 181 | | 1498 | 1329 | 70 |
| 49 | 243 | 224 | | 392 | 379 | 30 | 180 | 183 | 40 | 142 | 133 | 7 | 958 | 919 | 77 |
| 50 | 99 | 105 | | 313 | 295 | 20 | 108 | 110 | 20 | 156 | 154 | | 676 | 663 | 40 |
| 51 | 79 | 83 | | 212 | 219 | 20 | 81 | 82 | 40 | 78 | 81 | | 450 | 465 | 60 |
| 52 | 42 | 44 | | 119 | 123 | 10 | 90 | 91 | | 57 | 59 | 14 | 308 | 317 | 24 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 25 | 26 | | 93 | 96 | | 54 | 55 | | 27 | 28 | | 199 | 204 | |
| 54 | 12 | 13 | | 86 | 89 | | 18 | 18 | | 9 | 9 | | 126 | 129 | |
| 55 | 25 | 26 | | 40 | 41 | | 9 | 9 | | 21 | 21 | | 94 | 97 | |
| 56 | 10 | 10 | | 33 | 34 | | 36 | 36 | | 3 | 3 | | 82 | 84 | |
| 57 | 10 | 10 | | 27 | 27 | 10 | 36 | 36 | | 3 | 3 | | 75 | 77 | 10 |
| 58 | 5 | 5 | | 20 | 20 | | | | | | | | 25 | 26 | |
| 59 | 2 | 3 | | 13 | 14 | | 9 | 9 | | | | | 25 | 25 | |
| 60 | | | | | | | | | | | | | | | |
| 61 | | | | 7 | 7 | | | | | | | | 7 | 7 | |
| 62 | 5 | 5 | | | | | | | | | | | 5 | 5 | |
| 63 | | | | | | | | | | | | | | | |
| 64 | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | | | | | | | | | | | | |
| 69 | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 8424 | 8907 | 12 492 | 22 977 | 25 366 | 23 767 | 22 978 | 25 977 | 22 516 | 8581 | 9438 | 9258 | 62 959 | 69 688 | 68 034 |

**Table 7.7.5. *Nephrops* in VIIfgh. Length distribution of landings by country in 2004. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

- The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).
- The missing Irish data of the 1st and 4th quarters were calculated by likelihood function as explained (Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | 1 | | | 1 |
| 18 | | | 3 | | | | | | | | | 2 | | | 6 |
| 19 | | | 16 | | | | | | | | | 4 | | 1 | 20 |
| 20 | | | 30 | | | 1 | | | 1 | | | 8 | | 1 | 40 |
| 21 | | | 46 | | | 11 | | 1 | 1 | | | 19 | | 2 | 77 |
| 22 | | 1 | 69 | | | 8 | | 2 | | | 1 | 57 | | 3 | 134 |
| 23 | | 1 | 108 | | | 25 | | 3 | 4 | | 1 | 107 | | 6 | 245 |
| 24 | | 2 | 161 | | 1 | 100 | | 6 | 13 | | 2 | 207 | | 11 | 480 |
| 25 | | 4 | 213 | | 1 | 189 | | 12 | 37 | | 3 | 368 | | 19 | 807 |
| 26 | | 6 | 298 | | 2 | 446 | | 22 | 107 | | 4 | 565 | | 35 | 1416 |
| 27 | | 11 | 390 | | 3 | 578 | | 42 | 286 | | 7 | 799 | | 64 | 2053 |
| 28 | | 19 | 443 | | 6 | 705 | | 80 | 699 | | 12 | 1091 | | 117 | 2938 |
| 29 | | 34 | 538 | | 10 | 1013 | | 152 | 1126 | | 20 | 1360 | | 215 | 4037 |
| 30 | | 59 | 681 | | 16 | 1402 | | 290 | 1652 | | 32 | 1521 | | 397 | 5255 |
| 31 | | 102 | 737 | | 27 | 1965 | 73 | 880 | 1798 | | 53 | 1563 | 73 | 1063 | 6063 |
| 32 | 80 | 402 | 783 | 64 | 88 | 2493 | 254 | 1227 | 1606 | | 88 | 1542 | 398 | 1805 | 6424 |
| 33 | 321 | 669 | 800 | 64 | 119 | 2870 | 363 | 1114 | 1403 | | 145 | 1386 | 748 | 2047 | 6459 |
| 34 | 351 | 797 | 746 | | 350 | 3038 | 327 | 983 | 1336 | 161 | 312 | 1144 | 838 | 2442 | 6264 |
| 35 | 728 | 978 | 634 | 191 | 592 | 2299 | 689 | 1193 | 988 | 183 | 589 | 908 | 1792 | 3352 | 4829 |
| 36 | 618 | 823 | 553 | 318 | 1177 | 1906 | 1161 | 1336 | 708 | 688 | 1078 | 738 | 2785 | 4414 | 3905 |
| 37 | 763 | 825 | 444 | 1080 | 1723 | 1702 | 871 | 978 | 449 | 1009 | 1224 | 544 | 3723 | 4749 | 3138 |
| 38 | 827 | 786 | 373 | 1080 | 1745 | 1302 | 1161 | 999 | 353 | 596 | 817 | 397 | 3664 | 4346 | 2426 |
| 39 | 537 | 514 | 298 | 1652 | 1741 | 799 | 798 | 674 | 224 | 688 | 700 | 297 | 3675 | 3628 | 1618 |
| 40 | 695 | 584 | 216 | 826 | 1027 | 499 | 980 | 747 | 134 | 573 | 558 | 223 | 3074 | 2916 | 1072 |
| 41 | 486 | 412 | 150 | 1525 | 1348 | 448 | 1161 | 841 | 135 | 573 | 508 | 162 | 3745 | 3109 | 894 |
| 42 | 612 | 487 | 105 | 1789 | 1421 | 249 | 762 | 547 | 82 | 688 | 543 | 118 | 3852 | 2998 | 554 |
| 43 | 516 | 409 | 68 | 837 | 699 | 162 | 726 | 509 | 57 | 575 | 437 | 79 | 2653 | 2054 | 366 |
| 44 | 461 | 369 | 41 | 1218 | 895 | 74 | 635 | 449 | 59 | 392 | 296 | 59 | 2706 | 2009 | 234 |
| 45 | 470 | 366 | 31 | 1092 | 831 | 50 | 527 | 370 | 30 | 482 | 345 | 46 | 2571 | 1912 | 156 |
| 46 | 129 | 119 | 21 | 827 | 603 | | 142 | 111 | 22 | 432 | 298 | 29 | 1530 | 1130 | 72 |
| 47 | 309 | 249 | 16 | 457 | 370 | 50 | 408 | 310 | 24 | 90 | 75 | 17 | 1264 | 1004 | 107 |
| 48 | 178 | 166 | 11 | 661 | 570 | 25 | 278 | 225 | 11 | 182 | 136 | 14 | 1299 | 1099 | 61 |
| 49 | 178 | 166 | 9 | 352 | 320 | 25 | 282 | 229 | 11 | 123 | 102 | 6 | 935 | 816 | 51 |
| 50 | 125 | 120 | 5 | 395 | 361 | | 149 | 155 | 5 | 69 | 63 | 4 | 739 | 698 | 14 |
| 51 | 149 | 143 | 4 | 193 | 198 | | 145 | 151 | 3 | 54 | 56 | 3 | 541 | 548 | 10 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 52 | 117 | 118 | 2 | 215 | 219 | | 126 | 131 | 3 | 58 | 60 | 3 | 516 | 528 | 7 |
| 53 | 81 | 81 | 2 | 204 | 208 | | 114 | 106 | 8 | 81 | 83 | 2 | 479 | 478 | 12 |
| 54 | 60 | 60 | 2 | 129 | 131 | | 37 | 39 | 3 | 61 | 63 | 2 | 287 | 293 | 6 |
| 55 | 60 | 60 | | 64 | 66 | | 37 | 39 | 3 | 48 | 49 | 3 | 209 | 214 | 6 |
| 56 | 36 | 37 | | 54 | 55 | | 37 | 39 | | 36 | 37 | 3 | 164 | 167 | 3 |
| 57 | 26 | 26 | | 54 | 55 | | 37 | 39 | 16 | 17 | 18 | 3 | 134 | 137 | 19 |
| 58 | 18 | 18 | | 11 | 11 | | 26 | 27 | | 12 | 12 | 3 | 66 | 68 | 3 |
| 59 | 3 | 3 | | 32 | 33 | | 4 | 4 | 5 | 10 | 10 | 3 | 48 | 49 | 8 |
| 60 | 3 | 3 | | | | | 15 | 15 | | 6 | 6 | 1 | 23 | 24 | 1 |
| 61 | | | | | | | 15 | 15 | | 2 | 2 | 1 | 17 | 17 | 1 |
| 62 | | | | | | | 11 | 12 | | | | | 11 | 12 | |
| 63 | | | | | | | 4 | 4 | | | | | 4 | 4 | |
| 64 | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | 2 | 2 | | 2 | 2 | |
| 66 | | | | | | | | | 3 | | | | | | 3 |
| 67 | | | | | | | | | | | | 1 | | | 1 |
| 68 | | | | | | | | | | 2 | 2 | 1 | 2 | 2 | 1 |
| 69 | | | | | | | | | 3 | | | | | | 3 |
| 70 | | | | | | | | | | | | 1 | | | 1 |
| 71 | | | | | | | | | | | | 1 | | | 1 |
| 72 | | | | | | | | | 3 | | | | | | 3 |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 8938 | 10 029 | 9048 | 15 381 | 17 020 | 24 434 | 12 354 | 15 106 | 13 409 | 7892 | 8850 | 15 412 | 44 565 | 51 005 | 62 303 |

**Table 7.7.6. *Nephrops* in VIIfgh. Length distribution of landings by country in 2005. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | 1 | |
| 20 | | | | | | 17 | | | 12 | | 1 | 73 | | 1 | 102 |
| 21 | | | | | | 74 | | | 29 | | 1 | 355 | | 2 | 459 |
| 22 | | | | | | 92 | | | 46 | | 1 | 415 | | 2 | 553 |
| 23 | | 1 | | | | 271 | | | 110 | 1 | 3 | 783 | 1 | 4 | 1164 |
| 24 | | 1 | 101 | | 1 | 791 | | | 272 | | 3 | 1565 | | 5 | 2730 |
| 25 | | 2 | 202 | | 1 | 1833 | | | 381 | | 5 | 1897 | | 9 | 4313 |
| 26 | | 4 | 378 | | 2 | 2656 | | 1 | 596 | 8 | 13 | 3003 | 8 | 20 | 6634 |
| 27 | 9 | 14 | 1088 | | 3 | 4305 | | 2 | 781 | 1 | 14 | 2380 | 10 | 33 | 8554 |
| 28 | | 12 | 949 | | 6 | 5367 | | 3 | 849 | 2 | 24 | 1749 | 2 | 45 | 8913 |
| 29 | | 21 | 1059 | | 10 | 6785 | | 6 | 816 | 1 | 35 | 1270 | 1 | 73 | 9930 |
| 30 | 9 | 42 | 1403 | | 19 | 7049 | | 13 | 945 | 4 | 63 | 1021 | 13 | 136 | 10418 |
| 31 | | 61 | 2076 | | 33 | 7768 | | 25 | 974 | 21 | 109 | 998 | 21 | 228 | 11816 |
| 32 | 70 | 156 | 1655 | | 60 | 7758 | 8 | 54 | 926 | 70 | 239 | 628 | 148 | 509 | 10966 |
| 33 | 44 | 355 | 1059 | 10 | 114 | 5684 | 18 | 108 | 788 | 162 | 468 | 423 | 233 | 1045 | 7954 |
| 34 | 131 | 506 | 1655 | | 194 | 4222 | 58 | 593 | 615 | 471 | 826 | 624 | 660 | 2119 | 7116 |
| 35 | 289 | 734 | 1312 | 69 | 698 | 3430 | 196 | 804 | 609 | 769 | 1131 | 246 | 1323 | 3366 | 5597 |
| 36 | 464 | 845 | 933 | 223 | 1210 | 2467 | 297 | 931 | 412 | 1076 | 1309 | 323 | 2060 | 4294 | 4134 |
| 37 | 525 | 799 | 851 | 429 | 1394 | 1308 | 515 | 941 | 444 | 1188 | 1273 | 123 | 2656 | 4408 | 2726 |
| 38 | 578 | 762 | 936 | 483 | 1306 | 1356 | 558 | 859 | 261 | 1109 | 1076 | 191 | 2728 | 4004 | 2745 |
| 39 | 814 | 839 | 760 | 598 | 1132 | 862 | 761 | 832 | 245 | 934 | 830 | 177 | 3106 | 3634 | 2045 |
| 40 | 658 | 657 | 631 | 615 | 936 | 421 | 696 | 662 | 135 | 731 | 611 | 68 | 2700 | 2867 | 1255 |
| 41 | 735 | 654 | 296 | 617 | 788 | 378 | 545 | 475 | 94 | 589 | 460 | 40 | 2487 | 2377 | 809 |
| 42 | 780 | 646 | 166 | 744 | 725 | 233 | 493 | 392 | 62 | 415 | 323 | 27 | 2432 | 2087 | 488 |
| 43 | 570 | 465 | 268 | 588 | 545 | 64 | 412 | 312 | 34 | 450 | 324 | 13 | 2021 | 1647 | 380 |
| 44 | 613 | 480 | 166 | 598 | 491 | 40 | 276 | 214 | 24 | 288 | 216 | | 1775 | 1401 | 230 |
| 45 | 547 | 423 | | 746 | 554 | 17 | 247 | 193 | 8 | 271 | 201 | 13 | 1812 | 1371 | 38 |
| 46 | 520 | 406 | 129 | 701 | 502 | 47 | 161 | 135 | 25 | 182 | 141 | | 1563 | 1183 | 201 |
| 47 | 400 | 314 | | 752 | 520 | 17 | 199 | 164 | 3 | 135 | 111 | | 1486 | 1109 | 19 |
| 48 | 258 | 219 | | 757 | 516 | | 158 | 136 | 11 | 75 | 67 | | 1248 | 938 | 11 |
| 49 | 271 | 239 | | 677 | 465 | | 177 | 135 | | 49 | 48 | | 1174 | 886 | |
| 50 | 241 | 220 | | 698 | 491 | 23 | 302 | 226 | 1 | 34 | 35 | | 1275 | 973 | 24 |
| 51 | 263 | 240 | | 476 | 351 | | 271 | 203 | | 40 | 42 | | 1051 | 835 | |
| 52 | 179 | 171 | | 349 | 278 | | 215 | 165 | | 21 | 22 | | 764 | 636 | |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 153 | 139 | | 332 | 263 | | 198 | 144 | | 23 | 24 | | 707 | 570 | |
| 54 | 101 | 101 | | 241 | 194 | | 181 | 133 | 1 | 20 | 20 | | 543 | 448 | 1 |
| 55 | 89 | 88 | | 193 | 167 | | 205 | 149 | | 16 | 16 | | 502 | 421 | |
| 56 | 50 | 51 | | 132 | 114 | | 85 | 64 | | 9 | 9 | | 276 | 238 | |
| 57 | 58 | 56 | | 140 | 106 | | 73 | 56 | | 9 | 9 | | 280 | 228 | |
| 58 | 33 | 33 | | 64 | 53 | | 68 | 50 | | 4 | 5 | | 169 | 141 | |
| 59 | 31 | 32 | | 48 | 41 | | 48 | 35 | | 5 | 5 | | 133 | 113 | |
| 60 | 15 | 15 | | 8 | 8 | | 13 | 14 | | 4 | 4 | | 39 | 41 | |
| 61 | 15 | 15 | | 9 | 9 | | 18 | 13 | | 1 | 1 | | 43 | 39 | |
| 62 | 3 | 3 | | 5 | 5 | | 4 | 7 | | | | | 11 | 15 | |
| 63 | 3 | 3 | | 3 | 3 | | 10 | 8 | | 1 | 1 | | 17 | 15 | |
| 64 | | | | | | | 1 | 2 | | | | | 1 | 2 | |
| 65 | | | | 2 | 2 | | 1 | 2 | | | | | 2 | 3 | |
| 66 | | | | 2 | 2 | | 1 | 2 | | | | | 3 | 4 | |
| 67 | | | | | | | 1 | 2 | | | | | 1 | 2 | |
| 68 | | | | | | | 1 | 2 | | | | | 1 | 2 | |
| 69 | | | | | | | | | | | | | | | |
| 70 | | | | | | | 1 | 2 | | | | | 1 | 2 | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | 1 | 1 | | | | | 1 | 1 | |
| 73 | | | | | | | | 1 | | | | | | 1 | |
| 74 | | | | | | | | 1 | | | | | | 1 | |
| 75 | | | | | | | 1 | 3 | | | | | 1 | 3 | |
| Total | 9519 | 10 828 | 18 072 | 11 307 | 14 310 | 65 334 | 7474 | 9276 | 10 511 | 9190 | 10 123 | 18 409 | 37 491 | 44 537 | 112 326 |

**Table 7.7.7. *Nephrops* in VIIfgh. Length distribution of landings by country in 2006. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | 4 | | | | | | 4 |
| 19 | | | | | | 7 | | | 8 | | | | | | 15 |
| 20 | | | 80 | | | 21 | | | 11 | | | 123 | | | 235 |
| 21 | | | 93 | | | 57 | | | 12 | | | 335 | | 1 | 497 |
| 22 | | | 266 | | | 195 | | 1 | 70 | | 1 | 582 | | 1 | 1113 |
| 23 | | | 559 | | | 488 | | 1 | 123 | | 1 | 1141 | | 3 | 2312 |
| 24 | | | 1543 | | 1 | 852 | | 2 | 429 | | 2 | 1705 | | 5 | 4529 |
| 25 | | 1 | 2000 | | 1 | 1501 | | 4 | 692 | | 3 | 2210 | | 8 | 6403 |
| 26 | | 1 | 2946 | | 2 | 3065 | | 8 | 1333 | | 5 | 2705 | | 15 | 10050 |
| 27 | | 2 | 3263 | | 3 | 4601 | | 15 | 1722 | | 8 | 2869 | | 28 | 12454 |
| 28 | | 4 | 3245 | | 6 | 5701 | 10 | 35 | 2049 | 6 | 17 | 2354 | 15 | 62 | 13349 |
| 29 | | 7 | 2825 | | 12 | 6459 | | 58 | 1689 | | 22 | 1442 | | 99 | 12415 |
| 30 | | 14 | 1951 | 13 | 30 | 6443 | 10 | 119 | 1437 | 11 | 43 | 1119 | 34 | 205 | 10950 |
| 31 | | 25 | 1740 | | 41 | 4632 | 20 | 234 | 1012 | | 60 | 731 | 20 | 359 | 8115 |
| 32 | 18 | 58 | 990 | 26 | 91 | 4577 | 68 | 715 | 706 | 34 | 109 | 577 | 146 | 972 | 6849 |
| 33 | 53 | 319 | 673 | 13 | 148 | 3302 | 78 | 904 | 647 | 85 | 291 | 431 | 229 | 1662 | 5053 |
| 34 | 152 | 524 | 398 | 208 | 840 | 2438 | 205 | 907 | 573 | 312 | 538 | 346 | 877 | 2809 | 3755 |
| 35 | 286 | 676 | 412 | 312 | 1404 | 1679 | 254 | 982 | 269 | 431 | 729 | 332 | 1283 | 3791 | 2693 |
| 36 | 397 | 783 | 178 | 845 | 2036 | 1190 | 488 | 1055 | 274 | 738 | 915 | 265 | 2468 | 4789 | 1907 |
| 37 | 642 | 880 | 123 | 1430 | 2520 | 826 | 714 | 1160 | 144 | 772 | 880 | 248 | 3558 | 5440 | 1343 |
| 38 | 648 | 808 | 96 | 1963 | 2519 | 518 | 1143 | 1235 | 110 | 755 | 752 | 173 | 4509 | 5314 | 897 |
| 39 | 788 | 799 | 82 | 1769 | 2052 | 355 | 1133 | 1025 | 92 | 590 | 560 | 140 | 4281 | 4435 | 668 |
| 40 | 735 | 680 | 14 | 2015 | 1839 | 276 | 918 | 745 | 19 | 568 | 483 | 96 | 4237 | 3747 | 405 |
| 41 | 636 | 552 | 14 | 1755 | 1449 | 261 | 1026 | 709 | 51 | 540 | 420 | 67 | 3957 | 3130 | 393 |
| 42 | 722 | 577 | | 1496 | 1121 | 126 | 791 | 525 | 11 | 319 | 250 | 52 | 3329 | 2474 | 189 |
| 43 | 674 | 518 | 14 | 1257 | 879 | 98 | 815 | 507 | 7 | 315 | 227 | 32 | 3061 | 2131 | 151 |
| 44 | 486 | 370 | | 965 | 652 | 85 | 519 | 322 | 11 | 211 | 151 | 38 | 2181 | 1495 | 133 |
| 45 | 429 | 321 | | 897 | 585 | 56 | 335 | 208 | 7 | 119 | 89 | 17 | 1781 | 1202 | 80 |
| 46 | 346 | 262 | | 696 | 462 | 14 | 468 | 284 | 4 | 119 | 85 | 14 | 1629 | 1093 | 32 |
| 47 | 297 | 231 | 27 | 529 | 365 | 28 | 287 | 183 | | 86 | 65 | 14 | 1198 | 844 | 69 |
| 48 | 262 | 209 | | 465 | 333 | 7 | 138 | 107 | | 48 | 38 | 12 | 913 | 687 | 19 |
| 49 | 168 | 145 | | 248 | 203 | 14 | 138 | 98 | | 66 | 51 | 3 | 619 | 497 | 17 |
| 50 | 87 | 84 | | 216 | 185 | | 117 | 89 | | 23 | 22 | 6 | 443 | 381 | 6 |
| 51 | 71 | 72 | | 100 | 98 | | 115 | 92 | | 27 | 25 | | 313 | 286 | |
| 52 | 68 | 68 | | 156 | 127 | 14 | 70 | 63 | | 19 | 18 | | 313 | 276 | 14 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 62 | 64 | | 114 | 101 | | 46 | 52 | | 10 | 11 | | 231 | 228 | |
| 54 | 42 | 44 | | 72 | 69 | | 42 | 39 | | 9 | 10 | | 166 | 161 | |
| 55 | 34 | 35 | | 63 | 59 | | 27 | 28 | | 10 | 10 | | 134 | 133 | |
| 56 | 33 | 35 | | 39 | 41 | | 23 | 24 | | 8 | 9 | | 105 | 108 | |
| 57 | 29 | 30 | | 38 | 39 | | 13 | 14 | | 5 | 5 | | 85 | 87 | |
| 58 | 17 | 18 | | 38 | 39 | | 12 | 12 | | 5 | 5 | | 71 | 74 | |
| 59 | 11 | 11 | 14 | 26 | 27 | | 8 | 9 | | 3 | 4 | | 49 | 50 | 14 |
| 60 | 7 | 7 | | 15 | 15 | | 12 | 12 | | 2 | 2 | | 36 | 37 | |
| 61 | 4 | 4 | | 10 | 11 | | 6 | 6 | | 1 | 1 | | 21 | 22 | |
| 62 | 3 | 3 | | 3 | 3 | | 4 | 4 | | 1 | 1 | | 10 | 11 | |
| 63 | 1 | 1 | | | | | 1 | 1 | | 1 | 1 | | 3 | 3 | |
| 64 | 2 | 2 | | 2 | 2 | | 2 | 2 | | | | | 7 | 7 | |
| 65 | | | | 1 | 1 | | 1 | 1 | | | | | 2 | 2 | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | | | | | | | | | | | | |
| 69 | | 1 | | | | | | | | | | | | 1 | |
| 70 | | | | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 8209 | 9244 | 23 545 | 17 796 | 20 408 | 49 887 | 10 060 | 12 597 | 13 515 | 6249 | 6918 | 20 179 | 42 315 | 49 167 | 107 126 |

**Table 7.7.8. *Nephrops* in VIIfgh. Length distribution of landings by country in 2007. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (simulation of hand-sorting s-shaped curve vs. CL: see Stock Annex).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | 29 | | | | | | | | | 29 |
| 20 | | | 105 | | | 148 | | | 10 | | | 204 | | | 468 |
| 21 | | | 211 | | | 354 | | | 36 | | | | | | 601 |
| 22 | | | 495 | | | 1048 | | | 167 | | | 650 | | 1 | 2360 |
| 23 | | | 916 | | 1 | 2897 | | | 539 | | | 3669 | | 1 | 8021 |
| 24 | | | 2757 | | 1 | 3975 | | | 1307 | | 1 | 5096 | | 2 | 13135 |
| 25 | | 1 | 4218 | | 2 | 5684 | | | 2576 | | 1 | 5667 | | 4 | 18144 |
| 26 | | 2 | 5320 | | 4 | 8822 | | | 2946 | | 2 | 5620 | | 7 | 22708 |
| 27 | | 3 | 6276 | 21 | 18 | 9507 | | 1 | 3386 | | 3 | 3055 | 21 | 25 | 22225 |
| 28 | | 6 | 5458 | 21 | 25 | 11331 | | 2 | 4067 | | 5 | 3630 | 22 | 37 | 24486 |
| 29 | | 10 | 4525 | | 25 | 11794 | | 5 | 4174 | 5 | 10 | 3528 | 5 | 50 | 24021 |
| 30 | 5 | 21 | 1767 | 42 | 69 | 10040 | | 10 | 3040 | | 13 | 4662 | 47 | 113 | 19509 |
| 31 | 5 | 36 | 916 | | 87 | 6477 | | 22 | 2013 | 5 | 25 | 3376 | 10 | 170 | 12783 |
| 32 | 15 | 72 | 357 | 64 | 195 | 4084 | 22 | 60 | 1192 | 25 | 51 | 3386 | 125 | 378 | 9018 |
| 33 | 81 | 373 | 105 | 127 | 861 | 2757 | 54 | 504 | 1007 | 45 | 248 | 2526 | 307 | 1986 | 6395 |
| 34 | 161 | 490 | | 255 | 1541 | 1430 | 194 | 917 | 383 | 121 | 407 | 2196 | 731 | 3354 | 4009 |
| 35 | 218 | 538 | 105 | 806 | 2141 | 1118 | 517 | 1286 | 288 | 226 | 544 | 1797 | 1768 | 4509 | 3309 |
| 36 | 328 | 563 | | 1125 | 2539 | 707 | 862 | 1543 | 168 | 301 | 640 | 1697 | 2616 | 5286 | 2573 |
| 37 | 385 | 581 | | 1804 | 2644 | 441 | 1412 | 1562 | 69 | 453 | 738 | 1248 | 4053 | 5525 | 1757 |
| 38 | 603 | 648 | | 1973 | 2313 | 352 | 1121 | 1111 | 49 | 592 | 811 | 1073 | 4290 | 4883 | 1474 |
| 39 | 522 | 520 | | 1783 | 1860 | 293 | 1013 | 812 | 32 | 744 | 801 | 823 | 4063 | 3993 | 1148 |
| 40 | 461 | 407 | | 2295 | 1768 | 322 | 884 | 624 | 39 | 597 | 630 | 548 | 4238 | 3429 | 909 |
| 41 | 410 | 331 | | 1490 | 1134 | 233 | 766 | 492 | 27 | 646 | 556 | 678 | 3312 | 2513 | 938 |
| 42 | 363 | 277 | | 1429 | 946 | 72 | 540 | 332 | | 515 | 413 | 374 | 2848 | 1967 | 447 |
| 43 | 334 | 245 | | 1399 | 854 | 116 | 423 | 250 | 16 | 353 | 272 | 349 | 2510 | 1620 | 481 |
| 44 | 317 | 226 | | 866 | 539 | 87 | 267 | 159 | 6 | 335 | 232 | 50 | 1784 | 1156 | 143 |
| 45 | 233 | 167 | | 973 | 575 | 73 | 278 | 167 | | 293 | 198 | 75 | 1777 | 1107 | 148 |
| 46 | 264 | 184 | | 569 | 370 | 57 | 196 | 122 | 6 | 253 | 168 | 75 | 1282 | 844 | 138 |
| 47 | 116 | 88 | | 328 | 242 | 14 | 98 | 72 | | 205 | 135 | 50 | 747 | 537 | 64 |
| 48 | 136 | 100 | | 391 | 281 | | 72 | 60 | | 176 | 115 | 50 | 774 | 555 | 50 |
| 49 | 91 | 71 | | 158 | 147 | 14 | 46 | 44 | | 126 | 89 | 75 | 421 | 350 | 89 |
| 50 | 68 | 56 | | 160 | 125 | | 38 | 35 | | 86 | 60 | | 352 | 275 | |
| 51 | 44 | 40 | | 73 | 77 | | 35 | 32 | | 44 | 32 | | 196 | 181 | |
| 52 | 34 | 31 | | 70 | 62 | | 19 | 20 | | 20 | 19 | | 142 | 132 | |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 22 | 21 | | 39 | 41 | | 11 | 12 | | 25 | 19 | 24 | 98 | 93 | 24 |
| 54 | 18 | 17 | | 21 | 22 | | 9 | 9 | | 27 | 19 | | 76 | 67 | |
| 55 | 19 | 18 | | 17 | 18 | | 8 | 8 | | 6 | 6 | | 50 | 50 | |
| 56 | 9 | 9 | | 18 | 19 | | 5 | 5 | | 19 | 12 | | 51 | 46 | |
| 57 | 7 | 7 | | 7 | 7 | | 2 | 2 | | 8 | 6 | | 24 | 22 | |
| 58 | 11 | 10 | | 6 | 6 | 14 | 2 | 2 | | 2 | 2 | | 21 | 20 | 14 |
| 59 | 4 | 4 | | 5 | 5 | | | | | 1 | 1 | | 10 | 10 | |
| 60 | 5 | 5 | | 6 | 6 | | 1 | 1 | | 2 | 2 | | 13 | 13 | |
| 61 | 2 | 2 | | 5 | 5 | | 1 | 1 | | 1 | 1 | | 8 | 9 | |
| 62 | 2 | 2 | | 3 | 4 | | 1 | 1 | | | | | 7 | 7 | |
| 63 | 1 | 1 | | 2 | 2 | | | | | | | | 3 | 4 | |
| 64 | | | | 1 | 1 | | | | | | | | 2 | 2 | |
| 65 | | | | | | | | | | | | | 1 | 1 | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | | | | | | | | | | | | |
| 69 | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 5296 | 6180 | 33 532 | 18 354 | 21 584 | 84 288 | 8897 | 10 287 | 27 541 | 6256 | 7289 | 56 252 | 38 803 | 45 339 | 201 614 |

**Table 7.7.9. *Nephrops* in VIIfgh. Length distribution of landings by country in 2008. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | |
| 21 | | | | | | 28 | | | | | | | | | 28 |
| 22 | | | | | | 296 | | | | | | | | | 296 |
| 23 | | | | | | 651 | | | 69 | | | 539 | | | 1258 |
| 24 | | | | | | 1475 | | | 410 | | | 1736 | | | 3621 |
| 25 | | | 18 | | | 2557 | | | 913 | | | 3494 | | | 6981 |
| 26 | | | 958 | | 27 | 4475 | | 22 | 1136 | | | 5829 | | 49 | 12397 |
| 27 | | | 1011 | | 82 | 5408 | | 22 | 1782 | | | 1578 | | 104 | 9779 |
| 28 | | 26 | 3759 | | 218 | 6541 | | 89 | 1582 | | 10 | 2856 | | 343 | 14738 |
| 29 | 6 | 4 | 3033 | | 463 | 6436 | 10 | 72 | 2256 | 6 | 43 | 1777 | 22 | 582 | 13502 |
| 30 | 6 | 162 | 3336 | 12 | 742 | 7257 | | 245 | 2116 | | 108 | 1878 | 18 | 1256 | 14588 |
| 31 | 19 | 275 | 980 | 13 | 1042 | 7312 | | 467 | 2969 | 18 | 167 | 1419 | 50 | 1951 | 12680 |
| 32 | 38 | 497 | 1087 | 61 | 1774 | 6648 | 20 | 989 | 3241 | 55 | 307 | 1460 | 174 | 3567 | 12436 |
| 33 | 89 | 752 | 1319 | 280 | 1527 | 4916 | 30 | 1372 | 3063 | 146 | 488 | 1520 | 544 | 4140 | 10817 |
| 34 | 247 | 1058 | 1123 | 536 | 1789 | 4829 | 181 | 1629 | 2363 | 273 | 721 | 1698 | 1236 | 5198 | 10013 |
| 35 | 438 | 977 | 1462 | 925 | 1818 | 4573 | 441 | 1720 | 1221 | 450 | 817 | 1939 | 2253 | 5332 | 9194 |
| 36 | 554 | 1167 | 1123 | 1448 | 1993 | 3000 | 941 | 2116 | 1383 | 753 | 979 | 1219 | 3697 | 6254 | 6725 |
| 37 | 668 | 920 | 677 | 1692 | 1596 | 2042 | 1422 | 1589 | 718 | 863 | 897 | 900 | 4645 | 5001 | 4337 |
| 38 | 647 | 751 | 659 | 1814 | 1383 | 1224 | 1682 | 1525 | 666 | 1087 | 1032 | 999 | 5231 | 4690 | 3548 |
| 39 | 669 | 567 | 356 | 1583 | 1242 | 915 | 2063 | 1434 | 244 | 844 | 828 | 780 | 5159 | 4071 | 2294 |
| 40 | 597 | 444 | 339 | 1558 | 1148 | 562 | 1462 | 965 | 213 | 911 | 750 | 600 | 4528 | 3306 | 1713 |
| 41 | 654 | 465 | 267 | 1418 | 946 | 378 | 1382 | 856 | 282 | 772 | 619 | 679 | 4226 | 2886 | 1606 |
| 42 | 560 | 383 | 178 | 1027 | 671 | 393 | 1052 | 595 | 182 | 744 | 566 | 439 | 3383 | 2215 | 1192 |
| 43 | 576 | 367 | 89 | 1044 | 607 | 267 | 703 | 368 | 91 | 521 | 378 | 280 | 2845 | 1720 | 726 |
| 44 | 511 | 316 | 89 | 812 | 471 | 321 | 782 | 414 | | 374 | 291 | 60 | 2480 | 1493 | 470 |
| 45 | 598 | 371 | 53 | 568 | 342 | 84 | 455 | 245 | | 255 | 233 | 160 | 1876 | 1190 | 297 |
| 46 | 345 | 225 | | 405 | 259 | 84 | 277 | 180 | | 198 | 171 | 40 | 1225 | 835 | 123 |
| 47 | 290 | 206 | | 219 | 151 | | 184 | 112 | | 118 | 123 | 40 | 812 | 593 | 40 |
| 48 | 209 | 144 | | 201 | 173 | 41 | 105 | 76 | | 84 | 62 | 40 | 600 | 456 | 81 |
| 49 | 102 | 74 | | 128 | 97 | 167 | 100 | 76 | | 65 | 50 | 40 | 395 | 298 | 207 |
| 50 | 117 | 84 | | 93 | 81 | 125 | 55 | 45 | | 44 | 36 | 40 | 308 | 247 | 165 |
| 51 | 49 | 39 | | 56 | 56 | 41 | 74 | 60 | | 50 | 37 | 20 | 229 | 192 | 61 |
| 52 | 28 | 25 | | 47 | 40 | 41 | 30 | 30 | | 17 | 14 | | 120 | 109 | 41 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 36 | 29 | | 28 | 28 | | 23 | 23 | | 14 | 12 | | 102 | 92 | |
| 54 | 11 | 11 | | 21 | 21 | | 16 | 16 | | 6 | 16 | | 55 | 65 | |
| 55 | 13 | 11 | | 17 | 17 | | 12 | 12 | | 3 | 3 | | 46 | 43 | |
| 56 | 8 | 8 | | 12 | 12 | | 7 | 7 | | 1 | 1 | | 28 | 28 | |
| 57 | 12 | 10 | | 7 | 7 | | 5 | 5 | | 2 | 2 | | 27 | 24 | |
| 58 | 14 | 12 | | 4 | 4 | | 1 | 1 | | 1 | 1 | | 20 | 17 | |
| 59 | 4 | 4 | | 3 | 3 | | 1 | 1 | | | | | 8 | 8 | |
| 60 | 1 | 1 | | 3 | 3 | | 1 | 1 | | | | | 4 | 4 | |
| 61 | | | | 1 | 1 | | | | | | | | 2 | 2 | |
| 62 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 63 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 64 | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | | | | | | | | | | | | |
| 69 | | | | | | | | | | | | | | | |
| 70 | | | | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 8117 | 10 387 | 21 914 | 16 039 | 20 836 | 73 086 | 13 516 | 17 380 | 26 900 | 8676 | 9763 | 34 056 | 46 348 | 58 365 | 155 956 |

**Table 7.7.10. *Nephrops* in VIIfgh. Length distribution of landings by country in 2009. Quarterly and total values ($10^3$). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | | | 116 | | | | | | 11 | | | | | | 127 |
| 21 | | | 167 | | | | | | | | | | | | 167 |
| 22 | | | 399 | | | 35 | | | 31 | | | 102 | | | 566 |
| 23 | | | 1017 | | | 217 | | | 103 | | | 306 | | | 1643 |
| 24 | | | 2582 | | | 505 | | | 364 | | | 756 | | | 4207 |
| 25 | | | 3963 | | | 1284 | | | 879 | | | 1279 | | | 7405 |
| 26 | | | 6524 | | | 1969 | | | 1536 | | | 1495 | | | 11525 |
| 27 | | | 5825 | | | 3351 | | | 2396 | | 4 | 759 | | 4 | 12331 |
| 28 | | | 4684 | | | 3619 | | 14 | 2953 | | 21 | 489 | | 35 | 11744 |
| 29 | | | 5095 | | 107 | 3889 | | 14 | 2804 | | 30 | 831 | | 151 | 12619 |
| 30 | | 15 | 3619 | | 253 | 3852 | | 153 | 2735 | | 68 | 658 | | 490 | 10865 |
| 31 | | 169 | 2509 | | 587 | 3759 | | 334 | 1813 | 5 | 161 | 549 | 5 | 1251 | 8630 |
| 32 | 12 | 238 | 2044 | | 773 | 3074 | 10 | 646 | 2361 | 9 | 151 | 754 | 31 | 1808 | 8234 |
| 33 | 35 | 315 | 1671 | 32 | 898 | 2872 | 42 | 746 | 1716 | 23 | 292 | 472 | 132 | 2251 | 6731 |
| 34 | 127 | 606 | 1799 | 204 | 1370 | 2222 | 10 | 715 | 1273 | 92 | 367 | 400 | 434 | 3058 | 5694 |
| 35 | 197 | 697 | 1285 | 486 | 1453 | 2003 | 251 | 998 | 1117 | 129 | 479 | 242 | 1063 | 3627 | 4647 |
| 36 | 486 | 1008 | 1003 | 675 | 1762 | 1839 | 429 | 1024 | 774 | 268 | 433 | 417 | 1859 | 4228 | 4032 |
| 37 | 683 | 1013 | 1119 | 1160 | 1827 | 1433 | 639 | 1039 | 603 | 346 | 454 | 242 | 2828 | 4334 | 3397 |
| 38 | 857 | 1065 | 1054 | 1707 | 1821 | 1369 | 911 | 977 | 502 | 420 | 443 | 181 | 3895 | 4305 | 3106 |
| 39 | 1089 | 1093 | 694 | 1878 | 1732 | 1339 | 921 | 788 | 380 | 526 | 446 | 157 | 4414 | 4059 | 2569 |
| 40 | 1044 | 925 | 411 | 1832 | 1533 | 808 | 1141 | 906 | 209 | 466 | 398 | 199 | 4482 | 3761 | 1627 |
| 41 | 950 | 802 | 823 | 1963 | 1371 | 724 | 997 | 649 | 236 | 411 | 331 | 48 | 4322 | 3153 | 1831 |
| 42 | 927 | 695 | 308 | 1568 | 1075 | 420 | 840 | 481 | 113 | 491 | 340 | 24 | 3826 | 2592 | 864 |
| 43 | 744 | 531 | 334 | 1432 | 959 | 288 | 845 | 528 | 175 | 346 | 246 | | 3367 | 2264 | 797 |
| 44 | 715 | 564 | 154 | 1201 | 748 | 231 | 658 | 427 | 84 | 315 | 217 | 48 | 2888 | 1957 | 517 |
| 45 | 503 | 341 | 102 | 687 | 447 | 89 | 304 | 201 | 25 | 173 | 140 | 24 | 1667 | 1129 | 240 |
| 46 | 495 | 380 | 77 | 409 | 302 | 160 | 334 | 222 | 44 | 192 | 135 | 12 | 1430 | 1039 | 293 |
| 47 | 280 | 207 | 77 | 445 | 331 | 29 | 193 | 162 | 8 | 118 | 95 | 24 | 1035 | 796 | 137 |
| 48 | 238 | 200 | 102 | 146 | 126 | 43 | 135 | 106 | | 62 | 51 | 24 | 581 | 483 | 169 |
| 49 | 144 | 120 | | 174 | 154 | 29 | 138 | 108 | | 67 | 52 | 12 | 523 | 434 | 40 |
| 50 | 79 | 75 | | 100 | 87 | 43 | 112 | 78 | 8 | 30 | 28 | | 320 | 267 | 51 |
| 51 | 37 | 53 | | 96 | 89 | 29 | 37 | 33 | | 20 | 20 | | 191 | 194 | 29 |
| 52 | 33 | 33 | | 51 | 51 | 57 | 22 | 22 | 11 | 10 | 10 | | 115 | 115 | 68 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 18 | 18 | | 37 | 37 | 43 | 16 | 16 | | 9 | 9 | | 80 | 80 | 43 |
| 54 | 10 | 10 | | 24 | 24 | 171 | 12 | 12 | | 5 | 9 | | 50 | 55 | 171 |
| 55 | 10 | 10 | | 34 | 28 | 86 | 5 | 5 | | 2 | 2 | | 51 | 45 | 86 |
| 56 | 6 | 6 | | 9 | 9 | 171 | 3 | 3 | | 1 | 1 | | 20 | 20 | 171 |
| 57 | 1 | 1 | | 8 | 8 | 57 | 1 | 1 | | 1 | 1 | | 11 | 11 | 57 |
| 58 | 1 | 1 | | 1 | 1 | 86 | 1 | 1 | | 1 | 1 | | 4 | 4 | 86 |
| 59 | 1 | 1 | | 1 | 1 | 57 | | | | 1 | 1 | | 3 | 3 | 57 |
| 60 | 3 | 3 | | 1 | 1 | 86 | | | | | | | 4 | 4 | 86 |
| 61 | | | | 1 | 1 | 71 | | | | 1 | 1 | | 2 | 2 | 71 |
| 62 | | | | | | 43 | | | | | | | | | 43 |
| 63 | | | | | | 29 | | | | | | | | | 29 |
| 64 | | | | | | 57 | | | | | | | | | 57 |
| 65 | | | | | | 14 | | | | | | | | | 14 |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | | | 14 | | | | | | | | | 14 |
| 69 | | | | | | 14 | | | | | | | | | 14 |
| 70 | | | | | | 14 | | | | | | | | | 14 |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | | | | |
| Total | 9725 | 11 195 | 49 557 | 16 360 | 19 967 | 42 590 | 9010 | 11 410 | 25 263 | 4538 | 5438 | 10 505 | 39 633 | 48 010 | 127 915 |

**Table 7.7.11.** ***Nephrops*** **in VIIfgh. Length distribution of landings by country in 2010. Quarterly and total values (10³). The reported size is the carapace length (CL). Conversion of CL to TS (total size) is done by multiplication by 3.3.**

The French data are presented by 2 ways: (1) Previous method (tails not sampled and systematically apportioned in the smallest category of entire *Nephrops* at auction). (2) Tails are included (as performed since WGCSE 2009).

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | |
| 21 | | | | | | 43 | | | 34 | | | 92 | | | 169 |
| 22 | | | 181 | | | 97 | | | 59 | | | 228 | | | 564 |
| 23 | | | 699 | | | 301 | | | 207 | | | 319 | | | 1526 |
| 24 | | | 1032 | | | 691 | | | 481 | | | 360 | | | 2564 |
| 25 | | | 3177 | | | 1381 | | | 949 | | | 839 | | | 6346 |
| 26 | | | 5951 | | 17 | 2344 | | | 1623 | | 7 | 1128 | | 24 | 11047 |
| 27 | | 13 | 7952 | | 17 | 3558 | | 4 | 2014 | | 2 | 1663 | | 36 | 15188 |
| 28 | | 9 | 5362 | | 41 | 5352 | | 8 | 1984 | | 11 | 2048 | | 69 | 14745 |
| 29 | | 13 | 5254 | | 70 | 6136 | | 8 | 2736 | | 45 | 1811 | | 136 | 15938 |
| 30 | | 28 | 3887 | | 169 | 6558 | | 76 | 2385 | | 77 | 2570 | | 350 | 15399 |
| 31 | | 57 | 2667 | | 256 | 6066 | | 136 | 1915 | 2 | 141 | 1706 | 2 | 590 | 12355 |
| 32 | | 94 | 2222 | | 484 | 5360 | | 236 | 1706 | 8 | 149 | 1586 | 8 | 962 | 10875 |
| 33 | | 129 | 1968 | 6 | 522 | 4262 | | 296 | 1337 | 25 | 162 | 1036 | 31 | 1109 | 8603 |
| 34 | 6 | 243 | 2079 | 18 | 430 | 3673 | 20 | 292 | 737 | 49 | 200 | 844 | 93 | 1165 | 7333 |
| 35 | 40 | 224 | 1151 | 121 | 606 | 2834 | 66 | 439 | 467 | 94 | 164 | 409 | 322 | 1432 | 4861 |
| 36 | 91 | 313 | 1559 | 200 | 610 | 2306 | 158 | 462 | 323 | 113 | 172 | 316 | 562 | 1557 | 4504 |
| 37 | 233 | 363 | 1596 | 400 | 545 | 1853 | 286 | 470 | 247 | 139 | 146 | 82 | 1058 | 1524 | 3778 |
| 38 | 335 | 447 | 1518 | 388 | 509 | 1375 | 449 | 460 | 99 | 168 | 145 | 122 | 1340 | 1561 | 3115 |
| 39 | 460 | 442 | 928 | 509 | 515 | 941 | 541 | 551 | 88 | 164 | 127 | 122 | 1674 | 1635 | 2079 |
| 40 | 443 | 412 | 705 | 588 | 484 | 627 | 557 | 508 | 24 | 219 | 169 | 20 | 1807 | 1573 | 1375 |
| 41 | 460 | 388 | 482 | 485 | 373 | 420 | 587 | 443 | 7 | 185 | 159 | 20 | 1717 | 1362 | 929 |
| 42 | 552 | 450 | 593 | 661 | 422 | 698 | 450 | 337 | 20 | 159 | 118 | 41 | 1822 | 1328 | 1352 |
| 43 | 473 | 351 | 441 | 548 | 340 | 331 | 508 | 384 | 7 | 167 | 105 | 20 | 1695 | 1180 | 800 |
| 44 | 518 | 385 | 441 | 548 | 378 | 224 | 503 | 343 | | 132 | 101 | | 1701 | 1208 | 665 |
| 45 | 326 | 257 | 441 | 357 | 248 | 89 | 391 | 256 | | 127 | 101 | | 1201 | 863 | 530 |
| 46 | 268 | 234 | 148 | 237 | 179 | 107 | 228 | 181 | | 118 | 86 | | 851 | 680 | 255 |
| 47 | 216 | 203 | 74 | 259 | 179 | 79 | 136 | 104 | | 92 | 73 | | 703 | 559 | 152 |
| 48 | 130 | 132 | 111 | 252 | 185 | 54 | 138 | 123 | | 46 | 44 | | 567 | 483 | 164 |
| 49 | 107 | 108 | 111 | 196 | 151 | 35 | 117 | 98 | | 55 | 53 | | 474 | 409 | 146 |
| 50 | 58 | 65 | | 119 | 95 | 35 | 56 | 60 | | 28 | 28 | | 261 | 248 | 35 |
| 51 | 59 | 60 | | 101 | 76 | 79 | 44 | 40 | | 20 | 24 | | 224 | 200 | 79 |
| 52 | 30 | 30 | 74 | 34 | 34 | 35 | 24 | 28 | | 13 | 17 | | 100 | 109 | 109 |

| CL | Q1 | | | Q2 | | | Q3 | | | Q4 | | | Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (mm) | F | | IRL | F | | IRL | F | | IRL | F | | IRL | F | | IRL |
| | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | | no tails | tails | |
| 53 | 17 | 17 | | 29 | 29 | | 19 | 23 | | 10 | 10 | | 76 | 80 | |
| 54 | 14 | 14 | | 23 | 23 | | 12 | 12 | | 5 | 5 | | 54 | 54 | |
| 55 | 10 | 10 | | 16 | 22 | 17 | 8 | 8 | | 3 | 3 | | 37 | 43 | 17 |
| 56 | 3 | 3 | 36 | 5 | 5 | 17 | 3 | 3 | | 3 | 3 | | 14 | 14 | 53 |
| 57 | 4 | 4 | | 4 | 4 | | 1 | 1 | | | | | 9 | 9 | |
| 58 | | | | 3 | 3 | | 1 | 1 | | | | | 3 | 3 | |
| 59 | 1 | 1 | | 1 | 1 | | | | | | | | 2 | 2 | |
| 60 | | | | | | | | | | | | | | | |
| 61 | | | | 2 | 2 | | | | | | | | 2 | 2 | |
| 62 | | | | | | | | | | | | | | | |
| 63 | | | | 2 | 2 | | | | | | | | 2 | 2 | |
| 64 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 65 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 66 | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | |
| 68 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 69 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| 70 | | | | 1 | 1 | 17 | | | | | | | 1 | 1 | 17 |
| 71 | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | |
| 75 | | | | 1 | 1 | | | | | | | | 1 | 1 | |
| Total | 4853 | 5498 | 52 839 | 6120 | 8033 | 57 994 | 5303 | 6392 | 19 450 | 2145 | 2647 | 17 384 | 18 420 | 22 571 | 147 667 |

**Table 7.7.12. Nephrops in FUs 20-22 Celtic Sea (VIIfgh) landings length distributions in 1987-1998. French trawlers.**

| Landings CL mm/ | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10** | | | | | | | | | | | | |
| **11** | | | | | | | | | | | | |
| **12** | | | | | | | | | | | | |
| **13** | | | | | | | | | | | | |
| **14** | | | | | | | | | | | | |
| **15** | | | | | | | | | | | | |
| **16** | | | | | | | | | | | | |
| **17** | | | | | | | | | | | | |
| **18** | | | | | | | | | | | | |
| **19** | | | | | | | | | | | | |
| **20** | | | | | | | | | | | | |
| **21** | | 57 | | 7 | | | | | | | | |
| **22** | | | | | | | 38 | | | | | |
| **23** | | 53 | | 36 | | | | | 43 | | | |
| **24** | | 106 | | 57 | | 30 | | | 43 | | | |
| **25** | 24 | 289 | | | 14 | | 85 | | 86 | | | |
| **26** | 88 | 309 | | 29 | 53 | 60 | 19 | 12 | 109 | 15 | | |
| **27** | 149 | 490 | | 143 | 34 | 111 | 84 | 23 | 644 | 20 | 15 | |
| **28** | 684 | 1177 | 110 | 465 | 448 | 669 | 111 | 78 | 601 | 60 | 28 | 59 |
| **29** | 1104 | 3180 | 710 | 728 | 922 | 966 | 213 | 309 | 610 | 62 | 45 | 93 |
| **30** | 2030 | 4373 | 958 | 1241 | 1719 | 2139 | 393 | 631 | 1113 | 246 | 236 | 294 |
| **31** | 2317 | 7579 | 1804 | 2146 | 3047 | 3212 | 935 | 1113 | 1074 | 696 | 542 | 475 |
| **32** | 3640 | 8076 | 3103 | 2521 | 4057 | 4393 | 2253 | 2650 | 2486 | 1803 | 1220 | 1043 |
| **33** | 4449 | 8059 | 4294 | 4456 | 6036 | 6608 | 2468 | 3177 | 3203 | 2699 | 2144 | 1396 |
| **34** | 4312 | 8452 | 5210 | 5034 | 5804 | 6509 | 3757 | 4532 | 3129 | 4239 | 2186 | 2308 |
| **35** | 6179 | 6948 | 6479 | 6677 | 5721 | 7896 | 5213 | 6666 | 4870 | 6136 | 3608 | 3354 |
| **36** | 5691 | 5137 | 5914 | 5800 | 4591 | 8225 | 5941 | 5440 | 4339 | 5583 | 3827 | 3587 |
| **37** | 5479 | 5084 | 5281 | 5077 | 3959 | 8066 | 6026 | 6653 | 7127 | 6995 | 4262 | 4465 |
| **38** | 4940 | 3623 | 5931 | 6143 | 3797 | 7579 | 6784 | 6950 | 7141 | 7410 | 4804 | 4525 |
| **39** | 3870 | 2383 | 4832 | 5402 | 3091 | 5528 | 5667 | 4853 | 5497 | 5691 | 3619 | 3127 |
| **40** | 4622 | 2590 | 4843 | 4796 | 2772 | 3386 | 7263 | 5497 | 6493 | 5277 | 4918 | 4453 |
| **41** | 2482 | 2302 | 3636 | 3702 | 2216 | 2745 | 5349 | 4396 | 4044 | 4225 | 3062 | 2875 |
| **42** | 2695 | 2462 | 3675 | 4147 | 2218 | 2919 | 5485 | 4473 | 4433 | 4096 | 3414 | 2996 |
| **43** | 1994 | 1645 | 2371 | 3271 | 2110 | 2429 | 3652 | 3222 | 3257 | 3205 | 2725 | 2267 |
| **44** | 1275 | 1274 | 2165 | 3235 | 1793 | 1680 | 2415 | 2580 | 3403 | 2115 | 1849 | 2109 |
| **45** | 1590 | 1231 | 1999 | 2366 | 1550 | 1636 | 2732 | 2183 | 2142 | 2086 | 2288 | 1474 |
| **46** | 1265 | 988 | 1415 | 2066 | 1229 | 1222 | 1653 | 1348 | 1747 | 1183 | 1428 | 1014 |
| **47** | 1184 | 806 | 1151 | 1446 | 865 | 939 | 1604 | 1323 | 1635 | 1247 | 1021 | 1012 |
| **48** | 1182 | 778 | 858 | 1787 | 1057 | 966 | 1134 | 1204 | 1338 | 877 | 970 | 789 |
| **49** | 767 | 525 | 708 | 1277 | 766 | 738 | 950 | 898 | 816 | 747 | 603 | 433 |
| **50** | 834 | 437 | 565 | 809 | 527 | 576 | 981 | 969 | 972 | 702 | 733 | 420 |
| **51** | 571 | 307 | 511 | 692 | 437 | 406 | 489 | 639 | 743 | 504 | 353 | 274 |
| **52** | 668 | 353 | 447 | 786 | 403 | 278 | 612 | 571 | 770 | 510 | 372 | 253 |
| **53** | 526 | 260 | 315 | 477 | 303 | 303 | 365 | 395 | 635 | 389 | 286 | 157 |
| **54** | 268 | 205 | 253 | 387 | 236 | 191 | 344 | 462 | 448 | 294 | 198 | 110 |
| **55** | 391 | 111 | 148 | 204 | 128 | 171 | 276 | 364 | 262 | 197 | 110 | 109 |
| **56** | 150 | 107 | 156 | 95 | 121 | 96 | 162 | 191 | 152 | 141 | 54 | 76 |
| **57** | 129 | 85 | 118 | 90 | 48 | 74 | 93 | 110 | 176 | 116 | 81 | 41 |
| **58** | 55 | 49 | 96 | 91 | 73 | 68 | 83 | 154 | 124 | 56 | 36 | 28 |
| **59** | 92 | 33 | 74 | 31 | 12 | 48 | 93 | 68 | 49 | 22 | 8 | 7 |
| **60** | 52 | 4 | 26 | 26 | 17 | 24 | 47 | 71 | 69 | 17 | 23 | 13 |
| **61** | 7 | 4 | 22 | 8 | | 11 | 19 | 22 | 22 | 5 | 8 | |
| **62** | 11 | 10 | 7 | 21 | 7 | 9 | 25 | 9 | 29 | 20 | 3 | |
| **63** | 6 | | 12 | | 1 | | 5 | 12 | 13 | 2 | | 2 |
| **64** | | | 5 | | | | | | | | | |
| **65** | 16 | 4 | 5 | | | | 6 | 2 | 3 | | | |
| **66** | | | | | | 2 | | 2 | | | | |
| **67** | 6 | | | | | | | | | | | |
| **68** | | | 5 | | | | | | | | | |
| **69** | | | | | | | | | | | | |
| **70** | | | | | | | | | | | | |
| **71** | | | | | | | | | | | | |
| **72** | | | | | | | | 2 | | | | |
| **73** | | | | | | | | | | | | |
| **74** | | | | | | | | | | | | |
| **75** | | | | | | | | | | | | |
| **Total** | **67794** | **81948** | **70215** | **77770** | **62182** | **82908** | **75824** | **74255** | **75892** | **69686** | **51080** | **45637** |
| **Weights** | **3080** | **2926** | **3221** | **3762** | **2652** | **3415** | **3815** | **3658** | **3803** | **3363** | **2589** | **2241** |

**Table 7.7.13. Nephrops in FUs 20-22 Celtic Sea (VIIfgh) landings length distributions in 1999-2010. French trawlers.**

Years 2008-2010: DLFs including tails are provided by sampling at auction. For previous years sampling involved only in entire Nephrops; DLF including tails are estimated by simulation (see Stock Annex).

| Landings CL mm/Year | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails | no tails | tails |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 2 | 0 | 5 | 0 | 2 | 0 | 5 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 4 | 0 | 9 | 0 | 3 | 0 | 8 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 7 | 0 | 15 | 0 | 6 | 0 | 13 | 0 | 2 | 0 | 6 | 1 | 4 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 11 | 0 | 26 | 0 | 10 | 81 | 81 | 0 | 4 | 0 | 11 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 0 | 20 | 0 | 43 | 0 | 18 | 0 | 35 | 0 | 6 | 0 | 19 | 0 | 9 | 0 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 35 | 45 | 110 | 0 | 32 | 0 | 57 | 0 | 11 | 0 | 35 | 8 | 20 | 0 | 15 | 0 | 7 | 0 | 49 | 0 | 0 | 0 | 24 |
| 27 | 34 | 90 | 23 | 141 | 26 | 76 | 0 | 94 | 0 | 19 | 0 | 64 | 10 | 33 | 0 | 28 | 21 | 25 | 0 | 104 | 0 | 4 | 0 | 36 |
| 28 | 18 | 123 | 45 | 330 | 0 | 102 | 83 | 213 | 0 | 35 | 0 | 117 | 2 | 45 | 15 | 62 | 22 | 37 | 0 | 343 | 0 | 35 | 0 | 69 |
| 29 | 15 | 208 | 90 | 420 | 0 | 184 | 21 | 369 | 0 | 63 | 0 | 215 | 1 | 73 | 0 | 99 | 5 | 50 | 22 | 582 | 0 | 151 | 0 | 136 |
| 30 | 255 | 867 | 150 | 463 | 258 | 674 | 283 | 763 | 0 | 115 | 0 | 397 | 13 | 136 | 34 | 205 | 47 | 113 | 18 | 1256 | 0 | 490 | 0 | 350 |
| 31 | 469 | 1754 | 155 | 520 | 606 | 1529 | 289 | 1125 | 50 | 250 | 73 | 1063 | 21 | 228 | 20 | 359 | 10 | 170 | 50 | 1951 | 5 | 1251 | 2 | 590 |
| 32 | 1171 | 2570 | 324 | 719 | 1990 | 3594 | 375 | 1260 | 357 | 767 | 398 | 1805 | 148 | 509 | 146 | 972 | 125 | 378 | 174 | 3567 | 31 | 1808 | 8 | 962 |
| 33 | 1801 | 3142 | 739 | 1558 | 3095 | 4960 | 664 | 1676 | 146 | 1653 | 748 | 2047 | 233 | 1045 | 229 | 1662 | 307 | 1986 | 544 | 4140 | 132 | 2251 | 31 | 1109 |
| 34 | 2441 | 3493 | 1113 | 2461 | 3766 | 5975 | 927 | 2822 | 1191 | 3975 | 838 | 2442 | 660 | 2119 | 877 | 2809 | 731 | 3354 | 1236 | 5198 | 434 | 3058 | 93 | 1165 |
| 35 | 3034 | 3685 | 2115 | 3366 | 6159 | 7334 | 1985 | 4332 | 2778 | 5457 | 1792 | 3352 | 1323 | 3366 | 1283 | 3791 | 1768 | 4509 | 2253 | 5332 | 1063 | 3627 | 322 | 1432 |
| 36 | 3102 | 3437 | 2554 | 3729 | 5506 | 6564 | 3223 | 5217 | 3083 | 5345 | 2785 | 4414 | 2060 | 4294 | 2468 | 4789 | 2616 | 5286 | 3697 | 6254 | 1859 | 4228 | 562 | 1557 |
| 37 | 3457 | 3472 | 3381 | 4092 | 5602 | 5618 | 3718 | 5288 | 3591 | 5169 | 3723 | 4749 | 2656 | 4408 | 3558 | 5440 | 4053 | 5525 | 4645 | 5001 | 2828 | 4334 | 1058 | 1524 |
| 38 | 3483 | 3248 | 3354 | 3862 | 3324 | 3517 | 5150 | 5821 | 4979 | 5649 | 3664 | 4346 | 2728 | 4004 | 4509 | 5314 | 4290 | 4883 | 5231 | 4690 | 3895 | 4305 | 1340 | 1561 |
| 39 | 2646 | 2453 | 4471 | 4403 | 3500 | 3217 | 5364 | 5584 | 5297 | 5415 | 3675 | 3628 | 3106 | 3634 | 4281 | 4435 | 4063 | 3993 | 5159 | 4071 | 4414 | 4059 | 1674 | 1635 |
| 40 | 3819 | 3272 | 4316 | 4064 | 4325 | 3629 | 7063 | 6361 | 5168 | 5027 | 3074 | 2916 | 2700 | 2867 | 4237 | 3747 | 4238 | 3429 | 4528 | 3306 | 4482 | 3761 | 1807 | 1573 |
| 41 | 2365 | 2057 | 4108 | 3622 | 3404 | 2759 | 5978 | 5163 | 6683 | 5771 | 3745 | 3109 | 2487 | 2377 | 3957 | 3130 | 3312 | 2513 | 4226 | 2886 | 4322 | 3153 | 1717 | 1362 |
| 42 | 2898 | 2440 | 3889 | 3343 | 2180 | 1762 | 5334 | 4391 | 5535 | 4703 | 3852 | 2998 | 2432 | 2087 | 3329 | 2474 | 2848 | 1967 | 3383 | 2215 | 3826 | 2592 | 1822 | 1328 |
| 43 | 1828 | 1557 | 3223 | 2692 | 2723 | 2065 | 4196 | 3332 | 5535 | 4490 | 2653 | 2054 | 2021 | 1647 | 3061 | 2131 | 2510 | 1620 | 2845 | 1720 | 3367 | 2264 | 1695 | 1180 |
| 44 | 1938 | 1639 | 3006 | 2516 | 2231 | 1701 | 3454 | 2749 | 4467 | 3570 | 2706 | 2009 | 1775 | 1401 | 2181 | 1495 | 1784 | 1156 | 2480 | 1493 | 2888 | 1957 | 1701 | 1208 |
| 45 | 1459 | 1262 | 2688 | 2261 | 1346 | 1044 | 2727 | 2174 | 3971 | 3206 | 2571 | 1912 | 1812 | 1371 | 1781 | 1202 | 1777 | 1107 | 1876 | 1190 | 1667 | 1129 | 1201 | 863 |
| 46 | 1045 | 923 | 2280 | 1943 | 1073 | 849 | 1811 | 1466 | 3659 | 2954 | 1530 | 1130 | 1563 | 1183 | 1629 | 1093 | 1282 | 844 | 1225 | 835 | 1430 | 1039 | 851 | 680 |
| 47 | 921 | 844 | 1358 | 1211 | 934 | 767 | 1241 | 1061 | 1941 | 1679 | 1264 | 1004 | 1486 | 1109 | 1198 | 844 | 747 | 537 | 812 | 593 | 1035 | 796 | 703 | 559 |
| 48 | 825 | 766 | 1115 | 1014 | 652 | 577 | 1147 | 949 | 1498 | 1329 | 1299 | 1099 | 1248 | 938 | 913 | 687 | 774 | 555 | 600 | 456 | 581 | 483 | 567 | 483 |
| 49 | 530 | 505 | 846 | 794 | 466 | 451 | 477 | 420 | 958 | 919 | 935 | 816 | 1174 | 886 | 619 | 497 | 421 | 350 | 395 | 298 | 523 | 434 | 474 | 409 |
| 50 | 461 | 450 | 801 | 808 | 438 | 417 | 560 | 490 | 676 | 663 | 739 | 698 | 1275 | 973 | 443 | 381 | 352 | 275 | 308 | 247 | 320 | 267 | 261 | 248 |
| 51 | 330 | 321 | 650 | 658 | 335 | 330 | 435 | 371 | 450 | 465 | 541 | 548 | 1051 | 835 | 313 | 286 | 196 | 181 | 229 | 192 | 191 | 194 | 224 | 200 |
| 52 | 270 | 263 | 458 | 466 | 347 | 327 | 318 | 276 | 308 | 317 | 516 | 528 | 764 | 636 | 313 | 276 | 142 | 132 | 120 | 109 | 115 | 115 | 100 | 109 |
| 53 | 220 | 219 | 439 | 451 | 251 | 241 | 175 | 172 | 199 | 204 | 479 | 478 | 707 | 570 | 231 | 228 | 98 | 93 | 102 | 92 | 80 | 80 | 76 | 80 |
| 54 | 197 | 196 | 277 | 284 | 194 | 190 | 176 | 165 | 126 | 129 | 287 | 293 | 543 | 448 | 166 | 161 | 76 | 67 | 55 | 65 | 50 | 55 | 54 | 54 |
| 55 | 144 | 142 | 243 | 249 | 137 | 135 | 192 | 175 | 94 | 97 | 209 | 214 | 502 | 421 | 134 | 133 | 50 | 50 | 46 | 43 | 51 | 45 | 37 | 43 |
| 56 | 80 | 80 | 155 | 159 | 182 | 178 | 85 | 85 | 82 | 84 | 164 | 167 | 276 | 238 | 105 | 108 | 51 | 46 | 28 | 28 | 20 | 20 | 14 | 14 |
| 57 | 53 | 52 | 82 | 84 | 103 | 101 | 77 | 78 | 75 | 77 | 134 | 137 | 280 | 228 | 85 | 87 | 24 | 22 | 27 | 24 | 11 | 11 | 9 | 9 |
| 58 | 24 | 24 | 104 | 107 | 111 | 109 | 42 | 42 | 25 | 26 | 66 | 68 | 169 | 141 | 71 | 74 | 21 | 20 | 20 | 17 | 4 | 4 | 3 | 3 |
| 59 | 15 | 14 | 64 | 66 | 94 | 93 | 25 | 26 | 25 | 25 | 48 | 49 | 133 | 113 | 49 | 50 | 10 | 10 | 8 | 8 | 3 | 3 | 2 | 2 |
| 60 | 14 | 14 | 55 | 57 | 71 | 69 | 34 | 34 | 0 | 0 | 23 | 24 | 39 | 41 | 36 | 37 | 13 | 13 | 4 | 4 | 4 | 4 | 0 | 0 |
| 61 | 11 | 11 | 57 | 58 | 39 | 38 | 28 | 28 | 7 | 7 | 17 | 17 | 43 | 39 | 21 | 22 | 8 | 9 | 2 | 2 | 2 | 2 | 2 | 2 |
| 62 | 5 | 5 | 11 | 11 | 27 | 27 | 26 | 26 | 5 | 5 | 11 | 12 | 11 | 15 | 10 | 11 | 7 | 7 | 1 | 1 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 15 | 16 | 0 | 0 | 11 | 11 | 0 | 0 | 4 | 4 | 17 | 15 | 3 | 3 | 3 | 4 | 1 | 1 | 0 | 0 | 2 | 2 |
| 64 | 0 | 0 | 0 | 0 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 7 | 7 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 |
| 65 | 0 | 0 | 10 | 10 | 0 | 0 | 3 | 3 | 0 | 0 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 66 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Numbers | 41375 | 45680 | 48813 | 53226 | 55498 | 61282 | 57783 | 64824 | 62959 | 69688 | 44565 | 51005 | 37491 | 44537 | 42315 | 49168 | 38803 | 45340 | 46348 | 58365 | 39633 | 48010 | 18420 | 22571 |
| Weights | 2078 | | 2848 | | 2626 | | 3154 | | 3595 | | 2605 | | 2502 | | 2368 | | 2033 | | 2348 | | 2165 | | 1112 | |

**Table 7.7.14.a Nephrops in FUs 20-22 Celtic Sea (VIIfgh)**
landings length distributions in 2002-2010. Irish trawlers.

| Landings CL mm/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **12** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0 | 2 | 6 | 0 | 4 | 0 | 0 | 0 | 0 |
| **19** | 33 | 10 | 20 | 0 | 15 | 29 | 0 | 0 | 0 |
| **20** | 145 | 270 | 40 | 102 | 235 | 468 | 0 | 127 | 0 |
| **21** | 213 | 1071 | 77 | 459 | 497 | 601 | 28 | 167 | 169 |
| **22** | 653 | 1333 | 134 | 553 | 1113 | 2360 | 296 | 566 | 564 |
| **23** | 1340 | 2578 | 245 | 1164 | 2312 | 8021 | 1258 | 1643 | 1526 |
| **24** | 2243 | 2141 | 480 | 2730 | 4529 | 13135 | 3621 | 4207 | 2564 |
| **25** | 2245 | 2474 | 807 | 4313 | 6403 | 18144 | 6981 | 7405 | 6346 |
| **26** | 2459 | 5827 | 1416 | 6634 | 10050 | 22708 | 12397 | 11525 | 11047 |
| **27** | 2417 | 4372 | 2053 | 8554 | 12454 | 22225 | 9779 | 12331 | 15188 |
| **28** | 3459 | 6654 | 2938 | 8913 | 13349 | 24486 | 14738 | 11744 | 14745 |
| **29** | 3104 | 5578 | 4037 | 9930 | 12415 | 24021 | 13502 | 12619 | 15938 |
| **30** | 3483 | 5106 | 5255 | 10418 | 10950 | 19509 | 14588 | 10865 | 15399 |
| **31** | 4632 | 5247 | 6063 | 11816 | 8115 | 12783 | 12680 | 8630 | 12355 |
| **32** | 4325 | 5915 | 6424 | 10966 | 6849 | 9018 | 12436 | 8234 | 10875 |
| **33** | 4624 | 4380 | 6459 | 7954 | 5053 | 6395 | 10817 | 6731 | 8603 |
| **34** | 4281 | 3845 | 6264 | 7116 | 3755 | 4009 | 10013 | 5694 | 7333 |
| **35** | 3913 | 2639 | 4829 | 5597 | 2693 | 3309 | 9194 | 4647 | 4861 |
| **36** | 2742 | 1809 | 3905 | 4134 | 1907 | 2573 | 6725 | 4032 | 4504 |
| **37** | 2705 | 1441 | 3138 | 2726 | 1343 | 1757 | 4337 | 3397 | 3778 |
| **38** | 2460 | 1374 | 2426 | 2745 | 897 | 1474 | 3548 | 3106 | 3115 |
| **39** | 1628 | 1026 | 1618 | 2045 | 668 | 1148 | 2294 | 2569 | 2079 |
| **40** | 1606 | 495 | 1072 | 1255 | 405 | 909 | 1713 | 1627 | 1375 |
| **41** | 847 | 592 | 894 | 809 | 393 | 938 | 1606 | 1831 | 929 |
| **42** | 825 | 549 | 554 | 488 | 189 | 447 | 1192 | 864 | 1352 |
| **43** | 474 | 415 | 366 | 380 | 151 | 481 | 726 | 797 | 800 |
| **44** | 438 | 203 | 234 | 230 | 133 | 143 | 470 | 517 | 665 |
| **45** | 300 | 110 | 156 | 38 | 80 | 148 | 297 | 240 | 530 |
| **46** | 183 | 131 | 72 | 201 | 32 | 138 | 123 | 293 | 255 |
| **47** | 126 | 167 | 107 | 19 | 69 | 64 | 40 | 137 | 152 |
| **48** | 195 | 70 | 61 | 11 | 19 | 50 | 81 | 169 | 164 |
| **49** | 121 | 77 | 51 | 0 | 17 | 89 | 207 | 40 | 146 |
| **50** | 29 | 40 | 14 | 24 | 6 | 0 | 165 | 51 | 35 |
| **51** | 18 | 60 | 10 | 0 | 0 | 0 | 61 | 29 | 79 |
| **52** | 18 | 24 | 7 | 0 | 14 | 0 | 41 | 68 | 109 |
| **53** | 0 | 0 | 12 | 0 | 0 | 24 | 0 | 43 | 0 |
| **54** | 18 | 0 | 6 | 1 | 0 | 0 | 0 | 171 | 0 |
| **55** | 18 | 0 | 6 | 0 | 0 | 0 | 0 | 86 | 17 |
| **56** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 171 | 53 |
| **57** | 18 | 10 | 19 | 0 | 0 | 0 | 0 | 57 | 0 |
| **58** | 18 | 0 | 3 | 0 | 0 | 14 | 0 | 86 | 0 |
| **59** | 0 | 0 | 8 | 0 | 14 | 0 | 0 | 57 | 0 |
| **60** | 18 | 0 | 1 | 0 | 0 | 0 | 0 | 86 | 0 |
| **61** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 71 | 0 |
| **62** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 0 |
| **63** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| **64** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 0 |
| **65** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| **66** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| **67** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **68** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 0 |
| **69** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 14 | 0 |
| **70** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 17 |
| **71** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **72** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| **73** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **74** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **75** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **58378** | **68034** | **62303** | **112326** | **107126** | **201614** | **155956** | **127915** | **147667** |
| **Weights** | **1496** | **1389** | **1629** | **2387** | **1848** | **3214** | **3411** | **2844** | **3110** |

**Table 7.7.14.b Nephrops in FUs 20-22 Celtic Sea (VIIfgh)**
discards length distributions in 2002-2010. Irish trawlers.

| **Total Discards** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **CL mm/Year** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** |
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **11** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **12** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13** | 0 | 0 | 1 | 0 | 19 | 0 | 0 | 0 | 0 |
| **14** | 0 | 19 | 2 | 20 | 38 | 40 | 0 | 0 | 0 |
| **15** | 0 | 84 | 3 | 0 | 202 | 0 | 35 | 25 | 0 |
| **16** | 0 | 68 | 5 | 61 | 136 | 153 | 70 | 0 | 12 |
| **17** | 0 | 171 | 15 | 40 | 237 | 200 | 181 | 178 | 29 |
| **18** | 0 | 261 | 16 | 132 | 359 | 772 | 320 | 300 | 21 |
| **19** | 0 | 614 | 77 | 496 | 556 | 1784 | 744 | 644 | 102 |
| **20** | 0 | 1489 | 49 | 1094 | 868 | 3919 | 1372 | 1266 | 82 |
| **21** | 1 | 3118 | 94 | 1554 | 1656 | 7572 | 1854 | 1273 | 615 |
| **22** | 2 | 4657 | 125 | 2461 | 2940 | 11791 | 2848 | 3018 | 1384 |
| **23** | 7 | 5158 | 215 | 3753 | 3343 | 15300 | 4324 | 3688 | 2006 |
| **24** | 27 | 4482 | 358 | 6116 | 4735 | 17670 | 6275 | 5080 | 2304 |
| **25** | 112 | 4164 | 498 | 7164 | 5329 | 17336 | 9561 | 5596 | 3911 |
| **26** | 420 | 4026 | 748 | 8360 | 5522 | 13463 | 9047 | 4877 | 3783 |
| **27** | 685 | 2926 | 787 | 9873 | 6342 | 10636 | 8600 | 4447 | 4169 |
| **28** | 502 | 2227 | 751 | 8638 | 5130 | 10963 | 6591 | 2991 | 3436 |
| **29** | 243 | 1556 | 762 | 7511 | 2563 | 5085 | 4500 | 2335 | 3100 |
| **30** | 164 | 890 | 708 | 5773 | 1040 | 1772 | 3580 | 1650 | 2223 |
| **31** | 174 | 511 | 636 | 3893 | 586 | 546 | 2652 | 1150 | 2120 |
| **32** | 162 | 275 | 421 | 2731 | 332 | 153 | 1626 | 749 | 1446 |
| **33** | 103 | 67 | 304 | 1568 | 159 | 18 | 905 | 461 | 1035 |
| **34** | 61 | 0 | 107 | 807 | 60 | 5 | 617 | 236 | 671 |
| **35** | 34 | 0 | 92 | 554 | 0 | 1 | 55 | 68 | 330 |
| **36** | 19 | 0 | 9 | 201 | 0 | 0 | 27 | 0 | 152 |
| **37** | 10 | 0 | 5 | 50 | 0 | 0 | 0 | 0 | 63 |
| **38** | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 24 |
| **39** | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| **40** | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **41** | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **42** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **43** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **44** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **45** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **46** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **47** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **48** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **49** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **50** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **51** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **52** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **53** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **54** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **55** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **56** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **57** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **58** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **59** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **60** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **61** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **62** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **63** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **64** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **65** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **66** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **67** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **68** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **69** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **70** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **71** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **72** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **73** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **74** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **75** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **2738** | **36762** | **6800** | **72851** | **42153** | **119180** | **65784** | **40032** | **33018** |
| **Weights** | **42** | **333** | **99** | **946** | **437** | **1101** | **765** | **426** | **445** |

**Table 7.7.14.c Nephrops in FUs 20-22 Celtic Sea (VIIfgh)**
catches length distributions in 2002-2010. Irish trawlers.

| Total catches<br>CL mm/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 1 | 0 | 19 | 0 | 0 | 0 | 0 |
| 14 | 0 | 19 | 2 | 20 | 38 | 40 | 0 | 0 | 0 |
| 15 | 0 | 84 | 3 | 0 | 202 | 0 | 35 | 25 | 0 |
| 16 | 0 | 68 | 5 | 61 | 136 | 153 | 70 | 0 | 12 |
| 17 | 0 | 171 | 15 | 40 | 237 | 200 | 181 | 178 | 29 |
| 18 | 0 | 263 | 21 | 132 | 363 | 772 | 320 | 300 | 21 |
| 19 | 33 | 624 | 97 | 496 | 571 | 1813 | 744 | 644 | 102 |
| 20 | 145 | 1759 | 89 | 1196 | 1103 | 4387 | 1372 | 1393 | 82 |
| 21 | 214 | 4189 | 172 | 2013 | 2153 | 8173 | 1882 | 1440 | 784 |
| 22 | 655 | 5989 | 259 | 3014 | 4053 | 14151 | 3144 | 3584 | 1948 |
| 23 | 1347 | 7736 | 460 | 4917 | 5654 | 23321 | 5582 | 5331 | 3532 |
| 24 | 2270 | 6624 | 838 | 8846 | 9264 | 30805 | 9896 | 9287 | 4868 |
| 25 | 2357 | 6638 | 1305 | 11478 | 11732 | 35480 | 16542 | 13001 | 10257 |
| 26 | 2879 | 9854 | 2163 | 14994 | 15572 | 36171 | 21444 | 16402 | 14830 |
| 27 | 3102 | 7299 | 2840 | 18427 | 18797 | 32861 | 18379 | 16778 | 19357 |
| 28 | 3961 | 8881 | 3689 | 17551 | 18480 | 35449 | 21329 | 14735 | 18181 |
| 29 | 3348 | 7134 | 4799 | 17442 | 14978 | 29106 | 18002 | 14954 | 19038 |
| 30 | 3647 | 5996 | 5963 | 16191 | 11990 | 21280 | 18168 | 12515 | 17622 |
| 31 | 4806 | 5758 | 6699 | 15708 | 8701 | 13329 | 15332 | 9780 | 14475 |
| 32 | 4487 | 6190 | 6845 | 13698 | 7181 | 9171 | 14062 | 8983 | 12321 |
| 33 | 4728 | 4446 | 6763 | 9522 | 5212 | 6413 | 11722 | 7192 | 9638 |
| 34 | 4343 | 3845 | 6370 | 7923 | 3815 | 4014 | 10630 | 5930 | 8004 |
| 35 | 3948 | 2639 | 4921 | 6151 | 2693 | 3310 | 9249 | 4715 | 5191 |
| 36 | 2760 | 1809 | 3914 | 4336 | 1907 | 2573 | 6752 | 4032 | 4656 |
| 37 | 2715 | 1441 | 3144 | 2776 | 1343 | 1758 | 4337 | 3397 | 3841 |
| 38 | 2465 | 1374 | 2429 | 2745 | 897 | 1474 | 3548 | 3106 | 3139 |
| 39 | 1631 | 1026 | 1620 | 2045 | 668 | 1148 | 2294 | 2569 | 2079 |
| 40 | 1608 | 495 | 1074 | 1255 | 405 | 909 | 1713 | 1627 | 1375 |
| 41 | 848 | 592 | 895 | 809 | 393 | 938 | 1606 | 1831 | 929 |
| 42 | 826 | 549 | 555 | 488 | 189 | 447 | 1192 | 864 | 1352 |
| 43 | 475 | 415 | 366 | 380 | 151 | 481 | 726 | 797 | 800 |
| 44 | 438 | 203 | 234 | 230 | 133 | 143 | 470 | 517 | 665 |
| 45 | 300 | 110 | 156 | 38 | 80 | 148 | 297 | 240 | 530 |
| 46 | 183 | 131 | 72 | 201 | 32 | 138 | 123 | 293 | 255 |
| 47 | 126 | 167 | 107 | 19 | 69 | 64 | 40 | 137 | 152 |
| 48 | 195 | 70 | 61 | 11 | 19 | 50 | 81 | 169 | 164 |
| 49 | 121 | 77 | 51 | 0 | 17 | 89 | 207 | 40 | 146 |
| 50 | 29 | 40 | 14 | 24 | 6 | 0 | 165 | 51 | 35 |
| 51 | 18 | 60 | 10 | 0 | 0 | 0 | 61 | 29 | 79 |
| 52 | 18 | 24 | 7 | 0 | 14 | 0 | 41 | 68 | 109 |
| 53 | 0 | 0 | 12 | 0 | 0 | 24 | 0 | 43 | 0 |
| 54 | 18 | 0 | 6 | 1 | 0 | 0 | 0 | 171 | 0 |
| 55 | 18 | 0 | 6 | 0 | 0 | 0 | 0 | 86 | 17 |
| 56 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 171 | 53 |
| 57 | 18 | 10 | 19 | 0 | 0 | 0 | 0 | 57 | 0 |
| 58 | 18 | 0 | 3 | 0 | 0 | 14 | 0 | 86 | 0 |
| 59 | 0 | 0 | 8 | 0 | 14 | 0 | 0 | 57 | 0 |
| 60 | 18 | 0 | 1 | 0 | 0 | 0 | 0 | 86 | 0 |
| 61 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 71 | 0 |
| 62 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 0 |
| 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 0 |
| 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| 66 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 0 |
| 69 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 14 | 0 |
| 70 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 17 |
| 71 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **61116** | **104795** | **69103** | **185177** | **149279** | **320793** | **221740** | **167947** | **180685** |
| **Weights** | **1538** | **1723** | **1728** | **3333** | **2285** | **4315** | **4176** | **3271** | **3554** |

**Table 7.7.14.d Nephrops in FUs 20-22 Celtic Sea (VIIfgh)**
removals length distributions in 2002-2010. Irish trawlers.
**Removals=Landings+dead catches (discard survival rate : 25%)**

| CL mm/Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **12** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13** | 0 | 0 | 1 | 0 | 14 | 0 | 0 | 0 | 0 |
| **14** | 0 | 14 | 2 | 15 | 29 | 30 | 0 | 0 | 0 |
| **15** | 0 | 63 | 2 | 0 | 152 | 0 | 26 | 19 | 0 |
| **16** | 0 | 51 | 4 | 46 | 102 | 115 | 53 | 0 | 9 |
| **17** | 0 | 128 | 12 | 30 | 178 | 150 | 136 | 134 | 22 |
| **18** | 0 | 197 | 18 | 99 | 273 | 579 | 240 | 225 | 16 |
| **19** | 33 | 471 | 77 | 372 | 432 | 1367 | 558 | 483 | 77 |
| **20** | 145 | 1387 | 77 | 922 | 886 | 3407 | 1029 | 1076 | 62 |
| **21** | 214 | 3410 | 148 | 1624 | 1739 | 6280 | 1419 | 1122 | 630 |
| **22** | 654 | 4825 | 228 | 2398 | 3318 | 11203 | 2432 | 2830 | 1602 |
| **23** | 1345 | 6446 | 406 | 3979 | 4818 | 19496 | 4501 | 4409 | 3031 |
| **24** | 2263 | 5503 | 749 | 7317 | 8080 | 26387 | 8327 | 8017 | 4292 |
| **25** | 2329 | 5597 | 1180 | 9686 | 10399 | 31146 | 14152 | 11602 | 9280 |
| **26** | 2774 | 8847 | 1976 | 12904 | 14191 | 32805 | 19183 | 15183 | 13884 |
| **27** | 2931 | 6567 | 2644 | 15959 | 17211 | 30202 | 16229 | 15666 | 18314 |
| **28** | 3836 | 8324 | 3501 | 15391 | 17197 | 32708 | 19681 | 13988 | 17322 |
| **29** | 3287 | 6745 | 4609 | 15564 | 14338 | 27835 | 16877 | 14370 | 18263 |
| **30** | 3606 | 5773 | 5786 | 14748 | 11730 | 20837 | 17273 | 12102 | 17067 |
| **31** | 4763 | 5630 | 6540 | 14735 | 8554 | 13192 | 14669 | 9492 | 13945 |
| **32** | 4446 | 6121 | 6740 | 13015 | 7098 | 9133 | 13656 | 8796 | 11959 |
| **33** | 4702 | 4430 | 6687 | 9130 | 5172 | 6409 | 11496 | 7077 | 9379 |
| **34** | 4327 | 3845 | 6344 | 7721 | 3800 | 4012 | 10476 | 5871 | 7836 |
| **35** | 3939 | 2639 | 4898 | 6012 | 2693 | 3310 | 9236 | 4698 | 5108 |
| **36** | 2756 | 1809 | 3912 | 4285 | 1907 | 2573 | 6745 | 4032 | 4618 |
| **37** | 2712 | 1441 | 3142 | 2764 | 1343 | 1758 | 4337 | 3397 | 3825 |
| **38** | 2464 | 1374 | 2428 | 2745 | 897 | 1474 | 3548 | 3106 | 3133 |
| **39** | 1630 | 1026 | 1619 | 2045 | 668 | 1148 | 2294 | 2569 | 2079 |
| **40** | 1607 | 495 | 1073 | 1255 | 405 | 909 | 1713 | 1627 | 1375 |
| **41** | 847 | 592 | 895 | 809 | 393 | 938 | 1606 | 1831 | 929 |
| **42** | 825 | 549 | 555 | 488 | 189 | 447 | 1192 | 864 | 1352 |
| **43** | 475 | 415 | 366 | 380 | 151 | 481 | 726 | 797 | 800 |
| **44** | 438 | 203 | 234 | 230 | 133 | 143 | 470 | 517 | 665 |
| **45** | 300 | 110 | 156 | 38 | 80 | 148 | 297 | 240 | 530 |
| **46** | 183 | 131 | 72 | 201 | 32 | 138 | 123 | 293 | 255 |
| **47** | 126 | 167 | 107 | 19 | 69 | 64 | 40 | 137 | 152 |
| **48** | 195 | 70 | 61 | 11 | 19 | 50 | 81 | 169 | 164 |
| **49** | 121 | 77 | 51 | 0 | 17 | 89 | 207 | 40 | 146 |
| **50** | 29 | 40 | 14 | 24 | 6 | 0 | 165 | 51 | 35 |
| **51** | 18 | 60 | 10 | 0 | 0 | 0 | 61 | 29 | 79 |
| **52** | 18 | 24 | 7 | 0 | 14 | 0 | 41 | 68 | 109 |
| **53** | 0 | 0 | 12 | 0 | 0 | 24 | 0 | 43 | 0 |
| **54** | 18 | 0 | 6 | 1 | 0 | 0 | 0 | 171 | 0 |
| **55** | 18 | 0 | 6 | 0 | 0 | 0 | 0 | 86 | 17 |
| **56** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 171 | 53 |
| **57** | 18 | 10 | 19 | 0 | 0 | 0 | 0 | 57 | 0 |
| **58** | 18 | 0 | 3 | 0 | 0 | 14 | 0 | 86 | 0 |
| **59** | 0 | 0 | 8 | 0 | 14 | 0 | 0 | 57 | 0 |
| **60** | 18 | 0 | 1 | 0 | 0 | 0 | 0 | 86 | 0 |
| **61** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 71 | 0 |
| **62** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 0 |
| **63** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| **64** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 0 |
| **65** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 |
| **66** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| **67** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **68** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 0 |
| **69** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 14 | 0 |
| **70** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 | 17 |
| **71** | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **72** | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| **73** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **74** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **75** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **60432** | **95605** | **67403** | **166965** | **138741** | **290998** | **205294** | **157939** | **172430** |
| **Weights** | **1527** | **1639** | **1704** | **3097** | **2176** | **4039** | **3984** | **3164** | **3443** |

**Table 7.7.15.** ***Nephrops*** **in VIIfgh. Mean sizes (carapace length, CL in mm) of French and Irish landings. For the period 1999–2010, French values are calculated (1) including the samples involving in tailed individuals (italic fonts) and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

| | French sampling | | | Irish sampling | | |
|---|---|---|---|---|---|---|
| Year | Males | Females | Total | Males | Females | Total |
| 1987 | 38.8 | 35.1 | 38.1 | | | |
| 1988 | 35.7 | 34.7 | 35.6 | | | |
| 1989 | 38.9 | 36.0 | 38.5 | | | |
| 1990 | 39.7 | 35.4 | 39.0 | | | |
| 1991 | 38.2 | 34.1 | 37.5 | | | |
| 1992 | 37.6 | 34.9 | 37.3 | | | |
| 1993 | 40.0 | 36.6 | 39.6 | | | |
| 1994 | 39.7 | 37.1 | 39.3 | | | |
| 1995 | 39.9 | 36.1 | 39.4 | | | |
| 1996 | 39.5 | 36.8 | 39.2 | | | |
| 1997 | 39.9 | 37.4 | 39.8 | | | |
| 1998 | 39.9 | 36.4 | 39.5 | | | |
| 1999 | 39.0 | 35.3 | 38.3 | | | |
| | 40.1 | 36.9 | 39.6 | | | |
| 2000 | 41.0 | 37.8 | 40.2 | | | |
| | 42.0 | 39.2 | 41.4 | | | |
| 2001 | 37.9 | 37.1 | 37.7 | | | |
| | 38.8 | 39.1 | 38.9 | | | |
| 2002 | 39.6 | 36.8 | 39.3 | 33.0 | 31.1 | 32.2 |
| | 40.9 | 39.7 | 40.8 | | | |
| 2003 | 40.5 | 36.3 | 40.1 | 31.1 | 29.1 | 30.2 |
| | 41.5 | 39.8 | 41.4 | | | |
| 2004 | 40.1 | 36.3 | 39.6 | 33.5 | 32.3 | 32.9 |
| | 41.6 | 39.8 | 41.5 | | | |
| 2005 | 41.1 | 37.9 | 40.6 | 30.9 | 30.8 | 30.9 |
| | 43.1 | 40.3 | 42.8 | | | |
| 2006 | 40.0 | 37.3 | 39.2 | 29.7 | 28.6 | 29.2 |
| | 41.6 | 39.5 | 41.1 | | | |
| 2007 | 38.9 | 36.9 | 38.5 | 29.3 | 27.3 | 28.5 |
| | 40.7 | 38.7 | 40.4 | | | |
| 2008 | 37.6 | 34.7 | 37.2 | 32.0 | 29.7 | 31.1 |
| | 40.1 | 39.6 | 40.1 | | | |
| 2009 | 39.0 | 34.5 | 38.5 | 31.8 | 28.8 | 30.8 |
| | 41.0 | 40.1 | 41.0 | | | |
| 2010 | 40.2 | 34.2 | 39.3 | 31.6 | 29.5 | 30.7 |
| | 42.2 | 39.9 | 42.1 | | | |

**Table 7.7.16.** *Nephrops* in VIIfgh. French program of discard sampling onboard (years 1997 and 2010). Length distribution of landings (L) and discards (D) by sex ($10^3$). The reported size is the carapace length (CL, in mm). Conversion of CL to TS (total size) is done by multiplication by 3.3.

| CL | 1997 | | | | | | 2010 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | males | | females | | Total | | males | | females | | Total | |
| | L | D | L | D | L | D | L | D | L | D | L | D |
| 14 | | | | | | | | 7 | | 17 | | 24 |
| 15 | | | | | | | | | | | | |
| 16 | | | | 1 | | 1 | | | | | | |
| 17 | | | | | | | | 3 | | | | 3 |
| 18 | | | | 1 | | 1 | | | | | | |
| 19 | | 1 | | | | 1 | | | | 1 | | 1 |
| 20 | | 1 | | 12 | | 13 | | | | 5 | | 5 |
| 21 | | | | 10 | | 10 | | | | 4 | | 4 |
| 22 | | 187 | | 294 | | 481 | | 1 | | | | 1 |
| 23 | | 630 | | 1150 | | 1780 | | 11 | | 1 | | 12 |
| 24 | | 874 | | 1172 | | 2046 | | 23 | | 31 | | 54 |
| 25 | | 1428 | | 2490 | | 3918 | | 28 | | 25 | | 54 |
| 26 | | 1439 | | 1889 | | 3328 | | 98 | | 91 | | 189 |
| 27 | 15 | 4695 | | 7332 | 15 | 12027 | | 113 | | 163 | | 275 |
| 28 | 28 | 4399 | | 6888 | 28 | 11287 | | 115 | | 185 | | 300 |
| 29 | 45 | 3521 | | 5089 | 45 | 8610 | | 274 | | 291 | | 565 |
| 30 | 218 | 6863 | 19 | 9305 | 236 | 16167 | 24 | 424 | | 434 | 24 | 857 |
| 31 | 521 | 3140 | 21 | 4821 | 542 | 7960 | 23 | 499 | 13 | 535 | 36 | 1034 |
| 32 | 1155 | 4842 | 65 | 6535 | 1220 | 11377 | 54 | 507 | 15 | 1516 | 69 | 2023 |
| 33 | 1984 | 3885 | 160 | 5140 | 2144 | 9025 | 89 | 601 | 46 | 2133 | 136 | 2735 |
| 34 | 2035 | 1360 | 152 | 1384 | 2186 | 2744 | 119 | 465 | 231 | 2477 | 350 | 2943 |
| 35 | 3251 | 1385 | 357 | 1254 | 3608 | 2639 | 277 | 566 | 313 | 2127 | 590 | 2693 |
| 36 | 3409 | 570 | 418 | 950 | 3827 | 1520 | 499 | 501 | 463 | 1574 | 962 | 2075 |
| 37 | 3799 | 410 | 464 | 333 | 4262 | 743 | 575 | 491 | 533 | 1107 | 1109 | 1598 |
| 38 | 4138 | 205 | 666 | 189 | 4804 | 394 | 745 | 361 | 420 | 518 | 1165 | 879 |
| 39 | 3395 | 72 | 224 | 85 | 3619 | 157 | 1112 | 505 | 321 | 367 | 1432 | 871 |
| 40 | 4713 | 120 | 205 | 64 | 4918 | 184 | 1319 | 617 | 238 | 222 | 1557 | 840 |
| 41 | 2861 | 33 | 202 | 41 | 3062 | 74 | 1354 | 321 | 169 | 190 | 1524 | 511 |
| 42 | 3367 | 43 | 47 | 34 | 3414 | 77 | 1439 | 288 | 122 | 115 | 1561 | 403 |
| 43 | 2678 | 25 | 47 | | 2725 | 25 | 1494 | 477 | 141 | 230 | 1635 | 707 |
| 44 | 1787 | 8 | 63 | | 1849 | 8 | 1508 | 277 | 65 | 187 | 1573 | 464 |
| 45 | 2236 | 7 | 52 | 2 | 2288 | 9 | 1301 | 406 | 61 | 318 | 1362 | 724 |
| 46 | 1428 | 1 | | | 1428 | 1 | 1287 | 522 | 41 | 208 | 1328 | 731 |
| 47 | 1021 | | | | 1021 | | 1159 | 423 | 21 | 377 | 1180 | 800 |
| 48 | 954 | 2 | 16 | | 970 | 2 | 1187 | 364 | 20 | 173 | 1208 | 538 |
| 49 | 603 | | | | 603 | | 860 | 277 | 3 | 89 | 863 | 366 |
| 50 | 733 | 1 | | | 733 | 1 | 677 | 341 | 3 | 18 | 680 | 358 |
| 51 | 353 | | | | 353 | | 551 | 239 | 8 | 82 | 559 | 320 |
| 52 | 372 | | | | 372 | | 476 | 140 | 8 | 51 | 483 | 190 |
| 53 | 286 | 3 | | | 286 | 3 | 401 | 184 | 9 | 105 | 409 | 288 |
| 54 | 198 | | | | 198 | | 248 | 77 | | 8 | 248 | 85 |
| 55 | 110 | | | | 110 | | 199 | 80 | 1 | 27 | 200 | 107 |
| 56 | 54 | | | | 54 | | 109 | 38 | | | 109 | 38 |
| 57 | 81 | | | | 81 | | 80 | 1 | | | 80 | 1 |
| 58 | 36 | | | | 36 | | 54 | | | | 54 | |
| 59 | 8 | | | | 8 | | 43 | 1 | | | 43 | 1 |
| 60 | 23 | | | | 23 | | 14 | | | | 14 | |
| 61 | 8 | | | | 8 | | 8 | | | | 9 | |
| 62 | 3 | | | | 3 | | 3 | | | | 3 | |
| 63 | | | | | | | 2 | 2 | | | 2 | 2 |
| 64 | | | | | | | | | | | | |
| 65 | | | | | | | 2 | | | | 2 | |
| 66 | | | | | | | | | | | | |
| 67 | | | | | | | 2 | | | | 2 | |
| 68 | | | | | | | 1 | | | | 1 | |
| 68 | | | | | | | 1 | | | | 1 | |
| 70 | | | | | | | | | | | | |
| 71 | | | | | | | | | | | | |
| 72 | | | | | | | 1 | | | | 1 | |
| 73 | | | | | | | 1 | | | | 1 | |
| 74 | | | | | | | 1 | | | | 1 | |
| 75 | | | | | | | | | | | | |
| | **47904** | **40149** | **3176** | **56463** | **51080** | **96612** | **19304** | **10667** | **3265** | **16003** | **22569** | **26670** |
| %D | | *46* | | *95* | | *65* | | *36* | | *83* | | *54* |

**Table 7.7.17.** *Nephrops* in VIIfgh. Irish program of discard sampling onboard (years 2003, 2008-2010). Length distribution of landings (L) and discards (D) by sex ($10^3$). The reported size is the carapace length (CL, in mm). Conversion of CL to TS (total size) is done by multiplication by 3.3.

| CL | 2003 | | | | | | 2008 | | | | | | 2009 | | | | | | 2010 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | males | | females | | Total | | males | | females | | Total | | males | | females | | Total | | males | | females | | Total | |
| | L | D | L | D | L | D | L | D | L | D | L | D | L | D | L | D | L | D | L | D | L | D | L | D |
| 14 | | | | 10 | | 10 | | | | | | | | | | | | | | | | | | |
| 15 | | 10 | | 74 | | 84 | | | | 35 | | 35 | | 25 | | | | 25 | | | | | | |
| 16 | | 10 | | 58 | | 68 | | 35 | | 35 | | 70 | | | | | | | | | | | | |
| 17 | | 30 | | 141 | | 171 | | | | 181 | | 181 | | 42 | | 136 | | 178 | | | | | | |
| 18 | 1 | 134 | 1 | 127 | 2 | 261 | | 83 | | 237 | | 320 | | 77 | | 223 | | 300 | | | | | | |
| 19 | 3 | 242 | 7 | 372 | 10 | 614 | | 166 | | 578 | | 744 | | 239 | | 405 | | 644 | | | | | | |
| 20 | 53 | 452 | 215 | 1038 | 269 | 1489 | | 370 | | 1002 | | 1372 | | 247 | 127 | 1019 | 127 | 1266 | | | | 12 | | 12 |
| 21 | 164 | 902 | 904 | 2216 | 1068 | 3118 | | 988 | 28 | 866 | 28 | 1854 | 111 | 679 | 56 | 594 | 167 | 1273 | | 29 | | | | 29 |
| 22 | 472 | 1963 | 858 | 2693 | 1330 | 4657 | 98 | 1127 | 198 | 1721 | 296 | 2848 | 220 | 1182 | 346 | 1836 | 566 | 3018 | | | | 21 | | 21 |
| 23 | 1469 | 2503 | 1101 | 2655 | 2570 | 5158 | 195 | 1431 | 1063 | 2893 | 1258 | 4324 | 756 | 1610 | 887 | 2078 | 1643 | 3688 | | 54 | | 48 | | 102 |
| 24 | 1251 | 2392 | 888 | 2091 | 2139 | 4482 | 1491 | 2022 | 2130 | 4253 | 3621 | 6275 | 2015 | 2235 | 2192 | 2845 | 4207 | 5080 | | 41 | | 41 | | 82 |
| 25 | 1209 | 2056 | 1264 | 2109 | 2473 | 4164 | 3058 | 2931 | 3923 | 6630 | 6981 | 9561 | 4121 | 2814 | 3284 | 2782 | 7405 | 5596 | 21 | 164 | 148 | 451 | 169 | 615 |
| 26 | 3132 | 1631 | 2683 | 2396 | 5815 | 4026 | 5878 | 2971 | 6519 | 6076 | 12397 | 9047 | 5814 | 2316 | 5711 | 2561 | 11525 | 4877 | 280 | 666 | 284 | 718 | 564 | 1384 |
| 27 | 1978 | 1304 | 2392 | 1622 | 4370 | 2926 | 4798 | 3416 | 4981 | 5184 | 9779 | 8600 | 6595 | 2292 | 5735 | 2155 | 12331 | 4447 | 633 | 834 | 893 | 1172 | 1526 | 2006 |
| 28 | 3591 | 1030 | 3053 | 1196 | 6644 | 2227 | 8319 | 3258 | 6419 | 3333 | 14738 | 6591 | 6508 | 1644 | 5236 | 1347 | 11744 | 2991 | 1147 | 1097 | 1417 | 1207 | 2564 | 2304 |
| 29 | 2568 | 723 | 3006 | 833 | 5574 | 1556 | 8292 | 2362 | 5209 | 2138 | 13502 | 4500 | 7532 | 1311 | 5087 | 1024 | 12619 | 2335 | 2512 | 1614 | 3835 | 2297 | 6346 | 3911 |
| 30 | 2327 | 433 | 2775 | 457 | 5102 | 890 | 9274 | 1926 | 5314 | 1654 | 14588 | 3580 | 6985 | 1076 | 3879 | 574 | 10865 | 1650 | 4972 | 1601 | 6075 | 2182 | 11047 | 3783 |
| 31 | 2977 | 300 | 2265 | 211 | 5241 | 511 | 7186 | 1431 | 5495 | 1221 | 12680 | 2652 | 5539 | 751 | 3091 | 399 | 8630 | 1150 | 7992 | 2143 | 7196 | 2026 | 15188 | 4169 |
| 32 | 3570 | 166 | 2338 | 109 | 5908 | 275 | 7137 | 914 | 5299 | 712 | 12436 | 1626 | 5748 | 580 | 2486 | 169 | 8234 | 749 | 7087 | 1401 | 7658 | 2035 | 14745 | 3436 |
| 33 | 2313 | 57 | 2063 | 9 | 4376 | 67 | 7181 | 585 | 3636 | 320 | 10817 | 905 | 4680 | 388 | 2051 | 73 | 6731 | 461 | 8438 | 1236 | 7500 | 1864 | 15938 | 3100 |
| 34 | 2371 | | 1470 | | 3841 | | 7008 | 332 | 3005 | 285 | 10013 | 617 | 4353 | 220 | 1341 | 16 | 5694 | 236 | 8153 | 666 | 7246 | 1557 | 15399 | 2223 |
| 35 | 1468 | | 1168 | | 2637 | | 6570 | 55 | 2624 | | 9194 | 55 | 3721 | 68 | 926 | | 4647 | 68 | 6784 | 631 | 5570 | 1489 | 12355 | 2120 |
| 36 | 1108 | | 700 | | 1808 | | 5201 | 27 | 1524 | | 6725 | 27 | 3236 | | 797 | | 4032 | | 5954 | 428 | 4921 | 1018 | 10875 | 1446 |
| 37 | 1056 | | 384 | | 1440 | | 3430 | | 906 | | 4337 | | 2864 | | 533 | | 3397 | | 4960 | 424 | 3643 | 611 | 8603 | 1035 |
| 38 | 1140 | | 232 | | 1372 | | 2993 | | 556 | | 3548 | | 2785 | | 321 | | 3106 | | 4623 | 264 | 2710 | 407 | 7333 | 671 |
| 39 | 891 | | 134 | | 1025 | | 1928 | | 366 | | 2294 | | 2334 | | 235 | | 2569 | | 3181 | 152 | 1680 | 178 | 4861 | 330 |
| 40 | 404 | | 91 | | 495 | | 1526 | | 187 | | 1713 | | 1411 | | 216 | | 1627 | | 3315 | 76 | 1189 | 76 | 4504 | 152 |
| 41 | 572 | | 20 | | 592 | | 1459 | | 148 | | 1606 | | 1667 | | 163 | | 1831 | | 2873 | 38 | 904 | 25 | 3778 | 63 |
| 42 | 492 | | 57 | | 549 | | 1114 | | 78 | | 1192 | | 827 | | 37 | | 864 | | 2595 | 12 | 520 | 12 | 3115 | 24 |
| 43 | 386 | | 29 | | 414 | | 650 | | 76 | | 726 | | 766 | | 32 | | 797 | | 1871 | | 208 | | 2079 | |
| 44 | 155 | | 48 | | 203 | | 431 | | 40 | | 470 | | 503 | | 14 | | 517 | | 1219 | | 156 | | 1375 | |
| 45 | 110 | | | | 110 | | 297 | | | | 297 | | 226 | | 15 | | 240 | | 820 | | 109 | | 929 | |
| 46 | 131 | | | | 131 | | 123 | | | | 123 | | 270 | | 23 | | 293 | | 1213 | | 139 | | 1352 | |
| 47 | 167 | | | | 167 | | 40 | | | | 40 | | 137 | | | | 137 | | 702 | | 98 | | 800 | |
| 48 | 70 | | | | 70 | | 81 | | | | 81 | | 169 | | | | 169 | | 569 | | 96 | | 665 | |
| 49 | 77 | | | | 77 | | 207 | | | | 207 | | 40 | | | | 40 | | 482 | | 48 | | 530 | |
| 50 | 40 | | | | 40 | | 165 | | | | 165 | | 51 | | | | 51 | | 255 | | | | 255 | |
| 51 | 60 | | | | 60 | | 61 | | | | 61 | | 29 | | | | 29 | | 137 | | 15 | | 152 | |
| 52 | 24 | | | | 24 | | 41 | | | | 41 | | 57 | | 11 | | 68 | | 164 | | | | 164 | |
| 53 | | | | | | | | | | | | | 43 | | | | 43 | | 146 | | | | 146 | |
| 54 | | | | | | | | | | | | | 171 | | | | 171 | | 35 | | | | 35 | |
| 55 | | | | | | | | | | | | | 86 | | | | 86 | | 64 | | 15 | | 79 | |
| 56 | | | | | | | | | | | | | 171 | | | | 171 | | 109 | | | | 109 | |
| 57 | 10 | | | | 10 | | | | | | | | 57 | | | | 57 | | | | | | | |
| 58 | | | | | | | | | | | | | 86 | | | | 86 | | | | | | | |
| 59 | | | | | | | | | | | | | 57 | | | | 57 | | 17 | | | | 17 | |
| 60 | | | | | | | | | | | | | 86 | | | | 86 | | 53 | | | | 53 | |
| 61 | | | | | | | | | | | | | 71 | | | | 71 | | | | | | | |
| 62 | | | | | | | | | | | | | 43 | | | | 43 | | | | | | | |
| 63 | | | | | | | | | | | | | 29 | | | | 29 | | | | | | | |
| 64 | | | | | | | | | | | | | 57 | | | | 57 | | | | | | | |
| 65 | | | | | | | | | | | | | 14 | | | | 14 | | | | | | | |
| 66 | | | | | | | | | | | | | | | | | | | | | | | | |
| 67 | | | | | | | | | | | | | | | | | | | | | | | | |
| 68 | | | | | | | | | | | | | 14 | | | | 14 | | | | | | | |
| 68 | | | | | | | | | | | | | 14 | | | | 14 | | | | | | | |
| 70 | | | | | | | | | | | | | 14 | | | | 14 | | | | | | | |
| 71 | | | | | | | | | | | | | | | | | | | | | | | | |
| 72 | | | | | | | | | | | | | | | | | | | | | | | | |
| 73 | | | | | | | | | | | | | | | | | | | | | | | | |
| 74 | | | | | | | | | | | | | | | | | | | 17 | | | | 17 | |
| 75 | | | | | | | | | | | | | | | | | | | | | | | | |
| | **37807** | **16335** | **30146** | **20427** | **67953** | **36762** | **96232** | **26430** | **59724** | **39354** | **155956** | **65784** | **83082** | **19796** | **44833** | **20236** | **127915** | **40032** | **83395** | **13571** | **64271** | **19447** | **147667** | **33018** |
| %D | | *30* | | *40* | | *35* | | *22* | | *40* | | *30* | | *19* | | *31* | | ***24*** | | *14* | | *23* | | *18* |

**Table 7.7.18. *Nephrops* in the Celtic Sea (FU20–22). Production by rectangle for French and Irish trawlers. The total by rectangle and the % involve in years 1999–2010 (excluding 2009) for French fleet and in years 1999–2010 for Irish fleet. Landings by FU20 and 21 and by FU22 have been disaggregated for the time-series.**

| Year | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | French trawlers | | | | | | | | | | | | | |
| 28E1 | 78 | 75 | 127 | 207 | 246 | 164 | 191 | 212 | 375 | 362 | | 159 | 2197 | 8.1% |
| 28E2 | 146 | 350 | 331 | 287 | 363 | 259 | 296 | 214 | 189 | 252 | | 174 | 2861 | 10.5% |
| 29E1 | 105 | 182 | 302 | 535 | 653 | 353 | 277 | 258 | 398 | 354 | | 123 | 3540 | 13.0% |
| 29E2 | 129 | 287 | 205 | 204 | 249 | 261 | 371 | 423 | 240 | 223 | | 139 | 2732 | 10.0% |
| 30E1 | 121 | 170 | 205 | 437 | 374 | 205 | 179 | 104 | 106 | 146 | | 34 | 2081 | 7.6% |
| 30E2 | 293 | 424 | 434 | 741 | 806 | 781 | 577 | 773 | 437 | 661 | Not available | 294 | 6222 | 22.8% |
| 31E3 | 847 | 1016 | 763 | 489 | 679 | 396 | 423 | 249 | 193 | 230 | | 125 | 5410 | 19.8% |
| all FR | 2078 | 2848 | 2626 | 3154 | 3595 | 2605 | 2502 | 2368 | 2033 | 2348 | 2156 | 1112 | 27269 | |
| | Irish trawlers | | | | | | | | | | | | | |
| 28E1 | 0 | 0 | 0 | 0 | 6 | 4 | 10 | 2 | 10 | 18 | 64 | 102 | 215 | 0.8% |
| 28E2 | 0 | 3 | 1 | 1 | 2 | 23 | 15 | 6 | 2 | 6 | 72 | 16 | 147 | 0.6% |
| 29E1 | 15 | 22 | 0 | 9 | 34 | 38 | 105 | 91 | 194 | 374 | 476 | 255 | 1613 | 6.2% |
| 29E2 | 1 | 2 | 0 | 0 | 1 | 11 | 19 | 24 | 31 | 23 | 67 | 52 | 231 | 0.9% |
| 30E1 | 5 | 10 | 10 | 37 | 62 | 104 | 133 | 141 | 154 | 292 | 297 | 116 | 1361 | 5.3% |
| 30E2 | 4 | 5 | 3 | 2 | 5 | 36 | 52 | 99 | 69 | 147 | 151 | 105 | 676 | 2.6% |
| 30E3 | 15 | 11 | 0 | 5 | 2 | 27 | 55 | 39 | 40 | 15 | 16 | 16 | 241 | 0.9% |
| 31E2 | 44 | 55 | 54 | 50 | 37 | 56 | 68 | 49 | 101 | 61 | 59 | 52 | 684 | 2.6% |
| 31E3 | 616 | 1424 | 1679 | 1124 | 941 | 1101 | 1571 | 1168 | 2392 | 2257 | 1549 | 2096 | 17918 | 69.2% |
| 31E4 | 27 | 25 | 146 | 134 | 115 | 17 | 129 | 85 | 96 | 61 | 40 | 104 | 980 | 3.8% |
| 32E3 | 97 | 238 | 229 | 134 | 185 | 211 | 231 | 145 | 126 | 156 | 53 | 21 | 1828 | 7.1% |
| all IRL | 824 | 1793 | 2123 | 1496 | 1389 | 1629 | 2387 | 1848 | 3214 | 3411 | 2844 | 3110 | 26069 | |
| | | | | | | | | | | | | | | Average 99–10 |
| FU20-22 | 2902 | 4641 | 4749 | 4650 | 4984 | 4234 | 4889 | 4216 | 5247 | 5759 | 5000 | 4222 | 53338 | 4624 |
| FU20&21 | 1314 | 1939 | 1932 | 2769 | 3064 | 2508 | 2534 | 2569 | 2440 | 3055 | 3143 | 1876 | 27202 | 2429 |
| FU22 | 1588 | 2702 | 2817 | 1881 | 1921 | 1726 | 2355 | 1647 | 2807 | 2704 | 1857 | 2345 | 26136 | 2196 |
| FU22 %of total | 55% | 58% | 59% | 40% | 39% | 41% | 48% | 39% | 54% | 47% | 37% | 56% | 49% | |

**Table 7.7.19. Division VIIfgh. *Nephrops* effort and lpue data by country.**

*French data*: otter trawlers getting at least 10% of their landings by targeting this species (period 1983–2008). For years 2009 and 2010, these data were not available, but they were calculated *vs*. estimators based on threshold of 500 kg landed *Nephrops* by trip (fishing effort was expressed as number of trips and lpue as kg/trip; see report).
*Irish data*: otter trawlers where >30% of monthly landings in live weight were *Nephrops*. Effort and lpue for the Irish fleet are also presented separated (FU22: Smalls ground; FU20–21: other sectors). The spatially separated values involve in yearly threshold of 30% and that explains the slight differences on fishing effort between aggregated and separated values.

| | Effort (Effective hours fishing) | | | | lpue (kg/h) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | France | Rep. of Ireland | | | France | | | Rep. of Ireland | | |
| | Otter | Otter | | | Total otter | Single Otter[1 3] | Twin otter[1 3] | Otter | | |
| Year | | total | FU22 | FU20–21 | | | | total | FU22 | FU20–21 |
| 1983 | 231440 | | | | 14.2 | 14.2 | | | | |
| 1984 | 204600 | | | | 15.8 | 15.8 | | | | |
| 1985 | 202830 | | | | 16.0 | 16.0 | | | | |
| 1986 | 162510 | | | | 14.9 | 14.9 | | | | |
| 1987 | 189580 | | | | 15.2 | 15.2 | | | | |
| 1988 | 170840 | | | | 16.4 | 16.4 | | | | |
| 1989 | 179060 | | | | 16.8 | 16.8 | | | | |
| 1990 | 229470 | | | | 15.6 | 15.6 | | | | |
| 1991 | 224710 | | | | 11.3 | 11.3 | | | | |
| 1992 | 276450 | | | | 11.7 | 11.7 | | | | |
| 1993 | 268410 | | | | 13.2 | 13.2 | | | | |
| 1994 | 258490 | | | | 13.5 | 13.5 | | | | |
| 1995 | 239240 | 26681 | 25028 | 2296 | 14.6 | 14.6 | | 46.9 | 48.6 | 41.8 |
| 1996 | 220120 | 20579 | 18688 | 2319 | 14.2 | 14.2 | 14.2 | 50.0 | 46.6 | 30.4 |
| 1997 | 187180 | 23255 | 21824 | 1811 | 12.6 | 12.5 | 14.4 | 49.2 | 48.2 | 31.8 |
| 1998 | 155340 | 25380 | 24840 | 2654 | 13.0 | 12.9 | 14.9 | 53.1 | 53.6 | 32.4 |
| 1999 | 150770 | 15491 | 13899 | 2102 | 10.9 | 10.2 | 10.0 | 41.5 | 44.3 | 22.7 |
| 2000 | 194150 | 28267 | 26035 | 2530 | 13.8 | 11.5 | 11.4 | 47.8 | 50.6 | 23.6 |
| 2001 | 170320 | 36205 | 34166 | 1786 | 14.6 | 11.4 | 13.3 | 54.6 | 56.0 | 23.6 |
| 2002 | 165670 | 29990 | 27336 | 1727 | 18.7 | 15.4 | 16.7 | 44.3 | 47.0 | 33.4 |
| 2003 | 191600 | 28532 | 28334 | 2963 | 18.2 | 16.3 | 15.0 | 33.9 | 34.4 | 25.9 |
| 2004 | 152700 | 31309 | 28317 | 5658 | 15.8 | 13.5 | 12.9 | 32.8 | 34.4 | 26.5 |
| 2005 | 146880 | 51031 | 43502 | 10374 | 16.0 | 13.0 | 13.2 | 41.3 | 43.1 | 32.9 |
| 2006 | 136650 | 45383 | 35557 | 13476 | 16.3 | 14.4 | 12.8 | 34.9 | 38.6 | 26.0 |
| 2007 | 101980 | 59899 | 48111 | 16393 | 18.5 | 15.9 | 14.3 | 48.1 | 55.4 | 30.9 |
| 2008 | 99789 | 59875 | 41208 | 20880 | 22.6 | 18.4 | 16.4 | 53.8 | 60.5 | 44.4 |
| 2009 | 92116 | 55454 | 29096 | 27899 | 22.7 | na[4] | na[4] | 48.2 | 54.3 | 43.6 |
| 2010 | 66685 | 55417 | 39713 | 17780 | 16.9 | na[4] | na[4] | 47.3 | 54.6 | 34.4 |

**[1]The single and twin otter French lpue can be compared with the total otter indices until 1999 when the definition of the fishing effort of trawlers was changed (see note 2).**

**[2]For the period 1999–2008, the French statistics differentiate fishing effort calculated on the basis of the "number of fishing hours" from that deduced from the "number of hours of use of a fishing gear".**

**[3]Information for single and twin trawl lpue involve in the total fishing fleet whereas aggregated indices are calculated for the otter trawlers getting at least 10% of their landings by targeting this species.**

**[4] Not available.**

**Table 7.7.20. *Nephrops* of the Celtic Sea. Output of the SCA model applied on the Smalls component (FU22) of the stock.**

| | | Fbar 20-40 mm | | Harvest Rates | SPR | |
|---|---|---|---|---|---|---|
| | | Female | Male | | Female | Male |
| $F_{0.1}$ | Combined | 0.08 | 0.15 | 7.5% | 57.2% | 37.9% |
| | Female | 0.13 | 0.26 | 10.9% | 45.2% | 25.5% |
| | Male | 0.06 | 0.13 | 6.5% | 61.5% | 42.8% |
| $F_{35\%SPR}$ | Combined | 0.13 | 0.26 | 10.9% | 45.2% | 25.5% |
| | Female | 0.22 | 0.43 | 15.3% | 34.1% | 15.9% |
| | Male | 0.09 | 0.18 | 8.4% | 53.5% | 33.9% |
| $F_{max}$ | Combined | 0.15 | 0.31 | 12.3% | 41.2% | 21.8% |
| | Female | 0.28 | 0.56 | 17.7% | 29.5% | 12.6% |
| | Male | 0.13 | 0.26 | 10.9% | 45.2% | 25.5% |

**Table 7.7.21. *Nephrops* in the Smalls FU22. Short-term catch option prediction inputs (Bold) and recent estimates of mean weight in landings and harvest ratio (shaded area: years 2008–2010 are used as input for the SCA model).**

| Year | Landings (number 106) scaled | Discards (number 106) scaled | Removals (number 106) 25%discard survival | Prop Removals Retained | Adjusted Survey(106) | HarvestRatio | FU22 Landings (t) | FU22 Discards (t) | MeanWt landings(g) |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | 89.69 | 50.81 | 127.8 | 0.70 | Na | | 1,921 | 502 | 21.4 |
| 2004 | 67.67 | 8.06 | 73.7 | 0.92 | Na | | 1,726 | 112 | 25.5 |
| 2005 | 111.40 | 88.19 | 177.5 | 0.63 | Na | | 2,355 | 1,115 | 21.1 |
| 2006 | 91.37 | 51.40 | 129.9 | 0.70 | 1503 | 8.6% | 1,647 | 544 | 18.0 |
| 2007 | 160.64 | 146.11 | 270.2 | 0.59 | 1136 | 23.8% | 2,807 | 1,449 | 17.5 |
| 2008 | 114.55 | 52.56 | 154.0 | 0.74 | 1114 | 13.8% | 2,704 | 644 | 23.6 |
| 2009 | 76.72 | 25.71 | 96.0 | 0.80 | 1093 | 8.8% | 1,857 | 295 | 24.2 |
| 2010 | 107.13 | 23.42 | 124.7 | 0.86 | 1141 | 10.9% | 2,345 | 331 | 21.9 |
| Avg 08–10 | | | | 0.80 | | | | | 23.24 |

**Table 7.7.22. *Nephrops* in the Smalls FU22. Short-term catch options table giving landings options for 2012.**

| | Harvest rate | Adjusted Survey (millions) | Retained number (millions) | Landings (tonnes) |
|---|---|---|---|---|
| MSY framework | 10.9% | | 99 | 2,303 |
| $F_{35\%\ combined}$ | | 1,141 | | |
| $F_{2010}$ | 10.9% | 1,141 | 100 | 2,320 |
| $F_{0.1\ Combined}$ | 7.5% | 1,141 | 68 | 1,581 |
| $F_{max\ Combined}$ | 12.3% | 1,141 | 112 | 2,604 |
| | 0% | 1,141 | 0 | 0 |
| | 2% | 1,141 | 18 | 424 |
| | 4% | 1,141 | 37 | 849 |
| | 6% | 1,141 | 55 | 1,273 |
| | 8% | 1,141 | 73 | 1,698 |
| | 10% | 1,141 | 91 | 2,122 |
| | 12% | 1,141 | 110 | 2,547 |

| | | Basis |
|---|---|---|
| Landings Mean Weight (Kg) | 0.0232 | Sampling 2008–10 |
| Survey Overestimate Bias | 1.30 | WGCSE 2011 |
| Survey Numbers (Millions) | 1483 | UWTV Survey 2010 |
| Prop. Retained by the Fishery | 0.80 | Sampling 2008–10 |

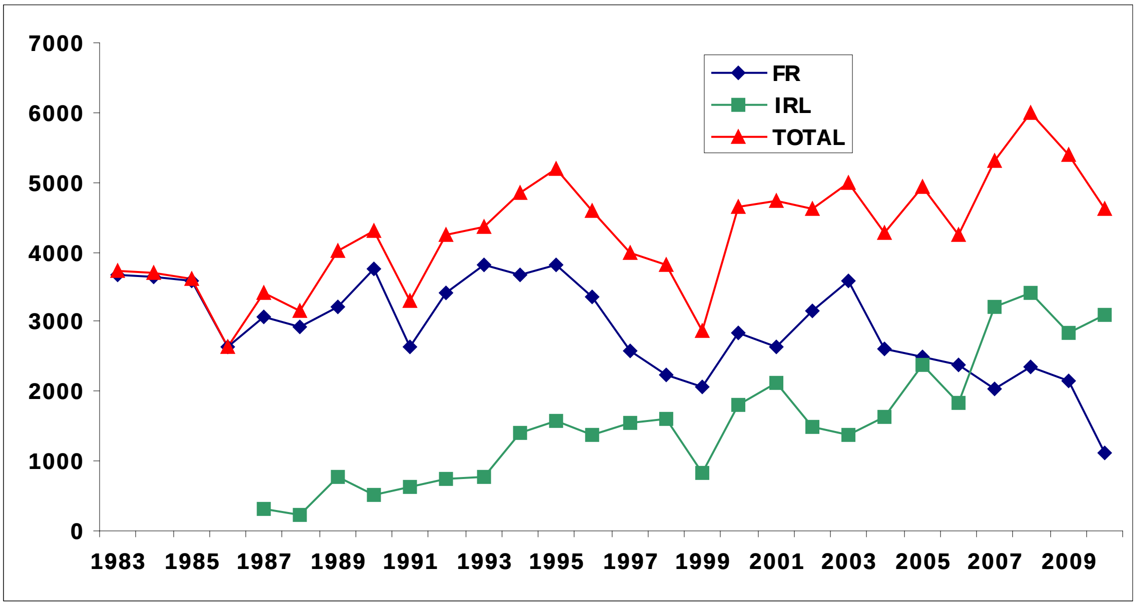



**Figure 7.7.1. *Nephrops* in VIIfgh. Evolution of nominal landings (t).**

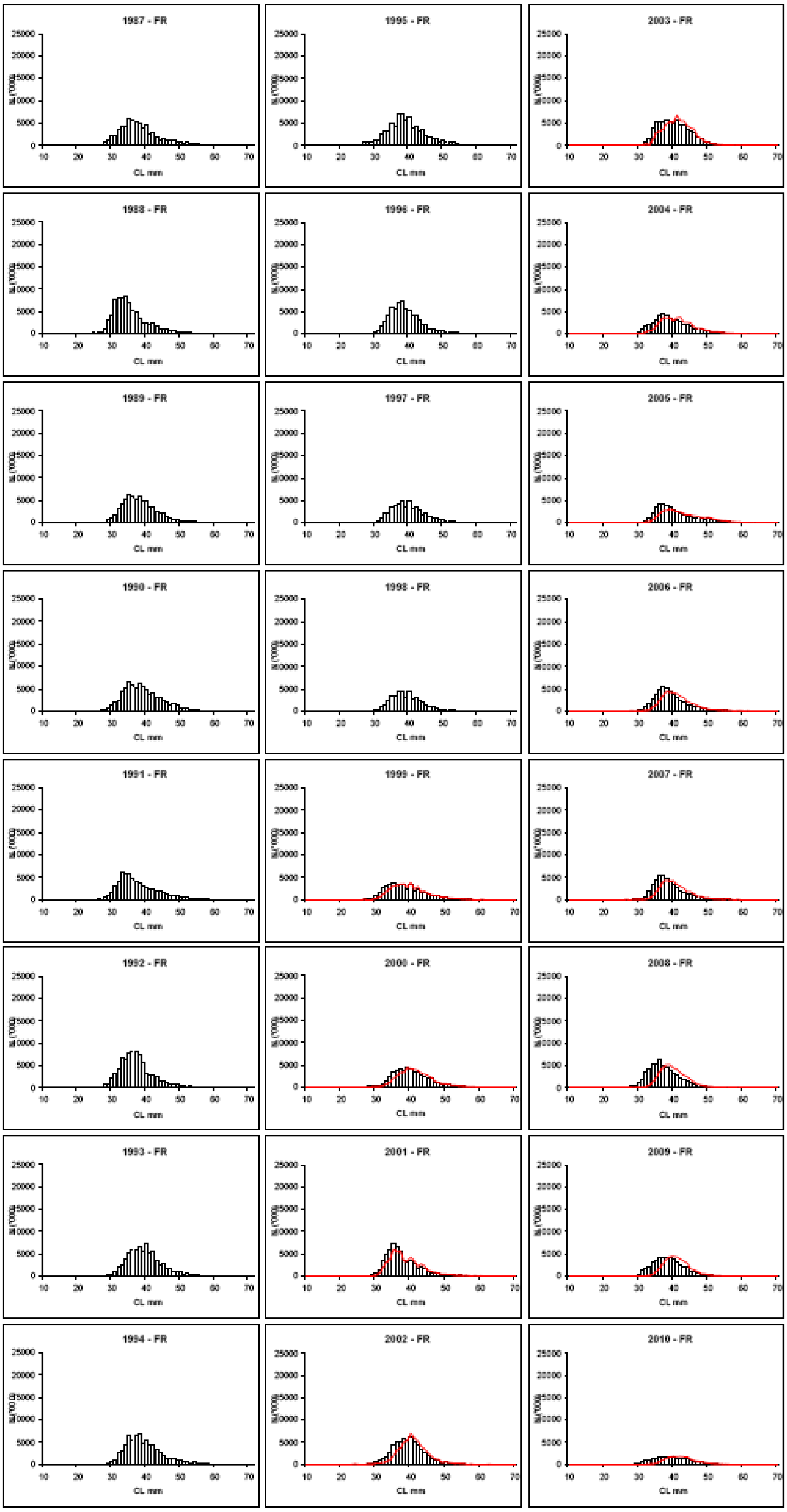


**Figure 7.7.2.** Nephrops in FU 20-22 Celtic Sea (VIIfgh) landings of French trawlers.

Landings since 1999 are presented by two ways: (1) Lines: previous method (tails not sampled and systematically apportioned in the smallest category of entire Nephrops at auction).(2) Bars: tails are included (years 1999-2007: simulation; since 2008: sampled data).

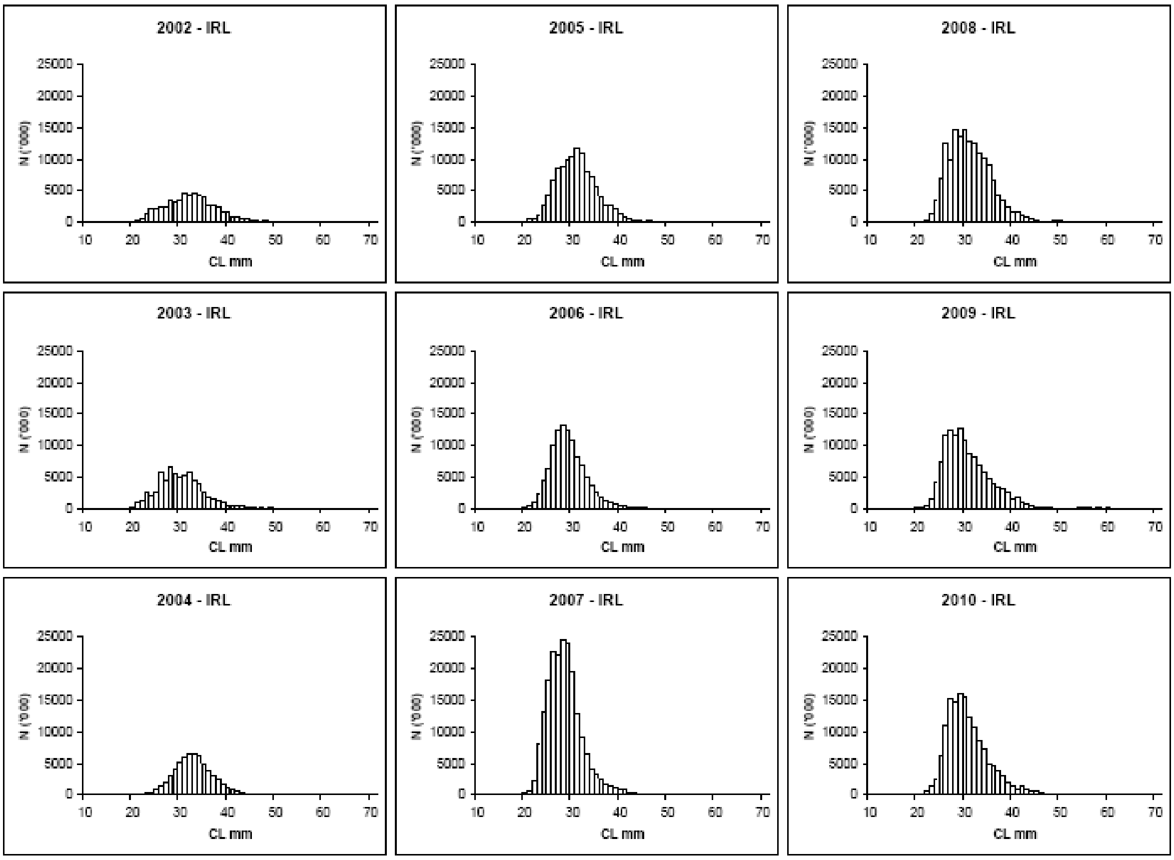



**Figure 7.7.3.** Nephrops in FU 20-22 Celtic Sea (VIIfgh) landings of Irish trawlers.

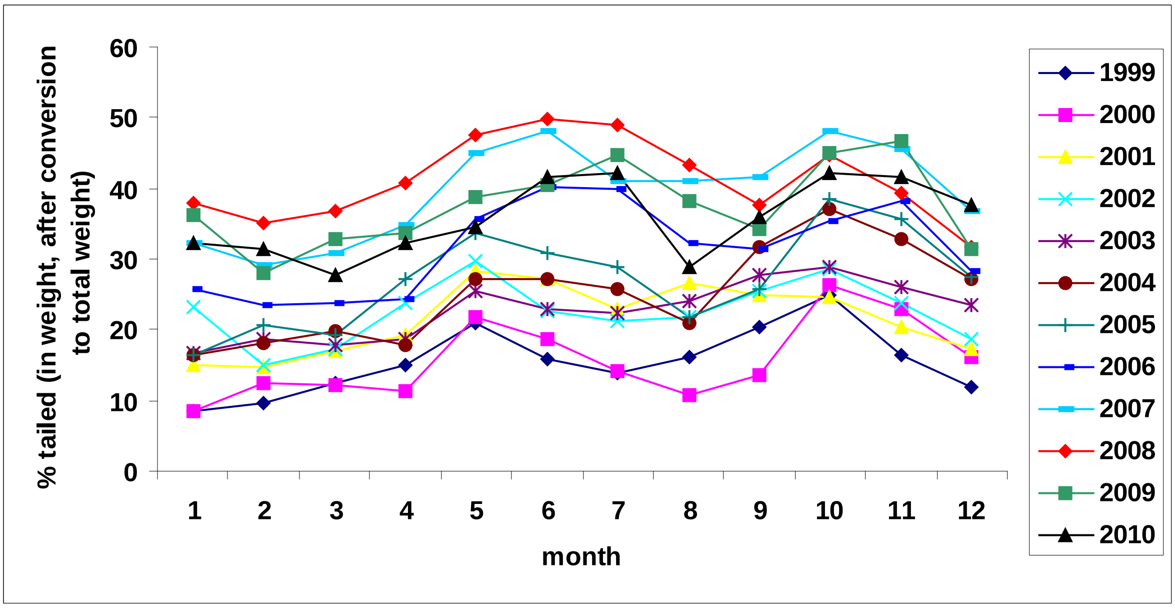



**Figure 7.7.4.** *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). Years 1999–2010. Monthly percentages of tailed individuals in the French landings (after conversion to total weight).**

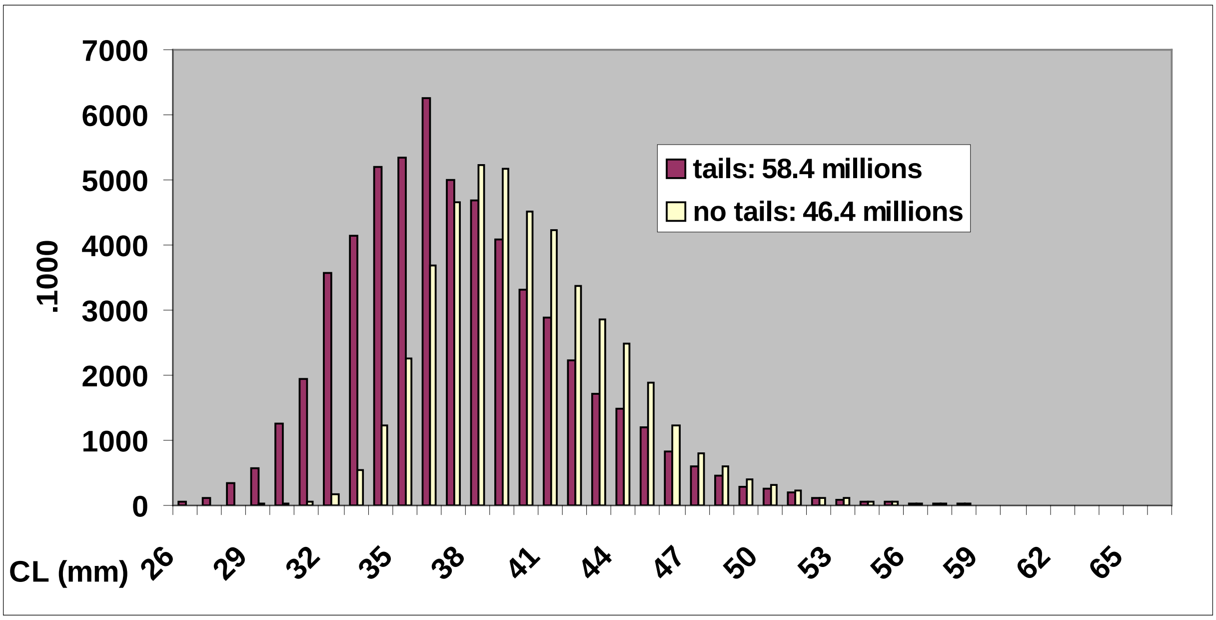



**Figure 7.7.5.** ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2008. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

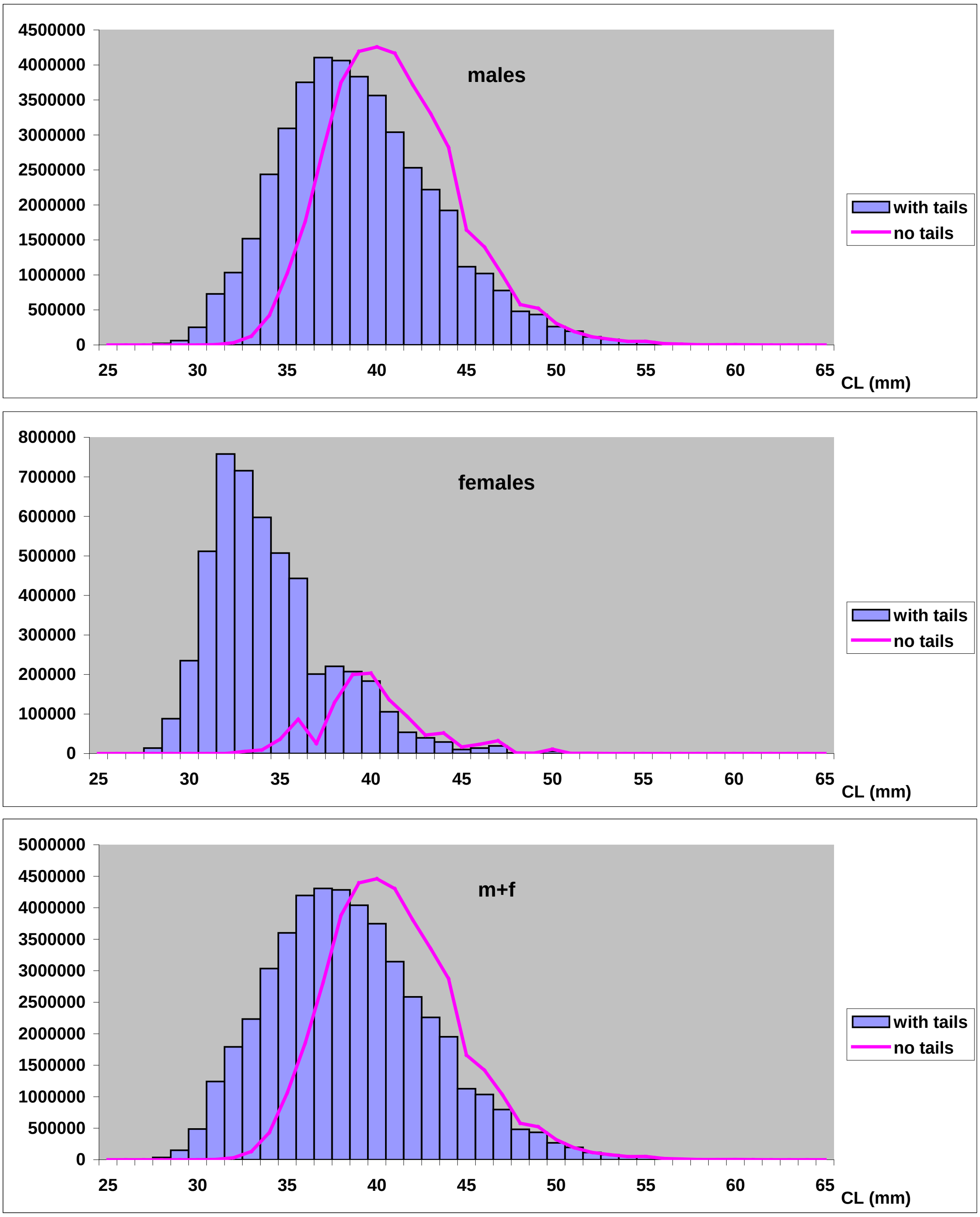



**Figure 7.7.6.** ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2009 by sex. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

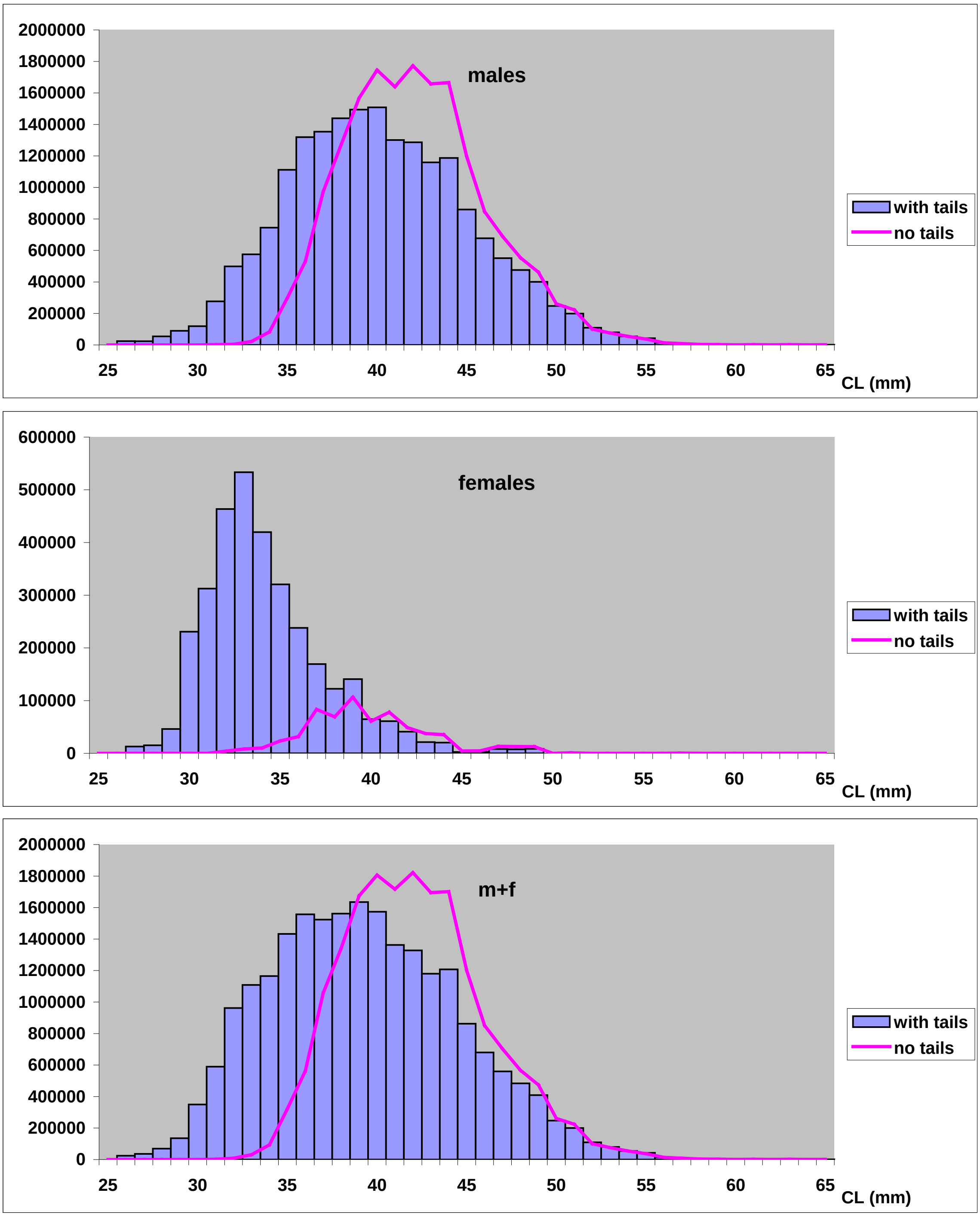



**Figure 7.7.7.** ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2010 by sex. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** ***Nephrops*** **at auction).**

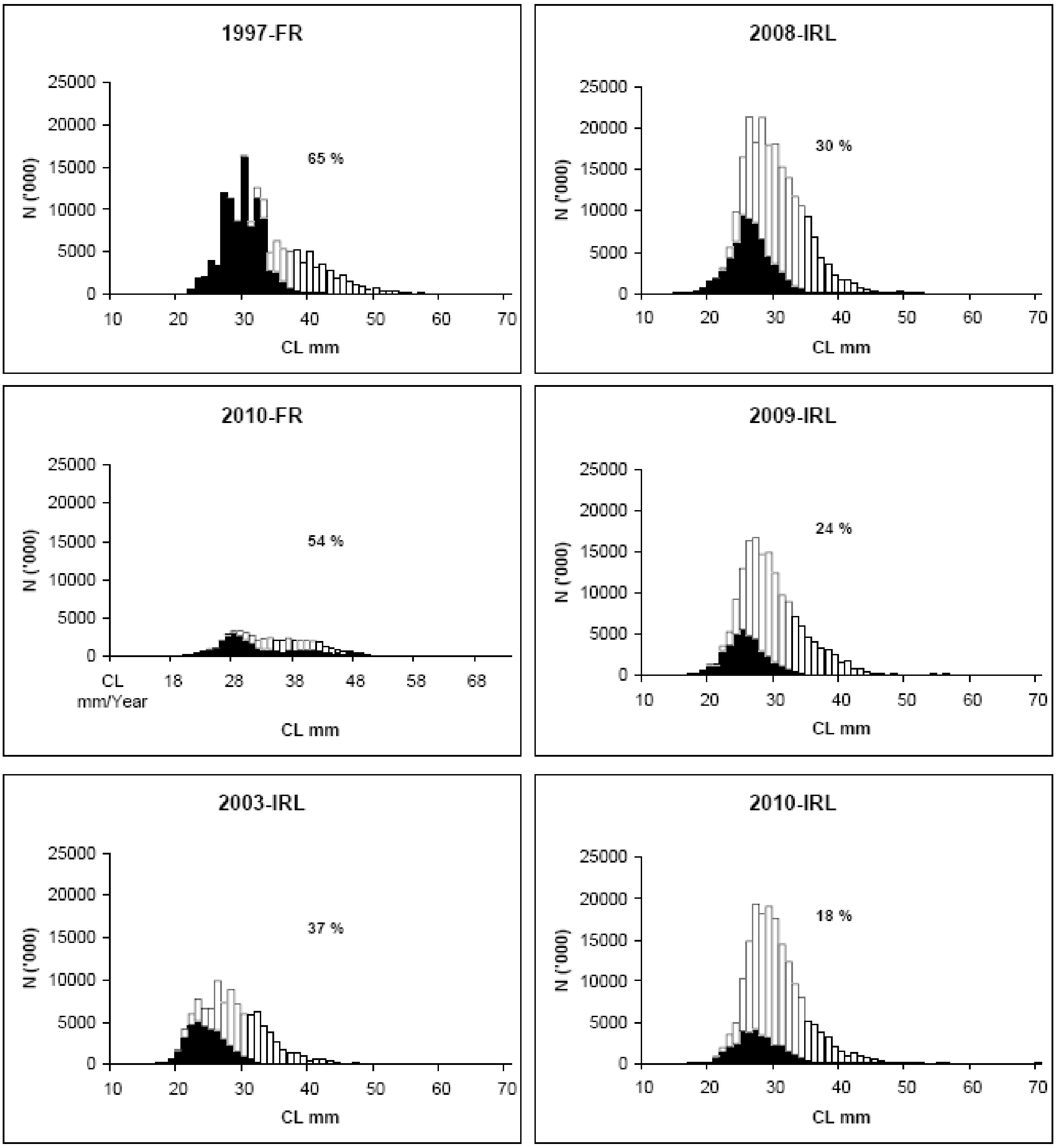



**Figure 7.7.8.** Nephrops in FU 20-22 Celtic Sea (VIIfgh).
Years with complete set of discard samples:
French data (1997 and 2010), Irish data (2003, 2008-2010).
Landings in white, discards in black.

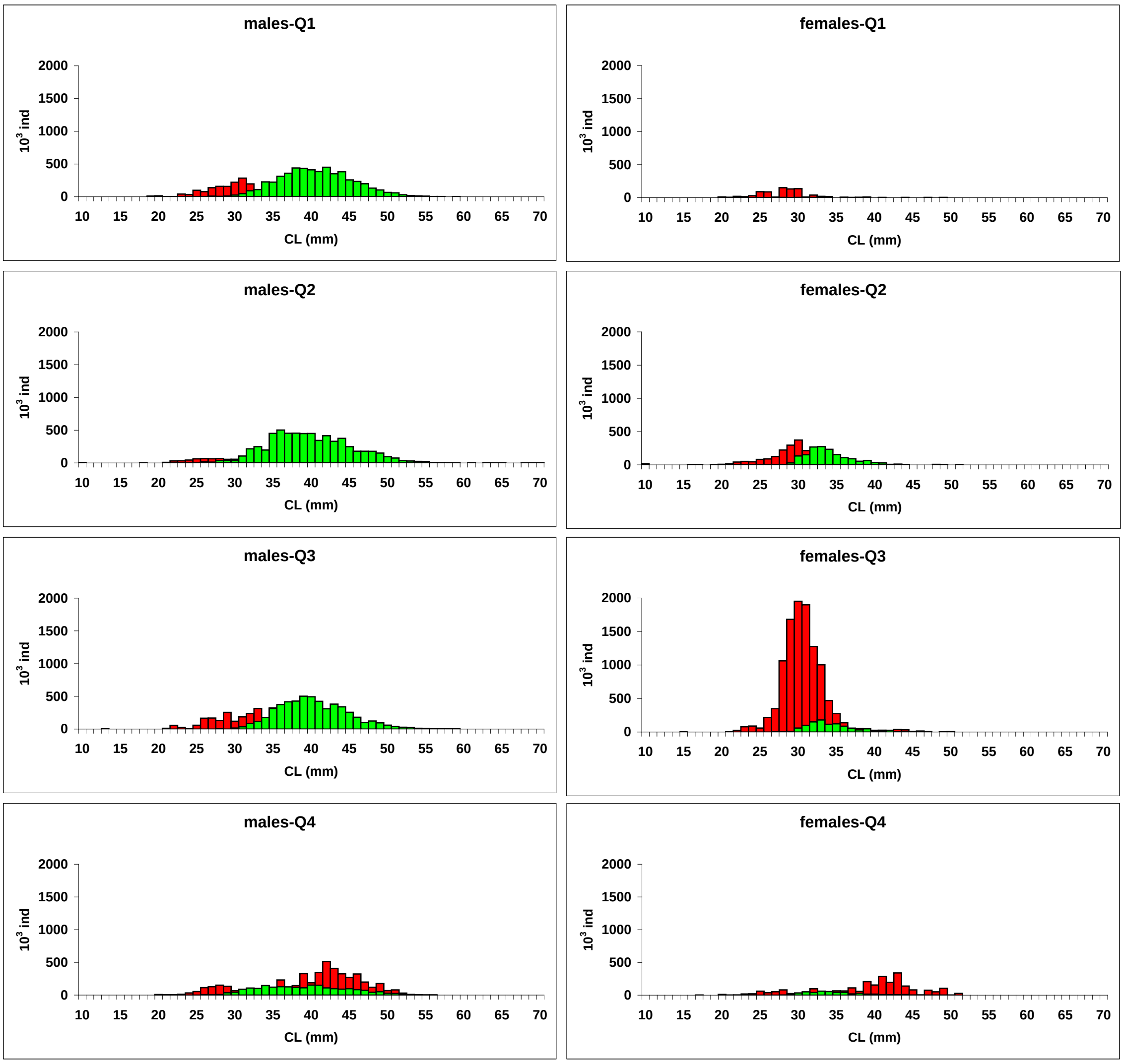



**Figure 7.7.9.** ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). Distribution of length frequencies (carapace length, CL in mm) by sex and by quarter for landings and discards of the French trawlers in 2010.**

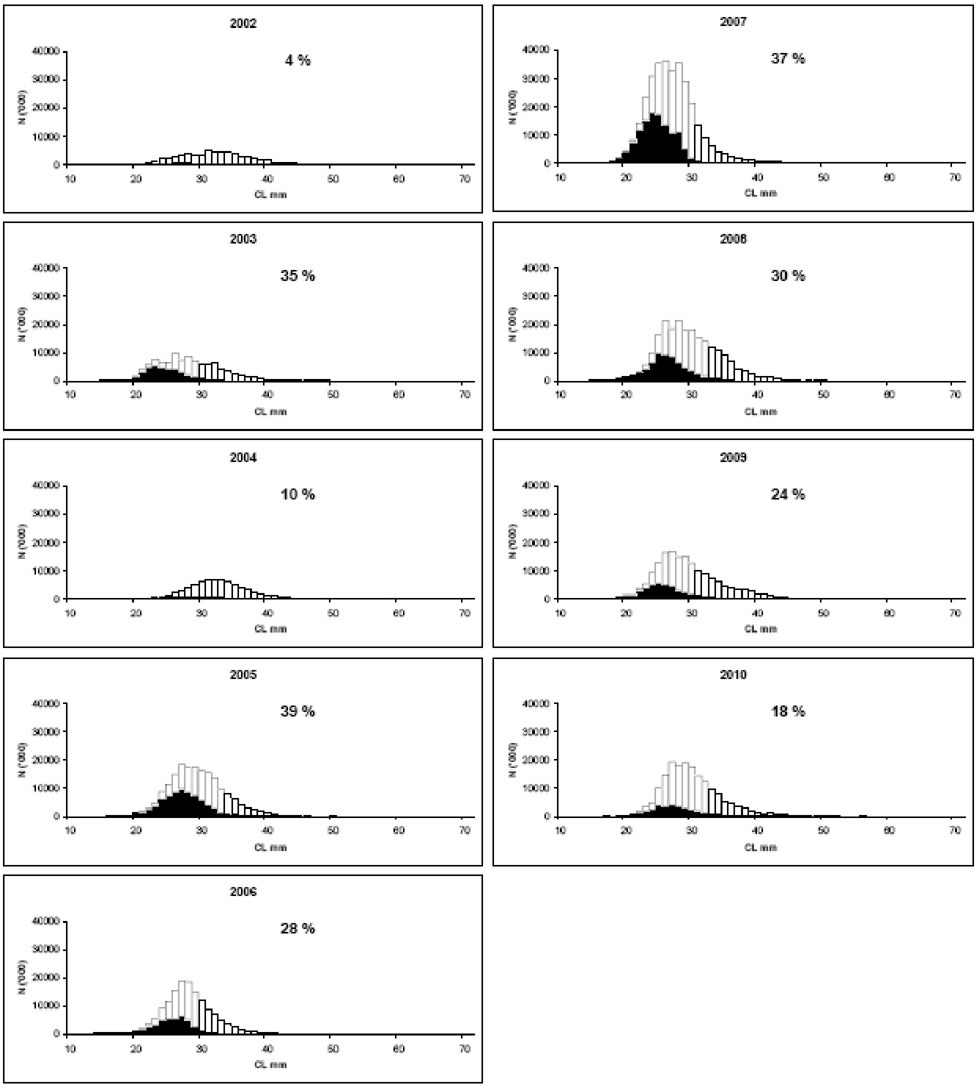



Figure 7.7.10. Nephrops in FU 20-22 Celtic Sea (VIIfgh).
Catches (landings in white and discards in black) of the Irish fleet.
Length distributions in 2002-2010.

| Ground | Year | Number of stations | Mean Density (no./m$_2$) | Domain Area (km$_2$) | Geostatistical Abundance (millions of burrows) | CV on Burrow estimate |
|---|---|---|---|---|---|---|
| | *2006 | 100 | 0.63 | 2962 | 1954 | 2% |
| | *2007 | 107 | 0.48 | 2955 | 1477 | 6% |
| | 2008 | 76 | 0.47 | 2698 | 1448 | 6% |
| | 2009 | 67 | 0.47 | 2824 | 1421 | 5% |
| Smalls | 2010 | 90 | 0.49 | 2861 | 1483 | 4% |

*Minor data revision due to transfer of survey data to SQL server.

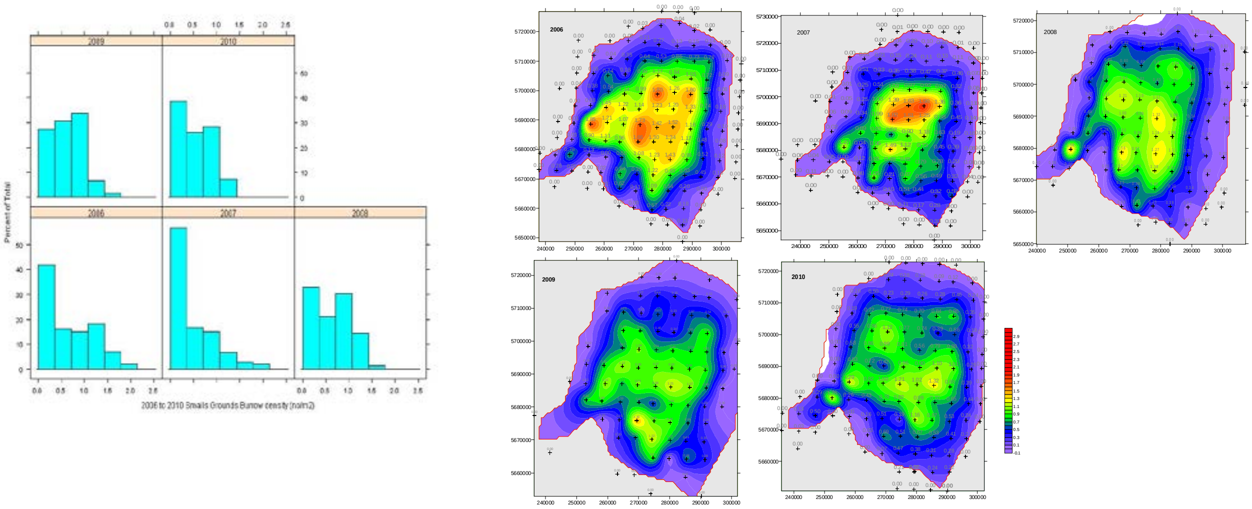
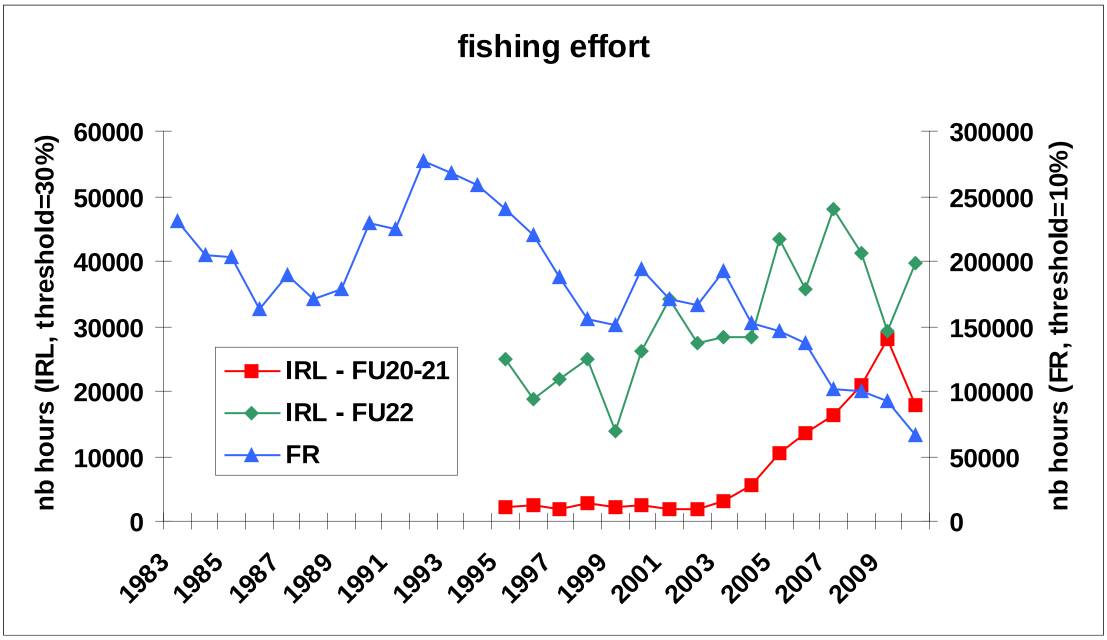



**Figure 7.7.11.** ***Nephrops*** **in the Celtic Sea (FU 20–22).Summary of geostatistics results 2006–2010 of the Irish UWTV survey carried out on the Smalls ground (FU22) and contour plots of burrow densities.**



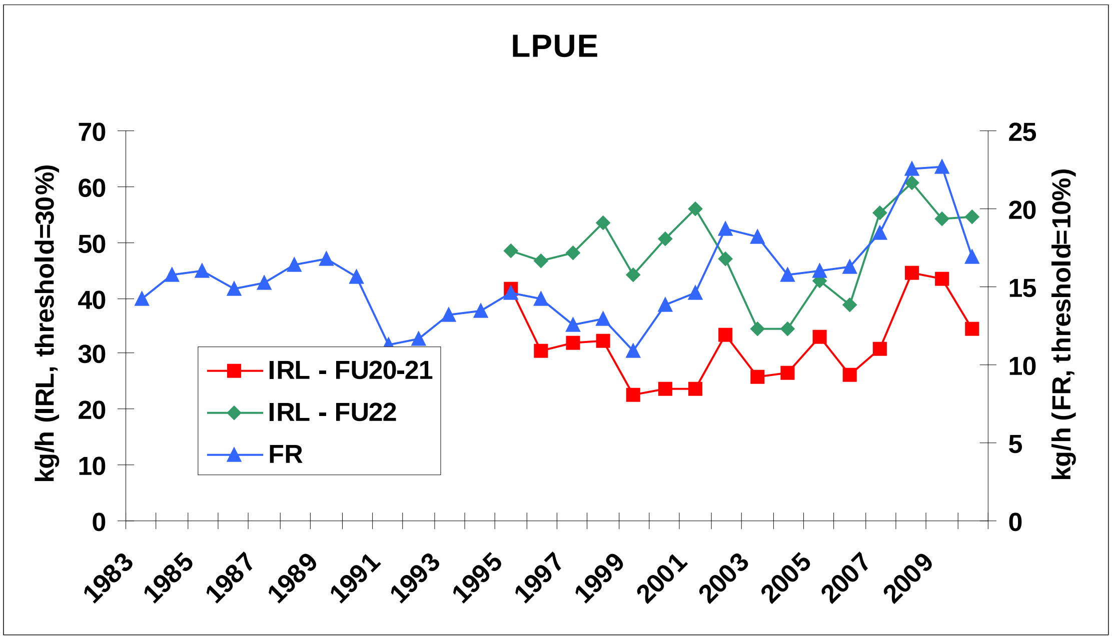




**Figure 7.7.12.** ***Nephrops*** **in VIIfgh (Celtic Sea, FU20–22). Lpue and fishing effort-series for French and Irish (inside and outside Smalls ground, FU22) fleets.**

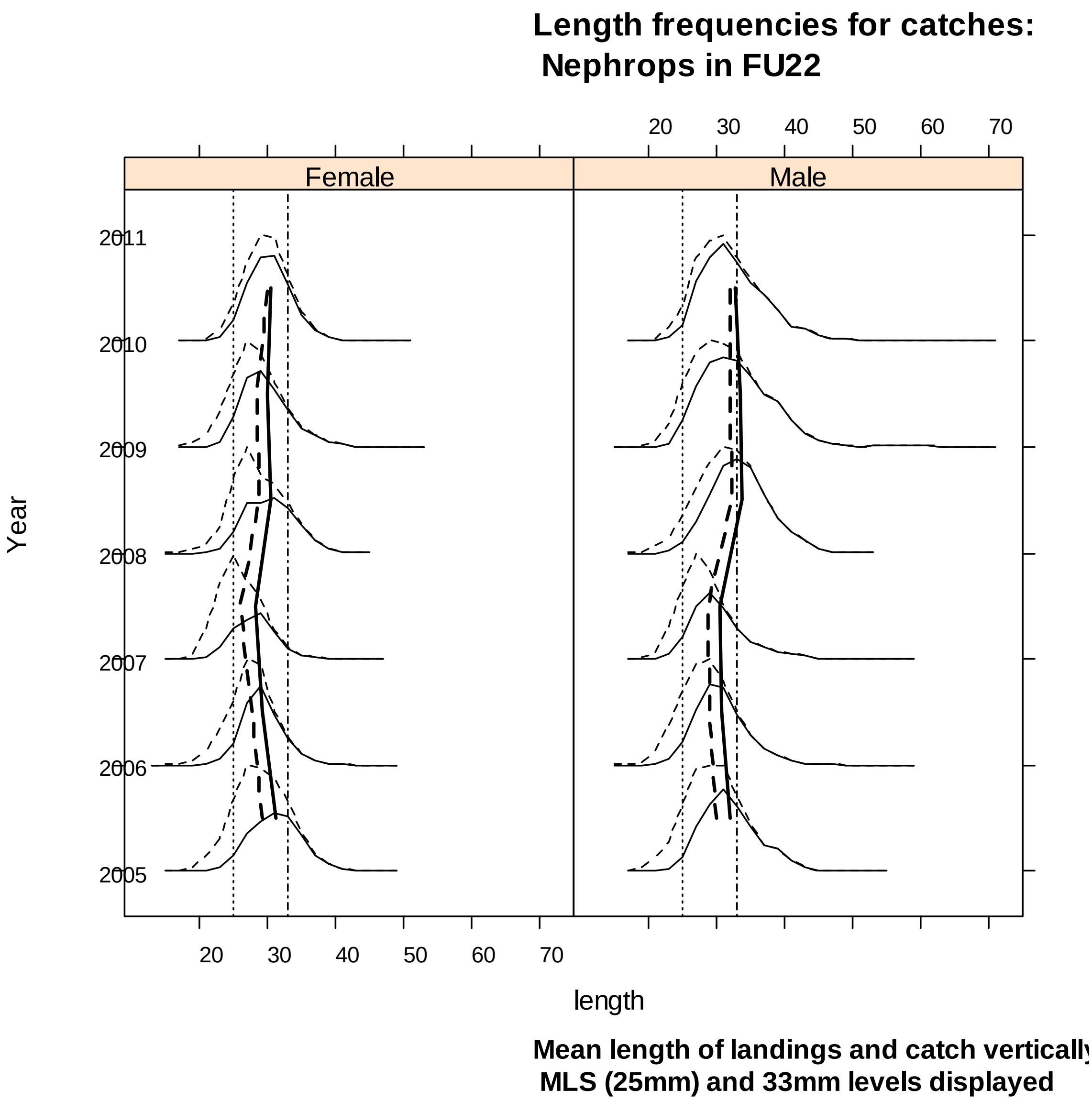



**Figure 7.7.13.** ***Nephrops*** **in the Smalls FU22. Female and Male landings length distributions for landings (solid line) and discards (dotted line) base on Irish sampling.**

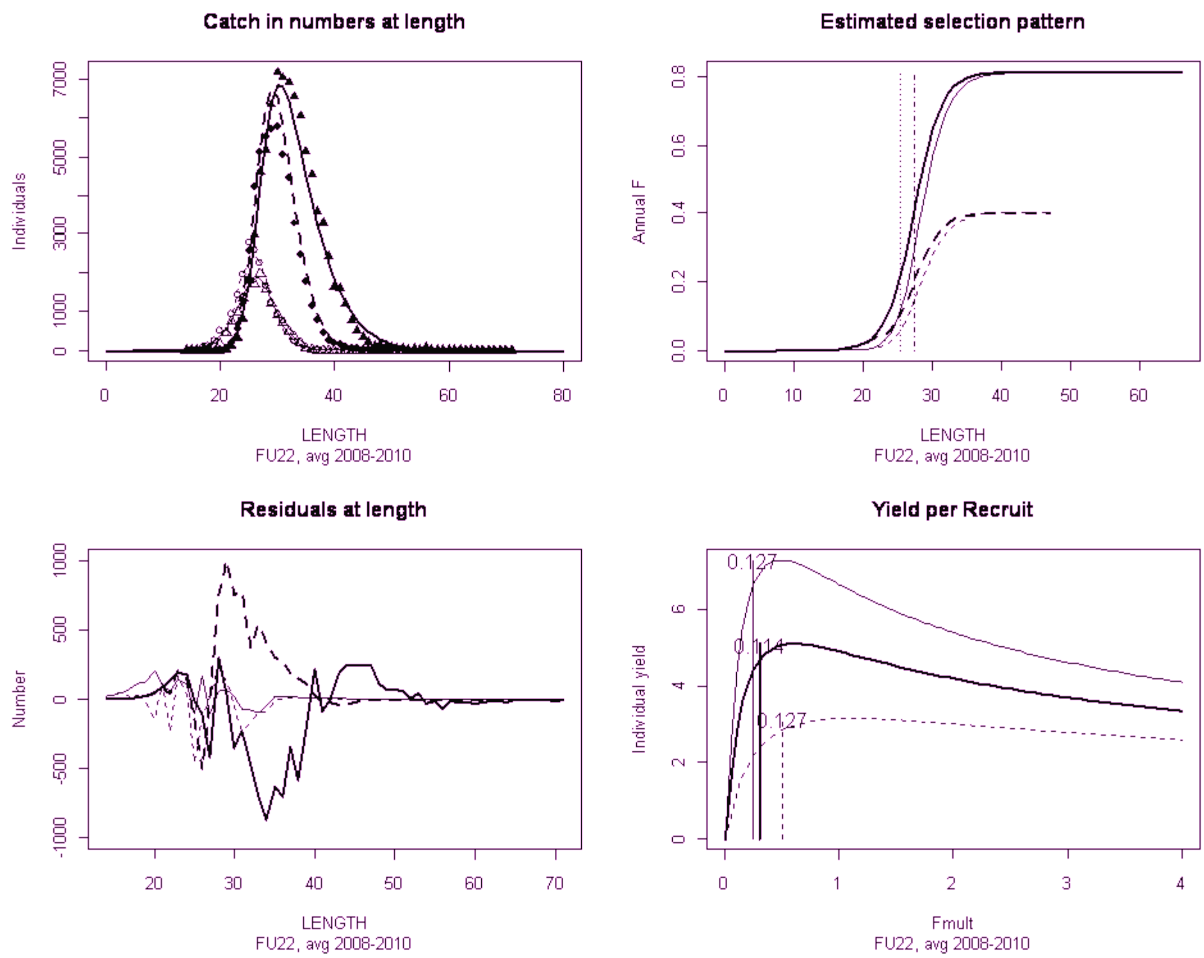



**Figure 7.7.14.** ***Nephrops*** **in the Smalls FU22. Separable Cohort Analysis model fit. Solid lines are for males, dashed lines are females, thick lines represent the landings component, the thin lines represent the discarded component. The top left panel gives observed and predicted numbers-at-length in the discards and landings, top right gives the fishing mortality-at-length with the vertical lines representing length at 25% selection and 50% selection. Bottom left shows residual numbers-(observed-expected)at-length. The bottom right gives the yield-per-recruit against fishing mortality, the thick solid line gives the combined value and vertical lines represent $F_{0.1}$ for the three curves.**

## 7.8 *Nephrops* in Divisions VIIjg (South and SW Ireland, FU19)

### Type of assessment in 2011

ICES is providing new advice for this stock this year so the Report consists of an update to available data.

### ICES advice applicable to 2010

#### Exploitation boundaries in relation to precautionary limits/considerations

*The current fishery appears sustainable. Therefore, ICES recommends that Nephrops fisheries should not be allowed to increase relative to 2007. This corresponds to landings of no more than 800 tonnes for the Ireland SW and SE Coast (FU 19).*

### ICES advice applicable to 2011

#### MSY approach

*Considering the stable lpue trend and unknown exploitation status, catches should be reduced from the recent level.*

#### PA considerations

*ICES considers that the current fishery does not appear to be detrimental to the stock and recommends that Nephrops fisheries should not be allowed to increase relative to recent landings. This corresponds to landings of no more than 800 tonnes.*

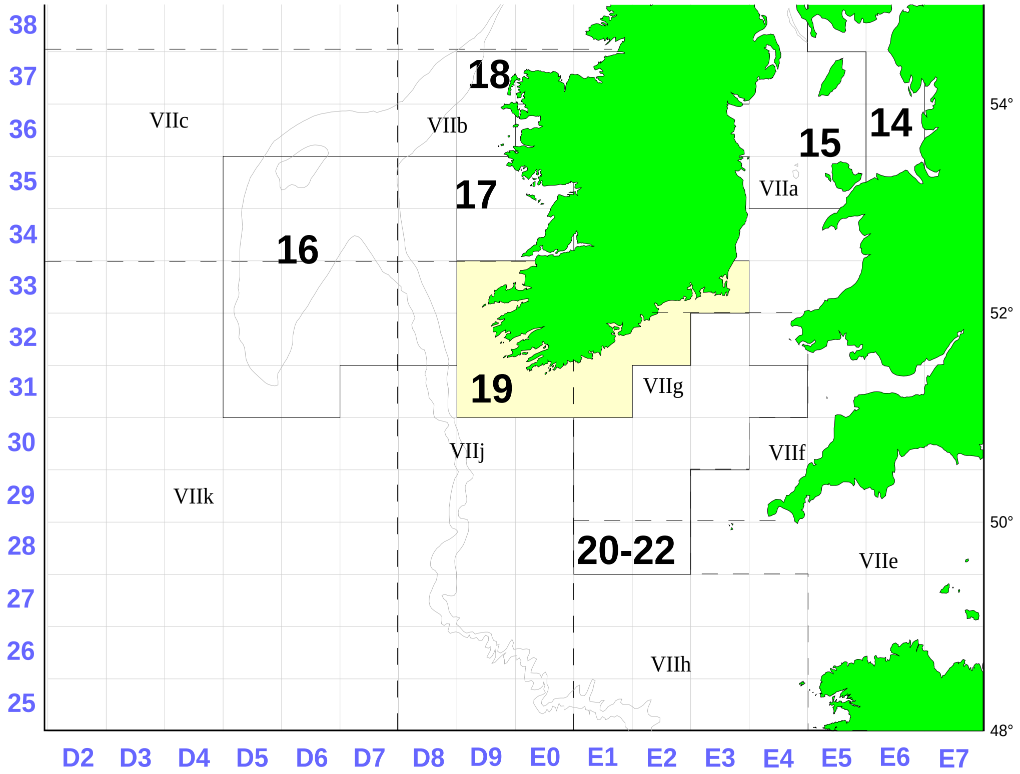
#### Policy paper

*In light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 6 because the state of the stock is unknown but advice for an appropriate catch level is available. Indicators have been stable in recent years. ICES notes that the TAC and the stock assessment areas do not match.*

### 7.8.1 General

#### Stock description and management units

In FU19 *Nephrops* are caught on a large number of spatially discrete small inshore grounds and on some larger grounds further offshore Figure 7.8.1. Of these the 'Galley ground', around the Kinsale Gas Rigs and south of Cork appear to be the most important.




A map of the spatial distribution of FU19 is given in the FU includes *Nephrops* within the following ICES statistical rectangles; 31–33 D9–E0; 31E1; 32E1–E2; 33E2–E3.

### 7.8.2 Fishery description

The number of Irish vessels reporting landings in this area has increased from 28 in 2000 to 76 in 2010. Of these, only 16 reported landings in excess of 10 t and these 16 vessels accounted for 66% of the total landings. Fleet segmentation data shows that the *Nephrops* métiers in this area also have important catches of megrim and monkfish. There are also some catches of hake and the offshore parts of FU19 which is an important nursery area for juvenile hake. The Irish fleet fishing *Nephrops* in FU19 was described in detail in the 2001 WG Report (ICES, 2001a). The minimum mesh size in use is 80 mm. French trawlers harvesting *Nephrops* on this area fish also in the Celtic Sea (FU20) and switch to the FU19 according to meteorological conditions. They have used mesh size 100 mm for codend since January 2000 (in order to not be constrained by bycatch composition) and they apply MLS of 11.5 cm (i.e. 35 mm CL) adopted by French Producers' Organizations larger than the European one (8.5 cm i.e. 25 mm CL). However, the increasing proportion of tailed individuals in French landings (as for FU20) may shift DLF for *Nephrops* to smaller sizes compared with previous years. In 2010, twelve French trawlers reported landings from FU19, but only one exceeded 5 tonnes (20 in 2009, 24 in 2008, 31 in 2007, 30 in 2006 and 35 in 2005).

### 7.8.3 Data

The sampling level for the species is given in Table 2.1.

### 7.8.4 Commercial catches and discards

Landings data for FU19 are summarized in Table 7.8.1. The Republic of Ireland, France and the UK report landings for FU19. The Republic of Ireland landings have fluctuated considerably throughout the time-series, with a marked dip in 1994 (Figure 7.8.2). The highest landings in the time-series were observed in 2002–2004 (>1000 t). Landings in 2005 and 2006 have been below average for the series. In 2010 landings decreased by approx. 13% for the Irish fleet and were below the series average. Landings by the French fleet have fluctuated with a declining trend throughout the time-series from the highest value in 1989 of 245 t to 5 t in 2010. Landings from the UK are minor.

Effort and lpue data are available for the Irish *Nephrops* directed fleet in FU19 from 1995–2010 (Table 7.8.2, Figure 7.8.3). The effort increases substantially in 2002 this is in part due to the inclusion of smaller vessels (10–18 m) in the dataset. These vessels did not record logbook operations prior 2002. The lpue and effort-series is based on the same criteria for FU16 and 17 (30% landings threshold) and will be contingent on the accuracy of landings data reported in logbooks. The lpues have fluctuated between 15–30 kg/hr with a slightly declining trend. The lpues are lower than that of other FUs reflecting the smaller size of the vessels and generally more mixed nature of this fishery.

For FU18 landings information from 1993 was available to the WG only. The Republic of Ireland has taken 100% of the landings for the last seven years. The highest reported landings were in 1994 with 124 t; landings in recent years have been minor (7 t in 2010).

### 7.8.5 Biological sampling

Length frequency data of the landings were collected on an irregular basis in the years 1996 to 1997, 1999 and 2002 to 2006. Spatial and temporal coverage is also problematic with landings from FU19 coming from several discrete grounds. In 2005 length frequency data are only available for quarters 2 and 3. The length frequencies for the remaining quarters have been derived by raising those length frequencies observed to the quarter 1 and 4 landings figures.

The dataseries of the mean sizes of *Nephrops* in the landings of Irish trawlers is too short and inconsistent to draw definite conclusions (Table 7.8.3; Figure 7.8.4). The mean size of males varied between 29 and 41 mm CL, and for females between 26 and 40 mm CL. There is a decrease in mean size for males in 2010. However, the dataseries are too short to provide useful information on the state of the stock.

It should be noted that due to the change in sampling methodology from 2001 onwards the profile of the length frequencies has changed as a result of inclusion of smaller individuals from the discard component.

### 7.8.6 Information from surveys

The UK March groundfish survey has been carried between 1984 and 2004. This survey was examined in 2006 and there is a slight indication of a decline in mean sizes of *Nephrops* compared with those observed in the late 1980s. In 2006 some UWTV stations were carried out within FU19 as part of the Celtic Sea UWTV survey (which mainly targets FU20–22). The heterogeneous distribution of *Nephrops* and sediment in FU19 will make accurate UWTV survey abundance estimate difficult to obtain on a regular basis.

### 7.8.7 Assessment

A much improved and longer historical time-series of data is needed to carry out analytical assessment of this stock. Although sampling of this stock is required under the EU data collection regulation it is difficult to obtain precise length frequency data at the spatial resolution required to assess *Nephrops* in such a heterogeneous area where several small discrete fisheries occur. Future assessments would benefit from a higher spatial resolution of landings and effort data (possibly from VMS as in Figure 7.8.1). Fishery-independent methods such as UWTV surveys may also be useful for this FU in future.

### 7.8.8 Management considerations

The time-series of lpue data based on logbook data for FU19 is short and variable but is without an obvious trend. Reported landings in 2010 have been around 18% below series average.

*Nephrops* fisheries in this area are fairly mixed also catching megrim, anglerfish and other demersal species. There are also some catches of hake, and the offshore parts of the area. The *Nephrops* grounds in FU19 coincide with an important nursery area for juvenile hake and anglerfish among other species (ICES, 2009).

ICES has repeatedly advised that management should be at a smaller scale than ICES Subarea VII. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort are at the same scale as the resource. A time-series of landings by all FUs in ICES Subarea VII together with the overall TAC is shown in Table 7.8.4. (Note that national quotas for Ireland and the UK are restrictive in most of the recent years).

### 7.8.9 References

ICES. 2009. Review of the Biologically Sensitive Area/Irish Box. http://www.ices.dk/committe/acom/comwork/report/2009/Special%20Requests/EC%20Irish%20box.pdf.

**Table 7.8.1. *Nephrops* in FU18 and FU19 (NW, SW and SE Ireland). Landings in tonnes by country and Functional Unit.**

| Year | FU 18 | | | FU 19 | | | |
|---|---|---|---|---|---|---|---|
| | Rep. of Ireland | UK | Total | France | Rep. of Ireland | UK | Total |
| 1989 | | 0 | | 245 | 652 | 2 | 899 |
| 1990 | | 0 | | 181 | 569 | 4 | 754 |
| 1991 | | 0 | | 212 | 860 | 5 | 1077 |
| 1992 | | 0 | | 233 | 640 | 15 | 888 |
| 1993 | 9 | 1 | 10 | 229 | 672 | 4 | 905 |
| 1994 | 124 | 2 | 126 | 216 | 153 | 21 | 390 |
| 1995 | 24 | 0 | 24 | 175 | 507 | 12 | 695 |
| 1996 | 46 | 1 | 46 | 145 | 736 | 7 | 888 |
| 1997 | 13 | 0 | 13 | 93 | 656 | 7 | 756 |
| 1998 | 77 | 1 | 78 | 92 | 733 | 2 | 827 |
| 1999 | 15 | 0 | 16 | 77 | 499 | 3 | 579 |
| 2000 | 9 | 0 | 9 | 144 | 541 | 11 | 696 |
| 2001 | 2 | 0 | 2 | 111 | 702 | 2 | 815 |
| 2002 | 14 | 0 | 14 | 188 | 1130 | 0 | 1318 |
| 2003 | 16 | 0 | 16 | 165 | 1075 | 0 | 1239 |
| 2004 | 22 | 0 | 22 | 76 | 997 | 1 | 1074 |
| 2005 | 15 | 0 | 15 | 62 | 648 | 2 | 711 |
| 2006 | 14 | 0 | 14 | 65 | 675 | 1 | 741 |
| 2007 | 3 | 0 | 3 | 63 | 894 | 0 | 957 |
| 2008 | 1 | 0 | 1 | 46 | 805 | 15 | 866 |
| 2009 | 14 | 0 | 14 | 55 | 764 | 15 | 833 |
| 2010 | 7 | 0 | 7 | 14 | 694 | 13 | 722 |

**Table 7.8.2. *Nephrops* in FU19 (SW and SE Ireland). Irish *Nephrops* directed effort hrs and lpue, 1993–2010.**

| Year | Irish Fleet | | |
|---|---|---|---|
| | Nephrops trawlers (>30% landings weight) | | |
| | Effort hrs | Landings Tonnes | LPUE Kg/hr |
| 1995 | 9126 | 206 | 22.5 |
| 1996 | 9295 | 220 | 23.7 |
| 1997 | 9604 | 248 | 25.8 |
| 1998 | 15775 | 386 | 24.5 |
| 1999 | 13345 | 206 | 15.4 |
| 2000 | 9329 | 178 | 19.1 |
| 2001 | 9701 | 309 | 31.8 |
| 2002 | 25565 | 764 | 29.9 |
| 2003 | 28887 | 621 | 21.5 |
| 2004 | 26554 | 529 | 19.9 |
| 2005 | 23848 | 455 | 19.1 |
| 2006 | 24272 | 460 | 19.0 |
| 2007 | 30361 | 665 | 21.9 |
| 2008 | 25101 | 573 | 22.8 |
| 2009 | 22797 | 527 | 23.1 |
| 2010 | 23650 | 467 | 19.7 |

**Table 7.8.3.** ***Nephrops*** **in FU19 (SW and SE Ireland). Mean time-series for catches and landings.**

| Year | Catches | | Landings | | | |
|---|---|---|---|---|---|---|
| | | | <35mm CL | | >35mm CL | |
| | Males | Females | Males | Females | Males | Females |
| 1995 | na | na | na | na | na | na |
| 1996 | 34.5 | 31.3 | 31.1 | 29.7 | 38.7 | 38.8 |
| 1997 | 34.6 | 32.9 | 31.2 | 30.9 | 39.8 | 38.4 |
| 1998 | na | na | na | na | na | na |
| 1999 | 38.5 | 35.4 | 31.8 | 31.2 | 41.3 | 39.1 |
| 2000 | na | na | na | na | na | na |
| 2001 | na | na | na | na | na | na |
| 2002 | 30.4 | 28.8 | 29.7 | 28.8 | 39.9 | 40.5 |
| 2003 | 33.1 | 29.4 | 31.1 | 30.0 | 38.4 | 38.0 |
| 2004 | 32.8 | 28.8 | 32.0 | 30.2 | 39.8 | 37.7 |
| 2005 | 31.3 | 27.5 | 29.1 | 26.9 | 38.4 | 37.0 |
| 2006 | 34.4 | 31.7 | 31.4 | 30.4 | 38.9 | 37.7 |
| 2007 | 35.6 | 33.2 | 32.4 | 31.7 | 39.1 | 38.2 |
| 2008 | 36.2 | 33.1 | 32.5 | 31.6 | 38.9 | 38.1 |
| 2009 | 33.9 | 29.2 | 31.2 | 29.8 | 39.3 | 37.4 |
| 2010 | 32.7 | 29.2 | 29.4 | 28.2 | 39.4 | 37.3 |

na = not available

**Table 7.8.4.** ***Nephrops*** **in VII summary table of landings by Function Unit and outside FU for TAC Area VII.**

| Year | FU 14 – Irish Sea East | FU 15 – Irish Sea West | FU 16 – Porcupine Bank | FU 17 – Aran Grounds | FU 18 – Ireland Northwest Coast | FU 19 – Ireland Southwest and Southeast coast | Fus 20+21+22 – All Celtic Sea FUs combined | Other statistical rectangles Outside FUs | Total Landings ICES Subarea VII | TAC for VII |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | 961 | 7296 | 1744 | 481 | | | | 249 | 10 730 | |
| 1979 | 900 | 8948 | 2,69 | 452 | | | | 237 | 12 807 | |
| 1980 | 730 | 4578 | 2925 | 442 | | | | 205 | 8880 | |
| 1981 | 829 | 7249 | 3381 | 414 | | | | 382 | 12 255 | |
| 1982 | 869 | 9315 | 4289 | 210 | | | | 234 | 14 917 | |
| 1983 | 763 | 9448 | 3426 | 131 | | | 3667 | 174 | 17 609 | |
| 1984 | 602 | 7760 | 3571 | 324 | | | 3653 | 187 | 16 097 | |
| 1985 | 498 | 6901 | 3919 | 207 | | | 3599 | 194 | 15 317 | |
| 1986 | 671 | 9978 | 2591 | 147 | | | 2638 | 113 | 16 138 | |
| 1987 | 449 | 9753 | 2499 | 62 | | | 3409 | 107 | 16 279 | 24 700 |
| 1988 | 462 | 8586 | 2375 | 828 | | | 3165 | 140 | 15 557 | 24 700 |
| 1989 | 401 | 8128 | 2115 | 344 | | 899 | 4005 | 134 | 16 026 | 26 000 |
| 1990 | 563 | 8300 | 1895 | 519 | | 754 | 4290 | 102 | 16 423 | 26 000 |
| 1991 | 747 | 9554 | 1640 | 410 | | 1077 | 3295 | 169 | 16 892 | 26 000 |
| 1992 | 427 | 7541 | 2015 | 372 | | 888 | 4165 | 409 | 15 816 | 20 000 |
| 1993 | 515 | 8102 | 1857 | 372 | 10 | 905 | 4648 | 455 | 16 863 | 20 000 |
| 1994 | 447 | 7606 | 2512 | 729 | 126 | 390 | 5143 | 570 | 17 523 | 20 000 |
| 1995 | 584 | 7796 | 2936 | 866 | 26 | 695 | 5,505 | 397 | 18 805 | 23 000 |
| 1996 | 475 | 7247 | 2230 | 525 | 46 | 888 | 4828 | 623 | 16 862 | 23 000 |
| 1997 | 566 | 9971 | 2409 | 841 | 15 | 756 | 4240 | 340 | 19 138 | 23 000 |
| 1998 | 388 | 9128 | 2155 | 1410 | 78 | 827 | 3925 | 514 | 18 426 | 23 000 |
| 1999 | 624 | 10 786 | 2289 | 1140 | 16 | 579 | 2943 | 322 | 18 699 | 23 000 |
| 2000 | 567 | 8370 | 911 | 880 | 9 | 696 | 4689 | 243 | 16 365 | 21 000 |
| 2001 | 532 | 7441 | 1222 | 913 | 2 | 815 | 4771 | 368 | 16 064 | 18 900 |
| 2002 | 577 | 6793 | 1327 | 1154 | 14 | 1318 | 4673 | 243 | 16 099 | 17 790 |
| 2003 | 376 | 7052 | 907 | 933 | 16 | 1239 | 5002 | 186 | 15 712 | 17 790 |
| 2004 | 472 | 7266 | 1525 | 525 | 22 | 1074 | 4268 | 161 | 15 314 | 17 450 |
| 2005 | 570 | 6529 | 2312 | 778 | 15 | 711 | 4946 | 180 | 16 042 | 19 544 |
| 2006 | 628 | 7535 | 2120 | 637 | 14 | 741 | 4264 | 270 | 16 210 | 21 498 |
| 2007 | 959 | 8424 | 2186 | 1096 | 3 | 957 | 5300 | 206 | 19 130 | 25 153 |
| 2008 | 726 | 10 482 | 1000 | 1057 | 1 | 841 | 6001 | 322 | 20 430 | 25 153 |
| 2009 | 693 | 9166 | 825 | 625 | 10 | 833 | 5359 | 107 | 17 619 | 24 650 |
| 2010 | 583 | 8929 | 917 | 1000 | 7 | 722 | 4622 | 359 | 16 602 | 22 432 |
| Average | 611 | 8241 | 2191 | 631 | 24 | 846 | 4322 | 270 | 16 171 | |

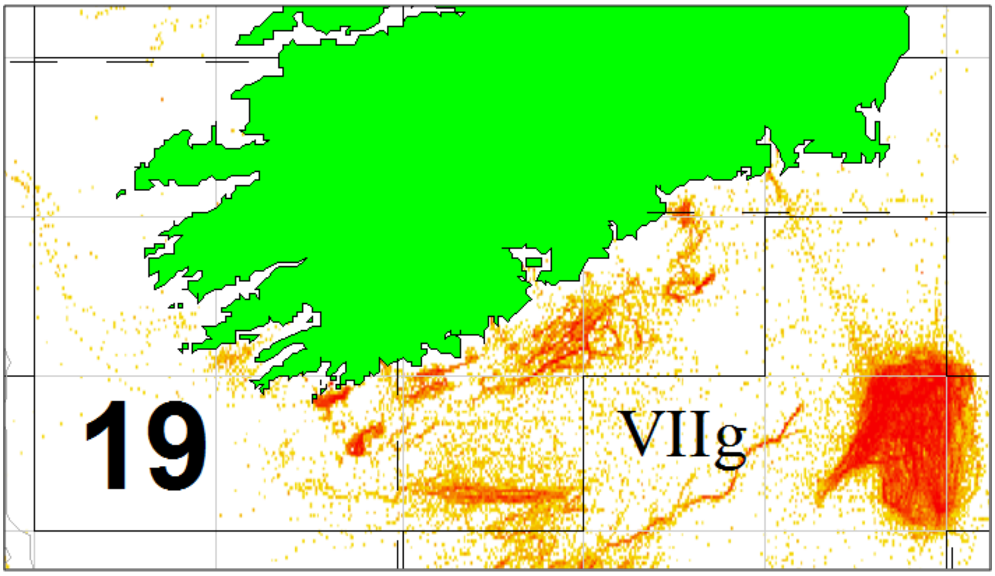



**Figure 7.8.1.** ***Nephrops*** **in FU19 (Ireland SW and SE Coast). The spatial distribution of the fishery of the Irish Fishery from VMS data.**

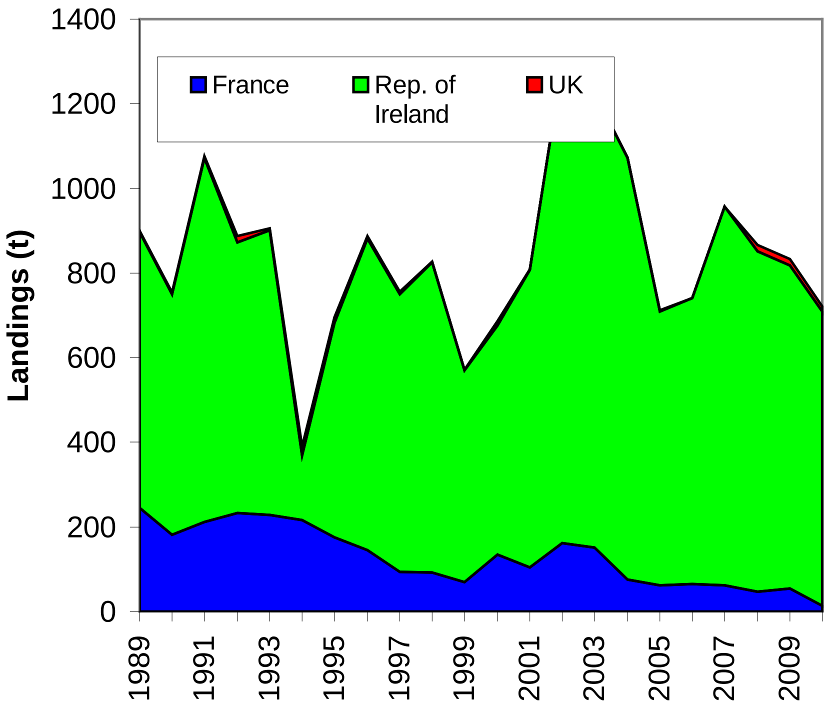



**Figure 7.8.2.** ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Landings in tonnes by country.**

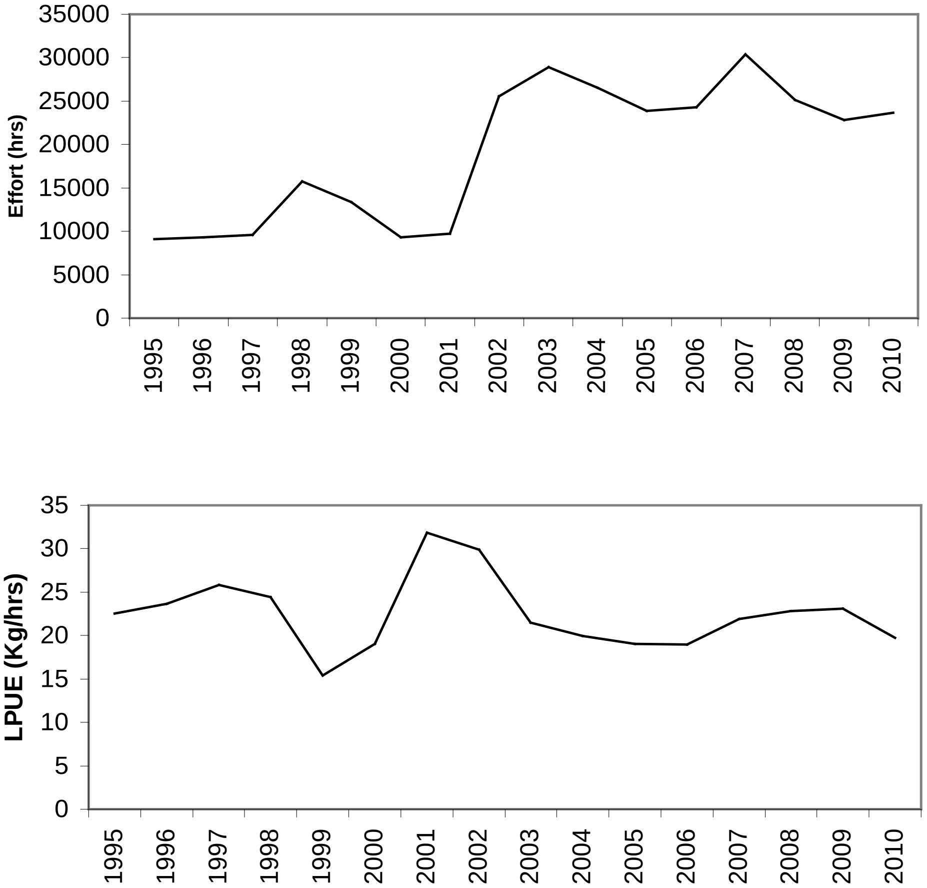



**Figure 7.8.3. *Nephrops* in FU19 (Ireland SW and SE Coast). Trawl effort for Irish OTB vessels where >30% of landed weight was *Nephrops*. Trawl lpue for Irish OTB vessels where >30% of landed weight was *Nephrops*.**

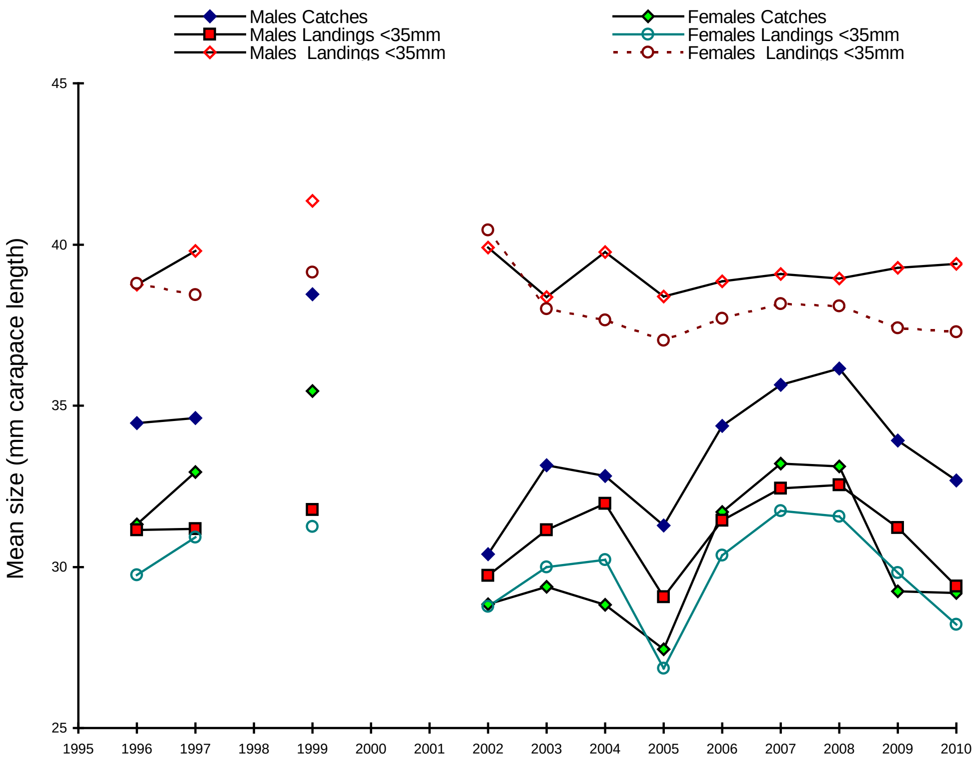



**Figure 7.8.4.** ***Nephrops*** **in FU19 (Ireland SW and SE Coast). Mean size trends for catches and whole landings by sex.**

## 7.9 Plaice in west of Ireland Division VII b, c

### Type of assessment in 2011

No assessment was performed.

### 7.9.1 General

#### Stock identity

Plaice in VIIb are mainly caught by Irish vessels on sandy grounds in coastal areas. Plaice catches in VIIc are negligible. There are two distinct areas in which plaice are caught by Irish vessels in VIIb: an area to the west of the Aran Islands and an area in the north of VIIb which extends into VIa (the Stags Ground). During 1995–2000 a large proportion of the VIIbc plaice landings were taken from the Stags Grounds (Rectangles 37D8, 37D9, 37E0 and 37E1). The landings and lpue in this area have dropped sharply since 2000, in line with a general decrease of lpue in Division VIa. The landings and lpue on the Aran grounds appear to have been more or less stable since the start of the logbooks time-series in 1995 (WD 1, WGCSE 2009). It is not known how much exchange there is between plaice on the Aran grounds and those on the Stags ground.

### 7.9.2 Data

The nominal landings are given in Table 7.9.1.

**Table 7.9.1. Landings of plaice in VIIbc as officially reported to ICES.**

| Country | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | - | - | - | - | - | - | 2 | - | - | - | - | - | - |
| France | 60 | 45 | 10 | 9 | 4 | 16 | 6 | 12 | 9 | 8.00 | 37 | 2 | 10 |
| Ireland | 124 | 106 | 153 | 133 | 135 | 122 | 117 | 142 | 135 | 122 | 108 | 110 | 150 |
| Spain | - | - | - | - | - | - | - | 65 | 58 | 22 | 7 | - | - |
| UK - Eng+Wales+N.Irl. | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - England & Wales | 1 | 1 | - | - | - | - | - | - | 4 | 4 | - | 3 | 7 |
| UK - Scotland | - | - | - | - | - | - | - | - | - | - | - | 3 | - |
| Total | 185 | 152 | 163 | 142 | 139 | 138 | 125 | 219 | 206 | 156 | 152 | 118 | 167 |

| Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | - | - | - | - | - | - | - | - | - | - | - | - | - |
| France | 11 | 13 | 9 | 1 | 11 | 9 | 3 | 2 | 1 | 5 | 1 | 3 | - |
| Ireland | 114 | 153 | 157 | 159 | 130 | 179 | 180 | 191 | 200 | 239 | 248 | 206 | 160 |
| Spain | - | - | - | - | - | - | - | - | - | - | - | - | - |
| UK - Eng+Wales+N.Irl. | . | . | . | 1 | 2 | - | 6 | 1 | 2 | 1 | 2 | - | 1 |
| UK - England & Wales | 5 | 1 | 2 | . | . | . | . | . | . | . | . | . | . |
| UK - Scotland | - | - | - | 13 | 90 | 3 | 3 | 2 | 3 | 1 | - | - | - |
| Total | 130 | 167 | 168 | 174 | 233 | 191 | 192 | 196 | 206 | 246 | 251 | 209 | 161 |

| Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | - | - | - | - | | | | | | | | |
| France | . | 31 | 8 | 17 | 7 | 14 | 12 | 11 | 12 | 9 | 7 | 6 |
| Ireland | 157 | 99 | 70 | 51 | 56 | 39 | 25 | 20 | 23 | 21 | 45 | 27 |
| Spain | - | - | - | 2 | | | | 1 | | 1 | | |
| UK - Eng+Wales+N.Irl. | - | - | - | 2 | | 0 | 0 | 0 | | | | |
| UK - England & Wales | . | . | . | . | | | | | | | | |
| UK - Scotland | 2 | - | - | - | 0 | | | | | | | |
| Total | 159 | 130 | 78 | 72 | 63 | 53 | 37 | 31.6 | 35.3 | 31 | 52 | 33 |

## 7.10 Plaice in Divisions VIIf,g (Celtic Sea)

### Type of assessment in 2011

Update of the analytic assessment used to derive relative trends (due to the short time-series of discard data) fitted by ICES WKFLAT (2011) benchmark meeting to a revised assessment data structure which includes estimates of discards-at-age.

### ICES advice applicable to 2010

*ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that a 50% reduction in F is needed to increase SSB to around Bpa in 2011. This corresponds to landings of less than 330 t in 2010.*

### ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Above | Above | Above |
| $F_{PA}/F_{lim}$ | Not defined | Not defined | Not defined |

| Spawning-stock biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | Below | Below | Below |
| $B_{PA}/B_{lim}$ | Below | Below | Between |

#### *MSY approach*

*Following the ICES MSY framework implies fishing mortality to be reduced to 0.14 (25% lower than $F_{MSY}$ because SSB is 25% below $B_{trigger}$), resulting in landings of 210 t in 2011. This is expected to lead to an SSB of 1700 t in 2012.*

*Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to ((0.8*0.44)+(0.2*0.19*0.25)) = 0.38, resulting in landings of less than 500 t in 2011. This is expected to lead to an SSB of 1500 t in 2012.*

#### *PA approach*

*Fishing mortality in 2011 should be no more than 0.10 corresponding to landings of less than 150 t in 2011. This is expected to bring SSB above $B_{pa}$ in 2012.*

### 7.10.1 General

#### Stock description and management units

A TAC is allocated to ICES Areas VIIf&g which corresponds to the stock area.

#### Management applicable to 2010 and 2011

TACs and quotas set for 2010 (source COUNCIL REGULATION (EU) No 23/2010).

Species: Plaice *Pleuronectes platessa,* Zone: VIIf and VIIg (PLE/7FG.)

| | |
|---|---|
| Belgium | 67 |
| France | 120 |
| Ireland | 201 |

| | |
|---|---|
| UK | 63 |
| Total EU | 451 |
| Total TAC | 451 |

TACs and quotas set for 2011 (source COUNCIL REGULATION (EU) No 57/2011).

Species: Plaice *Pleuronectes platessa,* Zone: VIIf and VIIg (PLE/7FG.)

| | |
|---|---|
| Belgium | 56 |
| France | 101 |
| Ireland | 200 |
| UK | 53 |
| Total EU | 410 |
| Total TAC | 410 |

#### Fishery in 2010

The main fishery is concentrated on the Trevose Head ground off the north Cornwall coast and around Land's End. Although plaice are taken throughout the year, heaviest landings are in March, after the peak of spawning, with a second peak in September. The fisheries taking plaice in the Celtic Sea mainly involve vessels from Belgium, France, England and Wales. In 2009 official statistics from France were not available; of the landings reported Belgium reported 58%, the UK 15% and Ireland 17%. In 2010 France reported 31% of the landings, Belgium 43%, the UK 12% and Ireland 14%. The WG estimated total international landings for 2010 were 433 t, below the TAC of 451 t.

Discards are a significant component of the catch and have been raised for the international fishery for the first time in this year's assessment of the stock status; the time-series is available from 2004–2010. In recent years the proportion that discards contribute to the total catch has been increasing and since 2006 they have exceeded the landings. Although the current assessment indicates a gradual decline in fishing mortality in recent years, it is unclear as to whether this is linked to the Trevose Head spring fishery closure.

### 7.10.2 Data

#### Landings

National landings data and estimates of total landings used by the WG are given in Table 7.10.1. Revisions to French landings (previously estimated) were reported for 2009.

#### Discards

Prior to 2010 indications were that discard rates, although variable, were substantial in some fleets/periods. At ICES WKFLAT (2010) meeting discard data from the countries participating in the fishery was raised and collated to the total international level for the years 2004–2010.

Discard information was available for Belgium and UK(E+W). The UK estimates were raised to incorporate equivalent levels of discards for the 'un-sampled' countries of France, Ireland and N. Ireland (on the basis of similar gear types). A raising factor based on tonnages 'landed' for these countries was calculated and applied to the UK(E+W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give total international discard numbers-at-age estimates. The total estimates (Table 7.10.1) confirm the perception of the significant level of discarding; discards have therefore been included within the assessment for the first time in the 2010 assessment. WG estimates of the combined, raised, level of discards are available from 2004, they have shown a steady increase in time to levels higher than landings since 2006; in 2007 a substantial increase occurred in the discarding by all fleets followed by a return to the previously lower levels. Data from national discard sampling programmes are summarized in Figures 7.10.3a–c.

#### Biological information

Following minor revisions to landings data for previous years (described previously), the international age compositions and landings weights-at-age have been amended.

Quarterly age compositions for 2010 were available for Belgium, Ireland and UK(E+W), representing approximately 69% of the total landings. Methods for the derivation of international catch numbers-at-age are fully described in the Stock Annex.

International landings and discard numbers-at-age in years for which both are available (2004–2010) are compared in Figure 7.10.4; in recent years discards considerably exceeds landing numbers at the majority of ages.

##### *Landings weight-at-age*

Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. WKFLAT (2011) decided not to continue with this approach, following concerns raised by WGCSE that poor fits of the quadratic smoothing curve were resulting in the youngest ages being estimated to have heavier weights than adjacent older ages. WKFLAT (2011) rejected the use of the polynomial smoother for weights-at-age and suggested that raw landings weights are used in future. Raw data back to 1995 was obtained by WKFLAT (2011) and used to update the catch weights and stock weights files (Table 7.10.6).

##### *Discard weight-at-age*

Discard weight-at-age raw data were available for Belgium and UK(E+W). UK weight-at-age data were derived from data collected for each year from 2002–2010. Belgian weight-at-age data were derived using estimates of total catch biomass and total numbers-at-age for years 2004–2010; the values were used to derive a weight-at-age matrix in grammes for an individual fish. The two national weight-at-age matrices were averaged to a total international estimates by weighting the individual weights-at-age for each year, by the catch numbers-at-age from the two countries for each year and age (Table 7.10.8).

##### *Stock weight-at-age*

For the years 2004–2010 for which discard estimates were available, a revised set of stock weights-at-age were calculated. The stock weights were derived from the total international landings weights-at-age and the discard weights-at-age averaged by numbers-at-age from the respective datasets. For the years prior to 2004, a revised set of stock weights-at-age data based on the international landings only was produced. These new values were based on the 'observed' weight data, but were SOP corrected (Table 7.10.9).

Landings and discard numbers and weights-at-age in the landings, discards and stock as used for the assessment are given in Tables 7.10.5–7.10.9. The separable assessment model fitted to estimate discards and landings mortality does not handle zero values efficiently (log zero) therefore zero numbers-at-age 1 were replaced by the value 1. This affected one discard age and age 1 for the landings. Sensitivity to the value used will be explored as the model is developed.

*Natural mortality and maturity*

The estimates of natural mortality (0.12 yr all years and all ages, from tagging studies) are based on the value estimated for Irish Sea plaice. The maturity ogive is based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

| Age | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|
| Maturity | 0 | 0.26 | 0.52 | 0.86 | 1.00 |

**Surveys**

Indices of abundance from the UK (BTS-Q3) beam trawl survey in VIIf and the Irish Celtic Explorer IBTS survey (IBTS-EA-4Q) are presented in Table 7.10.10. The UK(E&W) data indicate relatively strong 1994 and 1999 year classes. There is and indication at age 1 of a stronger year class entering the fishery but survey data at this age tend to be noisy.

The Celtic Explorer IBTS survey series started in 2003 and is not yet included in the assessment. WKFLAT (2011) noted that year effects in the survey catch rates dominate the abundance indices; year class and catch curve plots illustrated that the consistency of plaice year-class abundance estimates between ages is relatively poor (Figure 7.10.5). The survey was not fitted within the assessment model, but will be monitored for inclusion as the time-series progresses.

Figure 7.10.6 presents the log UK (BTS-Q3) cpue indices by year and year class, the log catch curves for each cohort and the gradient of the catch curves used as an indication of total mortality trends. The plots illustrate the historical consistency of year-class estimates from the survey, with less agreement in recent years.

**Commercial cpue**

Commercial tuning indices of abundance from the UK(E&W) beam trawl and otter trawl data are presented in Table 7.10.11. Figure 7.10.7 presents the log commercial cpue indices by year and year class, the log catch curves for each cohort and the gradient of the catch curves used as an indication of total mortality trends. The plots illustrates the historical consistency of year-class estimates from the commercial data throughout the time-series for the beam trawls with more noise resulting from two major year effects in the otter trawl data.

Effort and lpue data were available for the UK(E+W) beam trawl, UK(E&W) otter trawl, Irish otter trawl, beam trawl and seine fleets, Belgian beam trawl and the UK September beam trawl survey (Tables 7.10.2, 3, 4 and Figures 7.10.1 and 7.10.2).

Commercial lpue data show a general pattern of steep decline since the high levels in the early 1990s, with a further more gradual decline in recent years. There was an increase in 2007 and 2008 for beam trawlers in VIIf and a smaller increase in 2007 and 2008 for otter trawlers in VIIg east but the levels returned to the recent low levels in 2009 and 2010.

UK(E&W) beam trawl effort levels have declined in both VIIf and VIIg from the high levels observed in 1999–2001; effort in VIIf in 2008 was at the lowest level since 1984. UK(E&W) otter trawl effort levels for VIIf and VIIg have shown a general decline since 1990, increased in VIIf after 2000 and have been relatively stable since 2003.

Irish otter trawl effort has steadily increased since 1999, while beam trawl show a less-pronounced increase over the time-series prior to 2008, with a decrease in 2008 and 2009; the Irish seine fleet shows only a weak downward trend since 2003.

**Other relevant data**

Other than the rectangle closures, there were no early closures of the fishery for plaice in 2010. There is relatively little information on the level of landings misreporting on this stock, although it is not considered to be a problem. Reports from industry suggest that the main issues affecting the fishery in VIIf&g are displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W.

### 7.10.3 Stock assessment

#### Assessment model

WKFLAT (2011) agreed that the model that will be used as a temporary basis for the assessment and provision of advice for the Celtic Sea plaice is AP model (Aarts and Poos, 2009). This was selected on the basis that it was the only model available to WKFLAT which reconstructs the historic discarding rates (derived from the survey dataseries).

The AP statistical catch-at-age model allows for four types of discard selectivity pattern. Discard selectivity can be modelled as a linear function of age and or as a more flexible function of age. Two functions allow the landings and discard proportions to change in time. Although a good start, the AP model is not considered the definitive assessment structure for the Celtic Sea plaice but a temporary solution to the fitting of datasets which include recent discards estimates but for which historic discard information is not available. The model reconstructs historic discard rates as time invariant (having similar rates to those estimated for the period for which discard data are available) or using a time variant spline. Given that the spline extrapolates beyond the range of the recent data to which it is fitted it can potentially result in spurious estimates of historic discarding, which may change markedly as new discard data are added to the short time-series. In addition, it is highly likely that the discard patterns currently observed differ from those that would have been observed historically as a result of substantial changes in the composition of the gear types that have been used to prosecute the fisheries in which plaice is caught. A model which incorporates estimates of historic discards that are derived from the proportional allocation of the effort deployed by the dominant gear types is considered more appropriate in the long term.

Ideally the model with the lowest AIC would be retained for further analysis and inference of the population and fishery trends, however, the different model structures resulted in very similar fits to the data and therefore selection between the models was made on the basis of residual patterns and the perceived realism of estimated time-series of the changes in discard and landings selectivity-at-age and through time.

Models which consider the discard selection pattern to be constant in time were rejected. Discarding patterns are known to have changed as the types of gear used in the fishery have evolved. The TV_TVS model which fits a time variant selection pattern to the landings and a time variant spline for the discard selection resulted in the lowest AIC value for all of the model fits. However, examination of the fitted selection patterns established that the improvement in the fit resulted from estimates of selection at age seven that increased historically in time, independent of the adjacent ages; consequently this model was rejected as a plausible fit to the data. The remaining three models (TI_PTVS, TI_TVS and TV_PTVS), all had very similar fits in terms of the residual patterns in the fits to the data and therefore WKFLAT (2011) agreed that the TV_PTVS model which allows for variation in time in the selection patterns of both landings and discards was the most plausible model; given the known changes in gear types and discarding.

WKFLAT (2011) concluded that:

1) Due to the change in estimated fishing mortality when discards are included within the model fit, that discards should be retained within the assessment model structure.

2 ) Given that the time-series of discard data to which the models are fitted is short and that, consequently, there are likely to be changes in the management estimates as discard data are added in subsequent years, no definitive model structure can be recommended at this stage in the development process.

3 ) The most flexible of the models TVS_PTVS should be used as the basis for advice; in terms of relative changes in estimated total fishing mortality and biomass.

4 ) The other two models which provide similar structures should continue to be fitted at the WG to provide sensitivity comparisons.

5 ) As the dataseries are extended a final model selection can be then determined.

#### Comparative model runs

For each of the remaining three models (TI_PTVS, TI_TVS and TV_PTVS), Figures 7.10.8–7.10.10a present the estimated time-series of SSB, recruitment, fishing mortality, total discard and landings weight and the proportion of discards by weight. The text table below compares the log likelihood, the significance, number of observations and the Akaike Information Criteria (AICs) of the fit.

| Selection | Discards | – log.likelihood | AIC | N_param | N_obs |
|---|---|---|---|---|---|
| TI | PTVS | 191.85 | 561.71 | 89 | 488 |
| TI | TVS | 196.15 | 562.29 | 85 | 488 |
| TV | PTVS | 190.42 | 566.83 | 93 | 488 |

Consistent with the WKFLAT (2011) runs and, as would be expected from the similar log likelihood values, the models all have very similar fits in terms of the residual patterns in the fits to the data. All of the model fits indicate mostly negative residuals at oldest survey ages in the earliest part of the time-series and positive residuals in the most recent years. None of the models fit the large increase in the discard data in 2007 well; producing a very strong year effect in the discard residuals in that year and negative year effects in the adjacent years. This strong increase was observed for a number of fleets and is therefore considered to be a real effect; modelling a smooth transitions in the discard selection does not match the observed discard pattern in 2007 but does seem applicable to the other years which have reasonable fits. The fit to the landings-at-age data is reasonable apart from the first age, which is poor for all models.

Comparison of the management and stock metrics from the three model fits show very similar time-series trends and absolute values in the estimates from the three models (Figure 7.10.11), estimates from the TI models in which historic selection patterns for the landings are time invariant lie within the confidence intervals of the preferred TV model. In all model fits SSB has increased to the level at the start of the assessment time-series and total fishing mortality is gradually decreasing. The management advice that would be derived from all model fits would be similar.

#### Final assessment

The settings and data for the model fits are set out in the table below:

| Assessment year | | 2011 |
|---|---|---|
| Assessment model | | AP |
| Catch data | | Including discards 1990–2010 |
| Tuning fleets | UK(E&W)-BTSurvey | 1990–2010 ages 1–6 |
| | UK commercial beam trawl | 1990–2010 ages 4–8 |
| | UK commercial otter trawl | 1990–2010 ages 4–8 |
| | Ire GFS Q3/4 | Series omitted |
| Selectivity model | | Linear Time Varying Spline-at-age (TVS) |
| Discard fraction | | Polynomial Time Varying Spline-at-age (PTVS) |
| Landings num-at-age, range: | | 1–9+ |
| Discards num-at-age, year range, age range | | 2004–2010, ages 1–7 |

Model diagnostics are given in Table 7.10.12. Figure 7.10.10 presents the output and diagnostic plots for the "preferred" TV_PTVS model fit: the estimated time-series of SSB, recruitment, fishing mortality, total discard and landings weight and the proportion of discards by weight (Figure a); the estimated relative selection pattern (Figure b), the log survey (Figure c) and commercial fleet catchability residuals (Figures d and e) and the log residuals for the discard-at-age and landings-at-age data (Figure f). Figure 7.10.11 presents the time-series of stock and fishery metrics for the years 1997–2010 to which the model can be fitted. Tables 7.10.13 and 7.10.14 present the total fishing mortality-at-age and estimated numbers-at-age. Table 7.10.15 presents the time-series of estimates of SSB, landings, discards, total fishing mortality, landings and discard fishing mortality and recruitment.

#### State of the stock

WKFLAT (2011) concluded that the TV_PTVS model estimates should be used as the basis for advice only in terms of relative changes in estimated total fishing mortality and biomass, until the discard time-series is longer and a definitive model structure can be recommended.

On the relative scale SSB is estimated to have increased to the level of the start of the assessment time-series and total fishing mortality is gradually decreasing. Landings from the fishery have been decreasing while at the same time discarding has increased; in recent years discarding is estimated to comprise the majority of the catch of plaice in VIIfg (~60% by weight). There are indications that the most recent recruitment is strong, possibly the strongest in the short time-series.

### 7.10.4 Short-term projections

No short-term projections are presented for this stock. Catches are dominated by discards which will increase if the incoming recruitment is as substantial as indicated by surveys and the assessment fit.

### 7.10.5 Maximum sustainable yield evaluation

On the basis of the revision of the assessment data structures and model no MSY reference points are recommended for this stock they will be developed when the assessment model is developed further.

### 7.10.6 Precautionary approach reference points

On the basis of the revision of the assessment data structures and model no precautionary reference levels are suggested at this stage in the model development.

### 7.10.7 Management plans

There is no management plan for Celtic Sea plaice.

### 7.10.8 Uncertainties in assessment and forecast

#### Sampling

Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches, and associated CVs of some national catch-at-age datasets are available in the Stock Annex**.** The sampling levels for those countries supplying information are given in Table 2.1.

#### Discards

Estimates of discarding are now included in this assessment. The composition of the fleets and therefore the gear types employed in the fishery show fluctuations over time, so it is likely that the discard rates observed in the fishery now are not applicable to periods earlier in the time-series and this is incorporated within the assessment model estimation. From 2003 onwards, discard sampling for Ireland, Belgium, France and UK(E&W) has been improved under the Data Collection Regulation however only discard data from the UK and Belgium were available in a suitable form for the raising of the data to the international level.

#### Consistency

Historically the plaice in VIIfg assessment suffered from a retrospective pattern in estimated SSB, fishing mortality and recruitment, which was considered to result from the lack of discard information in the assessment. Figure 7.10.12 presents a comparison between the new assessment model estimates and the longer time-series from the previous XSA based assessment (without discards). Including discards raises the level of recruitment and fishing mortality as the 3–6 age range covers discarded ages. Spawning biomass levels in the recent years are comparable with those of the XSA assessment but historically there is a surprising difference with the AP model estimating considerably lower biomass than the previous assessment based on the landings data only; clearly this will need further investigation.

#### Misreporting

Misreporting has been considered a potential problem for this stock in earlier years. However, misreporting of catches across ICES divisions is thought to be minor.

### 7.10.9 Management considerations

Based on the historic assessment (Figure 7.10.12) the SSB of this stock is estimated to have been low since ~2000. The new assessment fit does not have the length of time-series from which to provide a historic comparison but the decrease in biomass through the time-series for which data are available is supported by the reduction in the catch rates from the survey and the commercial fleets. SSB has recently increased following a gradual reduction in total fishing mortality in recent years. Fishing mortality is estimated to be decreasing and is likely to be above the levels that would lead to high levels of biomass and yield.

The high level of discarding indicated for some fleets in this fishery indicates that there is a mismatch between the mesh size employed in the fishery and the size of the fish being landed on the market. Increases in the mesh size of the gear should result in lower fishing mortality levels, fewer discards and ultimately, in increased yield from the fishery. The results of studies presented to the 2004 WG (ICES, 2004) indicate that this would also benefit the sole VIIf,g stock without decreasing sole landings in the long term.

#### Regulations and their effects

Technical measures in force for this stock are minimum mesh sizes, minimum landing size, and restricted areas for certain classes of vessels. Technical regulations regarding allowable mesh sizes for specific target species, and associated minimum landing sizes, came into force on 1 January 2000 (Section 2.1). The minimum landing size for plaice in Divisions VIIf,g is currently 27 cm.

Since 2005, ICES rectangles 30E4, 31E4, and 32E3 have been closed during the first quarter with the intention of reducing fishing mortality on cod. There is evidence that this closure has redistributed effort to other areas. Many vessels (particularly beam trawlers from the UK and Belgium) fished close to the borders of the closed rectangles during the closure, and fished intensively inside the rectangles when they were reopened. Information from the UK shows that plaice can be caught in areas outside the closed area with the same catch rates. Fishing mortality has decreased since 2005, and the closure may have been one of the contributing factors.

**Table 7.10.1. Plaice in Divisions VIIf&g, Nominal landings (t) as reported to ICES, and total landings as used by the working group.**

| | 1977 | 1978 | 1979 | 1980 | | |
|---|---|---|---|---|---|---|
| Belgium | 214 | 196 | 171 | 372 | | |
| UK (Engl. & Wales) | 150 | 152 | 176 | 227 | | |
| France | 365 | 527 | 467 | 706 | | |
| Ireland | 28 | 0 | 49 | 61 | | |
| Scotland | 0 | 0 | 0 | 7 | N/A | Not available |
| Total | 757 | 875 | 863 | 1373 | | |
| Discards | N/A | N/A | N/A | N/A | | |
| Unallocated | 0 | 0 | 0 | 0 | | |
| Landings used by WG | 757 | 875 | 863 | 1373 | | |
| Catch as used by WG | N/A | N/A | N/A | N/A | | |

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 365 | 341 | 314 | 283 | 357 | 665 | 581 | 617 | 843 | 794 |
| UK (Engl. & Wales) | 251 | 196 | 279 | 366 | 466 | 529 | 496 | 629 | 471 | 497 |
| France | 697 | 568 | 532 | 558 | 493 | 878 | 708 | 721 | 1089 | 767 |
| Ireland | 64 | 198 | 48 | 72 | 91 | 302 | 127 | 226 | 180 | 160 |
| N. Ireland | | | | | | | | 1 | | |
| Netherlands | | | | | | 9 | | | | |
| Scotland | 0 | 0 | 0 | 0 | 0 | 1 | | | | 1 |
| Total | 1377 | 1303 | 1173 | 1279 | 1407 | 2384 | 1912 | 2194 | 2583 | 2219 |
| Discards | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Unallocated | 0 | 0 | -27 | -69 | 345 | -693 | -11 | -78 | -432 | -137 |
| Landings used by WG | 1377 | 1303 | 1146 | 1210 | 1752 | 1691 | 1901 | 2116 | 2151 | 2082 |
| Catch as used by WG | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 836 | 371 | 542 | 350 | 346 | 410 | 594 | 540 | 371 | 224 |
| UK (Engl. & Wales) | 392 | 302 | 290 | 251 | 284 | 239 | 258 | 176 | 170 | 134 |
| France | 444 | 504 | 373 | 298 | 254 | 246 | 329 | 298 | | 287 |
| Ireland | 155 | 180 | 89 | 82 | 70 | 83 | 78 | 135 | 115 | 76 |
| Scotland | | 5 | 9 | 1 | 2 | | | | | |
| Total reported | 1827 | 1362 | 1303 | 982 | 956 | 978 | 1259 | 1149 | 656 | 721 |
| Discards | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Unallocated | -326 | -174 | -189 | 88 | 72 | -26 | -42 | -82 | 312 | -3 |
| Landings used by WG | 1501 | 1188 | 1114 | 1070 | 1028 | 952 | 1217 | 1067 | 968 | 718 |
| Catch as used by WG | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 241 | 248 | 221 | 212 | 168 | 172 | 194 | 187 | 216 | 188 |
| UK (Engl. & Wales) | 136 | 105 | 127 | 87 | 55 | 88 | 61 | 63 | 55 | 54 |
| France | 262 | 186 | 165 | 145 | 132 | 106 | 104 | 62 | N/A | 136 |
| Ireland | 45 | 79 | 51 | 45 | 44 | 48 | 58 | 63 | 63 | 63 |
| Total reported | 684 | 618 | 564 | 489 | 399 | 414 | 417 | 375 | N/A | 442 |
| Discards | N/A | N/A | N/A | 247 | 309 | 451 | 1283 | 580 | 604 | 700 |
| Unallocated | 30 | 24 | 30 | 21 | -13 | -10 | -7 | 62 | N/A | -9 |
| Landings used by WG | 714 | 642 | 594 | 510 | 386 | 404 | 410 | 437 | 463 | 433 |
| Catch as used by WG | N/A | N/A | N/A | 757 | 695 | 855 | 1693 | 1017 | 1067 | 1133 |

**Table 7.10.2. Plaice in Divisions VIIf&g: lpue for UK(E&W) fleets.**

| | LANDINGS PER UNIT EFFORT (LPUE) | | | | | | LANDINGS/EFFORT DATA | | | | ADDITIONAL EFFORT DATA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RECT. GROUP VIIf (grp 1) | | RECT. GROUP VIIg EAST (grp 2) | | RECT. GROUP VIIg WEST (grp 3) | | RECT GROUP VIIf (grp1) | | | | VIIg (East) | | VIIg (West) | |
| | | | | | | | otter trawl catch | | Beam trawl catch | | Otter | Beam | Otter | Beam |
| YEAR | TRAWL | BEAM TRAWL | TRAWL | BEAM TRAWL | TRAWL | BEAM TRAWL | tonnes | 000s hr fished | tonnes | 000s hr fished | 000s hr fished | 000s hr fished | 000s hr fished | 000s hr fished |
| 1972 | 7.70 | | 4.97 | | 1.15 | | 361.82 | 45.72 | | | 6.01 | | 0.74 | |
| 1973 | 7.54 | | 2.75 | | 34.92 | | 353.95 | 45.28 | | | 3.59 | | 0.05 | |
| 1974 | 4.99 | | 1.22 | | 0.00 | | 198.12 | 38.94 | | | 2.03 | | 0.00 | |
| 1975 | 4.88 | | 4.07 | | 0.75 | | 173.01 | 33.53 | | | 10.35 | | 0.04 | |
| 1976 | 4.54 | | 2.70 | | 2.13 | | 112.09 | 25.61 | | | 5.21 | | 0.04 | |
| 1977 | 4.06 | | 1.76 | | 0.00 | | 102.81 | 27.16 | | | 5.36 | | 0.04 | |
| 1978 | 4.19 | 3.06 | 2.24 | 0.00 | 0.00 | 0.00 | 117.74 | 27.08 | 7.58 | 2.50 | 6.73 | 0.00 | 0.00 | 0.00 |
| 1979 | 5.31 | 3.62 | 3.34 | 2.19 | 0.00 | 0.00 | 125.81 | 23.84 | 6.30 | 1.96 | 4.54 | 0.13 | 0.00 | 0.00 |
| 1980 | 5.91 | 4.27 | 4.03 | 7.15 | 2.46 | 0.00 | 162.29 | 26.43 | 17.65 | 4.31 | 2.67 | 0.10 | 0.60 | 0.00 |
| 1981 | 5.36 | 3.50 | 3.20 | 3.13 | 1.05 | 5.23 | 126.27 | 24.10 | 23.72 | 6.24 | 7.78 | 0.78 | 4.78 | 0.10 |
| 1982 | 4.82 | 5.10 | 1.14 | 6.73 | 0.06 | 5.57 | 92.65 | 19.20 | 55.42 | 9.95 | 7.50 | 1.86 | 2.56 | 0.58 |
| 1983 | 6.05 | 3.92 | 2.66 | 5.24 | 0.00 | 4.88 | 108.76 | 17.61 | 47.72 | 12.35 | 5.33 | 6.82 | 0.00 | 0.80 |
| 1984 | 6.15 | 6.41 | 4.90 | 7.49 | 0.00 | 4.14 | 160.64 | 23.16 | 99.01 | 13.55 | 4.35 | 4.31 | 0.00 | 2.06 |
| 1985 | 6.98 | 6.38 | 5.09 | 8.05 | 2.61 | 7.10 | 188.06 | 25.24 | 146.73 | 18.69 | 5.72 | 5.14 | 0.57 | 1.41 |
| 1986 | 6.62 | 5.22 | 4.28 | 10.62 | 1.44 | 11.31 | 142.84 | 21.18 | 90.44 | 20.72 | 7.72 | 4.31 | 0.82 | 0.68 |
| 1987 | 6.60 | 4.32 | 6.46 | 10.79 | 0.86 | 10.66 | 199.03 | 24.43 | 145.37 | 38.76 | 9.87 | 4.83 | 0.83 | 0.92 |
| 1988 | 10.04 | 8.53 | 7.32 | 9.95 | 1.97 | 14.42 | 205.56 | 20.09 | 204.58 | 25.62 | 9.96 | 2.18 | 0.43 | 0.88 |
| 1989 | 7.40 | 5.63 | 6.36 | 9.67 | 4.35 | 16.42 | 130.67 | 17.61 | 96.05 | 20.26 | 8.13 | 3.72 | 0.25 | 0.26 |
| 1990 | 4.16 | 3.93 | 2.43 | 6.80 | 2.70 | 5.34 | 97.82 | 22.56 | 157.15 | 30.77 | 10.55 | 4.89 | 0.45 | 4.32 |
| 1991 | 2.87 | 3.58 | 2.22 | 2.83 | 1.17 | 2.94 | 56.52 | 18.57 | 193.27 | 40.81 | 6.25 | 12.39 | 0.91 | 2.52 |
| 1992 | 2.78 | 2.26 | 2.32 | 2.54 | 1.68 | 2.08 | 44.82 | 16.00 | 91.34 | 35.78 | 5.22 | 16.61 | 8.42 | 2.59 |
| 1993 | 2.72 | 2.84 | 1.43 | 2.28 | 1.77 | 1.41 | 38.14 | 13.79 | 107.43 | 39.64 | 4.43 | 18.44 | 0.94 | 2.73 |
| 1994 | 2.71 | 2.47 | 2.18 | 3.07 | 0.83 | 4.14 | 23.36 | 9.48 | 84.97 | 37.03 | 3.03 | 9.48 | 0.24 | 1.94 |
| 1995 | 2.93 | 2.66 | 2.23 | 3.34 | 3.35 | 2.22 | 26.38 | 8.46 | 96.28 | 37.59 | 2.61 | 11.60 | 0.46 | 2.16 |
| 1996 | 2.63 | 2.05 | 1.91 | 1.84 | 0.38 | 0.77 | 23.60 | 8.67 | 81.18 | 39.78 | 4.60 | 8.70 | 1.68 | 3.91 |
| 1997 | 2.41 | 1.90 | 1.89 | 2.33 | 1.30 | 0.48 | 20.47 | 8.14 | 83.68 | 43.00 | 5.18 | 12.67 | 1.90 | 2.56 |
| 1998 | 1.59 | 1.54 | 1.24 | 0.93 | 0.33 | 0.69 | 10.94 | 7.13 | 85.06 | 47.84 | 5.09 | 10.45 | 1.55 | 2.81 |
| 1999 | 2.59 | 1.63 | 1.99 | 0.67 | 0.35 | 0.68 | 11.99 | 5.69 | 85.44 | 50.87 | 1.97 | 26.00 | 3.86 | 5.47 |
| 2000 | 2.29 | 1.00 | 3.10 | 0.68 | 0.19 | 0.60 | 10.98 | 4.05 | 53.46 | 51.19 | 2.56 | 17.53 | 2.34 | 3.36 |
| 2001 | 2.25 | 1.07 | 2.53 | 0.87 | 0.32 | 0.68 | 9.78 | 4.42 | 53.31 | 49.32 | 2.71 | 19.95 | 2.68 | 1.55 |
| 2002 | 1.31 | 1.14 | 3.70 | 1.49 | 0.54 | 0.27 | 6.81 | 6.10 | 37.93 | 37.53 | 1.54 | 6.19 | 2.49 | 0.93 |
| 2003 | 1.67 | 1.17 | 0.82 | 1.25 | 0.29 | 0.09 | 15.83 | 9.94 | 47.73 | 40.71 | 0.55 | 11.87 | 1.73 | 2.40 |
| 2004 | 1.28 | 1.16 | 0.93 | 0.51 | 0.18 | 0.22 | 12.44 | 9.42 | 40.06 | 32.37 | 3.03 | 14.25 | 2.03 | 2.42 |
| 2005 | 0.81 | 0.75 | 0.13 | 0.51 | 0.01 | 0.07 | 9.5 | 12.09 | 22.25 | 27.73 | 0.30 | 9.57 | 2.35 | 1.67 |
| 2006 | 1.53 | 0.88 | 0.47 | 0.91 | 0.05 | 0.03 | 19.78 | 12.97 | 13.99 | 18.57 | 0.31 | 10.48 | 3.47 | 1.16 |
| 2007 | 1.07 | 1.95 | 1.45 | 0.85 | 0.1 | 0.56 | 11.85 | 10.66 | 18.10 | 15.37 | 0.41 | 6.79 | 3.49 | 0.19 |
| 2008 | 1.27 | 2.95 | 1.69 | 0.8 | 0.01 | 0.1 | 13.21 | 10.13 | 18.80 | 13.83 | 1.58 | 3.84 | 3.65 | 0.08 |
| 2009 | 1.02 | 1.39 | 0.81 | 1.07 | 0.09 | 0.09 | 8.23 | 8.97 | 24.31 | 12.31 | 3.43 | 3.54 | 4.38 | 0.71 |
| 2010 | 1.03 | 1.86 | 0.98 | 1.1 | 0.02 | 0.07 | 7.65 | 7.62 | 19.63 | 14.44 | 1.19 | 4.47 | 7.43 | 1.62 |

**Table 7.10.3. Plaice in Divisions VIIfg: lpue and effort for Belgian fleets in VIIf,g.**

| | BELGIAN Beam Trawl VIIfg | | |
|---|---|---|---|
| Year | Landings (t) | Effort (000 hr) | LPUE (kg/h) |
| 1996 | 356.89 | 53.27 | 6.70 |
| 1997 | 474.71 | 57.36 | 8.28 |
| 1998 | 443.38 | 57.79 | 7.67 |
| 1999 | 410.22 | 55.11 | 7.44 |
| 2000 | 230.63 | 51.34 | 4.49 |
| 2001 | 274.84 | 54.90 | 5.01 |
| 2002 | 259.80 | 49.60 | 5.24 |
| 2003 | 215.95 | 62.73 | 3.44 |
| 2004 | 207.27 | 78.73 | 2.63 |
| 2005 | 153.73 | 64.50 | 2.38 |
| 2006 | 134.44 | 50.28 | 2.67 |
| 2007 | 139.39 | 45.72 | 3.05 |
| 2008 | 106.29 | 28.71 | 3.70 |
| 2009 | 140.76 | 30.84 | 4.56 |
| 2010 | 127.15 | 32.74 | 3.88 |

**Table 7.10.4. Plaice in Divisions VIIfg: lpue and effort for Irish otter trawl, beam and seine fleets in VIIg.**

| | IR-OTB-7G | | | IR-SCC-7G | | |
|---|---|---|---|---|---|---|
| Year | Landings (t) | Effort (000 hr) | LPUE (kg/h) | Landings (t) | Effort (000 hr) | LPUE (kg/h) |
| 1995 | 94.23 | 63.56 | 1.48 | 9.55 | 6.43 | 1.49 |
| 1996 | 133.66 | 60.04 | 2.23 | 14.20 | 9.73 | 1.46 |
| 1997 | 119.84 | 65.10 | 1.84 | 38.79 | 16.13 | 2.40 |
| 1998 | 96.72 | 72.30 | 1.34 | 21.38 | 14.94 | 1.43 |
| 1999 | 60.05 | 51.66 | 1.16 | 10.40 | 8.01 | 1.30 |
| 2000 | 28.78 | 60.60 | 0.47 | 11.40 | 9.90 | 1.15 |
| 2001 | 23.82 | 69.43 | 0.34 | 10.93 | 16.33 | 0.67 |
| 2002 | 42.30 | 77.69 | 0.54 | 16.42 | 20.86 | 0.79 |
| 2003 | 26.35 | 86.79 | 0.30 | 13.80 | 20.91 | 0.66 |
| 2004 | 26.62 | 96.99 | 0.27 | 5.04 | 19.38 | 0.26 |
| 2005 | 22.78 | 124.40 | 0.18 | 6.47 | 14.81 | 0.44 |
| 2006 | 25.17 | 119.23 | 0.21 | 5.10 | 14.79 | 0.34 |
| 2007 | 30.99 | 136.52 | 0.23 | 4.76 | 15.82 | 0.30 |
| 2008 | 39.17 | 125.81 | 0.31 | 8.38 | 11.65 | 0.72 |
| 2009 | 43.81 | 137.11 | 0.32 | 7.98 | 8.19 | 0.98 |
| 2010 | 44.29 | 140.65 | 0.31 | 10.71 | 9.69 | 1.11 |

| | IR-TBB-7G | | |
|---|---|---|---|
| Year | Landings (t) | Effort (000 hr) | LPUE (kg/h) |
| 1995 | 37.92 | 20.78 | 1.83 |
| 1996 | 53.02 | 26.76 | 1.98 |
| 1997 | 94.59 | 28.25 | 3.35 |
| 1998 | 122.13 | 35.25 | 3.46 |
| 1999 | 25.80 | 40.87 | 0.63 |
| 2000 | 12.62 | 37.03 | 0.34 |
| 2001 | 4.80 | 39.71 | 0.12 |
| 2002 | 7.08 | 31.62 | 0.22 |
| 2003 | 9.37 | 49.26 | 0.19 |
| 2004 | 6.17 | 54.86 | 0.11 |
| 2005 | 9.49 | 49.65 | 0.19 |
| 2006 | 14.46 | 60.48 | 0.24 |
| 2007 | 21.18 | 55.86 | 0.38 |
| 2008 | 14.18 | 37.22 | 0.38 |
| 2009 | 6.96 | 37.96 | 0.18 |
| 2010 | 6.56 | 40.22 | 0.16 |

**Table 7.10.5. Plaice in Divisions VIIf&g: Landings numbers-at-age.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Landings numbers at age Numbers*10**-3

| AGE\YEAR | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 |
| 2 | 989 | 851 | 877 | 1921 |
| 3 | 426 | 903 | 673 | 1207 |
| 4 | 411 | 291 | 638 | 658 |
| 5 | 105 | 136 | 72 | 146 |
| 6 | 72 | 76 | 70 | 21 |
| 7 | 37 | 47 | 34 | 16 |
| 8 | 59 | 23 | 8 | 16 |
| +gp | 75 | 98 | 46 | 32 |
| TOTALNUM | 2175 | 2426 | 2419 | 4018 |

| AGE\YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 822 | 300 | 750 | 704 | 1461 | 703 | 434 | 967 | 797 | 164 |
| 3 | 2111 | 1180 | 560 | 918 | 2503 | 2595 | 1883 | 2099 | 3550 | 2078 |
| 4 | 681 | 955 | 827 | 343 | 393 | 1332 | 1812 | 1568 | 1807 | 2427 |
| 5 | 109 | 443 | 372 | 373 | 102 | 156 | 772 | 612 | 741 | 655 |
| 6 | 54 | 86 | 92 | 209 | 177 | 59 | 156 | 413 | 160 | 242 |
| 7 | 53 | 51 | 44 | 70 | 62 | 48 | 22 | 65 | 98 | 86 |
| 8 | 11 | 14 | 27 | 41 | 25 | 32 | 125 | 16 | 24 | 70 |
| +gp | 44 | 60 | 23 | 42 | 38 | 24 | 76 | 73 | 23 | 46 |
| TOTALNUM | 3886 | 3090 | 2696 | 2701 | 4762 | 4950 | 5281 | 5814 | 7201 | 5769 |

| AGE\YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 25 | 100 | 43 | 0 | 8 | 17 | 22 | 19 |
| 2 | 279 | 800 | 1019 | 428 | 488 | 812 | 420 | 426 | 243 | 320 |
| 3 | 1072 | 526 | 1179 | 936 | 572 | 734 | 1318 | 921 | 982 | 606 |
| 4 | 1193 | 357 | 284 | 730 | 743 | 515 | 929 | 849 | 802 | 482 |
| 5 | 578 | 471 | 139 | 164 | 334 | 219 | 272 | 287 | 372 | 203 |
| 6 | 179 | 275 | 185 | 117 | 117 | 137 | 121 | 96 | 116 | 145 |
| 7 | 94 | 80 | 115 | 86 | 57 | 59 | 60 | 82 | 45 | 53 |
| 8 | 78 | 21 | 62 | 92 | 48 | 37 | 20 | 39 | 27 | 22 |
| +gp | 79 | 96 | 59 | 65 | 132 | 96 | 82 | 56 | 69 | 32 |
| TOTALNUM | 3553 | 2627 | 3066 | 2716 | 2534 | 2609 | 3231 | 2773 | 2678 | 1881 |

| AGE\YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 75 | 3 | 15 | 6 | 24 | 12 | 8 | 15 | 2 | 0 |
| 2 | 651 | 170 | 239 | 126 | 201 | 331 | 130 | 270 | 127 | 134 |
| 3 | 371 | 661 | 571 | 578 | 327 | 458 | 513 | 341 | 626 | 224 |
| 4 | 323 | 543 | 465 | 428 | 265 | 140 | 340 | 443 | 345 | 428 |
| 5 | 199 | 183 | 150 | 261 | 134 | 134 | 104 | 145 | 273 | 189 |
| 6 | 108 | 113 | 85 | 46 | 73 | 76 | 76 | 47 | 68 | 150 |
| 7 | 62 | 65 | 34 | 27 | 24 | 50 | 46 | 29 | 20 | 44 |
| 8 | 23 | 24 | 26 | 15 | 14 | 12 | 26 | 11 | 10 | 8 |
| +gp | 28 | 28 | 24 | 17 | 16 | 15 | 13 | 15 | 12 | 8 |
| TOTALNUM | 1838 | 1789 | 1608 | 1504 | 1078 | 1229 | 1257 | 1315 | 1485 | 1187 |

**Table 7.10.6. Plaice in Divisions VIIf&g: Landings weights-at-age.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Landings weights at age (kg)

| AGE\YEAR | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|
| 1 | 0.078 | 0.194 | 0.076 | 0.118 |
| 2 | 0.205 | 0.258 | 0.203 | 0.238 |
| 3 | 0.323 | 0.323 | 0.325 | 0.354 |
| 4 | 0.43 | 0.389 | 0.44 | 0.467 |
| 5 | 0.528 | 0.457 | 0.55 | 0.576 |
| 6 | 0.615 | 0.525 | 0.652 | 0.682 |
| 7 | 0.693 | 0.595 | 0.749 | 0.784 |
| 8 | 0.76 | 0.666 | 0.839 | 0.882 |
| +gp | 0.8762 | 0.8435 | 1.0653 | 1.1812 |
| SOPCOFAC | 1.0052 | 1.0262 | 1.0225 | 1.0135 |

| AGE\YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.185 | 0.151 | 0.178 | 0.276 | 0.135 | 0 | 0.129 | 0.26 | 0.102 | 0.24 |
| 2 | 0.255 | 0.245 | 0.274 | 0.324 | 0.251 | 0.16 | 0.208 | 0.288 | 0.176 | 0.27 |
| 3 | 0.33 | 0.339 | 0.369 | 0.384 | 0.363 | 0.301 | 0.288 | 0.325 | 0.255 | 0.309 |
| 4 | 0.412 | 0.433 | 0.464 | 0.455 | 0.47 | 0.434 | 0.368 | 0.37 | 0.337 | 0.358 |
| 5 | 0.5 | 0.526 | 0.559 | 0.538 | 0.572 | 0.559 | 0.449 | 0.423 | 0.423 | 0.416 |
| 6 | 0.595 | 0.62 | 0.654 | 0.633 | 0.67 | 0.677 | 0.53 | 0.484 | 0.514 | 0.483 |
| 7 | 0.695 | 0.714 | 0.749 | 0.739 | 0.763 | 0.787 | 0.612 | 0.554 | 0.608 | 0.56 |
| 8 | 0.802 | 0.808 | 0.844 | 0.857 | 0.851 | 0.889 | 0.694 | 0.633 | 0.706 | 0.646 |
| +gp | 1.1824 | 1.0948 | 1.1579 | 1.2661 | 1.0036 | 1.1033 | 0.8632 | 0.8887 | 0.9932 | 0.9097 |
| SOPCOFAC | 1.0042 | 1.0125 | 0.9995 | 1 | 1.0047 | 0.9997 | 1.0034 | 1.0024 | 1.0006 | 1.0009 |

| AGE\YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.2 | 0.148 | 0.171 | 0.236 | 0.219 | 0 | 0.249 | 0.213 | 0.213 | 0.245 |
| 2 | 0.26 | 0.257 | 0.263 | 0.296 | 0.254 | 0.247 | 0.291 | 0.256 | 0.268 | 0.26 |
| 3 | 0.327 | 0.362 | 0.314 | 0.308 | 0.304 | 0.295 | 0.304 | 0.317 | 0.278 | 0.302 |
| 4 | 0.4 | 0.464 | 0.405 | 0.397 | 0.364 | 0.349 | 0.357 | 0.38 | 0.332 | 0.37 |
| 5 | 0.481 | 0.563 | 0.5 | 0.455 | 0.485 | 0.512 | 0.466 | 0.463 | 0.44 | 0.479 |
| 6 | 0.567 | 0.658 | 0.598 | 0.598 | 0.603 | 0.553 | 0.663 | 0.604 | 0.538 | 0.539 |
| 7 | 0.661 | 0.75 | 0.643 | 0.801 | 0.714 | 0.523 | 0.745 | 0.661 | 0.618 | 0.672 |
| 8 | 0.761 | 0.839 | 0.728 | 0.728 | 0.752 | 0.947 | 0.877 | 0.69 | 0.839 | 0.875 |
| +gp | 1.0465 | 1.0399 | 0.9886 | 0.9585 | 1.0655 | 1.0667 | 1.1007 | 1.1886 | 1.1906 | 1.2018 |
| SOPCOFAC | 1.0113 | 1.0022 | 0.9997 | 1.0001 | 1.0004 | 0.9998 | 1.0002 | 1.0009 | 1 | 1.0007 |

| AGE\YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.268 | 0.246 | 0.205 | 0.221 | 0.237 | 0.238 | 0.278 | 0.26 | 0.279 | 0.233 |
| 2 | 0.305 | 0.284 | 0.295 | 0.258 | 0.26 | 0.246 | 0.271 | 0.273 | 0.267 | 0.292 |
| 3 | 0.34 | 0.281 | 0.321 | 0.287 | 0.295 | 0.291 | 0.277 | 0.298 | 0.275 | 0.331 |
| 4 | 0.398 | 0.343 | 0.353 | 0.33 | 0.356 | 0.339 | 0.303 | 0.329 | 0.329 | 0.329 |
| 5 | 0.466 | 0.433 | 0.439 | 0.382 | 0.425 | 0.385 | 0.389 | 0.386 | 0.376 | 0.376 |
| 6 | 0.556 | 0.484 | 0.502 | 0.514 | 0.525 | 0.513 | 0.457 | 0.433 | 0.469 | 0.459 |
| 7 | 0.675 | 0.541 | 0.651 | 0.649 | 0.631 | 0.549 | 0.537 | 0.511 | 0.499 | 0.599 |
| 8 | 0.695 | 0.859 | 0.681 | 0.75 | 0.714 | 0.638 | 0.547 | 0.719 | 0.605 | 0.472 |
| +gp | 1.0905 | 1.1262 | 1.0389 | 0.9919 | 1.0163 | 0.8369 | 0.9862 | 0.9042 | 0.7197 | 1.0441 |
| SOPCOFAC | 1.0007 | 1.0004 | 0.9994 | 1.0007 | 1.0011 | 1.0008 | 1.0005 | 1.0001 | 0.9993 | 1.0002 |

**Table 7.10.7. Plaice in Divisions VIIf&g: Discard numbers-at-age.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Discard numbers at age Numbers*10**-3

| AGE\YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 448 | 536 | 542 | 1828 | 72 | 668 | 1504 |
| 2 | 0 | 0 | 0 | 327 | 1141 | 2584 | 3330 | 3580 | 982 | 2544 |
| 3 | 0 | 0 | 0 | 548 | 423 | 750 | 3408 | 630 | 2035 | 301 |
| 4 | 0 | 0 | 0 | 155 | 111 | 74 | 814 | 391 | 758 | 486 |
| 5 | 0 | 0 | 0 | 63 | 38 | 47 | 81 | 69 | 398 | 231 |
| 6 | 0 | 0 | 0 | 3 | 11 | 12 | 32 | 4 | 44 | 30 |
| 7 | 0 | 0 | 0 | 3 | 4 | 1 | 11 | 1 | 4 | 1 |
| 8 | 0 | 0 | 0 | 1 | 22 | 1 | 9 | 1 | 5 | 1 |
| +gp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTALNUM | 0 | 0 | 0 | 1548 | 2286 | 4011 | 9513 | 4748 | 4894 | 5098 |
| TONSLAND | 0 | 0 | 0 | 247 | 309 | 451 | 1283 | 580 | 604 | 700 |
| SOPCOF % | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 7.10.8. Plaice in Divisions VIIf&g: Discard weights-at-age.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Discardss weights at age (kg)

| AGE\YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0.123 | 0.094 | 0.065 | 0.088 | 0.083 | 0.088 | 0.1 |
| 2 | 0 | 0 | 0 | 0.152 | 0.128 | 0.107 | 0.126 | 0.11 | 0.127 | 0.144 |
| 3 | 0 | 0 | 0 | 0.177 | 0.157 | 0.152 | 0.158 | 0.155 | 0.127 | 0.174 |
| 4 | 0 | 0 | 0 | 0.195 | 0.19 | 0.172 | 0.162 | 0.169 | 0.127 | 0.172 |
| 5 | 0 | 0 | 0 | 0.214 | 0.231 | 0.179 | 0.21 | 0.221 | 0.14 | 0.174 |
| 6 | 0 | 0 | 0 | 0.253 | 0.433 | 0.35 | 0.21 | 0.247 | 0.186 | 0.206 |
| 7 | 0 | 0 | 0 | 0.133 | 0.634 | 0.35 | 0.414 | 0.2 | 0.182 | 0.267 |
| 8 | 0 | 0 | 0 | 0 | 0.418 | 0 | 0.437 | 0.217 | 0.2 | 0.221 |
| +gp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.10.9. Plaice in Divisions VIIf&g: Stock weights-at-age.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Stock weights at age (kg)

| YEAR | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|
| 1 | 0.112 | 0.086 | 0.107 | 0.109 |
| 2 | 0.216 | 0.170 | 0.212 | 0.217 |
| 3 | 0.315 | 0.252 | 0.313 | 0.322 |
| 4 | 0.406 | 0.334 | 0.412 | 0.426 |
| 5 | 0.492 | 0.414 | 0.507 | 0.528 |
| 6 | 0.570 | 0.493 | 0.599 | 0.628 |
| 7 | 0.642 | 0.570 | 0.689 | 0.727 |
| 8 | 0.707 | 0.646 | 0.775 | 0.823 |
| +gp | 0.839 | 0.822 | 1.015 | 1.132 |

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.082 | 0.096 | 0.103 | 0.256 | 0.075 | 0.000 | 0.089 | 0.249 | 0.066 | 0.228 |
| 2 | 0.167 | 0.192 | 0.206 | 0.298 | 0.193 | 0.087 | 0.168 | 0.273 | 0.139 | 0.254 |
| 3 | 0.257 | 0.288 | 0.307 | 0.352 | 0.307 | 0.232 | 0.248 | 0.305 | 0.215 | 0.288 |
| 4 | 0.350 | 0.383 | 0.408 | 0.418 | 0.417 | 0.369 | 0.328 | 0.346 | 0.295 | 0.332 |
| 5 | 0.447 | 0.479 | 0.507 | 0.495 | 0.521 | 0.498 | 0.408 | 0.395 | 0.380 | 0.386 |
| 6 | 0.548 | 0.574 | 0.606 | 0.584 | 0.621 | 0.619 | 0.489 | 0.453 | 0.468 | 0.448 |
| 7 | 0.653 | 0.668 | 0.704 | 0.685 | 0.717 | 0.733 | 0.571 | 0.518 | 0.560 | 0.520 |
| 8 | 0.762 | 0.763 | 0.801 | 0.797 | 0.808 | 0.839 | 0.653 | 0.593 | 0.657 | 0.602 |
| +gp | 1.129 | 1.049 | 1.114 | 1.190 | 0.965 | 1.064 | 0.822 | 0.837 | 0.938 | 0.854 |

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.173 | 0.092 | 0.171 | 0.236 | 0.219 | 0.000 | 0.249 | 0.213 | 0.213 | 0.245 |
| 2 | 0.229 | 0.203 | 0.263 | 0.296 | 0.254 | 0.247 | 0.291 | 0.256 | 0.268 | 0.260 |
| 3 | 0.293 | 0.310 | 0.314 | 0.308 | 0.304 | 0.295 | 0.304 | 0.317 | 0.278 | 0.302 |
| 4 | 0.363 | 0.414 | 0.405 | 0.397 | 0.364 | 0.349 | 0.357 | 0.380 | 0.332 | 0.370 |
| 5 | 0.440 | 0.514 | 0.500 | 0.455 | 0.485 | 0.512 | 0.466 | 0.463 | 0.440 | 0.479 |
| 6 | 0.523 | 0.611 | 0.598 | 0.598 | 0.603 | 0.553 | 0.663 | 0.604 | 0.538 | 0.539 |
| 7 | 0.613 | 0.705 | 0.643 | 0.801 | 0.714 | 0.523 | 0.745 | 0.661 | 0.618 | 0.672 |
| 8 | 0.710 | 0.795 | 0.728 | 0.728 | 0.752 | 0.947 | 0.877 | 0.690 | 0.839 | 0.875 |
| +gp | 0.987 | 1.000 | 0.989 | 0.959 | 1.066 | 1.067 | 1.101 | 1.189 | 1.191 | 1.202 |

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.268 | 0.246 | 0.205 | 0.221 | 0.237 | 0.238 | 0.278 | 0.260 | 0.279 | 0.233 |
| 2 | 0.305 | 0.284 | 0.295 | 0.258 | 0.260 | 0.246 | 0.271 | 0.273 | 0.267 | 0.292 |
| 3 | 0.340 | 0.281 | 0.321 | 0.287 | 0.295 | 0.291 | 0.277 | 0.298 | 0.275 | 0.331 |
| 4 | 0.398 | 0.343 | 0.353 | 0.330 | 0.356 | 0.339 | 0.303 | 0.329 | 0.329 | 0.329 |
| 5 | 0.466 | 0.433 | 0.439 | 0.382 | 0.425 | 0.385 | 0.389 | 0.386 | 0.376 | 0.376 |
| 6 | 0.556 | 0.484 | 0.502 | 0.514 | 0.525 | 0.513 | 0.457 | 0.433 | 0.469 | 0.459 |
| 7 | 0.675 | 0.541 | 0.651 | 0.649 | 0.631 | 0.549 | 0.537 | 0.511 | 0.499 | 0.599 |
| 8 | 0.695 | 0.859 | 0.681 | 0.750 | 0.714 | 0.638 | 0.547 | 0.719 | 0.605 | 0.472 |
| +gp | 1.091 | 1.126 | 1.039 | 0.992 | 1.016 | 0.837 | 0.986 | 0.904 | 0.720 | 1.044 |

**Table 7.10.10. Plaice in Divisions VIIf&g: Survey abundance indices (figures used in the assessment shown in bold).**

```
IRGFS
2003 2010
1 1 0.79 0.92
2 7
832   45    84    37    8     3     1
980   6     31    51    20    13    1
845   63    83    19    9     3     3
1046  105   80    22    18    11    12
1168  51    166   68    22    9     8
1139  113   106   72    19    8     5
1018  199   548   247   100   21    16
1381  871   304   479   197   84    23
```

**E+W BT Survey**

**1990 2010**

**1 1 0.75 0.85**

**0 10**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **69.86** | 12 | **161** | **215** | **64** | **15** | **6** | **0** | 0 | 2 | 0 | 1 |
| **123.41** | 2 | **841** | **33** | **65** | **21** | **12** | **3** | 0 | 1 | 0 | 0 |
| **125.08** | 3 | **487** | **307** | **13** | **5** | **15** | **2** | 5 | 0 | 0 | 2 |
| **127.67** | 4 | **120** | **107** | **44** | **2** | **5** | **1** | 1 | 0 | 0 | 0 |
| **120.82** | 144 | **127** | **40** | **20** | **11** | **1** | **0** | 0 | 0 | 0 | 0 |
| **114.9** | 1.18 | **275.26** | **103.33** | **19.17** | **3.4** | **7.86** | **1.77** | 0 | 0 | 1.95 | 0 |
| **118.6** | 9.6 | **265.28** | **341.68** | **36.5** | **1.17** | **3.11** | **0.95** | 0 | 0 | 0 | 0 |
| **114.9** | 8 | **258.92** | **117.34** | **39.68** | **4.88** | **2.03** | **1.92** | 0.98 | 0 | 0 | 0 |
| **114.9** | 5.73 | **272.51** | **145.01** | **53.99** | **10.25** | **2.3** | **1.11** | 0 | 0 | 0 | 1.05 |
| **118.6** | 192.35 | **180.96** | **94.43** | **34.42** | **23.33** | **8.3** | **0** | 0 | 2.01 | 0 | 0 |
| **118.6** | 100.48 | **402.77** | **74.92** | **37.06** | **7.78** | **6.52** | **0** | 1.05 | 0 | 0 | 0 |
| **118.6** | 42.17 | **250.76** | **185.17** | **18.75** | **10.37** | **5.02** | **4.02** | 1.96 | 0 | 0 | 0 |
| **118.6** | 1.11 | **162.16** | **207.68** | **95.41** | **7.03** | **7.27** | **2.41** | 4.17 | 1 | 0 | 0 |
| **118.6** | 72.02 | **116.66** | **95.45** | **72.29** | **25.89** | **3.22** | **2.05** | 1 | 1.05 | 2.17 | 0 |
| **114.9** | 188.27 | **296.99** | **38.39** | **31.11** | **15.42** | **2.52** | **1.11** | 1.11 | 2.85 | 0 | 2.23 |
| **118.6** | 3.08 | **228.29** | **89.2** | **24.74** | **9.55** | **12.96** | **2.98** | 0.95 | 0 | 0 | 0.99 |
| **118.6** | 95.51 | **101.72** | **120.93** | **40.51** | **11.34** | **2.12** | **10.71** | 0 | 2.94 | 0.93 | 0 |
| **118.6** | 41.3 | **178.36** | **109.4** | **56.05** | **17.92** | **1.98** | **2.98** | 0.99 | 1.98 | 0.99 | 0 |
| **118.6** | 7.43 | **166.85** | **257.39** | **56.51** | **18.62** | **5.72** | **0.98** | 2.95 | 0 | 0 | 1 |
| **118.6** | 221.89 | **191.89** | **66.36** | **93.19** | **25.44** | **12.92** | **4.85** | 1.89 | 0 | 0.99 | 0 |
| **118.6** | 169.87 | **393.45** | **105** | **31.32** | **47.37** | **7.93** | **5.09** | 1.04 | 0 | 0.99 | 2.1 |

**Table 7.10.11. Plaice in Divisions VIIf&g: Commercial tuning data available to the working group (figures used in the assessment shown in bold).**

```
UK (E+W) BEAM TRAWL VIIF.
1990 2010
1 1 0 1
4 8
30.8  159.5  46.3  26.6  11.0  9.2
40.8  141.5  87.1  29.0  15.1 14.1
35.8   32.0  46.7  27.4   7.5  2.3
39.6   25.0  15.5  24.6  15.1  7.3
37.0   49.1   9.2   9.1   7.6  9.8
37.6   39.5  29.7   9.9   5.8  6.4
39.8   13.6  13.6  12.8   3.8  4.4
43.0   23.7   8.4   6.7   4.5  0.7
47.8   63.1  17.5   3.6   4.3  2.7
50.8   52.5  25.8   7.7   2.4  1.9
51.2   26.9  17.8  12.7   4.9  1.8
49.3   27.5  17.7  10.1   5.9  2.4
37.5   16.8   7.8   7.4   3.5  1.8
40.7   33.8   9.9   4.9   3.4  2.4
32.4   25.8  17.5   3.4   2.5  2.0
27.7   12.7   7.5   5.0   1.9  1.1
18.6    4.5   4.4   3.0   1.6  0.4
15.4   12.0   3.2   2.0   1.4  0.6
13.8   18.1   5.2   1.9   1.4  0.9
12.2   15.2  10.6   3.0   1.0  0.6
14.1   18.6   7.2   5.9   1.7  0.1
```

```
UK(E+W) OTTER TRAWL VIIF
1989 2010
1 1 0 1
4 8
17.6   62.0  23.1  7.4  5.1  0.4
22.6  129.1  34.2 13.3  4.1  4.4
18.6   78.8  36.9 16.5  4.4  5.0
16.0   12.5  18.5  8.5  1.4  0.4
13.8    8.8   3.9  6.3  4.1  2.7
 9.5   15.1   2.7  3.1  1.4  1.7
 8.5   14.5   5.5  1.6  0.8  0.7
 8.7    4.3   3.4  2.5  1.0  1.1
 8.1    5.5   1.2  0.7  0.4  0.1
 7.1    8.6   2.0  0.5  0.7  0.2
 5.7    7.9   3.8  0.9  0.2  0.1
 4.1    6.5   2.5  1.3  0.4  0.1
 4.4    4.0   2.4  1.3  0.6  0.2
 6.1    3.0   1.5  1.1  0.4  0.2
 9.9    9.3   2.1  1.3  0.9  0.6
 9.4   10.4   5.8  0.9  0.5  0.3
 12.1    5.5   2.8  1.5  0.5  0.3
 13.0    6.8   6.4  4.5  2.3  0.6
 10.6    7.4   2.2  1.4  1.0  0.5
 10.1    8.2   2.4  1.6  1.1  0.6
 9.0     7.3   2.3  0.9  0.5  0.3
 7.6    4.4   2.9  0.7  0.3  0.2
```

**Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.**

| Sun May 15 18:52:11 2011 | |
|---|---|
| SEL_MODEL | TV |
| DISC_MODEL | PTVS |
| firstoptMETHOD | SANN |
| mainMETHOD | BFGS |
| BFGS_MAXIT | 1000 |
| BFGS_RELTOL | 1.00E-20 |
| n.tries for uncertainty | 1000 |
| eigenvalues Hessian positive? | FALSE |
| negative log.likelihood | 190.4164 |
| AIC | 566.8328 |
| Nparameters | 93 |
| Nobservations | 488 |
| Final parameter values | |
| Ftrend 1 | 0.538249 |
| Ftrend 2 | 0.675755 |
| Ftrend 3 | 0.759486 |
| Ftrend 4 | 0.734489 |
| Ftrend 5 | 0.880095 |
| Ftrend 6 | 0.830547 |
| Ftrend 7 | 0.854852 |
| Ftrend 8 | 0.785874 |
| Ftrend 9 | 0.731393 |
| Ftrend 10 | 0.857853 |
| Ftrend 11 | 0.813121 |
| Ftrend 12 | 0.825369 |
| Ftrend 13 | 0.629245 |
| Ftrend 14 | 0.620637 |
| Ftrend 15 | 0.768152 |
| Ftrend 16 | 0.524305 |
| Ftrend 17 | 0.613731 |
| Ftrend 18 | 0.626754 |
| sel.C 1 | -2.45892 |
| sel.C 2 | 6.213888 |
| sel.C 3 | -1.77793 |
| sel.C 4 | 1.478122 |
| sel.C 5 | 0.058086 |
| sel.C 6 | -0.15398 |
| sel.C 7 | 0.385898 |
| sel.C 8 | -0.25302 |

**Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.**

| | |
|---|---|
| logrecruitment 1 | 19.55866 |

| | |
|---|---|
| logrecruitment 2 | 17.87203 |
| logrecruitment 3 | 16.17875 |
| logrecruitment 4 | 13.92387 |
| logrecruitment 5 | 11.75304 |
| logrecruitment 6 | 10.17994 |
| logrecruitment 7 | 8.743988 |
| logrecruitment 8 | 8.345533 |
| logrecruitment 9 | 8.917262 |
| logrecruitment 10 | 9.340562 |
| logrecruitment 11 | 9.166612 |
| logrecruitment 12 | 8.98295 |
| logrecruitment 13 | 8.709882 |
| logrecruitment 14 | 8.566078 |
| logrecruitment 15 | 9.153922 |
| logrecruitment 16 | 8.958794 |
| logrecruitment 17 | 8.643788 |
| logrecruitment 18 | 8.179628 |
| logrecruitment 19 | 8.733661 |
| logrecruitment 20 | 9.245807 |
| logrecruitment 21 | 8.912797 |
| logrecruitment 22 | 9.214311 |
| logrecruitment 23 | 8.297601 |
| logrecruitment 24 | 8.817198 |
| logrecruitment 25 | 9.505879 |
| Catchability1 | -6.77021 |
| Catchability2 | -5.08736 |
| Catchability3 | -2.79867 |
| sel.U 1 | 0.955221 |
| sel.U 2 | 1.361871 |
| sel.U 3 | 3.403979 |
| sel.U 4 | 7.114822 |
| sel.U 5 | -1.70321 |
| sel.U 6 | -1.8111 |
| sel.U 7 | -1.67159 |
| sel.U 8 | -1.70573 |
| sel.U 9 | -5.36597 |
| sel.U 10 | -5.13736 |
| sel.U 11 | -6.60006 |
| sel.U 12 | -6.31946 |

**Table 7.10.12. Plaice in Divisions VIIf&g: AP Model Diagnostics.**

| | |
|---|---|
| b1 | 3.677171 |
| b2 | 0.358522 |
| b3 | -3.06563 |
| b4 | -2.68955 |
| b5 | 0.19585 |
| b6 | -0.24288 |
| b7 | 0.772269 |
| b8 | -0.09655 |
| b9 | -0.00304 |
| b10 | -0.00842 |
| b11 | -0.01607 |
| b12 | 0.012851 |
| sds.land1 | -2.04448 |
| sds.land2 | -1.55056 |
| sds.land3 | 2.55275 |
| sds.disc1 | -0.75546 |
| sds.disc2 | 0.38436 |
| sds.disc3 | 0.634873 |
| sds.tun1 | -2.02773 |
| sds.tun2 | 0.765797 |
| sds.tun3 | 1.195124 |
| sds.tun4 | -1.08616 |
| sds.tun5 | 0.108301 |
| sds.tun6 | -0.07763 |
| sds.tun7 | -0.87227 |
| sds.tun8 | 1.190155 |
| sds.tun9 | -0.00773 |

**Table 7.10.13. Plaice in Divisions VIIf&g: Fishing Mortalities.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Total Fishing mortality at age

| AGE\YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.032 | 0.041 | 0.047 | 0.052 | 0.064 | 0.06 | 0.072 | 0.068 | 0.063 | 0.085 | 0.083 | 0.084 | 0.074 | 0.075 | 0.092 | 0.071 | 0.086 |
| 2 | 0.377 | 0.454 | 0.486 | 0.521 | 0.602 | 0.539 | 0.614 | 0.547 | 0.483 | 0.624 | 0.576 | 0.553 | 0.464 | 0.448 | 0.523 | 0.391 | 0.448 |
| 3 | 0.537 | 0.643 | 0.69 | 0.741 | 0.851 | 0.765 | 0.873 | 0.773 | 0.683 | 0.886 | 0.813 | 0.782 | 0.657 | 0.631 | 0.738 | 0.553 | 0.634 |
| 4 | 0.521 | 0.626 | 0.752 | 0.734 | 0.845 | 0.765 | 0.88 | 0.78 | 0.694 | 0.907 | 0.832 | 0.805 | 0.681 | 0.653 | 0.768 | 0.58 | 0.663 |
| 5 | 0.437 | 0.53 | 0.656 | 0.64 | 0.742 | 0.755 | 0.792 | 0.705 | 0.635 | 0.838 | 0.771 | 0.753 | 0.643 | 0.617 | 0.732 | 0.557 | 0.636 |
| 6 | 0.386 | 0.465 | 0.583 | 0.561 | 0.647 | 0.669 | 0.692 | 0.614 | 0.615 | 0.733 | 0.671 | 0.658 | 0.564 | 0.539 | 0.642 | 0.491 | 0.559 |
| 7 | 0.493 | 0.577 | 0.702 | 0.654 | 0.728 | 0.741 | 0.734 | 0.628 | 0.619 | 0.707 | 0.625 | 0.661 | 0.496 | 0.458 | 0.529 | 0.393 | 0.432 |
| 8 | 0.489 | 0.573 | 0.7 | 0.649 | 0.723 | 0.739 | 0.732 | 0.624 | 0.625 | 0.705 | 0.621 | 0.667 | 0.494 | 0.454 | 0.585 | 0.392 | 0.429 |
| +gp | 0.489 | 0.573 | 0.7 | 0.649 | 0.723 | 0.739 | 0.732 | 0.624 | 0.625 | 0.705 | 0.621 | 0.667 | 0.494 | 0.454 | 0.585 | 0.392 | 0.429 |
| FBAR 3- 6 | 0.470 | 0.566 | 0.670 | 0.669 | 0.771 | 0.739 | 0.809 | 0.718 | 0.657 | 0.841 | 0.772 | 0.750 | 0.636 | 0.610 | 0.720 | 0.545 | 0.623 |

Discard Fishing mortality at age

| AGE\YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.027 | 0.036 | 0.042 | 0.048 | 0.060 | 0.057 | 0.069 | 0.066 | 0.061 | 0.083 | 0.081 | 0.083 | 0.073 | 0.074 | 0.091 | 0.070 | 0.085 |
| 2 | 0.262 | 0.332 | 0.371 | 0.412 | 0.490 | 0.449 | 0.521 | 0.472 | 0.422 | 0.551 | 0.513 | 0.496 | 0.419 | 0.406 | 0.475 | 0.356 | 0.408 |
| 3 | 0.122 | 0.176 | 0.223 | 0.276 | 0.359 | 0.358 | 0.446 | 0.425 | 0.399 | 0.545 | 0.521 | 0.518 | 0.447 | 0.438 | 0.519 | 0.393 | 0.453 |
| 4 | 0.016 | 0.027 | 0.045 | 0.059 | 0.088 | 0.103 | 0.149 | 0.161 | 0.172 | 0.263 | 0.278 | 0.304 | 0.285 | 0.298 | 0.377 | 0.303 | 0.364 |
| 5 | 0.002 | 0.006 | 0.011 | 0.015 | 0.023 | 0.032 | 0.046 | 0.054 | 0.063 | 0.106 | 0.123 | 0.146 | 0.150 | 0.172 | 0.236 | 0.206 | 0.266 |
| 6 | 0.005 | 0.009 | 0.012 | 0.015 | 0.016 | 0.026 | 0.025 | 0.031 | 0.038 | 0.049 | 0.059 | 0.069 | 0.071 | 0.079 | 0.113 | 0.100 | 0.134 |
| 7 | 0.154 | 0.145 | 0.140 | 0.109 | 0.096 | 0.084 | 0.061 | 0.055 | 0.046 | 0.047 | 0.041 | 0.038 | 0.020 | 0.021 | 0.024 | 0.027 | 0.018 |
| 8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| +gp | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| FBAR 3- 6 | 0.036 | 0.055 | 0.073 | 0.091 | 0.122 | 0.130 | 0.167 | 0.168 | 0.168 | 0.241 | 0.245 | 0.259 | 0.238 | 0.247 | 0.311 | 0.250 | 0.304 |

Landings Fishing mortality at age

| AGE\YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.005 | 0.005 | 0.005 | 0.004 | 0.004 | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 2 | 0.115 | 0.122 | 0.115 | 0.109 | 0.112 | 0.090 | 0.093 | 0.075 | 0.061 | 0.073 | 0.063 | 0.057 | 0.045 | 0.042 | 0.048 | 0.035 | 0.040 |
| 3 | 0.415 | 0.467 | 0.467 | 0.465 | 0.492 | 0.407 | 0.427 | 0.348 | 0.284 | 0.341 | 0.292 | 0.264 | 0.210 | 0.193 | 0.219 | 0.160 | 0.181 |
| 4 | 0.505 | 0.599 | 0.707 | 0.675 | 0.757 | 0.662 | 0.731 | 0.619 | 0.522 | 0.644 | 0.554 | 0.501 | 0.396 | 0.355 | 0.391 | 0.277 | 0.299 |
| 5 | 0.435 | 0.524 | 0.645 | 0.625 | 0.719 | 0.723 | 0.746 | 0.651 | 0.572 | 0.732 | 0.648 | 0.607 | 0.493 | 0.445 | 0.496 | 0.351 | 0.370 |

**Table 7.10.14. Plaice in Divisions VIIf&g: Population numbers.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Stock number at age (start of year) Numbers*10**-3

| AGE\YEAR | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4211 | 7460 | 11391 | 9572 | 7966 | 6063 | 5250 | 9451 | 7776 | 5675 | 3568 | 6208 | 10361 | 7426 | 10040 | 4014 | 6749 |
| 2 | 4836 | 3616 | 6348 | 9644 | 8056 | 6627 | 5062 | 4333 | 7833 | 6477 | 4622 | 2912 | 5064 | 8538 | 6113 | 8123 | 3316 |
| 3 | 3255 | 2942 | 2037 | 3464 | 5080 | 3915 | 3427 | 2429 | 2224 | 4288 | 3077 | 2304 | 1485 | 2825 | 4839 | 3214 | 4872 |
| 4 | 862 | 1688 | 1372 | 907 | 1464 | 1923 | 1616 | 1270 | 995 | 996 | 1568 | 1211 | 935 | 683 | 1334 | 2052 | 1639 |
| 5 | 528 | 454 | 801 | 573 | 386 | 558 | 793 | 594 | 516 | 441 | 357 | 606 | 480 | 420 | 315 | 549 | 1019 |
| 6 | 536 | 302 | 237 | 369 | 268 | 163 | 232 | 319 | 260 | 243 | 169 | 146 | 253 | 224 | 201 | 135 | 279 |
| 7 | 452 | 323 | 168 | 117 | 187 | 125 | 74 | 103 | 153 | 125 | 103 | 77 | 67 | 128 | 116 | 94 | 73 |
| 8 | 203 | 245 | 161 | 74 | 54 | 80 | 53 | 32 | 49 | 73 | 55 | 49 | 35 | 36 | 72 | 60 | 56 |
| +gp | 161 | 156 | 276 | 212 | 168 | 114 | 140 | 73 | 64 | 57 | 55 | 36 | 44 | 44 | 31 | 48 | 37 |
| TOTAL | 17037 | 19180 | 24786 | 26928 | 25626 | 21566 | 18646 | 20604 | 21871 | 20377 | 15577 | 15553 | 20729 | 22330 | 25068 | 20297 | 20049 |

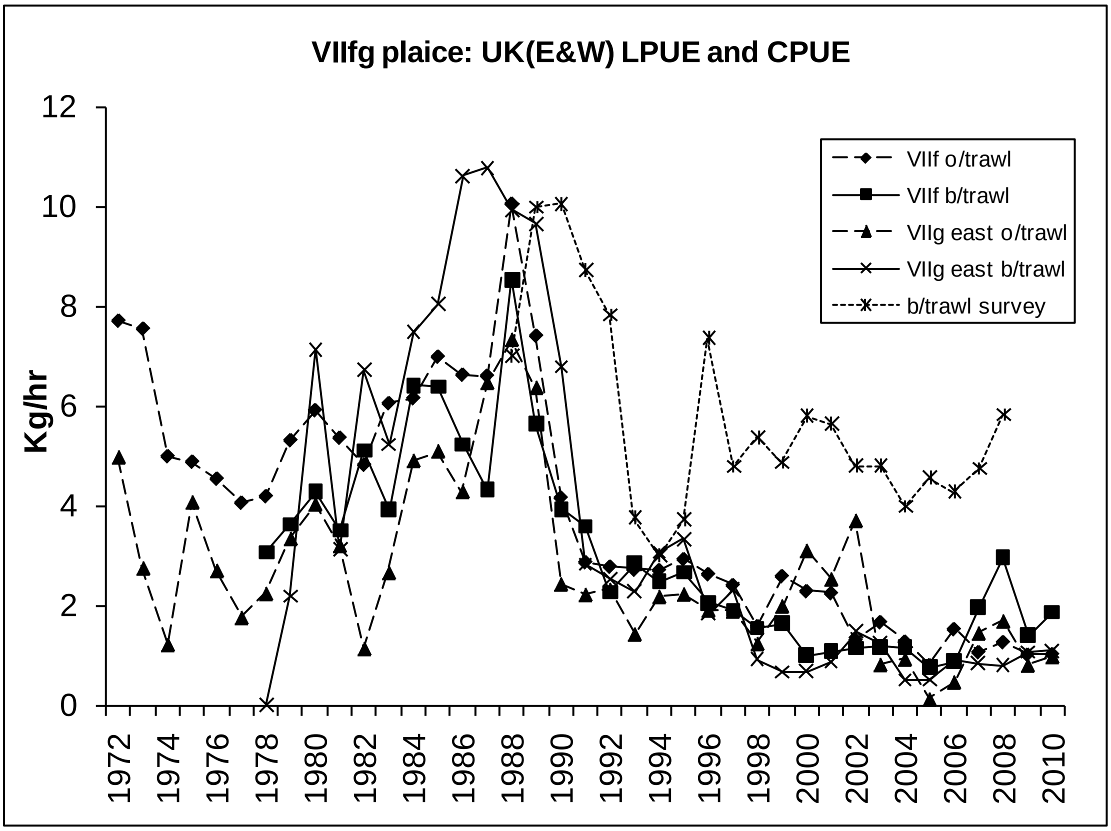
**Table 7.10.15. Plaice in Divisions VIIf&g: Summary table.**

Run title : CELTIC SEA PLAICE 2010 WG COMBSEX PLUSGROUP

At 16/05/2011 13:49

Stock Summary

| | SSB (t) | | | Recruitment (000's) | | | Landings (t) | | | Discards (t) | | | Total Fbar(3-6) | | | Partial Fbar | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentile | 0.05 | 0.5 | 0.95 | 0.05 | 0.5 | 0.95 | 0.05 | 0.5 | 0.95 | 0.05 | 0.5 | 0.95 | 0.05 | 0.5 | 0.95 | Landings | Discards |
| 1993 | 1980.39 | 2181.33 | 2396.43 | 3568 | 4196 | 5032 | 740.14 | 861.97 | 985.61 | 134.59 | 204.20 | 292.58 | 0.413 | 0.472 | 0.530 | 0.434 | 0.036 |
| 1994 | 1947.14 | 2143.23 | 2334.54 | 6298 | 7437 | 8813 | 851.37 | 966.16 | 1099.67 | 146.12 | 214.64 | 312.07 | 0.501 | 0.565 | 0.636 | 0.511 | 0.055 |
| 1995 | 1775.97 | 1932.88 | 2098.32 | 9670 | 11447 | 13360 | 795.60 | 906.58 | 1025.53 | 235.08 | 328.31 | 456.29 | 0.593 | 0.669 | 0.752 | 0.598 | 0.073 |
| 1996 | 1866.62 | 2042.13 | 2231.41 | 8054 | 9578 | 11314 | 793.75 | 910.16 | 1029.43 | 391.70 | 530.26 | 693.73 | 0.598 | 0.667 | 0.750 | 0.578 | 0.091 |
| 1997 | 2161.93 | 2401.77 | 2642.64 | 6718 | 7942 | 9438 | 1013.77 | 1172.21 | 1328.67 | 443.73 | 607.29 | 796.11 | 0.691 | 0.771 | 0.855 | 0.650 | 0.122 |
| 1998 | 1986.95 | 2204.55 | 2416.43 | 5060 | 6075 | 7249 | 871.72 | 995.15 | 1123.91 | 363.45 | 478.77 | 631.10 | 0.668 | 0.741 | 0.821 | 0.609 | 0.130 |
| 1999 | 1691.68 | 1871.83 | 2045.99 | 4434 | 5248 | 6206 | 759.91 | 858.15 | 971.04 | 343.30 | 457.97 | 592.96 | 0.738 | 0.812 | 0.893 | 0.643 | 0.167 |
| 2000 | 1477.30 | 1624.08 | 1766.27 | 7923 | 9496 | 11196 | 580.04 | 657.14 | 737.43 | 289.85 | 383.33 | 497.49 | 0.640 | 0.719 | 0.804 | 0.550 | 0.168 |
| 2001 | 1686.40 | 1869.56 | 2065.22 | 6618 | 7807 | 9225 | 533.17 | 607.85 | 687.00 | 370.55 | 480.23 | 615.98 | 0.580 | 0.657 | 0.738 | 0.489 | 0.168 |
| 2002 | 1643.73 | 1831.06 | 2025.01 | 4858 | 5685 | 6691 | 607.60 | 690.78 | 783.77 | 496.01 | 635.10 | 795.54 | 0.761 | 0.843 | 0.933 | 0.600 | 0.241 |
| 2003 | 1525.00 | 1682.98 | 1858.90 | 3096 | 3567 | 4140 | 516.54 | 590.74 | 665.69 | 369.14 | 464.43 | 581.13 | 0.688 | 0.774 | 0.866 | 0.526 | 0.245 |
| 2004 | 1173.13 | 1266.77 | 1384.42 | 5422 | 6194 | 7044 | 386.68 | 439.07 | 496.05 | 343.87 | 419.40 | 522.80 | 0.672 | 0.752 | 0.846 | 0.490 | 0.259 |
| 2005 | 1164.56 | 1251.07 | 1346.91 | 9119 | 10368 | 11776 | 304.53 | 340.68 | 383.35 | 327.51 | 394.65 | 480.15 | 0.570 | 0.637 | 0.718 | 0.398 | 0.238 |
| 2006 | 1412.91 | 1532.56 | 1666.71 | 6438 | 7453 | 8651 | 314.59 | 355.37 | 402.09 | 415.06 | 486.11 | 579.14 | 0.547 | 0.611 | 0.690 | 0.363 | 0.247 |
| 2007 | 1633.52 | 1779.23 | 1956.86 | 8550 | 10073 | 12155 | 413.47 | 472.54 | 535.54 | 572.63 | 679.78 | 811.39 | 0.641 | 0.721 | 0.804 | 0.409 | 0.311 |
| 2008 | 1828.64 | 2013.01 | 2211.63 | 3160 | 4039 | 5195 | 355.52 | 404.27 | 461.00 | 422.12 | 510.12 | 621.41 | 0.487 | 0.546 | 0.622 | 0.295 | 0.250 |
| 2009 | 1779.19 | 1972.76 | 2194.49 | 4877 | 6715 | 9324 | 413.51 | 469.68 | 528.92 | 375.97 | 461.47 | 570.82 | 0.546 | 0.620 | 0.717 | 0.319 | 0.304 |
| 2010 | 1740.06 | 1997.21 | 2287.32 | 8185 | 13425 | 21451 | 375.47 | 428.39 | 485.36 | 463.16 | 590.44 | 758.70 | 0.491 | 0.600 | 0.749 | 0.293 | 0.311 |
| Mean | 1693.06 | 1866.56 | 2051.64 | 6225 | 7597 | 9348 | 590.41 | 673.72 | 762.78 | 361.33 | 462.58 | 589.41 | 0.601 | 0.676 | 0.762 | 0.486 | 0.190 |



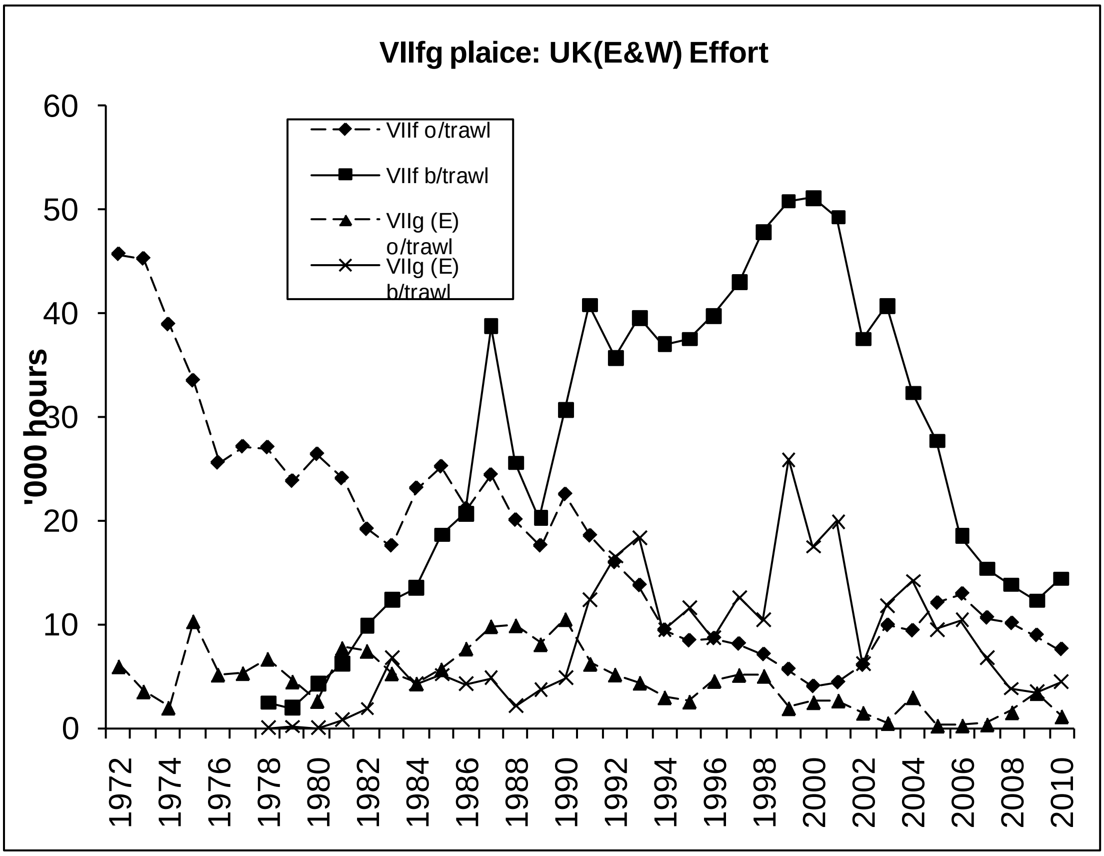




**Figure 7.10.1. Plaice in Division VIIf&g: UK(E&W) lpue and effort by fleet.**

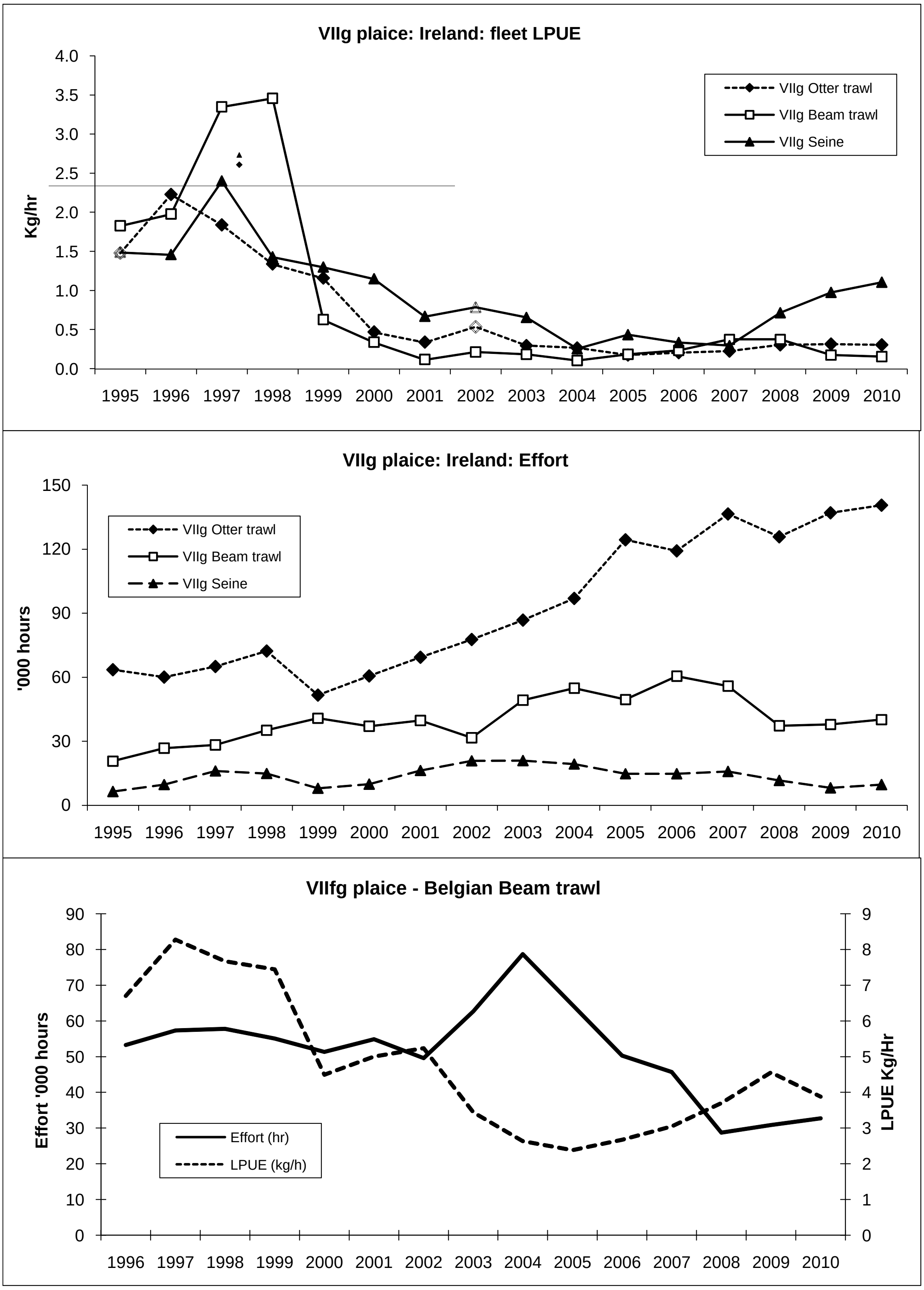



**Figure 7.10.2. Plaice in Division VIIf&g: Ireland and Belgium: lpue and effort by fleet.**

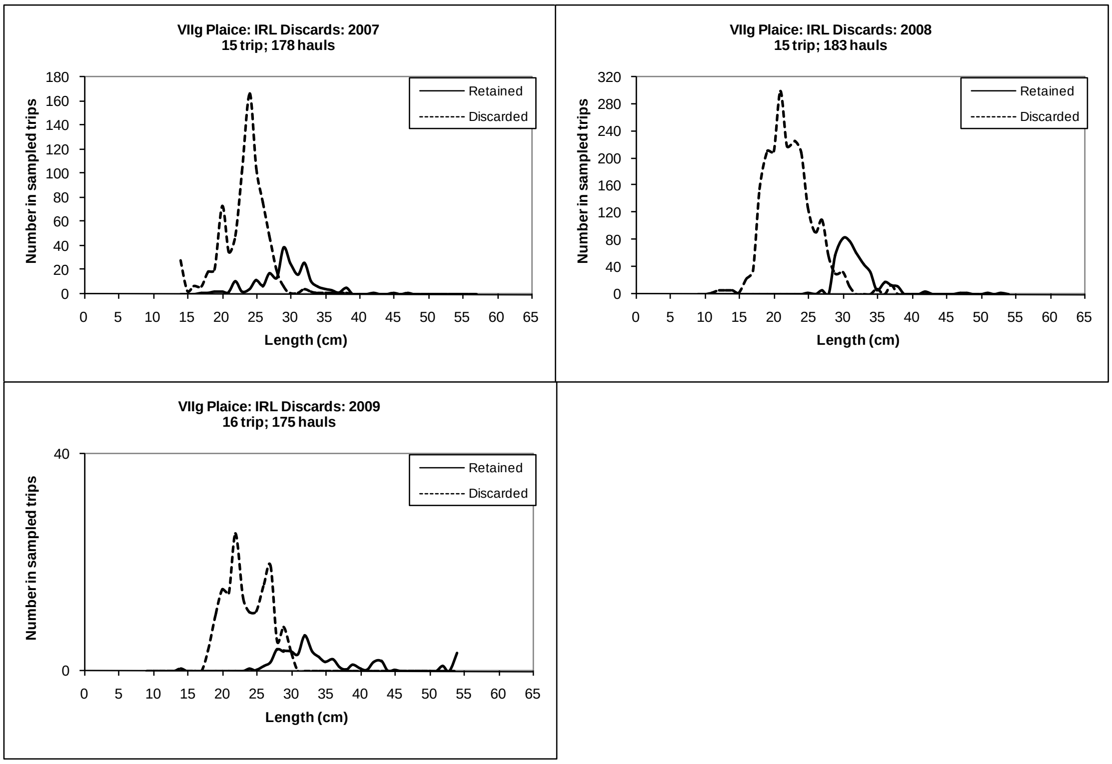



**Figure 7.10.3a. Plaice in Division VIIf&g: Ireland otter trawl discard sampling results in 2007–2009: raised to sampled trips.**

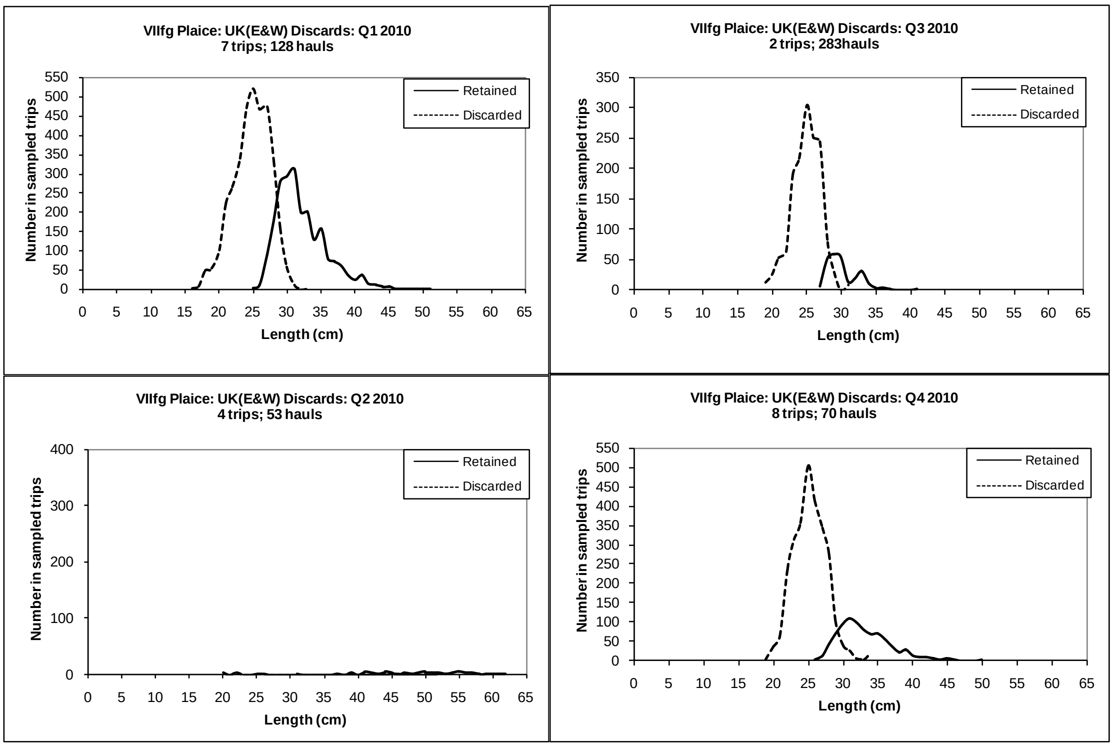



**Figure 7.10.3b. Plaice in Division VIIf&g: UK(E&W) Discard sampling results in 2010: raised to sampled trips. All gears.**

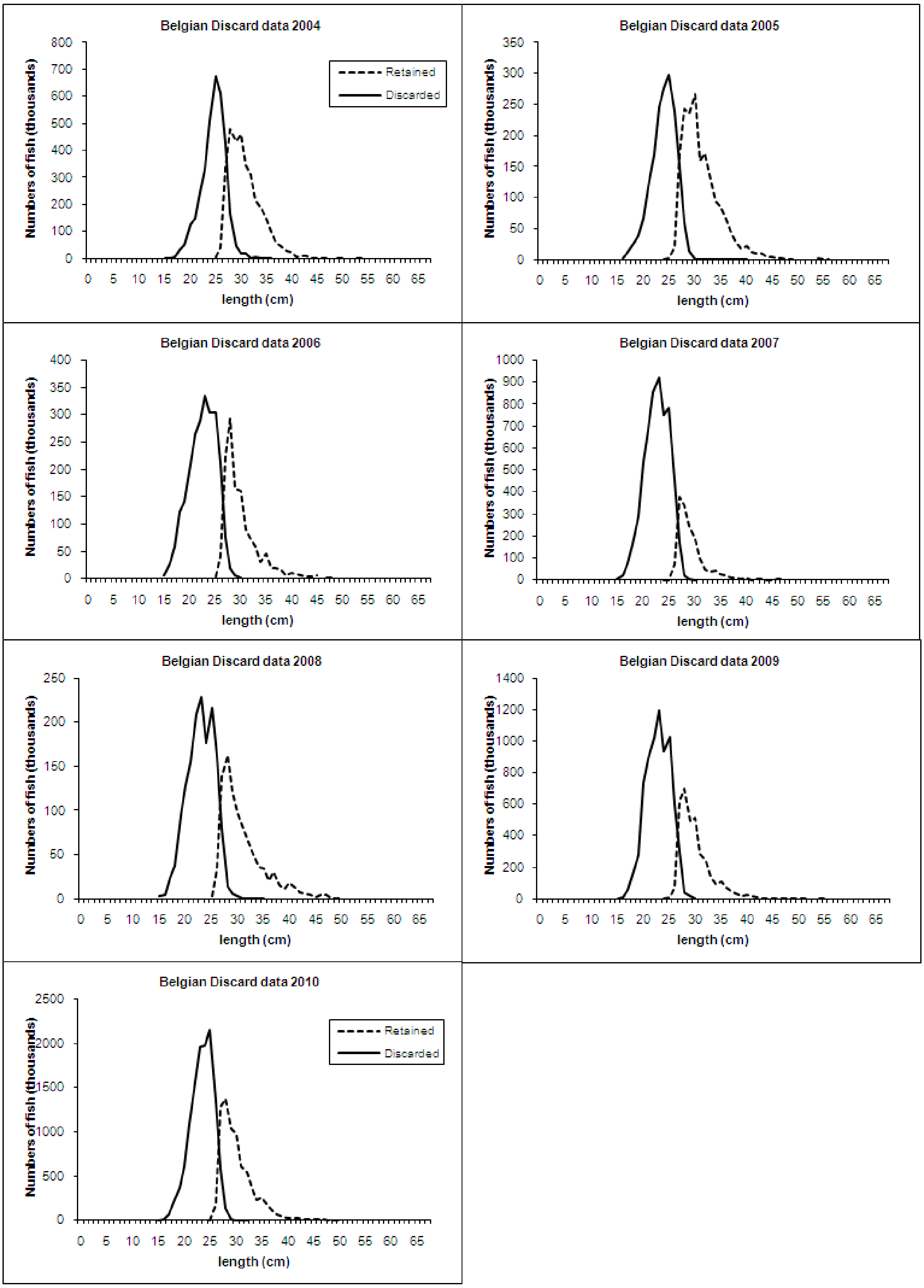



**Figure 7.10.3c. Plaice in Division VIIf&g: Belgian Discard sampling length distributions: raised to sampled trips. Beam trawl.**

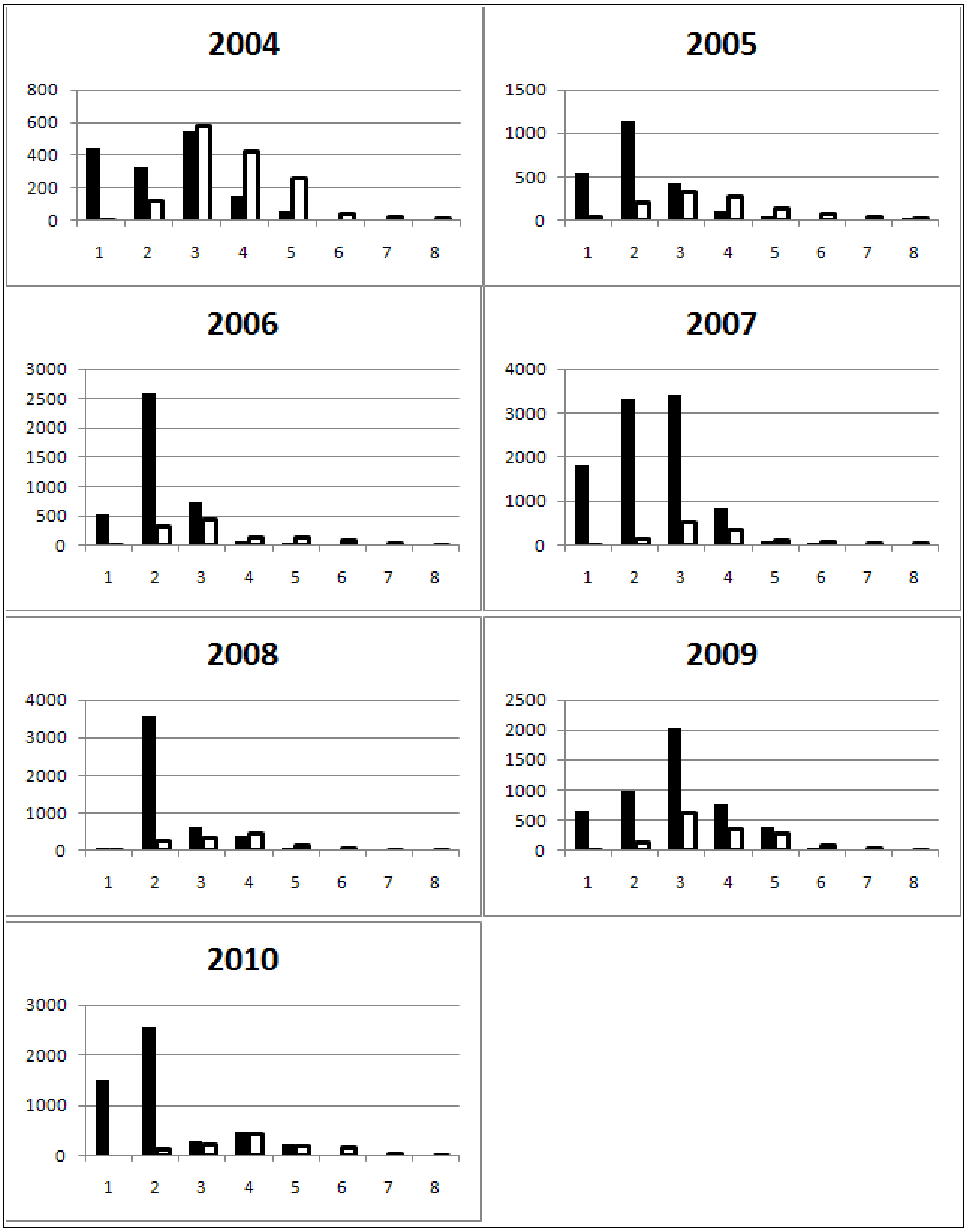



**Figure 7.10.4. Plaice in Division VIIf&g: Age composition of International landings and discards from 2000 to 2010.**

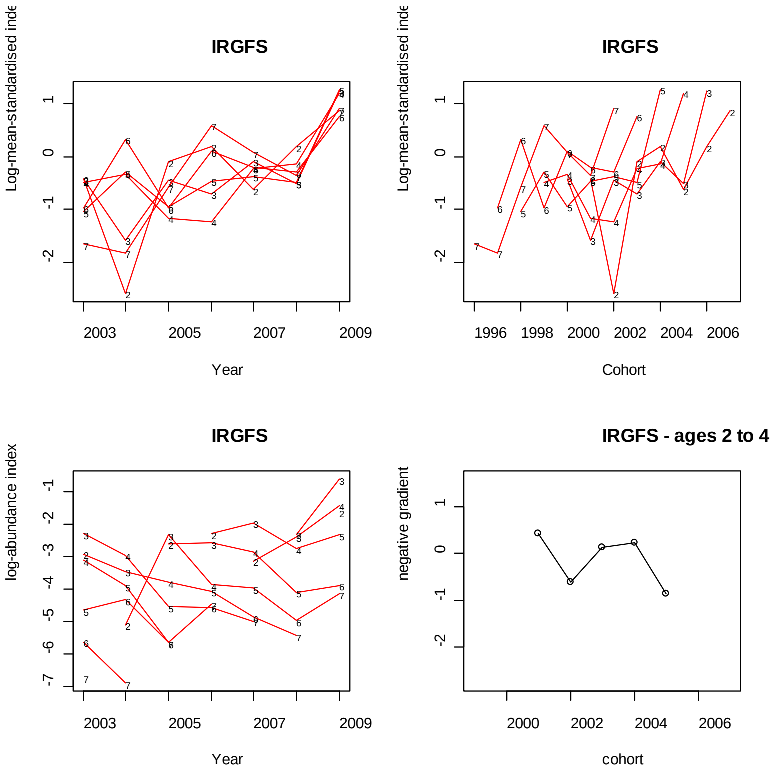



**Figure 7.10.5. Plaice in Division VIIf&g: Irish groundfish survey log cpue-at-age; by year and year class (top row), with log catch curves and the negative slope of the catch curves; ~Z (bottom row).**

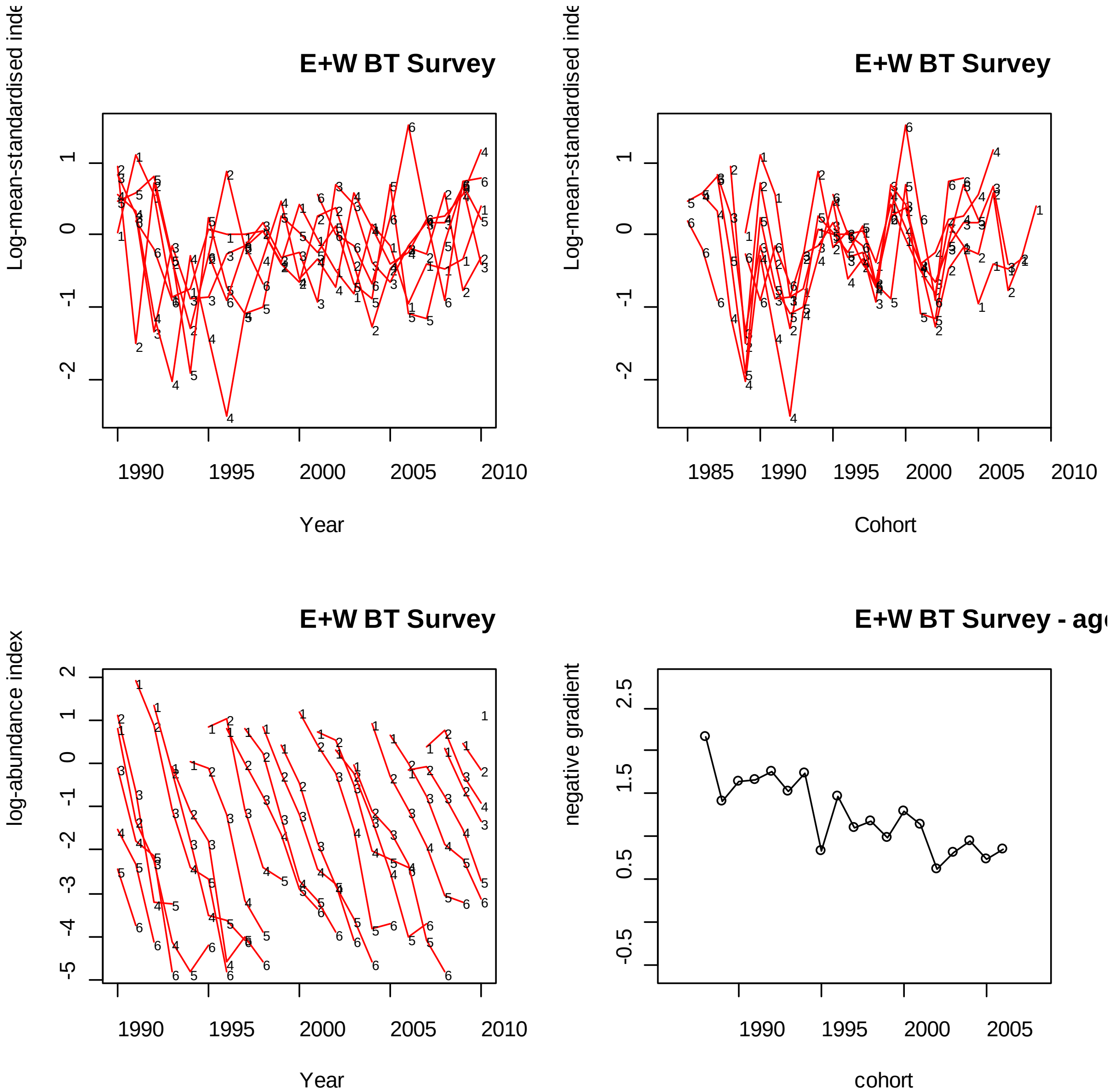



**Figure 7.10.6. Plaice in Division VIIf&g: UK (BTS-Q3) Beam trawl survey log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).**

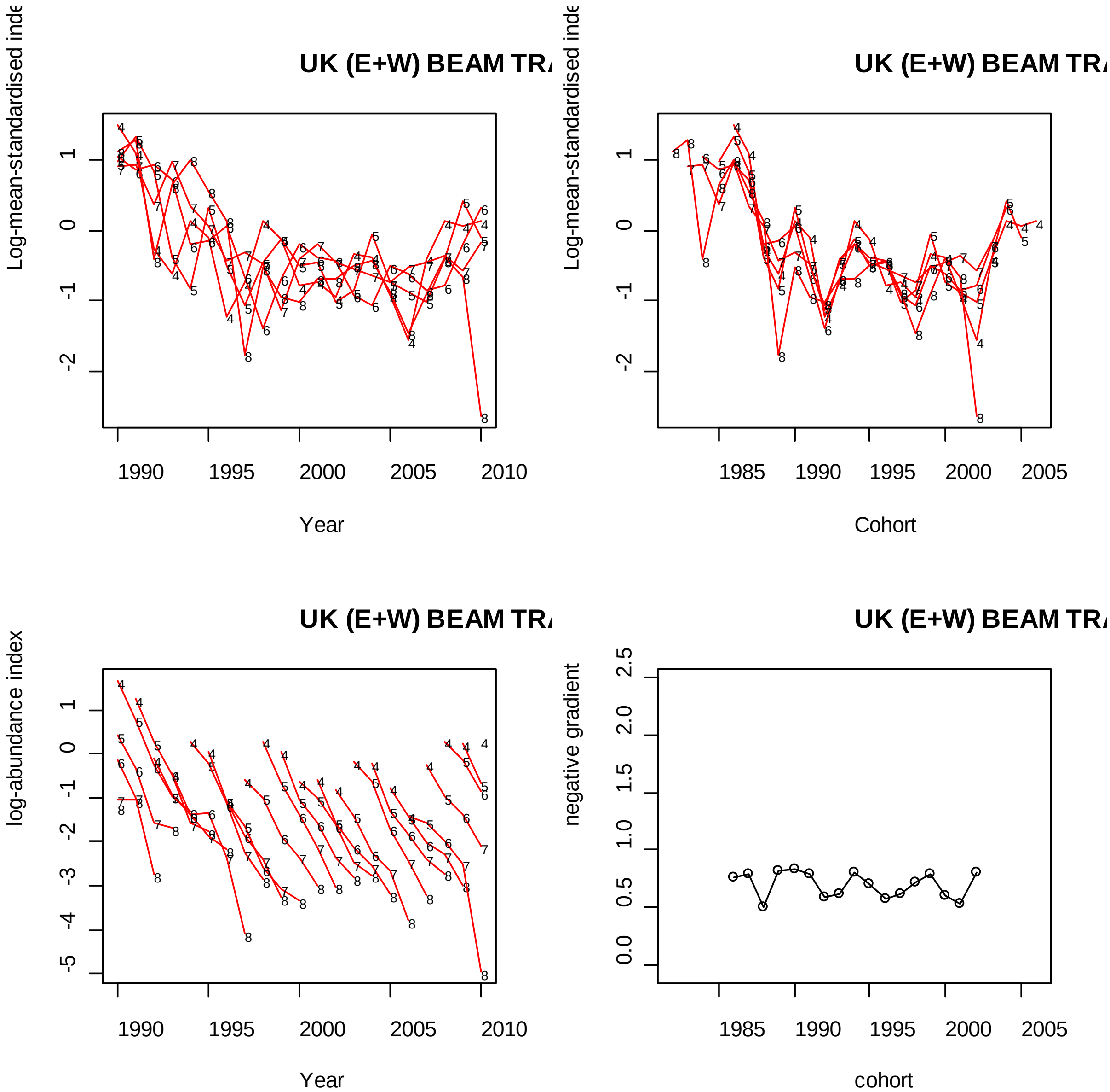



**Figure 7.10.7a. Plaice in Division VIIf&g: UK EW Beam trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).**

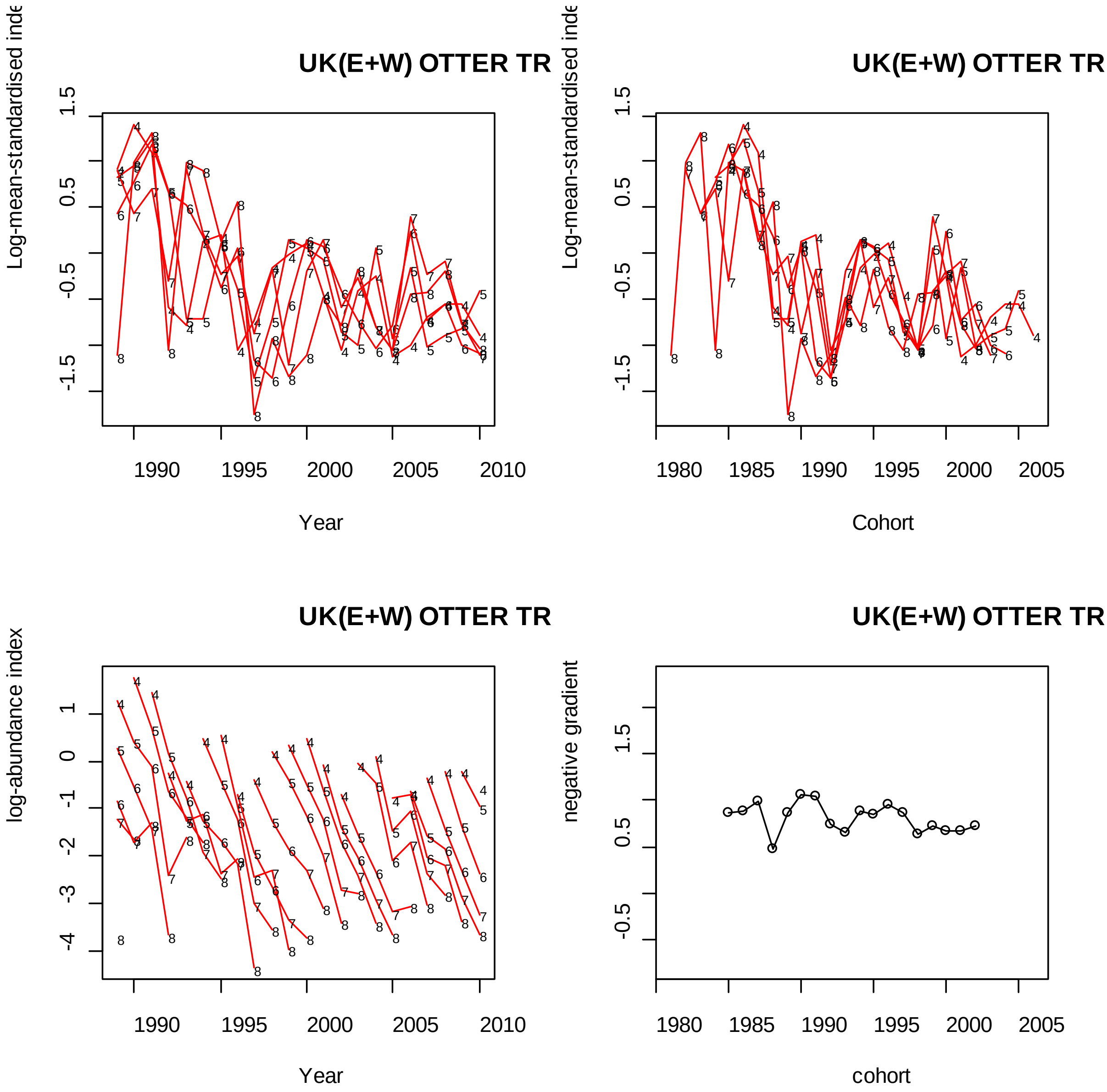



**Figure 7.10.7b. Plaice in Division VIIf&g: UK EW Otter trawl fleet log cpue by year, year class, log catch curves and the negative slope of the catch curves (~Z).**

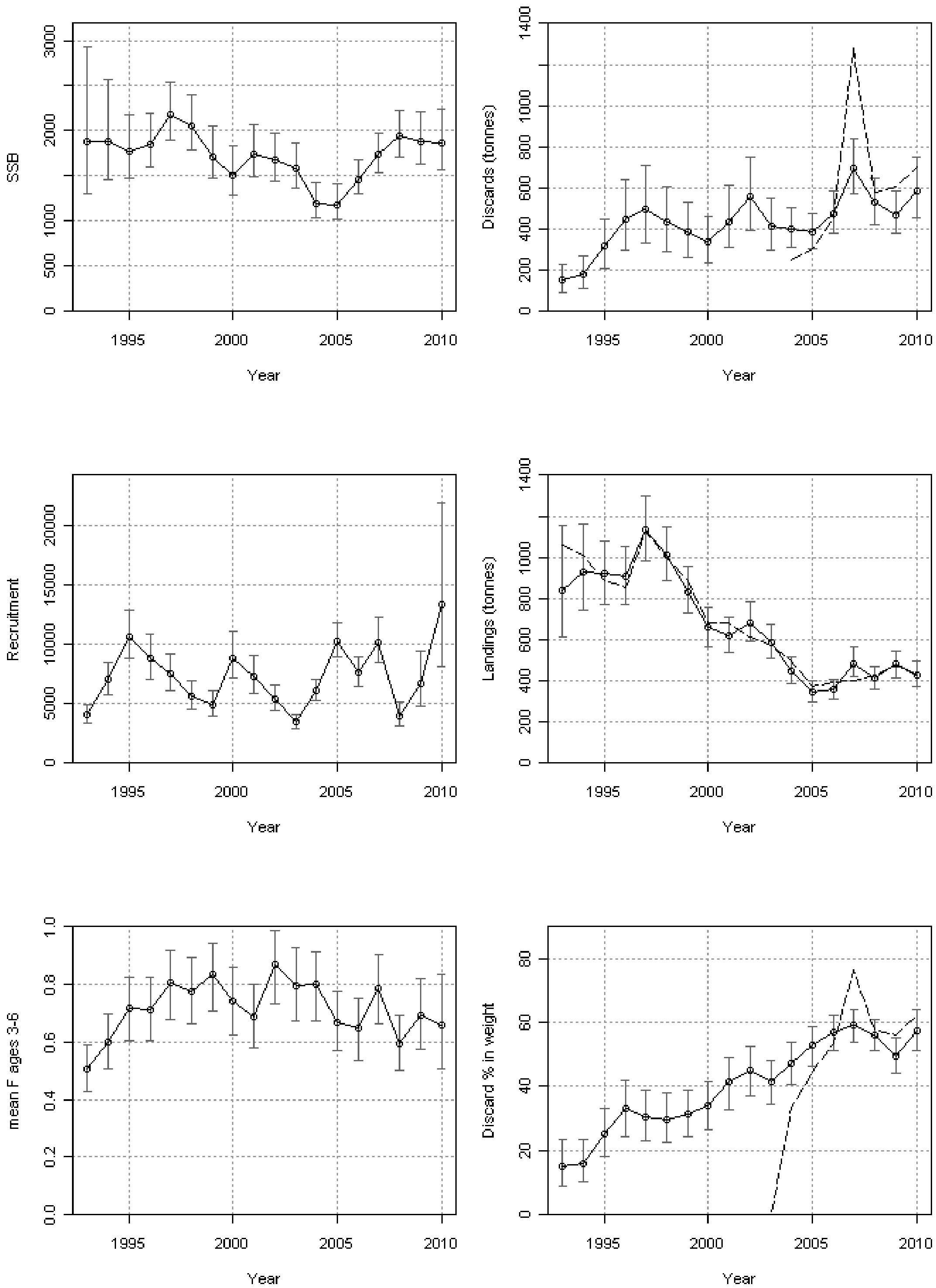



**Figure 7.10.8. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_PTVS model.**

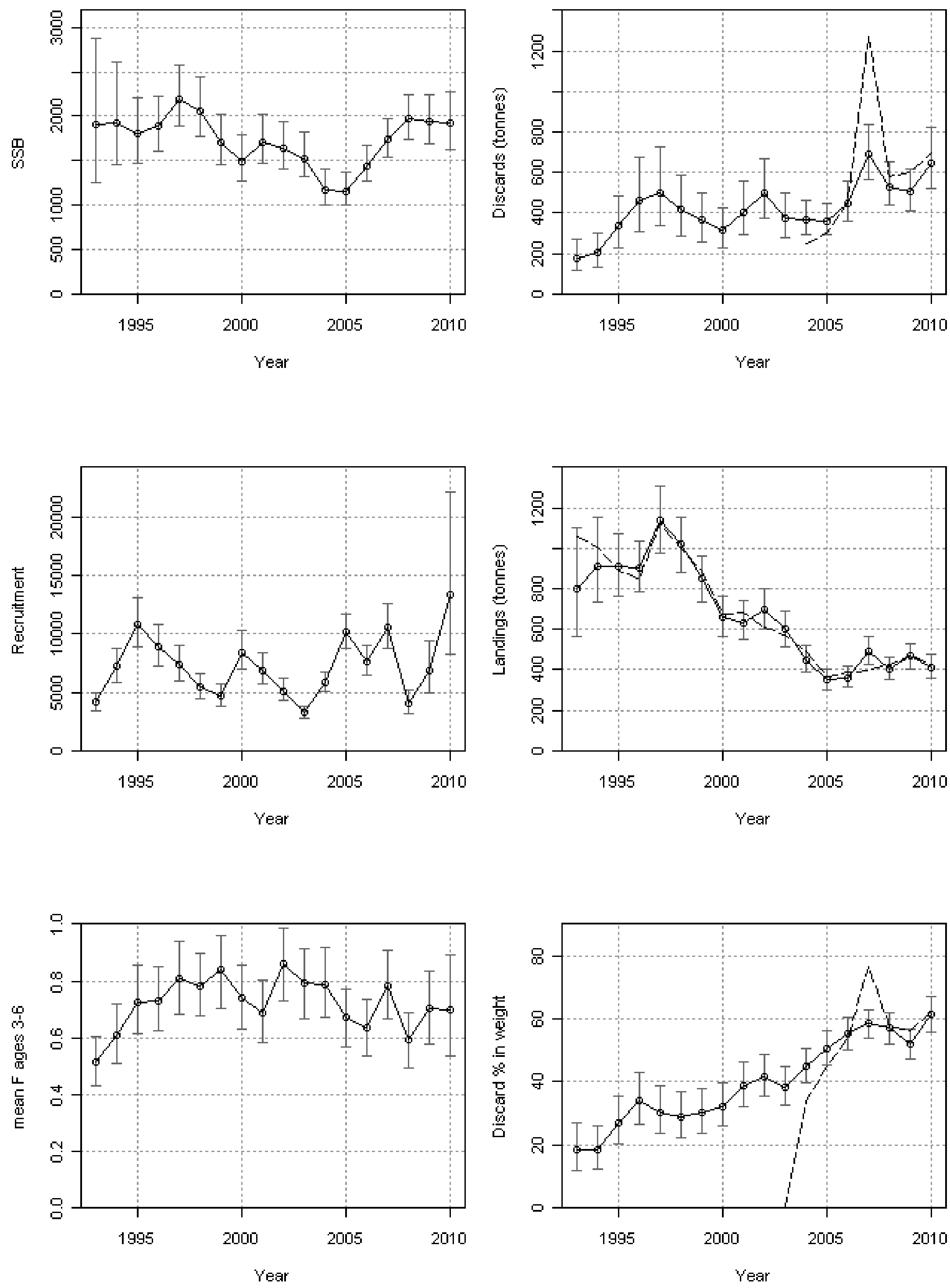



**Figure 7.10.9. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TI_TVS model.**

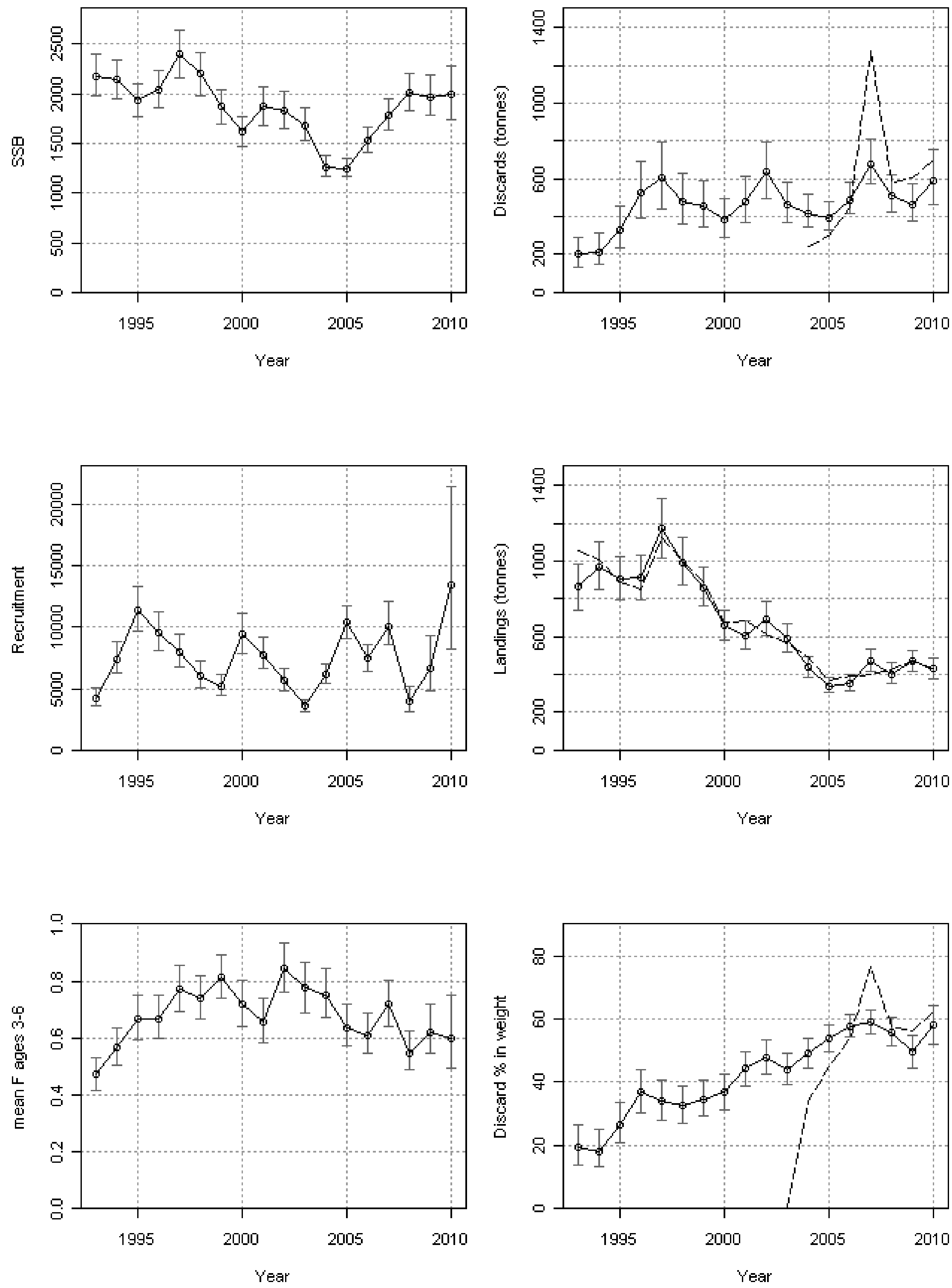



**Figure 7.10.10a. Plaice in Division VIIf&g: The estimated time-series of spawning–stock biomass, recruitment, average fishing mortality-at-ages 3–6, total discard weight, total landings weight and the discard percentage in weight with standard error bars derived from bootstrapping the hessian matrix, for the fit of the TV_PTVS model.**

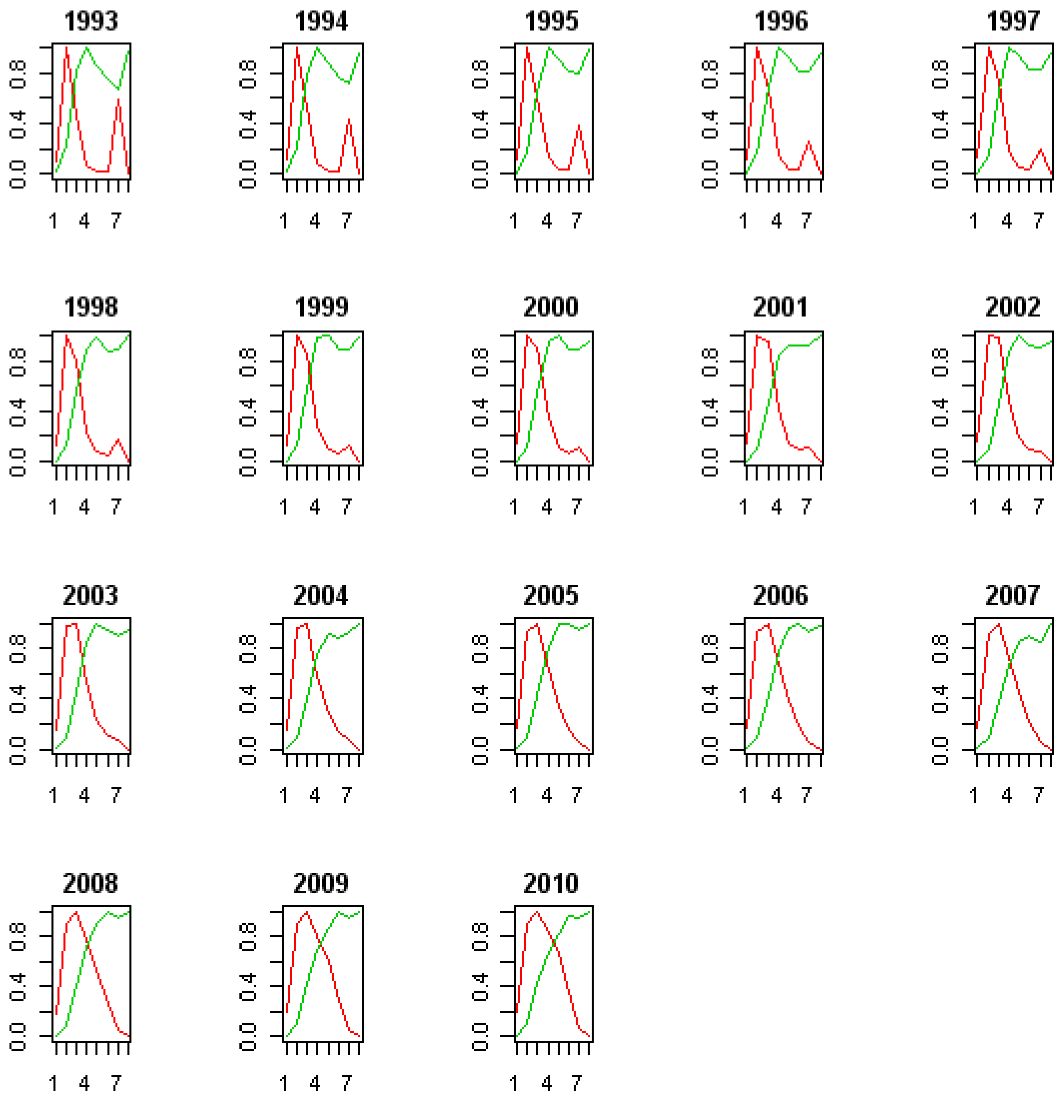



**Figure 7.10.10b. Plaice in Division VIIf&g: The estimated selection pattern-at-age for landings (green) and discards (red) scaled to a highest value = 1.0 for the TV_PTVS model which fits a time variant selection pattern to the landings and a polynomial time variant spline for the discard selection.**

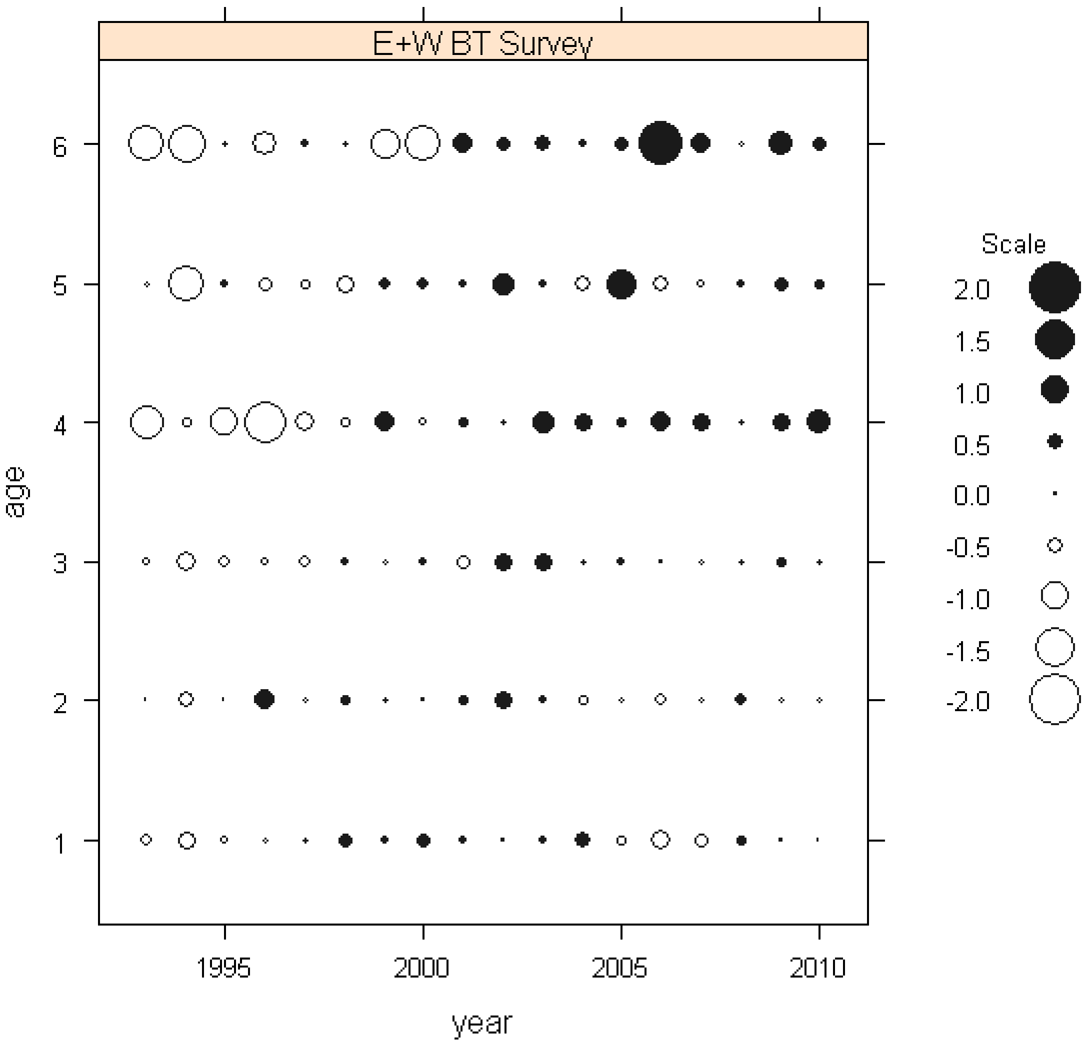



**Figure 7.10.10c. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UKBT survey.**

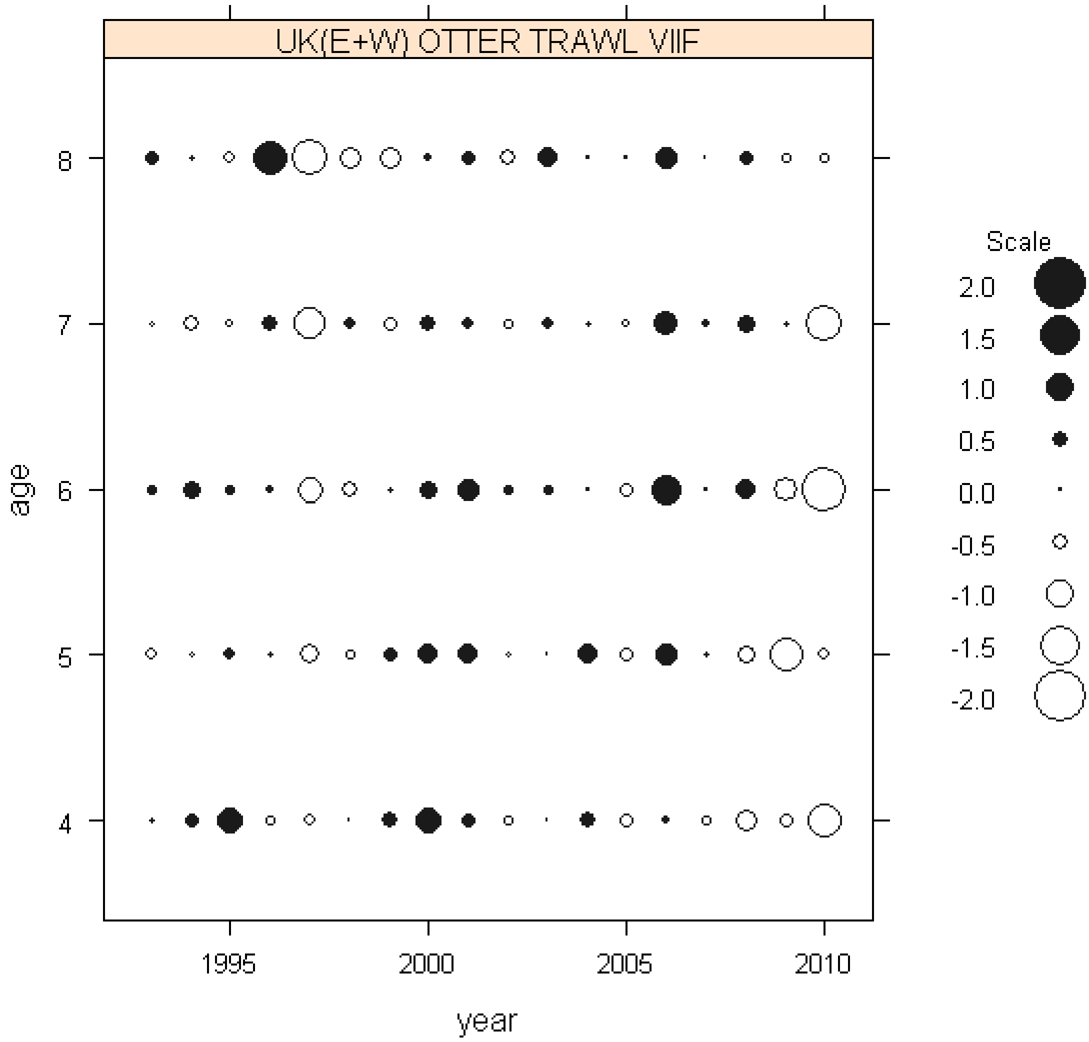



**Figure 7.10.10d. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UK commercial otter trawl data.**

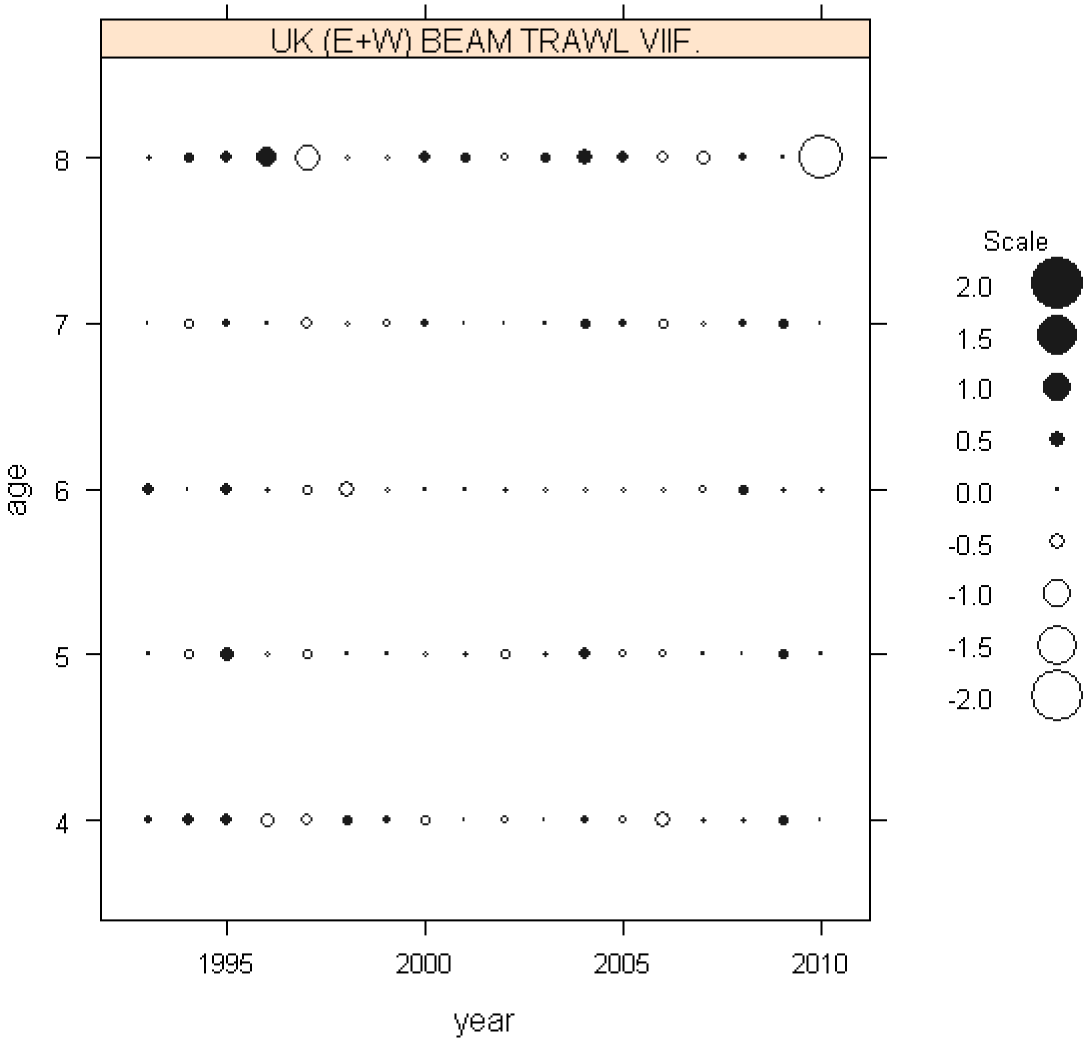



**Figure 7.10.10e. Plaice in Division VIIf&g: The Log-catchability residuals for the fit TV_PTVS model fit to the UK commercial beam trawl data.**

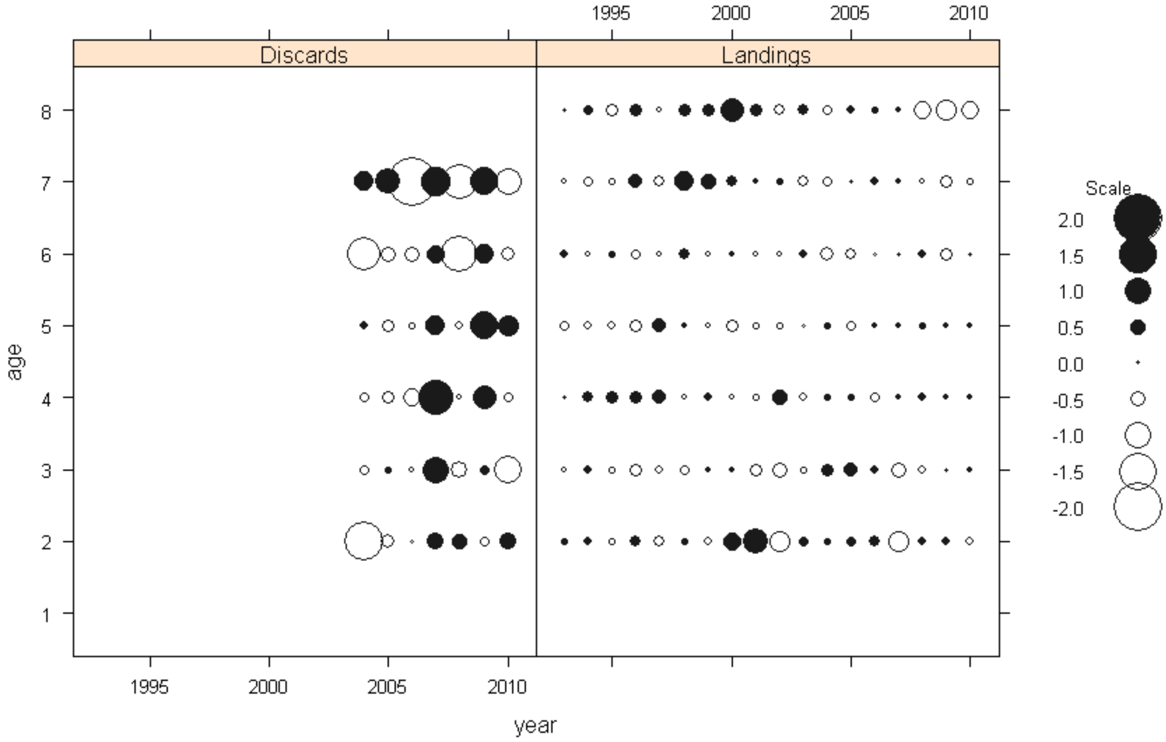



**Figure 7.10.10f. Plaice in Division VIIf&g: The Log residuals for the fit TV_PTVS model fit to the discard and landings numbers-at-age data.**

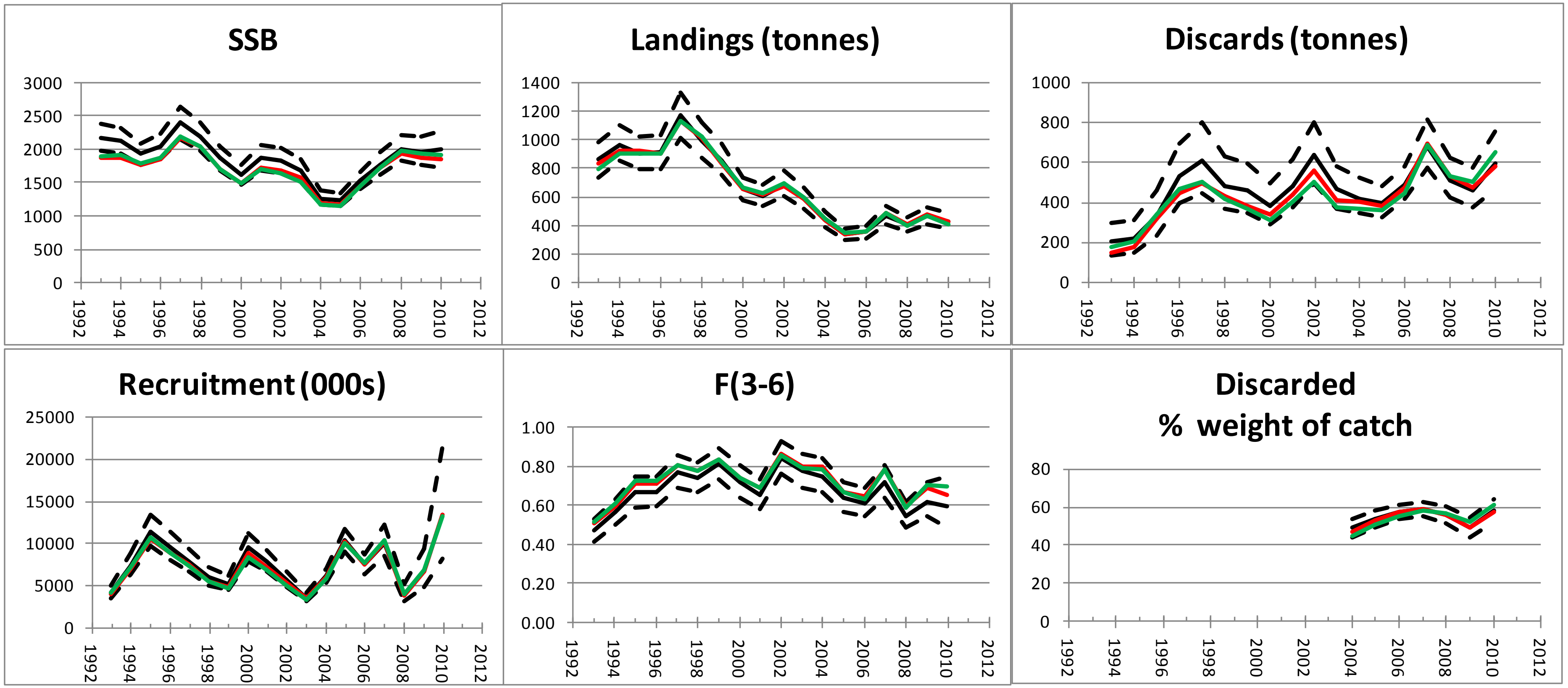



**Figure 7.10.11. Plaice in Division VIIf&g: The time-series of stock and fishery trends from fits the three WKFLAT models; black lines preferred TV_PTVS model with 5 and 95% C.L. red lines TI_PTVS model, green lines TI_TVS model.**

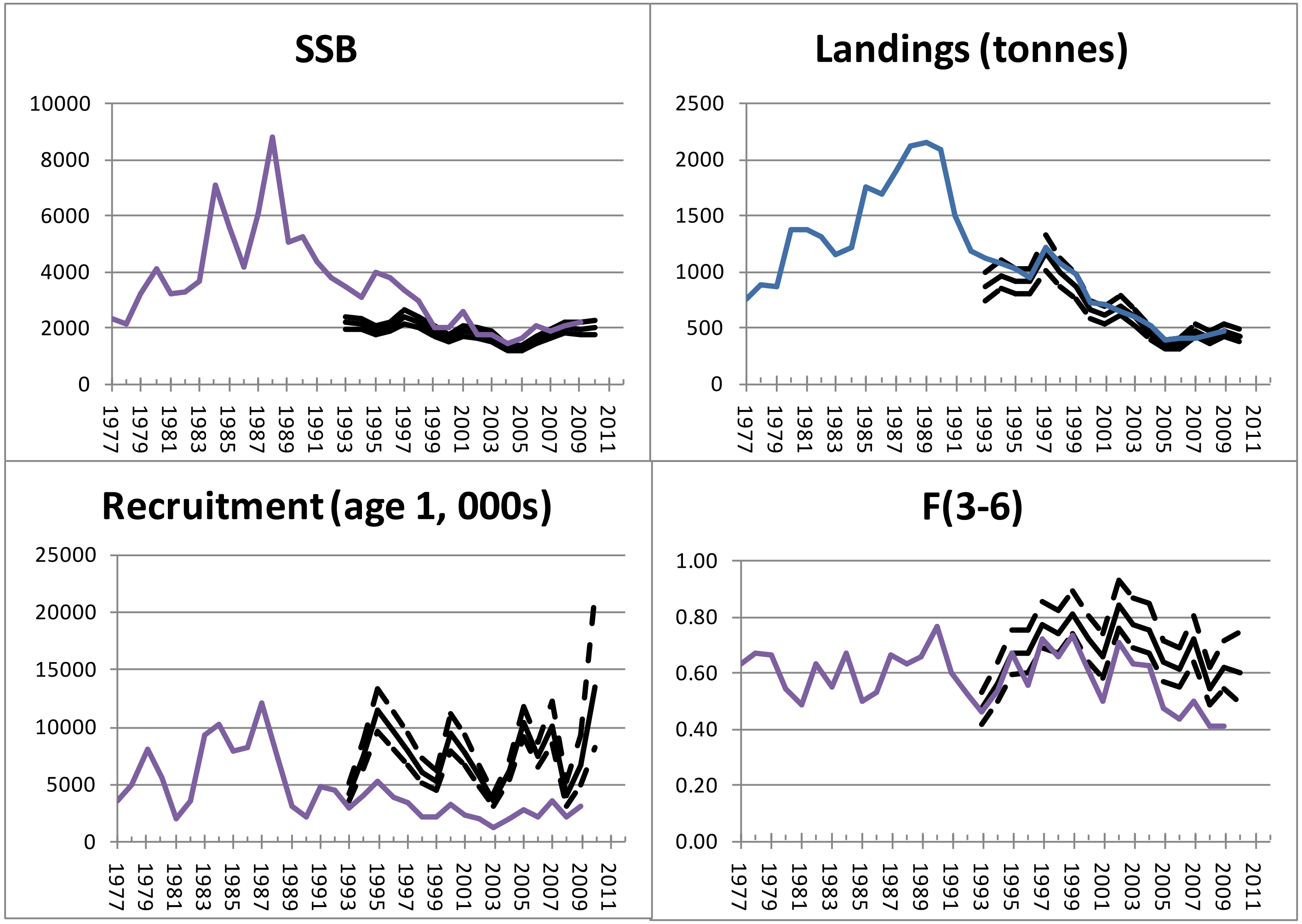



**Figure 7.10.12. Plaice in Division VIIf&g: The time-series of stock and fishery trends from the preferred TV_PTVS model with 5 and 95% C.L. compared to the 2010 assessment estimates based on the landings only assessment.**

## 7.11 Plaice in the Southwest of Ireland (ICES Divisions VIIh–k)

### Type of assessment in 2011

No assessment was performed, however catch numbers and weights were aggregated for the Irish landings for the years 1993–2010 and these were used to perform a yield-per-recruit analysis.

### 7.11.1 General

#### Stock Identity

Plaice in VIIj are mainly caught by Irish vessels on sandy grounds off counties Kerry and west Cork. Plaice catches in VIIk are negligible. VIIh is also considered part of the stock for assessment purposes but there is no evidence to suggest that this is actually the same stock.

### 7.11.2 Data

The nominal landings are given in Table 7.11.1.

Most non-Irish landings were from VIIh which is likely to be a different stock. Because age data were only available for Irish landings (which were mainly from VIIjk) the remainder of Section 7.11 concerns Irish data only in VIIjk.

#### Sampling

Figure 7.11.1 shows that plaice landings in VIIjk in 2010 were mostly taken in VIIj by otter trawlers. This was reflected in the sampling.

#### Data quality

Figure 7.11.2 shows the length distribution of the Irish landings in VIIjk between 1993 and 2010. There are no distinct modes of strong year classes discernible. One sample was removed (420-DEM196); it contained 192 plaice at 27 cm and no other length classes. In 1994 and 1995 a considerable number of small plaice (<20 cm) appeared in the samples. The most likely explanation for this is that discard fish were mistakenly entered as landings; these were therefore excluded from the analysis. The sample numbers appeared to be sufficient.

The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.

Annual Age–Length-Keys (ALKs) were constructed (all quarters and gear types combined) and applied to the sampled length frequency distributions. Figure 7.11.3 shows the age distribution of plaice in VIIjk between 1993 and 2010.

### 7.11.3 Historical stock development

Because plaice in VIIh were not sampled, it would not be appropriate to raise the data to all landings in VIIhjk. Instead, the official International landings figures for VIIjk were used to raise the age distributions (Table 7.11.2).

The estimated catch numbers-at-age are given in Table 7.11.3, catch weights-at-age are given in Table 7.11.4. There appears to be relatively little contrast (particularly weak or strong year classes) in the catch numbers. This is also illustrated by Figure 7.11.4, which shows the standardized catch proportions-at-age. Figure 7.11.5 shows the log catch numbers-at-age. The rate of decline in catch numbers through the cohorts appears to be reasonably stable. This can be further investigated by calculating the slope of the logcatch numbers (Z). Figure 7.11.6 shows the catch curve; plaice under the age of 4 are not fully selected and from age 7 onwards the data get quite noisy, therefore the slope of the logcatch numbers was estimated over ages 4 to 7 (Figure 7.11.7). It appears that Z varied between 0.6 and 1.2. The estimate for Z appears to be quite variable.

#### Yield-per-recruit

The yield-per-recruit was estimated using a method by Thompson and Bell (1934). This method requires the selectivity to be estimated. This was done by estimating the slope of the log catch numbers for ages that are fully selected and using this slope (Z) to predict the population numbers for ages that are not fully selected. The Z was estimated on pseudo-cohorts which were standardized to take account of annual variations in the catch numbers. Figure 7.11.8 shows that plaice in VIIjk appear to be fully selected by the age of 4 and that after the age of 9 the data get very sparse. Figure 7.11.9 shows the slope of the mean log standardized catch numbers. The predicted catch numbers from this slope were used to estimate the 'observed' selectivity. This was then modelled by applying a linear model after a logit transformation. The estimated selection curve is also shown in Figure 7.11.9. A natural mortality of 0.12 was assumed (based on the value used by the WG for plaice in VIIfg) and the WG maturity ogive for plaice in VIIfg was used to estimate SSB. The yield was estimated for a range of F values based on the average catch weights. Figure 7.11.10 shows the YPR curve, $F_{max}$ is estimated to be 0.25. $F_{0.1}$ is estimated as 0.15. Recent values of Z ranged from 0.6 to 1.2, with M=0.12 this would result in an F of between 0.48 and 1.08. This is well above $F_{max}$ and $F_{0.1}$

### 7.11.4 References

Thompson and Bell. 1934. W.F. Thompson and F.H. Bell, Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear, Rep. Int. Fish. (Pacific Halibut) Comm. 8 (1934), p. 49.

**Table 7.11.1. Plaice in Divisions VII h–k (Southwest Ireland). Nominal landings (t), 1987–2010, as officially reported to ICES.**

| Country | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|
| Belgium* | 250 | 245 | 403 | 301 | 252 | 246 | 344 | 197 | 235 |
| Denmark | 1 | 1 | 1 | - | - | - | - | - | - |
| France | 85 | 135 | 229 | 77 | 173 | 90 | 64 | 48 | 60 |
| Ireland | 300 | 369 | 454 | 338 | 478 | 477 | 383 | 271 | 321 |
| Netherlands | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - |
| UK - Eng+Wales+N | . | . | 73 | 88 | 287 | 264 | 218 | 258 | 282 |
| UK - England & Wa | 246 | 433 | . | . | . | . | . | . | . |
| UK - Scotland | - | 1 | - | 1 | 1 | 6 | 7 | 1 | 4 |
| Total | 882 | 1184 | 1160 | 805 | 1191 | 1083 | 1016 | 775 | 902 |

| Country | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|
| Belgium* | 304 | 442 | 335 | 45 | 4 | 27 | 69 | 20 | 67 |
| Denmark | - | - | - | - | - | - | - | - | - |
| France | 48 | 69 | 49 | . | 54 | 50 | 45 | 32 | 32 |
| Ireland | 305 | 344 | 286 | 299 | 200 | 160 | 155 | 127 | 91 |
| Netherlands | 52 | - | 13 | 1 | 2 | - | - | - | - |
| Spain | - | - | - | 1 | 5 | 3 | 2 | 6 | 6 |
| UK - Eng+Wales+N | 154 | 138 | 106 | 82 | 75 | 73 | 59 | 56 | 36 |
| UK - England & Wa | . | . | . | . | . | . | . | . | . |
| UK - Scotland | 1 | 1 | 1 | 1 | 1 | - | - | - | - |
| Total | 864 | 994 | 790 | 428 | 341 | 313 | 330 | 241 | 232 |

| Country | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Belgium | 32 | 22 | 7 | 25 | 1 | 0 |
| Denmark | | | | | | 0 |
| France | 20 | 37 | 30 | 12 | 43 | 53 |
| Ireland | 90 | 65 | 72 | 72 | 71 | 66 |
| Netherlands | . | | | | | |
| Spain | . | 1 | 13 | 1 | | |
| UK - Eng+Wales+N | 28 | 18 | 20 | 12 | 32 | 35 |
| UK - England & Wa | . | | | | | |
| UK - Scotland | . | | | | | |
| Total | 170 | 143 | 142 | 122 | 147 | 154 |

* Belgian Landings up to 1998 include VIIg

**Table 7.11.2. Official landings of plaice in VIIjk.**

| Year | Bel | Fra | Irl | Esp | UK | Total |
|---|---|---|---|---|---|---|
| 1993 | . | 8 | 383 | - | 46 | 437 |
| 1994 | . | 6 | 251 | - | 60 | 317 |
| 1995 | . | 12 | 317 | - | 90 | 419 |
| 1996 | . | 3 | 295 | - | 38 | 336 |
| 1997 | . | 6 | 337 | - | 32 | 375 |
| 1998 | . | 8 | 282 | - | 16 | 306 |
| 1999 | 42 | 0 | 296 | <0.5 | 15 | 353 |
| 2000 | 4 | 16 | 195 | 5 | 9 | 229 |
| 2001 | - | 16 | 157 | 3 | 6 | 182 |
| 2002 | 14 | 21 | 155 | 2 | 5 | 197 |
| 2003 | 4 | 7 | 125 | 6 | 9 | 151 |
| 2004 | <0.5 | 5 | 87 | 6 | 6 | 104 |
| 2005 | - | 4 | 88 | - | 2 | 94 |
| 2006 | - | 6 | 63 | 1 | 1 | 71 |
| 2007 | - | 9 | 72 | 11 | 2 | 94 |
| 2008 | - | 5 | 72 | 1 | 1 | 79 |
| 2009 | - | 6 | 71 | - | 2 | 79 |
| 2010* | - | 10 | 66 | - | 1 | 77 |

*** Preliminary data.**

**Table 7.11.3. Catch numbers-at-age for plaice in VIIjk.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 0 | 92 | 624 | 479 | 115 | 45 | 23 | 10 | 6 | 2 | 0 | 1 |
| 1994 | 68 | 104 | 340 | 260 | 82 | 46 | 18 | 8 | 5 | 1 | 1 | 0 |
| 1995 | 10 | 208 | 634 | 348 | 107 | 36 | 16 | 7 | 4 | 1 | 2 | 0 |
| 1996 | 1 | 77 | 316 | 229 | 127 | 37 | 23 | 5 | 1 | 0 | 0 | 0 |
| 1997 | 0 | 164 | 277 | 269 | 120 | 42 | 20 | 5 | 0 | 0 | 0 | 9 |
| 1998 | 0 | 46 | 355 | 164 | 103 | 38 | 26 | 10 | 4 | 3 | 0 | 0 |
| 1999 | 11 | 143 | 312 | 201 | 65 | 37 | 18 | 11 | 9 | 2 | 2 | 8 |
| 2000 | 2 | 74 | 161 | 190 | 64 | 36 | 7 | 5 | 3 | 2 | 0 | 2 |
| 2001 | 1 | 55 | 165 | 146 | 47 | 6 | 21 | 2 | 7 | 0 | 0 | 0 |
| 2002 | 0 | 54 | 155 | 172 | 54 | 42 | 44 | 12 | 4 | 2 | 0 | 1 |
| 2003 | 0 | 74 | 165 | 65 | 29 | 6 | 15 | 11 | 2 | 2 | 1 | 0 |
| 2004 | 7 | 31 | 121 | 91 | 27 | 12 | 2 | 2 | 4 | 1 | 1 | 0 |
| 2005 | 1 | 25 | 71 | 77 | 48 | 22 | 13 | 4 | 0 | 1 | 0 | 1 |
| 2006 | 0 | 17 | 41 | 53 | 38 | 12 | 7 | 1 | 1 | 0 | 2 | 0 |
| 2007 | 0 | 47 | 136 | 61 | 22 | 17 | 4 | 2 | 0 | 0 | 0 | 0 |
| 2008 | 1 | 55 | 106 | 70 | 21 | 5 | 2 | 1 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 13 | 112 | 78 | 30 | 11 | 5 | 0 | 1 | 0 | 0 | 0 |
| 2010 | 1 | 58 | 43 | 60 | 43 | 18 | 4 | 1 | 1 | 1 | 0 | 0 |

**Table 7.11.4. Weight-at-age for plaice in VIIjk.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | | 0.197 | 0.256 | 0.306 | 0.417 | 0.582 | 0.750 | 0.933 | 1.159 | 1.534 | | 1.969 |
| 1994 | 0.046 | 0.222 | 0.302 | 0.368 | 0.460 | 0.563 | 0.708 | 0.871 | 1.031 | 1.307 | 1.373 | |
| 1995 | 0.100 | 0.228 | 0.272 | 0.325 | 0.390 | 0.519 | 0.645 | 0.818 | 1.197 | 1.475 | 1.558 | |
| 1996 | 0.029 | 0.298 | 0.379 | 0.431 | 0.463 | 0.512 | 0.528 | 0.494 | 0.595 | 2.322 | | |
| 1997 | 1.111 | 0.285 | 0.338 | 0.431 | 0.485 | 0.653 | 0.807 | 0.928 | | | | 1.314 |
| 1998 | | 0.249 | 0.308 | 0.419 | 0.529 | 0.690 | 0.779 | 0.757 | 0.941 | 1.192 | 2.201 | |
| 1999 | 0.218 | 0.289 | 0.354 | 0.417 | 0.596 | 0.627 | 0.840 | 0.881 | 1.170 | 1.731 | 2.121 | 1.135 |
| 2000 | 0.119 | 0.274 | 0.348 | 0.420 | 0.486 | 0.610 | 0.805 | 1.113 | 1.437 | 1.088 | | 1.737 |
| 2001 | 0.214 | 0.243 | 0.325 | 0.405 | 0.536 | 0.648 | 0.798 | 0.561 | 1.119 | | | |
| 2002 | | 0.211 | 0.296 | 0.328 | 0.415 | 0.498 | 0.567 | 0.701 | 1.014 | 1.098 | | 1.532 |
| 2003 | | 0.274 | 0.356 | 0.402 | 0.482 | 0.575 | 0.737 | 0.881 | 1.048 | 1.872 | 1.257 | |
| 2004 | 0.128 | 0.258 | 0.309 | 0.341 | 0.448 | 0.550 | 0.633 | 0.635 | 0.900 | 1.137 | 1.328 | 1.803 |
| 2005 | 0.174 | 0.238 | 0.276 | 0.324 | 0.381 | 0.459 | 0.731 | 0.949 | | 1.222 | 1.534 | 2.020 |
| 2006 | | 0.272 | 0.319 | 0.370 | 0.438 | 0.520 | 0.794 | 0.895 | 0.792 | | 1.880 | |
| 2007 | | 0.239 | 0.281 | 0.354 | 0.433 | 0.482 | 0.573 | 0.727 | 1.394 | 0.837 | 1.266 | |
| 2008 | 0.293 | 0.239 | 0.282 | 0.336 | 0.358 | 0.530 | 0.756 | 0.399 | 1.106 | 1.576 | | |
| 2009 | | 0.224 | 0.255 | 0.335 | 0.403 | 0.462 | 0.520 | | 1.080 | | 1.393 | 1.138 |
| 2009 | 0.213 | 0.257 | 0.308 | 0.339 | 0.364 | 0.451 | 0.532 | 0.734 | 0.698 | 0.730 | 0.155 | |

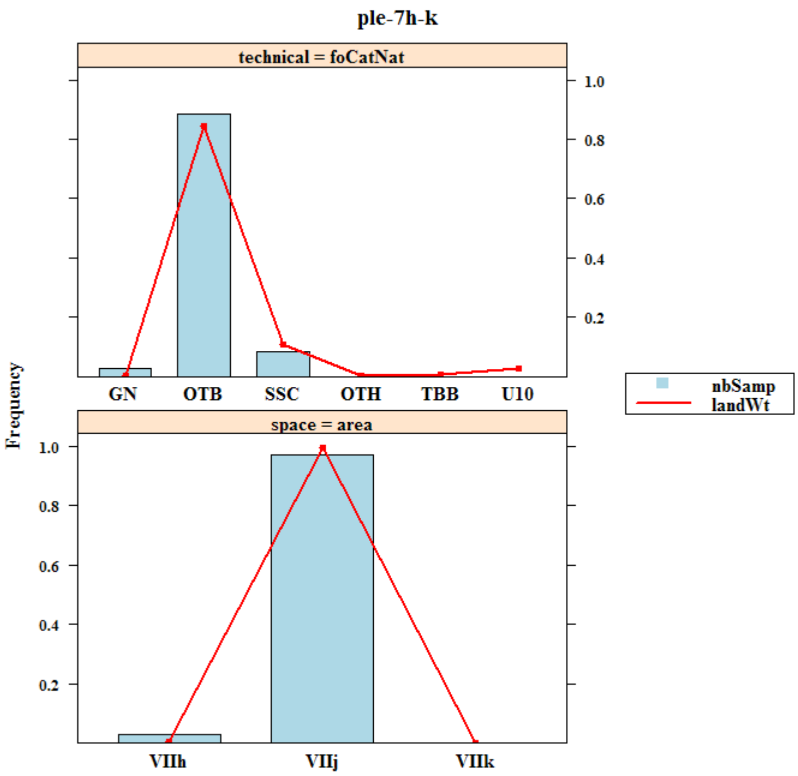



**Figure 7.11.1. Irish Operational landings and sampling levels (number of samples) for plaice in VIIjk by gear type (top) and ICES Division (bottom). The sampling appears to be representative of the landings.**

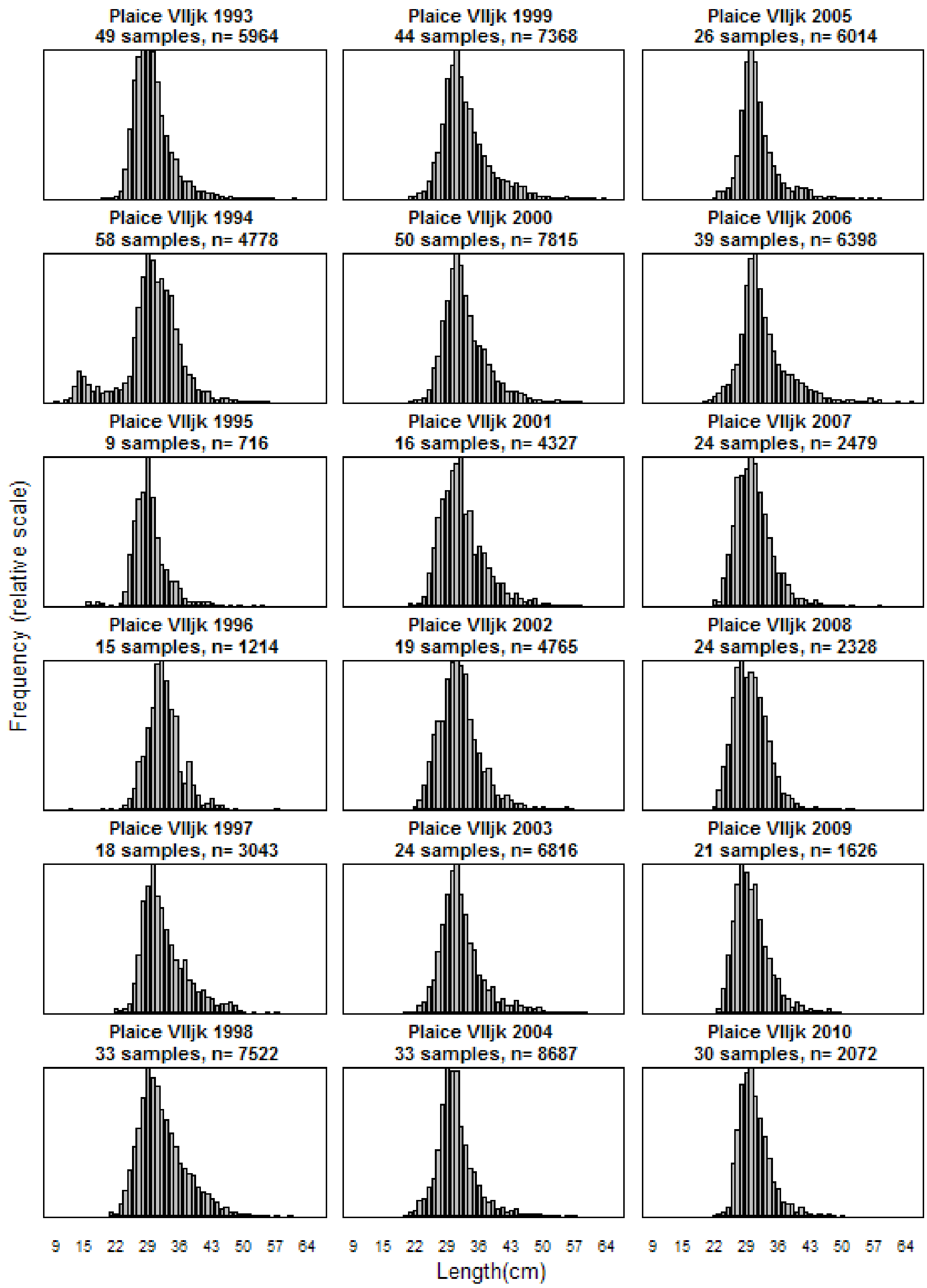



**Figure 7.11.2. Length frequency distribution of the Irish landings of plaice in VIIjk between 1993 and 2010. All gears and quarters combined.**

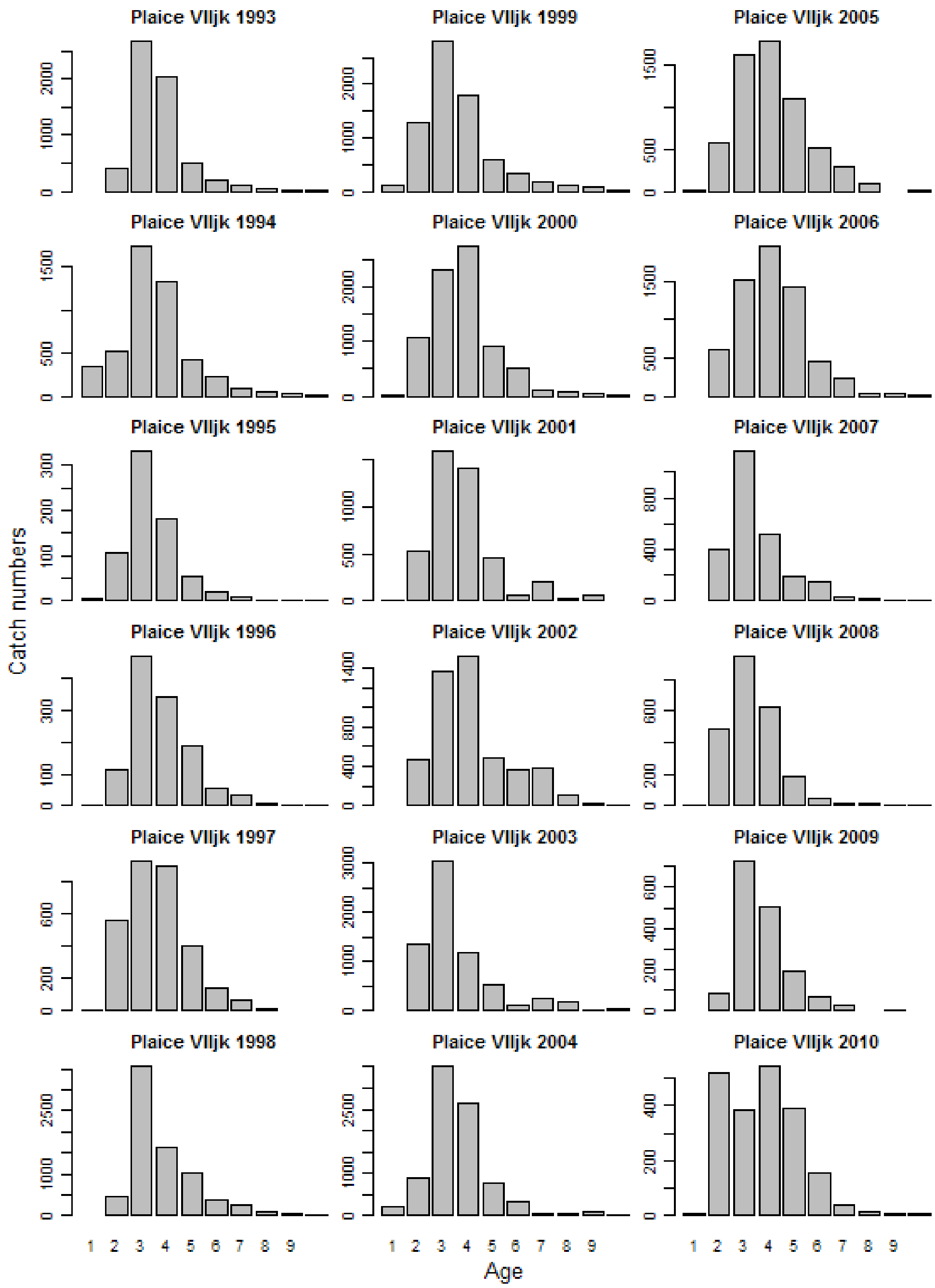



**Figure 7.11.3. Age distribution of plaice in VIIjk between 1993 and 2010. All gears and quarters combined. The age data for 1995 were considered insufficient and for this year the combined age data for 1993–1996 were used.**

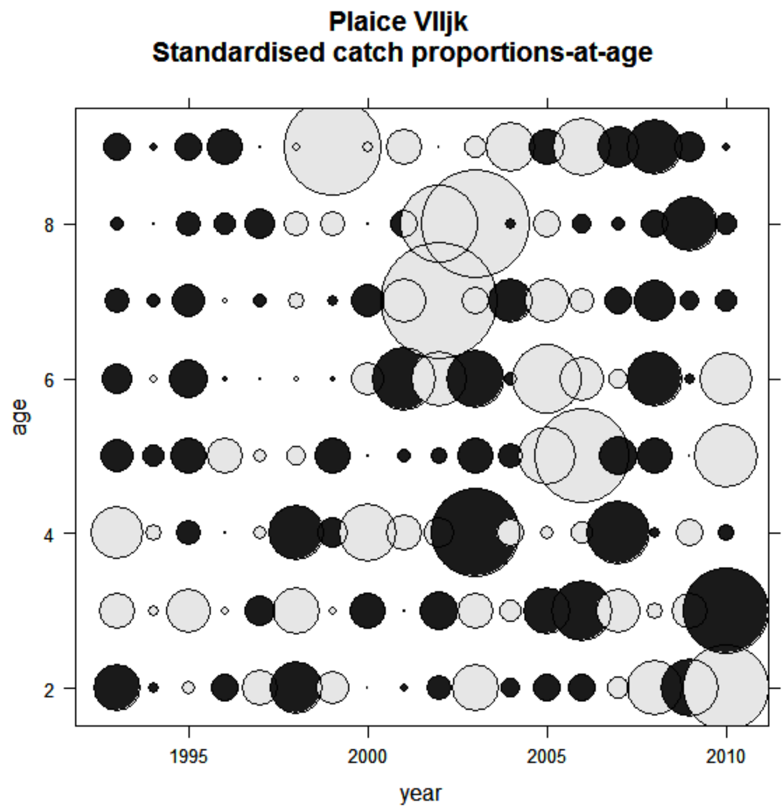



Figure 7.11.4. Standardized catch proportions-at-age for plaice in VIIjk. Grey bubbles represent higher than average catch-at-age and black bubbles represent lower than average catch-at-age.

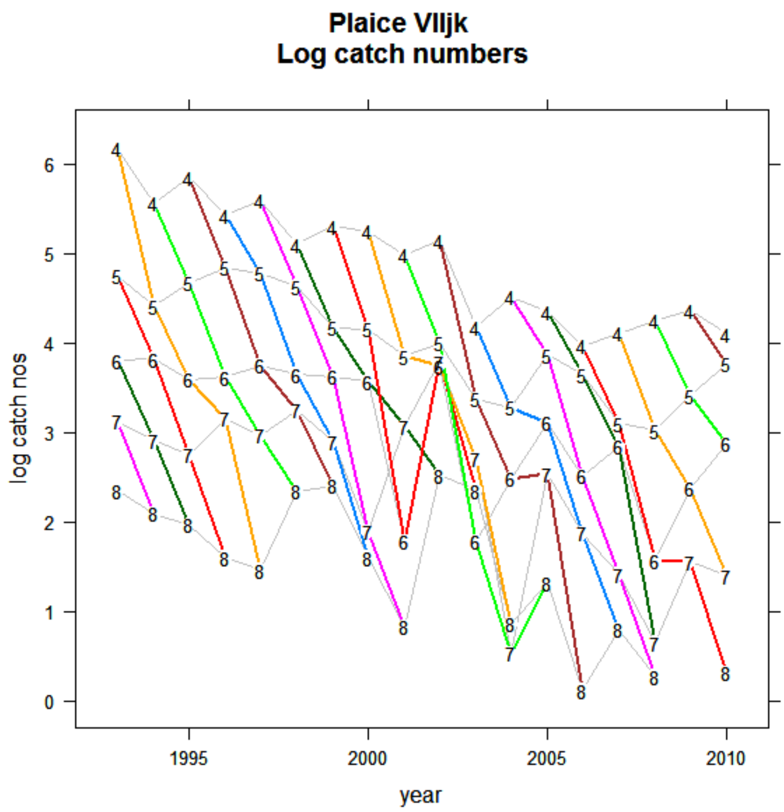



Figure 7.11.5. Log catch numbers-at-age (ages 4–8).

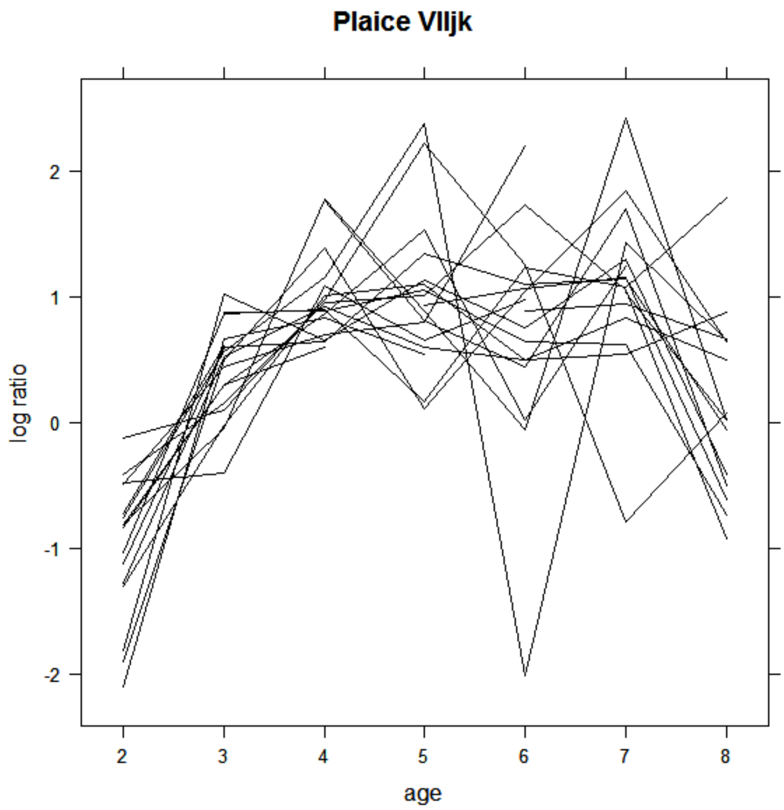



**Figure 7.11.6. Catch curve of plaice in VIIjk. Plaice from the age of 4 appear to be fully selected; the data get quite noisy from the age of 7 onwards.**

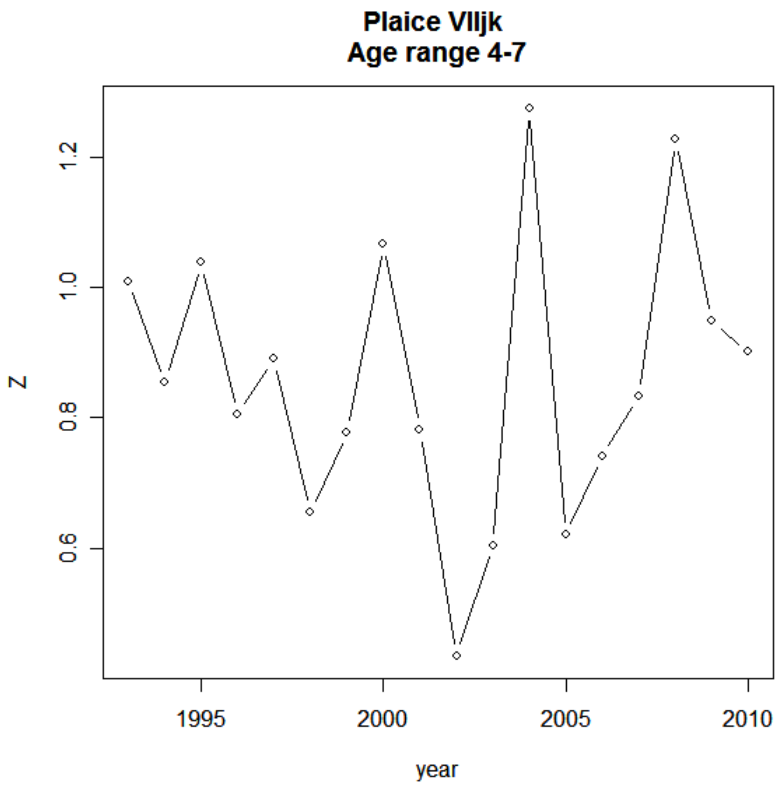



**Figure 7.11.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.**

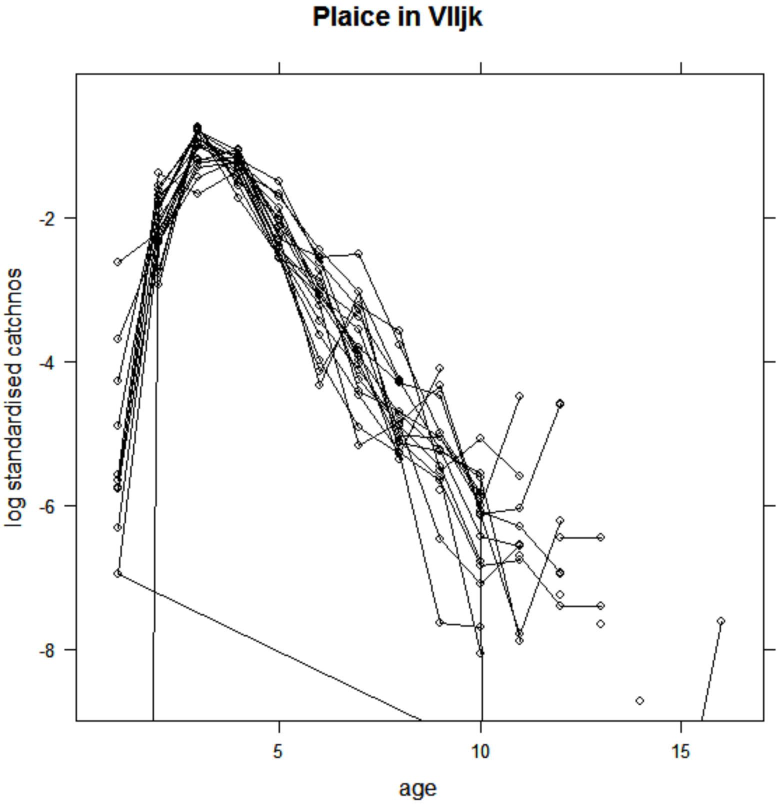



**Figure 7.11.8. Log catch numbers (standardized by year). Fish appear to be fully selected from the age of 4.**

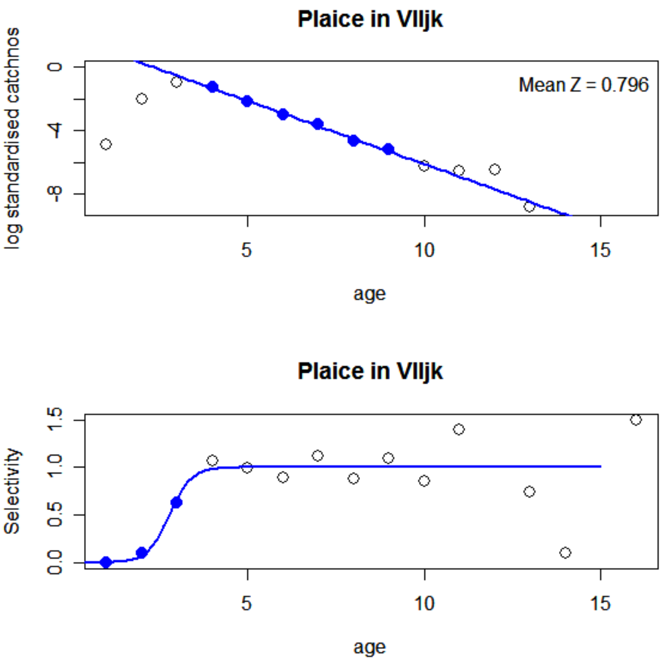



**Figure 7.11.9. Selectivity was modelled by fitting a line through the mean log standardized catch numbers of ages 4 to 9 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.**

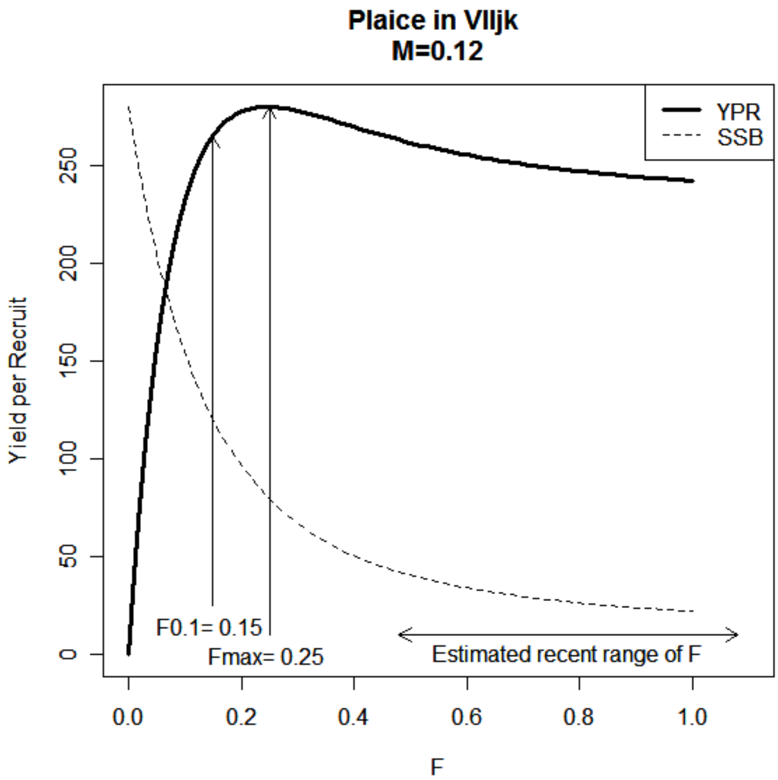



**Figure 7.11.10. YPR analysis using the Thompson-Bell approach. Recent estimates of Z were between 0.6 to 1.2 which translates to an F of 0.48 to 1.08.**

## 7.12 Sole in West of Ireland Division VIIb, c

### Type of assessment in 2011

No assessment was performed.

### 7.12.1 General

#### Stock Identity

Sole in VIIb are mainly caught by Irish vessels on sandy grounds in coastal areas. Sole catches in VIIc are negligible. In VIIb there are two distinct areas where sole are caught: an area to the west of the Aran Islands and an area in the north of VIIb which extends into VIa (the Stags Ground). The landings and lpue of Sole in VIIbc appear to have been more or less stable since the start of the logbooks time-series in 1995 (WD1, WGCSE 2009). It is not known how much exchange there is between sole on the Aran grounds and those on the Stags ground.

### 7.12.2 Data

The nominal landings are given in Table 7.12.1.

**Table 7.12.1. Landings of Sole in VIIbc as officially reported to ICES.**

| Country | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | - | 25 | 7 | 6 | 3 | 3 | 6 | 9 | 6 | 5 | 9 | 3 | 6 |
| Ireland | 12 | 12 | 19 | 44 | 14 | 16 | 13 | 24 | 47 | 55 | 40 | 17 | 44 |
| Spain | 19 | 16 | 30 | 25 | 1 | - | 11 | 1 | - | - | - | - | - |
| UK - Eng+\ | . | . | . | . | . | . | . | . | . | . | . | . | . |
| UK - Engla | - | - | - | - | - | - | - | - | - | 1 | - | - | - |
| Total | 31 | 53 | 56 | 75 | 18 | 19 | 30 | 34 | 53 | 61 | 49 | 20 | 50 |

| Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 8 | 2 | 2 | - | - | 5 | 2 | 1 | 1 | 2 | 2 | 3 | - |
| Ireland | 29 | 39 | 34 | 38 | 41 | 46 | 43 | 59 | 60 | 59 | 52 | 51 | 49 |
| Spain | - | - | - | - | - | - | - | - | - | - | - | - | - |
| UK - Eng+\ | . | . | . | - | - | - | - | - | - | - | - | 1 | - |
| UK - Engla | - | - | 1 | . | . | . | . | . | . | . | . | . | . |
| Total | 37 | 41 | 37 | 38 | 41 | 51 | 45 | 60 | 61 | 61 | 54 | 55 | 49 |

| Country | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | . | 12 | 7 | 14 | 19 | 18 | 7 | 12 | 7 | 6 | 4 | 8 |
| Ireland | 68 | 65 | 53 | 50 | 50 | 49 | 38 | 31 | 34 | 31 | 46 | 35 |
| Spain | - | - | - | - | - | - | . | . | | | | |
| UK - Eng+\ | - | - | - | - | 0 | - | . | . | | | | |
| UK - Engla | . | . | . | . | . | . | . | . | | | | 0 |
| Total | 68 | 77 | 60 | 64 | 69 | 67 | 45 | 43 | 41 | 37 | 50 | 43 |

## 7.13 Sole in Divisions VIIfg

### Type of assessment in 2011: Update

#### ICES advice applicable to 2010

In the advice for 2010 ICES considered the stock as having full reproductive capacity and being harvested sustainably.

*Single-stock exploitation boundaries*

*Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects.*

*The current fishing mortality (2008) is estimated to be 0.27, which is slightly above the rate expected to lead to high long-term yields and low risk of stock depletion.*

*Exploitation boundaries in relation to precautionary limits*

*F should be kept below $F_{pa}$, corresponding to landings of less than 1185 tonnes in 2010. This is expected to keep the stock above $B_{pa}$.*

*Conclusion on exploitation boundaries*

*ICES advises that there is no long-term gain in yield to increase fishing mortality. ICES therefore recommends limiting landings in 2010 to no more than 920 t.*

#### ICES advice applicable to 2011

In the advice for 2011, the stock status was presented as follows:

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Below | Below | Below |
| $F_{PA}/F_{lim}$ | Below | Below | Below |

| Spawning-stock biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | Above | Above | Above |
| $B_{PA}/B_{lim}$ | Above | Above | Above |

*MSY approach*

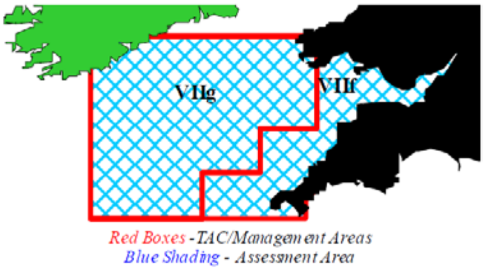
Following the ICES MSY framework implies fishing mortality to be 0.31, resulting in landings of 1400 t in 2011. This is expected to lead to an SSB of 4900 t in 2012.

*PA approach*

The fishing mortality in 2011 should be no more than $F_{pa}$ corresponding to landings of less than 1700 t in 2011. This is expected to keep SSB above $B_{pa}$ in 2012.

### 7.13.1 General

#### Stock description and management units




A TAC is in place for ICES Divisions VIIfg. These divisions do correspond to the stock area. The basis for the stock assessment Area VIIfg is described in detail in the Stock Annex.

#### Management applicable to 2010 and 2011

Management of sole in VIIfg is by TAC and technical measures. The agreed TACs in 2010 and 2011 are presented in the text tables below. Technical measures in force for this stock are minimum mesh sizes and minimum landing size (24 cm). National regulations also restricted areas for certain types of vessels.

#### 2010 TAC

| **Species:** | Common sole *Solea solea* | **Zone:** | VIIf and VIIg (SOL/7FG.) |
|---|---|---|---|
| Belgium | 621 | | |
| France | 62 | | |
| Ireland | 31 | | |
| United Kingdom | 279 | | |
| EU | 993 | | |
| TAC | 993 | | Analytical TAC |

#### 2011 TAC

| **Species:** | Common sole *Solea solea* | **Zone:** | VIIf and VIIg (SOL/7FG.) |
|---|---|---|---|
| Belgium | 775 | | |
| France | 78 | | |
| Ireland | 39 | | |
| United Kingdom | 349 | | |
| EU | 1 241 | | |
| TAC | 1 241 | | Analytical TAC |

Three rectangles in the Celtic Sea (30E4, 31E4 and 32E3) were closed during the first quarter of 2005, and in February–March each year from 2006 until 2011. A derogation has permitted beam trawlers to fish there in March 2005. The effects of this closure have been discussed in WGSSDS and ACFM 2007. No new information was available at the time of the update working group.

#### Fishery in 2010

The Working Group estimated the total international landings at 862 t in 2010 (Table 7.13.1), which is 13% below the 2010 TAC (993 t) and less than 1% different from last year's forecast of 866 t.

Early in the time-series officially reported landings included Divisions VIIg–k for some countries and their total was higher than the WG estimate. Since 1999 official landings correspond to Divisions VIIfg, and the total is lower than the working group estimate. During the period 2002–2004 the difference between the two estimates was substantial. This was mainly due to area misreporting, which was taken into account in the working group estimates.

### 7.13.2 Data

#### Landings

French landings submitted to the Working Group for 2009 were revised upward by 26% to 73 t. There were also minor revisions (<1%) from UK (E&W). The 2009 values for the numbers-at-age were therefore also updated. Total landings now amount to 805 t (Table 7.13.1).

Annual length compositions for 2010 are given by fleet in Table 7.13.2. Length distributions of the total Belgian and UK (E&W) landings for the last twelve years are plotted in Figure 7.13.1. Belgian land a greater proportion of small fish compared to the UK (England & Wales).

Quarterly numbers and weight-at-age data are available for the Belgian, UK(E&W) and Irish landings (approx. 95% of the total landings). Catch weights-at-age were calculated, weighted by national catch numbers-at-age, then quadratically smoothed in year (using age = 1.5, 2.5, etc.) and SOP-corrected. For 2010, the quadratic fit used was:

$$W(t) = +0.073 + (0.0569*(AGE)) - (0.0007*(AGE)^2) \qquad R2 = 0.97$$

Further details on raising procedures are given in the Stock Annex.

Stock weights-at-age were the first quarter catch weights of the Belgian, the UK and the Irish beam trawl fleets and smoothed by fitting a quadratic fit:

$$W(t) = -0.0505 + (0.0819*(AGE)) - (0.0023*(AGE)^2) \qquad R2 = 0.92$$

Catch numbers-at-age are given in Table 7.13.3, and weights-at-age in the catch and the stock are given in Tables 7.13.4-5. Age compositions over the last twelve years are plotted in Figure 7.13.2. The standardized catch proportion-at-age is presented in Figure 7.13.3.

All 2010 data has been uploaded into InterCatch. The aggregated data outside Intercatch has been compared with the Intercatch results and were almost identical apart from some minor differences of 1%.

Sampling levels for those countries providing age compositions are given in Table 2.1.

#### Discards

The available discard data indicate that discarding of sole is usually minor. In 2007, 2008, 2009 and 2010, discarding of sole in the UK fleet was estimated at about 3%, 1%, 6% and 9% respectively in numbers. Discard rates of sole in the Belgian beam trawl fleet were available to the working group for 2004–2005 and 2008–2010 accounting for about 5% of the total sole catches-in-weight. The length distributions of retained and discarded catches of sole from the Belgium beam trawl fleet in Area VIIf and VIIg separately for 2010 are presented in Figures 7.13.4a,b. The UK length distributions for 2007–2010 from samples of UK static gear are given in Figure 7.13.4c. The Irish length distributions from the otter trawl fleet for 2010 are shown in Figure 7.13.4d. It should be noted that the Irish otter trawl landings only amount to less than 2% of the total international landings.

#### Biological

Natural mortality was assumed to be 0.1 for all ages and years. The maturity ogive is based on samples taken during the UK(E&W) beam trawl survey of March 1993 and 1994 and is applied to all years of the assessment (See also stock annex).

The proportion of M and F before spawning was set to zero (see stock annex).

#### Surveys

Standardized abundance indices for the UK beam trawl survey (UK(E&W)-BTS-Q3)) are shown in Table 7.13.6 and Figure 7.13.5. Abundance-at-age 0 is highly variable and not used further on. The UK-survey appears to track the stronger year classes reasonably well from most of the ages. The internal consistency plot indicates also a reasonable fit for most of the age-range (Figure 7.13.6).

#### Commercial lpue

Available estimates of effort and lpue are presented in Tables 7.13.7–7.13.8 and Figure 7.13.7.

Belgian beam trawl (BE-CTB) effort was at highest levels in 2003–2005. During these years effort shifted from the Eastern English Channel (VIId) to the Celtic Sea because of days at sea limitations in the former area. In 2006, these restrictions had been lifted and effort decreased back to similar levels compared to the early 2000s. The sharp effort reduction in 2008 may be a combined result of the unrestricted effort regime in VIId and the high fuel prices. Effort stayed at the same level in 2009 and 2010. Lpue peaked in 2002. After a sharp decline to its record low in 2004, lpue has been increasing gradually to almost the highest level of the time-series in 2002.

The effort from the UK (E&W) beam trawl fleet (UK(E&W)-CBT) has declined sharply since the early 2000s to a record low in 2009. The 2010 value being slightly higher than the 2009 value. Lpue in the 1990s and 2000s was stable, but at lower levels compared to the period before. In 2007, lpue increased considerably and gave a similar value for 2008. In 2009, there was a decrease to a level just above the mean of the time-series, followed by a similar value for 2010.

Irish effort and lpue data are also presented. The main target species in the Irish fisheries are megrim, anglerfish, etc. The vessels usually operate on fishing grounds in the Western Celtic Sea with lower sole densities.

The internal consistency plots for the main two commercial lpue series, used in the assessment (UK(E&W)-CBT and BEL-CBT), show high consistencies for the entire age range (Figure 7.13.8–7.13.9).

#### Other relevant data

Reports from UK industry suggest that the main issues affecting the fishery in VIIfg were displacement of effort due to the rectangle closures and the restrictions on the use of 80 mm mesh west of 7°W (Trebilcock and Rozarieux, 2009).

No additional information was received from the Belgian, French and Irish industries.

### 7.13.3 Stock assessment

The method used to assess Celtic Sea sole is XSA, using one survey and two commercial tuning-series (Table 7.13.9). It should be noted that the year range of the Belgian commercial beam trawl tuning fleet only covers 1971 up to 2003 (see also Section 7.13.9. recommendation for next Benchmark). Table 7.13.9 also includes tuning indices of the Irish groundfish survey (IGFS-IBTS_Q4) and the commercial UK otter trawl fleet (UK(E&W)-COT) which are not used in this assessment.

#### Data screening

Adding the 2010 data to the time-series, together with the French and UK landings revisions for 2009 did not cause any additional anomalies compared to previous years. The "single fleet runs", "separable VPA", etc. that are usually used to screen the data of this stock are therefore not presented in this report, but are available in the 'Exploratory runs folder'. This folder also contains a comparison plot of SSB, R and F of last year's final assessment and of the same assessment but with the French and UK landings revisions. The trends were very similar for both assessments.

The catchability residuals for the final XSA are shown in Figure 7.13.10 and the XSA tuning diagnostics are given in Table 7.13.10. There is a year effect in 2007, 2008 and 2009 for the UK beam trawl fleet (UK-CBT, positive residuals) and for the UK beam trawl survey (UK(E&W)-BTS-Q3), negative residuals), indicating a conflicting signal between these two fleets (see also Section 7.13.9. recommendation for next Benchmark).

In this year's assessment the estimates for the recruiting year class 2009 were estimated solely by the UK beam trawl survey UK(E&W)-BTS-Q3) (Figure 7.13.11). The survivor estimates of the two prominent fleets (the UK(E&W)-BTS-Q3 survey and the UK(E&W)-CBT commercial fleet) which have at least 96% of the weighting for all the ages, differ from each other for most of the ages. However, it should be noted that the UK beam trawl survey is rather consistent in the predicted year-class strengths at different ages (see detailed diagnostics in ICES files), where the UK commercial beam trawl fleet has a higher variability of estimates of year-class strength at different ages. The working group was not able to clarify that particular issue. The different estimates from the two fleets do only generate a small retrospective bias and therefore probably balance off each other in the assessment. The working group also assumed that the Trevose closure, a change in special distribution of the UK beam trawl fleet and the ending of the Belgian tuning-series in 2003, may have an influence on the divergence in survivor estimates from both dominant tuning-series (see also Section 7.13.9 recommendation for next Benchmark).

F shrinkage gets low weights for all ages (<4%). The weighting of the survey decreases for the older ages as the commercial UK(E&W)-CBT fleet is given more weight (Figure 7.13.11).

#### Final update assessment

The final settings used in this year's assessment (and since 2006) are as detailed below:

| | 2011 assessment | | |
|---|---|---|---|
| Fleets | Years | Ages | α–β |
| BEL-CBT commercial | 1971–2003 | 2–9 | 0–1 |
| UK-CBT commercial | 1991–2009 | 2–9 | 0–1 |
| UK(E&W)-BTS-Q3 survey | 1988–2009 | 1–9 | 0.75–0.85 |

| | |
|---|---|
| -First data year | 1971 |
| -Last data year | 2010 |
| -First age | 1 |
| -Last age | 10+ |
| Time-series weights | None |
| -Model | Mean q model all ages |
| -Q plateau set at-age | 7 |
| -Survivors estimates shrunk towards mean F | 5 years/5 ages |
| -s.e. of the means | 1.5 |
| -Min s.e. for pop. Estimates | 0.3 |
| -Prior weighting | None |
| $F_{bar}$ (4–8) | |

Retrospective patterns for the final run are shown in Figure 7.13.12. SSB is generally underestimated and fishing mortality overestimated.

The final XSA output is given in Table 7.13.11 (fishing mortalities) and Table 7.13.12 (stock numbers). A summary of the XSA results is given in Table 7.13.13 and trends in yield, fishing mortality, recruitment and spawning–stock biomass are shown in Figure 7.13.13.

#### Comparison with previous assessment

With the addition of the 2010 data, estimates of fishing mortality and SSB for the most recent years were revised slightly. For example, last year fishing mortality and SSB in 2009 were estimated to be 0.19 and 4180 t. In this year's assessment, the 2009 estimates have been revised upwards by 20% (fishing mortality) and downwards by 10% (SSB). The estimated recruitment by XSA in 2009 (year class 2008) was revised downwards by 26% in this year's assessment.

#### State of the stock

Trends in landings, SSB, F(4–8) and recruitment are presented Table 7.13.13 and Figure 7.13.13.

During the eighties fishing mortality increased for this stock. In the following decades fishing mortality fluctuated around this higher level. However fishing mortality has decreased since the late 1990s and is estimated to be below $F_{MSY}$ (0.31) since 2006. Fishing mortality in 2010 is estimated to be 0.26.

Recruitment has fluctuated around 5 million recruits with occasional strong year classes. The 1998 year class is estimated to be the strongest in the time-series and the 2007 year class to be the second highest for this stock. The incoming recruitment (year class 2009) is estimated to be by far the weakest in the time-series.

SSB has declined almost continuously from the highest value of 8000 t in 1971 to the lowest observed in the time-series in 1998. The exceptional year class of 1998 has increased SSB to above the long-term average. The good recruitment 2008 is predicted to keep SSB well above $B_{pa}/B_{trigger}$.

### 7.13.4 Short-term projections

The 2008 year class was estimated to be around 5.4 million fish at age 1, which is about average and 26% lower than estimated last year.  The XSA survivor estimate for this year class was used for further prediction.

The 2009 year class in 2010 was estimated by XSA to be 1.2 million one year olds which is by far the lowest in the time-series. The estimates solely coming from the UK(E&W)-BTS-Q3 survey. The XSA survivor estimates for this year class were used for further prediction.

The long-term $GM_{71\text{–}08}$ recruitment (5.0 million) was assumed for the 2010 and subsequent year classes.

The working group estimates of year-class strength used for prediction can be summarized as follows:

| Year class | At age in 2011 | XSA | | Source |
|---|---|---|---|---|
| 2008 | 3 | 4206 | | XSA |
| 2009 | 2 | 1069 | | XSA |
| 2010 | 1 | - | 5025 | GM 1971–2008 |
| 2011 & 2012 | recruits | - | 5025 | GM 1971–2008 |

Population numbers at the start of 2011, estimated for ages 2 and older, were taken from the XSA output.

Fishing mortality was set as the mean over the last three years. Weights-at-age in the catch and in the stock are averages for the years 2008–2010. Input to the short-term predictions and the sensitivity analysis are shown in Table 7.13.14. Results are presented in Table 7.13.15 (management options) and Table 7.13.16 (detailed output).

Assuming *status quo* F, implies a catch in 2011 of around 960 t (the agreed TAC is 1241 t) and a catch of 880 t in 2012. Assuming *status quo* F will result in a SSB of 4060 t in 2012 and 3800 t in 2013.

Assuming *status quo* F, the proportional contributions of recent year classes to the predicted landings and SSB are given in Table 7.13.17. The assumed GM recruitment accounts for about 5% of the landings in 2012 and about 12% of the 2013 SSB.

Results of a sensitivity analysis are presented in Figure 7.13.14 (probability profiles). The approximate 90% confidence intervals of the expected *status quo* yield in 2012 are 650 t and 1150 t. There is less than 5% probability that at current fishing mortality SSB will fall below the $B_{pa}$ $B_{trigger}$ of 2200 t in 2013.

There are no known specific environmental drivers known for this stock.

### 7.13.5 MSY explorations

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2010, are given in Table 7.13.18 and Figure 7.13.15. $F_{max}$ is estimated to be 0.32. It should be noted that $F_{max}$ is poorly defined. Long-term yield and SSB (using GM recruitment and $F_{sq}$) are estimated to be 910 t and 4100 t respectively.

Investigations for possible $F_{msy}$ candidates for this stock were done in last year's WGCSE. ACOM adopted an $F_{msy}$ value of 0.31, based on stochastic simulations using a "Ricker" model (PLOTMSY program). $B_{trigger}$ was set to the $B_{pa}$ value of 2200 t.

### 7.13.6 Biological reference points

The Working Group's current approach to reference points is outlined in Section 1.4.4. Current biological reference points are given in the text table below:

| Reference points | ACFM 98 onwards |
|---|---|
| $F_{msy}$ | 0.31 (stochastic simulations using Ricker,WG2010) |
| $F_{lim}$ | 0.52 (based on $F_{loss}$, WG1998) |
| $F_{pa}$ | 0.37 ($F_{lim}$ x 0.72) |
| $B_{lim}$ | Not defined |
| $B_{pa}$ | 2200 t (based on $B_{loss}$ (1991), WG1998) |
| $B_{trigger}$ | $B_{pa}$ |

### 7.13.7 Management plans

There are no explicit management plans for Celtic Sea sole.

In 2006, the working group presented results from a series of medium-term scenarios, carried out in conjunction with VIIfg plaice, to simulate some possible management plans for the two stocks. Results indicated that an F in the range 0.27 to 0.49 in the long term would maintain yield at or above 95% of that given by $F_{max}$, while posing a low probability (<5%) of SSB falling below $B_{lim}$. Three year average exploitation patterns were calculated and are given in Figure 7.13.16. The results suggest that the results of the analysis carried out in 2006 can probably still be used. The results of the $F_{msy}$ analysis, carried out during last year's working group also confirm that a fishing mortality of 0.31 could be a candidate for a long-term management objective for sole in VIIfg, although other species caught in the fishery should also be considered.

### 7.13.8 Uncertainties and bias in assessment and forecast

#### Sampling

The major fleets fishing for VIIfg sole are sampled (approx. 95% of the total landings). Sampling is considered to be at a reasonable level (Table 2.1). However the assessment is likely to improve if a combined ALK is used to obtain the age composition (see Section 7.13.9).

#### Discards

Discard estimates, which are low (Figure 7.13.4a–d) are not included in the assessment.

#### Surveys

The UK(E&W)-BTS-Q3 survey, which is solely responsible for the recruiting estimates, has been able to track year-class strength at ages greater than 0 rather well in the past. However, the strong year classes have been revised downward in previous assessments and therefore estimates of the very strong year classes may cause bias in the forecast. This year's assessment estimates the incoming recruitment (year class 2009) the lowest of the time-series and therefore there is no major concern regarding an overly optimistic forecast.

#### Consistency

The assessment provided by the WG is highly consistent with last year's assessment with similar trends in fishing mortality, SSB and recruitment. There is only a slight retrospective pattern in the last few years, indicating that there is no major concern about the uncertainty in the assessment and the forecast.

#### Misreporting

Area misreporting is known to have been considerable over the period 2002–2004. This was due to a combination of the good 1998 year class still being an important part of the catch composition and more restrictive TACs. The area misreporting has been corrected for the years 2002–2006 (method explained in the report of WGSSDS 2007). Since 2007 the area misreporting that could be estimated was negligible (see stock annex).

### 7.13.9 Recommendation for next benchmark

| Year | Candidate Stock | Supporting Justification | Suggested time | Indicate expertise necessary at benchmark meeting |
|---|---|---|---|---|
| 2011 | VIIf,g sole | The use of a combined ALK from Belgium, UK(E&W) and Ireland instead of the use of separate ALK's by county at the moment.<br>A need to update the Belgian commercial tuning series. The Belgian beam trawl tuning-series is only used up to 2003, mainly because the estimation of the corresponding lpue series could not be calculated correctly. At the 2009 WKFLAT a possible way of calculating Belgian beam trawl lpue for Division VIId was proposed, using a more realistic horsepower correction method. The proposed method could be investigated, not only for the Belgian beam trawl lpue but also for the UK beam trawl lpue in Division VIIfg, which are the two commercial fleets used in this assessment.<br>Investigate the reason for the conflicting signals in the assessment diagnostics between the commercial UK(E&W)-CBT fleet and the UK(E&W)-BTS-Q3 survey (possible differences in spatial distributions, etc.)<br>Investigate if commercial tuning fleets should still be used in future assessments of sole in VIIfg.<br>Investigate the spatial distribution of the major Celtic sea fleets and possible impacts of the Trevose closure. | 2014 | Expert group members |

### 7.13.10 Management considerations

There is no apparent stock–recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 7.13.17).

SSB has declined almost continuously from the highest value of 8000 t in 1971 to the lowest observed in the time-series in 1998, increased subsequently due to the strong 1998 year class, to above the long-term average. The good recruitment in 2007 is predicted to keep SSB well above $B_{pa}/B_{trigger}$.

The Celtic Sea is an area without days at sea limitations for demersal fisheries. In this context and given that many demersal vessels are very mobile, changes in effort measures in areas other than the Celtic Sea, can influence the effort regime in the Celtic Sea (cfr. increased effort in Celtic Sea for Belgian beamers during 2004–2005 when days at sea limitations were in place for the Eastern English Channel).

## References

Trebilcock P. and N. de Rozarieux. 2009. National Federation Fishermen's Organisation Annual Fisheries Reports. Cornish Fish Producers Organisation / Seafood Cornwall Training Ltd, March 2009.

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Flatfish (WKFLAT 2009), 6–13 February 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:31. 192 pp.

**Table 7.13.1 - Celtic Sea Sole (ICES Divisions VIIfg). Official Nominal landings and data used by the Working Group (t)**

| Year | Belgium | Denmark | France | Ireland | UK(E.&W,NI.) | UK(Scotland) | Netherlands | Total-Official | Unallocated | Used by WG |
|---|---|---|---|---|---|---|---|---|---|---|
| 1986 | 1039 * | 2 | 146 | 188 | 611 | - | 3 | 1989 | -389 | 1600 |
| 1987 | 701 * | - | 117 | 9 | 437 | - | - | 1264 | -42 | 1222 |
| 1988 | 705 * | - | 110 | 72 | 317 | - | - | 1204 | -58 | 1146 |
| 1989 | 684 * | - | 87 | 18 | 203 | - | - | 992 | 0 | 992 |
| 1990 | 716 * | - | 130 | 40 | 353 | 0 | - | 1239 | -50 | 1189 |
| 1991 | 982 * | - | 80 | 32 | 402 | 0 | - | 1496 | -389 | 1107 |
| 1992 | 543 * | - | 141 | 45 | 325 | 6 | - | 1060 | -79 | 981 |
| 1993 | 575 * | - | 108 | 51 | 285 | 11 | - | 1030 | -102 | 928 |
| 1994 | 619 * | - | 90 | 37 | 264 | 8 | - | 1018 | -9 | 1009 |
| 1995 | 763 * | - | 88 | 20 | 294 | - | - | 1165 | -8 | 1157 |
| 1996 | 695 * | - | 102 | 19 | 265 | 0 | - | 1081 | -86 | 995 |
| 1997 | 660 * | - | 99 | 28 | 251 | 0 | - | 1038 | -111 | 927 |
| 1998 | 675 * | - | 98 | 42 | 198 | - | - | 1013 | -138 | 875 |
| 1999 | 604 | - | 61 | 51 | 231 | 0 | - | 947 | 65 | 1012 |
| 2000 | 694 | - | 74 | 29 | 243 | - | - | 1040 | 51 | 1091 |
| 2001 | 720 | - | 77 | 35 | 288 | - | - | 1120 | 48 | 1168 |
| 2002 | 703 | - | 65 | 32 | 318 | + | - | 1118 | 227 | 1345 |
| 2003 | 715 | - | 124 | 26 | 342 | + | - | 1207 | 185 | 1392 |
| 2004 | 735 | - | 79 | 33 | 283 | - | - | 1130 | 119 | 1249 |
| 2005 | 645 | - | 101 | 34 | 217 | - | - | 997 | 47 | 1044 |
| 2006 | 576 | - | 75 | 38 | 232 | - | - | 921 | 25 | 946 |
| 2007 | 582 | - | 85 | 32 | 244 | - | - | 943 | 2 | 945 |
| 2008 | 466 | - | 68 | 28 | 218 | - | - | 780 | 20 | 800 |
| 2009 | 513 | - | 74 | 26 | 194 | - | - | 807 | -2 | 805 |
| 2010 [1] | 620 | - | 45 | 27 | 179 | - | - | 871 | -9 | 862 |

1 Preliminar

* including VIIg-k

**Table 7.13.2 - Sole in VIIfg. Annual length distributions by fleet**

| Length (cm) | UK (England & Wales) Beam trawl | Belgium All gears | Ireland* All gears |
|---|---|---|---|
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | 62 | 189 | 61 |
| 22 | 1851 | 3743 | 210 |
| 23 | 1163 | 58842 | 657 |
| 24 | 10443 | 298836 | 1994 |
| 25 | 28050 | 393734 | 2880 |
| 26 | 40925 | 378233 | 4140 |
| 27 | 40343 | 346443 | 6103 |
| 28 | 44327 | 273845 | 5395 |
| 29 | 31067 | 187686 | 6268 |
| 30 | 29863 | 148949 | 5196 |
| 31 | 22994 | 107339 | 6275 |
| 32 | 26096 | 86778 | 5432 |
| 33 | 22690 | 67185 | 4629 |
| 34 | 22975 | 51023 | 4278 |
| 35 | 19108 | 54385 | 3714 |
| 36 | 19282 | 41765 | 2716 |
| 37 | 13266 | 31920 | 2967 |
| 38 | 14107 | 25279 | 1941 |
| 39 | 14509 | 21888 | 1655 |
| 40 | 11437 | 15140 | 1220 |
| 41 | 10292 | 11516 | 676 |
| 42 | 6378 | 6047 | 529 |
| 43 | 4784 | 5712 | 476 |
| 44 | 4018 | 2221 | 119 |
| 45 | 1810 | 2050 | 211 |
| 46 | 1679 | 642 | 16 |
| 47 | 949 | 487 | 43 |
| 48 | 330 | 788 | 0 |
| 49 | 13 | 278 | 16 |
| 50 | 123 | 28 | |
| 51 | 0 | 39 | |
| 52 | 42 | 101 | |
| 53 | | | |
| 54 | | | |
| 55 | | | |
| 56 | | | |
| 57 | | | |
| 58 | | | |
| 59 | | | |
| 60 | | | |
| Total | 444977 | 2623111 | 69817 |

* Distributions from sample only

## Table 7.13.3 - Sole in VIIfg. Catch numbers at age (in thousands)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 386 | 541 | 364 | 155 | 119 | 312 | 314 | 318 | 328 | 657 |
| 3 | 270 | 902 | 1882 | 438 | 287 | 834 | 438 | 741 | 560 | 972 |
| 4 | 1341 | 314 | 748 | 863 | 336 | 560 | 349 | 339 | 747 | 876 |
| 5 | 625 | 670 | 305 | 411 | 638 | 611 | 271 | 154 | 208 | 584 |
| 6 | 433 | 329 | 352 | 209 | 304 | 559 | 244 | 159 | 154 | 180 |
| 7 | 537 | 213 | 119 | 239 | 110 | 261 | 404 | 99 | 197 | 62 |
| 8 | 763 | 232 | 110 | 97 | 102 | 131 | 120 | 198 | 124 | 96 |
| 9 | 376 | 314 | 116 | 109 | 67 | 197 | 28 | 71 | 153 | 100 |
| +gp | 1220 | 730 | 644 | 541 | 372 | 463 | 365 | 174 | 169 | 352 |
| 0 TOTALNUM | 5951 | 4245 | 4640 | 3062 | 2335 | 3928 | 2533 | 2253 | 2640 | 3879 |
| TONSLAND | 1861 | 1278 | 1391 | 1105 | 919 | 1350 | 961 | 780 | 954 | 1314 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 602 | 342 | 647 | 672 | 196 | 494 | 318 | 526 | 479 | 277 |
| 3 | 675 | 831 | 1078 | 846 | 1473 | 1296 | 957 | 464 | 1164 | 994 |
| 4 | 792 | 309 | 729 | 606 | 766 | 1173 | 797 | 879 | 601 | 1176 |
| 5 | 399 | 467 | 284 | 542 | 565 | 526 | 577 | 441 | 621 | 399 |
| 6 | 377 | 280 | 349 | 184 | 296 | 358 | 273 | 387 | 237 | 452 |
| 7 | 150 | 207 | 225 | 277 | 100 | 193 | 205 | 127 | 188 | 138 |
| 8 | 120 | 92 | 192 | 106 | 140 | 87 | 100 | 78 | 82 | 115 |
| 9 | 94 | 111 | 52 | 47 | 73 | 103 | 61 | 67 | 24 | 50 |
| +gp | 380 | 326 | 320 | 274 | 240 | 328 | 179 | 268 | 102 | 129 |
| 0 TOTALNUM | 3589 | 2965 | 3876 | 3554 | 3849 | 4558 | 3467 | 3237 | 3498 | 3730 |
| TONSLAND | 1212 | 1128 | 1373 | 1266 | 1328 | 1600 | 1222 | 1146 | 992 | 1189 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1458 | 433 | 354 | 295 | 129 | 177 | 245 | 197 | 608 | 1721 |
| 3 | 690 | 1700 | 863 | 790 | 1156 | 1035 | 890 | 932 | 1718 | 1480 |
| 4 | 658 | 644 | 1104 | 739 | 1098 | 904 | 599 | 724 | 834 | 683 |
| 5 | 496 | 409 | 332 | 864 | 420 | 424 | 400 | 297 | 282 | 241 |
| 6 | 151 | 253 | 186 | 283 | 483 | 229 | 252 | 171 | 143 | 60 |
| 7 | 156 | 61 | 161 | 149 | 133 | 192 | 127 | 108 | 80 | 56 |
| 8 | 55 | 59 | 63 | 65 | 112 | 57 | 126 | 51 | 31 | 43 |
| 9 | 46 | 28 | 83 | 42 | 65 | 43 | 45 | 52 | 23 | 19 |
| +gp | 162 | 89 | 99 | 146 | 109 | 106 | 106 | 87 | 44 | 51 |
| 0 TOTALNUM | 3872 | 3676 | 3245 | 3373 | 3705 | 3167 | 2790 | 2619 | 3763 | 4354 |
| TONSLAND | 1107 | 981 | 928 | 1009 | 1157 | 995 | 927 | 875 | 1012 | 1091 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 704 | 29 | 119 | 425 | 271 | 685 | 335 | 211 | 612 | 264 |
| 3 | 1918 | 1465 | 697 | 1721 | 855 | 1330 | 865 | 447 | 468 | 1260 |
| 4 | 860 | 2202 | 1134 | 792 | 837 | 715 | 743 | 552 | 430 | 715 |
| 5 | 436 | 660 | 1860 | 794 | 473 | 576 | 474 | 558 | 349 | 333 |
| 6 | 242 | 249 | 402 | 721 | 398 | 163 | 325 | 274 | 295 | 247 |
| 7 | 65 | 95 | 223 | 114 | 348 | 148 | 157 | 196 | 175 | 157 |
| 8 | 39 | 54 | 80 | 60 | 48 | 178 | 145 | 75 | 104 | 114 |
| 9 | 26 | 36 | 26 | 34 | 41 | 44 | 184 | 108 | 44 | 64 |
| +gp | 81 | 51 | 75 | 49 | 43 | 51 | 70 | 171 | 194 | 112 |
| 0 TOTALNUM | 4371 | 4841 | 4616 | 4710 | 3314 | 3890 | 3298 | 2592 | 2671 | 3266 |
| TONSLAND | 1168 | 1345 | 1392 | 1249 | 1044 | 946 | 945 | 800 | 805 | 862 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

## Table 7.13.4 - Sole in VIIfg. Catch weights at age (kg)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

Table 2 Catch weights at age (kg)

| YEAR | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.039 | 0.106 | 0.081 | 0.063 | 0.046 | 0.114 | 0.098 | 0.068 | 0.023 | 0.048 |
| 2 | 0.106 | 0.147 | 0.143 | 0.137 | 0.132 | 0.167 | 0.169 | 0.154 | 0.132 | 0.144 |
| 3 | 0.167 | 0.186 | 0.202 | 0.205 | 0.212 | 0.218 | 0.235 | 0.234 | 0.232 | 0.234 |
| 4 | 0.222 | 0.226 | 0.258 | 0.270 | 0.286 | 0.268 | 0.297 | 0.309 | 0.321 | 0.316 |
| 5 | 0.272 | 0.264 | 0.311 | 0.329 | 0.355 | 0.316 | 0.355 | 0.378 | 0.401 | 0.392 |
| 6 | 0.315 | 0.302 | 0.361 | 0.385 | 0.417 | 0.363 | 0.409 | 0.441 | 0.471 | 0.461 |
| 7 | 0.352 | 0.340 | 0.408 | 0.436 | 0.473 | 0.409 | 0.460 | 0.499 | 0.531 | 0.523 |
| 8 | 0.383 | 0.376 | 0.452 | 0.483 | 0.523 | 0.453 | 0.506 | 0.551 | 0.581 | 0.579 |
| 9 | 0.408 | 0.413 | 0.493 | 0.525 | 0.567 | 0.496 | 0.548 | 0.598 | 0.622 | 0.627 |
| +gp | 0.4397 | 0.5384 | 0.6021 | 0.6239 | 0.6715 | 0.6649 | 0.6681 | 0.7196 | 0.6636 | 0.720 |
| 0 SOPCOFA | 1.000 | 1.001 | 1.001 | 1.000 | 1.000 | 0.999 | 1.000 | 0.998 | 1.001 | 0.999 |

Table 2 Catch weights at age (kg)

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.078 | 0.061 | 0.085 | 0.019 | 0.089 | 0.046 | 0.048 | 0.074 | 0.013 | 0.049 |
| 2 | 0.154 | 0.156 | 0.173 | 0.131 | 0.17 | 0.144 | 0.146 | 0.157 | 0.109 | 0.134 |
| 3 | 0.225 | 0.243 | 0.255 | 0.235 | 0.246 | 0.236 | 0.236 | 0.235 | 0.198 | 0.214 |
| 4 | 0.292 | 0.324 | 0.33 | 0.33 | 0.317 | 0.321 | 0.32 | 0.309 | 0.28 | 0.291 |
| 5 | 0.355 | 0.397 | 0.398 | 0.416 | 0.383 | 0.4 | 0.396 | 0.378 | 0.355 | 0.363 |
| 6 | 0.414 | 0.462 | 0.459 | 0.494 | 0.444 | 0.471 | 0.466 | 0.442 | 0.424 | 0.43 |
| 7 | 0.469 | 0.521 | 0.514 | 0.562 | 0.5 | 0.536 | 0.528 | 0.502 | 0.487 | 0.494 |
| 8 | 0.519 | 0.572 | 0.561 | 0.622 | 0.552 | 0.594 | 0.584 | 0.557 | 0.543 | 0.553 |
| 9 | 0.565 | 0.617 | 0.602 | 0.673 | 0.598 | 0.645 | 0.632 | 0.608 | 0.592 | 0.609 |
| +gp | 0.6654 | 0.7043 | 0.6786 | 0.7716 | 0.7026 | 0.7479 | 0.7404 | 0.7385 | 0.6909 | 0.7474 |
| 0 SOPCOFA | 0.9999 | 0.9994 | 1.0004 | 0.9985 | 1.0016 | 1.0004 | 1.001 | 0.9993 | 0.9993 | 0.9993 |

Table 2 Catch weights at age (kg)

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.054 | 0.073 | 0.057 | 0.081 | 0.068 | 0.027 | 0.074 | 0.079 | 0.015 | 0.078 |
| 2 | 0.15 | 0.147 | 0.134 | 0.151 | 0.147 | 0.124 | 0.156 | 0.163 | 0.122 | 0.166 |
| 3 | 0.239 | 0.216 | 0.207 | 0.216 | 0.22 | 0.214 | 0.234 | 0.244 | 0.222 | 0.248 |
| 4 | 0.32 | 0.281 | 0.275 | 0.276 | 0.288 | 0.296 | 0.307 | 0.32 | 0.315 | 0.322 |
| 5 | 0.393 | 0.342 | 0.338 | 0.331 | 0.351 | 0.372 | 0.376 | 0.393 | 0.4 | 0.39 |
| 6 | 0.459 | 0.398 | 0.396 | 0.38 | 0.409 | 0.439 | 0.44 | 0.462 | 0.478 | 0.451 |
| 7 | 0.516 | 0.451 | 0.45 | 0.425 | 0.462 | 0.5 | 0.5 | 0.528 | 0.549 | 0.506 |
| 8 | 0.566 | 0.499 | 0.5 | 0.465 | 0.51 | 0.552 | 0.555 | 0.589 | 0.613 | 0.553 |
| 9 | 0.608 | 0.543 | 0.545 | 0.5 | 0.553 | 0.598 | 0.605 | 0.647 | 0.67 | 0.594 |
| +gp | 0.674 | 0.6402 | 0.6445 | 0.5626 | 0.6429 | 0.6773 | 0.7071 | 0.7809 | 0.7655 | 0.6649 |
| 0 SOPCOFA | 0.9998 | 0.9995 | 0.9994 | 0.9996 | 0.9982 | 1.0008 | 0.9997 | 0.9994 | 1.0005 | 1 |

Table 2 Catch weights at age (kg)

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.066 | 0.054 | 0.123 | 0.066 | 0.068 | 0.085 | 0.075 | 0.098 | 0.132 | 0.091 |
| 2 | 0.148 | 0.13 | 0.171 | 0.13 | 0.145 | 0.139 | 0.139 | 0.155 | 0.178 | 0.145 |
| 3 | 0.225 | 0.202 | 0.218 | 0.194 | 0.219 | 0.192 | 0.2 | 0.209 | 0.225 | 0.198 |
| 4 | 0.296 | 0.271 | 0.266 | 0.256 | 0.288 | 0.245 | 0.258 | 0.26 | 0.271 | 0.249 |
| 5 | 0.363 | 0.336 | 0.313 | 0.317 | 0.354 | 0.297 | 0.313 | 0.31 | 0.317 | 0.299 |
| 6 | 0.425 | 0.399 | 0.361 | 0.377 | 0.415 | 0.349 | 0.365 | 0.356 | 0.362 | 0.348 |
| 7 | 0.482 | 0.457 | 0.408 | 0.435 | 0.473 | 0.4 | 0.414 | 0.401 | 0.408 | 0.395 |
| 8 | 0.533 | 0.513 | 0.454 | 0.493 | 0.528 | 0.451 | 0.46 | 0.443 | 0.453 | 0.44 |
| 9 | 0.579 | 0.564 | 0.501 | 0.549 | 0.578 | 0.501 | 0.503 | 0.482 | 0.498 | 0.485 |
| +gp | 0.6773 | 0.7045 | 0.6379 | 0.7217 | 0.6918 | 0.6177 | 0.6087 | 0.5448 | 0.6024 | 0.593 |
| 0 SOPCOFA | 0.9954 | 1.0001 | 1.0019 | 1.0003 | 1.0004 | 0.9992 | 0.9999 | 1.0035 | 0.9994 | 1.0012 |

**Table 7.13.5 - Sole in VIIfg. Stock weights at age (kg)**

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

Table 3 Stock weights at age (kg)

| YEAR | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 2 | 0.076 | 0.113 | 0.113 | 0.113 | 0.113 | 0.113 | 0.145 | 0.113 | 0.113 | 0.113 |
| 3 | 0.136 | 0.157 | 0.142 | 0.159 | 0.141 | 0.16 | 0.174 | 0.167 | 0.163 | 0.157 |
| 4 | 0.19 | 0.222 | 0.203 | 0.221 | 0.215 | 0.21 | 0.236 | 0.257 | 0.255 | 0.238 |
| 5 | 0.239 | 0.298 | 0.263 | 0.305 | 0.295 | 0.269 | 0.366 | 0.36 | 0.392 | 0.354 |
| 6 | 0.406 | 0.351 | 0.334 | 0.45 | 0.353 | 0.354 | 0.392 | 0.413 | 0.437 | 0.394 |
| 7 | 0.472 | 0.352 | 0.322 | 0.448 | 0.593 | 0.432 | 0.454 | 0.521 | 0.485 | 0.622 |
| 8 | 0.389 | 0.593 | 0.4 | 0.464 | 0.423 | 0.462 | 0.505 | 0.508 | 0.595 | 0.556 |
| 9 | 0.346 | 0.417 | 0.539 | 0.624 | 0.465 | 0.425 | 0.907 | 0.56 | 0.657 | 0.704 |
| +gp | 0.5826 | 0.6005 | 0.5822 | 0.6707 | 0.7112 | 0.728 | 0.7006 | 0.7826 | 0.6963 | 0.7714 |

Table 3 Stock weights at age (kg)

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 2 | 0.113 | 0.113 | 0.113 | 0.118 | 0.113 | 0.113 | 0.113 | 0.113 | 0.113 | 0.113 |
| 3 | 0.159 | 0.164 | 0.175 | 0.173 | 0.175 | 0.18 | 0.153 | 0.158 | 0.152 | 0.164 |
| 4 | 0.232 | 0.255 | 0.262 | 0.274 | 0.268 | 0.273 | 0.242 | 0.233 | 0.227 | 0.247 |
| 5 | 0.306 | 0.356 | 0.37 | 0.429 | 0.472 | 0.398 | 0.361 | 0.363 | 0.308 | 0.369 |
| 6 | 0.385 | 0.487 | 0.488 | 0.517 | 0.433 | 0.462 | 0.473 | 0.466 | 0.465 | 0.476 |
| 7 | 0.462 | 0.543 | 0.633 | 0.641 | 0.462 | 0.546 | 0.468 | 0.687 | 0.546 | 0.523 |
| 8 | 0.551 | 0.61 | 0.606 | 0.613 | 0.48 | 0.636 | 0.587 | 0.687 | 0.526 | 0.753 |
| 9 | 0.737 | 0.766 | 0.464 | 0.836 | 0.944 | 0.89 | 0.82 | 0.676 | 0.542 | 0.847 |
| +gp | 0.6627 | 0.8561 | 0.823 | 0.9784 | 0.7983 | 0.8435 | 0.8378 | 0.818 | 0.7522 | 0.9732 |

Table 3 Stock weights at age (kg)

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 2 | 0.113 | 0.113 | 0.148 | 0.113 | 0.113 | 0.104 | 0.113 | 0.113 | 0.11 | 0.062 |
| 3 | 0.179 | 0.184 | 0.196 | 0.135 | 0.143 | 0.186 | 0.178 | 0.195 | 0.204 | 0.169 |
| 4 | 0.23 | 0.265 | 0.267 | 0.227 | 0.233 | 0.284 | 0.276 | 0.282 | 0.317 | 0.306 |
| 5 | 0.356 | 0.388 | 0.392 | 0.329 | 0.335 | 0.387 | 0.386 | 0.371 | 0.433 | 0.434 |
| 6 | 0.536 | 0.498 | 0.47 | 0.43 | 0.441 | 0.486 | 0.495 | 0.454 | 0.541 | 0.534 |
| 7 | 0.376 | 0.751 | 0.492 | 0.521 | 0.54 | 0.573 | 0.598 | 0.529 | 0.635 | 0.603 |
| 8 | 0.859 | 0.754 | 0.576 | 0.599 | 0.629 | 0.647 | 0.689 | 0.593 | 0.712 | 0.648 |
| 9 | 0.735 | 0.475 | 0.636 | 0.661 | 0.705 | 0.708 | 0.766 | 0.644 | 0.772 | 0.677 |
| +gp | 0.6789 | 0.8963 | 0.7272 | 0.7572 | 0.8447 | 0.808 | 0.8923 | 0.7318 | 0.8525 | 0.707 |

Table 3 Stock weights at age (kg)

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| 2 | 0.113 | 0.113 | 0.158 | 0.116 | 0.149 | 0.143 | 0.117 | 0.151 | 0.147 | 0.14 |
| 3 | 0.187 | 0.189 | 0.205 | 0.176 | 0.213 | 0.188 | 0.177 | 0.2 | 0.21 | 0.208 |
| 4 | 0.312 | 0.289 | 0.258 | 0.248 | 0.275 | 0.235 | 0.236 | 0.249 | 0.271 | 0.271 |
| 5 | 0.434 | 0.403 | 0.317 | 0.329 | 0.337 | 0.284 | 0.294 | 0.298 | 0.33 | 0.33 |
| 6 | 0.538 | 0.512 | 0.381 | 0.415 | 0.399 | 0.334 | 0.35 | 0.349 | 0.386 | 0.385 |
| 7 | 0.619 | 0.609 | 0.449 | 0.502 | 0.459 | 0.386 | 0.406 | 0.4 | 0.439 | 0.434 |
| 8 | 0.68 | 0.691 | 0.521 | 0.587 | 0.52 | 0.441 | 0.46 | 0.453 | 0.491 | 0.479 |
| 9 | 0.725 | 0.757 | 0.594 | 0.667 | 0.579 | 0.496 | 0.513 | 0.506 | 0.54 | 0.52 |
| +gp | 0.7835 | 0.873 | 0.8113 | 0.869 | 0.7401 | 0.6414 | 0.6622 | 0.6027 | 0.6414 | 0.5988 |

**Table 7.13.6 - Sole in VIIfg. Indices of abundance (No/100km) for UK(E&W)-BTS-Q3) survey**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 30 | 81 | 326 | 49 | 19 | 5 | 0 | 0 | 0 | 0 |
| 1989 | 144 | 222 | 331 | 176 | 20 | 15 | 7 | 4 | 2 | 2 |
| 1990 | 30 | 385 | 313 | 50 | 16 | 4 | 7 | 3 | 0 | 0 |
| 1991 | 32 | 241 | 517 | 67 | 17 | 15 | 4 | 0 | 2 | 2 |
| 1992 | 4 | 394 | 260 | 139 | 30 | 18 | 10 | 1 | 2 | 1 |
| 1993 | 3 | 169 | 320 | 43 | 19 | 1 | 2 | 2 | 1 | 1 |
| 1994 | 1 | 333 | 387 | 99 | 14 | 7 | 7 | 0 | 0 | 2 |
| 1995 | 27 | 124 | 222 | 52 | 11 | 6 | 12 | 1 | 1 | 1 |
| 1996 | 3 | 150 | 211 | 54 | 23 | 6 | 2 | 3 | 1 | 2 |
| 1997 | 32 | 433 | 180 | 18 | 11 | 12 | 4 | 3 | 5 | 0 |
| 1998 | 90 | 770 | 411 | 50 | 9 | 7 | 4 | 2 | 1 | 5 |
| 1999 | 24 | 2464 | 250 | 32 | 14 | 5 | 4 | 4 | 1 | 0 |
| 2000 | 13 | 916 | 1356 | 31 | 22 | 5 | 0 | 2 | 1 | 1 |
| 2001 | 22 | 379 | 599 | 259 | 20 | 7 | 5 | 2 | 0 | 2 |
| 2002 | 8 | 663 | 238 | 127 | 102 | 12 | 6 | 2 | 3 | 0 |
| 2003 | 12 | 392 | 530 | 47 | 26 | 47 | 8 | 3 | 3 | 0 |
| 2004 | 55 | 750 | 377 | 87 | 13 | 19 | 37 | 4 | 2 | 0 |
| 2005 | 37 | 343 | 225 | 32 | 14 | 6 | 4 | 14 | 1 | 2 |
| 2006 | 11 | 273 | 201 | 39 | 13 | 7 | 0 | 2 | 10 | 0 |
| 2007 | 88 | 357 | 108 | 43 | 14 | 11 | 6 | 3 | 3 | 12 |
| 2008 | 5 | 1039 | 104 | 13 | 15 | 6 | 8 | 3 | 3 | 4 |
| 2009 | 1 | 509 | 318 | 24 | 6 | 8 | 3 | 2 | 2 | 2 |
| 2010 | 16 | 85 | 471 | 122 | 17 | 2 | 6 | 7 | 3 | 1 |
| Geomean | 15 | 359 | 306 | 55 | 17 | 8 | 6 | 3 | 2 | 2 |
| Mean | 30 | 499 | 359 | 72 | 20 | 10 | 6 | 3 | 2 | 2 |

**Table 7.13.7 - Sole in VIIfg. Indices of effort.**

| | England & Wales | | Belgium | | Ireland | | |
|---|---|---|---|---|---|---|---|
| Year | Otter trawl | Beam trawl[1] | Beam trawl[2] | Beam trawl[4] | Otter trawl[3] | Scottish seine[4] | Beam trawl[4] |
| 1971 | | | 11.06 | | | | |
| 1972 | 45.72 | | 8.44 | | | | |
| 1973 | 45.28 | | 17.39 | | | | |
| 1974 | 38.94 | | 18.83 | | | | |
| 1975 | 33.53 | | 16.38 | | | | |
| 1976 | 25.61 | | 28.07 | | | | |
| 1977 | 27.16 | | 24.11 | | | | |
| 1978 | 27.08 | 2.50 | 18.09 | | | | |
| 1979 | 23.84 | 1.96 | 18.90 | | | | |
| 1980 | 26.43 | 4.31 | 29.02 | | | | |
| 1981 | 24.10 | 6.24 | 35.39 | | | | |
| 1982 | 19.20 | 9.95 | 28.77 | | | | |
| 1983 | 17.61 | 12.35 | 34.95 | | | | |
| 1984 | 23.16 | 13.55 | 33.48 | | | | |
| 1985 | 25.24 | 18.70 | 40.49 | | | | |
| 1986 | 21.18 | 20.72 | 52.46 | | | | |
| 1987 | 24.43 | 38.76 | 37.26 | | | | |
| 1988 | 20.09 | 25.62 | 42.92 | | | | |
| 1989 | 17.61 | 20.26 | 53.58 | | | | |
| 1990 | 22.56 | 30.77 | 40.27 | | | | |
| 1991 | 18.57 | 40.81 | 18.05 | | | | |
| 1992 | 16.00 | 35.78 | 25.47 | | | | |
| 1993 | 13.79 | 39.64 | 31.27 | | | | |
| 1994 | 9.48 | 37.03 | 38.35 | | | | |
| 1995 | 8.46 | 37.59 | 47.81 | | 63.56 | 6.43 | 20.78 |
| 1996 | 8.67 | 39.78 | 47.63 | 53.27 | 60.22 | 9.73 | 26.76 |
| 1997 | 8.14 | 43.00 | 51.98 | 57.36 | 65.10 | 16.13 | 28.36 |
| 1998 | 7.13 | 47.84 | 52.11 | 57.79 | 72.30 | 14.94 | 35.37 |
| 1999 | 5.69 | 50.87 | 55.03 | 55.11 | 51.66 | 8.01 | 41.09 |
| 2000 | 4.05 | 51.19 | 56.05 | 51.34 | 60.60 | 9.90 | 37.11 |
| 2001 | 4.42 | 49.32 | 52.06 | 54.90 | 69.43 | 16.33 | 39.71 |
| 2002 | 6.10 | 37.53 | 43.24 | 49.60 | 79.63 | 20.86 | 31.62 |
| 2003 | 9.94 | 40.71 | 42.81 | 62.73 | 86.87 | 20.91 | 49.42 |
| 2004 | 9.42 | 32.37 | | 78.73 | 97.11 | 19.38 | 57.72 |
| 2005 | 12.09 | 27.73 | | 64.50 | 126.19 | 14.81 | 51.76 |
| 2006 | 12.97 | 18.57 | | 50.28 | 120.10 | 14.79 | 63.22 |
| 2007 | 10.66 | 15.37 | | 45.72 | 137.13 | 15.82 | 56.63 |
| 2008 | 10.13 | 13.83 | | 28.71 | 126.40 | 11.65 | 38.68 |
| 2009 | 8.97 | 12.31 | | 30.85 | 137.61 | 8.19 | 39.13 |
| 2010 | 7.62 | 14.44 | | 32.22 | 140.82 | 9.69 | 40.98 |

[1]Division VIIf only - Fishing hours (x10^3) corrected for fishing power

[2]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23

[3]Division VIIg only - Fishing hours (x10^3)

[4]Fishing hours (x10^3)

**Table 7.13.8 - Sole in VIIfg. LPUE**

| | UK | England & Wales | | | Belgium | | Ireland | | |
|---|---|---|---|---|---|---|---|---|---|
| | BT Survey[4] | Otter trawl[1] | Otter trawl[1] | Beam trawl[1] | Beam trawl[2] | Beam trawl[5] | Otter trawl[5] | Scottish sein[5] | Beam trawl[5] |
| Year | Division VIIfg | Division VIIf | Division VIIg[3] | Division VIIf | Division VIIfg | Division VIIfg | Division VIIg | Division VIIg | Division VIIg |
| 1971 | - | | | - | 47.92 | | | | |
| 1972 | - | 2.42 | 2.11 | - | 37.06 | | | | |
| 1973 | - | 2.45 | 0.98 | - | 39.47 | | | | |
| 1974 | - | 2.10 | 1.83 | - | 37.81 | | | | |
| 1975 | - | 1.82 | 1.79 | - | 31.41 | | | | |
| 1976 | - | 2.02 | 1.30 | - | 30.50 | | | | |
| 1977 | - | 1.84 | 1.21 | - | 27.90 | | | | |
| 1978 | - | 1.82 | 1.17 | 13.99 | 23.35 | | | | |
| 1979 | - | 1.80 | 1.15 | 14.83 | 33.19 | | | | |
| 1980 | - | 1.86 | 1.55 | 18.99 | 29.73 | | | | |
| 1981 | - | 1.45 | 0.60 | 13.58 | 24.03 | | | | |
| 1982 | - | 1.73 | 0.56 | 11.79 | 25.93 | | | | |
| 1983 | - | 2.22 | 1.14 | 13.50 | 22.18 | | | | |
| 1984 | - | 1.53 | 1.70 | 13.59 | 20.78 | | | | |
| 1985 | - | 1.55 | 1.55 | 12.52 | 17.94 | | | | |
| 1986 | - | 1.38 | 0.99 | 10.94 | 17.83 | | | | |
| 1987 | - | 0.94 | 1.15 | 7.31 | 17.32 | | | | |
| 1988 | 71.14 | 0.62 | 0.27 | 4.39 | 15.29 | | | | |
| 1989 | 135.18 | 0.99 | 0.87 | 5.38 | 11.33 | | | | |
| 1990 | 90.67 | 0.76 | 0.67 | 5.98 | 15.64 | | | | |
| 1991 | 122.88 | 0.69 | 0.85 | 4.80 | 24.24 | | | | |
| 1992 | 115.79 | 1.00 | 1.25 | 4.14 | 18.57 | | | | |
| 1993 | 75.42 | 0.55 | 0.25 | 4.80 | 15.21 | | | | |
| 1994 | 107.77 | 0.90 | 0.27 | 4.26 | 13.94 | | | | |
| 1995 | 72.50 | 0.96 | 0.87 | 4.52 | 13.62 | | 0.40 | 0.62 | 0.81 |
| 1996 | 70.15 | 0.66 | 0.52 | 3.94 | 11.27 | 11.45 | 0.73 | 0.05 | 0.88 |
| 1997 | 81.66 | 0.86 | 0.52 | 3.28 | 9.96 | 9.68 | 0.42 | 0.23 | 1.16 |
| 1998 | 135.41 | 0.60 | 0.40 | 2.67 | 10.12 | 9.64 | 0.48 | 0.11 | 1.13 |
| 1999 | 168.46 | 0.91 | 0.74 | 3.21 | 11.26 | 12.14 | 0.17 | 0.09 | 0.50 |
| 2000 | 236.43 | 0.49 | 1.85 | 3.36 | 11.90 | 13.77 | 0.19 | 0.05 | 0.26 |
| 2001 | 154.79 | 1.14 | 2.13 | 4.02 | 13.25 | 13.60 | 0.27 | 0.55 | 0.15 |
| 2002 | 118.11 | 0.78 | 3.60 | 5.64 | 18.71 | 17.80 | 0.42 | 0.29 | 0.14 |
| 2003 | 123.93 | 0.57 | 0.00 | 5.23 | 19.48 | 11.40 | 0.12 | 0.03 | 0.20 |
| 2004 | 149.65 | 0.60 | 0.19 | 5.75 | | 9.17 | 0.18 | 0.02 | 0.20 |
| 2005 | 76.26 | 0.76 | 0.26 | 4.94 | | 9.78 | 0.14 | 0.00 | 0.29 |
| 2006 | 68.96 | 1.16 | 0.60 | 5.97 | | 10.70 | 0.11 | 0.05 | 0.29 |
| 2007 | 80.95 | 0.78 | 1.00 | 9.87 | | 11.74 | 0.13 | 0.02 | 0.21 |
| 2008 | 115.96 | 0.82 | 0.86 | 9.46 | | 14.51 | 0.12 | 0.02 | 0.31 |
| 2009 | 89.80 | 0.94 | 0.46 | 6.37 | | 12.90 | 0.10 | 0.00 | 0.29 |
| 2010 | 109.55 | 1.00 | 0.63 | 5.92 | | 16.00 | 0.13 | 0.01 | 0.21 |

[1]Kg/hr corrected for GRT.

[2]Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[3]Division VIIg (East).

[4]Kg/100km

[5]Kg/hour

# Table 7.13.9 - Sole in VIIfg. Tuning series

**Indices in bold are used in the assessment**

**BE-CBT** **Belgium Beam trawl (Effort = Corrected formula)**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1971 | 2003 | | | | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | | | | |
| | 2 | 14 | | | | | | | | | | | | |
| 11.06 | | 111 | 77 | 384 | 179 | 124 | 154 | 218 | 108 | 32 | 107 | 76 | 21 | 40 |
| 8.44 | | 132 | 220 | 76 | 163 | 80 | 52 | 57 | 76 | 39 | 23 | 14 | 38 | 14 |
| 17.39 | | 179 | 926 | 368 | 150 | 173 | 58 | 54 | 57 | 108 | 32 | 23 | 21 | 45 |
| 18.83 | | 102 | 287 | 565 | 270 | 136 | 156 | 64 | 79 | 90 | 75 | 38 | 39 | 37 |
| 16.38 | | 69 | 167 | 195 | 370 | 176 | 64 | 59 | 39 | 33 | 29 | 37 | 18 | 23 |
| 28.07 | | 199 | 533 | 357 | 391 | 357 | 167 | 84 | 125 | 40 | 17 | 21 | 51 | 35 |
| 24.11 | | 220 | 307 | 244 | 190 | 170 | 283 | 84 | 20 | 35 | 39 | 36 | 18 | 52 |
| 18.09 | | 173 | 403 | 185 | 84 | 86 | 54 | 108 | 38 | 11 | 21 | 61 | 8 | 9 |
| 18.9 | | 222 | 379 | 506 | 141 | 104 | 133 | 84 | 103 | 35 | 12 | 16 | 4 | 6 |
| 29.02 | | 438 | 647 | 583 | 389 | 119 | 45 | 63 | 66 | 92 | 22 | 25 | 16 | 10 |
| 35.39 | | 429 | 481 | 565 | 286 | 268 | 107 | 86 | 67 | 86 | 74 | 33 | 13 | 13 |
| 28.77 | | 245 | 594 | 221 | 334 | 200 | 148 | 66 | 80 | 54 | 19 | 41 | 16 | 25 |
| 34.95 | | 363 | 605 | 409 | 159 | 196 | 127 | 108 | 29 | 44 | 32 | 15 | 12 | 12 |
| 33.48 | | 372 | 467 | 334 | 300 | 102 | 153 | 59 | 26 | 26 | 16 | 24 | 19 | 18 |
| 40.49 | | 52 | 909 | 471 | 372 | 208 | 75 | 104 | 46 | 68 | 15 | 29 | 16 | 10 |
| 52.46 | | 377 | 900 | 823 | 359 | 230 | 140 | 49 | 58 | 65 | 29 | 50 | 6 | 9 |
| 37.23 | | 247 | 664 | 438 | 344 | 191 | 119 | 47 | 29 | 20 | 4 | 14 | 2 | 16 |
| 42.92 | | 362 | 293 | 603 | 250 | 197 | 77 | 51 | 36 | 26 | 19 | 19 | 13 | 16 |
| 53.58 | | 244 | 680 | 428 | 471 | 179 | 145 | 62 | 13 | 24 | 10 | 19 | 3 | 17 |
| 40.27 | | 231 | 742 | 663 | 181 | 240 | 70 | 59 | 17 | 26 | 12 | 2 | 4 | 12 |
| 18.05 | | 1028 | 380 | 225 | 131 | 29 | 26 | 9 | 7 | 13 | 8 | 4 | 1 | 2 |
| 25.47 | | 327 | 1062 | 376 | 210 | 98 | 14 | 14 | 7 | 9 | 5 | 0 | 0.3 | 2 |
| 31.27 | | 296 | 615 | 629 | 161 | 81 | 75 | 38 | 36 | 19 | 4 | 2 | 1 | 1 |
| 38.35 | | 205 | 524 | 523 | 530 | 176 | 71 | 20 | 15 | 16 | 11 | 6 | 5 | 7 |
| 47.81 | | 77 | 827 | 838 | 277 | 250 | 78 | 48 | 21 | 17 | 8 | 1 | 5 | 2 |
| 47.63 | | 104 | 737 | 579 | 258 | 130 | 88 | 29 | 17 | 9 | 12 | 3 | 3 | 0 |
| 51.98 | | 193 | 661 | 377 | 241 | 143 | 74 | 55 | 23 | 16 | 18 | 7 | 3 | 2 |
| 52.11 | | 166 | 771 | 608 | 188 | 100 | 84 | 33 | 25 | 21 | 8 | 6 | 10 | 7 |
| 55.03 | | 493 | 1286 | 622 | 189 | 66 | 36 | 11 | 14 | 5 | 3 | 1 | 3 | 0 |
| 56.05 | | 1509 | 1174 | 435 | 124 | 20 | 16 | 14 | 6 | 2 | 9 | 3 | 1 | 1 |
| 52.06 | | 621 | 1445 | 710 | 307 | 174 | 38 | 16 | 11 | 11 | 6 | 17 | 1 | 1 |
| 43.24 | | 0 | 1292 | 1704 | 570 | 163 | 56 | 27 | 15 | 1 | 1 | 1 | 4 | 0.6 |
| 42.81 | | 16 | 538 | 929 | 1273 | 315 | 160 | 50 | 19 | 12 | 2 | 7 | 1 | 3 |

**UK(E&W)-CBT** **UK(E+W) VIIf Beam trawl**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 2010 | | | | | | | | | | | | | |
| | 1 | 1 | 0 | 1 | | | | | | | | | | | |
| | 1 | 14 | | | | | | | | | | | | | |
| 40.81 | | 0 | 52 | 98 | 189 | 171 | 60 | 67 | 23 | 20 | 16 | 13 | 5 | 4 | 4 |
| 35.78 | | 0 | 18 | 220 | 103 | 83 | 69 | 22 | 21 | 10 | 13 | 5 | 3 | 1 | 1 |
| 39.64 | | 1.9 | 6 | 83 | 198 | 77 | 50 | 41 | 11 | 24 | 9 | 5 | 4 | 3 | 4 |
| 37.03 | | 0 | 23 | 80 | 59 | 116 | 36 | 31 | 19 | 11 | 15 | 8 | 5 | 5 | 4 |
| 37.59 | | 0 | 16 | 87 | 73 | 56 | 105 | 24 | 30 | 23 | 8 | 8 | 4 | 5 | 3 |
| 39.78 | | 0.2 | 22 | 96 | 128 | 70 | 45 | 53 | 15 | 13 | 12 | 4 | 9 | 5 | 2 |
| 43 | | 0 | 10 | 60 | 86 | 69 | 53 | 27 | 39 | 11 | 11 | 5 | 5 | 3 | 2 |
| 47.84 | | 0 | 13 | 101 | 73 | 77 | 50 | 17 | 13 | 20 | 7 | 6 | 4 | 2 | 1 |
| 50.87 | | 0.4 | 31 | 204 | 107 | 52 | 50 | 28 | 13 | 6 | 10 | 4 | 2 | 1 | 0 |
| 51.19 | | 0.1 | 72 | 152 | 150 | 75 | 27 | 28 | 20 | 9 | 4 | 8 | 3 | 2 | 2 |
| 49.32 | | 0 | 37 | 272 | 99 | 89 | 48 | 19 | 17 | 11 | 9 | 3 | 7 | 1 | 2 |
| 37.53 | | 0 | 11 | 149 | 375 | 90 | 63 | 28 | 18 | 14 | 9 | 6 | 4 | 4 | 1 |
| 40.71 | | 0.1 | 18 | 101 | 176 | 369 | 77 | 45 | 18 | 6 | 7 | 3 | 4 | 1 | 2 |
| 32.37 | | 0 | 19 | 91 | 65 | 114 | 180 | 34 | 27 | 15 | 7 | 3 | 5 | 1 | 1 |
| 27.73 | | 0 | 27 | 78 | 126 | 55 | 60 | 115 | 15 | 14 | 4 | 5 | 2 | 2 | 1 |
| 18.57 | | 0 | 16 | 86 | 94 | 103 | 32 | 39 | 69 | 13 | 8 | 4 | 2 | 2 | 1 |
| 15.37 | | 0.9 | 18 | 77 | 89 | 77 | 82 | 32 | 41 | 76 | 8 | 8 | 4 | 2 | 3 |
| 13.83 | | 0 | 12 | 76 | 100 | 67 | 52 | 54 | 19 | 32 | 42 | 10 | 5 | 2 | 3 |
| 12.31 | | 0 | 23 | 54 | 72 | 72 | 63 | 27 | 29 | 12 | 12 | 29 | 4 | 3 | 1 |
| 14.44 | | 0 | 2 | 98 | 65 | 48 | 46 | 34 | 19 | 18 | 5 | 5 | 13 | 1 | 1 |

## Table 7.13.9 - Sole in VIIfg. Tuning series - continued

**Indices in bold are used in the assessment**

**UK(E&W)-BTS-Q3 UK(E+W) VIIf Corystes (automated indices since 1995)**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1988 | 2010 | | | | | | | | | |
| | 1 | 1 | 0.75 | 0.85 | | | | | | | |
| | 0 | 9 | | | | | | | | | |
| 74.120 | | 22 | 60 | 242 | 36 | 14 | 4 | 0 | 0 | 0 | 0 |
| 91.909 | | 132 | 204 | 304 | 162 | 18 | 14 | 6 | 4 | 2 | 2 |
| 69.858 | | 21 | 269 | 219 | 35 | 11 | 3 | 5 | 2 | 0 | 0 |
| 123.410 | | 40 | 297 | 638 | 83 | 21 | 18 | 5 | 0 | 3 | 2 |
| 125.078 | | 5 | 493 | 325 | 174 | 37 | 23 | 12 | 1 | 2 | 1 |
| 127.672 | | 6 | 207 | 436 | 52 | 28 | 3 | 2 | 2 | 1 | 1 |
| 120.816 | | 1 | 424 | 430 | 133 | 23 | 11 | 9 | 0 | 0 | 3 |
| 114.886 | | 31 | 142 | 255 | 60 | 13 | 7 | 14 | 1 | 1 | 1 |
| 118.592 | | 3 | 178 | 251 | 64 | 27 | 7 | 3 | 4 | 1 | 3 |
| 114.886 | | 37 | 498 | 207 | 21 | 13 | 14 | 5 | 3 | 6 | 0 |
| 114.886 | | 104 | 885 | 472 | 57 | 11 | 9 | 5 | 2 | 1 | 5 |
| 118.592 | | 29 | 2922 | 297 | 38 | 16 | 7 | 4 | 5 | 1 | 0 |
| 118.592 | | 16 | 1086 | 1608 | 37 | 26 | 6 | 0 | 2 | 1 | 1 |
| 118.592 | | 26 | 449 | 711 | 307 | 23 | 9 | 6 | 2 | 0 | 2 |
| 118.592 | | 9 | 786 | 283 | 151 | 121 | 14 | 7 | 2 | 3 | 0 |
| 118.592 | | 14 | 465 | 628 | 55 | 30 | 56 | 9 | 3 | 3 | 0 |
| 114.886 | | 63 | 862 | 434 | 99 | 15 | 22 | 42 | 4 | 3 | 0 |
| 118.592 | | 44 | 407 | 267 | 38 | 16 | 7 | 5 | 17 | 1 | 2 |
| 118.592 | | 13 | 324 | 238 | 47 | 16 | 8 | 0 | 2 | 12 | 0 |
| 118.592 | | 104 | 424 | 128 | 51 | 16 | 13 | 7 | 3 | 4 | 14 |
| 118.592 | | 6 | 1232 | 124 | 15 | 18 | 7 | 9 | 4 | 3 | 5 |
| 118.592 | | 1 | 604 | 377 | 29 | 8 | 10 | 4 | 3 | 3 | 2 |
| 118.592 | | 19 | 101 | 558 | 144 | 20 | 2 | 7 | 9 | 4 | 2 |

IR - GFS : Irish Groundfish Survey (IBTS 4th Qtr) - VIIb Sole number at age (Interim indices for new Celtic Explorer series)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2010 | | | | | | | | | |
| | 1 | 1 | 0.79 | 0.92 | | | | | | | |
| | 1 | 10 | | | | | | | | | |
| 832 | | 1.0 | 5.2 | 1.1 | 3.2 | 3.0 | 4.1 | 4.0 | 0.0 | 1.0 | 0.0 |
| 980 | | 1.0 | 8.0 | 6.0 | 5.0 | 1.0 | 2.0 | 1.0 | 0.0 | 0.0 | 1.0 |
| 845 | | 0.0 | 0.0 | 6.0 | 2.0 | 4.0 | 2.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| 1046 | | 0.0 | 0.0 | 4.0 | 4.0 | 6.0 | 4.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| 1168 | | 0.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| 1139 | | 2.0 | 9.0 | 7.0 | 3.0 | 2.0 | 0.0 | 2.0 | 0.0 | 1.0 | 0.0 |
| 1018 | | 0.0 | 15.0 | 3.0 | 4.0 | 1.0 | 1.0 | 2.0 | 1.0 | 0.0 | 2.0 |
| 1381 | | 0.0 | 12.0 | 24.7 | 9.1 | 8.2 | 1.0 | 3.0 | 3.9 | 0.0 | 2.1 |

UK (E+W) TRAWL 107F. (Processed as unsexed - from 2001WG)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | | 2010 | | | | | | | | | |
| 1 | | 1 | 0 | 1 | | | | | | | |
| 1 | | 10 | | | | | | | | | |
| 18.57 | | 0 | 1.7 | 6.4 | 13 | 11.2 | 3.5 | 3.3 | 1.1 | 0.8 | 0.8 |
| 16.00 | | 0 | 8.4 | 29.4 | 10.4 | 6.9 | 5.9 | 1.5 | 1.8 | 0.8 | 0.9 |
| 13.79 | | 0.1 | 0.8 | 3.7 | 10.2 | 3.8 | 2 | 1.4 | 0.3 | 0.6 | 0.2 |
| 9.48 | | 0 | 1.7 | 4.3 | 2.5 | 4.9 | 1.7 | 1.5 | 1.1 | 0.6 | 0.7 |
| 8.46 | | 0 | 2.3 | 12 | 5.3 | 2.5 | 4.5 | 0.9 | 1.2 | 0.7 | 0.2 |
| 8.67 | | 0.1 | 2.8 | 4.3 | 4.9 | 2.4 | 1.4 | 1.4 | 0.3 | 0.5 | 0.2 |
| 8.14 | | 0 | 2 | 8 | 6.8 | 4.1 | 2.1 | 0.7 | 1.2 | 0.4 | 0.3 |
| 7.13 | | 0 | 2 | 4 | 2.7 | 2.1 | 1.3 | 0.4 | 0.3 | 0.5 | 0.1 |
| 5.69 | | 0.1 | 8.5 | 12.4 | 3.5 | 1.5 | 1.2 | 0.8 | 0.4 | 0.1 | 0.3 |
| 4.05 | | 0 | 0.9 | 1.8 | 1.6 | 0.7 | 0.2 | 0.2 | 0.2 | 0.1 | 0 |
| 4.42 | | 0 | 1.5 | 10.1 | 2.3 | 1.7 | 0.6 | 0.3 | 0.2 | 0.2 | 0.1 |
| 6.10 | | 0 | 0.5 | 4.8 | 8.2 | 1.8 | 1 | 0.3 | 0.2 | 0.2 | 0.1 |
| 9.94 | | 0.1 | 1.6 | 2.8 | 3.3 | 6.7 | 1 | 0.7 | 0.3 | 0.1 | 0.1 |
| 9.42 | | 0 | 1 | 4.8 | 2.9 | 3.3 | 4.9 | 0.9 | 0.6 | 0.4 | 0.2 |
| 12.09 | | 0 | 2.6 | 4.9 | 6.1 | 2.3 | 2.6 | 4.9 | 0.7 | 0.7 | 0.2 |
| 12.97 | | 0 | 0.4 | 7.1 | 7.7 | 9.5 | 3 | 3.9 | 6.9 | 1.3 | 0.9 |
| 10.66 | | 0 | 0.5 | 2.6 | 3.5 | 3.2 | 3.2 | 1.2 | 1.5 | 2.6 | 0.3 |
| 10.13 | | 0 | 0.4 | 3.5 | 5 | 3.8 | 2.9 | 2.7 | 0.9 | 1.6 | 2.2 |
| 9.00 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.60 | | 0 | 0.2 | 5.3 | 3.7 | 2.3 | 2.1 | 1.1 | 0.8 | 0.9 | 0.2 |

**Table 7.13.10 - Sole VIIfg - XSA diagnostics**

Lowestoft VPA Version 3.1

1/05/2011 12:34

Extended Survivors Analysis

CELTIC SEA SOLE - 2011WG

CPUE data from file s7fgtun.txt

Catch data for 40 years. 1971 to 2010. Ages 1 to 10.

| Fleet | First year | Last year | First age | Last age | Alpha | Beta |
|---|---|---|---|---|---|---|
| BE-CBT | 1971 | 2010 | 2 | 9 | 0 | 1 |
| UK(E&W)-CBT | 1991 | 2010 | 2 | 9 | 0 | 1 |
| UK(E&W)-BTS-Q3 | 1988 | 2010 | 1 | 9 | 0.75 | 0.85 |

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 47 iterations

1

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0.11 | 0.008 | 0.021 | 0.098 | 0.052 | 0.153 | 0.113 | 0.061 | 0.077 | 0.058 |
| 3 | 0.207 | 0.311 | 0.244 | 0.403 | 0.261 | 0.345 | 0.263 | 0.195 | 0.167 | 0.202 |
| 4 | 0.402 | 0.345 | 0.374 | 0.425 | 0.311 | 0.322 | 0.294 | 0.238 | 0.26 | 0.366 |
| 5 | 0.4 | 0.545 | 0.486 | 0.433 | 0.43 | 0.325 | 0.327 | 0.333 | 0.208 | 0.293 |
| 6 | 0.536 | 0.372 | 0.668 | 0.312 | 0.356 | 0.229 | 0.273 | 0.284 | 0.263 | 0.2 |
| 7 | 0.376 | 0.368 | 0.59 | 0.354 | 0.218 | 0.194 | 0.321 | 0.235 | 0.263 | 0.194 |
| 8 | 0.38 | 0.543 | 0.534 | 0.273 | 0.22 | 0.148 | 0.263 | 0.223 | 0.169 | 0.244 |
| 9 | 0.522 | 0.638 | 0.485 | 0.402 | 0.271 | 0.287 | 0.201 | 0.285 | 0.176 | 0.134 |

1

XSA population numbers (Thousands)

| YEAR \ AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 4.17E+03 | 7.11E+03 | 1.08E+04 | 2.73E+03 | 1.39E+03 | 6.13E+02 | 2.18E+02 | 1.30E+02 | 6.72E+01 |
| 2002 | 6.80E+03 | 3.78E+03 | 5.76E+03 | 7.93E+03 | 1.65E+03 | 8.43E+02 | 3.25E+02 | 1.35E+02 | 8.03E+01 |
| 2003 | 5.27E+03 | 6.15E+03 | 3.39E+03 | 3.82E+03 | 5.08E+03 | 8.67E+02 | 5.26E+02 | 2.03E+02 | 7.12E+01 |
| 2004 | 6.17E+03 | 4.77E+03 | 5.45E+03 | 2.40E+03 | 2.38E+03 | 2.83E+03 | 4.02E+02 | 2.64E+02 | 1.08E+02 |
| 2005 | 5.60E+03 | 5.58E+03 | 3.91E+03 | 3.29E+03 | 1.42E+03 | 1.40E+03 | 1.87E+03 | 2.56E+02 | 1.82E+02 |
| 2006 | 3.63E+03 | 5.07E+03 | 4.79E+03 | 2.73E+03 | 2.19E+03 | 8.36E+02 | 8.84E+02 | 1.36E+03 | 1.86E+02 |
| 2007 | 4.15E+03 | 3.28E+03 | 3.93E+03 | 3.07E+03 | 1.79E+03 | 1.43E+03 | 6.02E+02 | 6.59E+02 | 1.06E+03 |
| 2008 | 9.56E+03 | 3.76E+03 | 2.65E+03 | 2.74E+03 | 2.07E+03 | 1.17E+03 | 9.84E+02 | 3.95E+02 | 4.58E+02 |
| 2009 | 5.44E+03 | 8.65E+03 | 3.20E+03 | 1.97E+03 | 1.95E+03 | 1.34E+03 | 7.95E+02 | 7.04E+02 | 2.86E+02 |
| 2010 | 1.18E+03 | 4.93E+03 | 7.25E+03 | 2.45E+03 | 1.38E+03 | 1.43E+03 | 9.34E+02 | 5.53E+02 | 5.38E+02 |

Estimated population abundance at 1st Jan 2010

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.00E+00 | 1.07E+03 | 4.21E+03 | 5.36E+03 | 1.54E+03 | 9.29E+02 | 1.06E+03 | 6.96E+02 | 3.92E+02 |

Taper weighted geometric mean of the VPA populations:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4.86E+03 | 4.57E+03 | 3.69E+03 | 2.44E+03 | 1.49E+03 | 9.05E+02 | 5.54E+02 | 3.52E+02 | 2.27E+02 |

Standard error of the weighted Log(VPA populations) :

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.4117 | 0.3424 | 0.3517 | 0.3545 | 0.4169 | 0.4917 | 0.6 | 0.7788 | 0.9558 |

### Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued

Log catchability residuals.

Fleet : BE-CBT

| Age | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 0.23 | 0.13 | 0.54 | 0.11 | -0.15 | 0.55 | 0.21 | 0.38 | 0.41 | 1.18 |
| 3 | -0.48 | 0.18 | 0.38 | -0.1 | -0.34 | 0.4 | 0.15 | 0.08 | 0.08 | 0.05 |
| 4 | 0.26 | -0.16 | 0.13 | -0.05 | -0.31 | -0.01 | -0.02 | 0.07 | 0.41 | 0.27 |
| 5 | 0.32 | 0.14 | 0.2 | 0.14 | 0 | 0.26 | -0.08 | -0.46 | 0.13 | 0.21 |
| 6 | 0.13 | 0.3 | -0.09 | 0.51 | 0.27 | -0.18 | 0.08 | -0.21 | 0.05 | -0.04 |
| 7 | 0.5 | -0.01 | -0.3 | 0.12 | 0.38 | 0.15 | 0.19 | -0.38 | 0.63 | -0.87 |
| 8 | 0.32 | 0.21 | -0.42 | -0.01 | -0.45 | 0.57 | -0.01 | -0.17 | 0.3 | -0.16 |
| 9 | 0.02 | -0.1 | -0.18 | 0.15 | -0.1 | 0.07 | -0.27 | -0.23 | 0.02 | -0.01 |

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 0.55 | 0.22 | 0.45 | 0.17 | -1.66 | -0.09 | 0.42 | 0.05 | -0.31 | 0.09 |
| 3 | 0.22 | 0.12 | -0.02 | -0.19 | -0.06 | 0.01 | -0.16 | -0.54 | -0.48 | 0.18 |
| 4 | -0.09 | -0.15 | -0.25 | -0.34 | -0.12 | -0.09 | 0 | -0.19 | -0.15 | 0.13 |
| 5 | -0.13 | 0.05 | -0.24 | 0.02 | 0.12 | -0.04 | 0 | -0.05 | -0.1 | -0.04 |
| 6 | 0.21 | 0.21 | -0.18 | -0.1 | 0.07 | 0.11 | 0.38 | -0.02 | 0.09 | 0.22 |
| 7 | 0.17 | 0.41 | 0.14 | 0.22 | -0.06 | 0.05 | 0.69 | 0.02 | 0.18 | 0.19 |
| 8 | -0.14 | 0.36 | 0.5 | -0.08 | 0.19 | -0.27 | -0.13 | 0.57 | 0.17 | 0.24 |
| 9 | 0.08 | 0.42 | -0.22 | -0.29 | -0.06 | -0.08 | 0.15 | 0.03 | -0.31 | -0.16 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 1.61 | 0.79 | 0.42 | -0.16 | -1.11 | -0.77 | -0.44 | -0.91 | 0.03 | 0.26 |
| 3 | 0.42 | 0.42 | 0.29 | -0.2 | 0.1 | 0.25 | 0.07 | 0 | 0.2 | -0.03 |
| 4 | 0.08 | 0.31 | -0.03 | 0.23 | 0.42 | 0.19 | -0.08 | 0.45 | 0.1 | -0.55 |
| 5 | 0 | 0.24 | -0.18 | 0.19 | 0.05 | 0.04 | 0.02 | -0.07 | 0.05 | -0.92 |
| 6 | -0.35 | 0.02 | -0.33 | 0.36 | -0.03 | 0.03 | 0.21 | -0.09 | -0.47 | -1.6 |
| 7 | -0.45 | -0.85 | 0.23 | -0.07 | 0.1 | -0.32 | 0.21 | 0.66 | -0.45 | -1.28 |
| 8 | -0.41 | -0.96 | 0.44 | -0.74 | -0.02 | -0.27 | -0.26 | 0.16 | -0.64 | -0.82 |
| 9 | -0.41 | -0.48 | 0.29 | -0.02 | -0.29 | -0.32 | 0.07 | -0.43 | -0.09 | -0.61 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 0.09 | 99.99 | -3.28 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 3 | -0.71 | 0.04 | -0.32 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 4 | -0.17 | -0.2 | -0.06 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | -0.31 | 0.39 | 0.06 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 0.07 | -0.2 | 0.57 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 7 | -0.4 | -0.23 | 0.45 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 8 | -0.74 | 0 | 0.21 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 9 | -0.4 | -0.03 | 0.27 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Mean Log q | -6.3727 | -5.1056 | -4.8867 | -4.9172 | -4.9827 | -5.0711 | -5.0711 | -5.0711 |
| S.E(Log q) | 0.8642 | 0.2857 | 0.2321 | 0.2421 | 0.3733 | 0.4505 | 0.4199 | 0.2593 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 0.97 | 0.065 | 6.43 | 0.15 | 32 | 0.85 | -6.37 |
| 3 | 1.06 | -0.419 | 4.91 | 0.58 | 33 | 0.31 | -5.11 |
| 4 | 1.07 | -0.603 | 4.68 | 0.71 | 33 | 0.25 | -4.89 |
| 5 | 0.85 | 1.926 | 5.28 | 0.84 | 33 | 0.2 | -4.92 |
| 6 | 0.76 | 2.375 | 5.4 | 0.76 | 33 | 0.27 | -4.98 |
| 7 | 0.81 | 1.753 | 5.29 | 0.74 | 33 | 0.36 | -5.07 |
| 8 | 0.89 | 1.315 | 5.21 | 0.83 | 33 | 0.36 | -5.15 |
| 9 | 0.92 | 2.109 | 5.19 | 0.96 | 33 | 0.21 | -5.18 |
| 1 | | | | | | | |

**Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued**

Fleet : UK(E&W)-CBT

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 0.43 | 0.17 | -1.1 | 0.31 | 0.17 | 0.47 | -0.59 | -0.74 | -0.05 | -0.08 |
| 3 | 0.04 | 0.3 | -0.16 | -0.25 | -0.12 | 0.18 | -0.35 | -0.15 | 0.22 | -0.2 |
| 4 | 0.52 | 0.11 | 0 | -0.48 | -0.35 | 0.29 | 0.06 | -0.15 | -0.16 | -0.1 |
| 5 | 0.54 | 0.06 | -0.07 | -0.2 | -0.23 | 0 | 0.04 | 0.21 | -0.08 | -0.25 |
| 6 | 0.4 | 0.16 | -0.22 | -0.36 | 0.18 | -0.01 | 0.24 | 0.15 | 0.17 | -0.38 |
| 7 | 0.37 | -0.05 | 0.08 | -0.18 | -0.15 | 0.02 | 0.09 | -0.16 | 0.07 | 0.06 |
| 8 | 0.4 | -0.21 | -0.35 | -0.07 | 0.45 | -0.06 | 0.28 | 0.01 | 0.29 | 0.26 |
| 9 | 0.51 | 0.23 | 0.34 | 0.4 | 0.73 | 0.28 | 0.21 | 0.13 | -0.17 | 0.57 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | -0.06 | -0.42 | -0.49 | 0.08 | 0.41 | 0.43 | 1.16 | 0.69 | 0.64 | -1.41 |
| 3 | -0.53 | -0.18 | -0.16 | -0.43 | -0.17 | 0.17 | 0.41 | 0.86 | 0.44 | 0.07 |
| 4 | -0.66 | -0.15 | -0.24 | -0.52 | -0.07 | 0.23 | 0.23 | 0.54 | 0.67 | 0.24 |
| 5 | -0.4 | -0.23 | -0.05 | -0.27 | -0.32 | 0.23 | 0.33 | 0.15 | 0.34 | 0.17 |
| 6 | -0.33 | -0.17 | 0.05 | -0.22 | -0.43 | -0.21 | 0.41 | 0.27 | 0.43 | -0.14 |
| 7 | -0.35 | -0.09 | -0.08 | 0.03 | -0.2 | -0.14 | 0.3 | 0.39 | 0.04 | -0.08 |
| 8 | 0.06 | 0.42 | -0.07 | 0.18 | -0.24 | -0.02 | 0.43 | 0.26 | 0.19 | -0.11 |
| 9 | 0.35 | 0.74 | -0.14 | 0.55 | 0.05 | 0.37 | 0.54 | 0.66 | 0.21 | -0.19 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Mean Log q | -8.9887 | -6.8971 | -6.3151 | -6.0034 | -5.8191 | -5.7614 | -5.7614 | -5.7614 |
| S.E(Log q) | 0.6362 | 0.3359 | 0.3613 | 0.2545 | 0.2809 | 0.1896 | 0.2655 | 0.4324 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 1.07 | -0.164 | 9.02 | 0.24 | 20 | 0.7 | -8.99 |
| 3 | 1.4 | -1.43 | 6.34 | 0.42 | 20 | 0.46 | -6.9 |
| 4 | 1.14 | -0.548 | 6.11 | 0.47 | 20 | 0.42 | -6.32 |
| 5 | 0.98 | 0.144 | 6.03 | 0.79 | 20 | 0.26 | -6 |
| 6 | 1.01 | -0.044 | 5.81 | 0.8 | 20 | 0.29 | -5.82 |
| 7 | 0.96 | 0.642 | 5.78 | 0.92 | 20 | 0.18 | -5.76 |
| 8 | 1.02 | -0.236 | 5.66 | 0.89 | 20 | 0.25 | -5.66 |
| 9 | 0.99 | 0.159 | 5.44 | 0.89 | 20 | 0.29 | -5.44 |
| 1 | | | | | | | |

Fleet : UK(E&W)-BTS-Q3

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -1.39 | -0.19 | -0.48 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.01 | 0.28 | 0.39 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.32 | 1.09 | 0.13 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.11 | 0.57 | -0.06 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.13 | 0.42 | -0.05 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.5 | 0.19 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.52 | 0.58 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.66 | 99.99 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 1.72 | 99.99 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.23 | 0.2 | -0.68 | 0.36 | -0.66 | -0.67 | 0.09 | 0.53 | 0.81 | 0.48 |
| 2 | 0.15 | 0.11 | 0.3 | 0.33 | 0.09 | 0.09 | -0.27 | 0.23 | -0.34 | 0.49 |
| 3 | 0.5 | 0.58 | -0.04 | 0.81 | 0.18 | 0.5 | -0.59 | 0.16 | -0.48 | -0.67 |
| 4 | 0.19 | 0.81 | -0.16 | 0.4 | -0.12 | 0.7 | 0.22 | 0.16 | 0.14 | 0.27 |
| 5 | 0.69 | 1.02 | -1.02 | -0.22 | 0.1 | 0.15 | 1.02 | 0.71 | 0.62 | -0.17 |
| 6 | 0.29 | 0.65 | -1.16 | 0.61 | 0.59 | -0.28 | 0.5 | 0.48 | 0.3 | 99.99 |
| 7 | 99.99 | -0.7 | -0.34 | 99.99 | -0.65 | 0.12 | 0.74 | 0.7 | 1.26 | 0.29 |
| 8 | 1 | -0.13 | -0.15 | 99.99 | -0.24 | -0.11 | 1.22 | 0.36 | 0.65 | 0.23 |
| 9 | 0.86 | 0.4 | -0.21 | 1.74 | 0.31 | 1.51 | 99.99 | 1.61 | 99.99 | 1.34 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.23 | 0.3 | 0.03 | 0.52 | -0.16 | 0.04 | 0.18 | 0.41 | 0.26 | 0 |
| 2 | 0.3 | -0.07 | 0.25 | 0.23 | -0.48 | -0.42 | -0.64 | -0.85 | -0.56 | 0.38 |
| 3 | 0.42 | 0.42 | -0.11 | 0.16 | -0.61 | -0.54 | -0.32 | -1.21 | -0.76 | 0.06 |
| 4 | -0.03 | 0.52 | -0.12 | -0.28 | -0.66 | -0.46 | -0.6 | -0.41 | -0.88 | -0.09 |
| 5 | -0.1 | 0.28 | 0.5 | 0.31 | -0.35 | -0.73 | -0.05 | -0.81 | -0.49 | -1.68 |
| 6 | 0.23 | -0.07 | 0.39 | 0.5 | -0.92 | 99.99 | -0.67 | -0.21 | -1.18 | -0.74 |
| 7 | 0.24 | -0.16 | -0.06 | 0.34 | 0.11 | -1.3 | -0.41 | -0.68 | -0.74 | 0.15 |
| 8 | 99.99 | 1.26 | 0.84 | 0.41 | -0.73 | 0.02 | -0.26 | -0.07 | -0.69 | -0.1 |
| 9 | 1.54 | 99.99 | 99.99 | 99.99 | 0.34 | 99.99 | 0.47 | 0.34 | -0.19 | -0.85 |

**Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued**

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Mean Log q | -7.1547 | -7.2118 | -8.508 | -9.1195 | -9.3122 | -9.122 | -9.3297 | -9.3297 | -9.3297 |
| S.E(Log q) | 0.5063 | 0.3785 | 0.5674 | 0.4365 | 0.6609 | 0.6171 | 0.6269 | 0.6321 | 1.1095 |

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | 0.72 | 1.783 | 7.53 | 0.67 | 23 | 0.35 | -7.15 |
| 2 | 0.87 | 0.659 | 7.37 | 0.56 | 23 | 0.33 | -7.21 |
| 3 | 0.78 | 0.845 | 8.46 | 0.42 | 23 | 0.45 | -8.51 |
| 4 | 1.34 | -1.015 | 9.57 | 0.29 | 23 | 0.59 | -9.12 |
| 5 | 1.38 | -0.894 | 10.09 | 0.21 | 23 | 0.91 | -9.31 |
| 6 | 1.72 | -1.598 | 10.85 | 0.22 | 20 | 1.02 | -9.12 |
| 7 | 1.87 | -2.22 | 12.16 | 0.27 | 20 | 1.07 | -9.33 |
| 8 | 1.61 | -2.129 | 11.3 | 0.41 | 19 | 0.87 | -9.11 |
| 9 | 2.65 | -3.22 | 14.43 | 0.23 | 15 | 1.67 | -8.6 |
| 1 | | | | | | | |

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-BTS-Q3 | 1069 | 0.517 | 0 | 0 | 1 | 1 | 0 |
| F shrinkage mean | 0 | 1.5 | | | | 0 | 0 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1069 | 0.52 | 0 | 1 | 0 | 0 |

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 1024 | 0.652 | 0 | 0 | 1 | 0.178 | 0.219 |
| UK(E&W)-BTS-Q3 | 5910 | 0.31 | 0.06 | 0.19 | 2 | 0.787 | 0.042 |
| F shrinkage mean | 2619 | 1.5 | | | | 0.036 | 0.092 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 4206 | 0.27 | 0.39 | 4 | 1.418 | 0.058 |

**Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued**

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 6459 | 0.305 | 0.228 | 0.75 | 2 | 0.446 | 0.17 |
| UK(E&W)-BTS-Q3 | 4626 | 0.273 | 0.297 | 1.09 | 3 | 0.531 | 0.23 |
| F shrinkage mean | 4283 | 1.5 | | | | 0.023 | 0.247 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 5360 | 0.2 | 0.17 | 6 | 0.844 | 0.202 |

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 2242 | 0.236 | 0.104 | 0.44 | 3 | 0.497 | 0.265 |
| UK(E&W)-BTS-Q3 | 1029 | 0.234 | 0.245 | 1.05 | 4 | 0.483 | 0.507 |
| F shrinkage mean | 2056 | 1.5 | | | | 0.02 | 0.286 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1536 | 0.17 | 0.19 | 8 | 1.136 | 0.366 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 1536 | 0.189 | 0.195 | 1.03 | 4 | 0.618 | 0.187 |
| UK(E&W)-BTS-Q3 | 400 | 0.225 | 0.256 | 1.14 | 5 | 0.366 | 0.583 |
| F shrinkage mean | 823 | 1.5 | | | | 0.016 | 0.325 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 929 | 0.14 | 0.25 | 10 | 1.756 | 0.293 |

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2004

| Fleet | E S | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 1305 | 0.163 | 0.138 | 0.85 | 5 | 0.683 | 0.166 |
| UK(E&W)-BTS-Q3 | 681 | 0.219 | 0.074 | 0.34 | 6 | 0.305 | 0.297 |
| F shrinkage mean | 722 | 1.5 | | | | 0.012 | 0.282 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1062 | 0.13 | 0.12 | 12 | 0.894 | 0.2 |

**Table 7.13.10 - Sole VIIfg - XSA diagnostics - continued**

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2003

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 817 | 0.151 | 0.09 | 0.6 | 6 | 0.728 | 0.168 |
| UK(E&W)-BTS-Q3 | 451 | 0.224 | 0.212 | 0.95 | 7 | 0.26 | 0.286 |
| F shrinkage mean | 534 | 1.5 | | | | 0.012 | 0.247 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 696 | 0.13 | 0.11 | 14 | 0.904 | 0.194 |

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2002

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| UK(E&W)-CBT | 422 | 0.14 | 0.072 | 0.52 | 7 | 0.753 | 0.229 |
| UK(E&W)-BTS-Q3 | 306 | 0.224 | 0.118 | 0.53 | 8 | 0.235 | 0.303 |
| F shrinkage mean | 477 | 1.5 | | | | 0.012 | 0.205 |

Weighted prediction :

| Survivors **at end of year** | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 392 | 0.12 | 0.07 | 16 | 0.554 | 0.244 |

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2001

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| BE-CBT | 16 | 0.878 | 0 | 0 | 1 | 0.005 | 1.565 |
| UK(E&W)-CBT | 505 | 0.136 | 0.095 | 0.7 | 8 | 0.765 | 0.114 |
| UK(E&W)-BTS-Q3 | 263 | 0.225 | 0.142 | 0.63 | 9 | 0.219 | 0.208 |
| F shrinkage mean | 205 | 1.5 | | | | 0.011 | 0.26 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 426 | 0.12 | 0.11 | 19 | 0.941 | 0.134 |

# Table 7.13.11 - Sole in VIIfg. Fishing mortality

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.000 |
| 2 | 0.0825 | 0.0676 | 0.1042 | 0.0546 | 0.0415 | 0.1300 | 0.0728 | 0.0831 | 0.0719 | 0.243 |
| 3 | 0.1455 | 0.2513 | 0.3134 | 0.1578 | 0.1221 | 0.3974 | 0.2426 | 0.2195 | 0.1846 | 0.280 |
| 4 | 0.3793 | 0.2248 | 0.3035 | 0.2065 | 0.1566 | 0.3284 | 0.2557 | 0.2677 | 0.3194 | 0.431 |
| 5 | 0.3888 | 0.2940 | 0.3156 | 0.2425 | 0.2075 | 0.4164 | 0.2331 | 0.1533 | 0.2334 | 0.393 |
| 6 | 0.3037 | 0.3236 | 0.2212 | 0.3300 | 0.2540 | 0.2527 | 0.2587 | 0.1866 | 0.2022 | 0.290 |
| 7 | 0.4001 | 0.2143 | 0.1658 | 0.2055 | 0.2580 | 0.3208 | 0.2608 | 0.1420 | 0.3297 | 0.105 |
| 8 | 0.3343 | 0.2678 | 0.1467 | 0.1772 | 0.1138 | 0.4899 | 0.2134 | 0.1761 | 0.2373 | 0.236 |
| 9 | 0.2478 | 0.1991 | 0.1859 | 0.1899 | 0.1602 | 0.2975 | 0.1617 | 0.1691 | 0.1796 | 0.273 |
| +gp | 0.2478 | 0.1991 | 0.1859 | 0.1899 | 0.1602 | 0.2975 | 0.1617 | 0.1691 | 0.1796 | 0.273 |
| FBAR 4-8 | 0.3613 | 0.2649 | 0.2305 | 0.2323 | 0.1980 | 0.3616 | 0.2444 | 0.1851 | 0.2644 | 0.291 |

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.1465 | 0.0853 | 0.1669 | 0.1221 | 0.0496 | 0.1070 | 0.1244 | 0.1126 | 0.1323 | 0.0905 |
| 3 | 0.3751 | 0.2754 | 0.3714 | 0.3046 | 0.3778 | 0.4646 | 0.2767 | 0.2404 | 0.3445 | 0.3923 |
| 4 | 0.3437 | 0.2617 | 0.3674 | 0.3278 | 0.4405 | 0.5176 | 0.5140 | 0.3910 | 0.4925 | 0.6147 |
| 5 | 0.3169 | 0.3110 | 0.3622 | 0.4538 | 0.5103 | 0.5448 | 0.4598 | 0.5292 | 0.4678 | 0.6292 |
| 6 | 0.4212 | 0.3413 | 0.3585 | 0.3748 | 0.4255 | 0.6277 | 0.5368 | 0.5669 | 0.5350 | 0.6535 |
| 7 | 0.3702 | 0.3825 | 0.4482 | 0.4752 | 0.3190 | 0.4816 | 0.8045 | 0.4546 | 0.5268 | 0.6075 |
| 8 | 0.2704 | 0.3619 | 0.6495 | 0.3487 | 0.4153 | 0.4482 | 0.4373 | 0.7330 | 0.5288 | 0.6326 |
| 9 | 0.3401 | 0.3818 | 0.3180 | 0.2843 | 0.3821 | 0.5422 | 0.5767 | 0.5212 | 0.4584 | 0.6342 |
| +gp | 0.3401 | 0.3818 | 0.3180 | 0.2843 | 0.3821 | 0.5422 | 0.5767 | 0.5212 | 0.4584 | 0.6342 |
| FBAR 4-8 | 0.3445 | 0.3317 | 0.4372 | 0.3961 | 0.4221 | 0.5240 | 0.5505 | 0.5349 | 0.5102 | 0.6275 |

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.2191 | 0.1276 | 0.0968 | 0.0806 | 0.0449 | 0.0640 | 0.0728 | 0.0427 | 0.1191 | 0.1414 |
| 3 | 0.3021 | 0.3793 | 0.3564 | 0.2888 | 0.4516 | 0.5234 | 0.4573 | 0.3820 | 0.5451 | 0.4158 |
| 4 | 0.4330 | 0.4523 | 0.4021 | 0.5195 | 0.7220 | 0.6799 | 0.5797 | 0.7367 | 0.6163 | 0.3834 |
| 5 | 0.5039 | 0.4655 | 0.3943 | 0.5587 | 0.5583 | 0.6011 | 0.6465 | 0.5629 | 0.6325 | 0.3176 |
| 6 | 0.4564 | 0.4610 | 0.3538 | 0.6076 | 0.6207 | 0.5989 | 0.7793 | 0.5611 | 0.5144 | 0.2325 |
| 7 | 0.4336 | 0.2987 | 0.5308 | 0.4713 | 0.5695 | 0.4746 | 0.6984 | 0.8184 | 0.4929 | 0.3441 |
| 8 | 0.4591 | 0.2573 | 0.5064 | 0.3746 | 0.6934 | 0.4517 | 0.5808 | 0.5950 | 0.5140 | 0.4755 |
| 9 | 0.4945 | 0.3972 | 0.6092 | 0.6651 | 0.6977 | 0.5525 | 0.6895 | 0.4450 | 0.5196 | 0.6073 |
| +gp | 0.4945 | 0.3972 | 0.6092 | 0.6651 | 0.6977 | 0.5525 | 0.6895 | 0.4450 | 0.5196 | 0.6073 |
| FBAR 4-8 | 0.4572 | 0.3870 | 0.4375 | 0.5063 | 0.6328 | 0.5612 | 0.6569 | 0.6548 | 0.5540 | 0.3506 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | FBAR 08-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.1100 | 0.0081 | 0.0206 | 0.0983 | 0.0524 | 0.1533 | 0.1135 | 0.0608 | 0.0773 | 0.0580 | 0.0654 |
| 3 | 0.2072 | 0.3111 | 0.2436 | 0.4034 | 0.2610 | 0.3451 | 0.2629 | 0.1951 | 0.1670 | 0.2018 | 0.1880 |
| 4 | 0.4022 | 0.3454 | 0.3742 | 0.4252 | 0.3107 | 0.3224 | 0.2937 | 0.2383 | 0.2601 | 0.3665 | 0.2883 |
| 5 | 0.4000 | 0.5446 | 0.4863 | 0.4326 | 0.4304 | 0.3245 | 0.3268 | 0.3331 | 0.2083 | 0.2933 | 0.2782 |
| 6 | 0.5360 | 0.3716 | 0.6680 | 0.3124 | 0.3565 | 0.2292 | 0.2732 | 0.2836 | 0.2626 | 0.1998 | 0.2487 |
| 7 | 0.3761 | 0.3677 | 0.5896 | 0.3536 | 0.2176 | 0.1936 | 0.3206 | 0.2350 | 0.2632 | 0.1943 | 0.2308 |
| 8 | 0.3799 | 0.5433 | 0.5336 | 0.2729 | 0.2199 | 0.1479 | 0.2630 | 0.2225 | 0.1688 | 0.2443 | 0.2119 |
| 9 | 0.5223 | 0.6376 | 0.4846 | 0.4023 | 0.2705 | 0.2866 | 0.2009 | 0.2846 | 0.1763 | 0.1336 | 0.1981 |
| +gp | 0.5223 | 0.6376 | 0.4846 | 0.4023 | 0.2705 | 0.2866 | 0.2009 | 0.2846 | 0.1763 | 0.1336 | |
| FBAR 4-8 | 0.4188 | 0.4345 | 0.5304 | 0.3594 | 0.3070 | 0.2435 | 0.2954 | 0.2625 | 0.2326 | 0.2597 | |

## Table 4.3.12 - Sole in VIIfg. Stock numbers at age (start of year, in thousand)

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9610 | 4276 | 3387 | 3404 | 2973 | 5193 | 4636 | 5493 | 3534 | 5131 |
| 2 | 5123 | 8695 | 3869 | 3065 | 3080 | 2690 | 4699 | 4195 | 4970 | 3198 |
| 3 | 2096 | 4268 | 7353 | 3154 | 2626 | 2674 | 2137 | 3953 | 3493 | 4185 |
| 4 | 4466 | 1639 | 3004 | 4863 | 2438 | 2103 | 1626 | 1517 | 2872 | 2628 |
| 5 | 2040 | 2766 | 1185 | 2006 | 3580 | 1886 | 1370 | 1139 | 1050 | 1888 |
| 6 | 1738 | 1251 | 1865 | 782 | 1425 | 2632 | 1125 | 982 | 884 | 753 |
| 7 | 1712 | 1161 | 819 | 1353 | 509 | 1000 | 1850 | 786 | 737 | 654 |
| 8 | 2823 | 1038 | 848 | 628 | 997 | 356 | 656 | 1289 | 617 | 480 |
| 9 | 1801 | 1828 | 719 | 662 | 476 | 805 | 197 | 480 | 978 | 440 |
| +gp | 5830 | 4241 | 3982 | 3281 | 2637 | 1886 | 2565 | 1174 | 1079 | 1546 |
| TOTAL | 37237 | 31163 | 27031 | 23199 | 20739 | 21224 | 20861 | 21008 | 20216 | 20903 |

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4859 | 4889 | 6792 | 4706 | 5657 | 3158 | 5740 | 4490 | 3720 | 8609 |
| 2 | 4643 | 4396 | 4424 | 6145 | 4258 | 5119 | 2858 | 5194 | 4063 | 3366 |
| 3 | 2269 | 3629 | 3653 | 3387 | 4921 | 3666 | 4162 | 2283 | 4199 | 3220 |
| 4 | 2862 | 1411 | 2493 | 2280 | 2260 | 3052 | 2085 | 2855 | 1625 | 2692 |
| 5 | 1545 | 1837 | 982 | 1562 | 1486 | 1317 | 1646 | 1128 | 1747 | 898 |
| 6 | 1153 | 1018 | 1218 | 619 | 898 | 807 | 691 | 940 | 601 | 990 |
| 7 | 510 | 685 | 655 | 770 | 385 | 531 | 390 | 365 | 483 | 319 |
| 8 | 532 | 319 | 423 | 378 | 433 | 253 | 297 | 158 | 210 | 258 |
| 9 | 343 | 368 | 201 | 200 | 242 | 259 | 146 | 173 | 69 | 112 |
| +gp | 1381 | 1076 | 1231 | 1161 | 792 | 820 | 427 | 690 | 290 | 287 |
| TOTAL | 20096 | 19626 | 22070 | 21208 | 21332 | 18981 | 18440 | 18277 | 17006 | 20751 |

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4200 | 4456 | 4427 | 3411 | 3319 | 4054 | 5478 | 6292 | 15162 | 7854 |
| 2 | 7790 | 3800 | 4032 | 4006 | 3086 | 3003 | 3668 | 4957 | 5693 | 13719 |
| 3 | 2782 | 5661 | 3026 | 3311 | 3344 | 2670 | 2549 | 3086 | 4298 | 4573 |
| 4 | 1968 | 1861 | 3506 | 1917 | 2245 | 1926 | 1431 | 1460 | 1906 | 2255 |
| 5 | 1317 | 1155 | 1071 | 2122 | 1032 | 987 | 883 | 725 | 632 | 931 |
| 6 | 433 | 720 | 656 | 653 | 1098 | 534 | 489 | 419 | 374 | 304 |
| 7 | 466 | 248 | 411 | 417 | 322 | 534 | 266 | 203 | 216 | 202 |
| 8 | 157 | 273 | 167 | 219 | 235 | 165 | 301 | 120 | 81 | 119 |
| 9 | 124 | 90 | 191 | 91 | 136 | 106 | 95 | 152 | 60 | 44 |
| +gp | 435 | 284 | 227 | 314 | 227 | 261 | 222 | 254 | 114 | 117 |
| TOTAL | 19672 | 18549 | 17714 | 16462 | 15045 | 14241 | 15383 | 17668 | 28536 | 30119 |

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | GMST 71-08 | AMST 71-08 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4173 | 6795 | 5273 | 6166 | 5601 | 3628 | 4153 | 9563 | 5444 | 1181 | 0* | 5025 | 5375 |
| 2 | 7107 | 3776 | 6149 | 4771 | 5579 | 5068 | 3283 | 3758 | 8653 | 4926 | 1069 | 4484 | 4771 |
| 3 | 10777 | 5761 | 3389 | 5450 | 3913 | 4791 | 3934 | 2652 | 3199 | 7248 | 4206 | 3639 | 3876 |
| 4 | 2730 | 7927 | 3819 | 2404 | 3295 | 2727 | 3070 | 2737 | 1974 | 2450 | 5360 | 2449 | 2630 |
| 5 | 1390 | 1652 | 5078 | 2377 | 1422 | 2185 | 1788 | 2071 | 1951 | 1377 | 1536 | 1480 | 1628 |
| 6 | 613 | 843 | 867 | 2825 | 1395 | 836 | 1429 | 1167 | 1343 | 1433 | 929 | 885 | 1001 |
| 7 | 218 | 325 | 526 | 402 | 1870 | 884 | 602 | 984 | 795 | 934 | 1062 | 541 | 652 |
| 8 | 130 | 135 | 203 | 264 | 256 | 1361 | 659 | 395 | 704 | 553 | 696 | 342 | 480 |
| 9 | 67 | 80 | 71 | 108 | 182 | 186 | 1063 | 458 | 286 | 538 | 392 | 220 | 363 |
| +gp | 208 | 113 | 204 | 155 | 190 | 215 | 403 | 724 | 1260 | 940 | 1170 | | |
| TOTAL | 27414 | 27408 | 25580 | 24923 | 23703 | 21880 | 20382 | 24508 | 25609 | 21580 | 16420 | | |

* Replaced with GM (5025)

# Table 7.13.13 - Sole in VIIfg. Summary

Run title : CELTIC SEA SOLE - 2011WG
At 1/05/2011 12:35

| | RECRUITS Age 1 | TOTALBIO | TOTSPBIO | LANDINGS | YIELD/SSB | FBAR 4- 8 |
|---|---|---|---|---|---|---|
| 1971 | 9610 | 9506 | 8038 | 1861 | 0.2315 | 0.3613 |
| 1972 | 4276 | 7998 | 6339 | 1278 | 0.2016 | 0.2649 |
| 1973 | 3387 | 6639 | 5304 | 1391 | 0.2622 | 0.2305 |
| 1974 | 3404 | 6704 | 5683 | 1105 | 0.1945 | 0.2323 |
| 1975 | 2973 | 5889 | 5034 | 919 | 0.1826 | 0.1980 |
| 1976 | 5193 | 5391 | 4364 | 1350 | 0.3094 | 0.3616 |
| 1977 | 4636 | 5944 | 4680 | 961 | 0.2053 | 0.2444 |
| 1978 | 5493 | 5086 | 3766 | 780 | 0.2071 | 0.1851 |
| 1979 | 3534 | 5098 | 3888 | 954 | 0.2454 | 0.2644 |
| 1980 | 5131 | 5247 | 4024 | 1314 | 0.3265 | 0.2911 |
| 1981 | 4859 | 4600 | 3424 | 1212 | 0.3540 | 0.3445 |
| 1982 | 4889 | 4810 | 3559 | 1128 | 0.3169 | 0.3317 |
| 1983 | 6792 | 5138 | 3660 | 1373 | 0.3752 | 0.4372 |
| 1984 | 4706 | 5378 | 3920 | 1266 | 0.3230 | 0.3961 |
| 1985 | 5657 | 4793 | 3310 | 1328 | 0.4012 | 0.4221 |
| 1986 | 3158 | 4625 | 3370 | 1600 | 0.4747 | 0.5240 |
| 1987 | 5740 | 3736 | 2519 | 1222 | 0.4851 | 0.5505 |
| 1988 | 4490 | 3906 | 2711 | 1146 | 0.4227 | 0.5349 |
| 1989 | 3720 | 3248 | 2113 | 992 | 0.4696 | 0.5102 |
| 1990 | 8609 | 3886 | 2407 | 1189 | 0.4939 | 0.6275 |
| 1991 | 4200 | 3606 | 2134 | 1107 | 0.5188 | 0.4572 |
| 1992 | 4456 | 3862 | 2451 | 981 | 0.4003 | 0.3870 |
| 1993 | 4427 | 3837 | 2479 | 928 | 0.3744 | 0.4375 |
| 1994 | 3411 | 3267 | 2259 | 1009 | 0.4467 | 0.5063 |
| 1995 | 3319 | 3088 | 2157 | 1157 | 0.5364 | 0.6328 |
| 1996 | 4054 | 3062 | 2082 | 995 | 0.4780 | 0.5612 |
| 1997 | 5478 | 2977 | 1823 | 927 | 0.5084 | 0.6569 |
| 1998 | 6292 | 3061 | 1627 | 875 | 0.5377 | 0.6548 |
| 1999 | 15162 | 4286 | 1822 | 1012 | 0.5553 | 0.5540 |
| 2000 | 7854 | 3899 | 1944 | 1091 | 0.5612 | 0.3506 |
| 2001 | 4173 | 5414 | 3125 | 1168 | 0.3737 | 0.4188 |
| 2002 | 6795 | 5966 | 4101 | 1345 | 0.3280 | 0.4345 |
| 2003 | 5273 | 5617 | 3774 | 1392 | 0.3688 | 0.5304 |
| 2004 | 6166 | 5182 | 3536 | 1249 | 0.3532 | 0.3594 |
| 2005 | 5601 | 5348 | 3553 | 1044 | 0.2939 | 0.3070 |
| 2006 | 3628 | 4664 | 3130 | 946 | 0.3023 | 0.2435 |
| 2007 | 4153 | 4564 | 3380 | 945 | 0.2796 | 0.2954 |
| 2008 | 9563 | 4905 | 3170 | 800 | 0.2523 | 0.2625 |
| 2009 | 5444 | 5788 | 3758 | 805 | 0.2142 | 0.2326 |
| 2010 | 1181 | 5487 | 3869 | 862 | 0.2228 | 0.2597 |
| 2011 | 5025[1] | 5429[2] | 4187[2] | | | 0.2516[3] |
| Arith. Mean | 5272 | 4888 | 3457 | 1125 | 0.3597 | 0.3964 |
| 0 Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | |

[1] Geometric mean 1971-2008
[2] From forecast
[3] Mean $F_{(2008\text{-}2010)}$

**Table 7.13.14 - Sole in VIIfg**
**Input for catch forecast and Fmsy analysis**

Input: F mean 08-10 not rescaled to F2010
Catch and stock weights are mean 08-10
Recruits age 1 in 2011,12 and 13 GM (71-08)

| Label | Value | CV | Label | Value | CV |
|---|---|---|---|---|---|
| Number at age | | | Weight in the stock | | |
| N1 | 5025 | 0.43 | WS1 | 0.090 | 0.00 |
| N2 | 1069 | 0.52 | WS2 | 0.146 | 0.04 |
| N3 | 4206 | 0.39 | WS3 | 0.206 | 0.03 |
| N4 | 5360 | 0.20 | WS4 | 0.264 | 0.05 |
| N5 | 1536 | 0.19 | WS5 | 0.319 | 0.06 |
| N6 | 929 | 0.25 | WS6 | 0.373 | 0.06 |
| N7 | 1062 | 0.13 | WS7 | 0.424 | 0.05 |
| N8 | 696 | 0.13 | WS8 | 0.474 | 0.04 |
| N9 | 392 | 0.12 | WS9 | 0.522 | 0.03 |
| N10 | 1170 | 0.12 | WS10 | 0.614 | 0.04 |
| H.cons selectivity | | | Weight in the HC catch | | |
| sH1 | 0.0000 | 0.00 | WH1 | 0.107 | 0.20 |
| sH2 | 0.0654 | 0.16 | WH2 | 0.159 | 0.11 |
| sH3 | 0.1880 | 0.10 | WH3 | 0.211 | 0.06 |
| sH4 | 0.2883 | 0.24 | WH4 | 0.260 | 0.04 |
| sH5 | 0.2782 | 0.23 | WH5 | 0.309 | 0.03 |
| sH6 | 0.2487 | 0.18 | WH6 | 0.355 | 0.02 |
| sH7 | 0.2308 | 0.15 | WH7 | 0.401 | 0.02 |
| sH8 | 0.2119 | 0.18 | WH8 | 0.445 | 0.02 |
| sH9 | 0.1982 | 0.39 | WH9 | 0.488 | 0.02 |
| sH10 | 0.1982 | 0.39 | WH10 | 0.580 | 0.05 |
| Natural mortality | | | Proportion mature | | |
| M1 | 0.1 | 0.1 | MT1 | 0 | 0 |
| M2 | 0.1 | 0.1 | MT2 | 0.14 | 0.1 |
| M3 | 0.1 | 0.1 | MT3 | 0.45 | 0.1 |
| M4 | 0.1 | 0.1 | MT4 | 0.88 | 0.1 |
| M5 | 0.1 | 0.1 | MT5 | 0.98 | 0.1 |
| M6 | 0.1 | 0.1 | MT6 | 1 | 0 |
| M7 | 0.1 | 0.1 | MT7 | 1 | 0 |
| M8 | 0.1 | 0.1 | MT8 | 1 | 0 |
| M9 | 0.1 | 0.1 | MT9 | 1 | 0 |
| M10 | 0.1 | 0.1 | MT10 | 1 | 0 |
| Relative effort in HC fihery | | | Year effect for natural mortality | | |
| HF11 | 1 | 0.1 | K10 | 1 | 0.1 |
| HF12 | 1 | 0.1 | K11 | 1 | 0.1 |
| HF13 | 1 | 0.1 | K12 | 1 | 0.1 |
| Recruitment in 2012 and 2013 | | | | | |
| R12 | 5025 | 0.43 | | | |
| R13 | 5025 | 0.43 | | | |

## Table 7.13.15 Sole in VIIfg - Management option table

MFDP version 1a
Run: S7fg_fin
Sole in VIId
Time and date: 18:34 1/05/2011
Fbar age range: 4-8

| 2011<br>Biomass | SSB | FMult | FBar | Landings |
|---|---|---|---|---|
| 5429 | 4187 | 1.0000 | 0.2516 | 956 |

| 2012<br>Biomass | SSB | FMult | FBar | Landings | 2013<br>Biomass | SSB |
|---|---|---|---|---|---|---|
| 5306 | 4057 | 0.0000 | 0.0000 | 0 | 6292 | 4759 |
| . | 4057 | 0.1000 | 0.0252 | 98 | 6181 | 4652 |
| . | 4057 | 0.2000 | 0.0503 | 193 | 6072 | 4547 |
| . | 4057 | 0.3000 | 0.0755 | 287 | 5967 | 4445 |
| . | 4057 | 0.4000 | 0.1006 | 378 | 5863 | 4346 |
| . | 4057 | 0.5000 | 0.1258 | 466 | 5762 | 4249 |
| . | 4057 | 0.6000 | 0.1509 | 553 | 5664 | 4154 |
| . | 4057 | 0.7000 | 0.1761 | 638 | 5568 | 4061 |
| . | 4057 | 0.8000 | 0.2013 | 721 | 5474 | 3971 |
| . | 4057 | 0.9000 | 0.2264 | 802 | 5382 | 3883 |
| . | 4057 | 1.0000 | 0.2516 | 881 | 5293 | 3798 |
| . | 4057 | 1.1000 | 0.2767 | 958 | 5205 | 3714 |
| . | 4057 | 1.2000 | 0.3019 | 1033 | 5120 | 3632 |
| . | 4057 | 1.3000 | 0.3271 | 1107 | 5037 | 3553 |
| . | 4057 | 1.4000 | 0.3522 | 1178 | 4956 | 3475 |
| . | 4057 | 1.5000 | 0.3774 | 1249 | 4876 | 3399 |
| . | 4057 | 1.6000 | 0.4025 | 1317 | 4799 | 3325 |
| . | 4057 | 1.7000 | 0.4277 | 1384 | 4723 | 3253 |
| . | 4057 | 1.8000 | 0.4528 | 1449 | 4649 | 3183 |
| . | 4057 | 1.9000 | 0.4780 | 1513 | 4577 | 3114 |
| . | 4057 | 2.0000 | 0.5032 | 1576 | 4507 | 3047 |

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 1.47

| | | | | | | |
|---|---|---|---|---|---|---|
| . | 4057 | 1.47 | 0.3698 | 1228 | 4900 | 3422 |

Fmult corresponding to Fmsy = 1.23

| | | | | | | |
|---|---|---|---|---|---|---|
| . | 4057 | 1.23 | 0.3094 | 1055 | 5095 | 3608 |

Bpa = 2 200 t

# Table 7.13.16 - Sole in VIIfg. Detailed results

MFDP version 1a
Run: S7fg_fin
Time and date: 18:34 1/05/2011
Fbar age range: 4-8

| Year: | **2011** | F multiplier: | 1 | Fbar: | 0.252 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.000 | 0 | 0 | 5025 | 452 | 0 | 0 | 0 | 0 |
| 2 | 0.065 | 64 | 10 | 1069 | 156 | 150 | 22 | 150 | 22 |
| 3 | 0.188 | 687 | 145 | 4206 | 866 | 1893 | 390 | 1893 | 390 |
| 4 | 0.288 | 1281 | 333 | 5360 | 1413 | 4717 | 1244 | 4717 | 1244 |
| 5 | 0.278 | 356 | 110 | 1536 | 490 | 1505 | 481 | 1505 | 481 |
| 6 | 0.249 | 195 | 69 | 929 | 347 | 929 | 347 | 929 | 347 |
| 7 | 0.231 | 209 | 84 | 1062 | 451 | 1062 | 451 | 1062 | 451 |
| 8 | 0.212 | 127 | 56 | 696 | 330 | 696 | 330 | 696 | 330 |
| 9 | 0.198 | 67 | 33 | 392 | 205 | 392 | 205 | 392 | 205 |
| 10 | 0.198 | 200 | 116 | 1170 | 719 | 1170 | 719 | 1170 | 719 |
| Total | | 3186 | 956 | 21445 | 5429 | 12513 | 4187 | 12513 | 4187 |

| Year: | **2012** | F multiplier: | 1 | Fbar: | 0.252 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.000 | 0 | 0 | 5025 | 452 | 0 | 0 | 0 | 0 |
| 2 | 0.065 | 274 | 44 | 4547 | 664 | 637 | 93 | 637 | 93 |
| 3 | 0.188 | 148 | 31 | 906 | 187 | 408 | 84 | 408 | 84 |
| 4 | 0.288 | 753 | 196 | 3154 | 831 | 2775 | 732 | 2775 | 732 |
| 5 | 0.278 | 842 | 260 | 3635 | 1161 | 3562 | 1138 | 3562 | 1138 |
| 6 | 0.249 | 221 | 78 | 1052 | 393 | 1052 | 393 | 1052 | 393 |
| 7 | 0.231 | 129 | 52 | 656 | 278 | 656 | 278 | 656 | 278 |
| 8 | 0.212 | 139 | 62 | 763 | 362 | 763 | 362 | 763 | 362 |
| 9 | 0.198 | 87 | 43 | 510 | 266 | 510 | 266 | 510 | 266 |
| 10 | 0.198 | 199 | 115 | 1159 | 712 | 1159 | 712 | 1159 | 712 |
| Total | | 2792 | 881 | 21406 | 5306 | 11521 | 4057 | 11521 | 4057 |

| Year: | **2013** | F multiplier: | 1 | Fbar: | 0.252 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.000 | 0 | 0 | 5025 | 452 | 0 | 0 | 0 | 0 |
| 2 | 0.065 | 274 | 44 | 4547 | 664 | 637 | 93 | 637 | 93 |
| 3 | 0.188 | 629 | 133 | 3854 | 794 | 1734 | 357 | 1734 | 357 |
| 4 | 0.288 | 162 | 42 | 679 | 179 | 598 | 158 | 598 | 158 |
| 5 | 0.278 | 495 | 153 | 2139 | 683 | 2096 | 669 | 2096 | 669 |
| 6 | 0.249 | 523 | 186 | 2490 | 930 | 2490 | 930 | 2490 | 930 |
| 7 | 0.231 | 146 | 59 | 743 | 315 | 743 | 315 | 743 | 315 |
| 8 | 0.212 | 86 | 38 | 471 | 223 | 471 | 223 | 471 | 223 |
| 9 | 0.198 | 96 | 47 | 558 | 292 | 558 | 292 | 558 | 292 |
| 10 | 0.198 | 212 | 123 | 1239 | 761 | 1239 | 761 | 1239 | 761 |
| Total | | 2624 | 824 | 21745 | 5293 | 10565 | 3798 | 10565 | 3798 |

Input units are thousands and kg - output in tonnes

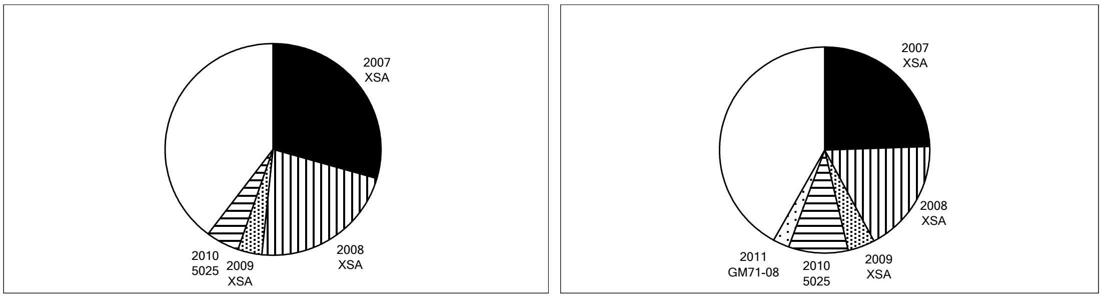
Table 7.13.17 Sole VIIf,g
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

| Year-class | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Stock No. (thousands) of 1 year-olds | 9563 | 5444 | 1181 | 5025 | 5025 |
| Source | XSA | XSA | XSA | 5025 | GM71-08 |
| Status Quo F: | | | | | |
| % in 2011 landings | 34.8 | 15.2 | 1.0 | 0.0 | - |
| % in 2012 landings | 29.5 | 22.2 | 3.5 | 5.0 | 0.0 |
| % in 2011 SSB | 29.7 | 9.3 | 0.5 | 0.0 | - |
| % in 2012 SSB | 28.0 | 18.0 | 2.1 | 2.3 | 0.0 |
| % in 2013 SSB | 24.5 | 17.6 | 4.2 | 9.4 | 2.4 |

GM : geometric mean recruitment

Sole VIIf,g : Year-class % contribution to

a ) 2012 landings b ) 2013 SSB




# Table 7.13.18 - Sole in VIIfg Yield per recruit summary table

MFYPR version 2a
Run: S7fg_yield_fin
Time and date: 18:41 1/05/2011
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 10.5083 | 4.3541 | 8.1776 | 4.0300 | 8.1776 | 4.0300 |
| 0.1000 | 0.0252 | 0.1525 | 0.0633 | 8.9847 | 3.4736 | 6.6598 | 3.1509 | 6.6598 | 3.1509 |
| 0.2000 | 0.0503 | 0.2603 | 0.1035 | 7.9081 | 2.8631 | 5.5889 | 2.5418 | 5.5889 | 2.5418 |
| 0.3000 | 0.0755 | 0.3403 | 0.1298 | 7.1103 | 2.4198 | 4.7968 | 2.0999 | 4.7968 | 2.0999 |
| 0.4000 | 0.1006 | 0.4017 | 0.1475 | 6.4976 | 2.0866 | 4.1897 | 1.7680 | 4.1897 | 1.7680 |
| 0.5000 | 0.1258 | 0.4502 | 0.1595 | 6.0139 | 1.8292 | 3.7114 | 1.5119 | 3.7114 | 1.5119 |
| 0.6000 | 0.1509 | 0.4895 | 0.1677 | 5.6234 | 1.6261 | 3.3262 | 1.3101 | 3.3262 | 1.3101 |
| 0.7000 | 0.1761 | 0.5217 | 0.1733 | 5.3022 | 1.4628 | 3.0103 | 1.1481 | 3.0103 | 1.1481 |
| 0.8000 | 0.2013 | 0.5487 | 0.1771 | 5.0339 | 1.3296 | 2.7471 | 1.0160 | 2.7471 | 1.0160 |
| 0.9000 | 0.2264 | 0.5716 | 0.1796 | 4.8069 | 1.2194 | 2.5251 | 0.9071 | 2.5251 | 0.9071 |
| 1.0000 | 0.2516 | 0.5912 | 0.1811 | 4.6124 | 1.1273 | 2.3356 | 0.8161 | 2.3356 | 0.8161 |
| 1.1000 | 0.2767 | 0.6082 | 0.1820 | 4.4442 | 1.0494 | 2.1723 | 0.7394 | 2.1723 | 0.7394 |
| 1.2000 | 0.3019 | 0.6230 | 0.1824 | 4.2974 | 0.9830 | 2.0304 | 0.6741 | 2.0304 | 0.6741 |
| 1.3000 | 0.3271 | 0.6361 | 0.1825 | 4.1683 | 0.9259 | 1.9059 | 0.6181 | 1.9059 | 0.6181 |
| 1.4000 | 0.3522 | 0.6477 | 0.1824 | 4.0539 | 0.8764 | 1.7961 | 0.5697 | 1.7961 | 0.5697 |
| 1.5000 | 0.3774 | 0.6580 | 0.1820 | 3.9518 | 0.8332 | 1.6986 | 0.5275 | 1.6986 | 0.5275 |
| 1.6000 | 0.4025 | 0.6673 | 0.1815 | 3.8602 | 0.7952 | 1.6115 | 0.4906 | 1.6115 | 0.4906 |
| 1.7000 | 0.4277 | 0.6757 | 0.1810 | 3.7775 | 0.7617 | 1.5333 | 0.4582 | 1.5333 | 0.4582 |
| 1.8000 | 0.4528 | 0.6834 | 0.1804 | 3.7025 | 0.7320 | 1.4627 | 0.4294 | 1.4627 | 0.4294 |
| 1.9000 | 0.4780 | 0.6903 | 0.1797 | 3.6342 | 0.7054 | 1.3986 | 0.4038 | 1.3986 | 0.4038 |
| 2.0000 | 0.5032 | 0.6967 | 0.1791 | 3.5718 | 0.6815 | 1.3404 | 0.3809 | 1.3404 | 0.3809 |

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(4-8) | 1.0000 | 0.2516 |
| FMax | 1.2772 | 0.3213 |
| F0.1 | 0.5553 | 0.1397 |
| F35%SPR | 0.5474 | 0.1377 |

Figure 7.13.1 - Sole in VIIfg. Dotted lines give the length distributions of UK (England and Wales) landings; solid lines of Belgian landings

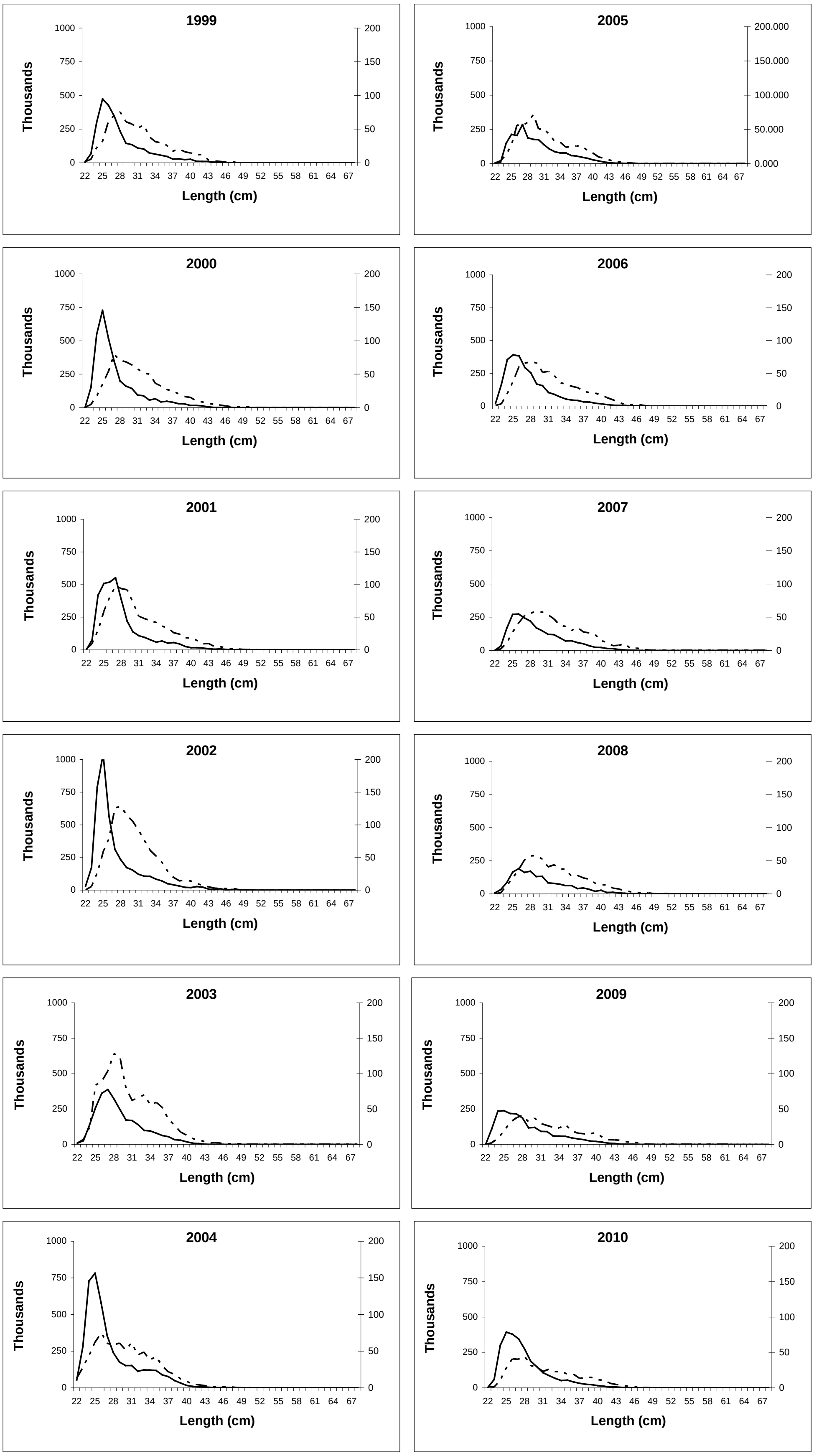


Figure 7.13.2 - Sole in VIIfg. Age composition of landings

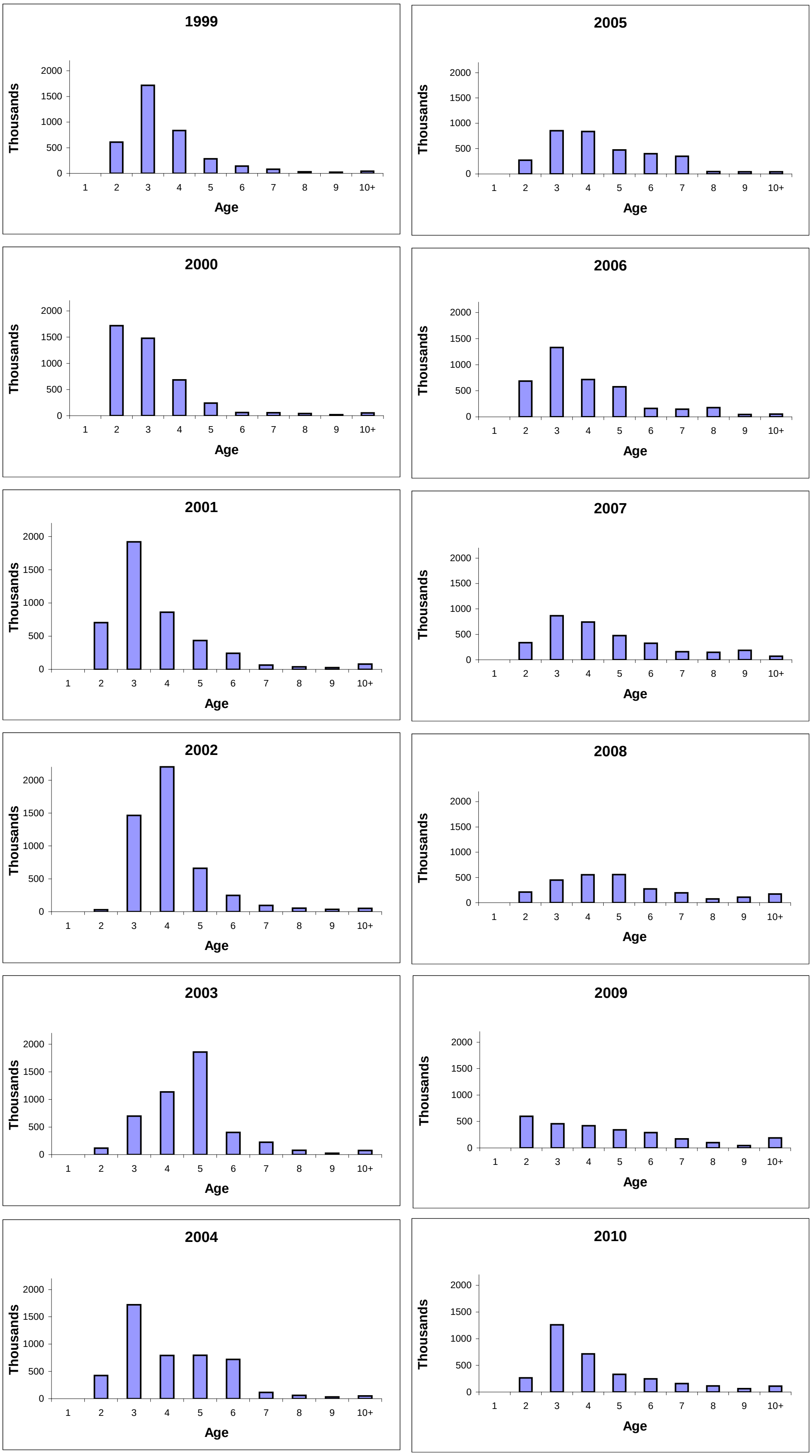


Figure 7.13.3 - Sole VIIfg - Standardized catch proportion

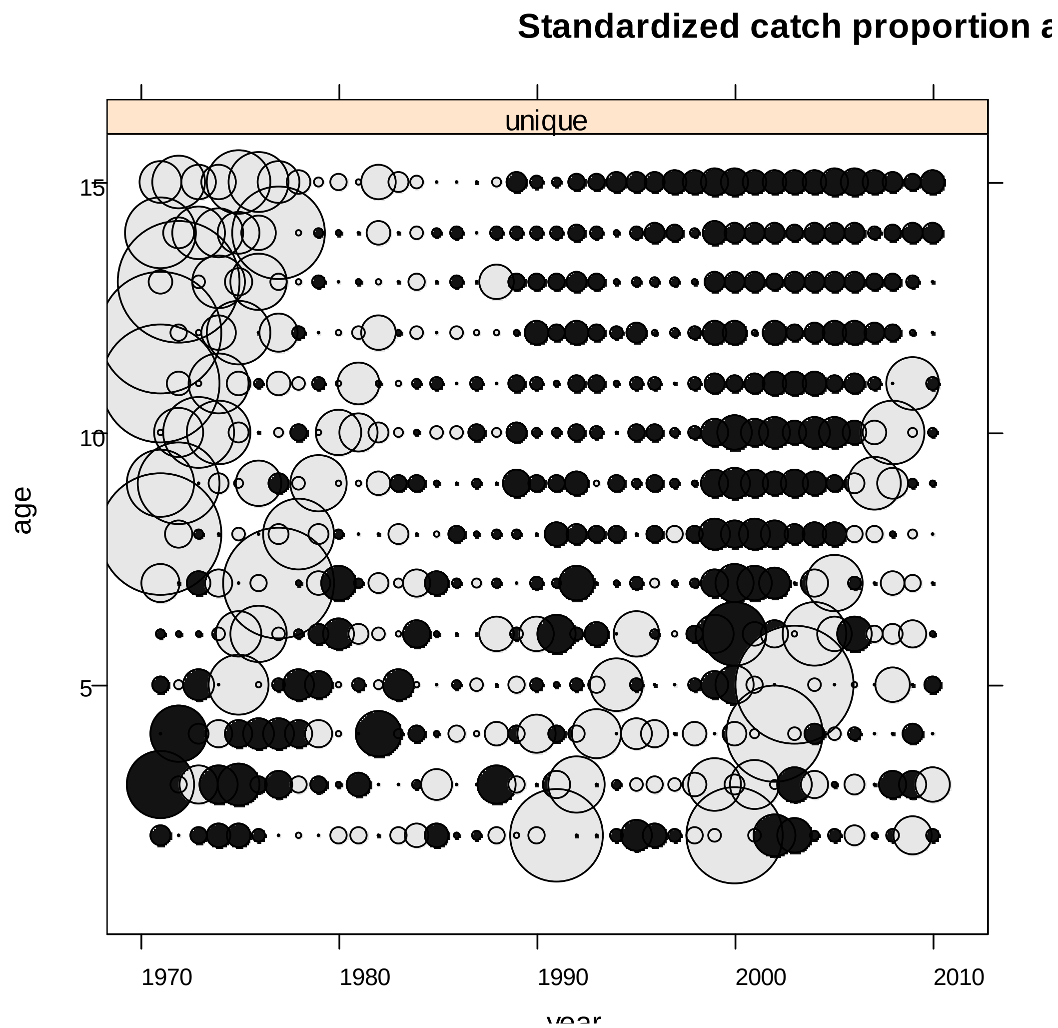


**Figure 7.13.4a - Sole VIIf - Length distributions of discarded and retained fish from Belgium bream trawls**

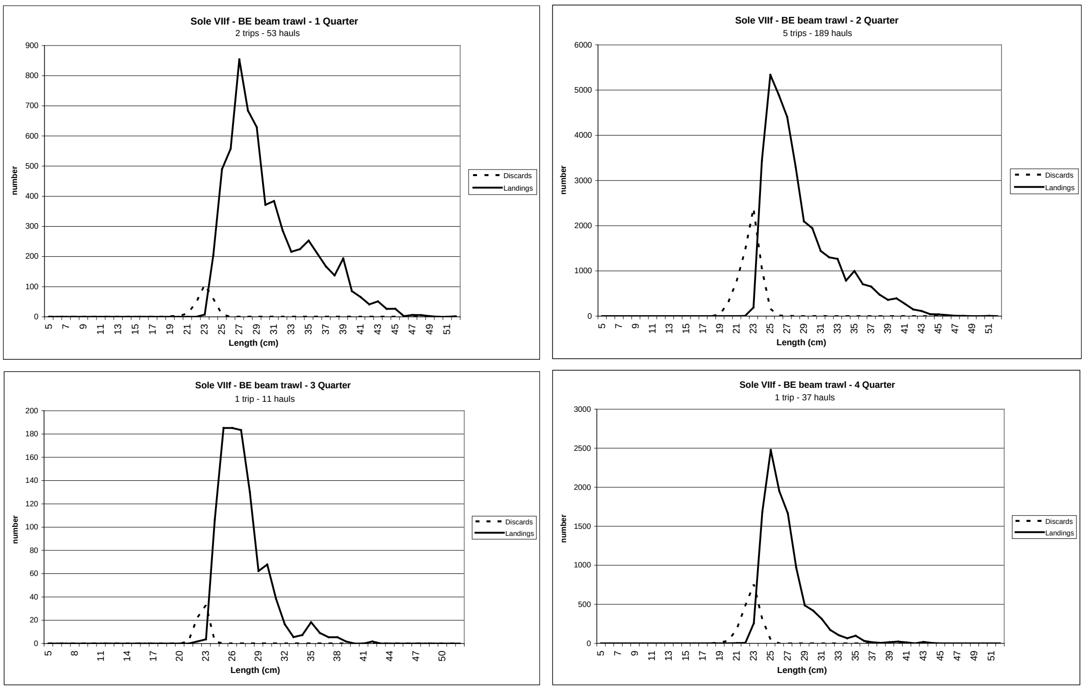



**Figure 7.13.4b - Sole VIIg - Length distributions of discarded and retained fish from Belgium bream trawls**

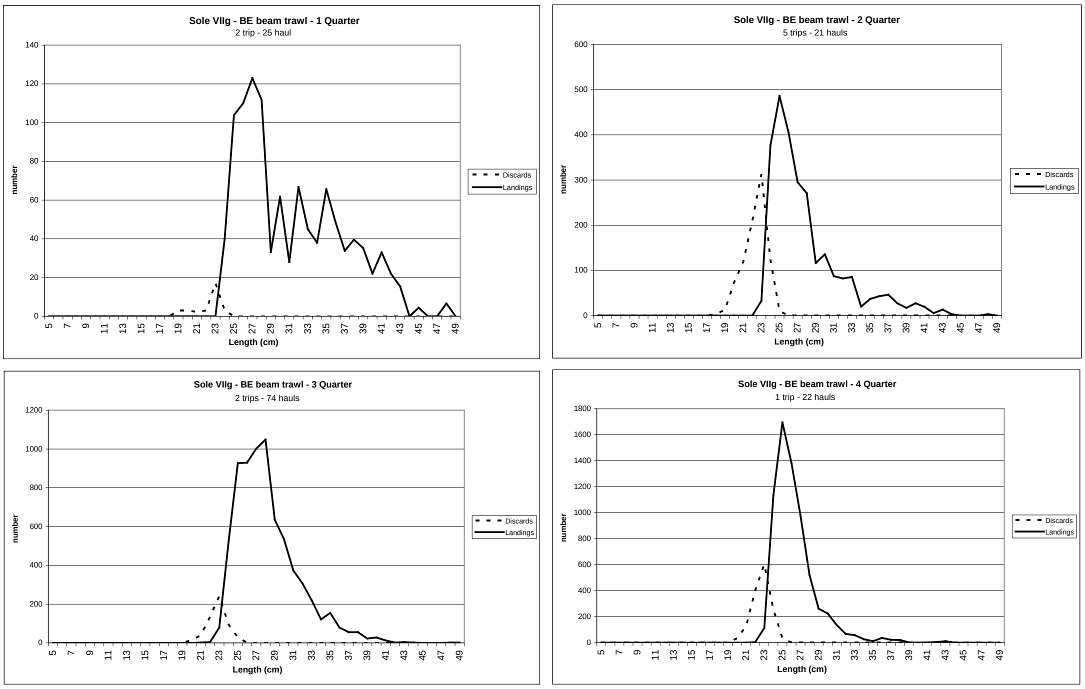


Figure 7.13.4c - Sole VIIfg - Length distributions of discarded and retained fish from UK static gear

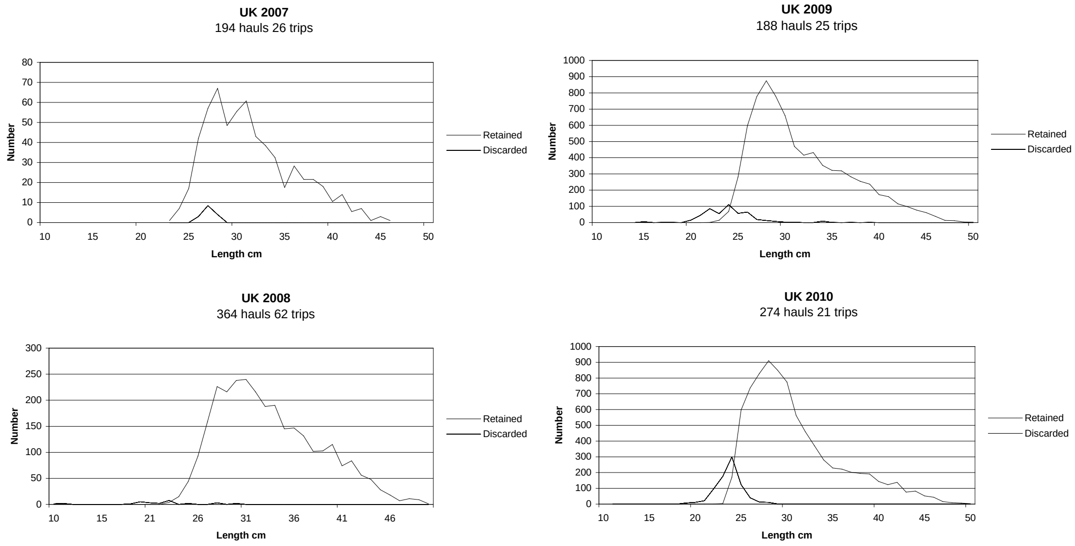



Figure 7.13.4d - Sole VIIfg - Length distributions of discarded and retained fish from Irish otter trawl

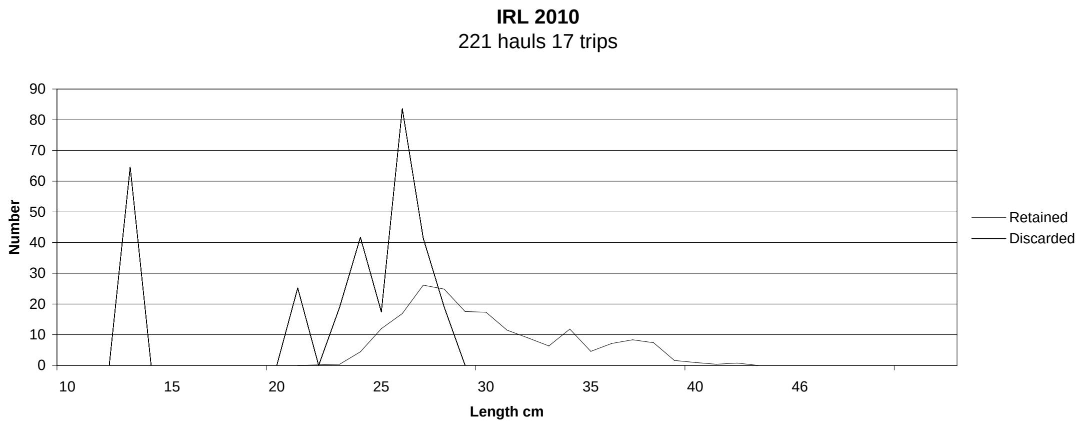
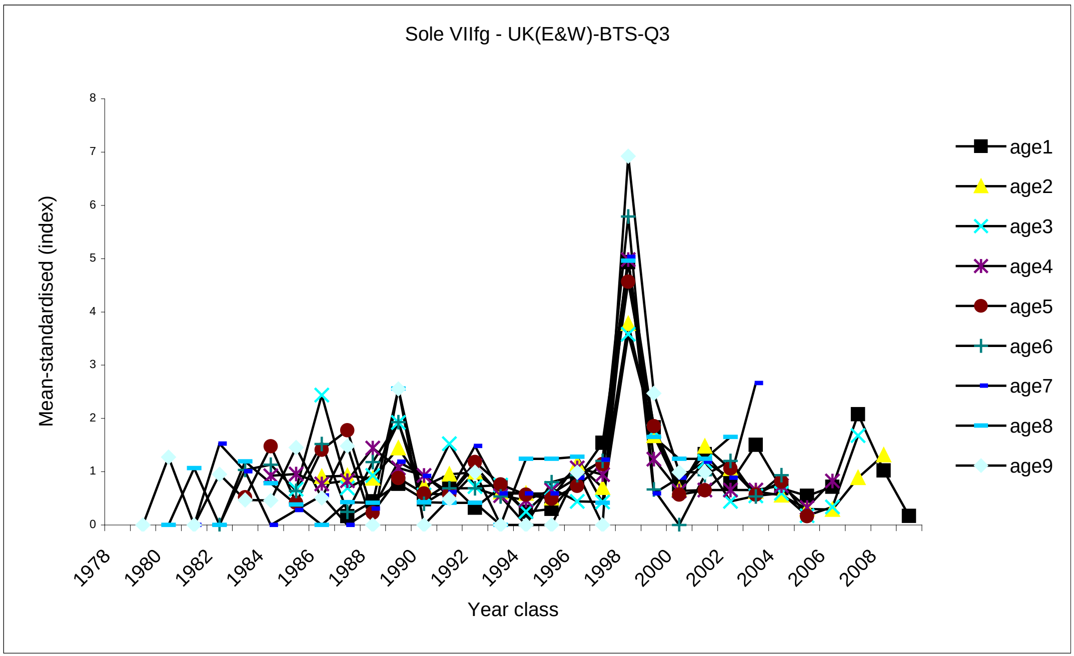


Figure 7.13.5 - Sole VIIfg - Mean-standardised index of UK(E&W) VIIfg Corystes survey



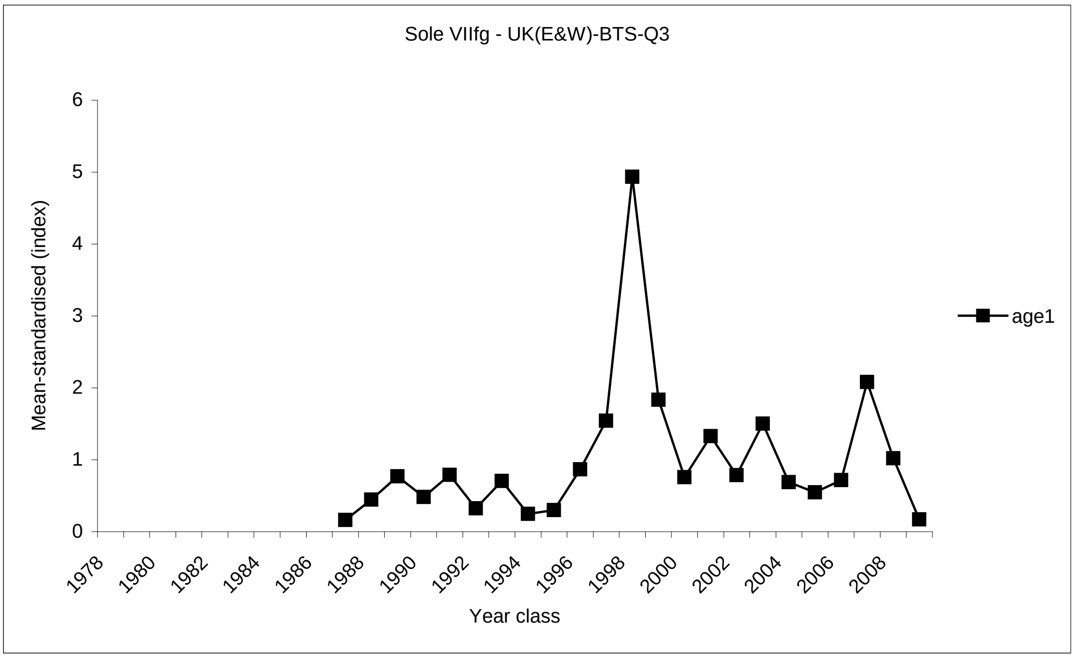
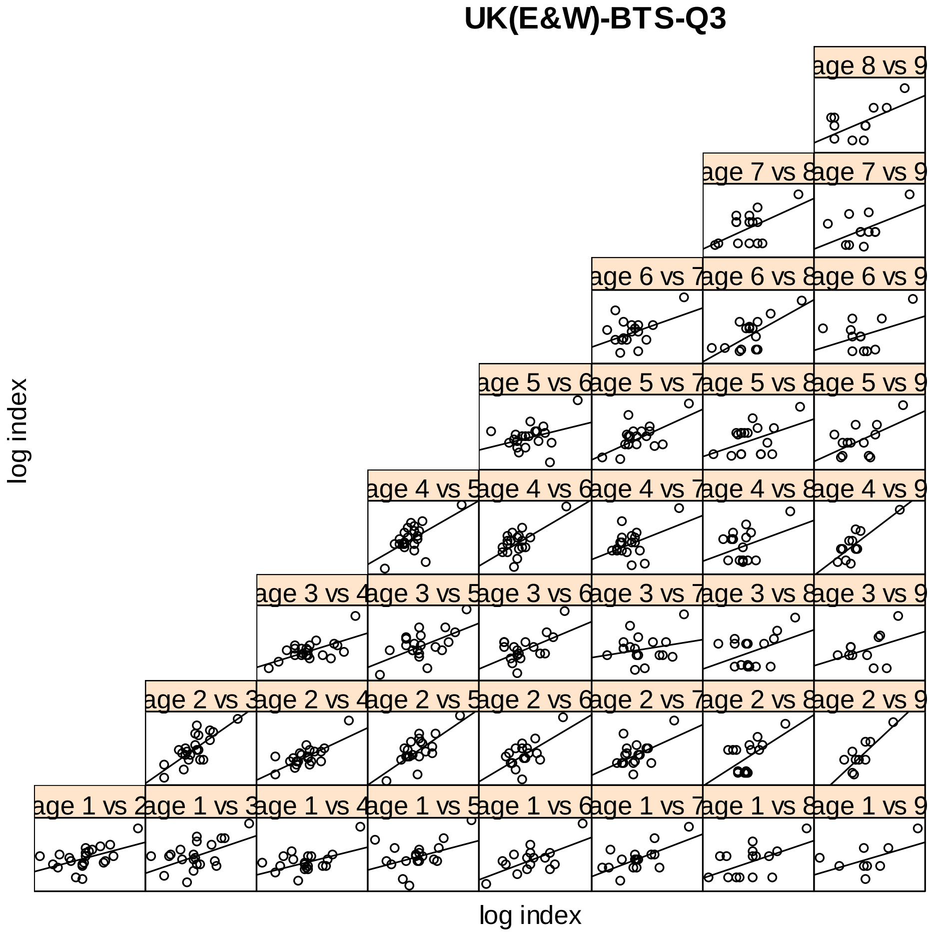



Figure 7.13.6 - Sole in VIIfg - Consistency plot UK(E&W)-BTS-Q3 survey



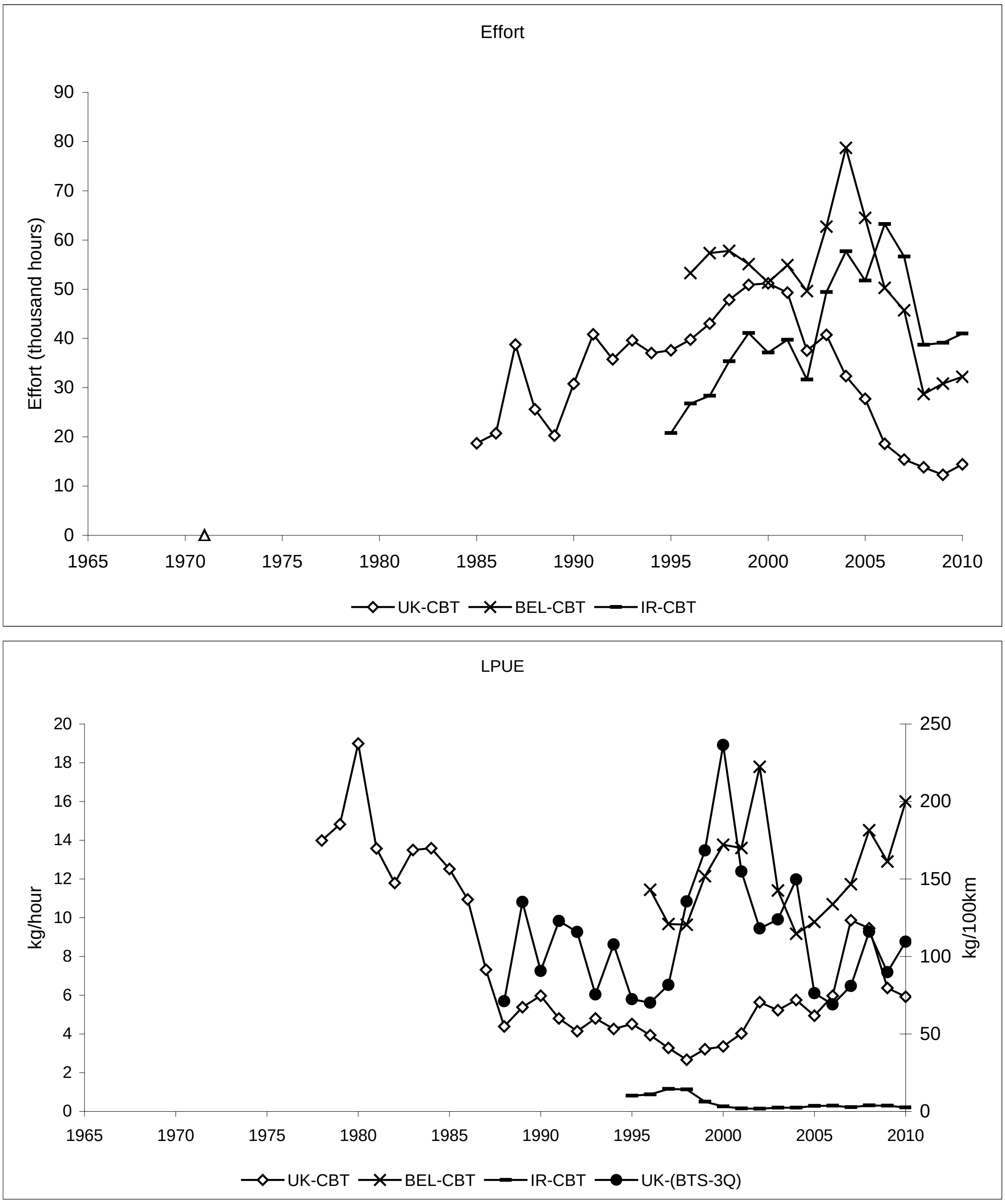



**Figure 7.13.7. Sole in VIIfg. Effort (in thousand hours, GRT corrected in case of E&W beam trawl fleet) and lpue (in kg/hour; or in kg/100km in case of UK(BTS-3Q) survey) for three beam trawl fleets and one survey.**

Figure 7.13.8 - Sole in VIIfg - Consistency plot Uk(E&W) beam trawl

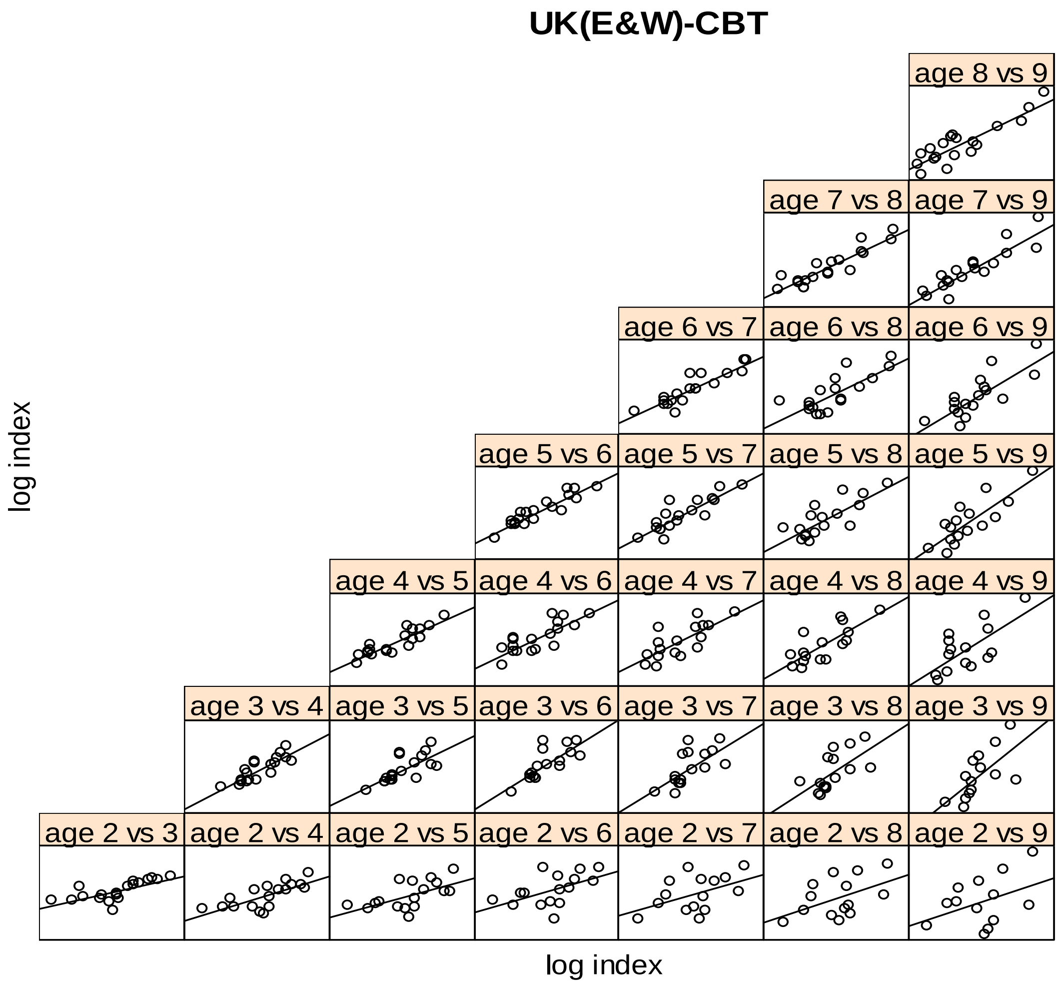


Figure 7.13.9 - Sole in VIIfg - Consistency plot Belgian beam trawl

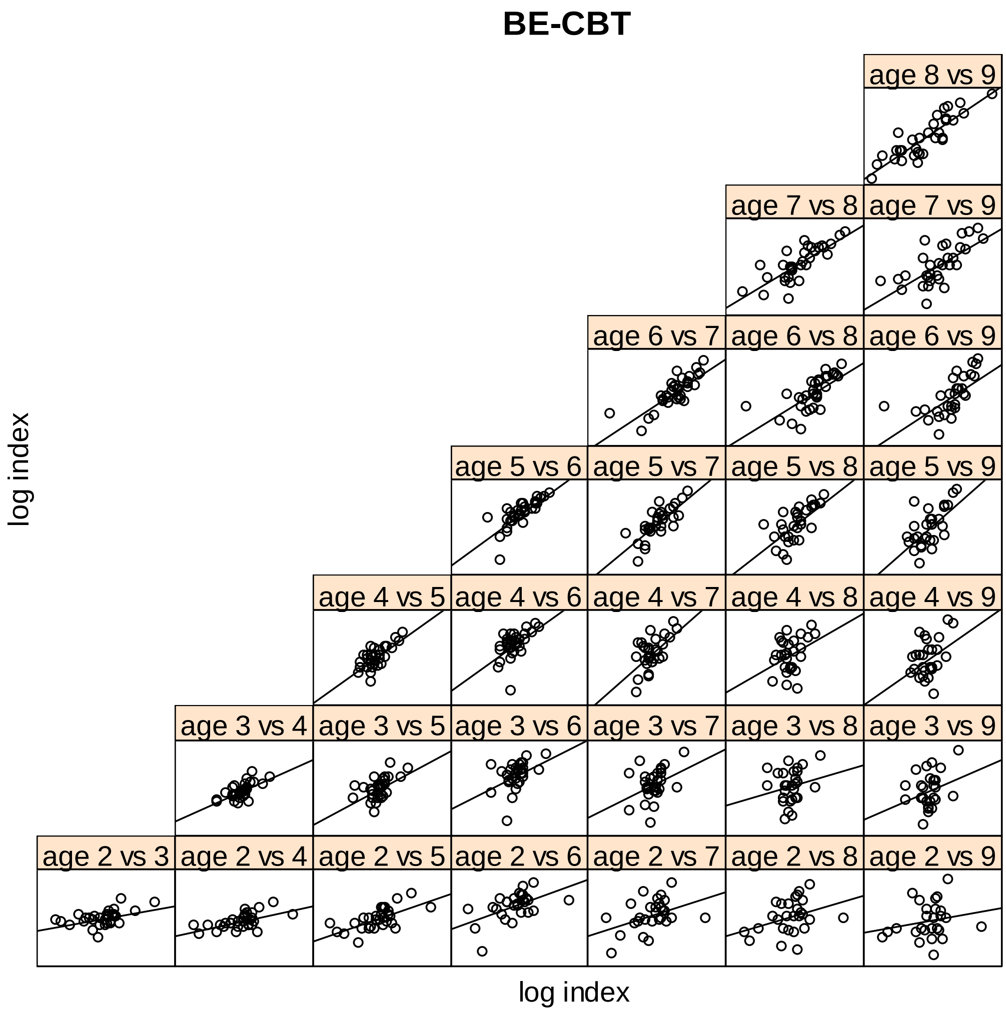
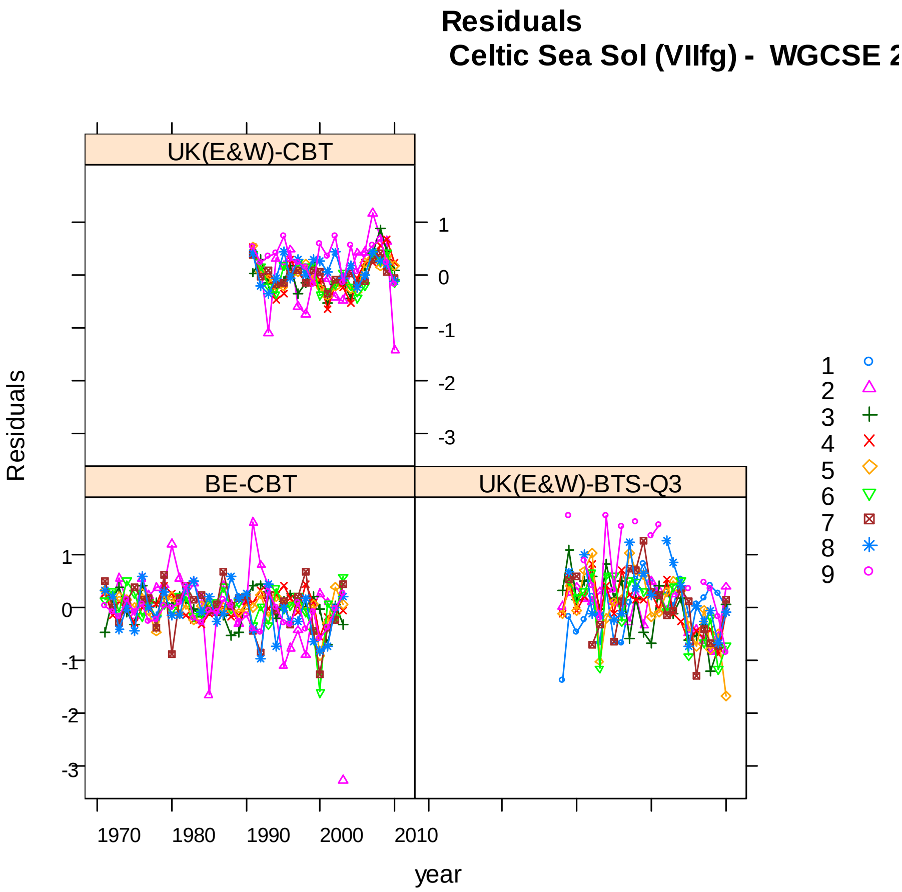


Figure 7.13.10 - Sole in VIIfg. Catchability residuals for final XSA run



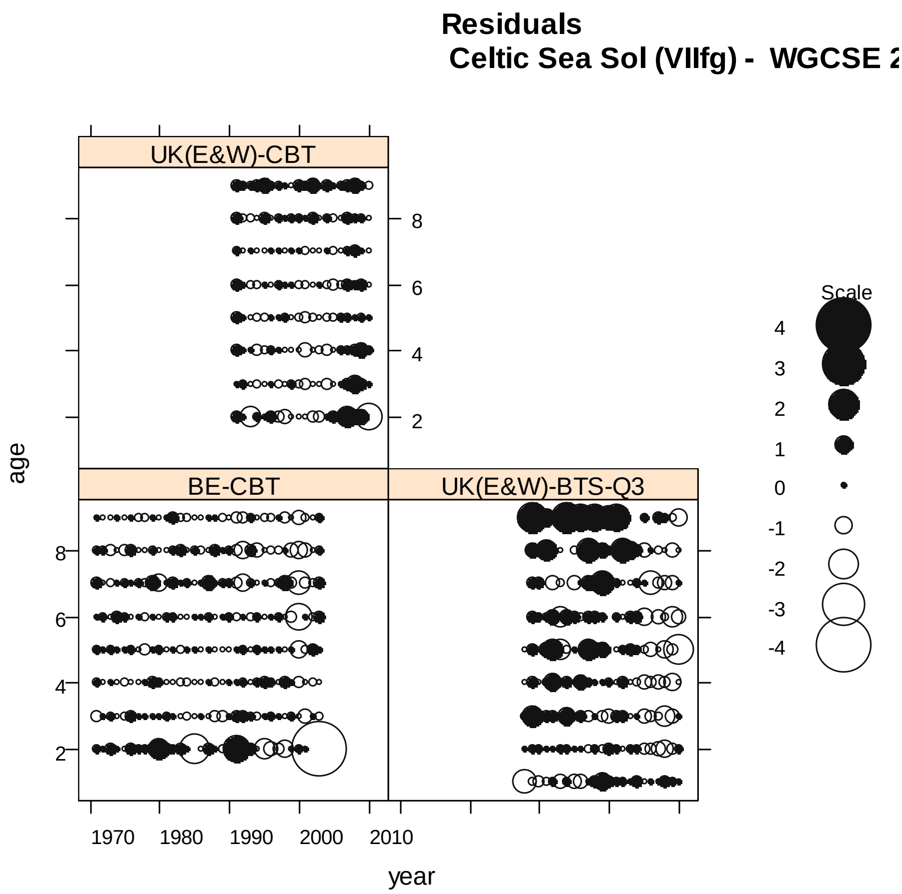



**Figure 7.13.11 - Sole in VIIfg. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run**

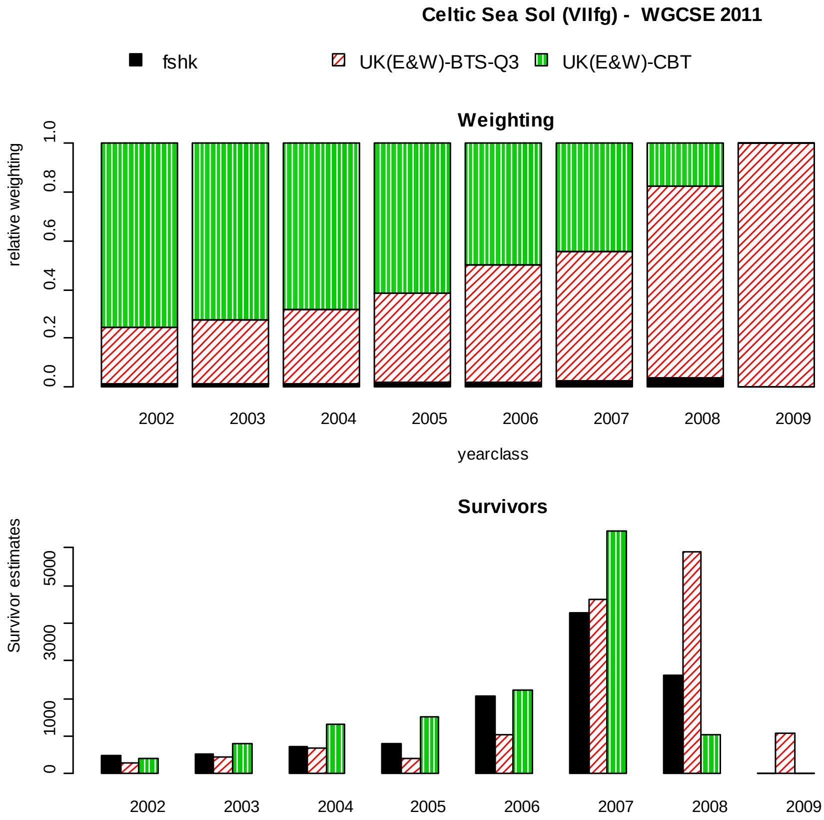
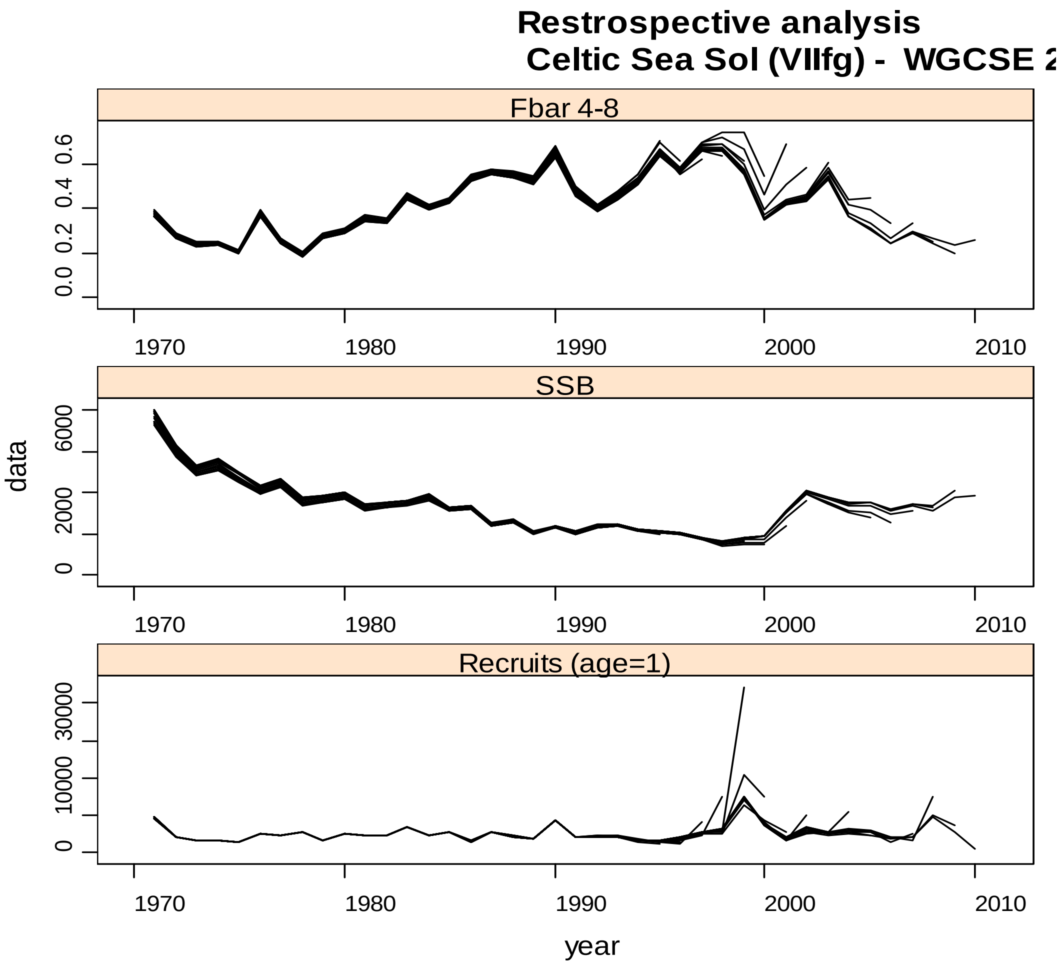
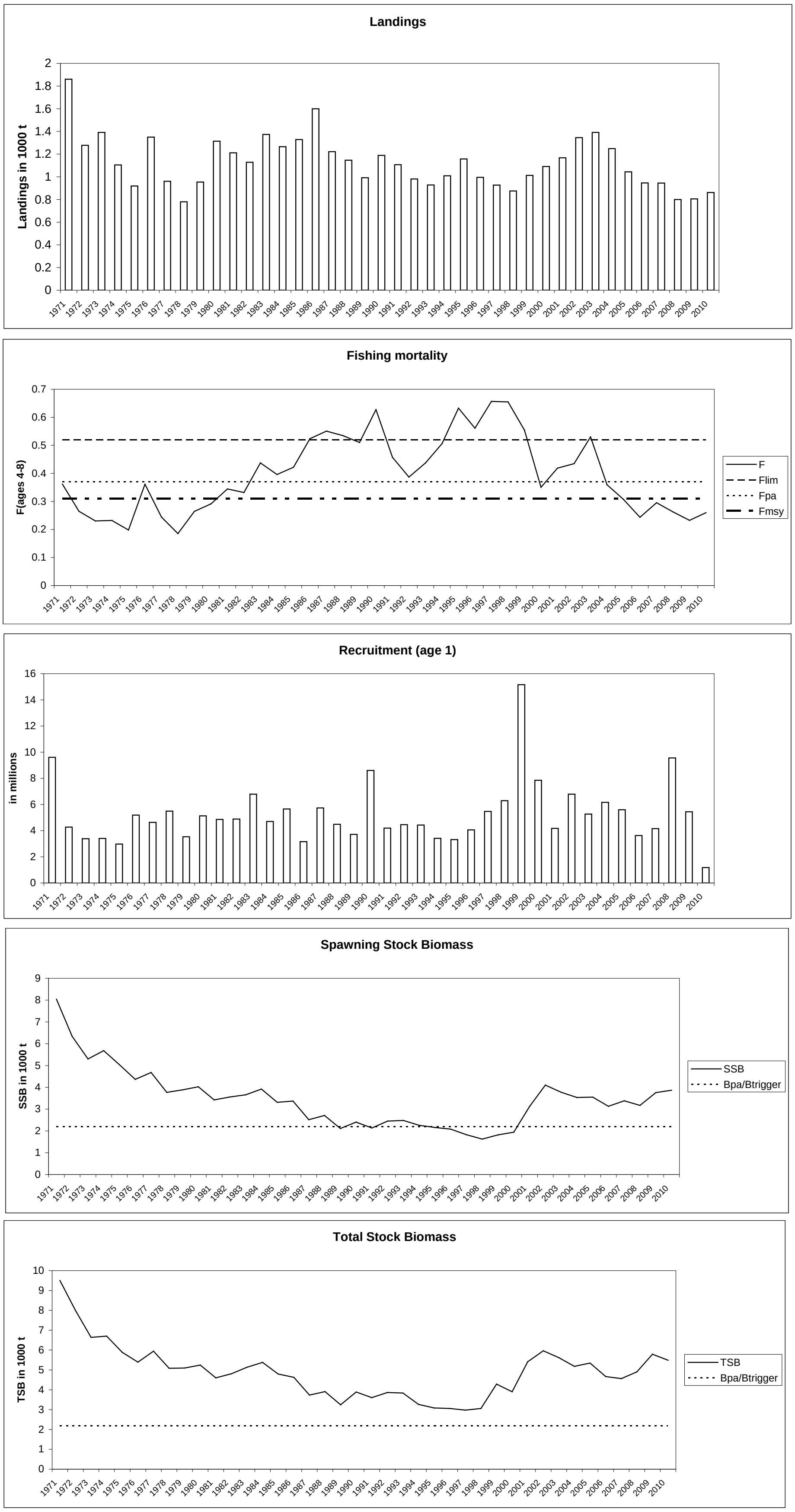


**Figure 7.13.12 - Sole VIIf,g retrospective XSA analysys (shinkage SE=1.5)**



# Figure 7.13.13 Sole in VIIfg. Summary plots



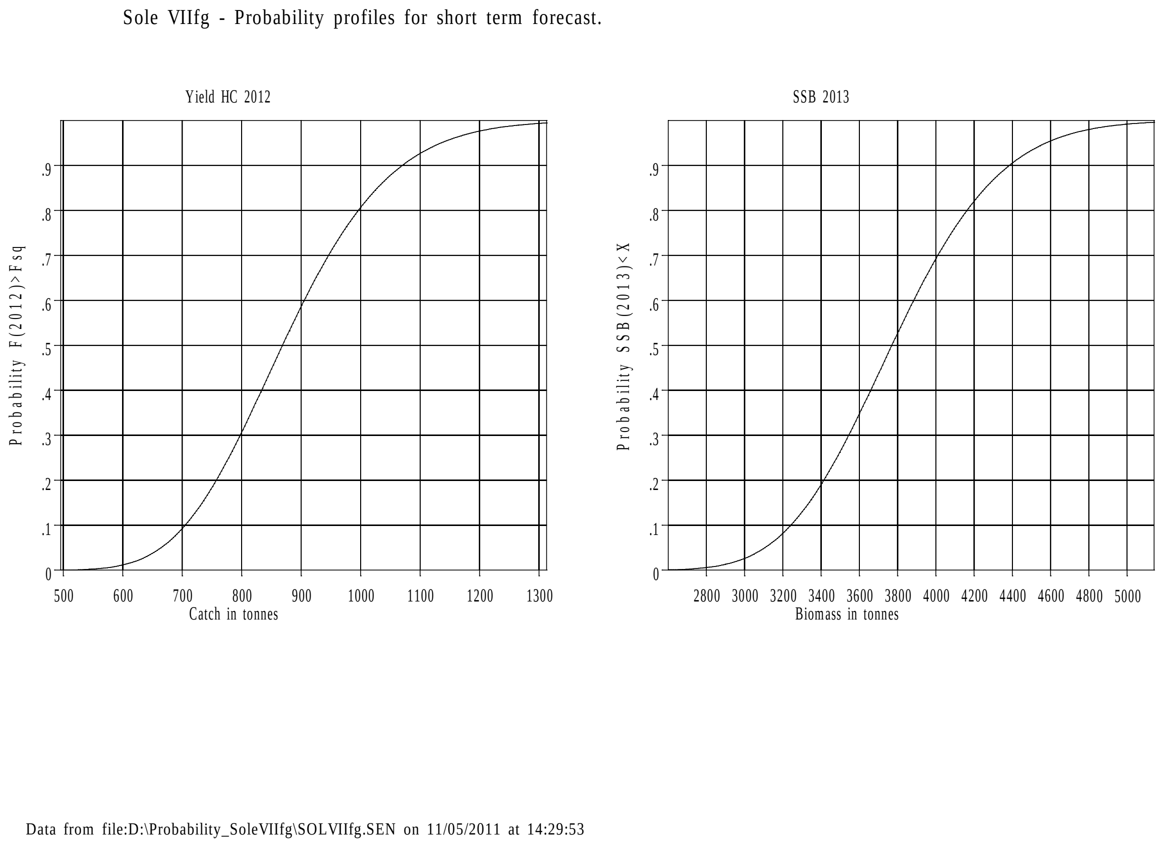
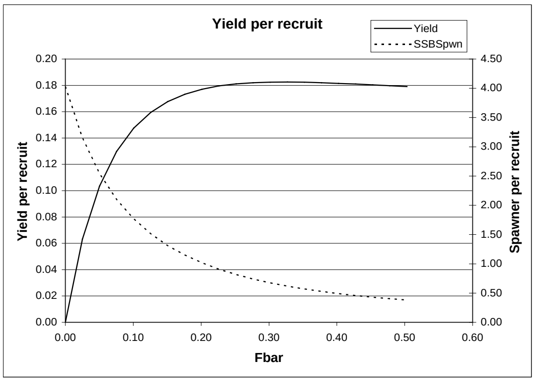
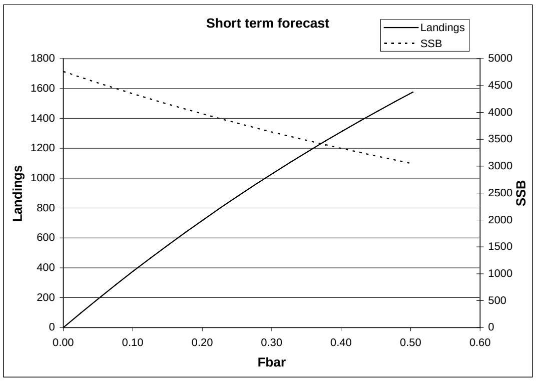



**Figure 7.13.14. Sole VIIfg. Probability profiles for short-term forecast.**

**Figure 7.13.15 - Sole in VIIfg Yield per recruit and short term forecast plots**




MFYPR version 2a
Run: S7fg_yield_fin
Time and date: 18:41 1/05/2011

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(4-8) | 1.0000 | 0.2516 |
| FMax | 1.2772 | 0.3213 |
| F0.1 | 0.5553 | 0.1397 |
| F35%SPR | 0.5474 | 0.1377 |

MFDP version 1a
Run: S7fg_fin
Sole in VIId
Time and date: 18:34 1/05/2011
Fbar age range: 4-8

Input units are thousands and kg - output in tonnes

**Figure 7.13.16 - Sole in VIIfg. Three year average exploitation pattern, standardised to Fbar (4-8)**

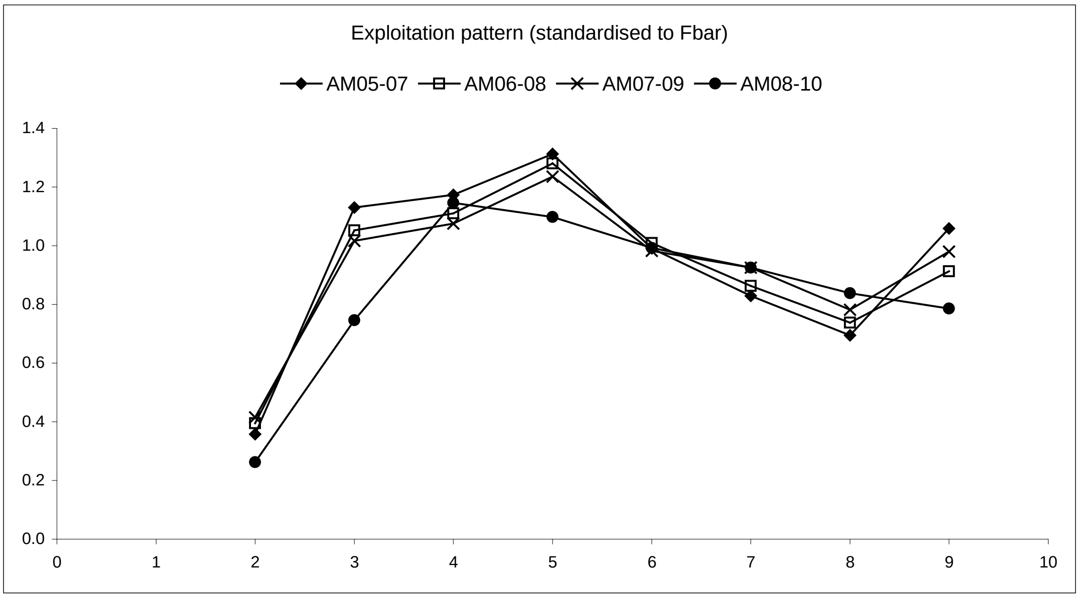



**Figure 7.13.17. Sole VIIfg. Stock–recruitment plot.**

## 7.14 Sole in the Southwest of Ireland (ICES Divisions VIIh–k)

### Type of assessment in 2011

No assessment was performed, however catch numbers and weighs were aggregated for the Irish landings for the years 1993–2010 and these were used to perform a yield-per-recruit analyis.

### 7.14.1 General

#### Stock Identity

Sole in VIIj are mainly caught by Irish vessels on sandy grounds off counties Kerry and west Cork. Sole catches in VIIk are negligible. VIIh is also considered part of the stock for assessment purposes but there is no evidence to suggest that this is actually the same stock

### 7.14.2 Data

The nominal landings are given in Table 7.14.1.

Most non-Irish landings were from VIIh which is likely to be a different stock. Because age data were only available for Irish landings (which were mainly from VIIjk) therefore the remainder of Section 7.14 concerns Irish data only in VIIgjk.

#### Sampling

Figure 7.14.1 shows that sole landings in VIIjk were mostly taken by otter trawlers in VIIj. This is reflected in the sampling.

#### Data quality

Figure 7.14.2 shows the length distribution of the Irish landings in VIIjk between 1993 and 2010. In some years distinct modes of strong year classes are discernible but cohorts cannot easily be tracked. The sample numbers appear to be adequate.

Annual Age–Length-Keys (ALKs) were constructed (all quarters and gear types combined) and applied to the sampled length frequency distributions. Figure 7.14.3 shows the age distribution of sole in VIIjk between 1993 and 2010.

### 7.14.3 Historical stock development

Because sole in VIIh were not sampled, it would not be appropriate to raise the data to all landings in VIIhjk. Instead, the official International landings figures for VIIjk were used to raise the age distributions (Table 7.14.2).

The estimated catch numbers-at-age are given in Table 7.14.3, catch weights-at-age are given in Table 7.14.4. It is possible to track some strong and weak year classes in the catch numbers-at-age matrix. This is also illustrated by Figure 7.14.4, which shows the standardized catch proportions-at-age. Figure 7.14.5 shows the log catch numbers-at-age. The rate of decline in catch numbers through the cohorts appears to be reasonably stable. This can be further investigated by calculating the slope of the logcatch numbers (Z). Figure 7.14.6 shows the catch curve, sole under the age of 4 are not fully selected and from age 10 onwards the data get quite noisy, therefore the slope of the log catch numbers was estimated over ages 4 to 9 (Figure 7.14.7). Z estimates varied mostly between 0.2 and 0.7.

#### Yield-per-recruit

The yield-per-recruit was estimated using a method by Thompson and Bell (1934). This method requires the selectivity to be estimated. This was done by estimating the slope of the log catch numbers for ages that are fully selected and using this slope (Z) to predict the population numbers for ages that are not fully selected. The Z was estimated on pseudo-cohorts which were standardized to take account of annual variations in the catch numbers. Figure 7.14.8 shows that sole in VIIjk appear to be fully selected by the age of 5 and that after the age of 10 the data get very sparse. Figure 7.14.9 shows the slope of the mean standardized log catch numbers. The predicted catch numbers from this slope were used to estimate the 'observed' selectivity. This was then modelled by applying a linear model after a logit transformation. The estimated selection curve is also shown in Figure 7.14.9. A natural mortality of 0.1 was assumed (based on the value used by the WG for sole in VIIfg) and the WG maturity ogive for sole in VIIfg was used to estimate SSB. The yield was estimated for a range of F values based on the average catch weights. Figure 7.14.10 shows the YPR curve, $F_{max}$ is estimated to be 0.32. $F_{0.1}$ is estimated as 0.15. Recent (2006–2010) values of Z ranged between 0.15 and 0.45, with M=1.0 this would result in an F of 0.05 to 0.35. This suggests that this stock may be within safe biological limits.

### 7.14.4 References

Thompson W.F. and Bell F.H. 1934. Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear, Rep. Int. Fish. (Pacific Halibut) Comm. 8 (1934), p. 49.

**Table 7.14.1. Sole in Divisions VIIh–k (Southwest Ireland). Nominal landings (t), 1973–2010, as officially reported to ICES.**

| Country | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 406 | 369 | 210 | 638 | 519 | 290 | 384 | 522 | 576 | 471 |
| Denmark | - | - | - | - | - | - | | - | - | - |
| France | 390 | 143 | 207 | 19 | 103 | 23 | 29 | 27 | 107 | 104 |
| Ireland | 108 | 116 | 97 | 152 | 126 | 73 | 109 | 162 | 195 | 172 |
| Netherlands | 4 | 15 | 2 | 33 | 140 | 60 | - | - | | |
| Spain | 190 | 153 | 152 | 131 | 26 | 1 | 8 | 2 | | |
| UK - Eng+Wales+N.I | . | . | . | . | . | . | . | . | . | . |
| UK - England & Wale | 6 | 5 | 24 | 11 | 12 | 11 | 18 | 42 | 83 | 108 |
| UK - Scotland | - | - | - | - | - | - | - | - | - | - |
| Total | 1104 | 801 | 692 | 984 | 926 | 458 | 548 | 755 | 961 | 855 |

| Country | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 411 | 474 | 318 | 442 | 271 | 254 | 252 | 353 | 358 | 312 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | 176 | 120 | 25 | 38 | 44 | 53 | 84 | 66 | 55 | 43 |
| Ireland | 176 | 156 | 201 | 188 | 168 | 182 | 206 | 266 | 306 | 255 |
| Netherlands | 51 | 194 | 280 | 3 | | - | - | - | - | - |
| Spain | 38 | | | | | - | - | - | - | - |
| UK - Eng+Wales+N.I | . | . | . | . | . | . | 177 | 144 | 234 | 215 |
| UK - England & Wale | 129 | 151 | 200 | 261 | 193 | 166 | . | . | . | . |
| UK - Scotland | - | - | - | - | - | - | - | - | - | 2 |
| Total | 981 | 1095 | 1024 | 932 | 676 | 655 | 719 | 829 | 953 | 827 |

| Country | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 317 | 338 | 433 | 375 | 368 | 346 | 101 | 8 | 13 | 154 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | 44 | 42 | 47 | 50 | 58 | 74 | . | 79 | 103 | 108 |
| Ireland | 237 | 184 | 243 | 183 | 203 | 221 | 207 | 111 | 125 | 130 |
| Netherlands | - | - | - | 70 | - | 7 | 1 | 10 | - | - |
| Spain | - | - | - | - | - | - | - | - | - | 1 |
| UK - Eng+Wales+N.I | 209 | 172 | 192 | 148 | 113 | 111 | 97 | 95 | 111 | 124 |
| UK - England & Wale | . | . | . | . | . | . | . | . | . | . |
| UK - Scotland | 5 | 2 | - | - | - | - | - | - | - | - |
| Total | 812 | 738 | 915 | 826 | 742 | 759 | 406 | 303 | 352 | 517 |

| Country | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| Belgium | 170 | 157 | 90 | 36 | 31 | 10 | 11 | 20 |
| Denmark | - | - | | | | | | |
| France | 133 | 103 | 93 | 92 | 78 | 57 | 77 | 83 |
| Ireland | 105 | 111 | 98 | 63 | 78 | 72 | 60 | 71 |
| Netherlands | - | - | | 1 | | | | |
| Spain | - | - | 2 | | | | | |
| UK - Eng+Wales+N.I | 78 | 79 | 112 | 87 | 91 | 80 | 58 | 51 |
| UK - England & Wale | . | . | | | | | | |
| UK - Scotland | - | - | | | | | | |
| Total | 486 | 450 | 395 | 279 | 278 | 219 | 206 | 225 |

**Table 7.14.2. Official landings of sole in VIIjk.**

| Year | Bel | Fra | Ire | Esp | UK | Total |
|---|---|---|---|---|---|---|
| 1993 | - | 1 | 237 | . | 8 | 246 |
| 1994 | - | 0 | 176 | . | 2 | 178 |
| 1995 | - | 3 | 232 | . | 6 | 241 |
| 1996 | - | 2 | 163 | . | 1 | 166 |
| 1997 | - | 2 | 187 | . | 2 | 191 |
| 1998 | - | 9 | 208 | . | 2 | 219 |
| 1999 | 96 | 0 | 199 | . | 1 | 296 |
| 2000 | 8 | 6 | 103 | . | 0 | 117 |
| 2001 | 7 | 13 | 114 | . | 0 | 134 |
| 2002 | 69 | 23 | 121 | . | 0 | 213 |
| 2003 | 48 | 20 | 82 | . | 0 | 150 |
| 2004 | 2 | 7 | 78 | . | 0 | 87 |
| 2005 | - | 7 | 70 | <0.5 | 0 | 77 |
| 2006 | - | 11 | 49 | - | 1 | 61 |
| 2007 | - | 9 | 74 | . | 0 | 83 |
| 2008 | - | 8 | 69 | - | 0 | 77 |
| 2009 | 0 | 7 | 60 | - | 0 | 67 |
| 2010* | 0 | 13 | 68 | - | 0 | 81 |

*** Preliminary data.**

**Table 7.14.3. Catch numbers-at-age for sole in VIIjk.**

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 2 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 33 | 218 | 224 | 77 | 56 | 57 | 32 | 21 | 12 | 11 | 5 | 5 | 14 |
| 1994 | 23 | 117 | 130 | 69 | 41 | 22 | 19 | 11 | 12 | 13 | 11 | 4 | 27 |
| 1995 | 0 | 279 | 81 | 174 | 117 | 51 | 15 | 15 | 4 | 22 | 8 | 8 | 6 |
| 1996 | 12 | 46 | 116 | 80 | 53 | 54 | 31 | 8 | 5 | 6 | 10 | 3 | 33 |
| 1997 | 39 | 161 | 84 | 110 | 43 | 41 | 38 | 16 | 1 | 0 | 4 | 3 | 17 |
| 1998 | 23 | 137 | 113 | 59 | 93 | 40 | 43 | 34 | 9 | 5 | 3 | 5 | 32 |
| 1999 | 51 | 179 | 218 | 187 | 67 | 77 | 30 | 28 | 19 | 2 | 11 | 1 | 19 |
| 2000 | 39 | 96 | 83 | 42 | 29 | 16 | 21 | 11 | 17 | 8 | 3 | 0 | 5 |
| 2001 | 65 | 115 | 53 | 49 | 38 | 22 | 22 | 14 | 9 | 4 | 2 | 5 | 8 |
| 2002 | 13 | 139 | 183 | 66 | 38 | 39 | 15 | 8 | 24 | 8 | 21 | 5 | 31 |
| 2003 | 2 | 54 | 93 | 128 | 76 | 45 | 18 | 4 | 5 | 9 | 14 | 0 | 9 |
| 2004 | 7 | 18 | 92 | 48 | 36 | 19 | 14 | 6 | 8 | 1 | 7 | 1 | 20 |
| 2005 | 10 | 34 | 47 | 65 | 17 | 38 | 21 | 9 | 4 | 4 | 0 | 4 | 14 |
| 2006 | 13 | 29 | 30 | 28 | 38 | 18 | 16 | 11 | 6 | 4 | 1 | 1 | 11 |
| 2007 | 1 | 44 | 36 | 30 | 44 | 42 | 21 | 16 | 10 | 4 | 4 | 1 | 8 |
| 2008 | 1 | 25 | 90 | 42 | 21 | 20 | 25 | 11 | 8 | 5 | 3 | 3 | 7 |
| 2009 | 0 | 14 | 37 | 74 | 30 | 16 | 16 | 15 | 6 | 6 | 5 | 1 | 4 |
| 2010 | 5 | 48 | 49 | 54 | 47 | 14 | 9 | 9 | 9 | 6 | 6 | 3 | 8 |

**Table 7.14.4. Weight-at-age for sole in VIIjk.**

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 2 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 0.154 | 0.221 | 0.275 | 0.342 | 0.412 | 0.455 | 0.511 | 0.496 | 0.628 | 0.567 | 0.761 | 0.499 | 0.706 |
| 1994 | 0.143 | 0.233 | 0.278 | 0.346 | 0.421 | 0.453 | 0.514 | 0.552 | 0.610 | 0.632 | 0.632 | 0.583 | 0.737 |
| 1995 | | 0.194 | 0.322 | 0.362 | 0.338 | 0.370 | 0.493 | 0.452 | 0.722 | 0.579 | 0.401 | 0.297 | 0.592 |
| 1996 | 0.138 | 0.169 | 0.230 | 0.307 | 0.435 | 0.421 | 0.505 | 0.587 | 0.613 | 0.711 | 0.755 | 0.643 | 0.698 |
| 1997 | 0.133 | 0.200 | 0.281 | 0.334 | 0.409 | 0.526 | 0.618 | 0.592 | 0.679 | | 0.692 | 0.846 | 0.922 |
| 1998 | 0.137 | 0.223 | 0.281 | 0.357 | 0.379 | 0.448 | 0.515 | 0.554 | 0.455 | 0.646 | 0.497 | 0.641 | 0.805 |
| 1999 | 0.152 | 0.192 | 0.308 | 0.345 | 0.400 | 0.426 | 0.461 | 0.575 | 0.578 | 0.657 | 0.449 | 0.896 | |
| 2000 | 0.180 | 0.210 | 0.255 | 0.396 | 0.416 | 0.472 | 0.502 | 0.489 | 0.505 | 0.452 | 0.554 | | 0.641 |
| 2001 | 0.164 | 0.228 | 0.295 | 0.337 | 0.394 | 0.481 | 0.548 | 0.530 | 0.587 | 0.795 | 0.542 | 0.740 | 0.727 |
| 2002 | 0.203 | 0.198 | 0.255 | 0.305 | 0.470 | 0.490 | 0.473 | 0.655 | 0.732 | 0.724 | 0.627 | 0.616 | 0.895 |
| 2003 | 0.168 | 0.191 | 0.296 | 0.323 | 0.329 | 0.378 | 0.371 | 0.575 | 0.503 | 0.548 | 0.477 | | 0.600 |
| 2004 | 0.095 | 0.200 | 0.198 | 0.294 | 0.313 | 0.353 | 0.287 | 0.581 | 0.632 | 0.498 | 0.595 | 0.498 | 0.724 |
| 2005 | 0.128 | 0.168 | 0.198 | 0.249 | 0.383 | 0.318 | 0.340 | 0.445 | 0.525 | 0.468 | | 0.489 | 0.614 |
| 2006 | 0.160 | 0.180 | 0.205 | 0.257 | 0.298 | 0.354 | 0.354 | 0.377 | 0.456 | 0.377 | 0.612 | 0.438 | 0.718 |
| 2007 | 0.154 | 0.208 | 0.268 | 0.282 | 0.329 | 0.341 | 0.378 | 0.395 | 0.449 | 0.376 | 0.418 | 0.554 | 0.522 |
| 2008 | 0.143 | 0.205 | 0.236 | 0.275 | 0.305 | 0.339 | 0.339 | 0.395 | 0.389 | 0.448 | 0.559 | 0.450 | 0.631 |
| 2009 | 0.123 | 0.196 | 0.234 | 0.265 | 0.268 | 0.318 | 0.386 | 0.420 | 0.393 | 0.417 | 0.368 | 0.476 | 0.587 |
| 2010 | 0.177 | 0.197 | 0.247 | 0.304 | 0.331 | 0.364 | 0.371 | 0.400 | 0.440 | 0.427 | 0.512 | 0.423 | 0.505 |

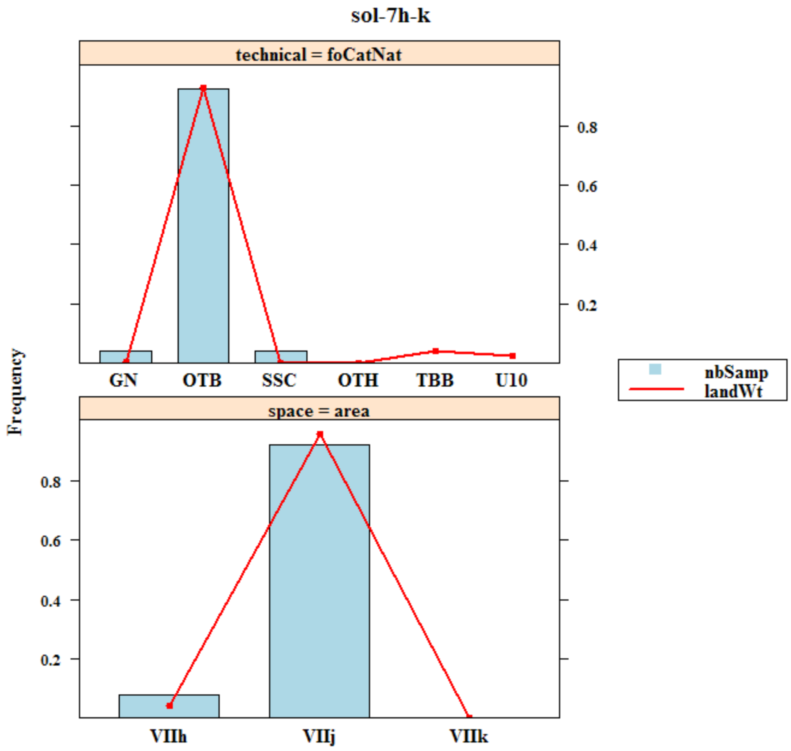



**Figure 7.14.1. Irish Operational landings and sampling levels (number of samples) for sole in VIIjk by quarter (top), geartype (middle) and ICES division (bottom). The sampling appears to be representative of the landings.**

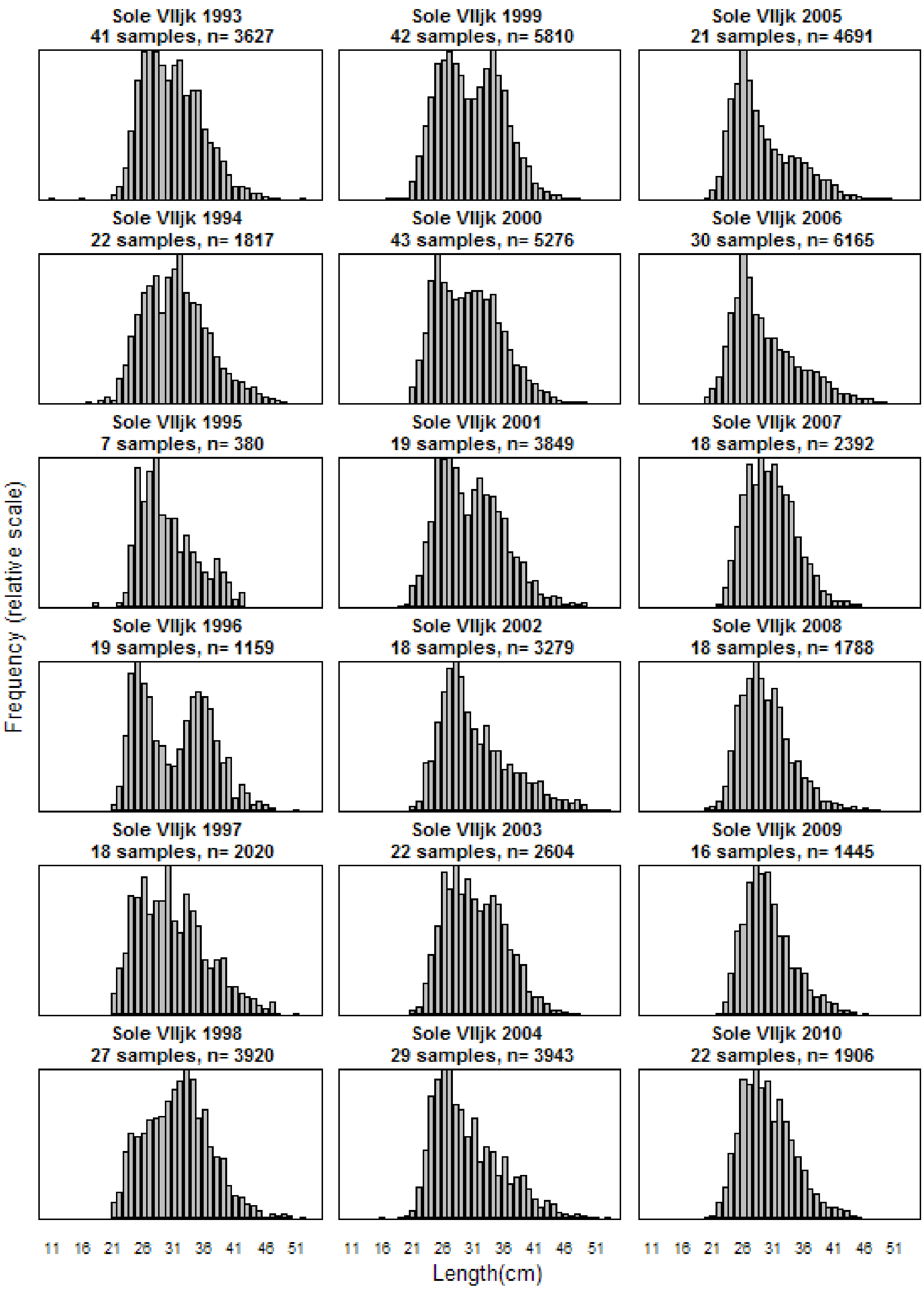



**Figure 7.14.2. Length frequency distribution of the Irish landings of sole in VIIjk between 1993 and 2010. All gears and quarters combined.**

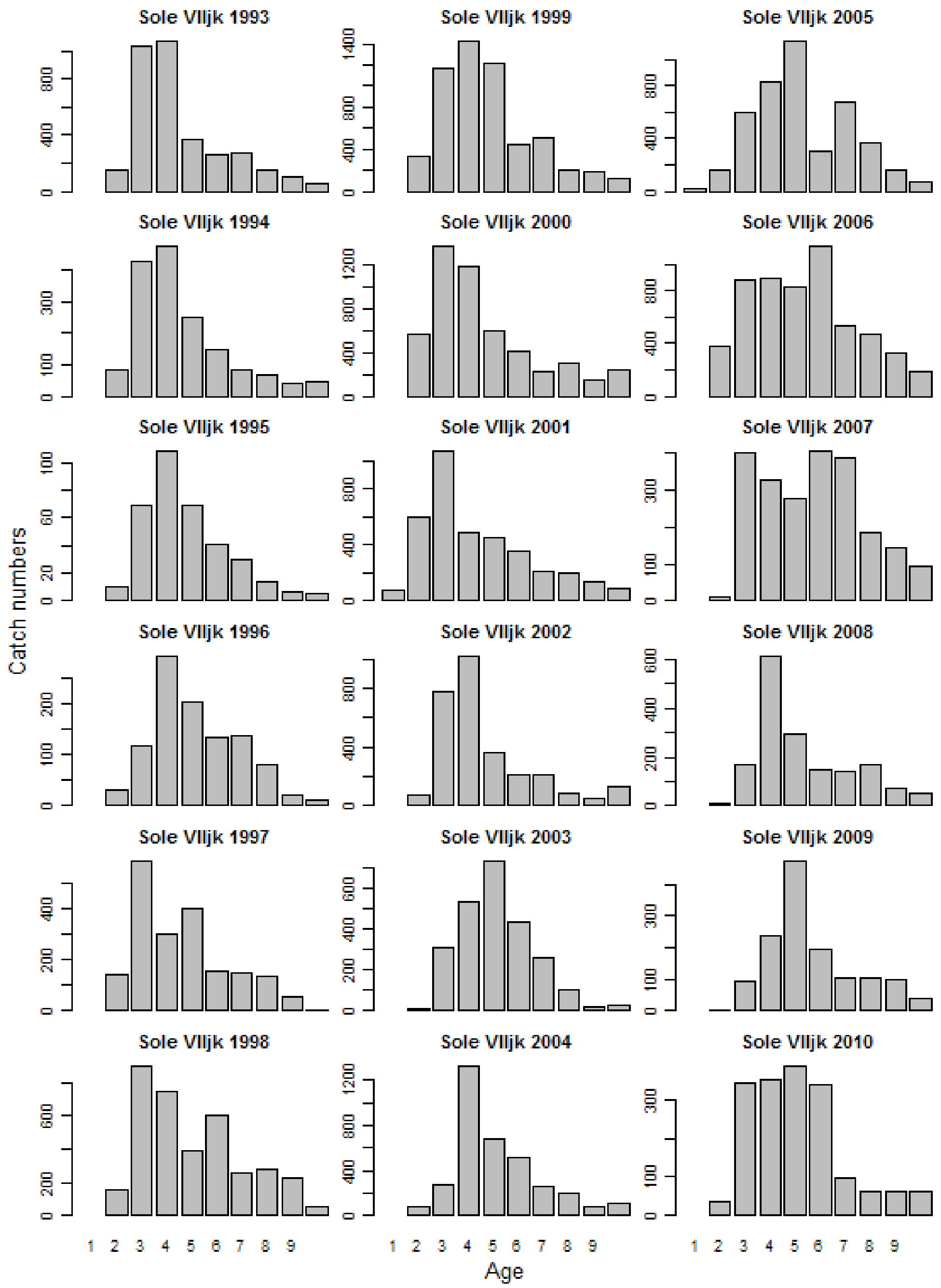



**Figure 7.14.3. Age distribution of sole in VIIjk between 1993 and 2010. All gears and quarters combined.**

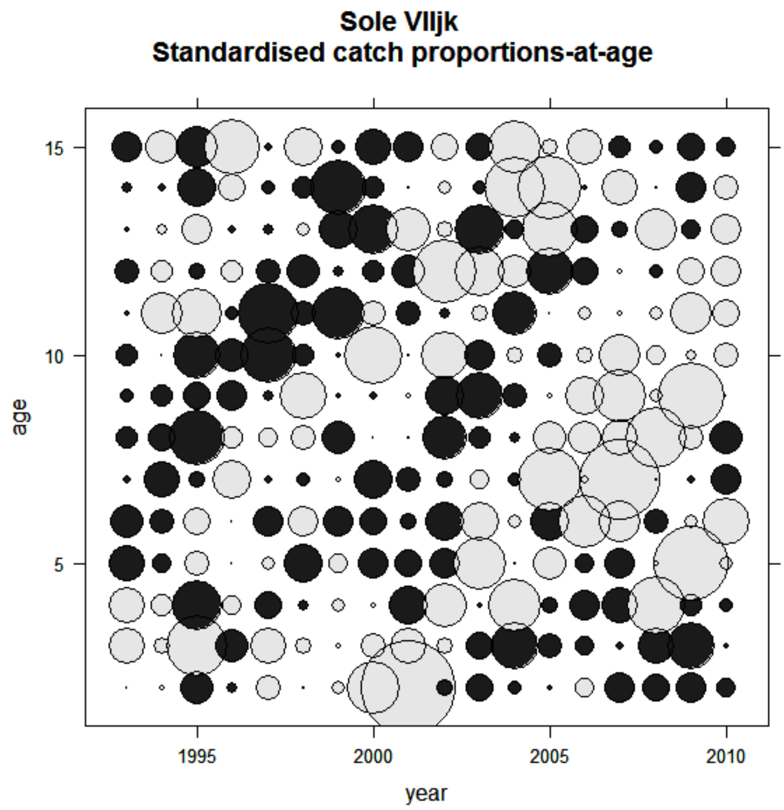



**Figure 7.14.4. Standardized catch proportions-at-age for sole in VIIjk. Grey bubbles represent higher-than-average catch-at-age and black bubbles represent lower-than-average catch-at-age.**

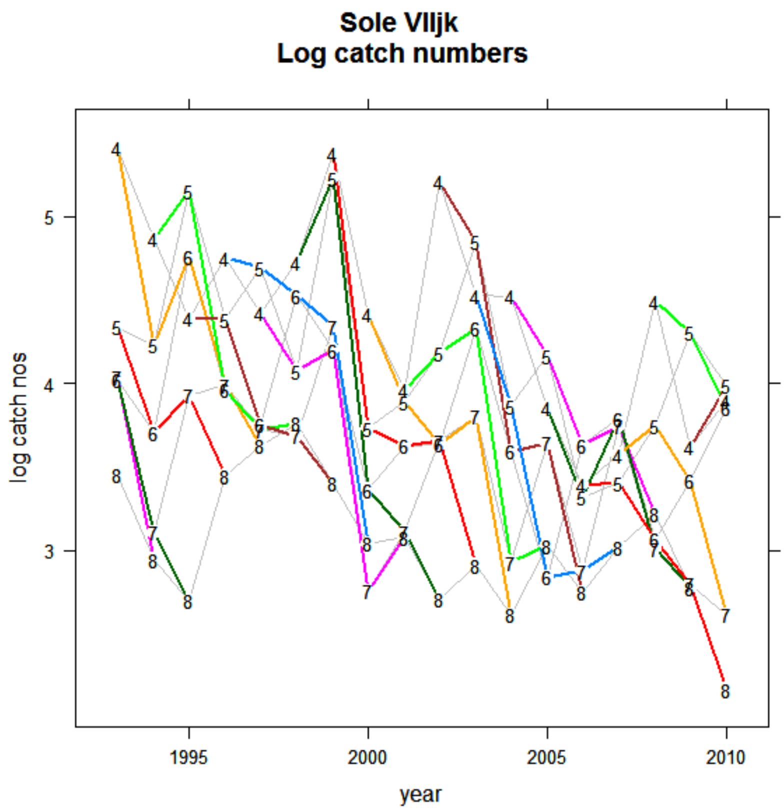



**Figure 7.14.5. Log catch numbers-at-age (ages 4–8).**

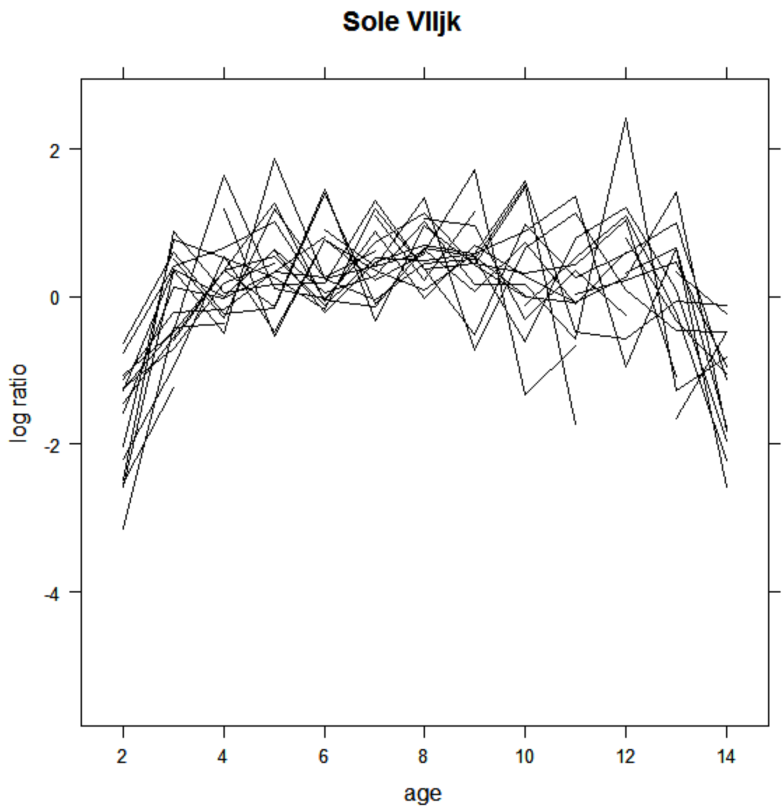



**Figure 7.14.6. Catch curve of plaice in VIIbc. Sole from the age of 4 appear to be fully selected; the data get quite noisy from the age of 10 onwards.**

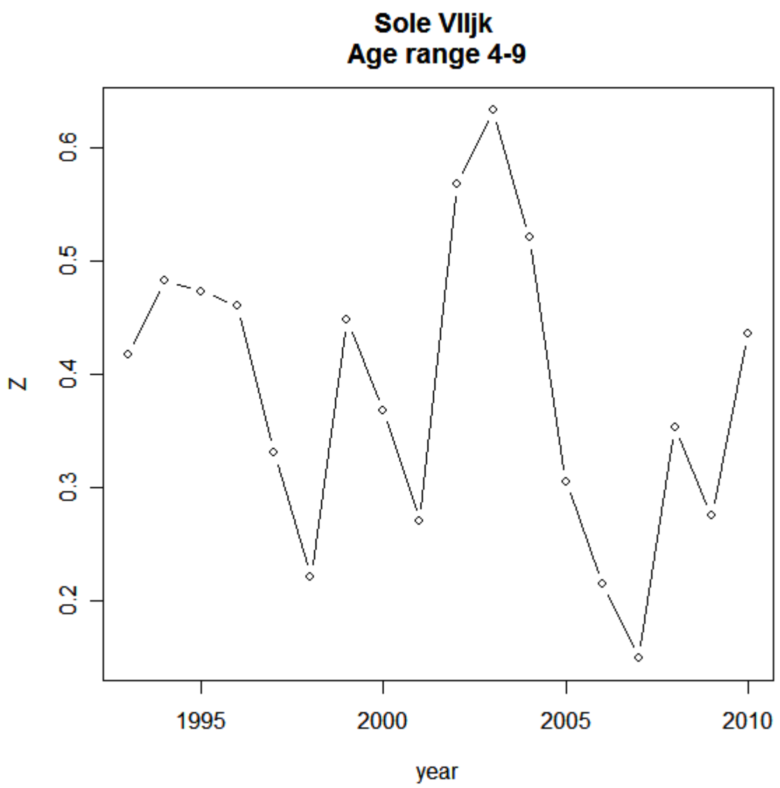



**Figure 7.14.7. Z estimated over pseudo-cohorts as the slope of the log catch numbers.**

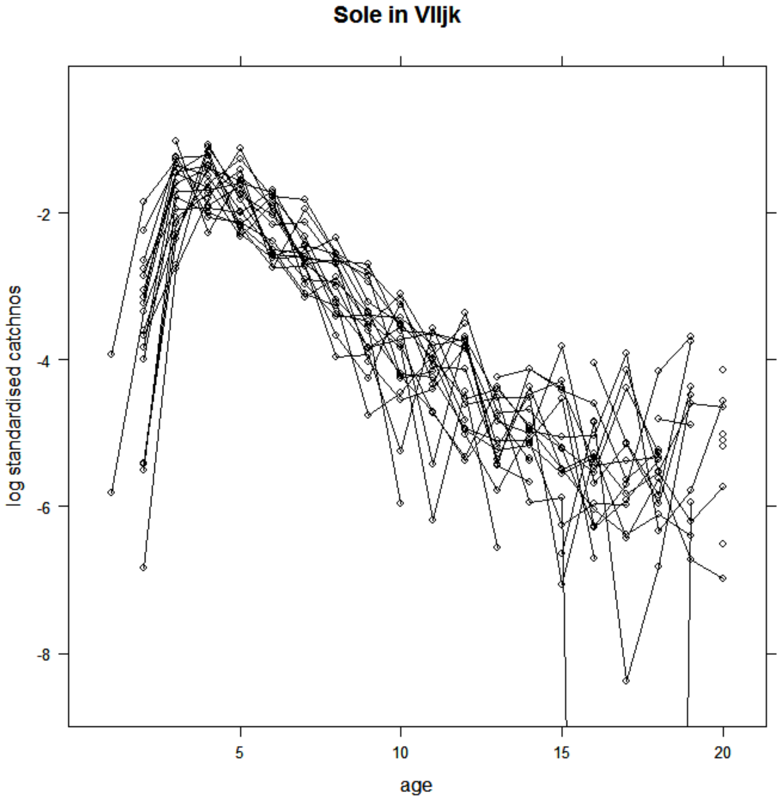



**Figure 7.14.8. Log catch numbers (standardized by year). Fish appear to be fully selected from the age of 4.**

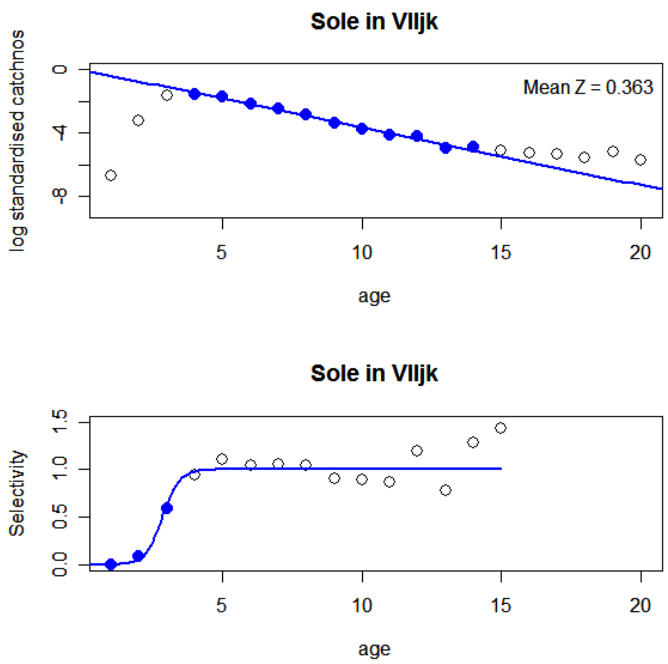



**Figure 7.14.9. Selectivity was modelled by fitting a line through the mean log standardized catch numbers of ages 4 to 14 to predict the expected catch numbers for ages 1 to 3 if these were fully selected. The proportions of observed divided by expected catch number were taken as the 'observed' selectivity. This was then modelled using a logit transformation.**

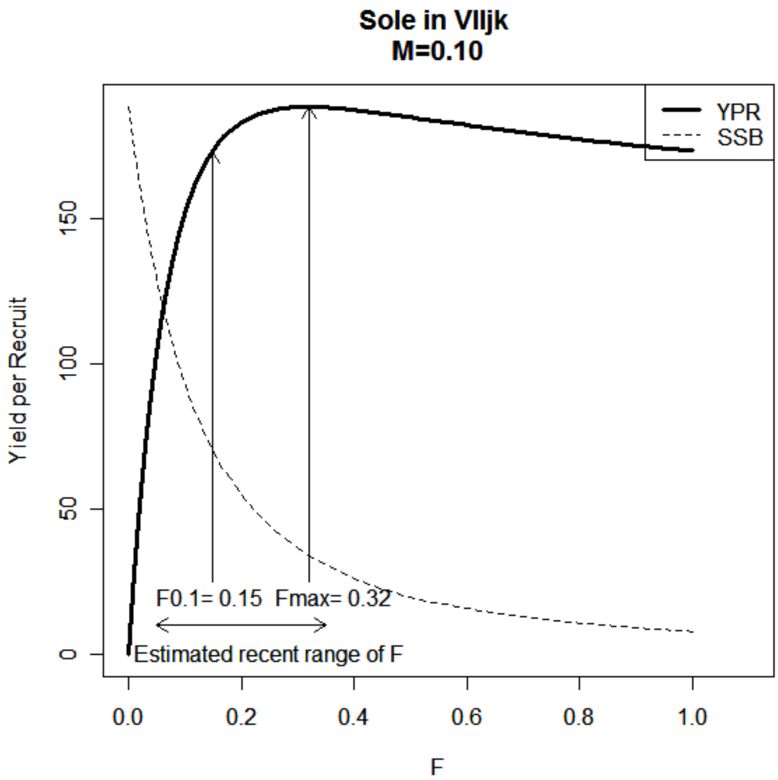



**Figure 7.14.10. YPR analysis using the Thompson–Bell approach. Recent estimates of Z were between 0.15 to 0.45 which translates to an F of 0.05 to 0.35.**

## 7.15 Whiting in Division VIIe–k

### Type of assessment in 2011

Update assessment. Same Advice as Last Year.

### ICES advice applicable to 2010

Exploitation boundaries in relation to precautionary limits: *The current estimates of fishing mortality and SSB are uncertain, but SSB shows a decreasing trend while recruitment has been low in recent years although the 2007 year class is above average, and the 2008 year class may be very strong. In order to reverse the trend in SSB, ICES considers that fishing mortality should be reduced. However, ICES cannot quantify the required reduction in fishing mortality.*

*In addition, ICES offers the following consideration: surveys indicate that the 2007 year class is above average, and the 2008 year class may be very strong. Management measures should be introduced in the Celtic Sea to reduce discarding of these year classes in order to maximize their contribution to future yield and SSB.*

### ICES advice applicable to 2011

Stock status

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Unknown | Unknown | Unknown |
| $F_{PA}/F_{lim}$ | Unknown | Unknown | Unknown |

| Spawning-stock biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | Unknown | Unknown | Unknown |
| $B_{PA}/B_{lim}$ | Unknown | Unknown | Unknown |

#### *MSY approach*

*The SSB estimates show an increase since 2007. The underlying data do not support the provision of estimates of $F_{MSY}$. However it is likely that recent F is above $F_{MSY}$ at the current selection pattern. Therefore, effort in fisheries that catch whiting should not be allowed to increase.*

*Management by TAC is inappropriate to this stock because landings – but not catches – are controlled. Recruitment in 2008 appears to be above average and catches and SSB may increase in 2011 if effort remains constant. Technical measures to minimize discards should be considered with urgency. ICES advises that the a square mesh panel of at least 120 mm should be introduced for the Nephrops fleet and a minimum mesh size of at least 100 mm with a square mesh panel of at least 110 mm for all other fleets.*

#### *PA considerations*

*The current estimates of fishing mortality and SSB are uncertain, but SSB shows an increasing trend since 2007. ICES considers that fishing effort should not be allowed to increase in fisheries that catch whiting in 2011.*

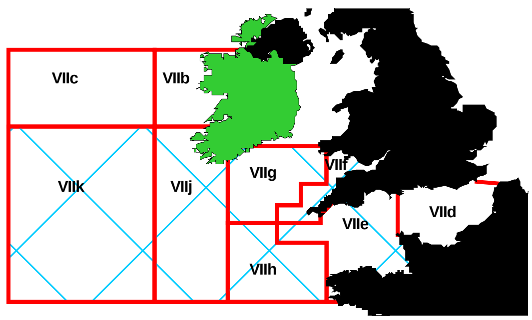
***Policy paper***

*In light of the EU policy paper on fisheries management (17 May 2010, COM(2010) 241) this stock is classified under category 8 (State of the stock is not known precisely but SSB is increasing). SSB estimates in the last 2 years are 70% higher than the SSB in the previous 3 years. This category would result in a TAC increase of 15% (16 568 t). However Annex IV.1 may apply because it is likely that the stock is overfished with regards to* $F_{MSY.}$

## 7.15.1 General

### Stock description and management units

The TAC for whiting is set for Divisions VIIb–h and VIIk. However VIIj has been omitted from the area for the last three years. This assessment area does not correspond to the TAC area. Whiting in VIIb,c are not assessed and whiting in VIId are included in the WDNSSK assessment of the North Sea stock. Any management measures implemented for this stock should be consistent with the assessment area.




**Red Boxes-TAC/Management Areas     Blue Shading– Assessment Area**

The 2011 TAC for whiting VIIb–h and k has been increased from 14 407 t to 16 658 t (2010). This TAC has not been considered restrictive, with officially reported VIIe–k landings totalling 8540 t in 2010,. The assessment is based on landings only, as reported in logbooks, and does not include discards. The introduction of buyers and sellers legislation in 2007 should improve landings statistics, but has not been analysed as yet.

**TAC in 2010**

| **Species:** Whiting *Merlangius merlangus* | | **Zone:** VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh and VIIk (WHG/7X7A.) |
|---|---|---|
| Belgium | 133 | |
| France | 8 180 | |
| Ireland | 4 565 | |
| The Netherlands | 66 | |
| United Kingdom | 1 463 | |
| EU | 14 407 | |
| TAC | 14 407 | Analytical TAC |

**TAC in 2011**

| **Species:** Whiting *Merlangius merlangus* | | **Zone:** VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk (WHG/7X7A-C) |
|---|---|---|
| Belgium | 158 | |
| France | 9 726 | |
| Ireland | 4 865 | |
| The Netherlands | 79 | |
| United Kingdom | 1 740 | |
| EU | 16 568 | |
| TAC | 16 568 | Analytical TAC<br>Article 13 of this Regulation applies. |

### Fishery in 2010

ICES officially reported landings for Divisions VIIe–k and landings as used by the Working Group are given in Table 7.15.1. Previously absent landings for France for 2009 of 2779 t were submitted to the WG, with official landings of 2739 t updated to the table also. ICES Official landings increased by ~3112 t, primarily resulting from French revisions. Landings from Spain, UK Scotland and the Channel Islands have also now been reported (combined 64 t). The 2009 reported landings were 674 t higher than those used by the WG. International landings in 2010 used by the Working Group are substantially higher than those for 2009 (+48%), but 166 t lower than the officially reported landings for 2010.

The VIIe–k whiting stock is primarily targeted by otter trawlers and to a lesser extent Scottish seines and beam trawls. Otter trawlers utilize two mesh size ranges to 70–89 mm and 100–119 mm. Effort of trawlers utilizing these two mesh size ranges has remained relatively stable within the Celtic Sea as a whole, however effort of the larger mesh range has declined within VIIf and VIIg over recent years. The vessels utilizing these mesh ranges have different species selectivity patterns. Several main species groups are targeted by otter trawlers catching whiting, as part of a targeted mixed gadoid fishery and as bycatch within the *Nephrops* and hake, anglerfish, and megrim fisheries. Beam trawlers operate to the eastern side of the assessment area, VIIe–h where small quantities of whiting are taken as a bycatch species in flatfish, anglerfish, and ray target fisheries. The spatial distributions of landings by country in 2010 are given in Figure 7.15.1. Irish catches are primarily from within VIIg particularly within 31E2 and 31E3. Landings also emanate, to a lesser extent from VIIj. In previous years French landings have exhibited similar spatial and temporal focus around 31E3. No French spatial data were available for 2010. The majority of UK landings are from otter trawlers in VIIe, and focused within 29E5 and 29E6.

### 7.15.2 Data

An overview of the data provided and used by the WG is provided in Table 2.1.

#### Landings

National landings and numbers-at-age data were aggregated for the Area VIIe–k following methodology described in the Stock Annex. The landings data were allocated to quarters using the mean proportion by quarter over the period 2006–2008, which appeared to be reasonably stable. Secondly, the sample length distributions within each quarter were assumed to be representative of the landings of each métier. National sampling levels for the landings are presented in Table 2.1.

The length compositions from various fleets for 2010 are displayed in Table 7.15.2 and Figure 7.15.2. The landings length distributions of the Irish otter trawl, UK and French fleets, which account for the majority of the landings, are similar, peaking around 32–36 cm. Scottish seine fleets land a wider distribution reaching sizes over 50 cm. The peak length ranges from 37 cm to 44 cm, with a slight tendency for seiners in VIIj to land smaller fish than in VIIg.

The international catch numbers-at-age are given in Table 7.15.3 and Figure 7.15.3. It is possible to track strong year classes in the landings-at-age matrices. The age distribution has remained similar over time, with the exception of periods where strong year classes pass through older ages. Older ages and the plus group were significantly higher in the 2010 landings than in the preceeding two years. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA, although landings at this age were not recorded in most years. Very small landings of 0-group whiting were not included in the catch-at-age data-file to avoid spurious F-shrinkage effects at this age. Mean weights-at-age in the catch and stock (Tables 7.15.4 and 7.15.5) were derived as per the methodology described in the Stock Annex. The stock weights are shown in Figure 7.15.4 At WGCSE 2011 an error was identified whereby age 7 mean weights have historically been used as in the calculation of SSB rather than a weighted average mean weight for 7+. The impact of this on the SSB calculation is negligible (max difference of 47 t). This together with the procedure for smoothing stock weights should be amended at the next benchmark. There is some variability of stock weights particularly at older ages. Mean weight-at-age appears to decline during periods of high SSB e.g. between 1994–1997. There is some indication of a decreasing trend in weights for ages 6 and 7 over the whole time period.

#### Discards

Discard data are available from the Irish fishery since 1994 (ICES: SGDBI, 2002), from French sampling in 1991, 1997, and 2005–2010, and for the UK (E&W) fisheries from

2001–2010. These data are not used in the assessment as the data available does not cover the full time-series of landings-at-age-data, and historically sampled fleets may not be representative of the main fleets involved in the fishery. Furthermore, there is a need to examine and agree the best raising practice for the various fleets. Discard rates are substantial (>50% by fleet/quarter) and variable. It is not clear if current sampling intensity will obtain precise enough annual estimates to support an assessment method where catch numbers are assumed to be exact as in XSA.

A summary of the 2010 discard sampling and discarding rates is presented in Table 7.15.6. Discard rates between years, quarters and fleets can be very variable, but France has reported a significant reduction in discard rate for 2010. This equates to a reduction from 2009 of 30%; 8% by weight for the gadoid fleet, and 42%; 9% for the French crustacean fleet. Overall discarding is up for the UK and Irish fleets. Sampling trips are down by 7% while sampled hauls increased by 87% from the previous year.

Discarded whiting length distributions from 2010 Irish and French otter trawlers, and all UK gears were made available to the WG (Figure 7.15.5). The available data indicate that discarding occurs above the 27 cm MLS with some fish being discarded up to 50 cm in some fleets. The discard $L_{50}$'s for most countries/fleets is around 30 cm in 2010 up from previous years.

Age compositions for Irish discard data were provided for otter trawlers in VIIg and VIIj for 2004–2010 indicating discarding from age 0 up to age 8 in some years. Substantial discarding of ages 1 and 2 occurs for most years (Figure 7.15.6). Discard numbers-at-age have not yet been calculated for other fleets.

#### Biological

Mean stock weights- and numbers-at-age data were calculated following the methodology described in the Stock Annex.

Natural mortality was assumed to be 0.2 over all age groups and years.

Available data on maturity-at-age are described in the Stock Annex. Since 2006 the knife-edge maturity ogive has been replaced with indices calculated based on data from the UK WCGFS but a fixed vector is still used. Recent maturity sampling by Ireland and the UK on dedicated surveys confirms the use of this ogive but is in-sufficient to provide annual data.

| Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| Maturity | 0 | 0.39 | 0.90 | 0.99 | 0.99 | 1.00 |

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of January 1st.

#### Surveys

A time-series of available standardized survey abundance indices for ages 0–3 are displayed in Table 7.15.8. Further details of these surveys are given in WGSSDS 2008 Table 1.3.3 and described in the Stock Annex. Figure 7.15.9 shows standardized and log standardized abundance indices by age (0–3) for the three surveys used in the assessment by year class. In total four fishery-independent survey indices including 2010 data were available to the WG. The strong 1999 year class is evident in all surveys. The complete time-series and ages available from these surveys are given in the tuning fleet information available to the Working Group (Table 7.15.8).

The internal consistency of the surveys was examined using pairwise scatterplots of log numbers-at-age, bearing in mind that the correlations may be impacted by changes in fishing mortality. Plots for the three surveys included in the assessment are provided in Figure 7.15.7b. Year effects were examined with mean log standardized plots of indices by age and year (Figure 7.15.8a). Cohort tracking was examined with mean log standardized plots of indices by age and cohort (Figure 7.15.8b).

The EVHOE-WIBTS-Q4 survey log indices scatterplots display reasonable positive correlation between adjacent ages. The mean log standardized indices by year display a year effect in 2006 and by cohort demonstrates good tracking of stronger year classes. The UK-WCGFS Q1 is now terminated, but shows reasonably good consistency between years in the log-index scatterplots and reasonably consistent cohort tracking with minor evidence of year effects. There is some suggestion of a trend over time (Fig 7.15.8). Log-indices for the Irish VIIg swept-area survey reveal some positive correlation for younger ages. The mean log standardized index by year demonstrated some slight year effect in 2003 which was the first year of the new series.

#### Commercial lpue

Estimates of commercial lpue, from 1995 to 2010, were available for the Irish otter trawl, Scottish seine, and beam trawl fleets operating in Divisions VIIg and VIIj (Table 7.15.9 and Figure 7.15.10). The effort-series is raw effort in hours uncorrected for changes in vessel power or changes in species targeting (i.e. métier compositions). Increased Irish VIIg otter trawl landings and lpue occurred 2005–2007, returning to prior levels in 2008. This increase coincides with the 1999 year class passing through the fishery. Effort for this fleet has steadily increased since 1999 with landings and lpue tracking each other and rising since 2008. The more recent elevated effort has been associated with the displacement due to restrictive management in other areas, particularly VIa and VIIa. The VIIj otter trawl fleet landings, effort, and lpue show similar levels since 2005, although marginal increases to those of 2008–2009 are observed. In the earlier part of the time-series lpue for the IR-7G-SSC and IR-7J-SSC showed declining tends. Since 2006/2007 lpue has increased. Landings by these two fleets however are low. Effort and lpue data for the Irish beam trawls (TBB) operating in VIIg and VIIj are also included in Table 7.15.9 but is not plotted as landings, effort and lpue are minimal.

Estimates of commercial lpue, up to 2008 were available for French gadoid trawlers and French *Nephrops* trawlers operating in Divisions VIIf,g (Table 7.15.9 and Figure 7.15.10). Fishing effort in the FR-GADOID fleet has been declining since 1989, while the effort in the FR-*NEPHROPS* has declined since 1992. The FR-GADOID fleet's lpue increased to high levels in 1994 and 1995 but declined since. Sharp increases in lpue for the French gadoid fleet occurred in both 1998 and 2005, since which lpue has declined. Lpue for the FR-*NEPHROPS* fleet peaked in the mid-to-late 1990s, having declined since to levels similar to the early 1980s. Landings, effort and lpue for both these fleets currently demonstrate the lowest levels within the time-series. Limited lpue data from France are available for Divisions VIIj–k, but they are not considered representative. The commercial tuning fleets available to the assessment are given in Table 7.15.8.

Abundance indices-at-age were available for three commercial fleets, the French gadoid, and *Nephrops* fleets, and the Irish otter trawl fleet. As with the surveys, the internal consistency of the French fleets (Figure 7.15.7a), any year effects (Figure 7.15.8a) and cohort tracking (Figure 7.15.8b) were examined. The French commercial *Nephrops* index demonstrates very good internal consistency. The French gadoid fleet shows good consistency, although consistency at age 3 is slightly poorer. The IR-OT-7g&j previously used in the assessment was not considered as a consequence of poor cohort tracking and *a priori* concerns about changes in targeting practice and fishing power following recent fleet changes since 2002.

#### Other relevant data

Meetings held with representatives of the fishing industry raised no specific concerns or comments.

### 7.15.3 Historical stock development

An XSA assessment was carried out for this stock applying the same settings as last year's update assessment, with the addition of 2010 data. The settings previously used and applied this year are detailed within the Stock Annex.

#### Data screening

The general methodology is outlined in Section 2. Preliminary investigations were carried out using FLR under R version 2.4.1. The packages FLCore 1.4–3, FLAssess 1.4.1, FLXSA 1.4–2 and FLEDA 1.4–2 were used.

#### Final update assessment

The assessment was carried out with FLXSA 1.4–2 under R version 2.4.1. The assessment uses the same settings as last year (detailed below), with the exception of the French commercial tuning fleets which were not updated for 2009–2010 due to data non-availability. The tuning data available, and the subset used in the assessment, are given in Table 7.15.8. No exploratory runs were carried out for this assessment.

| | | 2010 | 2011 |
|---|---|---|---|
| Catch date range: | Years | 82–08 | 82–10 |
| | Ages | 0–7+ | 0–7+ |
| $F_{bar}$ Age Range: | | 2–5 | 2–5 |
| Assessment Method: | | XSA | XSA |
| Commercial Tuning Fleets: | | | |
| FR-Gadoid Late | Yrs | 93–08 | 93–08 |
| | Ages | 3–6 | 3–6 |
| FR-*Nephrops* | Yrs | 93–08 | 93–08 |
| | Ages | 3–6 | 3–6 |
| Survey Tuning-series: | | | |
| FR-EVHOE | Yrs | 97–09?? | 97–10 |
| | Ages | 0–4 | 0–4 |
| UK-WCGFS | Yrs | 87–01 | 87–01 |
| | Ages | 1–6 | 1–6 |
| IR-IGFS Swept-area | Yrs | 99–09 | 99–010 |
| | Ages | 0–6 | 0–6 |
| Time taper: | | No | No |
| Q plateau age: | | 5 | 5 |
| F shrinkage S.E: | | 1.0 | 1.0 |
| | Num yrs | 5 | 5 |
| | Num ages | 3 | 3 |
| Fleet S.E: | | 0.5 | 0.5 |

The full XSA diagnostics are given in Table 7.15.10. Higher survivor estimates are given by the FR-EVHOE swept-area survey than the IR-IGFS Swept-area survey for the 2010 year class (age 0), although weighting between the two is almost equal. This situation is reversed from the previous year where IR-WIBTS-Q4 gave a significantly higher estimate. The IR-IGFS Swept-area survey estimated substantially higher survivors for both the 2008 year class (age 1) and the FR-EVHOE is higher for 2007 year class (age 2). The two estimates of survivors converge from the 2005 year class (age 4). Figure 7.15.11 shows the scaled weights received by each fleet in the assessment.

The log-catchability residuals from the XSA fit are plotted for each tuning-series in Figure 7.15.12. There are strong year effects apparent in the French commercial fleets and survey, with the UKWCGFS estimated to be noisy even in the short time-series of data.

The retrospective pattern is shown in Figure 7.15.13. The retrospective bias in recruitment around the 1999 year class remains. The trend is a result of the non-inclusion of discards in the assessment while discarding rates are high. The large 2008 recruitment given by the assessment has been revised downwards, most likely for the same reason. In addition, F is underestimated when F is increasing and usually overestimated when decreasing although this pattern has not been observed in the last two years because of the loss of French commercial tuning information from the assessment (last data point in 2008). SSB retrospective patterns are opposite in sign to those observed for F.

Estimates of fishing mortality and stock numbers from the final XSA are given in Tables 7.15.11 and 7.15.12. These are summarized in Table 7.15.13 and Figure 7.15.14. The assessment this year reveals a slight increase in fishing mortality. Although the last two years of recruitment have been revised downward they remain above average of recent years. Recruitment of 2010 is below the time-series average.

#### Comparison with previous assessments

This assessment is an update of the assessment settings carried out since 2007, with the exception of the French commercial tuning fleet for which 2009/2010 data were not available. Minor revisions to landings and landings numbers-at-age have been included. The current assessment estimates of F agree with those estimated last year, as do SSB with a slight reduction in 2008.

#### State of the stock

Trends in landings, F(2–5), SSB, and recruitment are presented in Table 7.15.13 and Figure 7.15.14. SSB displays peak biomass in the mid-1990s following a series of good recruitment in preceding years. Subsequently SSB has shown a declining trend, which was temporarily halted by the strong 1999 year class. SSB for the last three years shows an increase. This is particularly noticeable in 2010 when SSB is estimated to be 41 905 t, well above $B_{pa}$ (21 000 t) in response to two consecutive larger than the recent average recruitments (2008–2009). Fishing mortality ($F_{bar}$) is estimated to have been stable in the last three years following at low levels compared to the time-series average, following a recent peak in 2007.

Recruitment estimates of 2007–2009 year classes are above those of the six preceding year classes, however 2010 is the lowest in the time-series. The very large estimate of the 2008 year was revised downward by 25% in the 2010 assessment. The WG believed this to be an above average year class, although the size is still considered to be uncertain. The current assessment shows a 30% reduction in the estimate of the 2008 year class from 118 975 t down to 84 026 t. There is no apparent relationship between SSB and recruitment (Figure 7.15.16) nor is there evidence of reduced recruitment at the levels of SSB seen over the time-series.

### 7.15.4 Short-term projections

No projections were undertaken given no change from last year where projections were rejected by the working group.

### 7.15.5 Biological reference points

Precautionary approach to reference points.

The Working Groups current approach to reference points is outlined in Section 2. A summary of reference point proposals to date and their technical basis is given in the Stock Annex. The reference points were not re-examined in this update assessment, those currently adopted and their basis are as follows:

| | |
|---|---|
| $F_{LIM}$ | No Proposal |
| $F_{PA}$ | No Proposal |
| $B_{LIM}$ | 15 000 t ($B_{LIM}$ = $B_{LOSS}$ 1983, ACFM1998) |
| $B_{PA}$ | 21 000 t ($B_{PA}$ = $B_{LOSS}$ 1983 x 1.4) |

### 7.15.6 Management plans

No management plan has been agreed or proposed.

### 7.15.7 Uncertainties and bias in assessment and forecast

#### Sampling

The sampling levels for those countries supplying data for 2010 are given in Table 2.1. Sampling levels of the landed catch for recent years are considered to be sufficient to support current assessment approaches. Sampling levels were not available by fishery/métier and the WG was therefore unable to evaluate whether or not current sampling levels are sufficient to support fishery/métier disaggregated assessment approaches.

#### Ageing

The strong recent cohorts passing through the fishery indicates that age estimation is consistent throughout the age range used in the assessment, although some underestimation does occur at older ages.

#### Discards

Discarding is a major feature of most fisheries catching whiting in the Celtic Sea. The non-inclusion of discard data in the assessment may explain a large proportion of the retrospective bias problems and changing catchabilities in commercial fleets observed throughout the assessment period. The availability of discard data has improved in the most recent years since the implementation of the DCF sampling programmes, but is has not been possible to compile a sufficient time-series of raised discard information.

#### Surveys

Currently, there are two IBTS surveys (French and Irish) covering the Celtic Sea provided to the working group. Although these surveys normally catch large quantities of whiting they seem prone to year effects as has been observed for this species in other areas (e.g. Irish Sea, North Sea). These surveys have given very different estimates of the 2009, 2008, 2007, and 2006 year classes, while the survivor estimates for the 2010 year class seems more comparable 23 557 (FR-EVHOE) vs. 17 462 (IR-IGFS Swept-area). The estimation of younger year classes is one of the most important factors in the short-term development of the stock.

#### Misreporting

The level of misreporting of this stock is not known and underreporting has previously been considered unlikely to have been a significant source of unaccounted mortality of whiting in the assessment because the TAC has been in excess of recent landings.

#### Consistency

Interannual comparison between the results of this year's and last year's assessments shows consistent estimates up until 2005 inclusive. Estimated recruitment for the 2008 and 2009 year class have been revised downward, by 29% and up by 44% respectively. Recent estimates of F are consistent between assessments with only a slight upward revision is observed in 2008 (4%) and 2009 (12%). SSB estimates exhibit a small downward revision for the last two years (11–13%). Part of this improved consistency is the result of the recent termination of the French commercial information and thus the result of a bias variance trade-off rather than a decrease in the uncertainty in the assessment.

SSB has been rescaled upwards slightly in the past when the full time-series of commercial tuning data was included in the assessment. Consistency between more recent assessments showed some problems with recruitment and SSB estimates as strong year classes during the 1990s passed through the fishery and were heavily discarded. Assessments for the last few years have been reasonably consistent for SSB with some downward revisions, while F is revised upwards. Estimates of recruitment in the most recent assessment, remains problematic.

### 7.15.8 Recommendation for next benchmark

The 2010 assessment was accepted for trends only by the Celtic Sea Review Group which had no specific comments on the assessment of whiting VIIe–k. The RG commented that the WG should provide potential management actions that can be taken to protect the 2008 year class.

A benchmark assessment of whiting is necessary.

**Problem:** The assessment of this stock has not been accepted for a number of years and considered to be indicative of trends only. The primary uncertainty of this assessment is underestimation of mortality. Currently the assessment is based on landings only. Discarding is a major feature of most fisheries catching whiting in this stock area. Mortality may therefore be grossly underestimated in younger ages. This could explain some of the retrospective bias problems and changing catchabilities in commercial fleets observed throughout the assessment period.

The loss of the commercial tuning information may be consistent with recent ICES trends to remove commercial information from assessments. However in this stock there is little reason to believe that misreporting may have been an issue. Moreover the available survey information is only useful at younger ages and prone to year effects likely due to spatial distribution differences. Re-establishment of some form of tuning information at the older ages should be implemented at the next benchmark meeting to stabilize the assessment.

A better methodology of deriving stock weights is necessary in order to avoid the problem of declining weight-at-age at age 8 and 9 which is required to estimate the weight of the currently moderate +gp.

**Solution:** The available discard data has improved in the most recent years since the implementation of the DCR sampling programmes. Data are now available for the main fleets, operating within VIIe–k. Work is now required to compile a complete time-series of discard data, and evaluate raising options and uncertainty levels. Assessment model and settings then need to be reviewed to ensure optimum performance.

**Year of last benchmark:** No benchmark assessment of this species has been carried out. Exploratory analyses were carried out in the WGSSDS up until 2007.

WGCSE 2011 should review the time-series of discard data and options for inclusion of into this assessment. Until this happens WGCSE will not propose a time frame for the next benchmark.

**Expertise required:** Expertise in discard raising and uncertainty methods, in addition to expertise in assessment methods permitting inclusion of discard data.

A further matter for consideration is the improvement of commercial tuning fleets by selection of vessel subsets with consistent spatial and temporal effort and catch composition over the majority of the time-series, moving towards the métier based approach. This would require a detailed analysis of vessel behaviour.

### 7.15.9 Management considerations

Catches and SSB in VIIe–k whiting fluctuate considerably depending on year-class strength. Indications are that the 2008 and 2009 year classes were strong, but 2010 is quite weak. Management measures should be considered to reduce discarding such that yield and SSB contributions can be maximized. This could be achieved through gear modifications to increase the likelihood of small whiting passing through the gear, such as introduction of larger minimum mesh sizes, separator panels, or grids.

Technical measures applied to this stock include a minimum landing size (≥27 cm) and minimum mesh sizes applicable to the mixed demersal fisheries. These measures are set depending on areas and years by several regulations. Whiting are caught in directed gadoid trips and as part of mixed fisheries throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries. Discard rates are high as a consequence of the low market value of the species, particularly at smaller sizes. Highgrading above the MLS to some extent is also prevalent in most fisheries. The current assessment doesn't include discard estimates. Recent selection data from FTFB should be investigated at the next benchmark workshop.

From the 1 February to the 31 March fishing activity has been prohibited within ICES rectangles: 30E4, 31E4, 32E3 (excluding within six nautical miles from the baseline) annually since 2005 to protect the cod stock. The impact of this on whiting remains unclear but spatial distribution of landings in 2010 suggest that landings from the closed rectangles are lower than those of adjacent rectangles. Irish quarterly landings by rectangle indicate little or no landings from within these closed rectangles during the first quarter.

There have been major changes in fleet dynamics over the period of the assessment. Effort in the French gadoid fleet has been declining since 1999. Irish otter trawl effort in VIIg,j has been stable over the last four years, but risen recently somewhat. During this period there has been a fleet modernisation and several decommissioning schemes in Ireland both within the national whitefish fleet and beam trawl fleet. The most recent round of decommissioning occurred in 2008 and 2009 removed 40 vessels which had operated within the Celtic Sea in 2007–2008. The decommissioned vessels accounted for 15–16% of whiting landings from the stock area in 2007 and 2008. The majority of these vessels primarily landed *Nephrops* or a combination of Hake, monkfish and megrim. Only eight vessels primarily landed whitefish (cod, haddock and whiting). A French decommissioning scheme was implemented in 2008 and 2009. A reduction in the French fleet operating in VIIe–k was expected as a result and appears to be occuring.

**Table 7.15.1. Whiting in Divisions VIIe–k. Nominal Landings (t) as reported to ICES, and total landings as used by the Working Group.**

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 130 | 158 | 160 | 107 | 112 | 159 | 295 | 317 | 304 | 111 | 145 | 228 | 205 | 268 |
| Denmark | | | | | | | | | | | | | | |
| France | 7,572 | 4,024 | 7,819 | 7,763 | 9,773 | 10,947 | 19,771 | 19,348 | 10,006 | 9,620 | 11,285 | 13,535 | 13,400 | 9,936 |
| Germany | | | | | | | | | | 14 | | | | |
| Ireland | 1,511 | 1,227 | 2,241 | 1,309 | 1,518 | 2,036 | 1,651 | 1,764 | 1,403 | 1,875 | 3,630 | 5,053 | 6,077 | 6,115 |
| Netherlands | | 398 | | 124 | | | | | | | | | | 8 |
| Spain | | | | | | | | | | | | | 4 | 31 |
| UK (E/W/NI) | 1,192 | 986 | 751 | 910 | 1,098 | 1,632 | 1,326 | 1,829 | 2,023 | 1,393 | 1,776 | 1,624 | 1,803 | 1,724 |
| UK(Scotland) | | | | | | 1 | 33 | 32 | 20 | 41 | 16 | 23 | 23 | 34 |
| United Kingdom | | | | | | | | | | | | | | |
| Channel Islands | | | 2 | 2 | 2 | | | | | | | | 1 | 1 |
| | | | | | | | | | | | | | | |
| Total | 10,405 | 6,793 | 10,973 | 10,215 | 12,503 | 14,775 | 23,076 | 23,290 | 13,756 | 13,054 | 16,852 | 20,463 | 21,513 | 18,116 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Unallocated | 1,376 | 3,192 | -135 | -263 | 149 | 353 | -6,535 | -9,184 | -248 | -690 | -532 | -429 | 1,165 | 144 |
| | | | | | | | | | | | | | | |
| Total as used by Working Group | 11,781 | 9,985 | 10,838 | 9,952 | 12,652 | 15,128 | 16,541 | 14,106 | 13,508 | 12,364 | 16,320 | 20,034 | 22,678 | 18,260 |

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 449 | 479 | 448 | 194 | 171 | 149 | 129 | 180 | 218 | 128 | 127 | 122 | 87 | 102 |
| Denmark | | | | | | | | | | | | | | |
| France | 11,370 | 11,711 | 16,418b | 9,077 | 7,203 | 7,435 | 5,897 | 4,811 | 5,784 | 4,649 | 3,543 | 3,046 | 2,739 | 3,390 |
| Germany | | | | | | | | | | | | | | |
| Ireland | 6,893 | 5,226 | 5,807 | 4,795 | 5,008 | 5,332 | 4,093 | 4,215 | 5,709 | 4,521 | 4,764 | 2,330 | 2,704 | 4,186 |
| Netherlands | | 1 | | | 5 | 4 | 9 | 18 | 60 | 40 | 64 | 23 | 24 | 75 |
| Spain | 24 | 53 | 21 | 11 | 9 | 12 | - | 76 | 56 | 70 | 21 | 8 | 1 | |
| UK (E/W/NI) | 1,742 | 1,706 | 1,344 | 1,249 | 943 | 843 | 758 | 586 | 471 | 402 | 569 | 610 | 764 | |
| UK(Scotland) | 42 | 68 | 3 | 2 | 11 | 12 | 5 | 7 | - | 6 | 4 | 7 | 63 | |
| United Kingdom | | | | | | | | | | | | | | 785 |
| Channel Islands | | 3 | 2 | 3 | 3 | 1 | 4 | 0 | 0 | 0 | 1 | 1 | - | 2 |
| | | | | | | | | | | | | | | |
| Total | 20,520 | 19,247 | 24,043 | 15,331 | 13,353 | 13,788 | 10,895 | 9,893 | 12,298 | 9,816 | 9,093 | 6,147 | 6,382 | 8,540 |
| | | | | | | | | | | | | | | |
| Unallocated | 12 | -2 | -4,128 | -466 | -583 | -642 | -312 | 61 | -269 | -283 | -146 | -410 | -674 | -116 |
| | | | | | | | | | | | | | | |
| Total as used by Working Group | 20,532 | 19,245 | 19,915 | 14,865 | 12,770 | 13,146 | 10,583 | 9,954 | 12,030 | 9,533 | 8,948 | 5,737 | 5,708 | 8,424 |

**a: Preliminary.**

**b: Preliminary, Reported as VIIb–k.**

**Table 7.15.2. Whiting in Divisions VIIe–k. Raised length distributions for 2010 by country and fleet (Numbers in '000s).**

| Length | France | UK (E+W) | | Ireland | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (cm) | | Beam trawl | All gears (exc beam) | Scottish Seine | Otter trawl | Beam trawl | Gillnet | Otter trawl | Scottish seine |
| | VII e–k | VIIe–k | VIIe–k | VIIg | VIIg | VIIg | VIIg | VIIj | VIIj |
| 20 | | | | | | | | | |
| 21 | | | | 0.3 | | | | | 0.2 |
| 22 | | | | 0.3 | | | | | 0.2 |
| 23 | 0.4 | | | 1.8 | | | | 0.3 | 1.3 |
| 24 | 4.4 | | | 1.2 | | | | 1.0 | 0.9 |
| 25 | 1.9 | | | 1.3 | | | | 3.1 | 1.1 |
| 26 | 4.9 | 0.0 | 0.2 | 4.4 | 2.7 | | | 8.4 | 1.8 |
| 27 | 6.4 | 0.0 | 3.3 | 9.0 | 25.7 | | | 15.7 | 3.3 |
| 28 | 24.2 | 0.0 | 13.4 | 23.6 | 74.6 | | | 22.4 | 9.5 |
| 29 | 43.8 | 0.1 | 31.1 | 49.1 | 88.4 | | 0.1 | 37.6 | 21.9 |
| 30 | 76.7 | 0.8 | 54.6 | 79.7 | 148.8 | | 0.4 | 50.5 | 44.1 |
| 31 | 184.0 | 0.5 | 75.5 | 91.6 | 191.3 | | 0.9 | 75.7 | 45.9 |
| 32 | 343.4 | 2.4 | 140.3 | 125.2 | 247.5 | | 0.8 | 77.6 | 59.9 |
| 33 | 449.3 | 3.9 | 142.9 | 163.3 | 315.7 | 0.0 | 2.4 | 86.8 | 82.5 |
| 34 | 480.5 | 4.7 | 175.3 | 154.8 | 383.1 | 0.1 | 1.1 | 91.5 | 80.7 |
| 35 | 578.9 | 5.7 | 180.2 | 169.1 | 454.8 | 0.2 | 2.3 | 82.2 | 84.5 |
| 36 | 581.7 | 6.9 | 167.2 | 190.4 | 487.2 | 0.3 | 2.5 | 71.6 | 98.2 |
| 37 | 558.6 | 7.8 | 130.0 | 151.9 | 454.0 | 0.4 | 2.1 | 68.7 | 75.0 |
| 38 | 457.9 | 6.1 | 106.4 | 128.7 | 383.9 | 0.6 | 1.9 | 57.1 | 67.0 |
| 39 | 376.6 | 6.1 | 104.7 | 102.1 | 321.2 | 0.8 | 1.1 | 47.9 | 49.0 |
| 40 | 401.3 | 5.1 | 73.6 | 93.8 | 254.0 | 0.5 | 0.4 | 47.9 | 53.3 |
| 41 | 275.8 | 4.1 | 57.6 | 72.7 | 210.1 | 0.7 | 1.3 | 34.1 | 35.4 |
| 42 | 257.1 | 3.8 | 33.2 | 82.5 | 170.7 | 0.5 | 1.0 | 29.5 | 37.2 |
| 43 | 183.4 | 3.5 | 35.1 | 66.7 | 124.6 | 0.3 | 0.4 | 12.8 | 34.8 |
| 44 | 145.5 | 1.9 | 22.6 | 50.5 | 108.6 | 0.3 | 0.5 | 19.1 | 26.1 |
| 45 | 107.7 | 1.7 | 17.8 | 48.8 | 84.1 | 0.3 | 0.5 | 11.4 | 23.2 |
| 46 | 95.5 | 1.4 | 18.0 | 41.8 | 61.1 | 0.2 | 0.1 | 13.3 | 19.1 |
| 47 | 96.9 | 1.4 | 17.1 | 31.3 | 49.0 | 0.1 | 0.4 | 5.4 | 16.1 |
| 48 | 64.9 | 1.2 | 8.0 | 29.1 | 21.8 | 0.1 | 0.4 | 5.9 | 13.0 |
| 49 | 54.8 | 0.8 | 7.3 | 19.3 | 27.1 | 0.1 | 0.1 | 4.7 | 9.1 |
| 50 | 31.2 | 0.8 | 7.9 | 16.2 | 19.8 | 0.1 | 0.1 | 4.3 | 6.7 |
| 51 | 23.7 | 0.4 | 2.7 | 9.2 | 10.0 | 0.1 | 0.2 | 1.9 | 3.5 |
| 52 | 21.9 | 0.5 | 2.3 | 3.3 | 9.3 | 0.0 | 0.2 | 1.0 | 1.9 |
| 53 | 20.6 | 0.2 | 1.8 | 5.6 | 10.2 | 0.0 | 0.2 | 2.9 | 2.1 |
| 54 | 16.6 | 0.7 | 1.9 | 3.2 | 4.7 | 0.0 | 0.1 | 0.4 | 1.2 |
| 55 | 12.1 | 0.5 | 0.4 | 1.9 | 3.9 | 0.0 | 0.1 | 0.8 | 0.8 |

| Length | France | UK (E+W) | | Ireland | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (cm) | | Beam trawl | All gears (exc beam) | Scottish Seine | Otter trawl | Beam trawl | Gillnet | Otter trawl | Scottish seine |
| | VII e-k | VIIe-k | VIIe-k | VIIg | VIIg | VIIg | VIIg | VIIj | VIIj |
| 56 | 8.3 | 0.2 | 3.0 | 3.9 | 3.7 | 0.0 | 0.1 | 0.3 | 2.7 |
| 57 | 10.0 | 0.2 | 0.8 | 2.6 | 3.2 | 0.0 | 0.1 | 0.2 | 1.1 |
| 58 | 10.2 | 0.2 | 0.6 | 0.8 | 0.6 | 0.0 | | 0.2 | 0.3 |
| 59 | 2.8 | 0.0 | 0.0 | | 0.9 | 0.0 | | 0.2 | |
| 60 | 4.8 | 0.0 | 0.0 | | 0.7 | 0.0 | | | |
| 61 | 0.0 | 0.1 | 0.0 | | 0.9 | | | | |
| 62 | 0.6 | 0.0 | 0.4 | | | | | | |
| 63 | 0.6 | | | | | | | | |
| 64 | 1.0 | | | | | | | | |
| 65 | | | | | | | | | |
| 66 | 0.0 | | | | | | | | |
| 67 | 1.2 | | | | | | | | |
| 68 | | | | | | | | | |
| 69 | | | | | | | | | |
| Total N. | 6022.2 | 73.5 | 1637.3 | 2030.6 | 4757.7 | 6.1 | 22.1 | 994.1 | 1014.6 |
| Total (t) | 3222.1 | 40.3 | 691.0 | 1041.4 | 2162.1 | 4.1 | 11.5 | 416.6 | 518.2 |

**Table 7.15.3. Whiting in Divisions VIIe–k. Landings numbers-at-age ('000), examples of strong year classes are highlighted.**

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 1982 | 0 | 2624 | 12523 | 9862 | 4564 | 880 | 41 | 23 |
| 1983 | 0 | 5867 | 9981 | 9059 | 3393 | 1319 | 195 | 10 |
| 1984 | 0 | 2854 | 18645 | 4697 | 1815 | 618 | 128 | 28 |
| 1985 | 0 | 3698 | 15538 | 8005 | 1380 | 289 | 96 | 33 |
| 1986 | 0 | 3769 | 15157 | 6465 | 2091 | 553 | 60 | 45 |
| 1987 | 0 | 5977 | 19376 | 8825 | 2467 | 587 | 112 | 60 |
| 1988 | 0 | 2315 | 26780 | 11400 | 1962 | 409 | 70 | 21 |
| 1989 | 0 | 602 | 17057 | 24243 | 3459 | 339 | 63 | 25 |
| 1990 | 0 | 3270 | 9249 | 19509 | 8654 | 749 | 62 | 21 |
| 1991 | 0 | 8339 | 11997 | 5578 | 11742 | 2700 | 143 | 3 |
| 1992 | 0 | 4964 | 20513 | 9198 | 1420 | 1275 | 435 | 39 |
| 1993 | 0 | 2304 | 22277 | 17939 | 2829 | 526 | 382 | 172 |
| 1994 | 0 | 1272 | 14110 | 25384 | 6165 | 1019 | 135 | 177 |
| 1995 | 0 | 540 | 15062 | 21854 | 14142 | 2242 | 310 | 92 |
| 1996 | 0 | 1345 | 7473 | 17783 | 12850 | 5486 | 775 | 114 |
| 1997 | 0 | 609 | 4451 | 11734 | 21209 | 7322 | 2787 | 720 |
| 1998 | 0 | 1182 | 6680 | 10938 | 12758 | 13240 | 2865 | 882 |
| 1999 | 0 | 4163 | 10223 | 12444 | 8406 | 8733 | 6479 | 1188 |
| 2000 | 0 | 3575 | 9357 | 10328 | 5468 | 2351 | 1993 | 1845 |
| 2001 | 0 | 336 | 11648 | 11076 | 5135 | 2061 | 745 | 275 |
| 2002 | 0 | 1067 | 5962 | 19658 | 5732 | 1064 | 274 | 63 |
| 2003 | 0 | 462 | 3599 | 8264 | 11530 | 1675 | 264 | 20 |
| 2004 | 0 | 1209 | 4141 | 5963 | 6755 | 5978 | 496 | 69 |
| 2005 | 0 | 768 | 6169 | 8141 | 5008 | 4551 | 3456 | 147 |
| 2006 | 0 | 1366 | 6342 | 7631 | 3672 | 1767 | 1148 | 581 |
| 2007 | 0 | 988 | 5598 | 8479 | 4984 | 1535 | 412 | 226 |
| 2008 | 0 | 1269 | 3710 | 5948 | 2923 | 700 | 173 | 31 |
| 2009 | 0 | 341 | 4194 | 5693 | 2768 | 695 | 165 | 36 |
| 2010 | 0 | 530 | 3258 | 8335 | 4247 | 1273 | 217 | 117 |

**Table 7.15.4. Whiting in Divisions VIIe–k. Landings weights-at-age (kg).**

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|---|
| 1982 | 0.000 | 0.245 | 0.279 | 0.395 | 0.557 | 0.646 | 1.193 | 1.593 |
| 1983 | 0.000 | 0.273 | 0.328 | 0.441 | 0.545 | 0.678 | 0.731 | 1.652 |
| 1984 | 0.000 | 0.227 | 0.286 | 0.457 | 0.656 | 0.807 | 1.060 | 1.514 |
| 1985 | 0.000 | 0.233 | 0.335 | 0.433 | 0.631 | 1.008 | 1.157 | 0.980 |
| 1986 | 0.000 | 0.198 | 0.277 | 0.493 | 0.585 | 0.781 | 1.469 | 1.680 |
| 1987 | 0.000 | 0.222 | 0.284 | 0.398 | 0.658 | 0.877 | 0.897 | 0.990 |
| 1988 | 0.000 | 0.224 | 0.303 | 0.416 | 0.628 | 0.977 | 1.322 | 1.374 |
| 1989 | 0.000 | 0.201 | 0.281 | 0.376 | 0.593 | 0.980 | 1.444 | 1.877 |
| 1990 | 0.000 | 0.226 | 0.260 | 0.328 | 0.452 | 0.722 | 1.083 | 1.721 |
| 1991 | 0.000 | 0.220 | 0.291 | 0.355 | 0.395 | 0.534 | 0.834 | 1.695 |
| 1992 | 0.000 | 0.208 | 0.289 | 0.388 | 0.472 | 0.623 | 0.739 | 1.084 |
| 1993 | 0.086 | 0.205 | 0.286 | 0.379 | 0.589 | 0.831 | 0.963 | 1.360 |
| 1994 | 0.000 | 0.249 | 0.300 | 0.404 | 0.637 | 0.915 | 0.982 | 1.222 |
| 1995 | 0.090 | 0.202 | 0.275 | 0.382 | 0.527 | 0.844 | 1.124 | 1.197 |
| 1996 | 0.000 | 0.229 | 0.266 | 0.346 | 0.460 | 0.598 | 0.616 | 1.058 |
| 1997 | 0.000 | 0.196 | 0.277 | 0.329 | 0.406 | 0.536 | 0.714 | 1.005 |
| 1998 | 0.000 | 0.188 | 0.270 | 0.333 | 0.396 | 0.452 | 0.567 | 0.896 |
| 1999 | 0.000 | 0.222 | 0.298 | 0.352 | 0.426 | 0.441 | 0.497 | 0.633 |
| 2000 | 0.101 | 0.250 | 0.326 | 0.419 | 0.510 | 0.573 | 0.585 | 0.597 |
| 2001 | 0.000 | 0.265 | 0.286 | 0.393 | 0.521 | 0.624 | 0.761 | 0.820 |
| 2002 | 0.082 | 0.217 | 0.293 | 0.363 | 0.519 | 0.682 | 0.810 | 1.022 |
| 2003 | 0.000 | 0.211 | 0.281 | 0.369 | 0.447 | 0.603 | 0.831 | 1.149 |
| 2004 | 0.086 | 0.218 | 0.303 | 0.376 | 0.433 | 0.492 | 0.523 | 0.754 |
| 2005 | 0.101 | 0.246 | 0.318 | 0.396 | 0.506 | 0.509 | 0.487 | 0.595 |
| 2006 | 0.112 | 0.232 | 0.299 | 0.414 | 0.545 | 0.585 | 0.586 | 0.707 |
| 2007 | 0.000 | 0.206 | 0.290 | 0.389 | 0.492 | 0.603 | 0.564 | 0.673 |
| 2008 | 0.116 | 0.235 | 0.291 | 0.378 | 0.512 | 0.617 | 0.754 | 1.124 |
| 2009 | 0.000 | 0.245 | 0.322 | 0.405 | 0.504 | 0.592 | 0.669 | 0.902 |
| 2010 | 0.000 | 0.267 | 0.348 | 0.441 | 0.560 | 0.638 | 0.777 | 0.726 |

**Table 7.15.5. Whiting in Divisions VIIe–k. Stock weights-at-age (kg).**

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0 | 0.157 | 0.270 | 0.345 | 0.474 | 0.607 | 0.843 | 1.403 | 1.255 | 0.688 | 0.688 |
| 1983 | 0 | 0.167 | 0.276 | 0.363 | 0.498 | 0.632 | 0.826 | 1.313 | 1.256 | 0.732 | 0.732 |
| 1984 | 0 | 0.192 | 0.282 | 0.371 | 0.521 | 0.709 | 0.847 | 1.188 | 1.270 | 0.723 | 0.723 |
| 1985 | 0 | 0.179 | 0.272 | 0.389 | 0.534 | 0.738 | 1.030 | 1.187 | 1.382 | 1.046 | 0.957 |
| 1986 | 0 | 0.183 | 0.259 | 0.370 | 0.543 | 0.756 | 1.020 | 1.223 | 1.513 | 1.145 | 0.98 |
| 1987 | 0 | 0.171 | 0.253 | 0.367 | 0.533 | 0.752 | 1.059 | 1.261 | 1.474 | 1.585 | 0.864 |
| 1988 | 0 | 0.186 | 0.252 | 0.342 | 0.531 | 0.784 | 1.050 | 1.322 | 1.685 | 1.465 | 0.768 |
| 1989 | 0 | 0.173 | 0.249 | 0.331 | 0.477 | 0.760 | 1.114 | 1.439 | 1.643 | 1.853 | 0.599 |
| 1990 | 0 | 0.166 | 0.247 | 0.317 | 0.427 | 0.651 | 1.007 | 1.524 | 1.461 | 1.465 | 0.842 |
| 1991 | 0 | 0.151 | 0.248 | 0.317 | 0.396 | 0.553 | 0.815 | 1.310 | 1.154 | 1.032 | 0.929 |
| 1992 | 0 | 0.174 | 0.253 | 0.327 | 0.421 | 0.551 | 0.736 | 1.133 | 1.105 | 0.866 | 1.216 |
| 1993 | 0 | 0.166 | 0.251 | 0.340 | 0.470 | 0.637 | 0.779 | 1.034 | 1.337 | 0.954 | 1.126 |
| 1994 | 0 | 0.175 | 0.254 | 0.340 | 0.487 | 0.715 | 0.906 | 1.077 | 1.258 | 1.405 | 1.158 |
| 1995 | 0 | 0.108 | 0.259 | 0.346 | 0.476 | 0.711 | 0.861 | 0.994 | 1.047 | 1.341 | 1.044 |
| 1996 | 0 | 0.135 | 0.256 | 0.328 | 0.430 | 0.626 | 0.820 | 0.942 | 0.990 | 1.107 | 1.035 |
| 1997 | 0 | 0.110 | 0.245 | 0.307 | 0.396 | 0.525 | 0.645 | 0.830 | 1.123 | 0.912 | 0.912 |
| 1998 | 0 | 0.148 | 0.238 | 0.293 | 0.378 | 0.453 | 0.585 | 0.747 | 1.043 | 0.968 | 0.968 |
| 1999 | 0 | 0.112 | 0.245 | 0.324 | 0.419 | 0.491 | 0.518 | 0.677 | 0.779 | 0.725 | 0.725 |
| 2000 | 0 | 0.144 | 0.253 | 0.357 | 0.465 | 0.556 | 0.611 | 0.711 | 0.685 | 0.895 | 0.895 |
| 2001 | 0 | 0.182 | 0.259 | 0.370 | 0.490 | 0.612 | 0.676 | 0.802 | 0.649 | 0.995 | 0.995 |
| 2002 | 0 | 0.193 | 0.248 | 0.361 | 0.480 | 0.627 | 0.795 | 1.009 | 0.850 | 1.062 | 1.062 |
| 2003 | 0 | 0.187 | 0.244 | 0.332 | 0.439 | 0.560 | 0.693 | 0.886 | 1.202 | 0.875 | 1.127 |
| 2004 | 0 | 0.167 | 0.253 | 0.333 | 0.449 | 0.541 | 0.652 | 0.892 | 1.380 | 1.38 | 1.38 |
| 2005 | 0 | 0.163 | 0.256 | 0.346 | 0.484 | 0.535 | 0.582 | 0.765 | 1.431 | 1.431 | 1.431 |
| 2006 | 0 | 0.177 | 0.280 | 0.390 | 0.553 | 0.624 | 0.647 | 0.832 | 0.990 | 0.799 | 0.799 |
| 2007 | 0 | 0.204 | 0.285 | 0.403 | 0.566 | 0.666 | 0.727 | 0.951 | 0.811 | 0.633 | 0.633 |
| 2008 | 0 | 0.227 | 0.298 | 0.397 | 0.549 | 0.659 | 0.714 | 0.920 | 0.527 | 0.467 | 0.467 |
| 2009 | 0 | 0.220 | 0.286 | 0.380 | 0.525 | 0.631 | 0.723 | 0.981 | 0.540 | 0.54 | 0.54 |
| 2010 | 0 | 0.286 | 0.307 | 0.417 | 0.537 | 0.637 | 0.748 | 0.706 | 0.941 | 0.883 | 0.883 |

**Table 7.15.6. Whiting in Divisions VIIe–k. Summary of discard data in 2010 provided to the Working Group.**

| | | | | Sampling | | | | | | | Discard Rates | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Year** | **Quarter** | **Gear/Fleet** | **Trips** | **Hauls** | **Numbers Retained** | **Weight Retained** | **Number Discarded** | **Weight Discarded** | **Units** | **Number** | **Weight** |
| France | 2010 | Q1-3 | OT VIIe-k Crustacean | 14 | 551 | 1422 | 751 | 332 | 71 | No. & KG Sampled | 19% | 9% |
| France | 2010 | Q2-4 | OT VIIe-k Demersal fish | 31 | 1771 | 4544 | 2524 | 987 | 209 | No. & KG Sampled | 18% | 8% |
| UK | 2010 | 1 | All Gears | 32 | 366 | 3622 | 1490 | 2253 | 411 | Raised No. & KG Sampled | 38% | 22% |
| UK | 2010 | 2 | All Gears | 26 | 237 | 1213 | 490 | 6684 | 667 | Raised No. & KG Sampled | 85% | 58% |
| UK | 2010 | 3 | All Gears | 13 | 117 | 423 | 140 | 1702 | 313 | Raised No. & KG Sampled | 80% | 69% |
| UK | 2010 | 4 | All Gears | 22 | 219 | 622 | 354 | 5751 | 1240 | Raised No. & KG Sampled | 90% | 78% |
| Ireland | 2010 | All | Otter Trawls VIIg | 17 | 221 | 1551 | 554 | 12 194 | 2568 | No. '000s & tonnes raised to Fleet | 89% | 82% |
| Ireland | 2010 | All | Otter Trawls VIIj | 23 | 252 | 1804 | 713 | 3073 | 340 | No. '000s & tonnes raised to Fleet | 63% | 32% |

**Table 7.15.7. Whiting in Divisions VIIe–k. Standardized survey abundance indices of age groups 0–3.**

| Survey | UK-WCGFS | UK-BCCSBTS-S | FR-EVHOE | IR-GFS-7g&j | IR-GFS-7g-Swept-area |
|---|---|---|---|---|---|
| Units | No. per min | No. per km towed | No. per 30 min haul | No. per 30 min haul | No. per 10 kmsq |

| Year | 1-gp | 2-gp | 3-gp | 0-gp | 1-gp | 0-gp | 1-gp | 2-gp | 3-gp | 0-gp | 1-gp | 2-gp | 3-gp | 0-gp | 1-gp | 2-gp | 3-gp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 0.36 | 1.61 | 0.16 | | | | | | | | | | | | | | |
| 1988 | 0.24 | 0.23 | 0.06 | 0.1 | 0.9 | | | | | | | | | | | | |
| 1989 | 0.25 | 0.73 | 0.49 | 0.9 | 1.1 | | | | | | | | | | | | |
| 1990 | 0.02 | 0.06 | 0.25 | 5.2 | 0.5 | | | | | | | | | | | | |
| 1991 | 0.21 | 0.01 | 0.01 | 4.4 | 1.4 | | | | | | | | | | | | |
| 1992 | 1.31 | 0.53 | 0.11 | 6.7 | 1.3 | | | | | | | | | | | | |
| 1993 | 4.88 | 0.92 | 0.27 | 10.0 | 1.7 | | | | | | | | | | | | |
| 1994 | 8.99 | 1.33 | 0.92 | 2.7 | 1.5 | | | | | | | | | | | | |
| 1995 | 0.59 | 5.52 | 1.43 | 2.3 | 1.5 | | | | | | | | | | | | |
| 1996 | 0.52 | 1.51 | 1.39 | 4.6 | 1.5 | | | | | | | | | | | | |
| 1997 | 0.73 | 0.56 | 0.18 | 10.7 | 0.5 | 31 | 24 | 9 | 8.5 | | | | | | | | |
| 1998 | 1.19 | 0.77 | 0.53 | 5.3 | 0.5 | 48 | 15 | 7.9 | 1.2 | | | | | | | | |
| 1999 | 0.84 | 0.50 | 0.15 | 15.1 | 1.0 | 261 | 62 | 18 | 5.1 | | | | | 24175 | 7307 | 1881 | 633 |
| 2000 | 14.91 | 0.93 | 0.29 | 1.2 | 3.1 | 31 | 77 | 23 | 2.9 | | | | | 6077 | 15 835 | 3116 | 190 |
| 2001 | 2.49 | 1.35 | 0.24 | 1.7 | 0.5 | 23 | 35 | 49 | 8 | | | | | 4650 | 2836 | 13871 | 1849 |
| 2002 | 3.35 | 1.80 | 3.04 | 5.3 | 0.3 | 39 | 15 | 11 | 10 | | | | | 2468 | 3664 | 1719 | 1252 |
| 2003 | 3.20 | 2.51 | 2.48 | 3.9 | 0.1 | 47 | 58 | 27 | 20 | 127 | 88 | 38 | 11 | 6061 | 2219 | 1027 | 413 |
| 2004 | 2.00 | 1.80 | 0.99 | 10.3 | 0.1 | 28 | 108 | 31 | 14 | 295 | 95 | 48 | 10 | 9778 | 3444 | 655 | 321 |
| 2005 | Survey discontinued | | | 6.4 | 0.0 | 44 | 16 | 5 | 2 | 83 | 106 | 29 | 10 | 1146 | 3177 | 1573 | 422 |
| 2006 | | | | 4.3 | 0.3 | 15 | 10 | 3 | 1 | 373 | 161 | 50 | 10 | 15260 | 5883 | 2175 | 707 |
| 2007 | | | | 7.7 | 0.7 | 178 | 46 | 4 | 1 | 332 | 218 | 47 | 7 | 9951 | 8081 | 2718 | 455 |
| 2008 | | | | 25.1 | 0.7 | 365 | 45 | 10 | 3 | 402 | 140 | 44 | 11 | 16344 | 5554 | 2238 | 475 |
| 2009 | | | | 6.7 | 0.6 | 30 | 68 | 31 | 6 | 346 | 289 | 65 | 17 | 11053 | 10 819 | 2154 | 589 |
| 2010 | | | | 2.0 | 0.3 | 27 | 36 | 24 | 11 | 85 | 112 | 12 | 6 | 2105 | 10 592 | 5924 | 1016 |

**Table 7.15.8. Whiting in Divisions VIIe–k. Available commercial and survey tuning-series, ages and years used in the assessment are highlighted in bold.**

Whiting in the Celtic Sea VIIe-k Tuning data WGCSE 2010 (Sarah Davie 05/05/2011)

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FR-GADOID-Early: French Gadoid trawlers (FU5) - Effort, No. of whiting/age/1000 hours fished, Year, Live weight (t)

1983 1992

1 1 0 1

1 11

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | 18325 | 41531 | 38575 | 15377 | 6184 | 886 | 51 | 0 | 0 | 0 |
| | 0 | #1983 | 5742t | | | | | | | |
| 1000 | 13779 | 97659 | 25223 | 9993 | 3362 | 688 | 82 | 46 | 22 | 0 |
| | 0 | #1984 | 4598t | | | | | | | |
| 1000 | 14948 | 75447 | 37539 | 6687 | 1506 | 540 | 189 | 9 | 0 | 0 |
| | 0 | #1985 | 4514t | | | | | | | |
| 1000 | 13417 | 66679 | 29328 | 9073 | 2310 | 266 | 183 | 20 | 3 | 2 |
| | 0 | #1986 | 5049t | | | | | | | |
| 1000 | 25446 | 79928 | 33683 | 10141 | 2358 | 518 | 161 | 30 | 36 | 0 |
| | 0 | #1987 | 6859t | | | | | | | |
| 1000 | 6738 | 71192 | 30313 | 5029 | 1040 | 184 | 45 | 4 | 2 | 0 |
| | 0 | #1988 | 7921t | | | | | | | |
| 1000 | 1539 | 41365 | 58078 | 7808 | 843 | 161 | 30 | 12 | 0 | 0 |
| | 0 | #1989 | 8974t | | | | | | | |
| 1000 | 10547 | 29023 | 60936 | 24967 | 2297 | 148 | 49 | 18 | 2 | 0 |
| | 0 | #1990 | 7897t | | | | | | | |
| 1000 | 31392 | 41485 | 18143 | 40085 | 8616 | 352 | 15 | 0 | 0 | 0 |
| | 0 | #1991 | 7525t | | | | | | | |
| 1000 | 15843 | 65677 | 28694 | 4589 | 4435 | 1226 | 132 | 0 | 0 | 0 |
| | 0 | #1992 | 6460t | | | | | | | |

FR-GADOID-late: French Gadoid trawlers (FU5) - Effort, No. of whiting/age/1000 hours fished, Year, Live weight (t)

1993 2008

1 1 0 1

1 11

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | 4736 | 57675 | **35630** | **5286** | **825** | **883** | 469 | 40 | 20 | 6 |
| | 0 | #1993 | 7815t | | | | | | | |
| 1000 | 448 | 26922 | **65786** | **18395** | **2948** | **289** | 454 | 125 | 80 | 0 |
| | 0 | #1994 | 9236t | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | 86 | 10737 | **43840** | **34895** | **7662** | **1360** | 248 | 0 | 28 | 32 |
| | 0 | #1995 | 9186t | | | | | | | |
| 1000 | 8 | 2509 | **34872** | **31293** | **13650** | **1708** | 328 | 32 | 31 | 29 |
| | 0 | #1996 | 6028t | | | | | | | |
| 1000 | 0 | 3641 | **17743** | **45915** | **14168** | **4338** | 721 | 63 | 12 | 0 |
| | 0 | #1997 | 7218t | | | | | | | |
| 1000 | 3827 | 17367 | **32394** | **25399** | **30762** | **21832** | 3285 | 631 | 186 | 0 |
| | 0 | #1998 | 7674t | | | | | | | |
| 1000 | 3457 | 15689 | **29265** | **22945** | **27790** | **19723** | 2967 | 570 | 168 | 0 |
| | 0 | #1999 | 9102t | | | | | | | |
| 1000 | 4987 | 23934 | **29232** | **15124** | **6851** | **7110** | 5976 | 1306 | 132 | 10 |
| | 0 | #2000 | 6053t | | | | | | | |
| 1000 | 213 | 23745 | **25724** | **9253** | **3440** | **1465** | 593 | 539 | 114 | 57 |
| | 0 | #2001 | 4624t | | | | | | | |
| 1000 | 405 | 9574 | **48049** | **13052** | **2399** | **816** | 136 | 59 | 27 | 25 |
| | 0 | #2002 | 4799t | | | | | | | |
| 1000 | 13 | 2004 | **15027** | **33581** | **3776** | **542** | 94 | 48 | 67 | 13 |
| | 3 | #2003 | 2975t | | | | | | | |
| 1000 | 238 | 4747 | **10190** | **18892** | **20570** | **1688** | 269 | 17 | 0 | 0 |
| | 0 | #2004 | 2589t | | | | | | | |
| 1000 | 278 | 11772 | **23815** | **15806** | **17601** | **15832** | 418 | 54 | 0 | 0 |
| | 0 | #2005 | 3659t | | | | | | | |
| 1000 | 295 | 16943 | **35200** | **15517** | **7869** | **5396** | 2180 | 142 | 6 | 0 |
| | 0 | #2006 | 2795t | | | | | | | |
| 1000 | 369 | 13147 | **23994** | **12964** | **2496** | **461** | 400 | 460 | 53 | 0 |
| | 0 | #2007 | 1898t | | | | | | | |
| 1000 | 257 | 8841 | **14651** | **10665** | **2942** | **586** | 50 | 65 | 0 | 0 |
| | 0 | #2008 | 1133t | | | | | | | |

FR-NEPHROPS-Early: French Nephrops trawlers (FU8) - Effort, No. whiting/age/1000 hours fished, Year, Live weight (t)

1987 1992

1 1 0 1

1 11

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | 917 | 3681 | 2247 | 761 | 176 | 23 | 18 | 2 | 6 | 0 |
| | 0 | #1987 | 588t | | | | | | | |
| 1000 | 632 | 7960 | 3610 | 918 | 165 | 39 | 11 | 0 | 0 | 0 |
| | 0 | #1988 | 844t | | | | | | | |
| 1000 | 131 | 4874 | 6866 | 1294 | 128 | 31 | 5 | 1 | 0 | 0 |
| | 0 | #1989 | 891t | | | | | | | |
| 1000 | 321 | 1139 | 3596 | 2297 | 279 | 27 | 8 | 5 | 0 | 0 |
| | 0 | #1990 | 671t | | | | | | | |
| 1000 | 1048 | 2312 | 982 | 1745 | 498 | 33 | 6 | 0 | 0 | 0 |
| | 0 | #1991 | 527t | | | | | | | |
| 1000 | 1542 | 6078 | 3348 | 478 | 571 | 171 | 14 | 0 | 0 | 0 |
| | 0 | #1992 | 1153t | | | | | | | |

FR-NEPHROPS-Late: French Nephrops trawlers (FU8) - Effort, No. whiting/age/1000 hours fished, Year, Live weight (t)

1993 2008

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | | | | | | | |
| 1 | 11 | | | | | | | | | |
| 1000 | 766 | 6928 | **5695** | **1001** | **163** | **86** | 74 | 1 | 2 | 0 |
| | 0 | #1993 | 1356t | | | | | | | |
| 1000 | 184 | 6145 | **8313** | **1840** | **214** | **17** | 16 | 5 | 2 | 0 |
| | 0 | #1994 | 1565t | | | | | | | |
| 1000 | 29 | 2217 | **7580** | **4802** | **697** | **91** | 20 | 0 | 3 | 3 |
| | 0 | #1995 | 1446t | | | | | | | |
| 1000 | 2 | 979 | **5599** | **4992** | **2359** | **305** | 55 | 4 | 1 | 7 |
| | 0 | #1996 | 1230t | | | | | | | |
| 1000 | 0 | 737 | **3511** | **10406** | **4124** | **1231** | 275 | 23 | 1 | 0 |
| | 0 | #1997 | 1393t | | | | | | | |
| 1000 | 58 | 1042 | **2567** | **4299** | **5925** | **1236** | 239 | 46 | 2 | 0 |
| | 0 | #1998 | 881t | | | | | | | |
| 1000 | 1253 | 4408 | **4764** | **3762** | **3867** | **3563** | 575 | 136 | 8 | 0 |
| | 0 | #1999 | 1190t | | | | | | | |
| 1000 | 277 | 2381 | **3085** | **2213** | **923** | **836** | 959 | 232 | 23 | 0 |
| | 0 | #2000 | 869t | | | | | | | |
| 1000 | 104 | 2948 | **3131** | **1531** | **557** | **213** | 106 | 95 | 36 | 8 |
| | 0 | #2001 | 548t | | | | | | | |
| 1000 | 27 | 747 | **4007** | **1455** | **462** | **170** | 69 | 13 | 14 | 7 |
| | 0 | #2002 | 550t | | | | | | | |
| 1000 | 5 | 311 | **1708** | **3944** | **574** | **95** | 27 | 7 | 1 | 0 |
| | 2 | #2003 | 543t | | | | | | | |
| 1000 | 47 | 748 | **1090** | **2045** | **2726** | **233** | 49 | 6 | 0 | 0 |
| | 0 | #2004 | 435t | | | | | | | |
| 1000 | 104 | 1285 | **1926** | **1133** | **1266** | **1283** | 54 | 2 | 0 | 0 |
| | 0 | #2005 | 378t | | | | | | | |
| 1000 | 46 | 802 | **1299** | **591** | **299** | **187** | 101 | 12 | 0 | 0 |
| | 0 | #2006 | 174t | | | | | | | |
| 1000 | 138 | 981 | **1159** | **604** | **137** | **26** | 19 | 16 | 5 | 0 |
| | 0 | #2007 | 96t | | | | | | | |
| 1000 | 41 | 506 | **565** | **408** | **96** | **19** | 7 | 2 | 0 | 0 |
| | 0 | #2008 | 54t | | | | | | | |

FR-EVHOE: Thalassa Survey - No. whiting at age/30 min, Year

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 2010 | | | | | | | | | |
| 1 | 1 | 0.75 | 1 | | | | | | | |
| 0 | 8 | | | | | | | | | |
| 1 | **30.82** | **23.85** | **8.93** | **8.47** | 10.38 | 1.93 | 0.24 | 0.00 | 0.00 | #1997 |
| 1 | **48.10** | **15.15** | **7.88** | **1.23** | 1.67 | 0.55 | 0.18 | 0.02 | 0.00 | #1998 |
| 1 | **260.66** | **62.15** | **17.64** | **5.09** | 1.92 | 1.67 | 1.18 | 0.15 | 0.13 | #1999 |

```
1       30.62   76.50   23.18   2.85    1.17    0.33    0.18    0.50    0.06    #2000
1       22.77   35.46   48.80   8.12    0.79    0.14    0.11    0.02    0.04    #2001

1       38.50   15.33   11.00   9.58    0.82    0.00    0.00    0.00    0.00    #2002

1       46.62   58.30   27.11   19.94   14.74   0.05    0.01    0.00    0.00    #2003

1       28.23   108.11  31.11   14.36   6.98    3.98    0.00    0.00    0.00    #2004

1       44.14   15.85   5.19    1.89    1.15    0.63    0.16    0.00    0.00    #2005

1       14.60   9.53    3.45    1.18    0.30    0.03    0.00    0.01    0.00    #2006

1       178.39  46.30   4.34    0.68    0.36    0.07    0.00    0.00    0.01    #2007
1       364.99  44.55   10.17   3.27    1.43    0.14    0.00    0.00    0.03    #2008
1       29.93   68.10   30.54   6.47    1.34    0.02    0.01    0.00    0.00    #2009
1       26.91   36.04   24.03   10.89   2.95    0.71    0.01    0.00    0.00    #2010
UK-WCGFS:UK (E+W) PHHT Groundfish Survey in VIIf&g - Effort mins towed, no.s at-age,
Year, Vessel (final survey in 2004)

1987    2004
1       1       0.15    0.25
1       7
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 360 | 129 | 580 | 57 | 8 | 6 | 4 | 1 | #1987 | Cirolana |
| 540 | 129 | 125 | 31 | 3 | 3 | 0 | 0 | #1988 | Cirolana |
| 540 | 137 | 393 | 267 | 21 | 4 | 2 | 0 | #1989 | Cirolana |
| 540 | 11 | 31 | 137 | 55 | 9 | 1 | 0 | #1990 | Cirolana |
| 482 | 99 | 6 | 3 | 11 | 9 | 1 | 0 | #1991 | Cirolana |
| 840 | 1097 | 441 | 94 | 28 | 22 | 6 | 1 | #1992 | Cirolana |
| 840 | 4101 | 772 | 229 | 29 | 4 | 8 | 3 | #1993 | Cirolana |
| 535 | 4809 | 713 | 490 | 70 | 17 | 1 | 3 | #1994 | Cirolana |
| 1320 | 777.4 | 7282.9 | 1891.2 | 595 | 82.2 | 18.6 | 11.3 | #1995 | Cirolana |
| 1475 | 773 | 2225 | 2050 | 391 | 148 | 11 | 2 | #1996 | Corystes |
| 1519 | 1113 | 852 | 280 | 646 | 226 | 60 | 5 | #1997 | Cirolana |
| 900 | 1071.5 | 691.5 | 477 | 343.3 | 104.8 | 13.3 | 12.5 | #1998 | Cirolana |
| 900 | 760.2 | 453.9 | 139.4 | 52.1 | 47.8 | 90.2 | 30.5 | #1999 | Cirolana |
| 1038 | 15471.8 | 962.8 | 296.4 | 118.9 | 47.2 | 51 | 50.6 | #2000 | Cirolana |
| 880 | 2195.3 | 1186.5 | 206.8 | 35.4 | 2 | 7.6 | 1 | #2001 | Cirolana |
| 762 | 2551.5 | 1368.9 | 2313.6 | 155.9 | 75.7 | 1.2 | 4.4 | #2002 | Cirolana |
| 863 | 2765.7 | 2169.9 | 2138.8 | 1665.8 | 157.9 | 0 | 0 | #2003 | Cirolana |
| 860 | 1716.8 | 1548.2 | 852.1 | 203.6 | 184.3 | 2 | 0 | #2004 | Cefas Endeavour |

UK BT SURVEY : (Sept) - Prime stations only (VIIf) Effort (km towed), numbers-at-age per Km towed

| | | | | |
|---|---|---|---|---|
| 1988 | 2010 | | | |
| 1 | 1 | 0.75 | 0.85 | |
| 0 | 1 | | | |
| 74.12 | 6 | 66 | #1988 | Tows 15 minute duration - raised here to 30 minutes |
| 91.91 | 80 | 104 | #1989 | Tows 15 minute duration - raised here to 30 minutes |
| 69.86 | 363 | 37 | #1990 | |
| 123.41 | 540 | 175 | #1991 | |
| 125.08 | 839 | 164 | #1992 | |
| 127.67 | 1279 | 213 | #1993 | |
| 120.82 | 330 | 182 | #1994 | |
| 104.14 | 240 | 154 | #1995 | |
| 122.11 | 557 | 188 | #1996 | |
| 115.63 | 1238 | 56 | #1997 | |
| 104.7 | 553 | 49 | #1998 | |
| 117.11 | 1770 | 116 | #1999 | |
| 105.99 | 128 | 333 | #2000 | |
| 118.22 | 204 | 56 | #2001 | |
| 113.03 | 602 | 36 | #2002 | |
| 111.92 | 442 | 6 | #2003 | |
| 101.92 | 1053 | 6 | #2004 | |
| 119.11 | 760 | 5 | #2005 | |
| 120.56 | 520 | 31 | #2006 | |
| 118.59 | 910 | 81 | #2007 | |
| 119.33 | 2994 | 81 | #2008 | |
| 123.22 | 826 | 72 | #2009 | |
| 116.92 | 232 | 35 | #2010 | |

IR-GFS-7G Swept-area : Swept-area Method - Effort in kmsq

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | 2010 | | | | | | | | | |
| 1 | 1 | 0.75 | 0.92 | | | | | | | |
| 0 | 8 | | | | | | | | | |
| 10.0 | **24175** | **7307** | **1881** | **633** | **292** | **110** | **85** | 40 | 0 | #1999 |
| 10.0 | **6077** | **15835** | **3116** | **190** | **35** | **27** | **8** | 0 | 0 | #2000 |
| 10.0 | **4650** | **2836** | **13871** | **1849** | **222** | **18** | **22** | 6 | 0 | #2001 |
| 10.0 | **2468** | **3664** | **1719** | **1252** | **127** | **3** | **9** | 0 | 0 | #2002 |
| 10.0 | **6061** | **2219** | **1027** | **413** | **0** | **10** | **0** | 0 | 0 | #2003 *age 4 replaced with zero,was 22 |
| 10.0 | **9778** | **3444** | **655** | **321** | **147** | **123** | **1** | 0 | 0 | #2004 |
| 10.0 | **1146** | **3177** | **1573** | **422** | **169** | **104** | **163** | 0 | 0 | #2005 *revised 2009 |
| 10.0 | **15260** | **5883** | **2175** | **707** | **68** | **0** | **28** | 0 | 0 | #2006 *revised 2009 |
| 10.0 | **9951** | **8081** | **2718** | **455** | **83** | **23** | **4** | 0 | 3 | #2007 *revised 2009 |

10.0 **16344 5554 2238 475 65 2 0** 0 0 #2008

10.0 **11053 10819 2154 589 110 25 0** 3 0 #2009

10.0 **2817 30977 784 172 11 2 0** 0 0 #2010

IR-7G&J-OT : Irish Otter Trawl Fleet (Areas VIIg&j) - Effort in hours, no.s @ age, Year, Live weight (t), LPUE (kg/h)

1995 2010

1 1 0 1

1 4

157085 679 2281 1889 1333 # #1995

130257 164 1549 1889 905 # #1996

148276 170 756 1488 1247 # #1997

161909 180 933 980 736 # #1998

92195 388 960 962 449 # #1999

125229 619 1042 808 500 # 228 103 65 #2000 1506.6 t 12.03

137086 91 2224 1538 1046 # 412 125 48 #2001 2227.9 t 16.25

168134 291 1140 2615 613 # 86 13 6 #2002 1761.4 t 10.48

198059 147 878 1640 1195 # 155 8 0 #2003 1544.6 t 7.80

188948 132 628 1763 1002 # 428 42 2 #2004 2243.9 t 11.88

198315 96 1743 2848 1226 # 1162 745 31 #2005 3730.4 t 18.81

185083 188 1900 2070 950 # 427 283 127 #2006 3008.2 t 16.25

217009 78 1063 3112 2305 # 614 141 70 #2007 3597.2 t 16.58

192317 131 860 1038 677 # 173 55 7 #2008 1269.3 t 6.60

209568 216 894 1471 675 # 283 69 17 #2009 1576.6 t 7.52

225900 133 1078 2008 1339 # 379 94 12 #2010 2631.5 t 11.65

IR-ISCSGFS : Irish Sea Celtic Sea GFS (VIIg) - Whiting #/30 min towed (Prime stations only)

1997 2002

1 1 0.8 0.9

0 5

1 21 38 70 223 113 23 #1997

1 1605 1430 300 79 135 16 #1998

1 6389 507 120 38 17 6.3 #1999

1 6062 687 104 4.2 0.2 0.1 #2000

1 1661 1549 838 8.8 0.4 0.5 #2001

1 312 298 102 77 9.1 0.2 #2002

IR-WCGFS : Irish Autumn WCGFS (VIIj) - Effort min. towed, #@ age, Yr

1993 2002

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.75 | 0.79 | | | | | |
| 0 | 6 | | | | | | | |
| 323 | 372 | 912 | 1529 | 1722 | 352 | 0 | 0 | #1993 |
| 673 | 11235 | 123 | 304 | 344 | 25 | 0 | 0 | #1994 |
| 651 | 15564 | 1736 | 229 | 285 | 29 | 0 | 0 | #1995 |
| 671 | 406 | 618 | 189 | 42 | 59 | 0 | 0 | #1996 |
| 1232 | 478 | 171 | 345 | 59 | 22 | 21 | 12 | #1997 |
| 1310 | 2384 | 758 | 159 | 34 | 65 | 7 | 2 | #1998 |
| 1281 | 23133 | 3013 | 175 | 45 | 12 | 2 | 2 | #1999 |
| 1190 | 203 | 2445 | 664 | 44 | 6 | 0 | 0 | #2000 |
| 595 | 218 | 1253 | 1709 | 169 | 12 | 2 | 0 | #2001 |
| 606 | 3239 | 4489 | 1538 | 438 | 61 | 5 | 1 | #2002 |

IR-GFS-7G : Irish Groundfish Survey in VIIg (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | |
| 0 | 6 | | | | | | | |
| 832 | 6598 | 2571 | 1189 | 466 | 23 | 11 | 0 | #2003 |
| 980 | 12662 | 4470 | 853 | 417 | 191 | 159 | 2 | #2004 |
| 845 | 4078 | 4776 | 1745 | 483 | 178 | 107 | 182 | #2005 |
| 1046 | 22967 | 8854 | 3273 | 1064 | 102 | 0 | 43 | #2006 |
| 1168 | 16479 | 13382 | 4501 | 754 | 138 | 38 | 13 | #2007 |
| 1139 | 23296 | 7916 | 3190 | 677 | 93 | 3 | 0 | #2008 |
| 1018 | 14872 | 14558 | 2898 | 793 | 148 | 34 | 0 | #2009 |
| 1381 | 3390 | 17059 | 9541 | 1636 | 247 | 29 | 15 | #2010 |

IR-GFS-7J : Irish Groundfish Survey in VIIj (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2003 | 2010 | | | | | | | |
| 1 | 1 | 0.79 | 0.92 | | | | | |
| 0 | 6 | | | | | | | |
| 780 | 227 | 2121 | 883 | 146 | 67 | 3 | 0 | #2003 |
| 720 | 3864 | 1230 | 1675 | 155 | 27 | 6 | 4 | #2004 |
| 881 | 455 | 1001 | 234 | 121 | 17 | 4 | 9 | #2005 |
| 901 | 727 | 1141 | 403 | 31 | 15 | 3 | 3 | #2006 |
| 874 | 5221 | 582 | 144 | 35 | 8 | 4 | 0 | #2007 |
| 873 | 2468 | 1631 | 625 | 239 | 42 | 3 | 7 | #2008 |
| 747 | 4501 | 3513 | 908 | 193 | 47 | 10 | 0 | #2009 |
| 1021 | 2275 | 7315 | 1173 | 538 | 50 | 23 | 0 | #2010 |

IR-GFS-7G&J : Irish Groundfish Survey in VIIg&j (IBTS 4th Qtr) - Whiting no. @ age (Interim indices: New Celtic Explorer series)

| | | | |
|---|---|---|---|
| 2003 | 2010 | | |
| 1 | 1 | 0.79 | 0.92 |
| 0 | 6 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1612 | 6836 | 4714 | 2064 | 582 | 96 | 12 | 0 | #2003 |
| 1700 | 16710 | 5405 | 2733 | 570 | 170 | 115 | 10 | #2004 |
| 1726 | 4761 | 6085 | 1655 | 573 | 142 | 75 | 101 | #2005 |
| 1947 | 24194 | 10418 | 3250 | 637 | 100 | 3 | 25 | #2006 |
| 2042 | 22609 | 14869 | 3182 | 508 | 82 | 39 | 10 | #2007 |
| 2012 | 26990 | 9362 | 2957 | 734 | 135 | 6 | 8 | #2008 |
| 1765 | 20379 | 17026 | 3845 | 989 | 196 | 41 | 0 | #2009 |
| 2402 | 6783 | 25405 | 10268 | 2134 | 303 | 52 | 19 | #2010 |

**Table 7.15.9. Whiting in Divisions VIIe–k. Landings (t), lpue of French and Irish fleets, and Effort ('000 h) of French, Irish and UK fleets.**

| | FR-Gadoid | | | FR-Nephrops | | | IR-OTB-7G | | | IR-OTB-7J | | | UK (E&W) in VIIe-k | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VII fg French gadoid trawlers | | | VII fg French *Nephrops* trawlers | | | Irish otter trawlers VIIg | | | Irish otter trawlers VIIj | | | Beam | Otter |
| Year | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] | Effort[4] | Effort[4] |
| 1983 | 5,742 | 109 | 53 | 470 | 207 | 2 | | | | | | | 135 | 82 |
| 1984 | 4,598 | 84 | 55 | 340 | 173 | 2 | | | | | | | 131 | 87 |
| 1985 | 4,514 | 89 | 51 | 651 | 185 | 4 | | | | | | | 152 | 90 |
| 1986 | 5,049 | 116 | 44 | 374 | 146 | 3 | | | | | | | 136 | 85 |
| 1987 | 6,859 | 137 | 50 | 588 | 177 | 3 | | | | | | | 177 | 84 |
| 1988 | 7,921 | 200 | 40 | 844 | 156 | 5 | | | | | | | 195 | 89 |
| 1989 | 8,974 | 231 | 39 | 891 | 159 | 6 | | | | | | | 198 | 84 |
| 1990 | 7,897 | 188 | 42 | 671 | 196 | 3 | | | | | | | 208 | 99 |
| 1991 | 7,525 | 167 | 45 | 527 | 187 | 3 | | | | | | | 203 | 77 |
| 1992 | 6,460 | 173 | 37 | 1,153 | 234 | 5 | | | | | | | 196 | 86 |
| 1993 | 7,815 | 201 | 39 | 1,356 | 223 | 6 | | | | | | | 208 | 62 |
| 1994 | 9,236 | 171 | 54 | 1,565 | 223 | 7 | | | | | | | 220 | 54 |
| 1995 | 9,186 | 171 | 54 | 1,446 | 202 | 7 | 829 | 64 | 13 | 1,305 | 94 | 14 | 243 | 52 |
| 1996 | 6,028 | 152 | 40 | 1,230 | 179 | 7 | 906 | 60 | 15 | 803 | 70 | 11 | 261 | 61 |
| 1997 | 7,218 | 195 | 37 | 1,393 | 149 | 9 | 1,066 | 65 | 16 | 783 | 83 | 9 | 265 | 67 |
| 1998 | 9,102 | 172 | 53 | 881 | 125 | 7 | 813 | 72 | 11 | 545 | 90 | 6 | 255 | 62 |
| 1999 | 9,102 | 191 | 48 | 1,190 | 130 | 9 | 946 | 52 | 18 | 247 | 41 | 6 | 251 | 98 |
| 2000 | 6,053 | 157 | 38 | 869 | 161 | 5 | 990 | 61 | 16 | 517 | 65 | 8 | 259 | 104 |
| 2001 | 4,624 | 174 | 27 | 548 | 137 | 4 | 1,286 | 69 | 19 | 942 | 68 | 14 | 273 | 85 |
| 2002 | 4,841 | 165 | 29 | 550 | 142 | 4 | 1,004 | 78 | 13 | 758 | 90 | 8 | 249 | 83 |
| 2003 | 2,975 | 125 | 24 | 543 | 161 | 3 | 1,051 | 87 | 12 | 494 | 111 | 4 | 282 | 72 |
| 2004 | 2,589 | 107 | 24 | 435 | 127 | 3 | 1,932 | 97 | 20 | 312 | 92 | 3 | 274 | 76 |
| 2005 | 3,787 | 93 | 41 | 378 | 114 | 3 | 3,445 | 124 | 28 | 285 | 74 | 4 | 270 | 76 |
| 2006 | 2,795 | 75 | 37 | 175 | 107 | 2 | 2,757 | 119 | 23 | 251 | 66 | 4 | 252 | 83 |
| 2007 | 1,898 | 80 | 24 | 96 | 75 | 1 | 3,324 | 137 | 24 | 273 | 80 | 3 | 240 | 88 |
| 2008 | 1,133 | 62 | 18 | 54 | 70 | 1 | 1,037 | 126 | 8 | 233 | 67 | 4 | 217 | 71 |
| 2009 | Not available | | | Not available | | | 1,283 | 137 | 9 | 294 | 73 | 4 | 191 | 74 |
| 2010* | Not available | | | Not available | | | 2,208 | 141 | 16 | 424 | 85 | 5 | 196 | 78 |

| | IR-SSC-7J | | | IR-SSC-7G | | | IR-TBB-7J | | | IR-TBB-7G | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Irish Scottish Seiners | | | Irish Scottish Seiners | | | Irish Beam Trawls | | | Irish Beam Trawls | | |
| Year | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] | Landings | Effort[4] | Lpue[3] |
| 1995 | 1,008 | 5 | 192 | 1,123 | 6 | 175 | 0 | 0 | 1 | 63 | 21 | 3 |
| 1996 | 1,100 | 8 | 135 | 1,534 | 10 | 158 | 5 | 1 | 3 | 33 | 27 | 1 |
| 1997 | 806 | 11 | 75 | 2,654 | 16 | 165 | 3 | 2 | 2 | 44 | 28 | 2 |
| 1998 | 467 | 7 | 71 | 2,502 | 15 | 167 | 5 | 5 | 1 | 46 | 35 | 1 |
| 1999 | 77 | 1 | 55 | 1,378 | 8 | 172 | 8 | 7 | 1 | 47 | 41 | 1 |
| 2000 | 187 | 3 | 54 | 1,187 | 10 | 120 | 8 | 7 | 1 | 64 | 37 | 2 |
| 2001 | 236 | 4 | 53 | 1,005 | 16 | 62 | 6 | 3 | 2 | 79 | 40 | 2 |
| 2002 | 409 | 9 | 46 | 1,971 | 21 | 94 | 6 | 3 | 2 | 60 | 32 | 2 |
| 2003 | 371 | 9 | 41 | 1,560 | 21 | 75 | 13 | 9 | 1 | 55 | 49 | 1 |
| 2004 | 314 | 9 | 34 | 1,038 | 19 | 54 | 1 | 2 | 1 | 33 | 55 | 1 |
| 2005 | 253 | 6 | 41 | 1,004 | 15 | 68 | 1 | 2 | 1 | 24 | 50 | 0 |
| 2006 | 192 | 5 | 36 | 912 | 15 | 62 | 1 | 2 | 0 | 19 | 60 | 0 |
| 2007 | 205 | 4 | 58 | 825 | 16 | 52 | 0 | 2 | 0 | 25 | 56 | 0 |
| 2008 | 225 | 3 | 79 | 741 | 12 | 64 | 0 | 1 | 0 | 4 | 37 | 0 |
| 2009 | 347 | 3 | 104 | 734 | 8 | 90 | 0 | 3 | 0 | 2 | 38 | 0 |
| 2010* | 533 | 4 | 122 | 1,035 | 10 | 107 | 0 | 1 | 0 | 4 | 40 | 0 |

**[1] = Lpue calculated as landings in kg/h fishing, power corrected.**

**[2] = Effort in hours fishing, power corrected.**

**[3] = Lpue calculated as landings in kg/h fishing.**

**[4] = Effort in 000 hours fishing.**

*** Provisional.**

**Table 7.15.10. Whiting in Divisions VIIe–k. XSA Diagnostics.**

Lowestoft VPA Version 3.1

10/05/2011 12:19

Extended Survivors Analysis

"Whiting in the Celtic Sea (VIIe-k) WGCSE 2011 COMBSEX (Updated by DS 09/05/20

cpue data from file whg7ektutrimed.txt

Catch data for 29 years. 1982 to 2010. Ages 0 to 7.

| Fleet | First year | Last year | First age | Last age | Alpha | Beta | | |
|---|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | | 1993 | 2010 | 3 | 6 | 0 | 1 | |
| "FR-NEPHROPS-Late: F | 1993 | 2010 | 3 | 6 | 0 | 1 | | |
| "FR-EVHOE: Thalassa | | 1997 | 2010 | 0 | 4 | 0.75 | 1 | |
| "UK-WCGFS: UK (E+W) | 1987 | 2010 | 1 | 6 | 0.15 | 0.25 | | |
| IR-GFS-7G-SweptArea: | | 1999 | 2010 | 0 | 6 | 0.75 | 0.92 | |

Time-series weights:

Tapered time weighting not applied

Catchability analysis:

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 5

Terminal population estimation:

Survivor estimates shrunk towards the mean F

of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population

estimates derived from each fleet = .500

Prior weighting not applied

Tuning converged after 23 iterations

1

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.007 | 0.038 | 0.016 | 0.039 | 0.027 | 0.054 | 0.032 | 0.029 | 0.005 | 0.009 |
| 2 | 0.161 | 0.168 | 0.173 | 0.199 | 0.285 | 0.316 | 0.328 | 0.163 | 0.125 | 0.066 |
| 3 | 0.685 | 0.445 | 0.371 | 0.481 | 0.755 | 0.69 | 0.934 | 0.7 | 0.404 | 0.389 |
| 4 | 1.272 | 0.973 | 0.513 | 0.594 | 1.006 | 0.97 | 1.57 | 1.051 | 0.859 | 0.606 |
| 5 | 1.377 | 1.05 | 0.886 | 0.553 | 1.101 | 1.377 | 1.808 | 1.06 | 0.777 | 1.444 |
| 6 | 1.011 | 0.656 | 0.827 | 0.725 | 0.736 | 0.964 | 1.86 | 1.21 | 0.782 | 0.595 |

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XSA population numbers (Thousands)

| | AGE | | | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2001 | 3.88E+04 | 5.24E+04 | 8.68E+04 | 2.47E+04 | 7.88E+03 | 3.05E+03 | 1.29E+03 |
| 2002 | 3.84E+04 | 3.18E+04 | 4.26E+04 | 6.05E+04 | 1.02E+04 | 1.81E+03 | 6.30E+02 |
| 2003 | 4.26E+04 | 3.14E+04 | 2.50E+04 | 2.95E+04 | 3.17E+04 | 3.15E+03 | 5.18E+02 |
| 2004 | 3.96E+04 | 3.49E+04 | 2.53E+04 | 1.72E+04 | 1.67E+04 | 1.56E+04 | 1.06E+03 |
| 2005 | 3.49E+04 | 3.24E+04 | 2.75E+04 | 1.70E+04 | 8.72E+03 | 7.54E+03 | 7.33E+03 |
| 2006 | 4.19E+04 | 2.85E+04 | 2.59E+04 | 1.69E+04 | 6.54E+03 | 2.61E+03 | 2.05E+03 |
| 2007 | 6.07E+04 | 3.43E+04 | 2.21E+04 | 1.54E+04 | 6.95E+03 | 2.03E+03 | 5.39E+02 |
| 2008 | 8.40E+04 | 4.97E+04 | 2.72E+04 | 1.31E+04 | 4.97E+03 | 1.18E+03 | 2.72E+02 |
| 2009 | 8.07E+04 | 6.88E+04 | 3.95E+04 | 1.89E+04 | 5.31E+03 | 1.42E+03 | 3.36E+02 |
| 2010 | 2.41E+04 | 6.61E+04 | 5.60E+04 | 2.86E+04 | 1.03E+04 | 1.84E+03 | 5.35E+02 |

Estimated population abundance at 1st Jan 2011

0.00E+00 1.98E+04 5.36E+04 4.29E+04 1.58E+04 4.62E+03 3.56E+02

Taper weighted geometric mean of the VPA populations:

6.65E+04 5.51E+04 4.22E+04 2.34E+04 8.72E+03 2.43E+03 5.83E+02

Standard error of the weighted Log(VPA populations):

0.5256 0.5038 0.5132 0.6305 0.8658 1.1205 1.418

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Log-catchability residuals.

Fleet : "FR-GADOID-late: Fre

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 99.99 | 99.99 | 0.24 | 0.09 | -0.36 | -1.02 | -1.1 | 0.16 | 0.31 | 0.51 |
| 4 | 99.99 | 99.99 | -0.32 | 0.12 | -0.21 | -0.48 | -0.67 | -0.61 | 0.27 | 0.21 |
| 5 | 99.99 | 99.99 | -0.33 | -0.03 | 0.1 | -0.43 | -0.63 | -0.45 | 0.31 | 0.1 |
| 6 | 99.99 | 99.99 | -0.07 | 0.01 | 0.18 | -0.4 | -0.63 | 0.68 | 0.11 | 0.14 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 0.18 | -0.19 | -0.67 | -0.47 | 0.51 | 0.88 | 0.69 | 0.26 | 99.99 | 99.99 |
| 4 | 0.06 | 0.03 | -0.36 | -0.26 | 0.39 | 0.64 | 0.63 | 0.57 | 99.99 | 99.99 |
| 5 | -0.11 | -0.08 | -0.24 | -0.29 | 0.51 | 0.87 | 0.13 | 0.56 | 99.99 | 99.99 |
| 6 | -0.25 | -0.26 | -0.4 | -0.03 | 0.28 | 0.57 | -0.22 | 0.47 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability

independent of year-class strength and constant w.r.t. time

| Age | 3 | 4 | 5 | 6 |
|---|---|---|---|---|
| Mean Log q | -6.6398 | -6.1555 | -5.9887 | -5.9887 |
| S.E(Log q) | 0.5859 | 0.4332 | 0.4096 | 0.3702 |

Regression statistics:

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 3 | 2.72 | -3.263 | 0.31 | 0.2 | 16 | 1.24 | -6.64 |
| 4 | 1.83 | -4.908 | 3.36 | 0.71 | 16 | 0.5 | -6.16 |
| 5 | 1.16 | -1.463 | 5.59 | 0.85 | 16 | 0.46 | -5.99 |
| 6 | 0.95 | 0.67 | 6.04 | 0.93 | 16 | 0.36 | -5.98 |

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Fleet : "FR-NEPHROPS-Late: F

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 99.99 | 99.99 | 0.7 | 0.32 | 0.19 | -0.55 | -0.42 | -0.08 | 0.79 | 0.56 |
| 4 | 99.99 | 99.99 | 0.22 | 0.03 | 0.01 | -0.11 | 0.06 | -0.17 | 0.67 | 0.5 |
| 5 | 99.99 | 99.99 | 0.23 | -0.48 | -0.12 | -0.01 | 0.31 | 0.09 | 0.52 | 0.28 |
| 6 | 99.99 | 99.99 | -0.22 | -0.64 | -0.34 | 0.06 | 0.29 | -0.01 | 0.57 | 0.18 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 0.38 | -0.38 | -0.54 | -0.41 | 0.3 | -0.12 | -0.04 | -0.69 | 99.99 | 99.99 |
| 4 | 0.47 | 0.04 | -0.29 | -0.27 | -0.04 | -0.42 | -0.23 | -0.48 | 99.99 | 99.99 |
| 5 | 0.25 | 0.46 | 0.05 | -0.13 | 0.06 | -0.22 | -0.59 | -0.69 | 99.99 | 99.99 |
| 6 | 0 | 0.35 | 0.03 | 0.17 | -0.05 | -0.61 | -0.91 | -0.78 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability

independent of year-class strength and constant w.r.t. time

| Age | 3 | 4 | 5 | 6 |
|---|---|---|---|---|
| Mean Log q | -8.9402 | -8.3659 | -8.1672 | -8.1672 |
| S.E(Log q) | 0.4756 | 0.3299 | 0.3572 | 0.4469 |

Regression statistics:

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 3 | 1.05 | -0.231 | 8.87 | 0.6 | 16 | 0.52 | -8.94 |
| 4 | 1.01 | -0.093 | 8.35 | 0.84 | 16 | 0.35 | -8.37 |
| 5 | 0.89 | 1.419 | 8.19 | 0.93 | 16 | 0.31 | -8.17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | 0.82 | 2.948 | 8.1 | 0.95 | 16 | 0.29 | -8.29 |
| 1 | | | | | | | |

Fleet : "FR-EVHOE: Thalassa

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.54 | -0.25 | 0.73 | -0.67 |
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.45 | -0.86 | 0.45 | -0.1 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.64 | -0.63 | 0.35 | 0.48 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.39 | -1.56 | 0.22 | -0.15 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -0.13 | -1.27 | 0.05 | -0.12 |
| 5 | No data for this fleet at this age | | | | | | | | | |
| 6 | No data for this fleet at this age | | | | | | | | | |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -0.47 | 0.07 | 0.16 | -0.27 | 0.3 | -0.99 | 1.15 | 1.54 | -0.93 | 0.18 |
| 1 | -0.15 | -0.46 | 0.87 | 1.4 | -0.46 | -0.82 | 0.56 | 0.15 | 0.23 | -0.36 |
| 2 | 0.34 | -0.43 | 1.01 | 1.16 | -0.64 | -0.96 | -0.57 | -0.07 | 0.63 | -0.01 |
| 3 | 0.66 | -0.28 | 1.1 | 1.41 | -0.37 | -0.89 | -1.14 | 0.4 | 0.45 | 0.55 |
| 4 | -0.03 | -0.51 | 0.85 | 0.81 | 0.02 | -1.07 | -0.43 | 0.84 | 0.54 | 0.44 |
| 5 | No data for this fleet at this age | | | | | | | | | |
| 6 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability

independent of year-class strength and constant w.r.t. time

| Age | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Mean Log q | -6.7998 | -6.9673 | -7.5084 | -7.9027 | -7.8986 |
| S.E(Log q) | 0.7486 | 0.6506 | 0.6721 | 0.8428 | 0.6672 |

Regression statistics:

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 0.7 | 0.888 | 8 | 0.43 | 14 | 0.53 | -6.8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.15 | -0.267 | | 6.4 | | 0.21 | | 14 | 0.78 | -6.97 |
| 2 | 0.89 | 0.242 | | 7.84 | | 0.28 | | 14 | 0.62 | -7.51 |
| 3 | 1.18 | -0.279 | | 7.51 | | 0.17 | | 14 | 1.03 | -7.9 |
| 4 | 1.09 | -0.318 | | 7.76 | | 0.51 | | 14 | 0.75 | -7.9 |
| 1 | | | | | | | | | | |

Fleet : "UK-WCGFS: UK (E+W)

| Age | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | |
| 1 | -1.22 | -1.4 | -0.18 | -3.2 |
| 2 | 1.34 | -1.28 | 0.05 | -1.28 |
| 3 | 0.56 | -0.86 | 0.4 | -0.21 |
| 4 | 0.06 | -1.11 | 0.2 | 0.08 |
| 5 | 1.13 | 0.16 | 0.63 | 0.73 |
| 6 | 1.74 | 99.99 | 1.12 | 0.62 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | -1.56 | -0.14 | 1.29 | 1.62 | -0.52 | -0.1 | 0.31 | 0.83 | 0.34 | 2.49 |
| 2 | -3.28 | -0.21 | -0.16 | 0.29 | 1.41 | 0.69 | 0.26 | 0.65 | 0.31 | 0.81 |
| 3 | -2.38 | -0.12 | 0.04 | 0.55 | 0.98 | 0.58 | -0.86 | 0.8 | -0.24 | 0.57 |
| 4 | -1.37 | 0.64 | -0.09 | 0.44 | 0.73 | 0.07 | -0.02 | 0.51 | -0.49 | 0.56 |
| 5 | -0.44 | 0.39 | -0.31 | 0.68 | 0.53 | -0.07 | 0.08 | -0.75 | -0.76 | 0.3 |
| 6 | 0.24 | 0.12 | 0.6 | 0.14 | 0.88 | -0.58 | -0.09 | -1.34 | 0.04 | 0.41 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | No data for this fleet at this age | | | | | | | | | |
| 1 | 1.44 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 2 | 0.4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 3 | 0.2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 4 | -0.21 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | -2.3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | -0.18 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability

independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|---|
| Mean Log q | | -11.3524 | -11.3958 | -11.5835 | -11.6823 | -11.4955 | -11.4955 |
| S.E(Log q) | | 1.4621 | 1.1905 | 0.8605 | 0.6082 | 0.8429 | 0.7952 |

Regression statistics:

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | 0.6 | 0.856 | 11.29 | 0.26 | 15 | 0.88 | -11.35 |
| 2 | 0.55 | 1.314 | 11.2 | 0.4 | 15 | 0.64 | -11.4 |
| 3 | 0.59 | 2.204 | 11.07 | 0.69 | 15 | 0.45 | -11.58 |
| 4 | 0.91 | 0.551 | 11.48 | 0.76 | 15 | 0.57 | -11.68 |
| 5 | 1.38 | -1.658 | 12.81 | 0.6 | 15 | 1.1 | -11.5 |
| 6 | 1.44 | -2.745 | 13.18 | 0.76 | 14 | 0.88 | -11.23 |
| 1 | | | | | | | |

Fleet : IR-GFS-7G-SweptArea:

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.31 | -0.33 |
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.06 | 0.08 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.02 | 0.38 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.21 | -0.78 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.7 | -1.09 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.4 | 0.13 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 0.2 | -1.16 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -0.1 | -0.72 | 0.07 | 0.63 | -1.39 | 1.01 | 0.22 | 0.39 | 0.04 | -0.12 |
| 1 | -0.93 | -0.14 | -0.65 | -0.3 | -0.32 | 0.45 | 0.57 | -0.18 | 0.14 | 1.23 |
| 2 | 1 | -0.38 | -0.35 | -0.79 | 0.07 | 0.48 | 0.87 | 0.33 | -0.11 | -1.52 |
| 3 | 1.25 | -0.24 | -0.69 | -0.31 | 0.21 | 0.67 | 0.52 | 0.54 | 0.14 | -1.52 |
| 4 | 1.23 | 0.17 | 99.99 | -0.5 | 0.63 | -0.02 | 0.62 | 0.28 | 0.58 | -2.6 |
| 5 | 0.37 | -1.17 | -0.65 | -0.02 | 0.99 | 99.99 | 1.38 | -1.14 | 0.97 | -1.26 |
| 6 | 1.13 | 0.66 | 99.99 | -2.01 | 1.17 | 0.87 | 1 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability

independent of year-class strength and constant w.r.t. time

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Mean Log q | -4.16 | -4.1199 | -4.8307 | -5.4064 | -5.8743 | -6.4953 | -6.4953 |
| S.E(Log q) | 0.6256 | 0.5723 | 0.7043 | 0.7525 | 1.069 | 0.9403 | 1.209 |

Regression statistics:

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 0 | 0.72 | 0.968 | 6.02 | 0.55 | 12 | 0.45 | -4.16 |
| 1 | 0.77 | 0.693 | 5.63 | 0.48 | 12 | 0.45 | -4.12 |
| 2 | 1.07 | -0.115 | 4.45 | 0.22 | 12 | 0.79 | -4.83 |
| 3 | 3.25 | -1.28 | -4.91 | 0.03 | 12 | 2.38 | -5.41 |
| 4 | 6.15 | -0.935 | -10.57 | 0 | 11 | 6.62 | -5.87 |
| 5 | 0.76 | 0.945 | 6.89 | 0.63 | 11 | 0.72 | -6.5 |
| 6 | 1.03 | -0.065 | 6.22 | 0.46 | 8 | 1.31 | -6.26 |

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Terminal year survivor and F summaries:

Age 0 Catchability constant w.r.t. time and dependent on age

Year class = 2010

| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated | |
|---|---|---|---|---|---|---|---|---|
| | Survivors | s.e | s.e | Ratio | | Weights | F | |
| "FR-GADOID-late: Fre | | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-NEPHROPS-Late: F | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| "FR-EVHOE: Thalassa | | 23557 | 0.775 | 0 | 0 | 1 | 0.414 | 0 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| IR-GFS-7G-SweptArea: | | 17462 | 0.651 | 0 | 0 | 1 | 0.586 | 0 |
| F shrinkage mean | 0 | 1 | | | | 0 | 0 | |

Weighted prediction:

| Survivors | Int | Ext | N | Var | F |
|---|---|---|---|---|---|
| at end of year | s.e | s.e | | Ratio | |
| 19766 | 0.5 | 0.15 | 2 | 0.296 | 0 |

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated |
|---|---|---|---|---|---|---|---|
| | Survivors | s.e | s.e | Ratio | | Weights | F |
| "FR-GADOID-late: Fre | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-NEPHROPS-Late: F | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| "FR-EVHOE: Thalassa | 29270 | 0.508 | 0.278 | 0.55 | 2 | 0.385 | 0.016 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 106727 | 0.44 | 0.597 | 1.36 | 2 | 0.515 | 0.004 |
| F shrinkage mean | 16002 | 1 | | | | 0.1 | 0.03 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 53622 | 0.32 | 0.44 | 5 | 1.384 | 0.009 |

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Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-NEPHROPS-Late: F | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-EVHOE: Thalassa | 71495 | 0.41 | 0.458 | 1.12 | 3 | 0.423 | 0.04 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 34506 | 0.377 | 0.558 | 1.48 | 3 | 0.501 | 0.082 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| F shrinkage mean | 10636 | 1 | | | | 0.076 | 0.245 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 42914 | 0.27 | 0.36 | 7 | 1.352 | 0.066 |

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-NEPHROPS-Late: F | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-EVHOE: Thalassa | 28450 | 0.372 | 0.205 | 0.55 | 4 | 0.413 | 0.235 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 11225 | 0.34 | 0.362 | 1.06 | 4 | 0.493 | 0.514 |
| F shrinkage mean | 7393 | 1 | | | | 0.094 | 0.703 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 15840 | 0.25 | 0.25 | 9 | 1.022 | 0.389 |

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-NEPHROPS-Late: F | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| "FR-EVHOE: Thalassa | 5432 | 0.339 | 0.26 | 0.77 | 5 | 0.451 | 0.535 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 5123 | 0.332 | 0.563 | 1.7 | 5 | 0.417 | 0.56 |
| F shrinkage mean | 1906 | 1 | | | | 0.132 | 1.104 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 4617 | 0.24 | 0.28 | 11 | 1.147 | 0.606 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | 463 | 0.604 | 0 | 0 | 1 | 0.055 | 1.249 |
| "FR-NEPHROPS-Late: F | 178 | 0.5 | 0 | 0 | 1 | 0.081 | 2.011 |
| "FR-EVHOE: Thalassa | 397 | 0.369 | 0.274 | 0.74 | 5 | 0.195 | 1.361 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 250 | 0.431 | 0.425 | 0.98 | 6 | 0.263 | 1.725 |
| F shrinkage mean | 469 | 1 | | | | 0.406 | 1.24 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 356 | 0.43 | 0.18 | 14 | 0.427 | 1.444 |

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2004

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| "FR-GADOID-late: Fre | 439 | 0.414 | 0.047 | 0.11 | 2 | 0.156 | 0.369 |
| "FR-NEPHROPS-Late: F | 169 | 0.386 | 0.197 | 0.51 | 2 | 0.171 | 0.77 |
| "FR-EVHOE: Thalassa | 253 | 0.388 | 0.407 | 1.05 | 5 | 0.131 | 0.575 |
| "UK-WCGFS: UK (E+W) | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IR-GFS-7G-SweptArea: | 441 | 0.497 | 0.19 | 0.38 | 6 | 0.196 | 0.368 |

| | | | | | |
|---|---|---|---|---|---|
| F shrinkage mean | 154 | 1 | | 0.346 | 0.822 |

Weighted prediction:

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 242 | 0.37 | 0.16 | 16 | 0.439 | 0.595 |

**Table 7.15.11. Whiting in Divisions VIIe–k. Fishing mortality (F)-at-age. $F_{bar}$ range is 2–5.**

| AGE | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1 | 0.1058 | 0.1366 | 0.0798 | 0.097 | 0.0739 | 0.0626 | 0.0301 | 0.0249 | 0.0836 | |
| 2 | 0.6227 | 0.7307 | 0.8392 | 0.8031 | 0.7132 | 0.6564 | 0.4359 | 0.3215 | 0.64 | |
| 3 | 1.048 | 1.441 | 0.9644 | 1.1689 | 0.9843 | 1.347 | 1.0988 | 0.9266 | 0.7543 | |
| 4 | 1.2366 | 1.5064 | 1.5566 | 0.8735 | 1.2303 | 1.5192 | 1.4821 | 1.3525 | 1.0945 | |
| 5 | 1.3855 | 1.985 | 1.5183 | 1.3016 | 1.1488 | 1.7752 | 1.2823 | 1.2656 | 1.4198 | |
| 6 | 1.2385 | 1.6665 | 1.3637 | 1.1279 | 1.1343 | 0.7612 | 1.2515 | 0.6736 | 0.8407 | |
| +gp | 1.2385 | 1.6665 | 1.3637 | 1.1279 | 1.1343 | 0.7612 | 1.2515 | 0.6736 | 0.8407 | |
| FBAR 2–5 | 1.0732 | 1.4158 | 1.2196 | 1.0368 | 1.0191 | 1.3245 | 1.0748 | 0.9665 | 0.9772 | |

| AGE | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.1097 | 0.0419 | 0.0216 | 0.0089 | 0.0068 | 0.0291 | 0.0141 | 0.0285 | 0.089 | 0.0366 |
| 2 | 0.4959 | 0.4281 | 0.2672 | 0.178 | 0.1386 | 0.1228 | 0.1273 | 0.2114 | 0.3643 | 0.295 |
| 3 | 1.0798 | 0.9191 | 0.8456 | 0.5557 | 0.4598 | 0.2414 | 0.2883 | 0.5233 | 0.7669 | 0.7817 |
| 4 | 1.7591 | 0.9275 | 0.835 | 0.8166 | 0.7045 | 0.5434 | 0.5069 | 0.5867 | 1.0368 | 0.9647 |
| 5 | 1.4168 | 1.0148 | 1.1755 | 0.8534 | 0.823 | 0.6629 | 0.6979 | 0.6999 | 1.1003 | 0.9722 |
| 6 | 1.3144 | 0.9538 | 1.0318 | 1.2112 | 0.6947 | 0.7749 | 0.876 | 0.6587 | 0.931 | 0.8185 |
| +gp | 1.3144 | 0.9538 | 1.0318 | 1.2112 | 0.6947 | 0.7749 | 0.876 | 0.6587 | 0.931 | 0.8185 |
| FBAR 2–5 | 1.1879 | 0.8224 | 0.7809 | 0.6009 | 0.5315 | 0.3926 | 0.4051 | 0.5053 | 0.8171 | 0.7534 |

| AGE | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.0071 | 0.0378 | 0.0164 | 0.039 | 0.0265 | 0.0543 | 0.0323 | 0.0286 | 0.0055 | 0.0089 |
| 2 | 0.1606 | 0.168 | 0.173 | 0.1994 | 0.285 | 0.3161 | 0.3278 | 0.1634 | 0.1248 | 0.0664 |
| 3 | 0.6852 | 0.4448 | 0.3706 | 0.4815 | 0.7547 | 0.6896 | 0.934 | 0.7001 | 0.4045 | 0.3894 |
| 4 | 1.2721 | 0.9732 | 0.5131 | 0.594 | 1.0062 | 0.9698 | 1.5705 | 1.051 | 0.8588 | 0.6056 |
| 5 | 1.3767 | 1.0498 | 0.8859 | 0.5526 | 1.1011 | 1.3775 | 1.8079 | 1.0596 | 0.7771 | 1.4445 |
| 6 | 1.0112 | 0.6557 | 0.8273 | 0.7246 | 0.736 | 0.9636 | 1.8601 | 1.2097 | 0.7825 | 0.5946 |
| +gp | 1.0112 | 0.6557 | 0.8273 | 0.7246 | 0.736 | 0.9636 | 1.8601 | 1.2097 | 0.7825 | 0.5946 |
| FBAR 2–5 | 0.8737 | 0.659 | 0.4856 | 0.4569 | 0.7867 | 0.8382 | 1.1601 | 0.7435 | 0.5413 | 0.6265 |

**Table 7.15.12. Whiting in Divisions VIIe–k. Stock number-at-age ('000).**

| AGE | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 62046 | 50257 | 53997 | 71465 | 133034 | 105422 | 33073 | 55007 | 108374 |
| 1 | 28887 | 50799 | 41147 | 44209 | 58511 | 108919 | 86312 | 27078 | 45036 |
| 2 | 29860 | 21277 | 36282 | 31106 | 32849 | 44494 | 83767 | 68572 | 21625 |
| 3 | 16784 | 13116 | 8389 | 12835 | 11408 | 13180 | 18897 | 44351 | 40708 |
| 4 | 7108 | 4818 | 2542 | 2618 | 3265 | 3490 | 2806 | 5156 | 14375 |
| 5 | 1297 | 1690 | 875 | 439 | 895 | 781 | 626 | 522 | 1092 |
| 6 | 64 | 266 | 190 | 157 | 98 | 232 | 108 | 142 | 121 |
| +gp | 35 | 13 | 41 | 53 | 72 | 123 | 32 | 56 | 40 |
| TOTAL | 146082 | 142237 | 143463 | 162882 | 240131 | 276642 | 225620 | 200883 | 231370 |

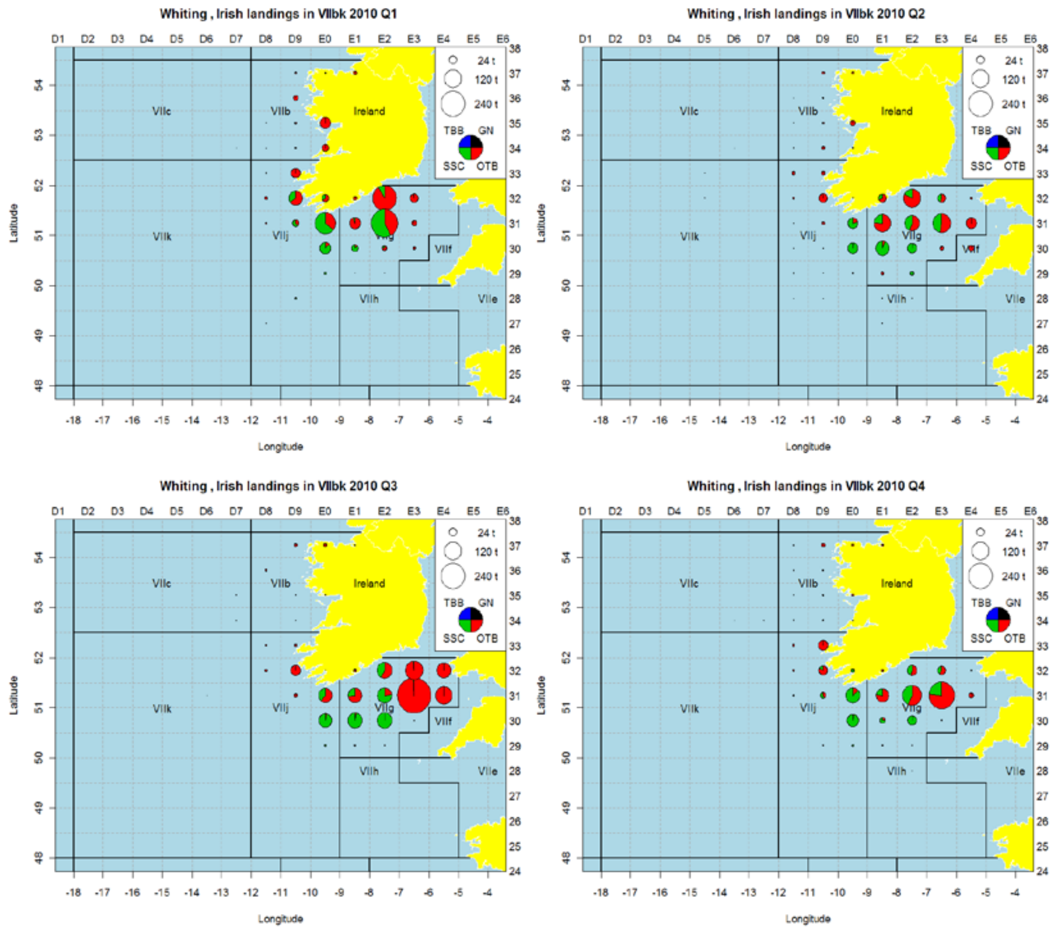
| AGE | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 163335 | 145774 | 193541 | 107379 | 63215 | 58626 | 56796 | 66012 | 134277 | 64022 |
| 1 | 88729 | 133727 | 119349 | 158458 | 87914 | 51756 | 47999 | 46501 | 54046 | 109936 |
| 2 | 33914 | 65100 | 104995 | 95630 | 128584 | 71489 | 41157 | 38747 | 37002 | 40482 |
| 3 | 9336 | 16911 | 34738 | 65806 | 65528 | 91647 | 51769 | 29669 | 25679 | 21045 |
| 4 | 15677 | 2596 | 5523 | 12209 | 30909 | 33876 | 58943 | 31767 | 14394 | 9764 |
| 5 | 3939 | 2210 | 841 | 1962 | 4418 | 12510 | 16108 | 29068 | 14465 | 4179 |
| 6 | 216 | 782 | 656 | 212 | 684 | 1588 | 5278 | 6563 | 11819 | 3941 |
| +gp | 4 | 69 | 290 | 273 | 200 | 230 | 1342 | 1995 | 2131 | 3594 |
| TOTAL | 315150 | 367169 | 459933 | 441929 | 381452 | 321722 | 279392 | 250322 | 293812 | 256963 |

| AGE | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 38799 | 38393 | 42647 | 39621 | 34864 | 41910 | 60665 | 84026 | 80709 | 24142 | 0 |
| 1 | 52417 | 31766 | 31433 | 34916 | 32439 | 28544 | 34313 | 49668 | 68795 | 66079 | 19766 |
| 2 | 86773 | 42611 | 25042 | 25317 | 27493 | 25864 | 22134 | 27199 | 39517 | 56016 | 53622 |
| 3 | 24678 | 60505 | 29493 | 17246 | 16981 | 16928 | 15437 | 13057 | 18912 | 28559 | 42914 |
| 4 | 7885 | 10182 | 31750 | 16669 | 8724 | 6537 | 6954 | 4967 | 5308 | 10332 | 15840 |
| 5 | 3047 | 1809 | 3150 | 15562 | 7535 | 2612 | 2029 | 1184 | 1422 | 1841 | 4617 |
| 6 | 1294 | 630 | 518 | 1063 | 7332 | 2051 | 539 | 272 | 336 | 535 | 356 |
| +gp | 469 | 143 | 39 | 146 | 308 | 1020 | 287 | 48 | 72 | 285 | 371 |
| TOTAL | 215361 | 186038 | 164072 | 150541 | 135677 | 125466 | 142359 | 180421 | 215070 | 187789 | 137485 |

**Table 7.15.13. Whiting in Divisions VIIe–k. Summary table.**

| | RECRUITS | TOTALBIO | TOTSPBIO | LANDINGS | YIELD/SSB | FBAR 2- 5 |
|---|---|---|---|---|---|---|
| | Age 0 | | | | | |
| 1982 | 62046 | 22648 | 18983 | 11225 | 0.5913 | 1.0732 |
| 1983 | 50257 | 22821 | 16988 | 11781 | 0.6935 | 1.4158 |
| 1984 | 53997 | 23398 | 17511 | 9985 | 0.5702 | 1.2196 |
| 1985 | 71465 | 23313 | 17576 | 10838 | 0.6166 | 1.0368 |
| 1986 | 133034 | 26073 | 18631 | 9952 | 0.5342 | 1.0191 |
| 1987 | 105422 | 37568 | 25014 | 12652 | 0.5058 | 1.3245 |
| 1988 | 33073 | 45762 | 33779 | 15128 | 0.4479 | 1.0748 |
| 1989 | 55007 | 39533 | 34797 | 16541 | 0.4754 | 0.9665 |
| 1990 | 108374 | 32753 | 27468 | 14106 | 0.5135 | 0.9772 |
| 1991 | 163335 | 33336 | 24231 | 13508 | 0.5575 | 1.1879 |
| 1992 | 145774 | 48233 | 32326 | 12364 | 0.3825 | 0.8224 |
| 1993 | 193541 | 61919 | 47054 | 16320 | 0.3468 | 0.7809 |
| 1994 | 107379 | 82229 | 62601 | 20034 | 0.32 | 0.6009 |
| 1995 | 63215 | 84112 | 74617 | 22678 | 0.3039 | 0.5315 |
| 1996 | 58626 | 79265 | 72727 | 18260 | 0.2511 | 0.3926 |
| 1997 | 56796 | 67573 | 62951 | 20532 | 0.3262 | 0.4051 |
| 1998 | 66012 | 55303 | 49975 | 19245 | 0.3851 | 0.5053 |
| 1999 | 134277 | 44137 | 39394 | 19915 | 0.5055 | 0.8171 |
| 2000 | 64022 | 45413 | 34611 | 14865 | 0.4295 | 0.7534 |
| 2001 | 38799 | 48124 | 39927 | 12770 | 0.3198 | 0.8737 |
| 2002 | 38393 | 45207 | 40143 | 13146 | 0.3275 | 0.659 |
| 2003 | 42647 | 37875 | 33442 | 10583 | 0.3165 | 0.4856 |
| 2004 | 39621 | 34706 | 30376 | 9953 | 0.3277 | 0.4569 |
| 2005 | 34864 | 30958 | 26927 | 12030 | 0.4468 | 0.7867 |
| 2006 | 41910 | 26317 | 22408 | 9533 | 0.4254 | 0.8382 |
| 2007 | 60665 | 25482 | 20479 | 8947 | 0.4369 | 1.1601 |
| 2008 | 84026 | 28309 | 20542 | 5737 | 0.2793 | 0.7435 |
| 2009 | 80709 | 41479 | 29198 | 6386 | 0.2187 | 0.5413 |
| 2010 | 24142 | 55327 | 41905 | 8451 | 0.2017 | 0.6265 |
| | | | | | | |
| GeoMean | 66471.06 | | | | | |
| ArithMean | 76256 | | | | | |

**Irish landings for the main gear types by quarter in 2010:**



**UK (E&W) whiting landings for all gears 2010:**

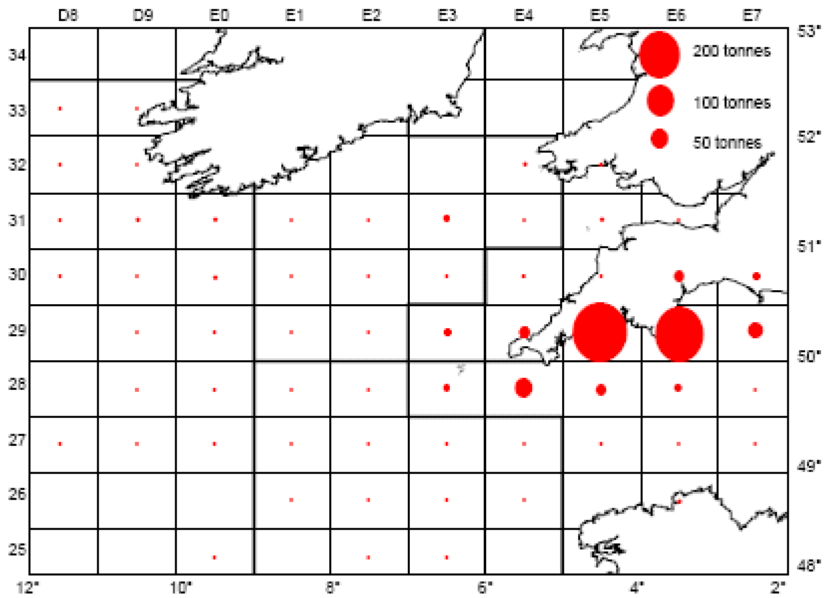



**Figure 7.15.1. Whiting in VIIe–k (Celtic Sea). The spatial and temporal distribution of UK landings data in 2010 available to the WG.**

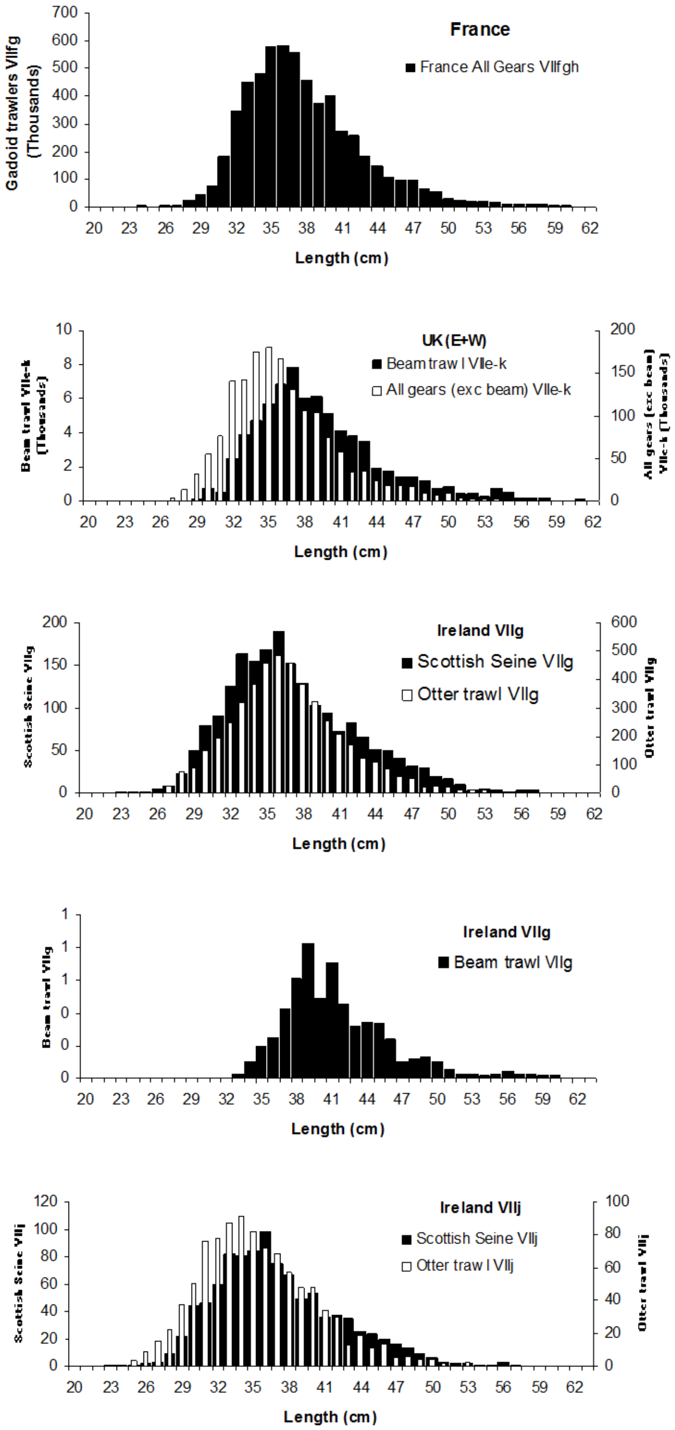
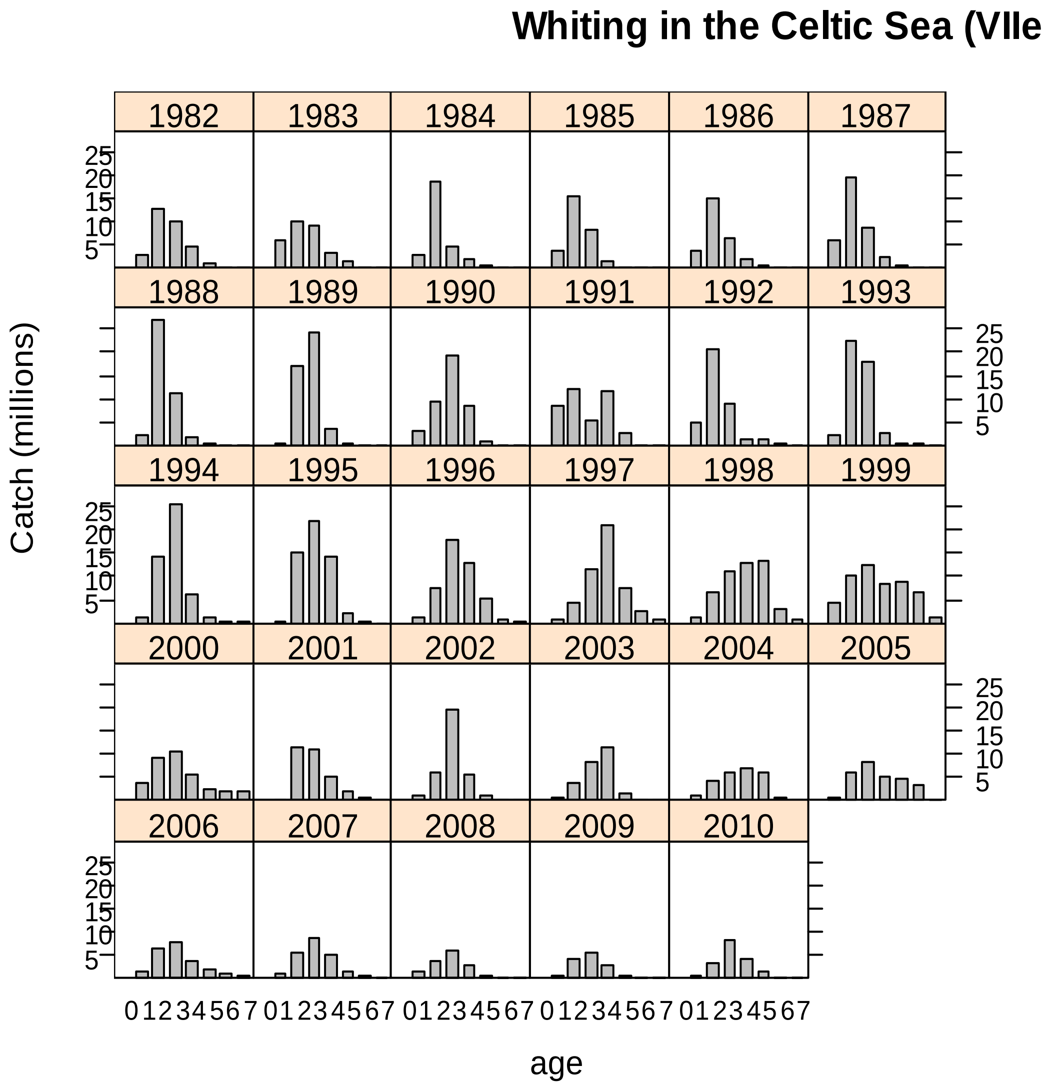



**Figure 7.15.2. Whiting in VIIe–k (Celtic Sea). 2010 length compositions (raised numbers) of French, UK and Irish fleets.**

**(a)**


Whiting in the Celtic Sea (VIIe
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Catch (millions)
5
10
15
20
25
0 1 2 3 4 5 6 7
age

**(b)**

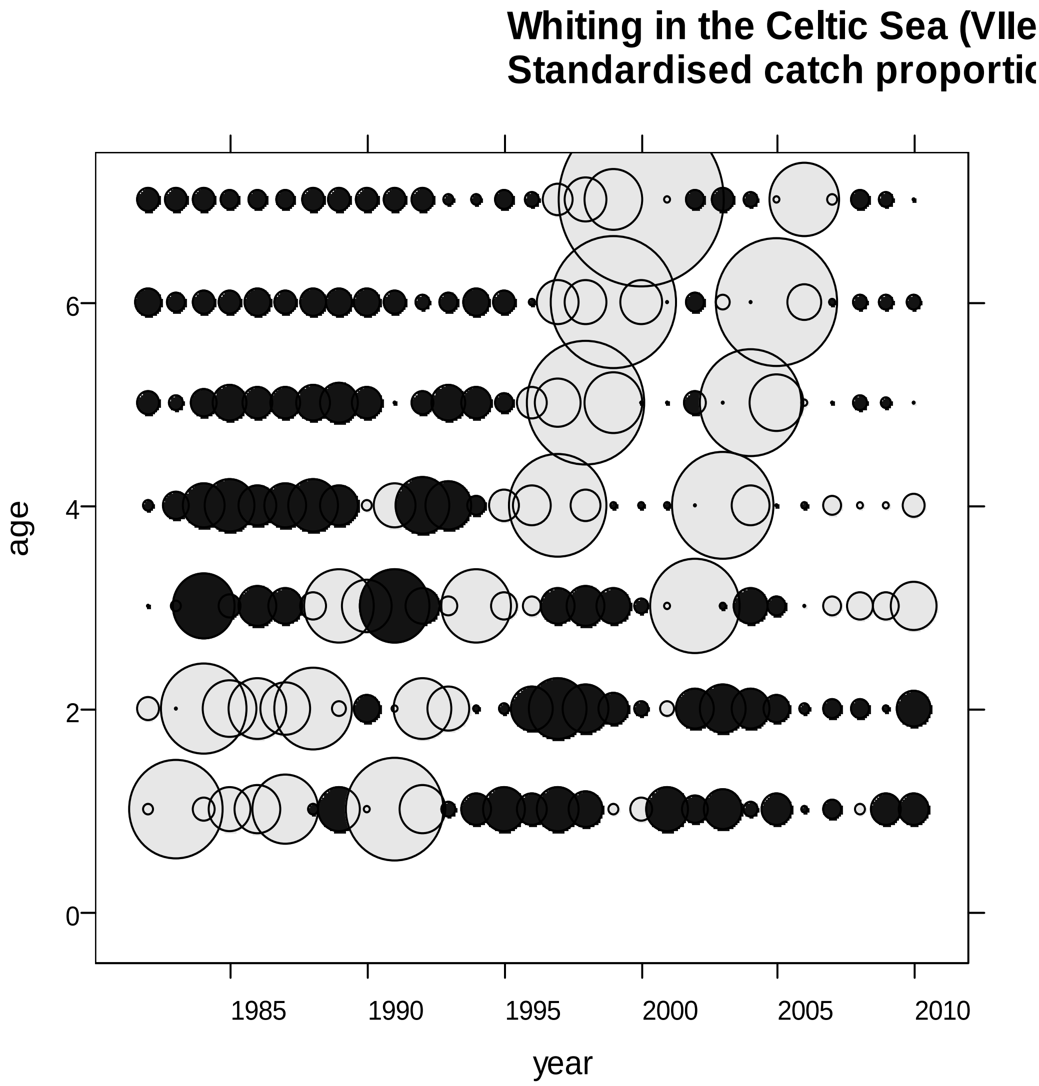



**Figure 7.15.3. Whiting in VIIe–k (Celtic Sea). Annual landings age composition (a) and standardized catch proportions-at-age (b).**

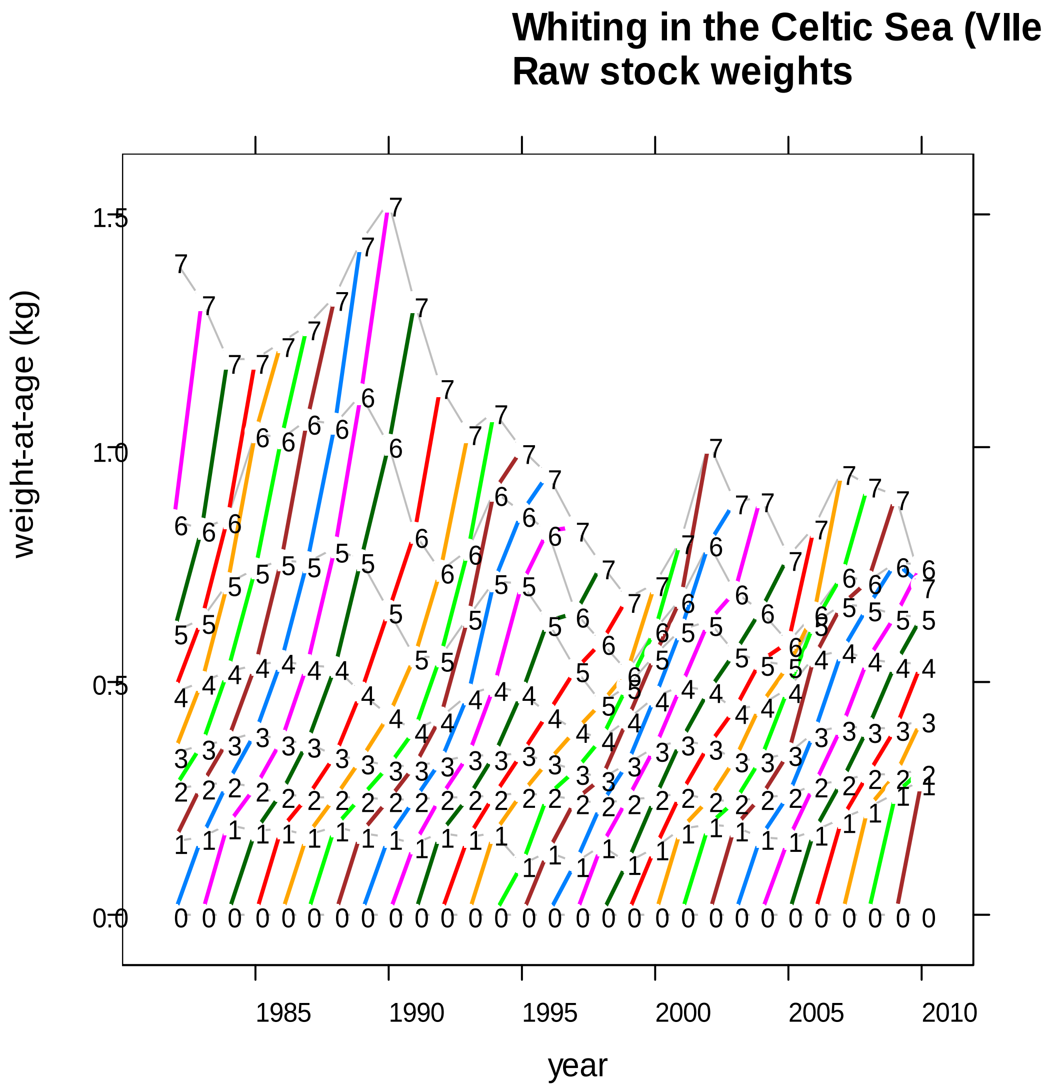



**Figure 7.15.4. Whiting in VIIe–k (Celtic Sea). Stock weights-at-age.**

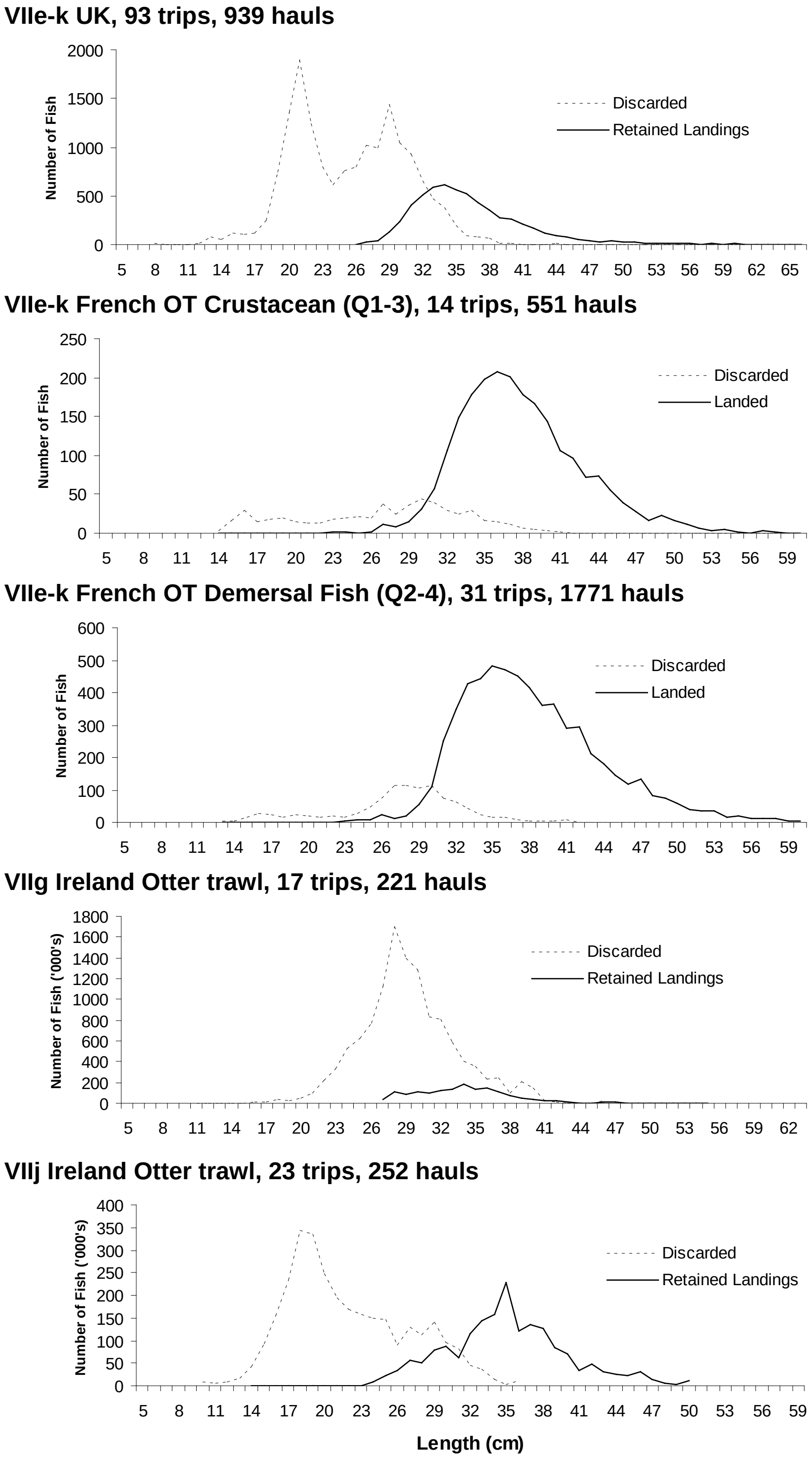



**Figure 7.15.5. Whiting in VIIe–k (Celtic Sea). 2010 Annual length compositions of Irish, UK and French discards. Numbers are raised to the sampled catch for the UK and are raised by trip to the fleet for Ireland and are unraised sampled lengths for France.**

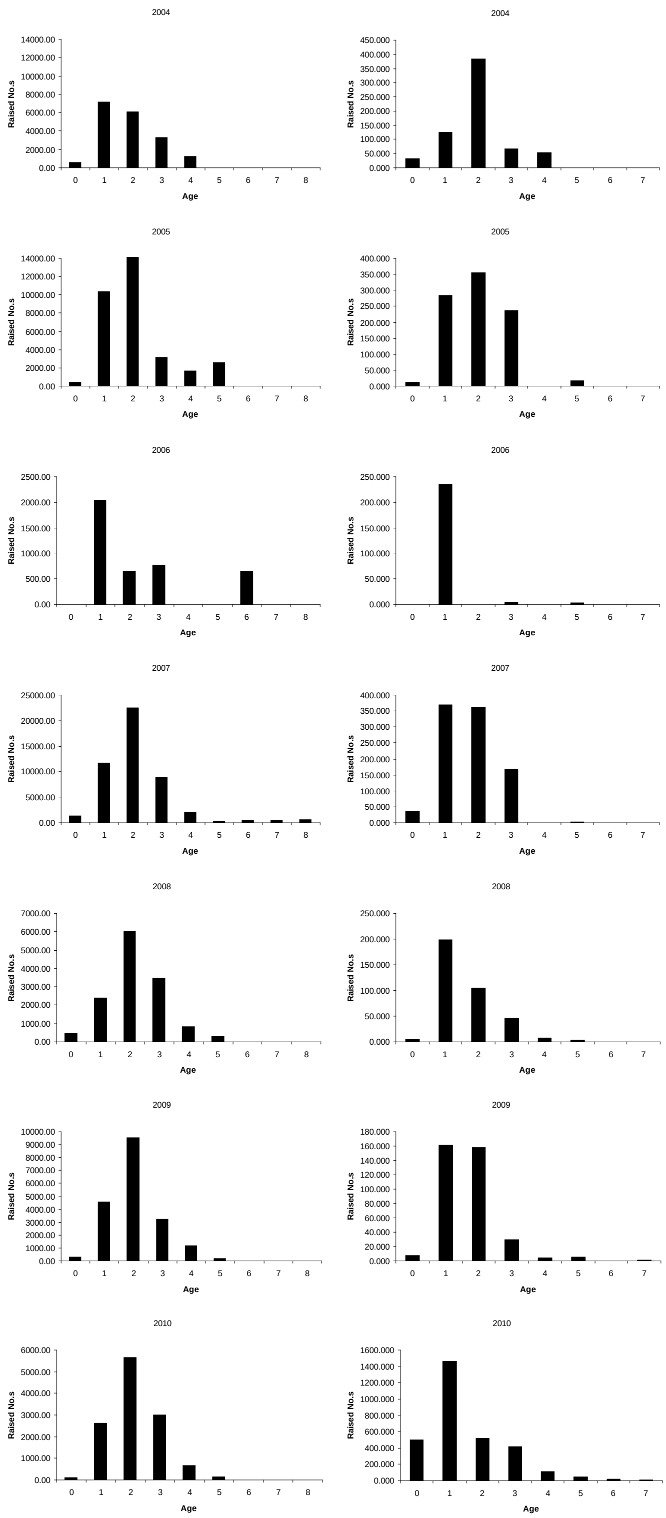
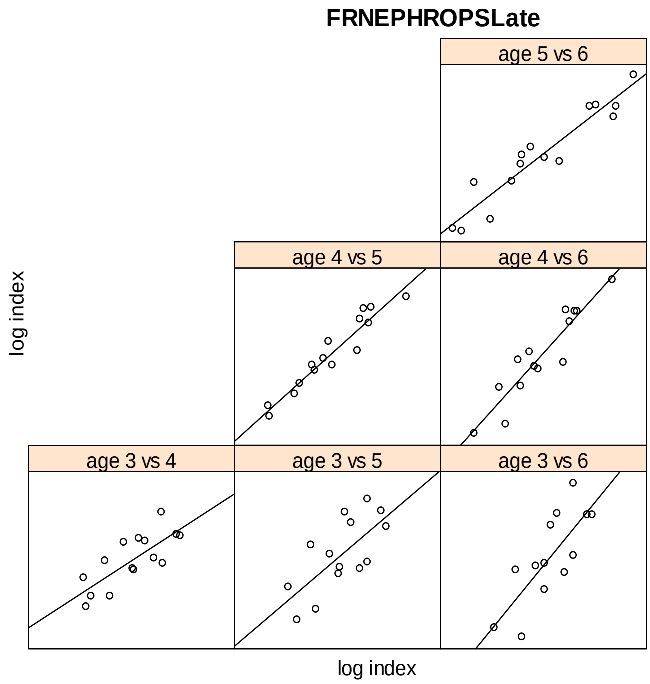
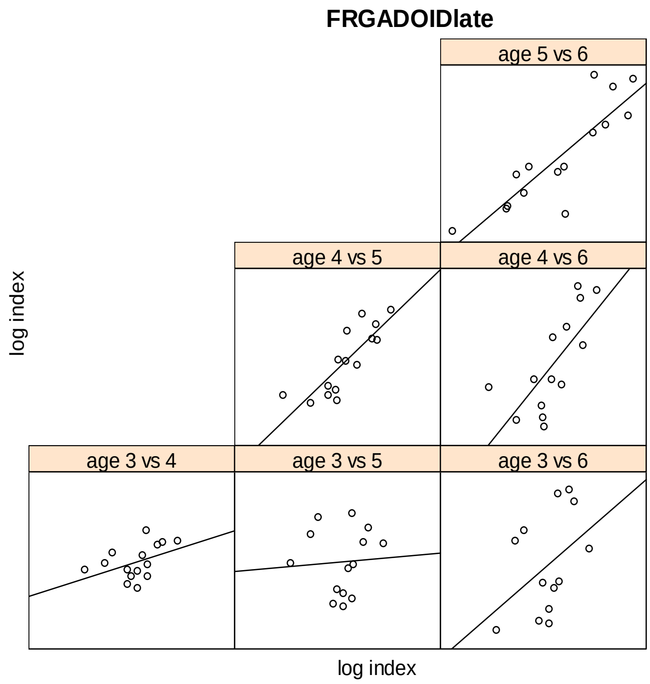


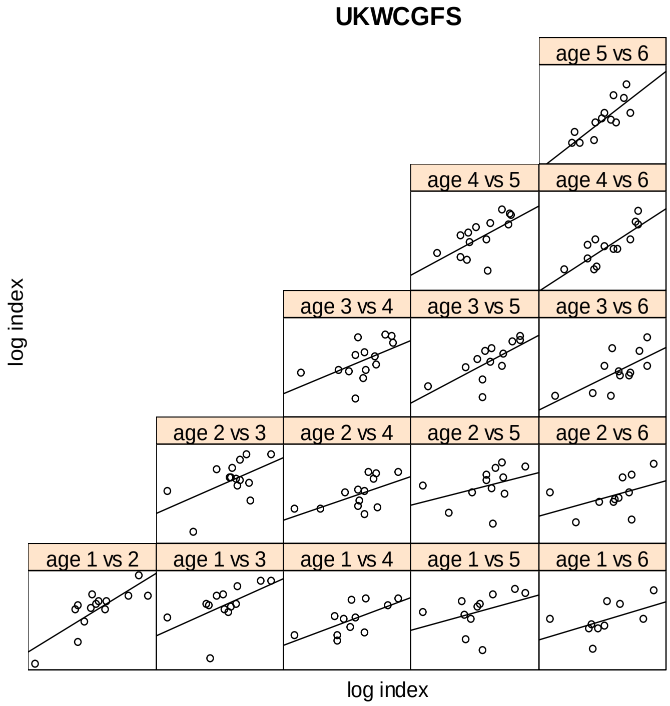

**Figure 7.15.6. Whiting in VIIe–k (Celtic Sea). Age Composition of Discards from Irish otter board trawlers 2004–2010 in VIIg (left) and VIIj (right).**

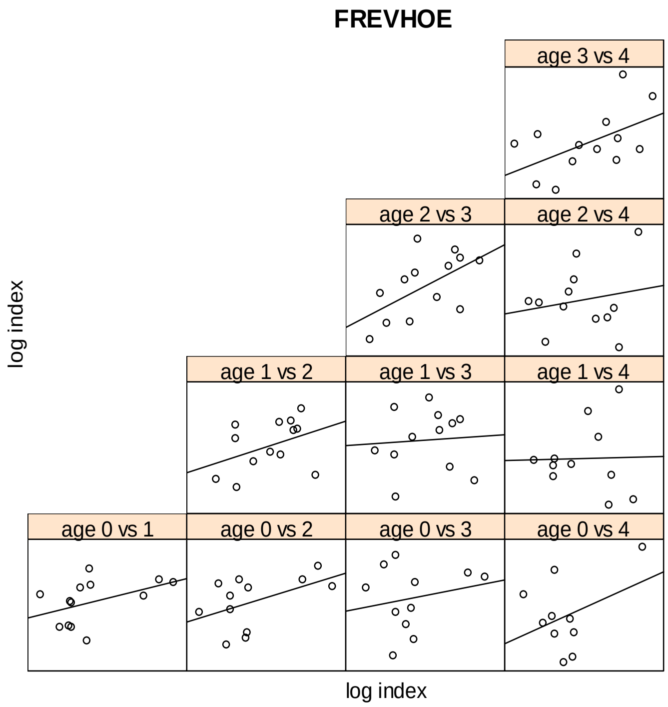
(A)


FRNEPHROPSLate
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
log index
log index

(B)


FRGADOIDlate
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
log index
log index


UKWCGFS
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
age 2 vs 3
age 2 vs 4
age 2 vs 5
age 2 vs 6
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 1 vs 5
age 1 vs 6
log index
log index


FREVHOE
age 3 vs 4
age 2 vs 3
age 2 vs 4
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 0 vs 1
age 0 vs 2
age 0 vs 3
age 0 vs 4
log index
log index

**(b) Cont.**

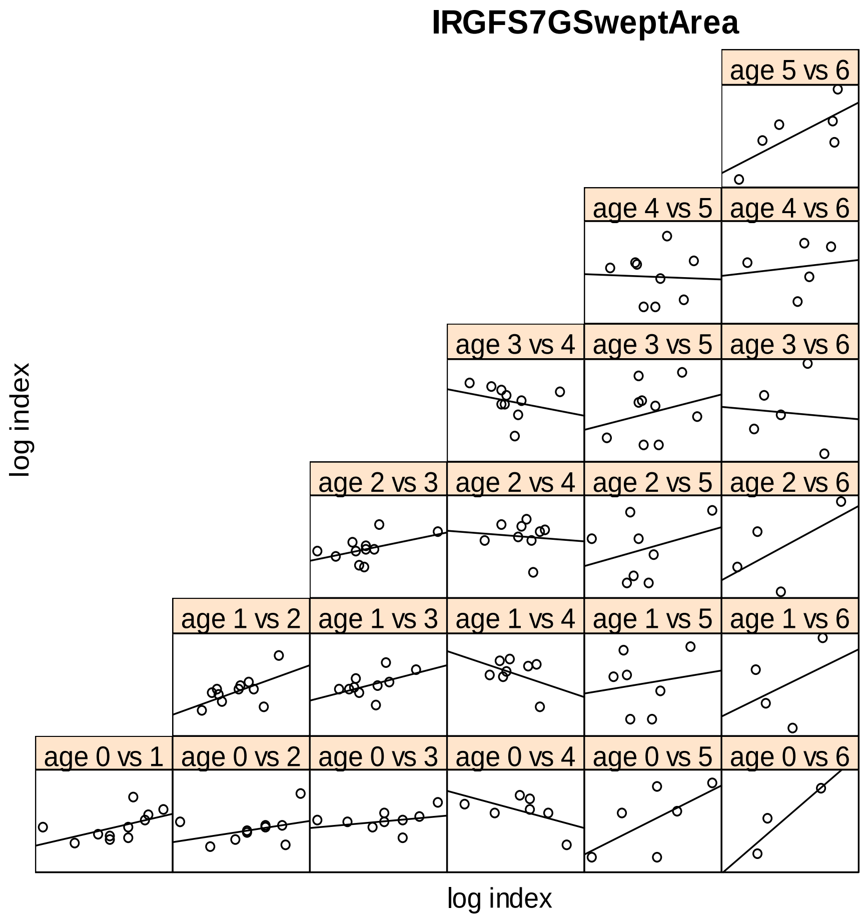
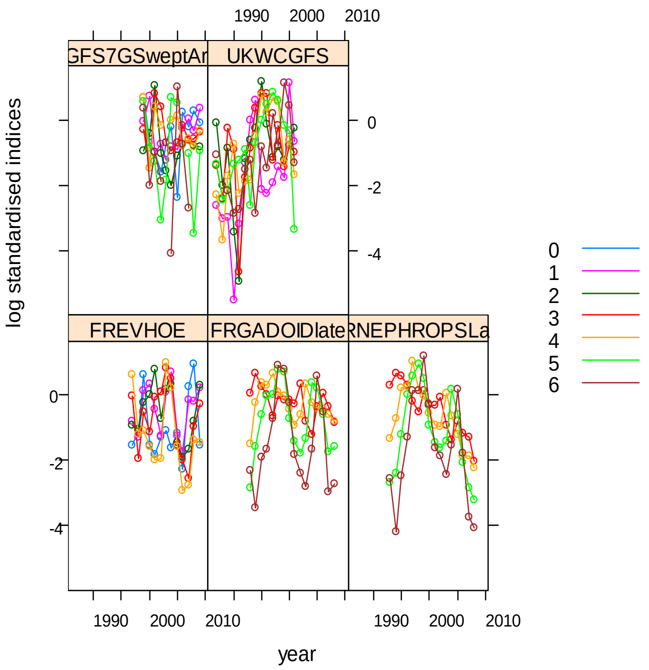
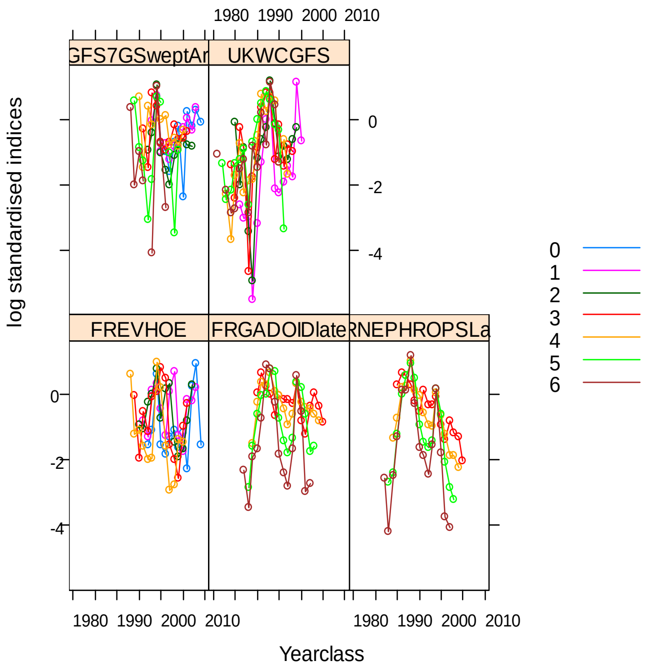



**Figure 7.15.7. Whiting in VIIe–k (Celtic Sea). Pairwise scatterplots for the log numbers-at-age for the main tuning fleets to examine internal constancy of the indices (a) commercial fleets and (b) surveys.**




a)




b)

**Figure 7.15.8. Whiting in VIIe–k (Celtic Sea). Mean log standardized plots of indices by (a) age and year, and (b) age and cohort.**

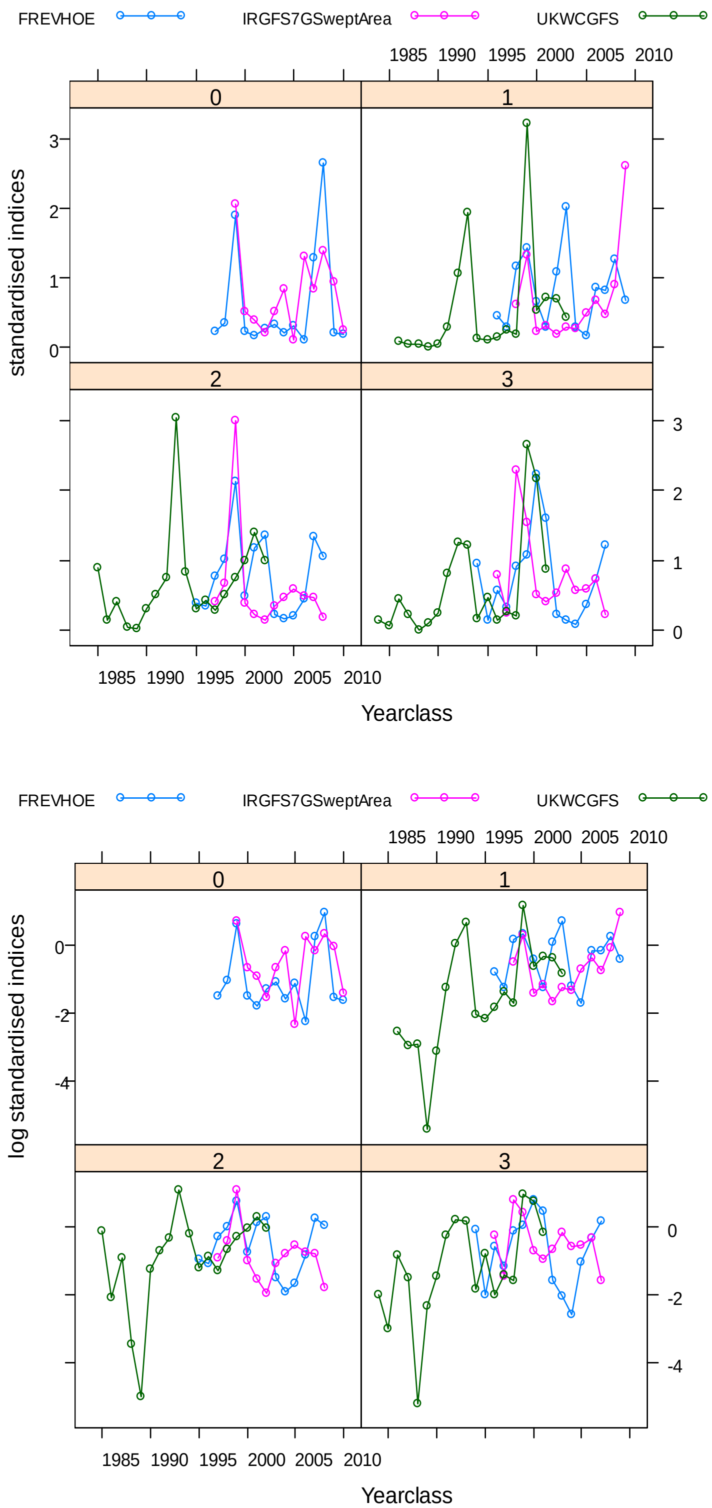



**Figure 7.15.9. Whiting in VIIe–k (Celtic Sea). (a) standardized and (b) log standardized plots of survey indices used within the assessment for younger ages (0–2) by cohort.**

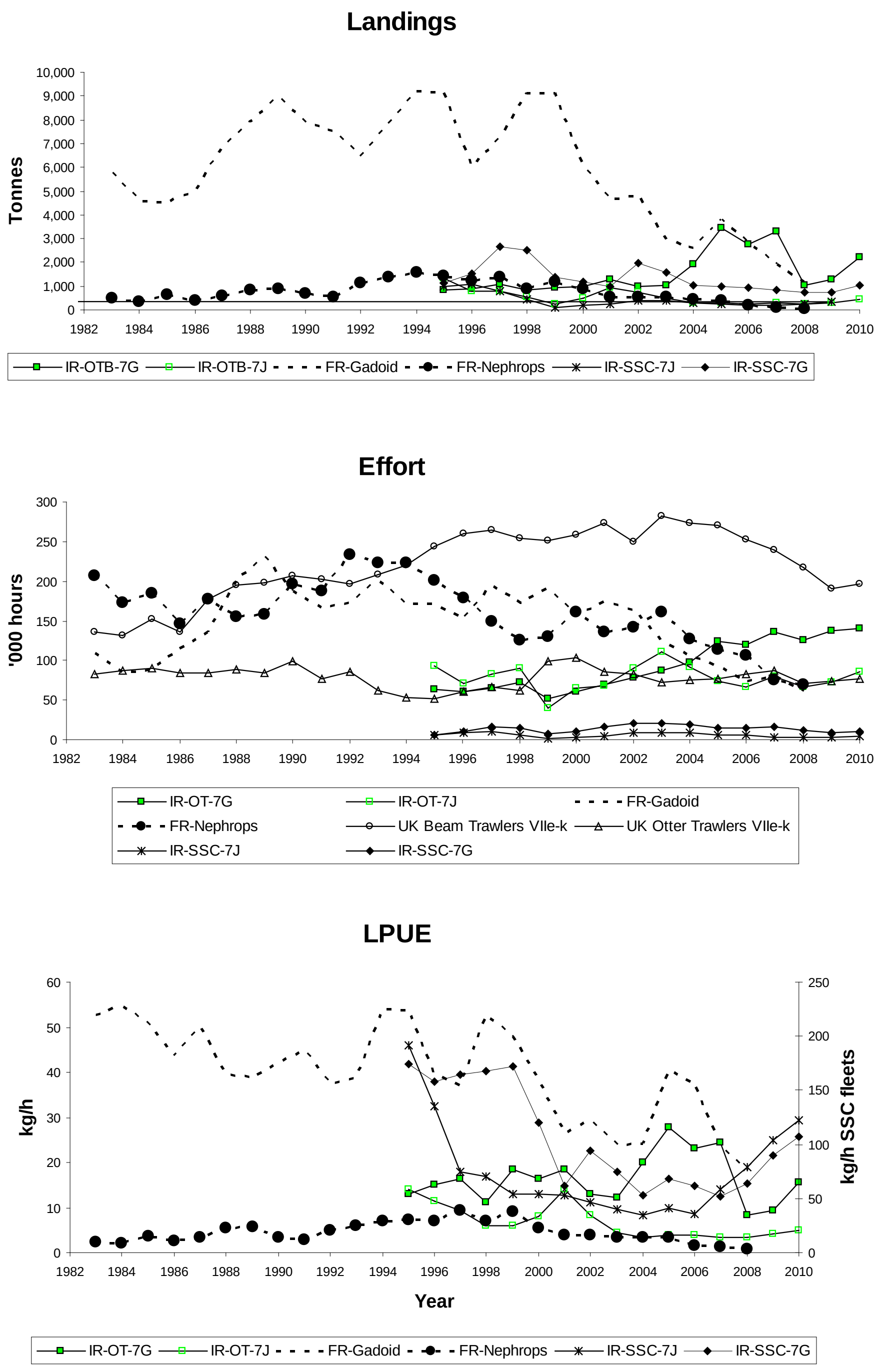



**Figure 7.15.10. Whiting in VIIe–k (Celtic Sea). Landings, Effort and Landings per Unit Effort (lpue) for some fleets landing whiting. For the UK fleets Effort is GRT corrected.**

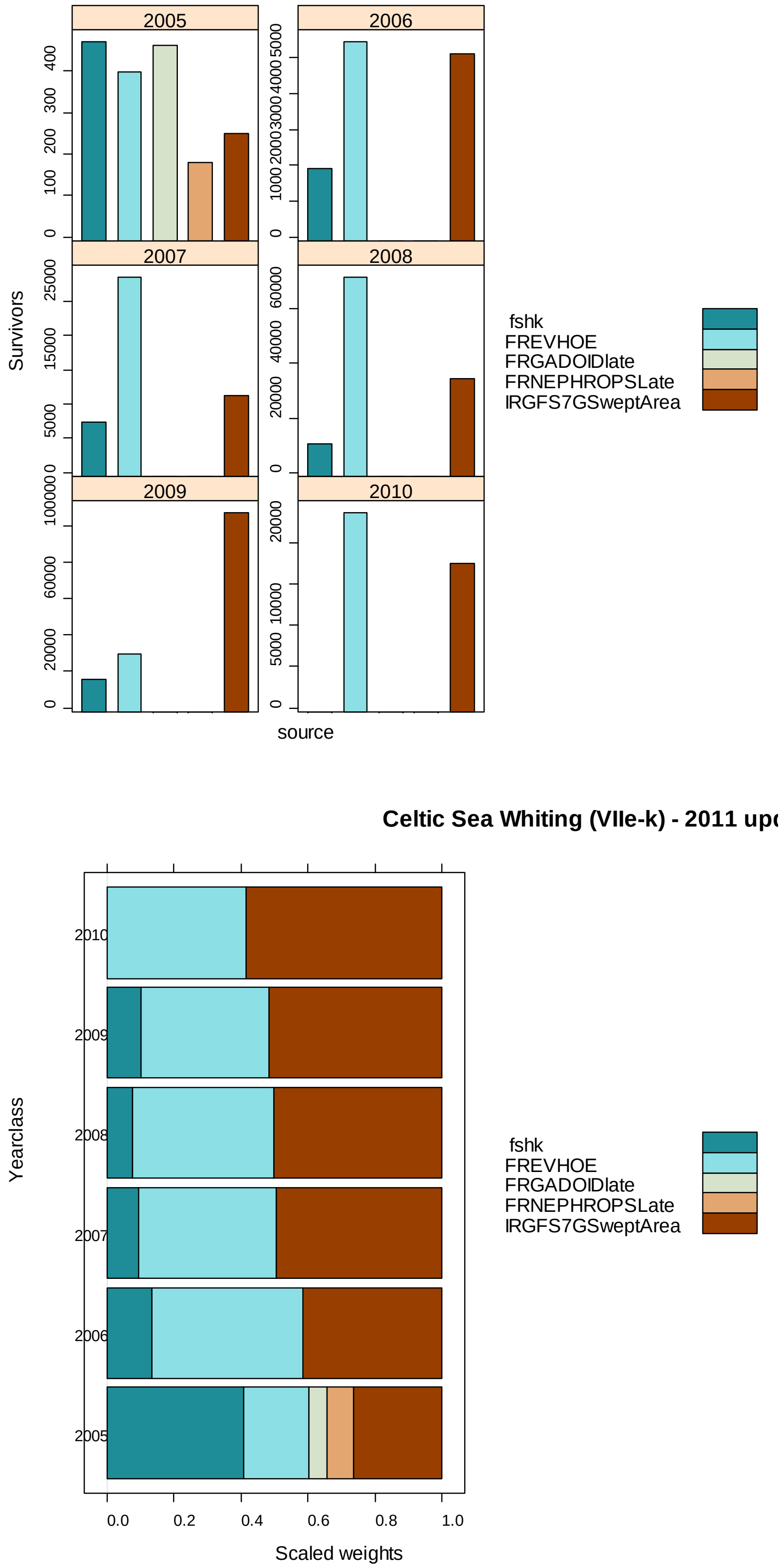
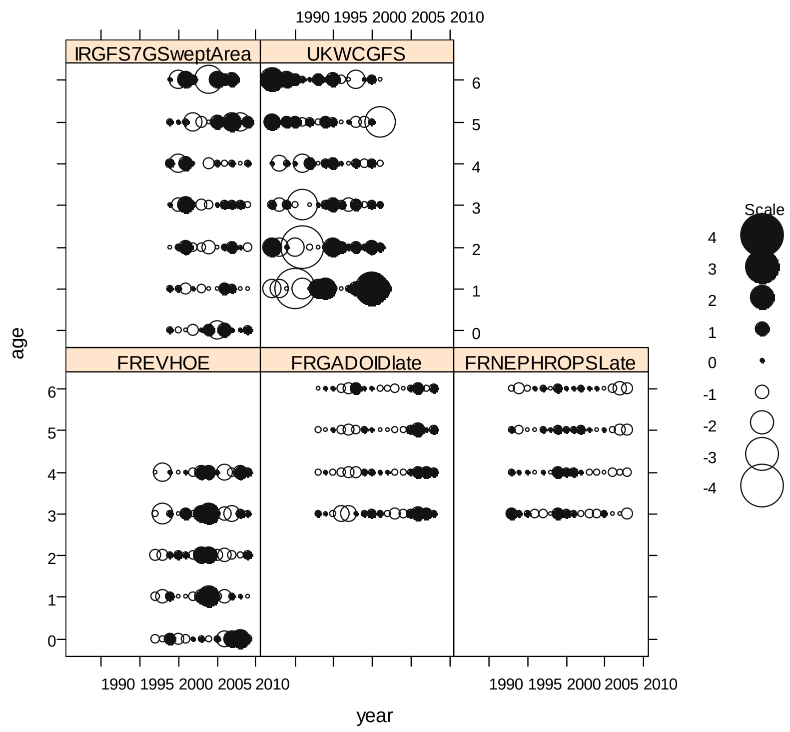



**Figure 7.15.11. Whiting in VIIe–k (Celtic Sea). The survivor estimate weightings given by all fleets.**

**(a)**




**(b)**

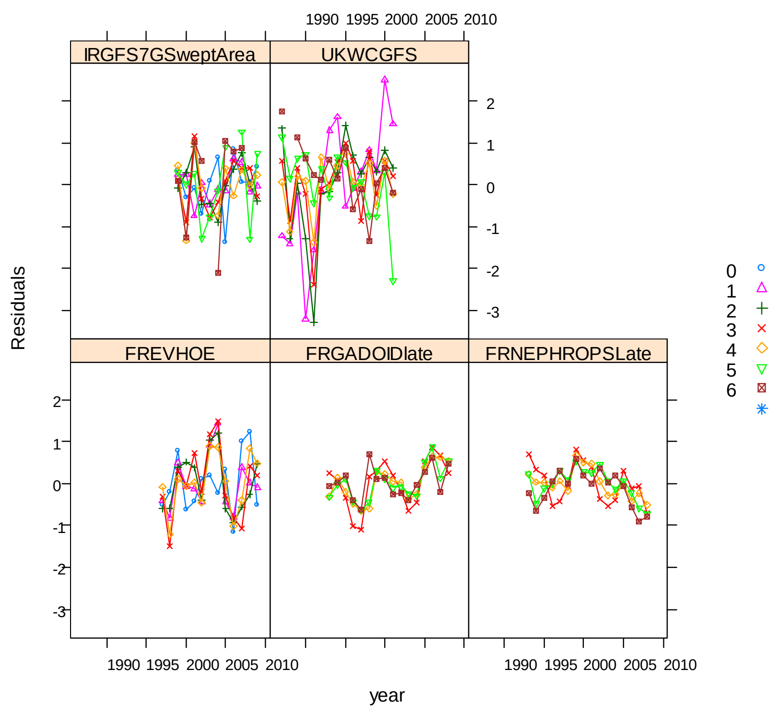



**Figure 7.15.12. Whiting in VIIe–k (Celtic Sea). Log fleet catchability residuals bubble (a) and line (b) plots.**

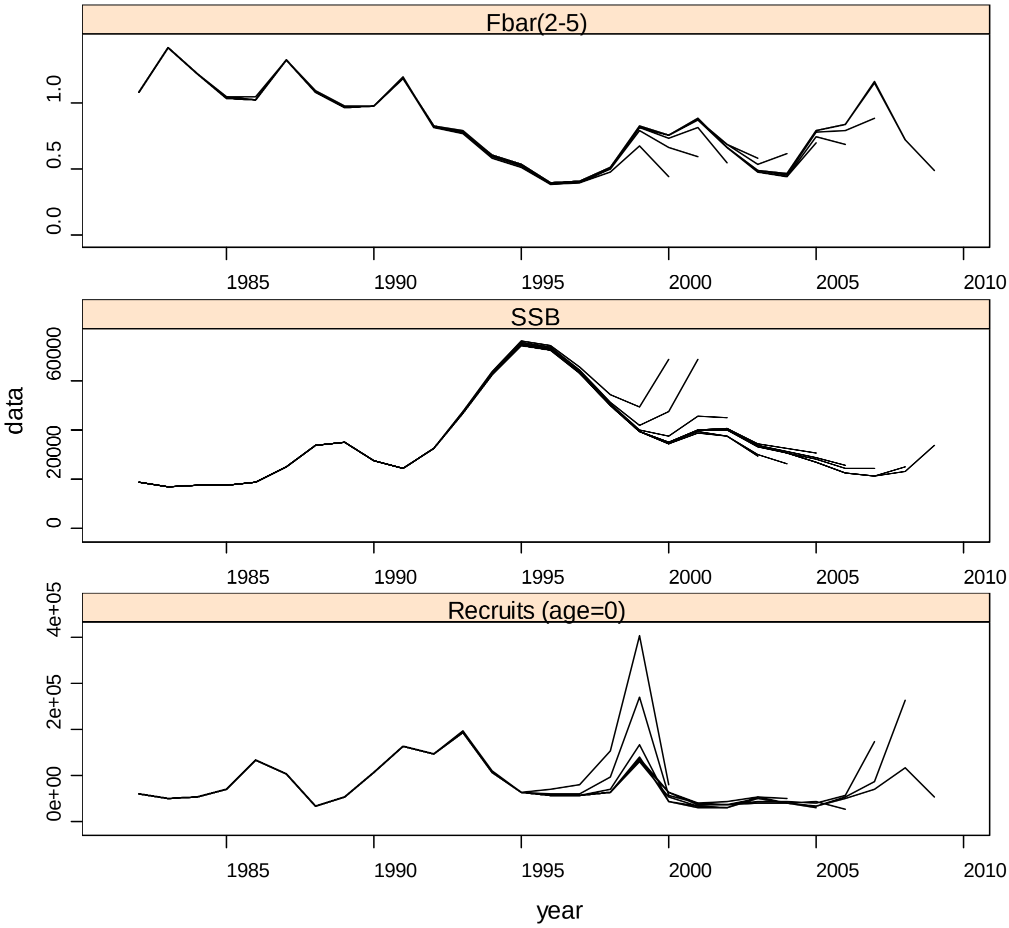



**Figure 7.15.13. Whiting in VIIe–k (Celtic Sea). Retrospective analysis.**

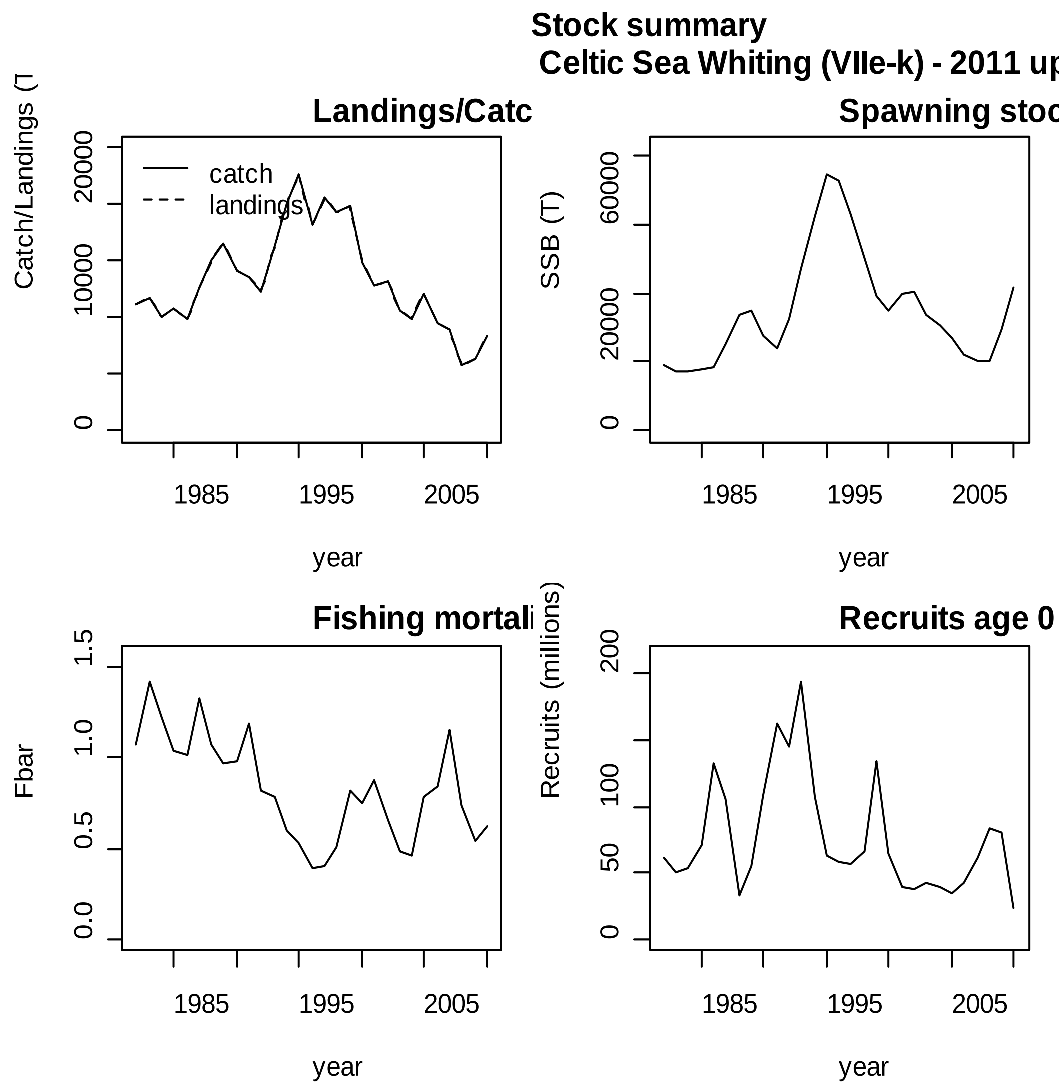



**Figure 7.15.14. Whiting in VIIe–k (Celtic Sea). Stock summary.**

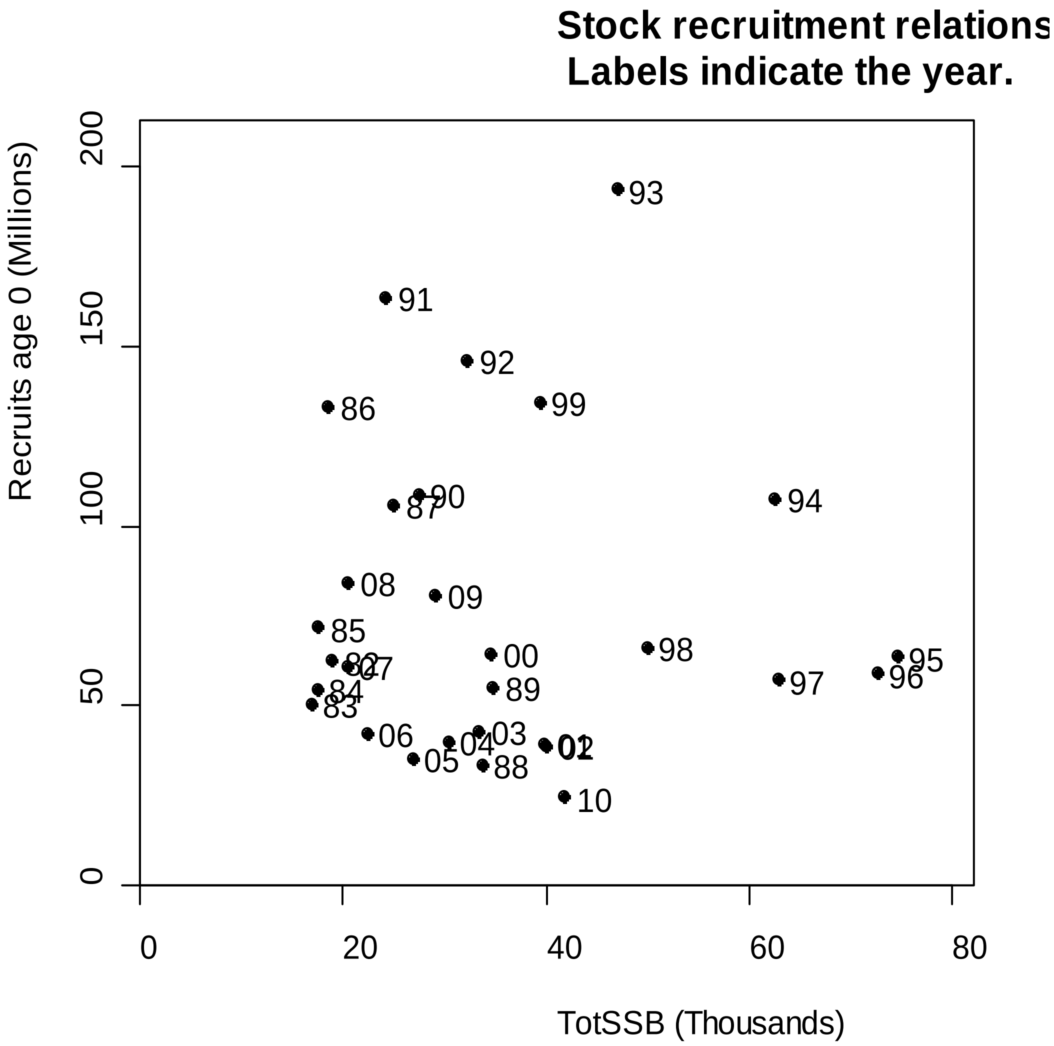



**Figure 7.15.16. Whiting in VIIe–k (Celtic Sea). Stock–recruitment relationship.**

## 7.16 Whiting in Divisions VIIb, c

### Type of assessment

No assessment.

The nominal landings are given in Table 7.16.1.

**Table 7.16.1. Nominal Landings (t) of Whiting in Division VIIb,c for 1995–2010.**

| Country | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | |
| France | 57 | 76 | 65 | 37* | …1* | 107 | 114 | 111 | 92 | 59 | 102 | 62 | 32 | 26 | 32 | 70 |
| Ireland | 1894 | 1233 | 403 | 323 | 206 | 563 | 357 | 386 | 423 | 135 | 65 | 49 | 100 | 76.0 | 94 | 143 |
| Netherlands | - | - | - | - | - | - | 2 | - | 3 | - | 2 | - | - | - | - | - |
| Spain | + | + | - | 27 | 1 | 4 | - | 6 | - | 31 | 18 | 19 | 1 | 4 | - | - |
| UK(E/W/NI) | 24 | 96 | 75 | 49 | 10 | 6 | 5 | 4 | 5 | 1 | 11 | 5 | 1 | 1 | 2 | 0.4 |
| UK(Scotland) | 71 | 17 | 4 | 27 | - | 19 | 1 | + | - | - | - | - | - | - | - | - |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| Total | 2046 | 1422 | 547 | 463 | 217 | 699 | 479 | 507 | 523 | 226 | 198 | 135 | 134 | 107 | 128 | 214 |

*** See VIIg–k.**

**[a] provisional.**

## 8.2 Plaice in the Western Channel (ICES Divisions VIIe)

### Type of assessment in 2011

Update assessment with no changes to the assessment settings as agreed at the Benchmark assessment meeting (WKFLAT 2010) held in February 2010.

### ICES advice applicable to 2010

Exploitation boundaries in relation to precautionary limits: Given the low stock size, recent poor recruitment, high fishing mortality, the uncertainty in the assessment, and the inability to reliably forecast catch, ICES recommends a substantial reduction in catch until the estimate of SSB is above $B_{pa}$ or other strong evidence of rebuilding is observed.

### ICES advice applicable to 2011

Following the ICES MSY framework implies fishing mortality to be reduced to 0.18 (6% lower than $F_{MSY}$ because SSB is 6% below MSY $B_{trigger}$), resulting in landings of 480 t in 2011. This is expected to lead to an SSB of 2980 t 2012.

Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced following (0.8*F(2010)+0.2$F_{MSY}$*SSB(2011)*MSY $B_{trigger}$) corresponding to F of 0.39 for 2011. This results in landings of 950 t in 2011. This is expected to lead to an SSB of 2530 t in 2012.

### Stock status

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | above | above | above |
| $F_{PA}$ | above | above | below |

| Spawning-Stock Biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | below | below | below |
| $B_{PA}$/$B_{lim}$ | between | between | between |

### Technical comments made by the Review Group (RGCS)

The upward adjustment of SSB throughout the series caused by the addition of VIId data means that the basis for the previous $B_{lim}$ and $B_{pa}$ is no longer valid. A revision to the precautionary reference points is needed if these are to be retained for the stock. The $B_{lim}$ value now lies below all historic SSB values in the assessment (see Figure 8.2.11). Alternative reference points are considered in the Stock Annex but the old values continue to be added to the biomass and stock–recruit plots which are misleading.

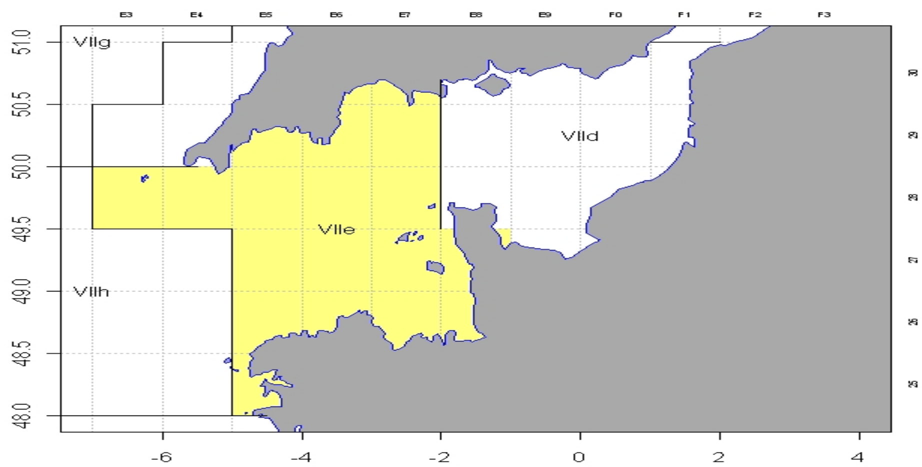
WKFLAT 2010 examined the stock dynamics provided by the migration model to determine appropriate biological reference points for this stock on the basis of the new assessment. It concluded that the historical reference points for this stock were no longer appropriate as the new assessment indicated significant changes to the historical perspective of the stock caused by the inclusion of catches from VIId in the VIIe plaice stock. The Group could not come to a consensus with regards to suitable precautionary reference points but clearly stated that $F_{sq}$ is currently too high and should be reduced, while biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly under-stood.

The Working Group agreed with these points, and given that the advice for this stock is now given on the basis of the ICES Maximum Sustainable Yield (MSY) framework, deemed it inappropriate to propose alternate PA reference points at this time. These MSY reference levels have been added to the biomass and stock–recruits plots in this assessment report to remove the potential misinterpretation.

### 8.2.1 General

#### Stock description and management units

The management area for this stock is strictly that for ICES Area VIIe called the Western English Channel. The TAC area does not correspond to the stock area as it includes the larger component of VIId (Eastern English Channel). However, as determined by WKFLAT 2010, a significant proportion of the catches of the VIIe stock are taken in the adjacent area during the time of spawning. Plaice is not the target species in VIIe, and it is generally caught as a bycatch by the sole and anglerfish directed fleets.




**TAC area = VIId+e; Assessment area = VIIe.**

#### Management applicable to 2010 and 2011

There are technical measures in operation including a minimum 80 mm mesh size and a MLS (27 cm) for this species.

#### The TAC and the national quotas by country for 2010

| Species: | Plaice *Pleuronectes platessa* | Zone: | VIId and VIIe (PLE/7DE.) |
|---|---|---|---|
| Belgium | 699 | | |
| France | 2 332 | | |
| United Kingdom | 1 243 | | |
| EU | 4 274 | | |
| TAC | 4 274 | | Analytical TAC |

In addition, Annex IIc, restricts the number of days-at-sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet.

#### The TAC and the national quotas by country for 2011

| Species: Plaice *Pleuronectes platessa* | | Zone: VIId and VIIe (PLE/7DE.) |
|---|---|---|
| Belgium | 763 | |
| France | 2 545 | |
| United Kingdom | 1 357 | |
| EU | 4 665 | |
| TAC | 4 665 | Analytical TAC |

In addition, Annex IIc, restricts the number of days-at-sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet.

#### The fishery in 2010

A full description of the fishery is provided in the Stock Annex, Section A2.

In the western English Channel plaice are taken mainly as a bycatch in beam trawls directed at sole and anglerfish. In 2010, the UK beam trawl fleet took around 51% of the total landing of this stock with the UK otter trawl fleet taking around 26%. The remainder of the landings are taken by the French fleets (around 20%) and the Belgian fleets (around 5%).

UK otter trawl effort has increased in 2010 following a steady decline and is now at the highest level observed since 2002. The UK beam trawl effort has increased slightly in 2010 following the sharp fall seen the previous year but is still only just above the level observed in 2000.

This stock is the smaller of the two stocks that make up the larger TAC area of VIId,e. The landings from this stock amounted to around 25% of the TAC in 2010 and only 20% of the TAC in 2009.

#### Landings

National landings data reported to ICES, and estimates of total landings used by the Working Group, are given in Table 8.2.1. Total international reported landings in 2010 were 1111 t with Working Group estimates of VIIe plaice landings 3% lower at 1078 t. The Working Group estimate of the 2009 landings was revised upwards due to minor revisions to the landings by UK (E&W), France and UK (Guernsey) and the addition of Netherlands landings data not available last year. These combined additional landings totalled just 7 t making the revised total international landings in 2009 to be 923 t.

Landings increased to levels of 2600 t during the latter half of the 1980s due to a series of good recruitments in 1986–1988, but subsequently dropped to levels fluctuating around 1200 t. The last few years had seen landings fall to under 1000 t, but in 2010 landings increased for the first time since 2006 and is now just under 1100 t. Unallocated landings in recent years, are generally the additional French landings derived from sales note information.

In addition to the estimated 2010 landings for VIIe an extra 149 tonnes was added from the VIId plaice stock representing an adjustment for migration of 15% of quarter 1 between the two stocks. In addition, the 2009 migration adjustment was increased to 142 t, as a result of an increase in the French VIId component. This process was agreed at the Benchmark Assessment meeting in February 2010 and the method is documented in the Stock Annex. A reciprocal correction was made to the VIId stock.

### Data

Sampling levels are detailed Section 2 (Table 2.1).

Annual length compositions of the 2010 UK (E&W) landings (two fleets) and France (five fleets) are provided (Table 8.2.3). Length distributions of UK (E&W) landings from 2001 to 2010 as used by the WG are illustrated in Figure 8.2.3.

Quarterly age compositions for landings in 2010 were available from UK (E&W) only, which accounted for almost 80% of the total reported international landings. Additional age compositions representing the migration adjustment (15% of quarter 1 landings for VIId) were available from UK (E&W), Belgium and France and a small landing (only) for the Netherlands. The method for the derivation of the international catch numbers and the calculation of the catch and stock weights-at-age are fully described in the Stock Annex, Section B1. Catch numbers-at-age landed annually (including migration element) are given in Table 8.2.4 and plotted for 2001 to 2010 in Figure 8.2.4. Catch and stock weights-at-age are given in Tables 8.2.5 and 8.2.6.

Catch weights are plotted as mid-year values; stock weights are interpolated back to January 1st, as standard for this stock. The standard settings used for natural mortality and the proportions of F and M before spawning were used. (See Stock Annex). This is consistent with the procedures developed and agreed at the benchmark workshop held in February 2010.

### Discards

Discards estimates, from the UK (E&W) and French discard sampling programme, are available for the period 2002–2010 (Annual Data Files on ICES network) and indicate that discarding appears to be higher in quarters 1 and 2 in this fishery, but is still low compared to other plaice stocks. This year, in addition to these data, Belgian quarterly discard length frequency data were also available and showed similar discarding ratios to both the UK and France. Quarterly profiles of numbers landed and discarded-at-length, in 2010, are given in Figure 8.2.2.

### Biological

Natural mortality and the maturity ogive used were as in previous assessments and described in the stock annex.

### Surveys

There are currently two surveys that provide abundance estimates to the Working Group. The UK (E&W) commercial beam trawl survey (UK-WEC-BTS) has used the FV Carhelmar for most survey years with the exception being 2002 and 2004, when the RV Corystes was used instead. Detailed information on the survey protocols and area coverage can be found in the Stock Annex.

Table 8.2.7 gives abundance indices as numbers caught per 100 km for age groups 1 to 9 as obtained by UK-WEC-BTS. Strong and weak year classes have been well tracked by this survey in the past. (Figure 8.2.6). This survey takes place in the north of VIIe and its cpue shows a similar but slightly earlier trend to that of the commercial beam trawl fleet lpue in the same area. This difference is likely due to the inclusion of non-recruited year classes in the survey catches that do not appear in the commercial catches. The last two years have seen a large increase in this survey's cpue as a result of large increases in numbers of recent year classes caught. This may be an indication of recently improved recruitments entering the fishery.

Since 2003 the UK Fisheries Science Partnership (FSP: Cefas-UK industry cooperative project) has been conducting a survey using commercial vessels with scientific observers and following a standard grid of stations extending from the Scilly Isles to Lyme Bay (FSP-7e UK). This survey covers a substantially larger area than the UK-WEC-BTS survey and is thought to be more representative of the stock in UK waters.

This dataset was first included in the 2007 assessment, and the exploratory analysis can be seen in that report (ICES, 2007; Section 3.2.5). There have been a number of vessel changes, gear changes and temporal variations in this survey-series, but the survey has performed well in tracking year classes in the past. However, a strong year effect was noticed in 2008 that had a significant impact on the survivor estimates and the 2009 and 2010 Working Groups both excluded these data. These data were excluded once again at the 2011 Working Group.

The FSP-7e survey shows a similar recent trend in cpue to that of the UK-WEC-BTS survey.

#### Commercial fleet effort and lpue

The UK cpue data shows the individual fleets that make up the composite of all otter trawl and all beam trawl fleets that are used in the commercial tuning datasets. Trends in commercial lpue and effort are given in Table 8.2.2 and Figure 8.2.1; more detailed information on the distribution of effort by area and trends in the fishery can be found in the Stock Annex. Lpue in the North of VIIe for both commercial beam and otter trawlers reached a peak in 1988–1990, fell sharply to 1995 and is now at stable but low levels.

Commercial beam trawl lpue in the South and West of VIIe show a general decline from 1990 to 2008 followed by a small upturn in the last few years. Commercial otter trawler lpue shows slow declining trend since 1997 in the west, but shows much more variation throughout the time-series in both the north and south areas.

All lpue time-series show an increase in 2010 with the exception of commercial otter trawlers in the south of the area.

Effort (fishing power corrected, using GRT) by UK (E&W) beam trawlers shows an increasing trend between 1992 and 2003, then remaining stable at this high level until 2008 (Figure 8.2.1). In 2009 effort fell dramatically back to the level observed in 2000. In contrast, effort by otter trawlers continues to decline slowly from the highest values shown at the beginning of the time-series. However commercial otter trawl effort now shows a small increase in 2009 and 2010.

### 8.2.2 Stock assessment

#### Catch-at-age analysis

Section 1.3 outlines the general approach adopted at this year's Working Group meeting, and the specific approach for this stock is given in the Stock Annex. All relevant tuning and XSA outputs not included in this report are available in the 'Exploratory runs' folder. The details of the previous assessment approaches for this stock can be found in the Stock Annex.

#### Data screening

The age range for the analysis was 1–10+, as standard.

As this was an update assessment, full data screening, tuning data and exploratory XSA trials were not carried out. For catch data screening, a separable VPA was carried out using the standard setting as detailed in the Stock Annex. The results (Figure 8.2.5. cont.) show no anomalies in recent years, and high residuals on the youngest age as previously observed.

Tuning information available consisted of same five fleets as last year: three UK commercial series, UK otter historic, UK otter trawl, UK beam trawl; and two UK survey-series: UK-WEC-BTS, and FSP-7e (UK (E+W)). These are presented in Table 8.2.8. The figures in bold indicate the data used for the final run.

Details of the derivation of the tuning fleets are presented in the Stock Annex.

Tuning indices were examined for inconsistencies using SURBA version 3.0. Log(cpue) plots plotted by year class and by year (Figure 8.2.6). Four of the tuning indices indicate highly consistent year-class estimates, and plots of index by year do not indicate substantial year effects in the tuning data. The FSP-7e UK (E&W) indices continues to show a large year effect in the 2008 data. Inclusion of these data at the WGCSE 2009 led to the final estimates of each year class for this fleet being reduced significantly from the previous year's estimate at all ages and given that this fleet's estimates received heavy weighting in the final estimates or survivors, these data were excluded from the final assessment.

These data remain excluded from the assessment despite its impact being greatly reduced with the effect mostly now seen in the fleet residuals. The cause of this year effect remains unclear. There were a number of changes to the survey in 2008, but these mostly affected the eastern part of the survey, whereas the greatest change in abundance was noted in the western survey and these changes continued in 2009.

#### Final update assessment

The settings used for the final run are shown in the table. The full assessment history is given in the Stock Annex.

| | | 2010 WKFLAT | 2010 XSA | 2011 XSA |
|---|---|---|---|---|
| Catch-at-age data | | 1980–2008, 1–10+ add catch from 7d | 1980–2009, 1–10+ add catch from 7d | 1980–2010, 1–10+ add catch from 7d |
| Fleets | UK-WECBTS – Survey | 1986–2008, 1–8 | 1986–2009, 1–8 | 1986–2010, 1–8 |
| | UK WECOT – Commercial | 1988–2008, 3–9 | 1988–2009, 3–9 | 1988–2010, 3–9 |
| | UK WECOT– Commercial historic | 1980–1987, 2–9 | 1980–1987, 2–9 | 1980–1987, 2–9 |
| | UK WECBT – Commercial | 1989–2008, 3–9 | 1989–2009, 3–9 | 1989–2010, 3–9 |
| | FSP-7e (UK E+W) | 2003–2007, 2–8 | 2003–2009, 2–8 (exc 08) | 2003–2010, 2–8 (exc 08) |
| Taper | | No | No | No |
| Taper range | | - | - | - |
| Ages catch dep. Stock size | | None | None | None |
| q plateau | | 7 | 7 | 7 |
| F shrinkage se | | 2.5 | 2.5 | 2.5 |
| year range | | 5 | 5 | 5 |
| age range | | 4 | 4 | 4 |
| Fleet SE threshold | | 0.5 | 0.5 | 0.5 |
| Prior weighting | | - | - | - |
| Plus group | | 10 | 10 | 10 |
| F Bar Range | | F(3–6) | F(3–6) | F(3–6) |

The diagnostics for the final XSA run are shown in Table 8.2.9 and the catchability residuals are plotted in Figure 8.2.5. Some weak trends/patterns can be seen in the commercial beam trawl and otter trawl fleets (UK-WECBT; UK-WECOT) and a year effect can be seen in the survey results (UK-WEC-BTS) for 2004 probably associated with a change in vessel effect.

Estimates for the youngest age are almost entirely determined by the UK beam trawl survey and this fleet gets more weight than the other fleets up to age 5. The FSP-7e UK survey provides >25% of the weight for age 2 and older. The commercial fleets provide around 50% of the weight of ages 5 and older. The contribution of F-shrinkage is minor for all ages. Fishing mortalities and population numbers estimated from the final run are given in Tables 8.2.10 and 8.2.11, and summarized in Table 8.2.12. The 2006–2008 above average year classes have led to a further increase in SSB in 2010. The 2009 year class appears to be the highest in the time-series. In last year's assessment, the 2008 year class was estimated to be weak but is now being estimated to be above average given the age 2 catches in this survey.

A retrospective analysis (Figure 8.2.7) was run without the short FSP-7e UK (E&W) tuning-series, and indicates a strong downward revision of the 2001 year-class strength, going from the second strongest year class in history to a value much closer to long-term GM. However, this year there has been strong upward revision to the estimate of the 2008 year class from a level well below the GM average last year to around double the GM this year. This assessment shows no retrospective bias in either SSB or F estimation.

#### Comparison with previous assessments

Fishing mortality has increased slightly in 2010 (0.45) and SSB is estimated to have increased to 2629 t. Last year, fishing mortality and SSB in 2009 were estimated to be 0.44 and 1833 t; this year's estimates for 2008 are 0.43 and 1868 t, a downward revision in F of 2% and an upward revision in SSB of 2%.

There is no major bias in the retrospective analysis and historical stock trends are strongly converged. Other recent estimates of F show a slight underestimation with a slight overestimation in SSB.

#### State of the stock

A summary of the final assessment is given in Table 8.2.12 and Figure 8.2.8. Spawning–stock biomass (SSB) was stable during the period 1981–1987, peaked above 5000 t during 1988–1990 following good recruitments in the mid-1980s, then decreased to around 2400 t in 1995–1996. Since then SSB increased following the good 1996 year class but subsequently declined steadily to the lowest level in the time-series of around 1650 t in 2008. Above average recruitments in the 2006–2008 year classes has led to an increase in the SSB estimate for 2010 to over 2600 t.

Fishing mortality showed a gradually increasing trend up until the mid 1990s, then a slight decline followed by a sharp increase up to 2007. This assessment shows a small reduction in F in 2008 and a much larger reduction in 2009, followed by a small increase again in 2010. These changes in F are corroborated by corresponding changes in the effort observed for the UK beam trawl fleet and the F for sole, the target species for this fishery.

Two periods of below average recruitments in the period 1989–1994 and from 1998–2006 contributed to the decrease in yield and SSB seen in 2008. This assessment now estimates that five year classes have been above the long-term GM80-08 (5007) since 2000. The above average estimates of recruitment for the 2006–2008 year classes have led the significant increase in SSB in 2010.

### 8.2.3 Short-term projections

At last year's Working Group, a short-term forecast was run with F scaled to the last year due to the large fall in F observed in the penultimate year of the assessment.

#### Estimating year-class abundance

The 2009 year class is estimated to be highest value in the time-series at around 21.0 million with 91% of the weight coming from the UK-WEC-BTS. However, given that other year classes have been significantly revised in following assessments, the Working Group considered this estimate to be highly uncertain and replaced it with the GM recruitment (GM89-08).

Working Group estimates of year-class strength used for prediction can be summarized as follows:

**Recruitment at-age 1:**

| Year class | Thousands | Basis | Surveys | Commercial | Shrinkage |
|---|---|---|---|---|---|
| 2008 | 10 062 | XSA | 98% | - | 2% |
| 2009 | 5007 | GM (89-08) | - | - | - |
| 2010 | 5007 | GM (89-08) | - | - | - |
| 2011 | 5007 | GM (89-08) | - | - | - |

The input values for the catch forecast (using the MFDP software) are given in Table 8.2.13. The F at-age values used were calculated as the mean of the XSA values from 2008–2010, scaled to 2010. Catch and stock weights-at-age were also the mean of the period 2008–2010. Stock numbers-at-age in 2011 for ages 3 and older were obtained from the XSA, with the values for age 2 being set at 4438, the GM(89-08) less a reduction for natural mortality (0.12) and fishing mortality (0.0007) at age 1. Recruitment for 2011 onwards are taken to be 5007, the GM (89-08).

Table 8.2.14 gives the management option table from the *status quo* catch prediction, and short-term results are shown in Figure 8.2.9.

Assuming *status quo* F ($F_{sq}$ = 0.45) implies landings of 1755 t in 2011 and 1733 t in 2012. (The TAC for 2011 is 4665 t. for VIId,e). SSB is predicted to rise from 3371 t in 2011 to 3751 t in 2012 and 3710 t in 2013. Uncertainties in these results are discussed in Section 8.2.7.

The detailed output for the *status quo* F forecast by age group is given in Table 8.2.15, and the estimated contributions of recent year classes to the predicted catches and SSBs are given in Table 8.2.16. The assumptions of GM1989-08 recruitment are predicted to contribute 30% to the landings in 2012 and 41% to SSB in 2013.

The stock and recruitment scatterplot is given in Figure 8.2.10.

### 8.2.4 $F_{MSY}$ evaluation

A full $F_{MSY}$ evaluation was carried out at WGCSE in 2010 and the suggested level of $F_{MSY}$ for this stock was F's within the range of 0.14 and 0.31. No further work was carried out this year.

### 8.2.5 Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY Approach | MSY $B_{trigger}$ | 2500 t | $B_{pa}$ |
| | $F_{MSY}$ | 0.19 | Provisional proxy by analogy with plaice in the Celtic Sea. Fishing mortalities in the range 0.14–0.31are consistent with $F_{MSY}$ |
| Precautionary Approach | $B_{lim}$ | 1300 t | $B_{lim}$=$B_{loss}$ The lowest observed spawning–stock biomass. |
| | $B_{pa}$ | 2500 t | MBAL, biomass above this affords a high probability of maintaining SSB above $B_{lim}$, taking into account the uncertainty in assessments. |
| | $F_{lim}$ | Not defined. | |
| | $F_{pa}$ | 0.45 | This F affords low probability that ($SSB_{MT}$< $B_{pa}$). |

However the Working Groups since 2004 had considered the precautionary reference points for this stock as unreliable for the following reasons:

- The stock–recruitment relation shows no evidence of reduced recruitment at low stock levels;
- The basis for $B_{pa}$ is weak, and heavily dependent on two consecutive points (1985 and 1986);
- $F_{pa}$ is based on $B_{pa}$, and then this reference point is also rejected.

#### Yield-per-recruit analysis

Results for the deterministic yield and SSB per recruit (using program MFYPR), conditional on the recent exploitation pattern, are given in Table 8.2.17 and Figure 8.2.10. $F_{max}$ is given by a reference F of 0.25, around 55% of $F_{sq}$. Long-term yield and SSB (at $F_{sq}$ and assuming GM89-08 recruitment = 5.007 million) are given as 1510 t and 3210 t respectively.

### 8.2.6 Management plans

There is no management plan in place for this stock.

### 8.2.7 Uncertainties and bias in assessment and forecast

The assessment model changes introduced by WKFlat 2010 added new uncertainties into a portion of the data (~10%). The spawning migration correction assumes that a constant 15% of quarter 1 catches in VIId to originate from VIIe, based on historical tagging information. This proportion makes no provision for changes in the relative sizes of the two populations. In addition, this correction utilizes the age structure of the VIId catches, representing a mix of age structure from VIIe, VIId and portions of the Area IV populations migrating into VIId for spawning.

There is a heavy reliance on the age composition data derived from UK (E&W) sample data. Around 20% of the landings for this stock is taken by countries that do not provide age based data and this situation is improved only slightly once the migration correction data from VIId is added. Survivor estimates for ages 1 and 2 almost entirely come from the UK survey data and some consideration should be given to using age 2 data from the commercial tuning fleets.

UK and Belgian discard data provided to this year continue to support previous WG conclusions that discard levels are low in the second half of the year, and overall that discarding for this stock is variable but relatively low compared to other plaice stocks. As the time-series of data expands, the WG will be able to better determine how to include these data in the assessment appropriately.

Both the UK-WEC_BTS and the FSP-7e UK (E&W) surveys are spatially restricted to the same area as the commercial tuning fleets and little information exists on stock dynamics on the French coast.

The assessments ability to accurately estimate age 1 recruits depends heavily upon the Carhelmar UK beam trawl survey which is not particularly consistent at catching fish of this age. The Working Group has considered these values too uncertain for use in the short-term forecast opting instead to use GM recruitment. The large 2010 recruits estimate as suggested by the assessment may lead to increased discarding in 2012.

### 8.2.8 Recommendation for next benchmark

A benchmark assessment was carried out for this stock in February 2010.

### 8.2.9 Management considerations

The stock unit (Division VIIe) does not correspond to the management unit (Divisions VIId and VIIe). This hampers effective management of plaice in the Western English Channel, but because components of the VIIe stock are also taken during spawning time in Area VIId, some provision must be made in management to accommodate effective management of both plaice stocks.

Plaice are taken as a bycatch in the beam trawl fishery mainly targeting sole, and as part of a mixed demersal fishery by otter trawlers. Therefore the restrictions under the management plan for sole appear to have benefited the plaice stocks.

The assessment is now able to accurately estimate recent trends in F and historical trends are estimated with some certainty. Fishing mortality is estimated to be well above long-term targets with some certainty.

**Table 8.2.1** Plaice in VIIe. Nominal landings (t) in Division VIIe, as used by Working Group.

| Year | Belgium | Denmark | Netherlands | France | UK (E &W) inc. CI's. | Others | Total reported | Unallocated[1] | Total | VIIe stock caught in VIId[4] | As used by WG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | 5 | - | - | 323 | 312 | - | 640 | - | 640 | - | 640 |
| 1977 | 3 | - | - | 336 | 363 | - | 702 | - | 702 | - | 702 |
| 1978 | 3 | - | - | 314 | 467 | - | 784 | - | 784 | - | 784 |
| 1979 | 2 | - | - | 458 | 515 | - | 975 | 2 | 977 | - | 977 |
| 1980 | 23 | - | - | 325 | 609 | 9 | 966 | 113 | 1079 | 136 | 1215 |
| 1981 | 27 | - | - | 537 | 953 | - | 1517 | -16 | 1501 | 245 | 1746 |
| 1982 | 81 | - | - | 363 | 1109 | - | 1553 | 135 | 1688 | 250 | 1938 |
| 1983 | 20 | - | - | 371 | 1195 | - | 1586 | -91 | 1495 | 259 | 1754 |
| 1984 | 24 | - | - | 278 | 1144 | - | 1446 | 101 | 1547 | 266 | 1813 |
| 1985 | 39 | - | - | 197 | 1122 | - | 1358 | 83 | 1441 | 310 | 1751 |
| 1986 | 26 | - | - | 276 | 1389 | - [1] | 1691 | 119 | 1810 | 351 | 2161 |
| 1987 | 68 | - | - | 435 | 1419 | - | 1922 | 36 | 1958 | 430 | 2388 |
| 1988 | 90 | - | - | 584 | 1654 | - | 2328 | 130 | 2458 | 536 | 2994 |
| 1989 | 89 | - | - | 448 [1] | 1712 | - | 2250 | 108 | 2358 | 450 | 2808 |
| 1990 | 82 | 2 | - | N/A [2] | 1891 | 2 | 1979 | 614 | 2593 | 465 | 3058 |
| 1991 | 57 | - | - | 251 [1] | 1326 | - | 1635 | 213 | 1848 | 402 | 2250 |
| 1992 | 25 | - | - | 419 | 1110 | 14 | 1568 | 56 | 1624 | 326 | 1950 |
| 1993 | 56 | - | - | 284 | 1080 | 24 | 1444 | -27 | 1417 | 274 | 1691 |
| 1994 | 10 | - | - | 277 | 998 | - | 1285 | -129 | 1156 | 315 | 1471 |
| 1995 | 13 | - | - | 288 | 857 | - | 1158 | -127 | 1031 | 264 | 1295 |
| 1996 | 4 | - | - | 279 | 855 | - | 1138 | -94 | 1044 | 277 | 1321 |
| 1997 | 6 | - | - | 329 | 1038 | 1 | 1374 | -51 | 1323 | 331 | 1654 |
| 1998 | 22 | - | - | 327 | 892 | 1 | 1242 | -111 | 1131 | 299 | 1430 |
| 1999 | 12 | - | - | 194 [1] | 947 | - | 1154 | 117 | 1271 | 345 | 1616 |
| 2000 | 4 | - | - | 360 | 926 | + | 1290 | -9 | 1281 | 397 | 1678 |
| 2001 | 12 | - | - | 303 | 797 | - | 1112 | -6 | 1106 | 273 | 1379 |
| 2002 | 27 | - | - | 242 | 978 | + | 1247 | 10 | 1257 | 351 | 1608 |
| 2003 | 39 | - | - | 216 | 985 | - | 1240 | -22 | 1218 | 260 | 1478 |
| 2004 | 46 | - | - | 184 | 912 | - | 1142 | 12 | 1154 | 248 | 1402 |
| 2005 | 48 | - | - | 198 | 887 | - | 1133 | 66 | 1199 | 171 | 1370 |
| 2006 | 52 | - | - | 223 | 966 | - | 1241 | 72 | 1313 | 153 | 1466 |
| 2007 | 84 | - | - | 202 | 679 | - | 965 | 38 | 1003 | 181 | 1184 |
| 2008 | 66 | - | - | 148 | 677 | - | 891 | 83 | 974 | 170 | 1144 |
| 2009 | 53 | - | 2 | 193 | 724 | 5 | 978 | -55 | 923 | 142 | 1065 |
| 2010 | 51 | - | 2 | 220 | 838 | - | 1111 | -33 | 1078 | 149 | 1227 |

[1]Estimated by the Working Group.

[2]Divisions VIId,e = 4,739 t.

[3]Included in Division VIId

[4]Migration correction (15% of VIId Qtr 1) added to stock.

**Table 8.2.2** Division VIIe PLAICE effort and CPUE data.
The UK (E&W) data are for vessels > 12m and are corrected for fishing power (based on GRT). All effort data are in fishing hours, CPUE data are kg/hr for commercial fleets, in kg/10 km towed for Carhelmar beam survey and Kg/hour/ Metre beam length for FSP survey .

| Year | (CPUE) (kg/hr). | | | | | | Effort (000 hours) | | Landings (tonnes) | | (CPUE) (kg/10 km) | (CPUE) (Kg $h^{-1}$ $m^{-1}$ beam) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | West Sector | | North Sector | | South Sector | | | | | | Carhelmar Survey (UK-WEC-BTS) | FSP survey (FSP-7e) |
| | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | Otter | Beam | | |
| 1972 | 2.31 | - | 4.50 | - | 0.00 | - | 64.60 | - | 194.36 | - | - | - |
| 1973 | 2.25 | - | 3.85 | - | 0.00 | - | 69.54 | - | 200.45 | - | - | - |
| 1974 | 1.65 | - | 3.47 | - | 2.94 | - | 50.09 | - | 121.03 | - | - | - |
| 1975 | 1.78 | - | 3.53 | - | 2.54 | - | 54.69 | - | 132.95 | - | - | - |
| 1976 | 1.89 | - | 3.62 | - | 4.14 | - | 56.13 | - | 144.56 | - | - | - |
| 1977 | 1.37 | - | 3.10 | - | 4.96 | - | 55.40 | - | 117.72 | - | - | - |
| 1978 | 1.61 | 5.41 | 3.63 | 10.35 | 4.24 | 11.84 | 48.80 | 22.09 | 114.02 | 204.69 | - | - |
| 1979 | 1.84 | 4.16 | 4.58 | 7.37 | 1.64 | 6.58 | 49.92 | 39.38 | 142.52 | 233.81 | - | - |
| 1980 | 2.02 | 3.15 | 5.82 | 6.06 | 0.67 | 6.45 | 49.95 | 62.16 | 150.69 | 335.16 | - | - |
| 1981 | 2.61 | 4.44 | 10.98 | 8.35 | 7.30 | 8.33 | 46.88 | 65.29 | 257.28 | 471.20 | - | - |
| 1982 | 3.28 | 4.43 | 10.77 | 9.23 | 0.00 | 7.69 | 38.51 | 81.59 | 249.60 | 611.52 | - | - |
| 1983 | 2.57 | 2.76 | 11.03 | 9.64 | 8.10 | 5.71 | 52.59 | 103.07 | 303.04 | 612.16 | - | - |
| 1984 | 2.95 | 4.08 | 10.92 | 10.38 | 2.43 | 7.80 | 52.89 | 87.63 | 281.94 | 575.22 | - | - |
| 1985 | 2.60 | 3.79 | 8.81 | 9.00 | 0.09 | 6.38 | 57.69 | 92.19 | 255.86 | 540.61 | 15.21 | - |
| 1986 | 3.25 | 6.30 | 10.94 | 12.21 | 10.17 | 6.85 | 49.52 | 76.33 | 315.08 | 602.07 | 16.46 | - |
| 1987 | 3.56 | 5.37 | 11.02 | 9.69 | 3.63 | 7.45 | 45.11 | 87.05 | 329.97 | 672.81 | 20.59 | - |
| 1988 | 3.90 | 3.50 | 15.38 | 6.51 | 5.04 | 4.85 | 53.40 | 103.36 | 433.20 | 564.72 | 25.34 | - |
| 1989 | 2.69 | 6.50 | 10.87 | 14.25 | 1.42 | 6.88 | 54.71 | 109.95 | 315.73 | 900.19 | 14.80 | - |
| 1990 | 2.95 | 6.52 | 7.77 | 15.64 | 3.55 | 10.17 | 53.05 | 100.95 | 268.81 | 990.05 | 11.60 | - |
| 1991 | 2.80 | 6.16 | 5.08 | 13.24 | 0.41 | 7.47 | 40.79 | 83.57 | 152.93 | 721.46 | 8.72 | - |
| 1992 | 1.92 | 6.30 | 3.51 | 10.61 | 3.06 | 9.69 | 39.91 | 80.87 | 105.41 | 695.70 | 7.45 | - |
| 1993 | 1.39 | 6.14 | 3.03 | 11.04 | 5.46 | 7.17 | 39.17 | 83.92 | 81.77 | 655.48 | 6.16 | - |
| 1994 | 1.46 | 4.62 | 2.48 | 9.17 | 2.11 | 6.47 | 38.77 | 100.42 | 63.67 | 650.99 | 5.70 | - |
| 1995 | 1.61 | 4.60 | 1.99 | 6.29 | 2.36 | 5.40 | 35.45 | 100.80 | 60.20 | 531.06 | 5.13 | - |
| 1996 | 2.00 | 3.09 | 2.49 | 6.66 | 11.62 | 4.39 | 30.54 | 116.45 | 64.83 | 482.18 | 5.97 | - |
| 1997 | 2.69 | 3.50 | 3.08 | 7.16 | 1.56 | 5.58 | 33.28 | 108.39 | 99.05 | 561.74 | 9.82 | - |
| 1998 | 1.65 | 2.97 | 4.13 | 6.10 | 1.85 | 3.03 | 29.80 | 111.17 | 73.30 | 459.22 | 8.74 | - |
| 1999 | 1.39 | 3.49 | 3.60 | 8.55 | 1.11 | 4.59 | 27.52 | 103.56 | 59.67 | 576.76 | 8.42 | - |
| 2000 | 0.81 | 2.98 | 4.00 | 6.63 | 1.25 | 3.72 | 30.49 | 118.83 | 61.82 | 541.33 | 11.31 | - |
| 2001 | 0.89 | 2.30 | 3.03 | 5.45 | 3.14 | 3.61 | 31.90 | 143.27 | 48.82 | 527.38 | 10.56 | - |
| 2002 | 0.90 | 2.90 | 4.18 | 6.52 | 0.56 | 3.45 | 28.35 | 139.83 | 57.44 | 651.04 | 8.05 | - |
| 2003 | 0.96 | 3.26 | 2.10 | 8.18 | 0.50 | 2.89 | 25.06 | 159.95 | 36.88 | 743.07 | 7.96 | 0.48 |
| 2004 | 0.88 | 3.38 | 2.01 | 6.16 | 0.19 | 2.80 | 25.58 | 158.68 | 37.98 | 701.17 | 4.53 | 0.57 |
| 2005 | 0.88 | 2.62 | 2.13 | 8.20 | 3.48 | 2.75 | 21.13 | 157.81 | 29.44 | 691.27 | 7.02 | 0.47 |
| 2006 | 0.96 | 2.68 | 3.41 | 6.97 | 1.71 | 2.50 | 21.06 | 161.44 | 28.57 | 665.16 | 7.47 | 0.47 |
| 2007 | 0.68 | 1.71 | 1.95 | 4.55 | 1.31 | 2.13 | 22.35 | 158.01 | 27.27 | 472.27 | 7.94 | 0.29 |
| 2008 | 0.94 | 1.83 | 2.07 | 4.88 | 0.71 | 2.06 | 19.86 | 158.50 | 25.72 | 465.09 | 8.18 | 0.24 |
| 2009 | 1.26 | 2.62 | 2.23 | 7.58 | 1.78 | 3.48 | 21.41 | 122.53 | 32.45 | 521.17 | 12.85 | 0.44 |
| 2010 | 1.68 | 2.64 | 2.71 | 8.55 | 0.45 | 3.50 | 26.06 | 128.45 | 52.41 | 549.64 | 21.63 | 0.71 |

**Table 8.2.3. Plaice in VIIe. Annual length distribution by fleet (2010)**

| | UK (England & Wales) | | France | | | | |
|---|---|---|---|---|---|---|---|
| Length (cm) | Beam trawl | All gears (excl. beam trawl) | Trammel & Gill nets | Otter (inc twin) targetting Dem | Otter (inc twin) targetting Mol | Beam Trawl | Other Gears |
| 24 | | 543 | | 713 | | 56 | 161 |
| 25 | 3178 | 2660 | | 1663 | 873 | 199 | 574 |
| 26 | 13112 | 11364 | | 4254 | 3346 | 597 | 1721 |
| 27 | 25110 | 36151 | 342 | 8066 | 15710 | 1895 | 5461 |
| 28 | 49921 | 71338 | 1254 | 14544 | 16582 | 2544 | 7331 |
| 29 | 92926 | 93959 | 1505 | 23502 | 15564 | 3188 | 9186 |
| 30 | 104262 | 101408 | 593 | 18557 | 11055 | 2373 | 6839 |
| 31 | 113419 | 97501 | 684 | 28092 | 4800 | 2638 | 7602 |
| 32 | 106815 | 88272 | 1368 | 28096 | 3346 | 2578 | 7429 |
| 33 | 104246 | 65901 | 1961 | 17819 | 1455 | 1669 | 4808 |
| 34 | 92292 | 54996 | 935 | 21129 | 2327 | 1917 | 5523 |
| 35 | 91240 | 43279 | 684 | 13866 | 1746 | 1280 | 3690 |
| 36 | 70410 | 31952 | 2121 | 8107 | 0 | 804 | 2316 |
| 37 | 68448 | 21710 | 479 | 5823 | 727 | 552 | 1592 |
| 38 | 54467 | 15042 | 502 | 11383 | | 934 | 2691 |
| 39 | 43322 | 14065 | 1459 | 3751 | | 409 | 1180 |
| 40 | 32819 | 8952 | 935 | 5675 | | 519 | 1497 |
| 41 | 26036 | 5266 | 1551 | 3660 | | 409 | 1180 |
| 42 | 24724 | 4272 | 844 | 5524 | | 500 | 1442 |
| 43 | 21583 | 6994 | 502 | 1900 | | 189 | 544 |
| 44 | 15200 | 1885 | 844 | 1068 | | 150 | 433 |
| 45 | 12953 | 1680 | 1163 | 452 | | 127 | 366 |
| 46 | 7138 | 1208 | 0 | 0 | | 0 | 0 |
| 47 | 4686 | 817 | 297 | 1557 | | 146 | 420 |
| 48 | 4534 | 934 | 228 | 1685 | | 150 | 433 |
| 49 | 4216 | 501 | 456 | 973 | | 112 | 324 |
| 50 | 4026 | 484 | 0 | 1022 | | 80 | 231 |
| 51 | 2414 | 307 | 1687 | 0 | | 133 | 382 |
| 52 | 1956 | 2060 | 0 | 238 | | 19 | 54 |
| 53 | 1835 | 326 | 639 | 951 | | 125 | 360 |
| 54 | 1932 | 135 | 0 | | | 0 | 0 |
| 55 | 1555 | 65 | 776 | | | 61 | 176 |
| 56 | 1055 | 43 | 228 | | | 18 | 52 |
| 57 | 1134 | 53 | 0 | | | 0 | 0 |
| 58 | 624 | 110 | 228 | | | 18 | 52 |
| 59 | 252 | 18 | 0 | | | 0 | 0 |
| 60 | 436 | 0 | 342 | | | 27 | 77 |
| 61 | 12 | 44 | 456 | | | 36 | 103 |
| 62 | 313 | 0 | | | | | |
| 63 | 11 | 9 | | | | | |
| 64 | 0 | | | | | | |
| 65 | 0 | | | | | | |
| 66 | 11 | | | | | | |
| Total | 1204624 | 786303 | 25063 | 234071 | 77530 | 26455 | 76226 |

## Table 8.2.4 Plaice in VIIe. Catch numbers-at-age.

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1980 |
|---|---|
| AGE | |
| 1 | 19 |
| 2 | 814 |
| 3 | 800 |
| 4 | 252 |
| 5 | 230 |
| 6 | 62 |
| 7 | 63 |
| 8 | 23 |
| 9 | 13 |
| +gp | 138 |
| TOTALNUM | 2415 |
| TONSLAND | 1215 |
| SOPCOF % | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 41 | 72 | 3 | 77 | 3 | 10 | 74 | 12 | 10 | 57 |
| 2 | 723 | 310 | 790 | 970 | 727 | 1025 | 1258 | 1932 | 352 | 391 |
| 3 | 2268 | 2131 | 893 | 1864 | 1605 | 2532 | 2303 | 5179 | 2960 | 3408 |
| 4 | 591 | 1420 | 1702 | 702 | 1399 | 963 | 1407 | 1160 | 3014 | 2757 |
| 5 | 120 | 263 | 593 | 531 | 157 | 488 | 657 | 464 | 843 | 1222 |
| 6 | 103 | 89 | 104 | 197 | 255 | 116 | 233 | 155 | 274 | 272 |
| 7 | 21 | 83 | 41 | 92 | 142 | 129 | 90 | 116 | 121 | 135 |
| 8 | 47 | 17 | 50 | 30 | 28 | 68 | 52 | 40 | 97 | 80 |
| 9 | 19 | 28 | 2 | 33 | 16 | 29 | 45 | 25 | 32 | 57 |
| +gp | 95 | 122 | 100 | 51 | 52 | 62 | 52 | 53 | 101 | 73 |
| TOTALNUM | 4027 | 4534 | 4276 | 4546 | 4383 | 5421 | 6170 | 9136 | 7805 | 8451 |
| TONSLAND | 1746 | 1938 | 1754 | 1813 | 1751 | 2161 | 2388 | 2994 | 2808 | 3058 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 41 | 90 | 36 | 84 | 6 | 15 | 7 | 7 | 19 | 46 |
| 2 | 691 | 841 | 844 | 409 | 421 | 1160 | 963 | 636 | 678 | 399 |
| 3 | 1352 | 1430 | 1488 | 1707 | 818 | 774 | 2443 | 1732 | 2480 | 1331 |
| 4 | 1943 | 760 | 650 | 878 | 986 | 403 | 486 | 1158 | 1219 | 2069 |
| 5 | 973 | 654 | 266 | 256 | 269 | 392 | 185 | 159 | 414 | 496 |
| 6 | 528 | 452 | 272 | 111 | 120 | 127 | 155 | 66 | 94 | 181 |
| 7 | 106 | 264 | 219 | 119 | 58 | 60 | 80 | 61 | 38 | 38 |
| 8 | 46 | 72 | 171 | 83 | 84 | 41 | 34 | 23 | 40 | 14 |
| 9 | 33 | 33 | 40 | 86 | 69 | 48 | 18 | 21 | 17 | 22 |
| +gp | 51 | 50 | 86 | 65 | 90 | 107 | 101 | 63 | 46 | 52 |
| TOTALNUM | 5764 | 4646 | 4071 | 3797 | 2920 | 3127 | 4472 | 3926 | 5046 | 4648 |
| TONSLAND | 2250 | 1950 | 1691 | 1471 | 1295 | 1321 | 1654 | 1430 | 1616 | 1678 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 1 Catch numbers at age Numbers*10**-3

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 6 | 188 | 23 | 21 | 22 | 18 | 3 | 5 | 5 | 18 |
| 2 | 585 | 1400 | 1004 | 600 | 831 | 1089 | 428 | 1015 | 742 | 844 |
| 3 | 946 | 1251 | 1208 | 1644 | 1034 | 1448 | 1168 | 781 | 1359 | 1024 |
| 4 | 795 | 597 | 622 | 600 | 858 | 543 | 723 | 563 | 295 | 761 |
| 5 | 950 | 428 | 207 | 349 | 282 | 388 | 287 | 252 | 147 | 202 |
| 6 | 145 | 511 | 172 | 102 | 146 | 121 | 196 | 107 | 76 | 108 |
| 7 | 79 | 116 | 224 | 75 | 52 | 60 | 70 | 83 | 30 | 41 |
| 8 | 19 | 49 | 54 | 96 | 50 | 29 | 30 | 32 | 21 | 15 |
| 9 | 12 | 13 | 41 | 44 | 53 | 22 | 10 | 15 | 7 | 19 |
| +gp | 37 | 42 | 39 | 38 | 44 | 45 | 49 | 28 | 16 | 25 |
| TOTALNUM | 3574 | 4595 | 3594 | 3569 | 3372 | 3764 | 2962 | 2882 | 2698 | 3057 |
| TONSLAND | 1379 | 1608 | 1478 | 1402 | 1370 | 1466 | 1184 | 1144 | 1065 | 1227 |
| SOPCOF % | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

## Table 8.2.5 Plaice in VIIe. Catch weights-at-age.

Table 2 Catch weights at age (kg)

| YEAR | 1980 |
|---|---|
| AGE | |
| 1 | 0.248 |
| 2 | 0.337 |
| 3 | 0.428 |
| 4 | 0.519 |
| 5 | 0.612 |
| 6 | 0.706 |
| 7 | 0.801 |
| 8 | 0.898 |
| 9 | 0.996 |
| +gp | 1.404 |
| SOPCOFAC | 0.9999 |

Table 2 Catch weights at age (kg)

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.144 | 0.186 | 0.106 | 0.136 | 0.098 | 0.171 | 0.252 | 0.134 | 0.156 | 0.236 |
| 2 | 0.268 | 0.273 | 0.221 | 0.238 | 0.214 | 0.257 | 0.288 | 0.215 | 0.217 | 0.267 |
| 3 | 0.389 | 0.360 | 0.330 | 0.343 | 0.328 | 0.346 | 0.337 | 0.303 | 0.285 | 0.308 |
| 4 | 0.507 | 0.447 | 0.432 | 0.447 | 0.437 | 0.438 | 0.403 | 0.399 | 0.360 | 0.359 |
| 5 | 0.622 | 0.532 | 0.529 | 0.550 | 0.543 | 0.533 | 0.480 | 0.504 | 0.440 | 0.421 |
| 6 | 0.733 | 0.619 | 0.617 | 0.654 | 0.644 | 0.632 | 0.572 | 0.618 | 0.528 | 0.493 |
| 7 | 0.841 | 0.702 | 0.699 | 0.757 | 0.743 | 0.734 | 0.679 | 0.740 | 0.622 | 0.577 |
| 8 | 0.946 | 0.786 | 0.775 | 0.861 | 0.837 | 0.840 | 0.799 | 0.870 | 0.723 | 0.670 |
| 9 | 1.047 | 0.869 | 0.844 | 0.965 | 0.928 | 0.950 | 0.933 | 1.009 | 0.830 | 0.775 |
| +gp | 1.387 | 1.217 | 1.027 | 1.390 | 1.253 | 1.427 | 1.388 | 1.357 | 1.122 | 1.078 |
| SOPCOFAC | 1.0007 | 0.9999 | 1.0003 | 1.0000 | 0.9996 | 0.9993 | 0.9997 | 0.9991 | 1.0001 | 0.9996 |

Table 2 Catch weights at age (kg)

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.194 | 0.242 | 0.212 | 0.201 | 0.213 | 0.173 | 0.188 | 0.179 | 0.107 | 0.117 |
| 2 | 0.245 | 0.282 | 0.269 | 0.258 | 0.281 | 0.266 | 0.259 | 0.239 | 0.196 | 0.204 |
| 3 | 0.306 | 0.335 | 0.332 | 0.322 | 0.353 | 0.360 | 0.334 | 0.294 | 0.282 | 0.290 |
| 4 | 0.377 | 0.401 | 0.405 | 0.391 | 0.429 | 0.455 | 0.412 | 0.411 | 0.364 | 0.375 |
| 5 | 0.456 | 0.481 | 0.484 | 0.464 | 0.507 | 0.551 | 0.494 | 0.526 | 0.444 | 0.459 |
| 6 | 0.545 | 0.574 | 0.571 | 0.543 | 0.588 | 0.647 | 0.580 | 0.638 | 0.521 | 0.542 |
| 7 | 0.643 | 0.680 | 0.667 | 0.628 | 0.674 | 0.743 | 0.669 | 0.747 | 0.596 | 0.624 |
| 8 | 0.750 | 0.799 | 0.769 | 0.717 | 0.763 | 0.840 | 0.762 | 0.853 | 0.667 | 0.705 |
| 9 | 0.866 | 0.933 | 0.880 | 0.812 | 0.855 | 0.938 | 0.860 | 0.958 | 0.735 | 0.784 |
| +gp | 1.221 | 1.317 | 1.202 | 1.117 | 1.055 | 1.170 | 1.110 | 1.274 | 0.950 | 1.029 |
| SOPCOFAC | 1.0004 | 0.9996 | 1.0000 | 1.0002 | 0.9998 | 1.0006 | 0.9992 | 1.0004 | 1.0000 | 0.9997 |

Table 2 Catch weights at age (kg)

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.167 | 0.193 | 0.147 | 0.254 | 0.226 | 0.206 | 0.186 | 0.208 | 0.098 | 0.180 |
| 2 | 0.231 | 0.246 | 0.250 | 0.293 | 0.287 | 0.276 | 0.259 | 0.279 | 0.239 | 0.268 |
| 3 | 0.305 | 0.306 | 0.352 | 0.342 | 0.354 | 0.352 | 0.334 | 0.356 | 0.376 | 0.361 |
| 4 | 0.384 | 0.372 | 0.450 | 0.400 | 0.426 | 0.434 | 0.412 | 0.438 | 0.507 | 0.458 |
| 5 | 0.468 | 0.446 | 0.548 | 0.468 | 0.504 | 0.521 | 0.493 | 0.526 | 0.634 | 0.559 |
| 6 | 0.558 | 0.525 | 0.641 | 0.545 | 0.586 | 0.614 | 0.577 | 0.619 | 0.757 | 0.665 |
| 7 | 0.654 | 0.612 | 0.734 | 0.632 | 0.674 | 0.712 | 0.663 | 0.718 | 0.874 | 0.775 |
| 8 | 0.754 | 0.706 | 0.822 | 0.728 | 0.766 | 0.814 | 0.752 | 0.822 | 0.987 | 0.890 |
| 9 | 0.861 | 0.806 | 0.910 | 0.833 | 0.864 | 0.923 | 0.844 | 0.932 | 1.096 | 1.009 |
| +gp | 1.272 | 1.137 | 1.231 | 1.189 | 1.106 | 1.165 | 1.095 | 1.270 | 1.336 | 1.260 |
| SOPCOFAC | 1.0001 | 0.9998 | 1.0003 | 1.0005 | 1.0002 | 1.0003 | 1.0001 | 1.0002 | 1.0000 | 0.9996 |

## Table 8.2.6 Plaice in VIIe. Stock weights-at-age.

Table 3 Stock weights at age (kg)

| YEAR | 1980 |
|---|---|
| AGE | |
| 1 | 0.114 |
| 2 | 0.227 |
| 3 | 0.338 |
| 4 | 0.447 |
| 5 | 0.554 |
| 6 | 0.66 |
| 7 | 0.764 |
| 8 | 0.867 |
| 9 | 0.967 |
| +gp | 1.351 |

Table 3 Stock weights at age (kg)

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.126 | 0.108 | 0.116 | 0.111 | 0.112 | 0.096 | 0.068 | 0.103 | 0.138 | 0.236 |
| 2 | 0.25 | 0.214 | 0.228 | 0.222 | 0.222 | 0.195 | 0.145 | 0.184 | 0.2 | 0.262 |
| 3 | 0.373 | 0.318 | 0.335 | 0.334 | 0.331 | 0.297 | 0.232 | 0.275 | 0.27 | 0.3 |
| 4 | 0.492 | 0.419 | 0.436 | 0.446 | 0.438 | 0.401 | 0.326 | 0.373 | 0.347 | 0.349 |
| 5 | 0.609 | 0.517 | 0.532 | 0.56 | 0.543 | 0.507 | 0.429 | 0.481 | 0.431 | 0.408 |
| 6 | 0.725 | 0.615 | 0.623 | 0.673 | 0.647 | 0.615 | 0.539 | 0.598 | 0.522 | 0.479 |
| 7 | 0.838 | 0.71 | 0.71 | 0.788 | 0.749 | 0.727 | 0.659 | 0.723 | 0.62 | 0.561 |
| 8 | 0.949 | 0.802 | 0.791 | 0.903 | 0.849 | 0.84 | 0.788 | 0.858 | 0.725 | 0.654 |
| 9 | 1.057 | 0.893 | 0.867 | 1.018 | 0.948 | 0.955 | 0.924 | 1.002 | 0.837 | 0.758 |
| +gp | 1.435 | 1.255 | 1.094 | 1.498 | 1.329 | 1.442 | 1.347 | 1.363 | 1.143 | 1.064 |

Table 3 Stock weights at age (kg)

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.182 | 0.235 | 0.188 | 0.188 | 0.191 | 0.134 | 0.171 | 0.169 | 0.069 | 0.082 |
| 2 | 0.232 | 0.269 | 0.241 | 0.248 | 0.262 | 0.233 | 0.248 | 0.225 | 0.171 | 0.181 |
| 3 | 0.292 | 0.317 | 0.302 | 0.314 | 0.336 | 0.333 | 0.329 | 0.254 | 0.27 | 0.279 |
| 4 | 0.362 | 0.378 | 0.371 | 0.385 | 0.413 | 0.434 | 0.414 | 0.382 | 0.365 | 0.376 |
| 5 | 0.442 | 0.454 | 0.447 | 0.462 | 0.495 | 0.535 | 0.503 | 0.507 | 0.457 | 0.472 |
| 6 | 0.531 | 0.543 | 0.531 | 0.545 | 0.58 | 0.637 | 0.596 | 0.629 | 0.545 | 0.567 |
| 7 | 0.631 | 0.646 | 0.623 | 0.633 | 0.668 | 0.739 | 0.694 | 0.749 | 0.631 | 0.66 |
| 8 | 0.74 | 0.763 | 0.723 | 0.728 | 0.76 | 0.842 | 0.795 | 0.866 | 0.712 | 0.752 |
| 9 | 0.858 | 0.893 | 0.83 | 0.828 | 0.856 | 0.945 | 0.901 | 0.98 | 0.791 | 0.842 |
| +gp | 1.223 | 1.274 | 1.145 | 1.15 | 1.064 | 1.191 | 1.176 | 1.326 | 1.04 | 1.122 |

Table 3 Stock weights at age (kg)

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.139 | 0.18 | 0.1 | 0.246 | 0.205 | 0.177 | 0.156 | 0.175 | 0.026 | 0.138 |
| 2 | 0.204 | 0.233 | 0.211 | 0.282 | 0.266 | 0.248 | 0.229 | 0.243 | 0.169 | 0.223 |
| 3 | 0.277 | 0.293 | 0.319 | 0.327 | 0.334 | 0.323 | 0.305 | 0.317 | 0.308 | 0.314 |
| 4 | 0.356 | 0.36 | 0.425 | 0.383 | 0.406 | 0.405 | 0.385 | 0.396 | 0.442 | 0.409 |
| 5 | 0.441 | 0.435 | 0.529 | 0.448 | 0.484 | 0.492 | 0.467 | 0.481 | 0.571 | 0.508 |
| 6 | 0.531 | 0.516 | 0.63 | 0.523 | 0.567 | 0.584 | 0.551 | 0.572 | 0.696 | 0.611 |
| 7 | 0.627 | 0.605 | 0.728 | 0.608 | 0.656 | 0.682 | 0.639 | 0.668 | 0.816 | 0.72 |
| 8 | 0.729 | 0.701 | 0.824 | 0.702 | 0.749 | 0.786 | 0.73 | 0.769 | 0.931 | 0.832 |
| 9 | 0.836 | 0.805 | 0.918 | 0.807 | 0.849 | 0.895 | 0.823 | 0.876 | 1.042 | 0.949 |
| +gp | 1.253 | 1.148 | 1.263 | 1.16 | 1.095 | 1.139 | 1.078 | 1.207 | 1.288 | 1.195 |

## Table 8.2.7 UK-WEC-BTS effort standardised plaice abundance indices

| age<br>year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1985** | 0.00 | 82.16 | 75.37 | 72.36 | 113.06 | 20.35 | 15.83 | 8.29 | 0.75 | 0.00 | 2.26 |
| **1986** | 0.00 | 61.62 | 86.67 | 168.60 | 64.33 | 23.70 | 2.71 | 12.19 | 1.35 | 0.00 | 1.35 |
| **1987** | 0.74 | 398.98 | 110.17 | 104.21 | 54.34 | 27.54 | 21.59 | 10.42 | 5.95 | 5.95 | 2.98 |
| **1988** | 0.00 | 108.40 | 289.33 | 265.15 | 75.65 | 17.16 | 8.58 | 7.80 | 3.12 | 4.68 | 3.12 |
| **1989** | 0.00 | 18.71 | 42.26 | 169.63 | 113.49 | 13.88 | 6.64 | 8.45 | 4.83 | 3.62 | 10.87 |
| **1990** | 0.00 | 14.23 | 21.63 | 125.24 | 49.53 | 42.70 | 1.14 | 3.42 | 0.57 | 3.42 | 3.98 |
| **1991** | 1.16 | 12.81 | 15.73 | 36.70 | 46.02 | 36.11 | 23.88 | 5.24 | 0.00 | 0.58 | 1.75 |
| **1992** | 0.00 | 77.31 | 22.38 | 36.62 | 12.21 | 20.35 | 10.17 | 8.65 | 1.53 | 2.54 | 2.03 |
| **1993** | 0.00 | 11.10 | 37.00 | 31.71 | 12.69 | 6.87 | 13.21 | 6.87 | 5.81 | 1.06 | 1.06 |
| **1994** | 0.00 | 16.52 | 15.54 | 47.60 | 14.57 | 4.86 | 0.97 | 4.37 | 6.31 | 3.89 | 0.97 |
| **1995** | 0.00 | 26.72 | 24.58 | 24.04 | 25.65 | 6.41 | 2.14 | 2.67 | 3.21 | 0.53 | 2.14 |
| **1996** | 0.54 | 17.90 | 57.49 | 16.27 | 9.22 | 13.56 | 2.71 | 0.54 | 1.63 | 3.80 | 4.34 |
| **1997** | 0.00 | 28.69 | 66.04 | 106.63 | 12.99 | 3.25 | 6.50 | 3.79 | 0.54 | 0.54 | 3.79 |
| **1998** | 0.00 | 43.67 | 67.39 | 67.39 | 45.83 | 4.85 | 3.23 | 3.77 | 2.16 | 0.00 | 1.62 |
| **1999** | 0.53 | 20.22 | 23.42 | 96.86 | 28.21 | 15.97 | 1.60 | 1.06 | 3.19 | 2.13 | 1.06 |
| **2000** | 0.00 | 26.57 | 34.79 | 69.51 | 99.00 | 21.13 | 12.30 | 0.60 | 1.11 | 0.00 | 2.77 |
| **2001** | 11.52 | 17.91 | 35.78 | 28.65 | 62.57 | 54.75 | 13.79 | 7.08 | 0.00 | 1.69 | 2.81 |
| **2002** | 0.00 | 76.78 | 56.50 | 48.17 | 12.91 | 13.06 | 22.18 | 2.97 | 1.11 | 0.00 | 1.11 |
| **2003** | 0.00 | 15.82 | 75.35 | 32.84 | 27.52 | 2.47 | 9.91 | 14.86 | 3.96 | 0.00 | 1.10 |
| **2004** | 0.00 | 6.71 | 19.82 | 35.67 | 14.03 | 6.10 | 1.83 | 0.61 | 6.10 | 0.00 | 2.44 |
| **2005** | 0.80 | 16.31 | 40.42 | 48.71 | 37.42 | 6.90 | 1.71 | 1.43 | 2.81 | 1.18 | 1.47 |
| **2006** | 0.00 | 29.77 | 55.43 | 55.78 | 16.45 | 16.89 | 1.44 | 2.06 | 0.00 | 2.44 | 1.08 |
| **2007** | 0.00 | 20.44 | 50.35 | 66.58 | 18.67 | 14.93 | 3.31 | 3.04 | 0.28 | 1.38 | 2.21 |
| **2008** | 0.00 | 8.54 | 83.46 | 38.71 | 17.67 | 6.87 | 4.48 | 5.44 | 2.00 | 0.57 | 1.72 |
| **2009** | 1.74 | 9.40 | 90.88 | 124.18 | 16.93 | 8.50 | 6.36 | 4.65 | 2.68 | 0.58 | 1.45 |
| **2010** | 5.56 | 103.60 | 194.03 | 126.03 | 62.13 | 18.23 | 7.92 | 9.75 | 0.56 | 1.85 | 2.22 |

**Table 8.2.8 Plaice in VIIe. Tuning fleet data available** (data in bold have been used for tuning)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **W.CHANNEL PLAICE 2011 WGCSE** | | | | | | | | | |
| **105** | **idh** | **09/05/2011** | | | | | | | |
| **UK-WEC-BTS** | | | | | | | | | |
| **1986** | **2010** | | | | | | | | |
| **1** | **1** | **0.75** | **0.8** | | | | | | |
| **1** | **8** | | | | | | | | |
| **147.68** | **91** | **128** | **249** | **95** | **35** | **4** | **18** | **2** | 0 |
| **134.34** | **536** | **148** | **140** | **73** | **37** | **29** | **14** | **8** | 8 |
| **128.23** | **139** | **371** | **340** | **97** | **22** | **11** | **10** | **4** | 6 |
| **165.66** | **31** | **70** | **281** | **188** | **23** | **11** | **14** | **8** | 6 |
| **175.66** | **25** | **38** | **220** | **87** | **75** | **2** | **6** | **1** | 6 |
| **171.68** | **22** | **27** | **63** | **79** | **62** | **41** | **9** | **0** | 1 |
| **196.6** | **152** | **44** | **72** | **24** | **40** | **20** | **17** | **3** | 5 |
| **189.19** | **21** | **70** | **60** | **24** | **13** | **25** | **13** | **11** | 2 |
| **205.87** | **34** | **32** | **98** | **30** | **10** | **2** | **9** | **13** | 8 |
| **187.15** | **50** | **46** | **45** | **48** | **12** | **4** | **5** | **6** | 1 |
| **184.37** | **33** | **106** | **30** | **17** | **25** | **5** | **1** | **3** | 7 |
| **184.74** | **53** | **122** | **197** | **24** | **6** | **12** | **7** | **1** | 1 |
| **185.49** | **81** | **125** | **125** | **85** | **9** | **6** | **7** | **4** | 0 |
| **187.89** | **38** | **44** | **182** | **53** | **30** | **3** | **2** | **6** | 4 |
| **180.37** | **48** | **63** | **125** | **179** | **38** | **22** | **1** | **2** | 0 |
| **177.98** | **32** | **64** | **51** | **111** | **97** | **25** | **13** | **0** | 3 |
| **179.74** | **138** | **102** | **87** | **23** | **23** | **40** | **5** | **2** | 0 |
| **182.24** | **29** | **137** | **60** | **50** | **5** | **18** | **27** | **7** | 0 |
| **163.99** | **11** | **33** | **59** | **23** | **10** | **3** | **1** | **10** | 0 |
| **186.6** | **30** | **75** | **91** | **70** | **13** | **3** | **3** | **5** | 2 |
| **184.74** | **55** | **102** | **103** | **30** | **31** | **3** | **4** | **0** | 5 |
| **181.02** | **37** | **91** | **121** | **34** | **27** | **6** | **6** | **1** | 3 |
| **174.66** | **15** | **146** | **68** | **31** | **12** | **8** | **10** | **4** | 1 |
| **172.05** | **16** | **156** | **214** | **29** | **15** | **11** | **8** | **5** | 1 |
| **179.93** | **186** | **349** | **227** | **112** | **33** | **14** | **18** | **1** | 3 |
| **UK-WECOT** | | | | | | | | | |
| **1988** | **2010** | | | | | | | | |
| **1** | **1** | **0** | **1** | | | | | | |
| **3** | **9** | | | | | | | | |
| **53.402** | **754.5** | **116.9** | **51.5** | **15.1** | **10** | **3.4** | **1.9** | | |
| **54.707** | **494** | **359.7** | **77** | **26.5** | **7** | **5.9** | **0.8** | | |
| **53.05** | **347.1** | **265.9** | **85.3** | **18.4** | **11.3** | **6** | **2.8** | | |
| **40.789** | **89.5** | **134.9** | **64.8** | **30.3** | **6.3** | **2.7** | **1.9** | | |
| **39.909** | **71.7** | **46.3** | **40.1** | **25.5** | **12.9** | **3.9** | **1.3** | | |
| **39.24** | **76.1** | **33.1** | **12** | **12.2** | **9.8** | **7.7** | **1.7** | | |
| **38.768** | **86.1** | **37.1** | **9.8** | **3.5** | **4.4** | **2.4** | **2.7** | | |
| **35.453** | **47.8** | **48.8** | **10.8** | **5.7** | **1.3** | **2.7** | **2.2** | | |
| **30.541** | **39.8** | **16.3** | **14.5** | **4** | **2** | **1** | **1.2** | | |
| **33.281** | **180.1** | **14.6** | **5.5** | **4.3** | **1.6** | **0.6** | **0.3** | | |
| **29.802** | **96.2** | **61.3** | **6.4** | **2.4** | **1.6** | **0.4** | **0.5** | | |
| **27.516** | **90.1** | **34.6** | **14.3** | **2.8** | **1.1** | **0.9** | **0.3** | | |
| **30.493** | **49.6** | **64.4** | **13.3** | **6.5** | **1.3** | **0.5** | **0.8** | | |
| **31.9** | **31.3** | **29.3** | **31.5** | **4.4** | **2.6** | **0.5** | **0.3** | | |
| **28.346** | **57.1** | **17.9** | **12.6** | **15.6** | **3.3** | **1.4** | **0.5** | | |
| **25.06** | **33.2** | **15.8** | **5.1** | **3.5** | **4.3** | **1.2** | **0.6** | | |
| **25.584** | **50.7** | **18.2** | **10.5** | **2.8** | **1.4** | **2.1** | **1.1** | | |
| **21.129** | **24.1** | **17.6** | **5.7** | **2.6** | **0.8** | **0.8** | **0.8** | | |
| **21.058** | **32.4** | **9.9** | **6.5** | **1.9** | **1** | **0.4** | **0.3** | | |
| **22.347** | **36.6** | **18.6** | **5.3** | **2.8** | **1** | **0.3** | **0.1** | | |
| **19.855** | **19.2** | **12.2** | **5.4** | **1.9** | **1.2** | **0.6** | **0.3** | | |
| **21.412** | **43.7** | **8.6** | **3.5** | **1.8** | **0.7** | **0.5** | **0.1** | | |
| **26.062** | **49** | **36.6** | **7.7** | **3.1** | **1.1** | **0.4** | **0.3** | | |

**Table 8.2.8 (Cont.) Plaice in VIIe. Tuning fleet data available** (data in bold have been used for tuning)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **UK-WECBT** | | | | | | | | |
| **1989** | **2010** | | | | | | | |
| **1** | **1** | **0** | **1** | | | | | |
| **3** | **9** | | | | | | | |
| **109.947** | **922.6** | **784.7** | **210.1** | **96.9** | **48.9** | **35.2** | **7.5** | |
| **100.947** | **1053.9** | **826.9** | **326.5** | **77.2** | **54.4** | **23.5** | **13.1** | |
| **83.574** | **365.7** | **641.3** | **355.6** | **159.9** | **35.7** | **11.3** | **8.1** | |
| **80.865** | **465.5** | **308** | **293.7** | **172** | **89.2** | **25.9** | **9.7** | |
| **83.918** | **543.6** | **248.2** | **102.7** | **114.7** | **89.6** | **66.6** | **14.3** | |
| **100.415** | **659** | **312.7** | **104.4** | **43.1** | **53.3** | **34.7** | **38** | |
| **100.797** | **285.7** | **343.6** | **101.6** | **51.4** | **18.9** | **34.3** | **33.5** | |
| **116.446** | **221.8** | **115** | **126.4** | **41.1** | **21.5** | **12.6** | **19.2** | |
| **108.388** | **683.6** | **76.7** | **43.9** | **46.9** | **20.7** | **9.6** | **5.4** | |
| **111.171** | **413.3** | **297.9** | **48.6** | **26.1** | **26.7** | **8.8** | **8.8** | |
| **103.555** | **747.8** | **274.5** | **135.3** | **40** | **14.4** | **16** | **8** | |
| **118.833** | **388.4** | **529.8** | **111.8** | **54.7** | **11** | **5.4** | **6.8** | |
| **143.272** | **248.7** | **283.6** | **393.2** | **61** | **35** | **7.4** | **4** | |
| **139.832** | **497.3** | **164.6** | **148.5** | **197.6** | **46.8** | **19.2** | **4.5** | |
| **159.894** | **495.5** | **260.2** | **95** | **81.9** | **116.1** | **26.8** | **22.9** | |
| **158.681** | **690** | **299.6** | **168.3** | **49.9** | **40.1** | **51.6** | **24.9** | |
| **157.812** | **464.1** | **355.3** | **136.4** | **71.6** | **24.9** | **23** | **27.3** | |
| **161.44** | **599** | **202.1** | **159.3** | **52.5** | **27.5** | **11.2** | **8.3** | |
| **158.005** | **416.7** | **246.1** | **100.2** | **67.6** | **27.3** | **13.2** | **4.3** | |
| **158.501** | **261.7** | **187.1** | **94.7** | **41.4** | **25.5** | **14.1** | **6.3** | |
| **122.528** | **617.7** | **135.5** | **63.3** | **34.8** | **11.4** | **10.4** | **4** | |
| **128.448** | **388.1** | **291** | **89.4** | **50.2** | **19.3** | **7.3** | **9** | |
| **UK-WECOT (historic)** | | | | | | | | |
| **1976** | **1987** | | | | | | | |
| **1** | **1** | **0** | **1** | | | | | |
| **2** | **9** | | | | | | | |
| **22.771** | **13.7** | **80.4** | **20.2** | **14.2** | **7.5** | **7.7** | **4.8** | **1.8** |
| **21.194** | **60.1** | **29.4** | **25.8** | **8.1** | **4.8** | **3** | **4.5** | **1.4** |
| **16.823** | **18.8** | **71.1** | **8** | **10.6** | **3.8** | **2.3** | **2** | **1.6** |
| **16.981** | **42.5** | **57.1** | **44.5** | **5.7** | **6.1** | **2.9** | **1.9** | **1.2** |
| **13.647** | **53.1** | **50.8** | **14.7** | **13.4** | **4** | **4.2** | **1.4** | **1** |
| **15.172** | **76.6** | **216.2** | **44.4** | **11** | **10.3** | **1.8** | **5** | **1.6** |
| **14.422** | **27** | **169.1** | **111.9** | **19.5** | **7.1** | **7.3** | **1.1** | **2.6** |
| **19.117** | **103.7** | **102.2** | **173.4** | **75.3** | **12.4** | **4.8** | **5.5** | **0.3** |
| **15.8** | **100.5** | **155** | **49.7** | **40.6** | **16.3** | **7.7** | **2.2** | **3.2** |
| **17.545** | **60.5** | **129.6** | **102.4** | **12.9** | **21.2** | **13.4** | **2.1** | **0.4** |
| **20.758** | **108.3** | **254.8** | **77.8** | **44.1** | **8.2** | **12.9** | **7.4** | **3.3** |
| **17.995** | **116.3** | **208.7** | **124.7** | **62.2** | **22** | **5.6** | **4.2** | **4.1** |
| **UK(E+W) FSP** | | | | | | | | |
| **2003** | **2010** | | | | | | | |
| **1** | **1** | **0.75** | **0.8** | | | | | |
| **2** | **8** | | | | | | | |
| **1** | **0.295** | **0.320** | **0.159** | **0.061** | **0.047** | **0.090** | **0.038** | 0.025 |
| **1** | **0.288** | **0.567** | **0.220** | **0.130** | **0.022** | **0.038** | **0.047** | 0.019 |
| **1** | **0.296** | **0.362** | **0.235** | **0.086** | **0.044** | **0.010** | **0.016** | 0.032 |
| **1** | **0.492** | **0.375** | **0.175** | **0.097** | **0.036** | **0.027** | **0.006** | 0.008 |
| **1** | **0.132** | **0.294** | **0.139** | **0.068** | **0.034** | **0.010** | **0.006** | 0.005 |
| -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 |
| **1** | **0.362** | **0.373** | **0.153** | **0.049** | **0.028** | **0.019** | **0.006** | 0.003 |
| **1** | **0.711** | **0.567** | **0.436** | **0.046** | **0.034** | **0.014** | **0.010** | 0.003 |

**Table 8.2.9. Plaice in VIIe Diagnostics.**

Lowestoft VPA Version 3.1

11/05/2011 14:28

Extended Survivors Analysis

W.CHANNEL PLAICE 2011 WGCSE

cpue data from file c:\vpa\PLE7ETU5.dat

Catch data for 31 years. 1980 to 2010. Ages 1 to 10.

| Fleet | First year | Last year | First age | Last age | Alpha | Beta |
|---|---|---|---|---|---|---|
| UK-WEC-BTS | 1986 | 2010 | 1 | 8 | .750 | .800 |
| UK WECOT | 1988 | 2010 | 3 | 9 | .000 | 1.000 |
| UK WECBT | 1989 | 2010 | 3 | 9 | .000 | 1.000 |
| UK WECOT historic | 1980 | 2010 | 2 | 9 | .000 | 1.000 |
| FSP-7e UK(E+W) | 2003 | 2010 | 2 | 8 | .750 | .800 |

Time-series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 4 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2.500

Minimum standard error for population
estimates derived from each fleet = .500

Prior weighting not applied

Tuning converged after 28 iterations

Regression weights

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

Fishing mortalities

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .001 | .032 | .006 | .005 | .005 | .007 | .000 | .001 | .001 | .001 |
| 2 | .169 | .387 | .219 | .208 | .228 | .343 | .195 | .209 | .174 | .106 |
| 3 | .562 | .587 | .615 | .602 | .597 | .697 | .682 | .584 | .432 | .351 |
| 4 | .599 | .769 | .593 | .647 | .666 | .661 | .838 | .758 | .413 | .418 |
| 5 | .580 | .689 | .601 | .719 | .656 | .658 | .817 | .726 | .405 | .503 |
| 6 | .363 | .649 | .597 | .615 | .687 | .594 | .753 | .761 | .449 | .536 |
| 7 | .420 | .501 | .598 | .509 | .663 | .614 | .750 | .767 | .439 | .422 |
| 8 | .483 | .458 | .421 | .503 | .700 | .907 | .654 | .868 | .393 | .377 |
| 9 | .645 | .628 | .802 | .650 | .518 | .700 | .786 | .717 | .449 | .672 |

XSA population numbers (Thousands)

| | AGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2001 | 5.23E+03 | 3.99E+03 | 2.34E+03 | 1.87E+03 | 2.29E+03 | 5.07E+02 | 2.44E+02 | 5.20E+01 | 2.57E+01 |
| 2002 | 6.31E+03 | 4.63E+03 | 2.99E+03 | 1.18E+03 | 9.13E+02 | 1.14E+03 | 3.13E+02 | 1.42E+02 | 2.84E+01 |
| 2003 | 3.85E+03 | 5.42E+03 | 2.79E+03 | 1.48E+03 | 4.86E+02 | 4.07E+02 | 5.27E+02 | 1.68E+02 | 7.98E+01 |
| 2004 | 4.91E+03 | 3.39E+03 | 3.86E+03 | 1.34E+03 | 7.23E+02 | 2.36E+02 | 1.99E+02 | 2.57E+02 | 9.80E+01 |
| 2005 | 4.52E+03 | 4.34E+03 | 2.44E+03 | 1.88E+03 | 6.21E+02 | 3.12E+02 | 1.13E+02 | 1.06E+02 | 1.38E+02 |
| 2006 | 2.91E+03 | 3.99E+03 | 3.06E+03 | 1.19E+03 | 8.55E+02 | 2.86E+02 | 1.39E+02 | 5.17E+01 | 4.66E+01 |
| 2007 | 6.45E+03 | 2.57E+03 | 2.51E+03 | 1.35E+03 | 5.47E+02 | 3.93E+02 | 1.40E+02 | 6.69E+01 | 1.85E+01 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | 5.56E+03 | 5.71E+03 | 1.87E+03 | 1.13E+03 | 5.19E+02 | 2.14E+02 | 1.64E+02 | 5.87E+01 | 3.08E+01 |
| 2009 | 1.01E+04 | 4.93E+03 | 4.11E+03 | 9.26E+02 | 4.68E+02 | 2.23E+02 | 8.88E+01 | 6.76E+01 | 2.18E+01 |
| 2010 | 2.12E+04 | 8.92E+03 | 3.67E+03 | 2.37E+03 | 5.43E+02 | 2.77E+02 | 1.26E+02 | 5.08E+01 | 4.05E+01 |

**Table 8.2.9 Plaice in VIIe Diagnostics (continued).**

Estimated population abundance at 1st Jan 2011

0.00E+00 1.88E+04 7.12E+03 2.29E+03 1.38E+03 2.91E+02 1.44E+02 7.34E+01 3.09E+01

Taper weighted geometric mean of the VPA populations:

6.33E+03 5.41E+03 3.91E+03 1.92E+03 8.49E+02 4.03E+02 2.12E+02 1.12E+02 5.87E+01

Standard error of the weighted Log(VPA populations) :

.5050 .4593 .4900 .5580 .5501 .5785 .6187 .6592 .7501

Log-catchability residuals.

Fleet : UK-WEC-BTS

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.24 | 1.86 | .87 | -.04 | -.38 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .16 | -.36 | .91 | -.81 | -.57 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .59 | .05 | .24 | -.01 | .02 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .42 | .27 | .36 | .15 | -.45 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .14 | .49 | -.10 | -.40 | -.01 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.61 | .83 | .10 | -.14 | -1.96 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .79 | 1.05 | -.04 | .31 | -.43 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.92 | .63 | .47 | .07 | -1.72 |
| 9 | No data for this fleet at this age | | | | | | | | | |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -.61 | 1.05 | -.11 | .24 | -.27 | -.55 | -.51 | .64 | .29 | .30 |
| 2 | -.90 | -.66 | -.31 | -.39 | .02 | -.12 | .12 | -.37 | -.63 | .19 |
| 3 | -.28 | -.22 | -.53 | -.30 | -.16 | -.65 | .33 | -.17 | -.42 | .15 |
| 4 | -.11 | -.53 | -.48 | -.41 | -.10 | -.34 | -.06 | .34 | -.27 | .28 |
| 5 | .08 | -.05 | -.23 | -.61 | -.37 | .19 | -.46 | -.23 | .15 | .33 |
| 6 | .25 | -.28 | .40 | -1.31 | -.54 | -.33 | .39 | .43 | -.39 | .77 |
| 7 | -.22 | -.54 | -.37 | -.51 | -.01 | -1.61 | .49 | .09 | -.32 | -1.12 |
| 8 | 99.99 | -.88 | -.34 | .04 | -.22 | .30 | -.92 | .57 | .53 | .30 |
| 9 | No data for this fleet at this age | | | | | | | | | |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -.24 | 1.05 | -.05 | -1.16 | -.20 | .86 | -.32 | -1.04 | -1.55 | .11 |
| 2 | -.03 | .44 | .44 | -.42 | .04 | .53 | .76 | .48 | .68 | .80 |
| 3 | -.28 | .02 | -.28 | -.52 | .23 | .22 | .59 | .27 | .52 | .59 |
| 4 | .74 | -.25 | .15 | -.38 | .28 | -.11 | .05 | .12 | -.01 | .36 |
| 5 | .49 | .05 | -.93 | -.44 | -.20 | .36 | .81 | .02 | .11 | .78 |
| 6 | .70 | .57 | .75 | -.38 | -.74 | -.71 | -.19 | .75 | .80 | .84 |
| 7 | .48 | -.67 | .55 | -1.73 | -.08 | -.03 | .50 | .90 | 1.05 | 1.45 |
| 8 | 99.99 | -.83 | .21 | .31 | .53 | 99.99 | -.63 | 1.09 | .82 | -.56 |
| 9 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Mean Log q | -9.9458 | -9.0569 | -8.1984 | -8.1893 | -8.2942 | -8.5133 | -8.1737 | -8.1737 |
| S.E(Log q) | .7652 | .5329 | .3689 | .3357 | .4180 | .7334 | .7962 | .7142 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 1 | .96 | .155 | 9.89 | .35 | 25 | .75 | -9.95 |
| 2 | .95 | .226 | 9.03 | .48 | 25 | .52 | -9.06 |
| 3 | .90 | .711 | 8.20 | .71 | 25 | .34 | -8.20 |
| 4 | .86 | 1.293 | 8.11 | .80 | 25 | .29 | -8.19 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | .85 | 1.206 | 8.06 | .73 | 25 | .35 | -8.29 |
| 6 | .94 | .235 | 8.37 | .41 | 25 | .70 | -8.51 |
| 7 | 1.18 | -.565 | 8.68 | .30 | 25 | .95 | -8.17 |
| 8 | 1.46 | -1.333 | 9.77 | .30 | 22 | 1.02 | -8.23 |

**Table 8.2.9 Plaice in VIIe Diagnostics (continued).**

Fleet : UK WECOT

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .59 | .39 | .34 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .10 | .53 | .46 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .39 | .58 | .05 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .08 | .56 | .18 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .14 | -.01 | .63 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .45 | .12 | .50 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.12 | -.27 | .07 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | .17 | .01 | -.06 | -.09 | .22 | .11 | .59 | .09 | -.47 | -.30 |
| 4 | .45 | .31 | .04 | .04 | .19 | .04 | -.24 | .44 | -.16 | -.32 |
| 5 | .30 | .27 | -.01 | -.23 | -.08 | .14 | -.14 | .01 | .05 | -.23 |
| 6 | .13 | .27 | -.02 | -.35 | .20 | -.04 | -.21 | .07 | .15 | .05 |
| 7 | .15 | .05 | .17 | -.26 | -.44 | .13 | -.10 | -.28 | .23 | .17 |
| 8 | .06 | .24 | .13 | -.67 | -.10 | .18 | -.49 | -.63 | -.19 | -.02 |
| 9 | .25 | -.13 | .01 | -.31 | -.14 | -.13 | -.22 | .23 | -.18 | .21 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | -.37 | .11 | -.22 | -.15 | -.25 | -.13 | .12 | -.15 | -.26 | -.27 |
| 4 | -.22 | -.06 | -.36 | -.12 | -.29 | -.41 | .11 | -.04 | -.42 | -.11 |
| 5 | -.18 | -.01 | -.20 | .16 | -.14 | -.32 | -.07 | .08 | -.47 | .02 |
| 6 | -.54 | .16 | -.21 | .10 | -.03 | -.29 | -.21 | .13 | -.18 | -.01 |
| 7 | -.13 | .01 | -.08 | -.28 | -.02 | -.02 | -.03 | .12 | -.02 | -.13 |
| 8 | -.20 | -.07 | -.29 | -.14 | .06 | .18 | -.54 | .50 | -.11 | -.25 |
| 9 | .06 | .58 | -.07 | .24 | -.28 | -.09 | -.29 | .38 | -.56 | -.18 |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|
| Mean Log q | -7.0830 | -7.0640 | -7.2422 | -7.4345 | -7.6159 | -7.6159 | -7.6159 |
| S.E(Log q) | .2911 | .2920 | .2389 | .2364 | .2185 | .3376 | .2672 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 3 | .82 | 2.004 | 7.29 | .85 | 23 | .22 | -7.08 |
| 4 | .79 | 2.824 | 7.17 | .89 | 23 | .20 | -7.06 |
| 5 | .84 | 2.398 | 7.16 | .91 | 23 | .18 | -7.24 |
| 6 | .90 | 1.370 | 7.29 | .89 | 23 | .21 | -7.43 |
| 7 | .96 | .564 | 7.52 | .90 | 23 | .21 | -7.62 |
| 8 | .96 | .416 | 7.55 | .82 | 23 | .32 | -7.67 |
| 9 | 1.03 | -.388 | 7.77 | .88 | 23 | .28 | -7.66 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Fleet : UK WECBT

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.31 | .18 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.15 | .19 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.07 | -.20 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .03 | -.15 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.01 | .31 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | -.03 | -.02 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | .03 | -.28 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | .23 | .54 | .52 | .36 | .33 | -.14 | .11 | -.39 | -.31 | -.23 |
| 4 | .53 | .74 | .53 | .46 | .33 | -.10 | -.52 | -.06 | -.17 | -.33 |
| 5 | .33 | .60 | .42 | .23 | .16 | .01 | -.20 | -.24 | .02 | -.41 |
| 6 | -.05 | .35 | .34 | .09 | .23 | -.17 | -.12 | .02 | .37 | -.30 |
| 7 | -.07 | .04 | .38 | .04 | -.05 | -.07 | .04 | -.02 | .24 | -.30 |
| 8 | -.47 | .19 | .29 | -.19 | .15 | .13 | -.14 | -.10 | .12 | -.25 |
| 9 | -.25 | -.07 | .14 | .14 | .29 | .06 | .24 | .53 | .53 | -.25 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | No data for this fleet at this age | | | | | | | | | |
| 3 | -.43 | .05 | .00 | .00 | .07 | .12 | -.03 | -.25 | .01 | -.42 |
| 4 | -.21 | -.20 | -.17 | .10 | -.06 | -.19 | -.02 | -.15 | -.17 | -.39 |
| 5 | -.11 | -.09 | -.08 | .15 | .07 | -.11 | -.04 | -.09 | -.27 | -.08 |
| 6 | -.54 | -.02 | -.03 | .04 | .15 | -.13 | -.10 | .01 | -.08 | .06 |
| 7 | -.28 | -.17 | .12 | .01 | .16 | .01 | .08 | -.14 | -.22 | -.10 |
| 8 | -.25 | -.29 | -.28 | .00 | .17 | .23 | .05 | .34 | -.06 | -.18 |
| 9 | -.09 | -.06 | .48 | .30 | -.01 | -.05 | .27 | .11 | .14 | .38 |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|
| Mean Log q | -6.4536 | -6.3026 | -6.2864 | -6.3127 | -6.3739 | -6.3739 | -6.3739 |
| S.E(Log q) | .2907 | .3301 | .2387 | .2129 | .1741 | .2161 | .2714 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 3 | 1.10 | -.652 | 6.28 | .67 | 22 | .32 | -6.45 |
| 4 | .95 | .426 | 6.37 | .77 | 22 | .32 | -6.30 |
| 5 | .94 | .745 | 6.31 | .88 | 22 | .23 | -6.29 |
| 6 | 1.01 | -.065 | 6.31 | .89 | 22 | .22 | -6.31 |
| 7 | .92 | 1.549 | 6.29 | .95 | 22 | .15 | -6.37 |
| 8 | .97 | .429 | 6.35 | .92 | 22 | .21 | -6.40 |
| 9 | 1.06 | -.784 | 6.38 | .89 | 22 | .26 | -6.26 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Fleet : UK WECOT historic

| Age | 1980 |
|---|---|
| 1 | No data for this fleet at this age |
| 2 | -.16 |
| 3 | -.25 |
| 4 | -.37 |
| 5 | -.34 |
| 6 | .38 |
| 7 | -.41 |
| 8 | -.39 |
| 9 | .00 |

| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | .08 | -.06 | .25 | .54 | -.30 | .09 | -.44 | 99.99 | 99.99 | 99.99 |
| 3 | .26 | .02 | .08 | -.06 | -.18 | .12 | .03 | 99.99 | 99.99 | 99.99 |
| 4 | -.02 | .22 | .35 | .11 | -.05 | -.40 | .17 | 99.99 | 99.99 | 99.99 |
| 5 | -.03 | .05 | .50 | .08 | -.50 | -.18 | .42 | 99.99 | 99.99 | 99.99 |
| 6 | -.12 | .29 | .00 | -.08 | .11 | -.53 | -.05 | 99.99 | 99.99 | 99.99 |
| 7 | .14 | -.02 | .19 | .23 | .11 | .02 | -.26 | 99.99 | 99.99 | 99.99 |
| 8 | .16 | .54 | -.05 | .34 | -.57 | -.03 | -.36 | 99.99 | 99.99 | 99.99 |
| 9 | .23 | .11 | -.24 | .17 | -.41 | .30 | .17 | 99.99 | 99.99 | 99.99 |

| Age | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 | 99.99 |

Mean log-catchability and standard error of ages with catchability independent of year-class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Mean Log q | -7.2670 | -5.9585 | -5.8030 | -5.9634 | -6.0641 | -5.9756 | -5.9756 | -5.9756 |
| S.E(Log q) | .3115 | .1647 | .2705 | .3447 | .2798 | .2255 | .3850 | .2512 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | 1.43 | -1.131 | 6.58 | .54 | 8 | .44 | -7.27 |
| 3 | .83 | 1.323 | 6.37 | .91 | 8 | .13 | -5.96 |
| 4 | .79 | 1.596 | 6.18 | .91 | 8 | .19 | -5.80 |
| 5 | .73 | 1.525 | 6.18 | .84 | 8 | .23 | -5.96 |
| 6 | 1.32 | -1.450 | 6.10 | .77 | 8 | .34 | -6.06 |
| 7 | 1.12 | -.741 | 6.06 | .87 | 8 | .26 | -5.98 |
| 8 | 1.47 | -1.576 | 6.69 | .65 | 8 | .51 | -6.02 |
| 9 | .81 | 2.931 | 5.53 | .98 | 8 | .14 | -5.93 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Fleet : FSP-7e UK(E+W)

| Age | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No data for this fleet at this age | | | | | | | | | |
| 2 | 99.99 | 99.99 | -.29 | .14 | -.06 | .62 | -.37 | 99.99 | -.03 | .00 |
| 3 | 99.99 | 99.99 | -.06 | .18 | .18 | .07 | .02 | 99.99 | -.43 | .04 |
| 4 | 99.99 | 99.99 | -.27 | .20 | -.06 | .09 | -.12 | 99.99 | .02 | .13 |
| 5 | 99.99 | 99.99 | .02 | .47 | .16 | -.04 | .17 | 99.99 | -.32 | -.45 |
| 6 | 99.99 | 99.99 | .00 | -.20 | .27 | .09 | -.16 | 99.99 | -.03 | .02 |
| 7 | 99.99 | 99.99 | .23 | .28 | -.37 | .37 | -.52 | 99.99 | .34 | -.33 |
| 8 | 99.99 | 99.99 | .38 | .23 | .19 | .09 | -.37 | 99.99 | -.58 | .21 |
| 9 | No data for this fleet at this age | | | | | | | | | |

Mean log-catchability and standard error of ages with catchability
independent of year-class strength and constant w.r.t. time

| Age | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Mean Log q | -9.2604 | -8.4468 | -8.3170 | -8.4399 | -8.5152 | -8.3539 | -8.3539 |
| S.E(Log q) | .3247 | .2099 | .1614 | .3112 | .1573 | .3887 | .3535 |

Regression statistics :

Ages with q independent of year-class strength and constant w.r.t. time.

| Age | Slope | t-value | Intercept | RSquare | No Pts | Reg s.e | Mean Q |
|---|---|---|---|---|---|---|---|
| 2 | .96 | .109 | 9.23 | .61 | 7 | .34 | -9.26 |
| 3 | 1.80 | -1.119 | 8.76 | .28 | 7 | .37 | -8.45 |
| 4 | .98 | .078 | 8.30 | .79 | 7 | .17 | -8.32 |
| 5 | .61 | 1.119 | 7.64 | .62 | 7 | .19 | -8.44 |
| 6 | .95 | .181 | 8.37 | .71 | 7 | .16 | -8.52 |
| 7 | .85 | .629 | 7.85 | .77 | 7 | .35 | -8.35 |
| 8 | .79 | 1.175 | 7.54 | .86 | 7 | .27 | -8.33 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Terminal year survivor and F summaries:

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 20990. | .780 | .000 | .00 | 1 | .911 | .001 |
| UK WECOT | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| UK WECBT | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| F shrinkage mean | 6059. | 2.50 | | | | .089 | .003 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 18796. | .74 | .37 | 2 | .497 | .001 |

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 7339. | .446 | 1.102 | 2.47 | 2 | .546 | .103 |
| UK WECOT | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| UK WECBT | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 7105. | .500 | .000 | .00 | 1 | .435 | .106 |
| F shrinkage mean | 3072. | 2.50 | | | | .019 | .230 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 7115. | .33 | .48 | 4 | 1.441 | .106 |

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 3247. | .334 | .441 | 1.32 | 3 | .345 | .260 |
| UK WECOT | 1754. | .500 | .000 | .00 | 1 | .168 | .438 |
| UK WECBT | 1502. | .500 | .000 | .00 | 1 | .168 | .496 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 2305. | .355 | .033 | .09 | 2 | .309 | .349 |
| F shrinkage mean | 1169. | 2.50 | | | | .010 | .601 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 2291. | .20 | .18 | 8 | .892 | .351 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 1995. | .288 | .133 | .46 | 4 | .316 | .307 |
| UK WECOT | 1167. | .361 | .075 | .21 | 2 | .225 | .479 |
| UK WECBT | 1096. | .361 | .198 | .55 | 2 | .225 | .503 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 1265. | .361 | .277 | .77 | 2 | .225 | .449 |
| F shrinkage mean | 750. | 2.50 | | | | .008 | .671 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 1383. | .17 | .11 | 11 | .621 | .418 |

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 475. | .270 | .178 | .66 | 5 | .284 | .337 |
| UK WECOT | 249. | .309 | .139 | .45 | 3 | .239 | .568 |
| UK WECBT | 253. | .309 | .047 | .15 | 3 | .239 | .561 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 220. | .315 | .154 | .49 | 3 | .231 | .624 |
| F shrinkage mean | 206. | 2.50 | | | | .008 | .656 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 291. | .15 | .11 | 15 | .702 | .503 |

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2004

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 206. | .294 | .148 | .50 | 6 | .216 | .401 |
| UK WECOT | 124. | .293 | .126 | .43 | 4 | .267 | .599 |
| UK WECBT | 133. | .293 | .085 | .29 | 4 | .267 | .570 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 135. | .314 | .133 | .42 | 4 | .242 | .562 |
| F shrinkage mean | 111. | 2.50 | | | | .009 | .652 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 144. | .15 | .07 | 19 | .477 | .536 |

**Table 8.2.9. Plaice in VIIe Diagnostics (continued).**

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2003

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 138. | .333 | .265 | .79 | 7 | .166 | .246 |
| UK WECOT | 67. | .288 | .049 | .17 | 5 | .287 | .456 |
| UK WECBT | 68. | .288 | .020 | .07 | 5 | .287 | .450 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 61. | .316 | .076 | .24 | 5 | .253 | .492 |
| F shrinkage mean | 42. | 2.50 | | | | .008 | .650 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 73. | .15 | .09 | 23 | .559 | .422 |

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2002

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 37. | .369 | .265 | .72 | 8 | .151 | .327 |
| UK WECOT | 27. | .283 | .066 | .23 | 6 | .293 | .418 |
| UK WECBT | 26. | .283 | .038 | .13 | 6 | .293 | .428 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 39. | .313 | .032 | .10 | 6 | .256 | .307 |
| F shrinkage mean | 14. | 2.50 | | | | .008 | .708 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 31. | .15 | .07 | 27 | .443 | .377 |

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2001

| Fleet | Estimated Survivors | Int s.e | Ext s.e | Var Ratio | N | Scaled Weights | Estimated F |
|---|---|---|---|---|---|---|---|
| UK-WEC-BTS | 33. | .393 | .150 | .38 | 8 | .105 | .423 |
| UK WECOT | 16. | .277 | .045 | .16 | 7 | .363 | .735 |
| UK WECBT | 21. | .277 | .096 | .35 | 7 | .363 | .615 |
| UK WECOT historic | 1. | .000 | .000 | .00 | 0 | .000 | .000 |
| FSP-7e UK(E+W) | 12. | .357 | .102 | .29 | 6 | .156 | .905 |
| F shrinkage mean | 30. | 2.50 | | | | .012 | .461 |

Weighted prediction :

| Survivors at end of year | Int s.e | Ext s.e | N | Var Ratio | F |
|---|---|---|---|---|---|
| 18. | .16 | .07 | 29 | .423 | .672 |

## Table 8.2.10 Plaice in VIIe. Fishing mortality-at-age.

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

| YEAR | 1980 |
|---|---|
| AGE | |
| 1 | 0.0024 |
| 2 | 0.1242 |
| 3 | 0.433 |
| 4 | 0.4919 |
| 5 | 0.4282 |
| 6 | 0.7305 |
| 7 | 0.3466 |
| 8 | 0.3914 |
| 9 | 0.4644 |
| +gp | 0.4644 |
| FBAR 3- 6 | 0.5209 |

Table 8 Fishing mortality (F) at age

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.0121 | 0.0098 | 0.0005 | 0.0097 | 0.0004 | 0.0006 | 0.0055 | 0.0012 | 0.0024 | 0.0127 |
| 2 | 0.1087 | 0.1092 | 0.1304 | 0.1834 | 0.1091 | 0.1505 | 0.0881 | 0.1773 | 0.0413 | 0.1114 |
| 3 | 0.5365 | 0.4804 | 0.4689 | 0.4632 | 0.4708 | 0.6029 | 0.5301 | 0.5576 | 0.4082 | 0.6165 |
| 4 | 0.5999 | 0.6958 | 0.8103 | 0.7552 | 0.69 | 0.5218 | 0.7305 | 0.5059 | 0.673 | 0.7535 |
| 5 | 0.4157 | 0.5307 | 0.641 | 0.5781 | 0.3348 | 0.4953 | 0.7479 | 0.5106 | 0.7759 | 0.5781 |
| 6 | 0.3151 | 0.5654 | 0.374 | 0.4094 | 0.5504 | 0.4034 | 0.4229 | 0.3519 | 0.5881 | 0.556 |
| 7 | 0.5128 | 0.4086 | 0.5063 | 0.6077 | 0.5301 | 0.5442 | 0.5708 | 0.3505 | 0.4642 | 0.5873 |
| 8 | 0.4286 | 0.9872 | 0.4186 | 0.7736 | 0.3427 | 0.4711 | 0.3968 | 0.4882 | 0.506 | 0.574 |
| 9 | 0.5758 | 0.4379 | 0.2938 | 0.49 | 1.1751 | 0.6192 | 0.6008 | 0.3075 | 0.8236 | 0.5714 |
| +gp | 0.5758 | 0.4379 | 0.2938 | 0.49 | 1.1751 | 0.6192 | 0.6008 | 0.3075 | 0.8236 | 0.5714 |
| FBAR 3- 6 | 0.4668 | 0.5681 | 0.5735 | 0.5515 | 0.5115 | 0.5058 | 0.6078 | 0.4815 | 0.6113 | 0.626 |

Table 8 Fishing mortality (F) at age

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 0.008 | 0.0154 | 0.0134 | 0.0299 | 0.0008 | 0.0022 | 0.0007 | 0.0014 | 0.0059 | 0.0109 |
| 2 | 0.1916 | 0.2067 | 0.1787 | 0.1894 | 0.1877 | 0.1904 | 0.1766 | 0.072 | 0.1664 | 0.1491 |
| 3 | 0.6152 | 0.6793 | 0.6133 | 0.5916 | 0.6357 | 0.5586 | 0.689 | 0.497 | 0.3978 | 0.5122 |
| 4 | 0.7945 | 0.7739 | 0.6902 | 0.8272 | 0.7456 | 0.6796 | 0.7542 | 0.7551 | 0.7156 | 0.6152 |
| 5 | 0.5929 | 0.6164 | 0.6178 | 0.5818 | 0.5888 | 0.6849 | 0.6991 | 0.5358 | 0.6068 | 0.6528 |
| 6 | 0.4799 | 0.5522 | 0.5105 | 0.5123 | 0.5399 | 0.5547 | 0.5777 | 0.5232 | 0.637 | 0.5299 |
| 7 | 0.3953 | 0.4274 | 0.5157 | 0.3998 | 0.5059 | 0.521 | 0.7499 | 0.4297 | 0.5965 | 0.5233 |
| 8 | 0.3623 | 0.4673 | 0.4908 | 0.3387 | 0.4926 | 0.743 | 0.5799 | 0.4519 | 0.503 | 0.4203 |
| 9 | 0.4586 | 0.4368 | 0.4597 | 0.4482 | 0.4778 | 0.5291 | 0.806 | 0.7824 | 0.6478 | 0.5044 |
| +gp | 0.4586 | 0.4368 | 0.4597 | 0.4482 | 0.4778 | 0.5291 | 0.806 | 0.7824 | 0.6478 | 0.5044 |
| FBAR 3- 6 | 0.6206 | 0.6555 | 0.6079 | 0.6282 | 0.6275 | 0.6194 | 0.68 | 0.5778 | 0.5893 | 0.5775 |

Table 8 Fishing mortality (F) at age

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | FBAR 08-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 1 | 0.0012 | 0.0321 | 0.0064 | 0.0046 | 0.0053 | 0.0067 | 0.0004 | 0.001 | 0.0006 | 0.0009 | 0.0008 |
| 2 | 0.1689 | 0.3869 | 0.219 | 0.208 | 0.2275 | 0.3426 | 0.1948 | 0.209 | 0.1743 | 0.106 | 0.1631 |
| 3 | 0.5619 | 0.5869 | 0.6153 | 0.6019 | 0.5967 | 0.6971 | 0.682 | 0.5844 | 0.4322 | 0.3512 | 0.4559 |
| 4 | 0.599 | 0.769 | 0.5934 | 0.6471 | 0.6656 | 0.6608 | 0.8378 | 0.758 | 0.4132 | 0.4177 | 0.5296 |
| 5 | 0.5804 | 0.6888 | 0.6014 | 0.7188 | 0.6561 | 0.6579 | 0.817 | 0.7262 | 0.4046 | 0.5032 | 0.5447 |
| 6 | 0.3626 | 0.6487 | 0.5967 | 0.6152 | 0.6875 | 0.5937 | 0.7525 | 0.7606 | 0.4489 | 0.5357 | 0.5818 |
| 7 | 0.4201 | 0.5006 | 0.598 | 0.5093 | 0.6633 | 0.6138 | 0.7502 | 0.7673 | 0.4387 | 0.4215 | 0.5425 |
| 8 | 0.4829 | 0.4577 | 0.4209 | 0.503 | 0.7003 | 0.9069 | 0.6542 | 0.8678 | 0.3926 | 0.3773 | 0.5459 |
| 9 | 0.6449 | 0.6284 | 0.8017 | 0.65 | 0.5183 | 0.7001 | 0.7863 | 0.7171 | 0.4488 | 0.6716 | 0.6125 |
| +gp | 0.6449 | 0.6284 | 0.8017 | 0.65 | 0.5183 | 0.7001 | 0.7863 | 0.7171 | 0.4488 | 0.6716 | |
| FBAR 3- 6 | 0.526 | 0.6734 | 0.6017 | 0.6458 | 0.6515 | 0.6524 | 0.7723 | 0.7073 | 0.4247 | 0.4520 | |

## Table 8.2.11 Plaice in VIIe. Stock numbers-at-age.

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 1980 |
|---|---|
| AGE | |
| 1 | 8426 |
| 2 | 7403 |
| 3 | 2418 |
| 4 | 689 |
| 5 | 700 |
| 6 | 128 |
| 7 | 229 |
| 8 | 76 |
| 9 | 38 |
| +gp | 392 |
| TOTAL | 20499 |

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 3635 | 7808 | 6936 | 8502 | 8787 | 17872 | 14314 | 10429 | 4450 | 4802 |
| 2 | 7455 | 3185 | 6858 | 6149 | 7468 | 7790 | 15841 | 12626 | 9238 | 3937 |
| 3 | 5799 | 5931 | 2532 | 5339 | 4540 | 5939 | 5944 | 12865 | 9379 | 7862 |
| 4 | 1391 | 3008 | 3254 | 1405 | 2979 | 2515 | 2882 | 3103 | 6534 | 5531 |
| 5 | 374 | 677 | 1330 | 1283 | 586 | 1325 | 1324 | 1231 | 1659 | 2956 |
| 6 | 404 | 219 | 353 | 622 | 639 | 372 | 716 | 556 | 655 | 677 |
| 7 | 55 | 262 | 110 | 216 | 366 | 327 | 220 | 416 | 347 | 323 |
| 8 | 143 | 29 | 154 | 59 | 104 | 191 | 168 | 110 | 260 | 193 |
| 9 | 46 | 83 | 10 | 90 | 24 | 66 | 106 | 100 | 60 | 139 |
| +gp | 230 | 362 | 414 | 138 | 79 | 141 | 121 | 212 | 189 | 176 |
| TOTAL | 19532 | 21565 | 21952 | 23802 | 25571 | 36536 | 41637 | 41649 | 32772 | 26597 |

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 5433 | 6267 | 2874 | 3033 | 8019 | 7137 | 10969 | 5302 | 3470 | 4553 |
| 2 | 4206 | 4780 | 5473 | 2515 | 2611 | 7107 | 6316 | 9722 | 4696 | 3060 |
| 3 | 3124 | 3080 | 3447 | 4060 | 1846 | 1919 | 5210 | 4695 | 8024 | 3526 |
| 4 | 3764 | 1498 | 1385 | 1656 | 1993 | 867 | 974 | 2320 | 2533 | 4781 |
| 5 | 2309 | 1508 | 613 | 616 | 642 | 839 | 390 | 406 | 967 | 1098 |
| 6 | 1471 | 1132 | 722 | 293 | 305 | 316 | 375 | 172 | 211 | 468 |
| 7 | 345 | 807 | 578 | 385 | 156 | 158 | 161 | 187 | 90 | 99 |
| 8 | 159 | 206 | 467 | 306 | 229 | 83 | 83 | 67 | 108 | 44 |
| 9 | 97 | 98 | 114 | 254 | 193 | 124 | 35 | 41 | 38 | 58 |
| +gp | 148 | 149 | 245 | 189 | 249 | 276 | 192 | 121 | 101 | 139 |
| TOTAL | 21054 | 19525 | 15919 | 13306 | 16242 | 18825 | 24705 | 23034 | 20238 | 17825 |

Table 10 Stock number at age (start of year) Numbers*10**-3

| YEAR | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | GMST 80-08 | AMST 80-08 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | | |
| 1 | 5230 | 6307 | 3849 | 4912 | 4517 | 2913 | 6445 | 5560 | 10062 | 21212 | 0 | 5974 | 6647 |
| 2 | 3994 | 4633 | 5417 | 3392 | 4337 | 3985 | 2566 | 5714 | 4927 | 8919 | 18796 | 5335 | 5947 |
| 3 | 2338 | 2992 | 2791 | 3860 | 2444 | 3064 | 2509 | 1873 | 4112 | 3670 | 7115 | 3911 | 4460 |
| 4 | 1874 | 1182 | 1475 | 1338 | 1875 | 1193 | 1353 | 1125 | 926 | 2367 | 2291 | 1958 | 2292 |
| 5 | 2292 | 913 | 486 | 723 | 621 | 855 | 547 | 519 | 468 | 543 | 1383 | 880 | 1027 |
| 6 | 507 | 1138 | 407 | 236 | 312 | 286 | 393 | 214 | 223 | 277 | 291 | 417 | 493 |
| 7 | 244 | 313 | 527 | 199 | 113 | 139 | 140 | 164 | 89 | 126 | 144 | 222 | 265 |
| 8 | 52 | 142 | 168 | 257 | 106 | 52 | 67 | 59 | 68 | 51 | 73 | 117 | 143 |
| 9 | 26 | 28 | 80 | 98 | 138 | 47 | 19 | 31 | 22 | 40 | 31 | 62 | 79 |
| +gp | 83 | 94 | 75 | 84 | 114 | 94 | 94 | 58 | 47 | 53 | 42 | | |
| TOTAL | 16639 | 17743 | 15275 | 15099 | 14577 | 12628 | 14133 | 15318 | 20943 | 37259 | 30168 | | |

# Table 8.2.12 Plaice in VIIe. Summary

Run title : W.CHANNEL PLAICE 2011 WGCSE

At 11/05/2011 14:29

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

| | RECRUITS Age 1 | TOTALBIO | TOTSPBIO | LANDINGS | YIELD/SSB | FBAR 3- 6 |
|---|---|---|---|---|---|---|
| 1980 | 8426 | 5046 | 2406 | 1215 | 0.5050 | 0.5209 |
| 1981 | 3635 | 6250 | 3279 | 1746 | 0.5326 | 0.4668 |
| 1982 | 7808 | 5894 | 3464 | 1938 | 0.5595 | 0.5681 |
| 1983 | 6936 | 6225 | 3657 | 1754 | 0.4797 | 0.5735 |
| 1984 | 8502 | 6377 | 3479 | 1813 | 0.5210 | 0.5515 |
| 1985 | 8787 | 6671 | 3556 | 1751 | 0.4923 | 0.5115 |
| 1986 | 17872 | 7571 | 3743 | 2161 | 0.5774 | 0.5058 |
| 1987 | 14314 | 7081 | 3615 | 2388 | 0.6607 | 0.6078 |
| 1988 | 10429 | 9802 | 5149 | 2994 | 0.5815 | 0.4815 |
| 1989 | 4450 | 8989 | 5475 | 2808 | 0.5130 | 0.6113 |
| 1990 | 4802 | 8585 | 5285 | 3058 | 0.5786 | 0.6260 |
| 1991 | 5433 | 6640 | 4300 | 2250 | 0.5232 | 0.6206 |
| 1992 | 6267 | 6557 | 3585 | 1950 | 0.5440 | 0.6555 |
| 1993 | 2874 | 5145 | 3057 | 1691 | 0.5532 | 0.6079 |
| 1994 | 3033 | 4444 | 2711 | 1471 | 0.5425 | 0.6282 |
| 1995 | 8019 | 4862 | 2411 | 1295 | 0.5369 | 0.6275 |
| 1996 | 7137 | 4910 | 2368 | 1321 | 0.5579 | 0.6194 |
| 1997 | 10969 | 6414 | 2500 | 1654 | 0.6616 | 0.6800 |
| 1998 | 5302 | 5876 | 2665 | 1430 | 0.5366 | 0.5778 |
| 1999 | 3470 | 4959 | 2956 | 1616 | 0.5468 | 0.5893 |
| 2000 | 4553 | 4795 | 3288 | 1678 | 0.5104 | 0.5775 |
| 2001 | 5230 | 4452 | 2718 | 1379 | 0.5073 | 0.5260 |
| 2002 | 6307 | 4922 | 2507 | 1608 | 0.6414 | 0.6734 |
| 2003 | 3849 | 4249 | 2503 | 1478 | 0.5906 | 0.6017 |
| 2004 | 4912 | 4865 | 2271 | 1402 | 0.6174 | 0.6458 |
| 2005 | 4517 | 4530 | 2252 | 1370 | 0.6083 | 0.6515 |
| 2006 | 2913 | 3849 | 2059 | 1466 | 0.7118 | 0.6524 |
| 2007 | 6445 | 3606 | 1725 | 1184 | 0.6863 | 0.7723 |
| 2008 | 5560 | 4025 | 1677 | 1144 | 0.6820 | 0.7073 |
| 2009 | 10062 | 3411 | 1868 | 1065 | 0.5701 | 0.4247 |
| 2010 | 5007* | 7717 | 2629 | 1227 | 0.4667 | 0.4520 |
| Arith. Mean | 7227 | 5765 | 3070 | 1720 | 0.5676 | 0.5908 |
| Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | |

* replaced with GM89-08 recruitment (21212)

**Table 8.2.13 VIIe plaice : Catch forecast input data**

MFDP version 1a
Run: p7e2011wg
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

**2011**

| **Age** | ***N*** | ***M*** | ***Mat*** | ***PF*** | ***PM*** | ***SWt*** | ***Sel*** | ***CWt*** |
|---|---|---|---|---|---|---|---|---|
| 1 | 5007 | 0.12 | 0 | 0 | 0 | 0.113 | 0.001 | 0.162 |
| 2 | 4438 | 0.12 | 0.26 | 0 | 0 | 0.212 | 0.140 | 0.262 |
| 3 | 7115 | 0.12 | 0.52 | 0 | 0 | 0.313 | 0.390 | 0.364 |
| 4 | 2291 | 0.12 | 0.86 | 0 | 0 | 0.416 | 0.453 | 0.468 |
| 5 | 1383 | 0.12 | 1 | 0 | 0 | 0.520 | 0.466 | 0.573 |
| 6 | 291 | 0.12 | 1 | 0 | 0 | 0.626 | 0.498 | 0.680 |
| 7 | 144 | 0.12 | 1 | 0 | 0 | 0.735 | 0.464 | 0.789 |
| 8 | 73 | 0.12 | 1 | 0 | 0 | 0.844 | 0.467 | 0.900 |
| 9 | 31 | 0.12 | 1 | 0 | 0 | 0.956 | 0.524 | 1.012 |
| 10 | 42 | 0.12 | 1 | 0 | 0 | 1.230 | 0.524 | 1.289 |

**2012**

| **Age** | **N** | **M** | **Mat** | **PF** | **PM** | **SWt** | **Sel** | **CWt** |
|---|---|---|---|---|---|---|---|---|
| 1 | 5007 | 0.12 | 0 | 0 | 0 | 0.113 | 0.001 | 0.162 |
| 2 | . | 0.12 | 0.26 | 0 | 0 | 0.212 | 0.140 | 0.262 |
| 3 | . | 0.12 | 0.52 | 0 | 0 | 0.313 | 0.390 | 0.364 |
| 4 | . | 0.12 | 0.86 | 0 | 0 | 0.416 | 0.453 | 0.468 |
| 5 | . | 0.12 | 1 | 0 | 0 | 0.520 | 0.466 | 0.573 |
| 6 | . | 0.12 | 1 | 0 | 0 | 0.626 | 0.498 | 0.680 |
| 7 | . | 0.12 | 1 | 0 | 0 | 0.735 | 0.464 | 0.789 |
| 8 | . | 0.12 | 1 | 0 | 0 | 0.844 | 0.467 | 0.900 |
| 9 | . | 0.12 | 1 | 0 | 0 | 0.956 | 0.524 | 1.012 |
| 10 | *.* | *0.12* | *1* | *0* | *0* | *1.230* | *0.524* | *1.289* |

**2013**

| **Age** | **N** | **M** | **Mat** | **PF** | **PM** | **SWt** | **Sel** | **CWt** |
|---|---|---|---|---|---|---|---|---|
| 1 | 5007 | 0.12 | 0 | 0 | 0 | 0.113 | 0.001 | 0.162 |
| 2 | . | 0.12 | 0.26 | 0 | 0 | 0.212 | 0.140 | 0.262 |
| 3 | . | 0.12 | 0.52 | 0 | 0 | 0.313 | 0.390 | 0.364 |
| 4 | . | 0.12 | 0.86 | 0 | 0 | 0.416 | 0.453 | 0.468 |
| 5 | . | 0.12 | 1 | 0 | 0 | 0.520 | 0.466 | 0.573 |
| 6 | . | 0.12 | 1 | 0 | 0 | 0.626 | 0.498 | 0.680 |
| 7 | . | 0.12 | 1 | 0 | 0 | 0.735 | 0.464 | 0.789 |
| 8 | . | 0.12 | 1 | 0 | 0 | 0.844 | 0.467 | 0.900 |
| 9 | . | 0.12 | 1 | 0 | 0 | 0.956 | 0.524 | 1.012 |
| 10 | . | 0.12 | 1 | 0 | 0 | 1.230 | 0.524 | 1.289 |

Input units are thousands and kg - output in tonnes

**Table 8.2.14 VIIe plaice : management option table - status quo forecast**

MFDP version 1a
Run: p7e2011wg
W.CHANNEL PLAICE 2011 WGCSE forecast inputs
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

| 2011 | | | | |
|---|---|---|---|---|
| Biomass | SSB | FMult | FBar | Landings |
| 5835 | 3371 | 1.0000 | 0.4520 | 1755 |

| 2012 | | | | | 2013 | |
|---|---|---|---|---|---|---|
| Biomass | SSB | FMult | FBar | Landings | Biomass | SSB |
| 5774 | 3751 | 0.0000 | 0.0000 | 0 | 7460 | 5431 |
| . | 3751 | 0.1000 | 0.0452 | 212 | 7237 | 5223 |
| . | 3751 | 0.2000 | 0.0904 | 416 | 7024 | 5024 |
| . | 3751 | 0.3000 | 0.1356 | 611 | 6819 | 4834 |
| . | 3751 | 0.4000 | 0.1808 | 798 | 6623 | 4652 |
| . | 3751 | 0.5000 | 0.2260 | 978 | 6435 | 4477 |
| . | 3751 | 0.6000 | 0.2712 | 1151 | 6255 | 4310 |
| . | 3751 | 0.7000 | 0.3164 | 1316 | 6082 | 4150 |
| . | 3751 | 0.8000 | 0.3616 | 1475 | 5916 | 3997 |
| . | 3751 | 0.9000 | 0.4068 | 1627 | 5757 | 3851 |
| . | 3751 | 1.0000 | 0.4520 | 1773 | 5605 | 3710 |
| . | 3751 | 1.1000 | 0.4971 | 1914 | 5458 | 3575 |
| . | 3751 | 1.2000 | 0.5423 | 2049 | 5318 | 3447 |
| . | 3751 | 1.3000 | 0.5875 | 2178 | 5183 | 3323 |
| . | 3751 | 1.4000 | 0.6327 | 2303 | 5054 | 3205 |
| . | 3751 | 1.5000 | 0.6779 | 2422 | 4930 | 3092 |
| . | 3751 | 1.6000 | 0.7231 | 2537 | 4811 | 2983 |
| . | 3751 | 1.7000 | 0.7683 | 2647 | 4697 | 2879 |
| . | 3751 | 1.8000 | 0.8135 | 2753 | 4587 | 2779 |
| . | 3751 | 1.9000 | 0.8587 | 2855 | 4482 | 2684 |
| . | 3751 | 2.0000 | 0.9039 | 2952 | 4381 | 2592 |

Input units are thousands and kg - output in tonnes

**Table 8.2.15** **VIIe plaice : forecast detailed results - status quo projection**

MFDP version 1a
Run: p7e2011wg
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

| Year: | 2011 | F multiplier: | 1 | Fbar: | 0.452 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.1332 | 3 | 1 | 5007 | 566 | 0 | 0 | 0 | 0 |
| 2 | 0.1396 | 546 | 143 | 4438 | 939 | 1154 | 244 | 1154 | 244 |
| 3 | 0.3903 | 2175 | 792 | 7115 | 2227 | 3700 | 1158 | 3700 | 1158 |
| 4 | 0.4534 | 790 | 370 | 2291 | 952 | 1970 | 819 | 1970 | 819 |
| 5 | 0.4662 | 488 | 280 | 1383 | 719 | 1383 | 719 | 1383 | 719 |
| 6 | 0.498 | 108 | 74 | 291 | 182 | 291 | 182 | 291 | 182 |
| 7 | 0.4644 | 51 | 40 | 144 | 106 | 144 | 106 | 144 | 106 |
| 8 | 0.4673 | 26 | 23 | 73 | 62 | 73 | 62 | 73 | 62 |
| 9 | 0.5243 | 12 | 12 | 31 | 30 | 31 | 30 | 31 | 30 |
| 10 | 0.5243 | 16 | 21 | 42 | 52 | 42 | 52 | 42 | 52 |
| Total | | 4215 | 1755 | 20815 | 5835 | 8788 | 3371 | 8788 | 3371 |

| Year: | 2012 | F multiplier: | 1 | Fbar: | 0.452 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.1332 | 3 | 1 | 5007 | 566 | 0 | 0 | 0 | 0 |
| 2 | 0.1396 | 546 | 143 | 4438 | 939 | 1154 | 244 | 1154 | 244 |
| 3 | 0.3903 | 1046 | 381 | 3423 | 1071 | 1780 | 557 | 1780 | 557 |
| 4 | 0.4534 | 1474 | 689 | 4271 | 1775 | 3673 | 1527 | 3673 | 1527 |
| 5 | 0.4662 | 456 | 261 | 1291 | 671 | 1291 | 671 | 1291 | 671 |
| 6 | 0.498 | 286 | 194 | 770 | 482 | 770 | 482 | 770 | 482 |
| 7 | 0.4644 | 55 | 44 | 157 | 115 | 157 | 115 | 157 | 115 |
| 8 | 0.4673 | 28 | 26 | 80 | 68 | 80 | 68 | 80 | 68 |
| 9 | 0.5243 | 16 | 16 | 41 | 39 | 41 | 39 | 41 | 39 |
| 10 | 0.5243 | 15 | 19 | 38 | 47 | 38 | 47 | 38 | 47 |
| Total | | 3925 | 1773 | 19516 | 5774 | 8984 | 3751 | 8984 | 3751 |

| Year: | 2013 | F multiplier: | 1 | Fbar: | 0.452 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | F | CatchNos | Yield | StockNos | Biomass | SSNos(Jan) | SSB(Jan) | SSNos(ST) | SSB(ST) |
| 1 | 0.1332 | 3 | 1 | 5007 | 566 | 0 | 0 | 0 | 0 |
| 2 | 0.1396 | 546 | 143 | 4438 | 939 | 1154 | 244 | 1154 | 244 |
| 3 | 0.3903 | 1046 | 381 | 3423 | 1071 | 1780 | 557 | 1780 | 557 |
| 4 | 0.4534 | 709 | 332 | 2055 | 854 | 1767 | 735 | 1767 | 735 |
| 5 | 0.4662 | 849 | 487 | 2407 | 1252 | 2407 | 1252 | 2407 | 1252 |
| 6 | 0.498 | 267 | 182 | 718 | 450 | 718 | 450 | 718 | 450 |
| 7 | 0.4644 | 146 | 115 | 415 | 305 | 415 | 305 | 415 | 305 |
| 8 | 0.4673 | 31 | 28 | 87 | 74 | 87 | 74 | 87 | 74 |
| 9 | 0.5243 | 17 | 17 | 45 | 43 | 45 | 43 | 45 | 43 |
| 10 | 0.5243 | 16 | 21 | 41 | 51 | 41 | 51 | 41 | 51 |
| Total | | 3631 | 1706 | 18637 | 5605 | 8415 | 3710 | 8415 | 3710 |

Input units are thousands and kg - output in tonnes -

**Table 8.2.16** **Plaice in VIIe**
**Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes**

| Year-class | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Stock No. (thousands) of 1 year-olds | 5560 | 10062 | 5007 | 5007 | 5007 |
| Source | XSA | XSA | GM89-08 | GM89-08 | GM89-08 |
| Status Quo F: | | | | | |
| % in 2011 landings | 21.1 | 45.1 | 8.1 | 0.1 | - |
| % in 2012 | 14.7 | 38.8 | 21.5 | 8.1 | 0.1 |
| % in 2011 SSB | 24.3 | 34.3 | 7.2 | 0.0 | - |
| % in 2012 SSB | 17.9 | 40.7 | 14.9 | 6.5 | 0.0 |
| % in 2013 SSB | 12.1 | 33.7 | 19.8 | 15.0 | 6.6 |

GM : geometric mean recruitment

**Plaice in VIIe : Year-class % contribution to**

**a ) 2012 landings** **b ) 2013 SSB**

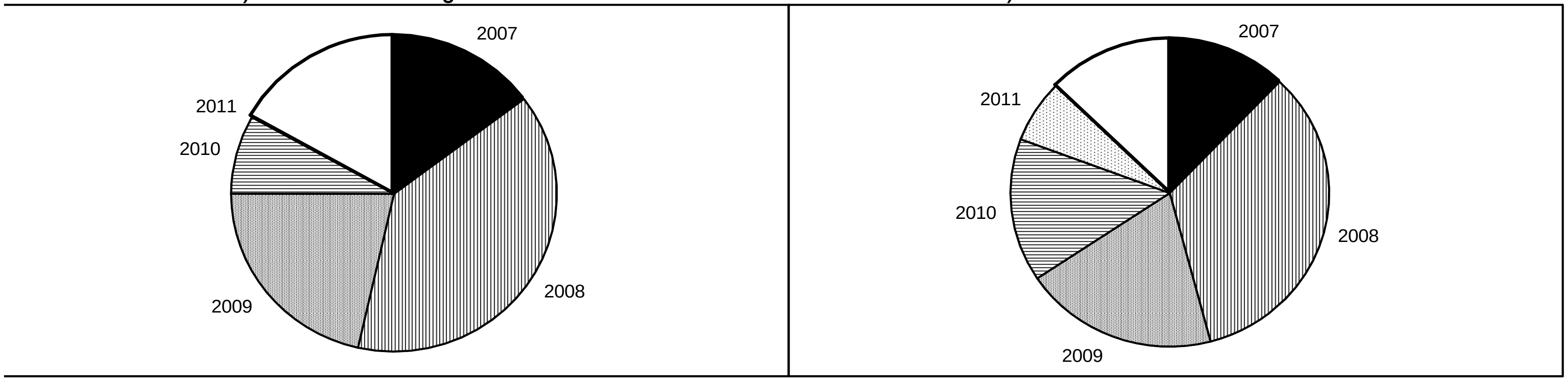


**Table 8.2.17 VIIe plaice : Yield per recruit**

MFYPR version 2a
Run: p7e2011
Time and date: 08:49 15/05/2011
Yield per results

| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJan | SSBJan | SpwnNosSpwn | SSBSpwn |
|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 8.8433 | 6.2842 | 6.7118 | 5.8735 | 6.7118 | 5.8735 |
| 0.1000 | 0.0452 | 0.2321 | 0.1901 | 6.9120 | 4.1388 | 4.7908 | 3.7318 | 4.7908 | 3.7318 |
| 0.2000 | 0.0904 | 0.3584 | 0.2649 | 5.8631 | 3.0452 | 3.7519 | 2.6419 | 3.7519 | 2.6419 |
| 0.3000 | 0.1356 | 0.4384 | 0.2966 | 5.1989 | 2.3976 | 3.0974 | 1.9977 | 3.0974 | 1.9977 |
| 0.4000 | 0.1808 | 0.4941 | 0.3095 | 4.7379 | 1.9771 | 2.6458 | 1.5807 | 2.6458 | 1.5807 |
| 0.5000 | 0.2260 | 0.5352 | 0.3137 | 4.3978 | 1.6864 | 2.3148 | 1.2932 | 2.3148 | 1.2932 |
| 0.6000 | 0.2712 | 0.5670 | 0.3137 | 4.1357 | 1.4757 | 2.0615 | 1.0857 | 2.0615 | 1.0857 |
| 0.7000 | 0.3164 | 0.5924 | 0.3117 | 3.9269 | 1.3175 | 1.8613 | 0.9305 | 1.8613 | 0.9305 |
| 0.8000 | 0.3616 | 0.6131 | 0.3087 | 3.7563 | 1.1951 | 1.6990 | 0.8110 | 1.6990 | 0.8110 |
| 0.9000 | 0.4068 | 0.6305 | 0.3054 | 3.6142 | 1.0980 | 1.5649 | 0.7168 | 1.5649 | 0.7168 |
| 1.0000 | 0.4520 | 0.6452 | 0.3021 | 3.4937 | 1.0195 | 1.4522 | 0.6411 | 1.4522 | 0.6411 |
| 1.1000 | 0.4971 | 0.6579 | 0.2989 | 3.3901 | 0.9548 | 1.3563 | 0.5791 | 1.3563 | 0.5791 |
| 1.2000 | 0.5423 | 0.6690 | 0.2958 | 3.3001 | 0.9007 | 1.2736 | 0.5276 | 1.2736 | 0.5276 |
| 1.3000 | 0.5875 | 0.6787 | 0.2929 | 3.2209 | 0.8549 | 1.2016 | 0.4843 | 1.2016 | 0.4843 |
| 1.4000 | 0.6327 | 0.6874 | 0.2902 | 3.1508 | 0.8156 | 1.1384 | 0.4474 | 1.1384 | 0.4474 |
| 1.5000 | 0.6779 | 0.6952 | 0.2877 | 3.0882 | 0.7816 | 1.0826 | 0.4157 | 1.0826 | 0.4157 |
| 1.6000 | 0.7231 | 0.7022 | 0.2853 | 3.0318 | 0.7518 | 1.0328 | 0.3883 | 1.0328 | 0.3883 |
| 1.7000 | 0.7683 | 0.7085 | 0.2831 | 2.9808 | 0.7256 | 0.9882 | 0.3642 | 0.9882 | 0.3642 |
| 1.8000 | 0.8135 | 0.7143 | 0.2811 | 2.9344 | 0.7023 | 0.9480 | 0.3431 | 0.9480 | 0.3431 |
| 1.9000 | 0.8587 | 0.7196 | 0.2792 | 2.8920 | 0.6814 | 0.9117 | 0.3243 | 0.9117 | 0.3243 |
| 2.0000 | 0.9039 | 0.7245 | 0.2774 | 2.8530 | 0.6627 | 0.8786 | 0.3076 | 0.8786 | 0.3076 |

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(3-6) | 1.0000 | 0.452 |
| FMax | 0.5465 | 0.247 |
| F0.1 | 0.251 | 0.1134 |
| F35%SPR | 0.2889 | 0.1306 |

Weights in kilograms

**Figure 8.2.1 VIIe plaice: UK(E&W) commercial fleet LPUE and effort; and survey CPUE**

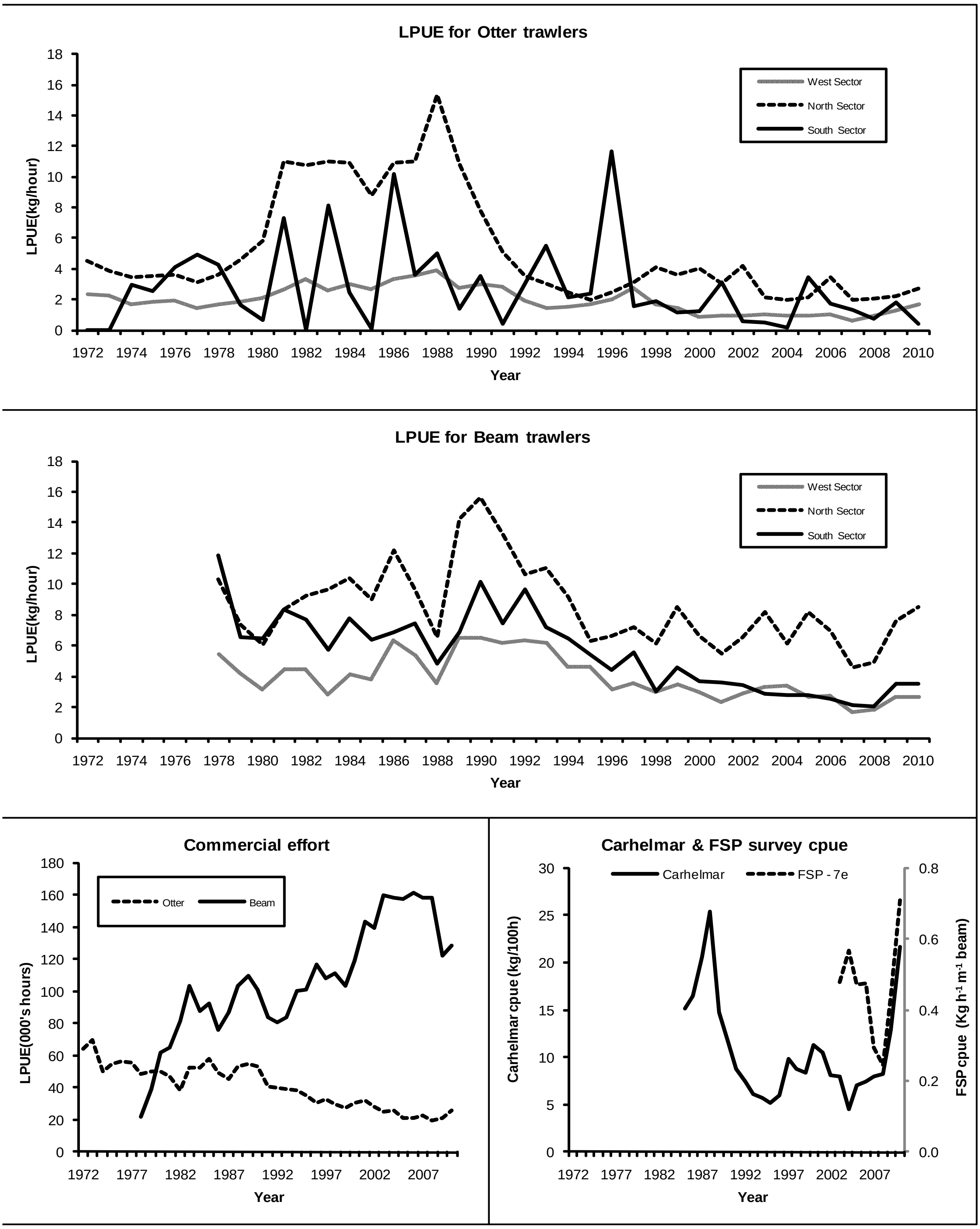


**Figure 8.2.2 Plaice VIIe Discards - French Annual by fleet (2010)**

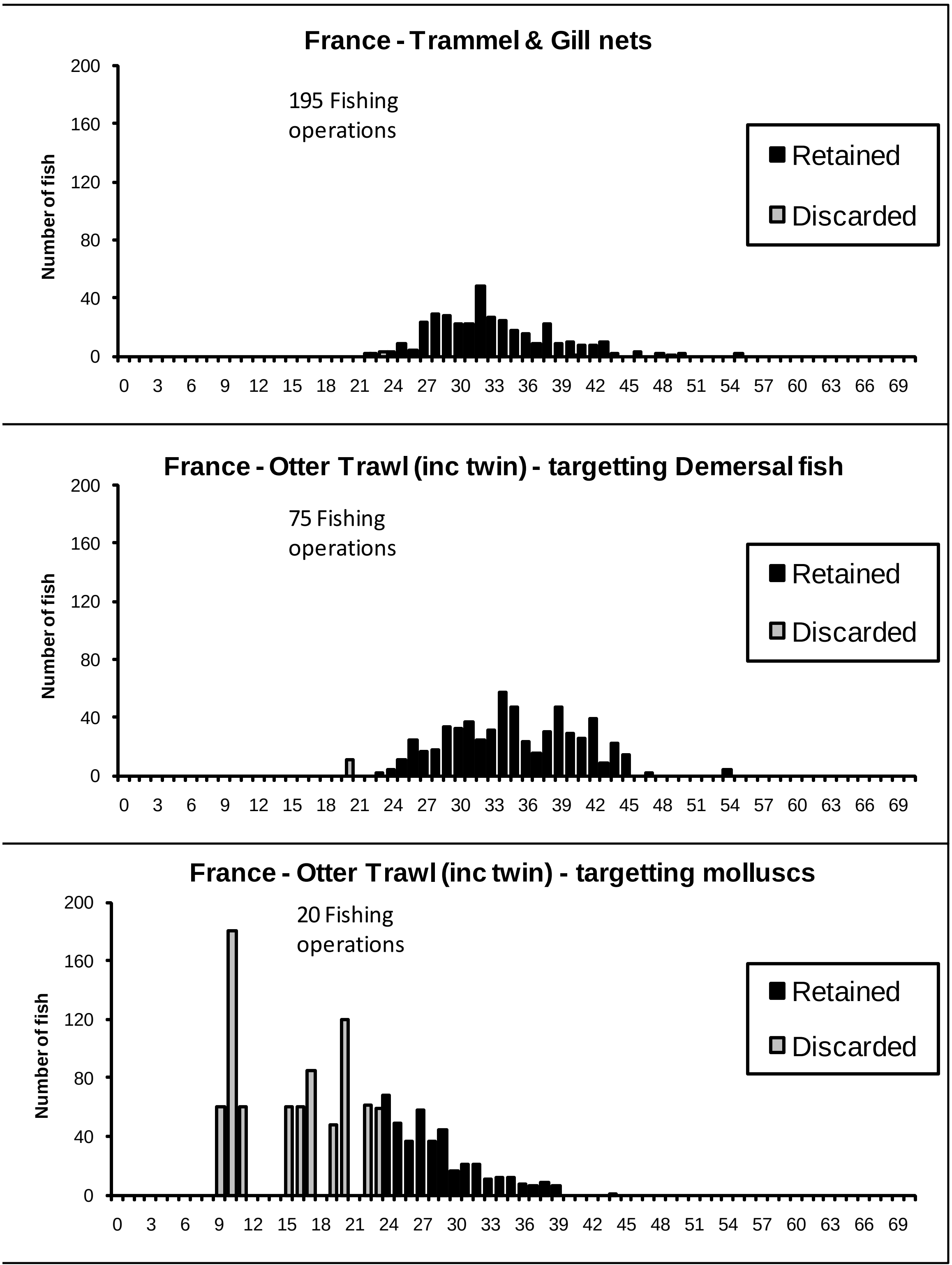


**Figure 8.2.2 (cont.) Plaice VIIe Discards - UK by Quarter (2010)**

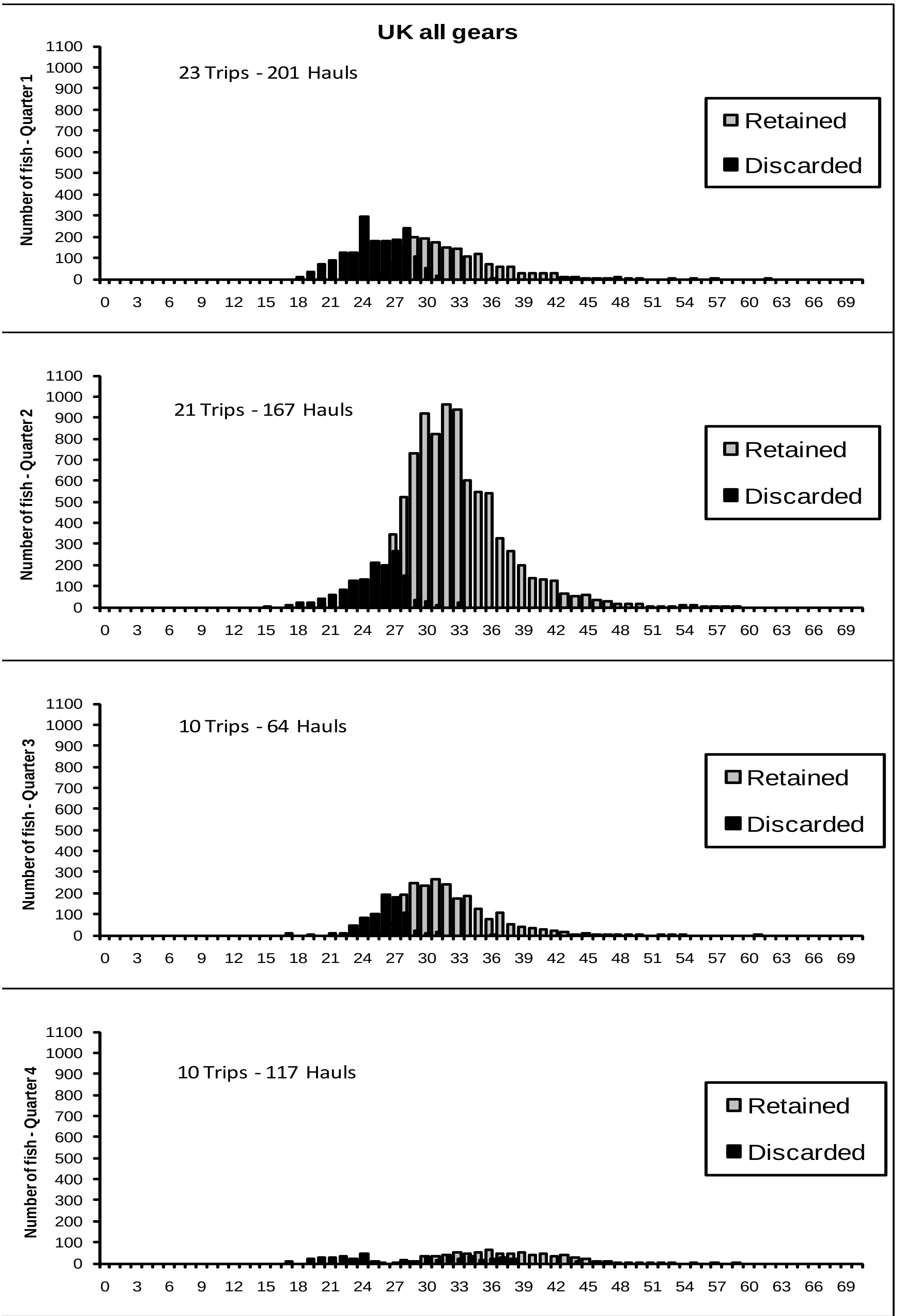
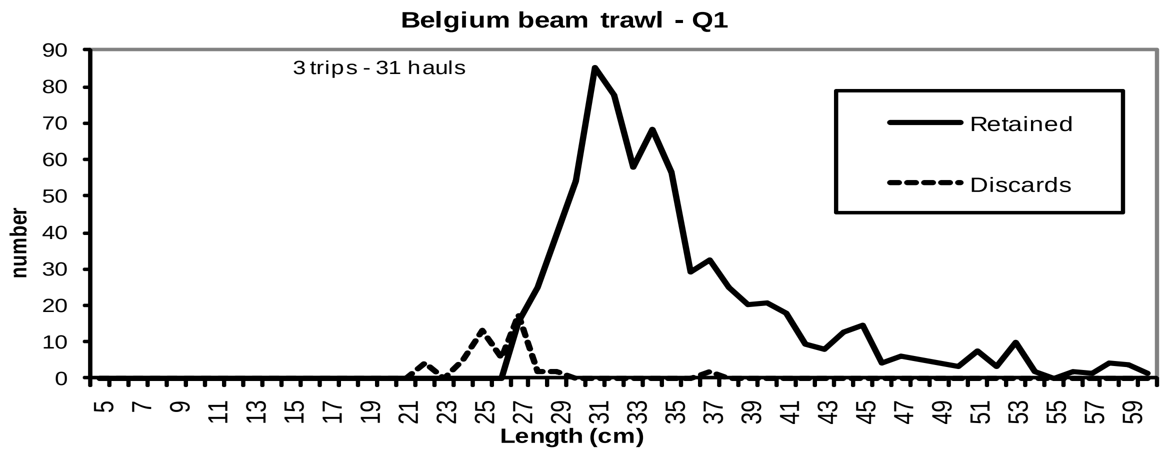
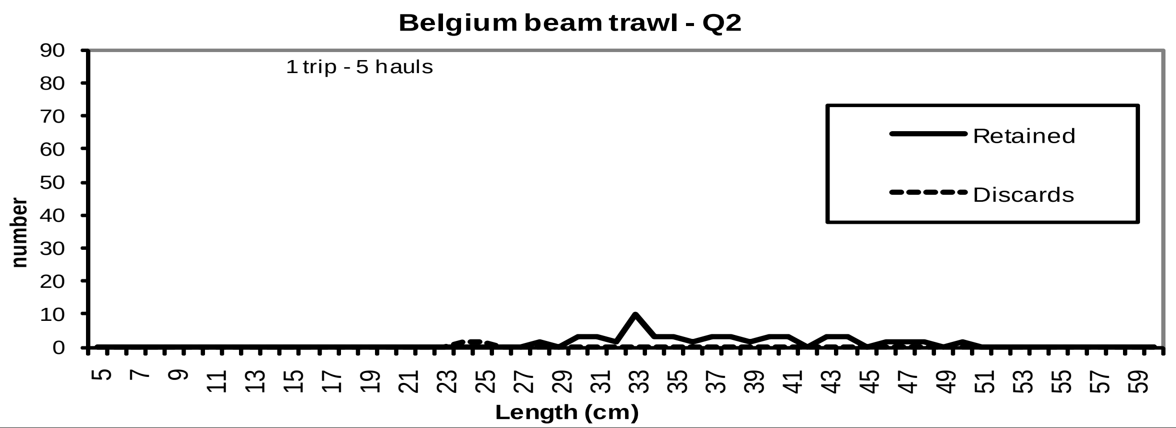
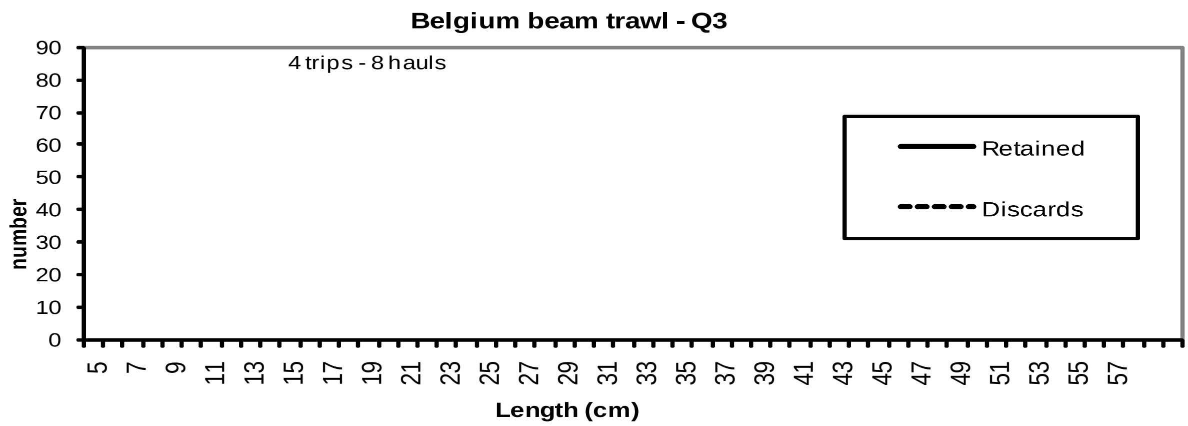


**Figure 8.2.2 (cont.) Plaice VIIe Discards - Belgium by Quarter (2010)**



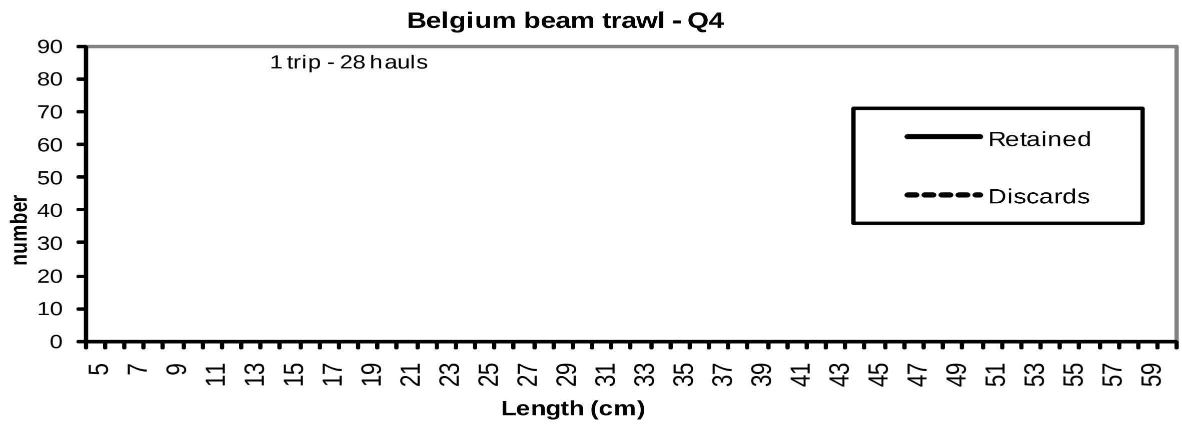



**Figure 8.2.3 : Plaice in Division VIIe Length distributions of UK (England & Wales) landings from 2001 to 2010**

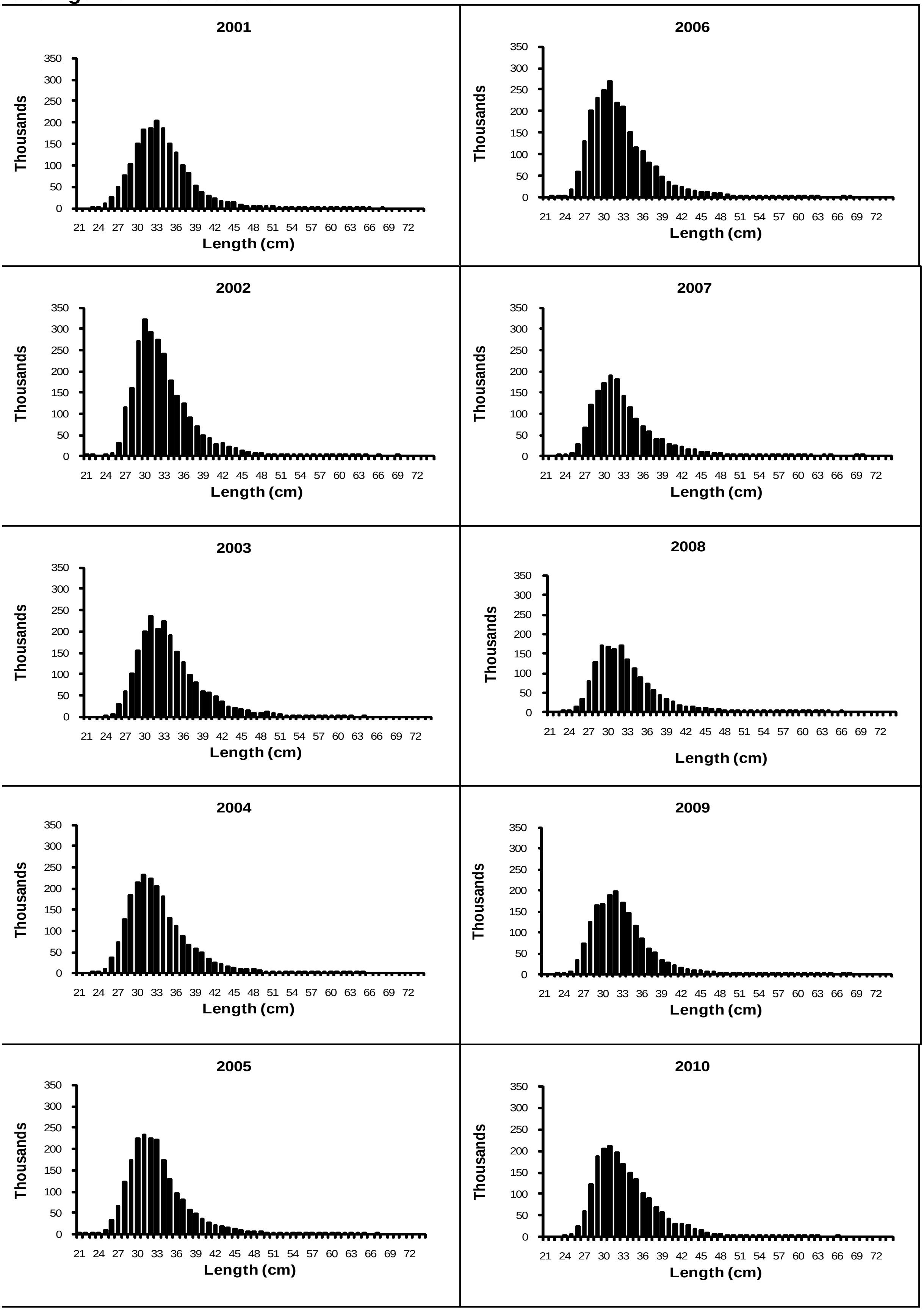


**Figure 8.2.4 : Plaice in Division VIIe Age composition of international landings 2001-2010**

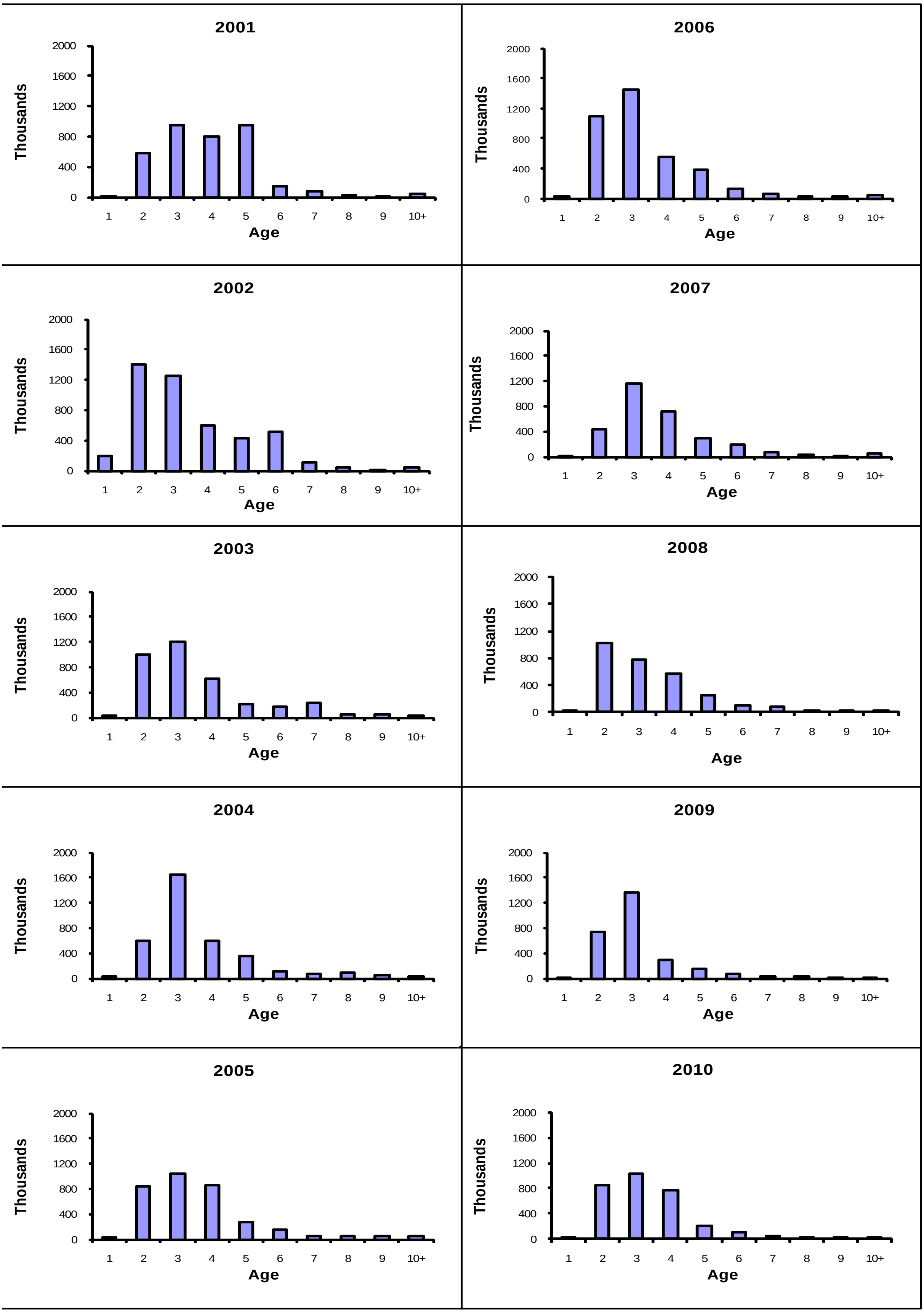


**Figure 8.2.5 VIIe Plaice fleet log catchability residuals from the final run**

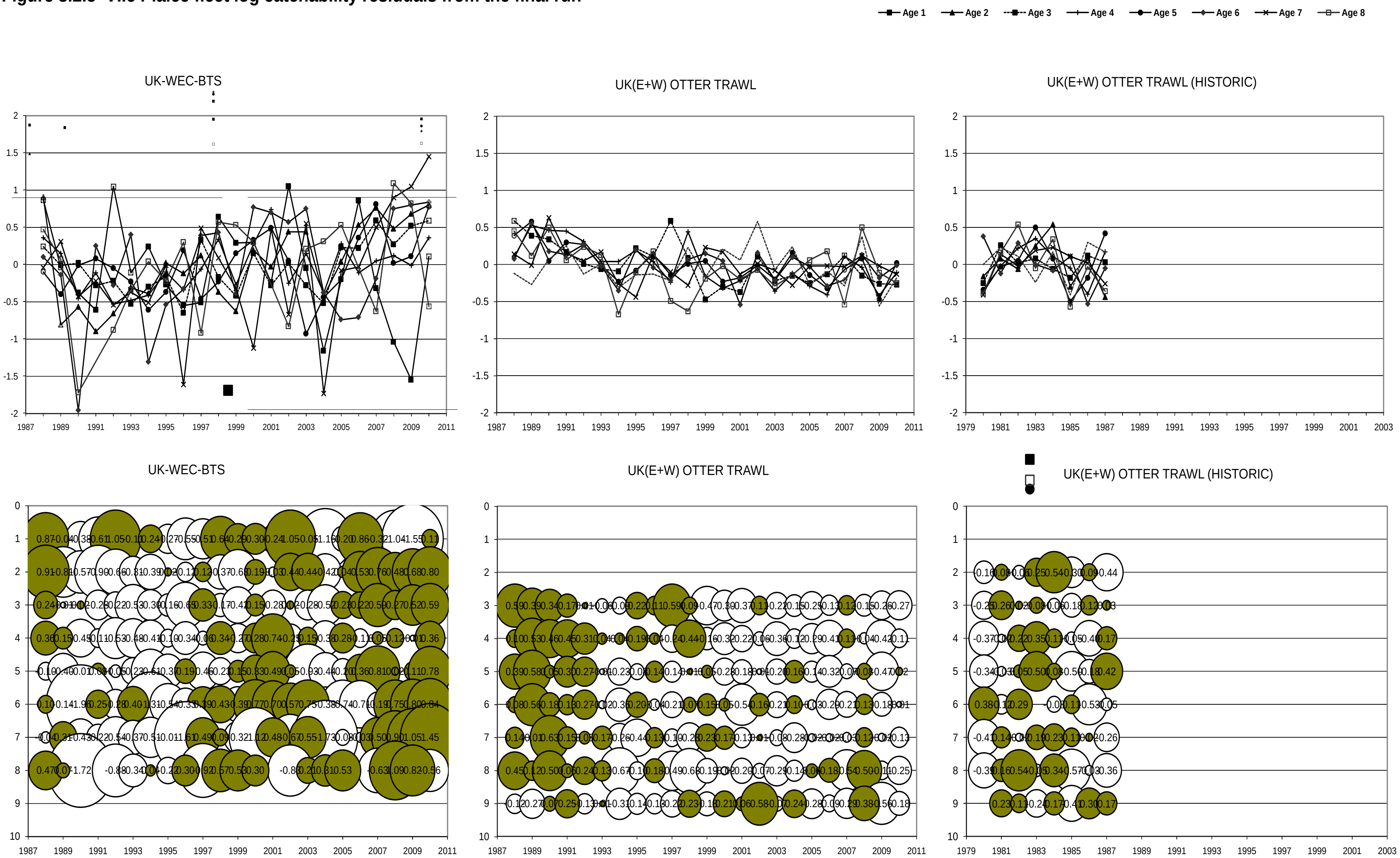
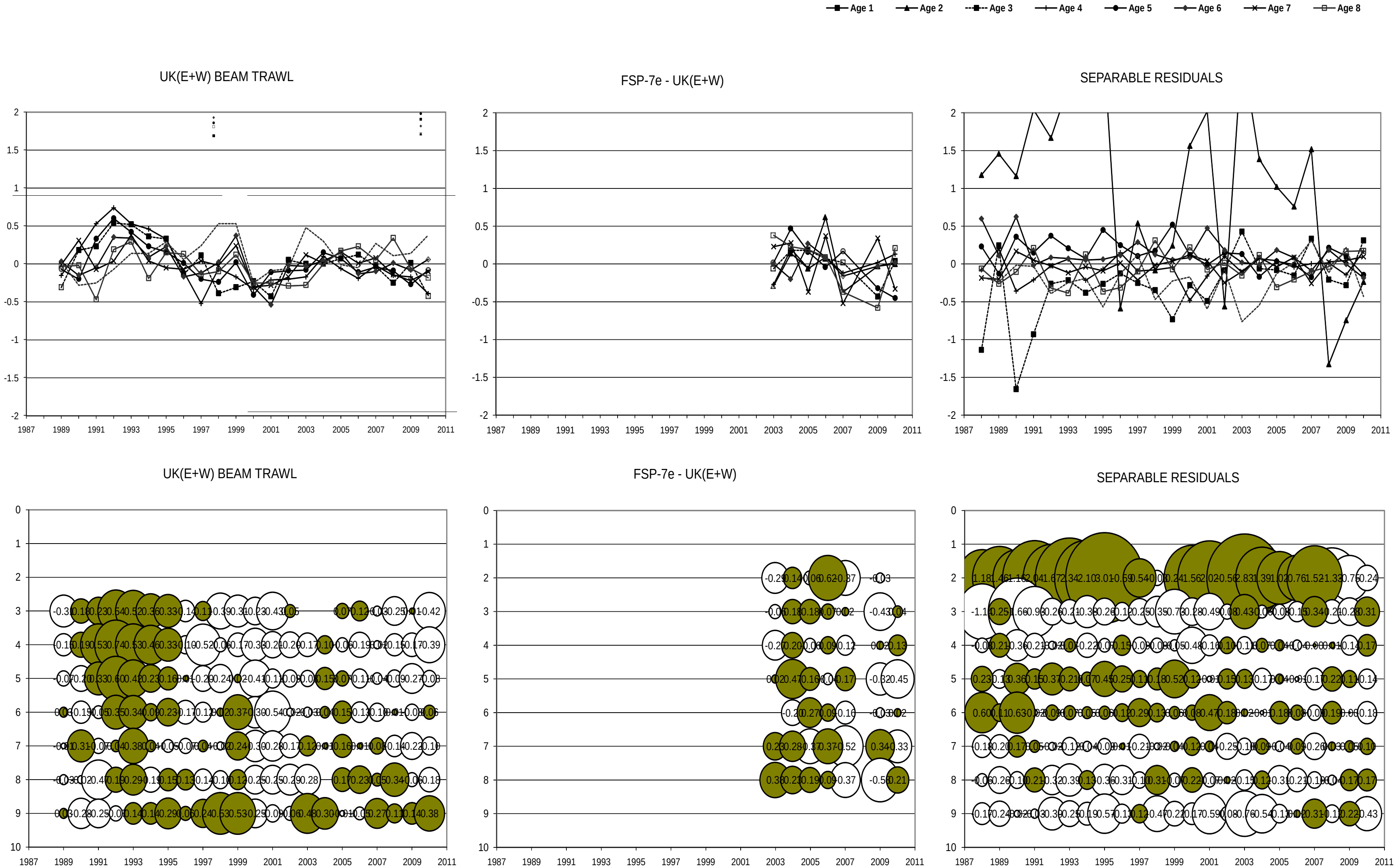
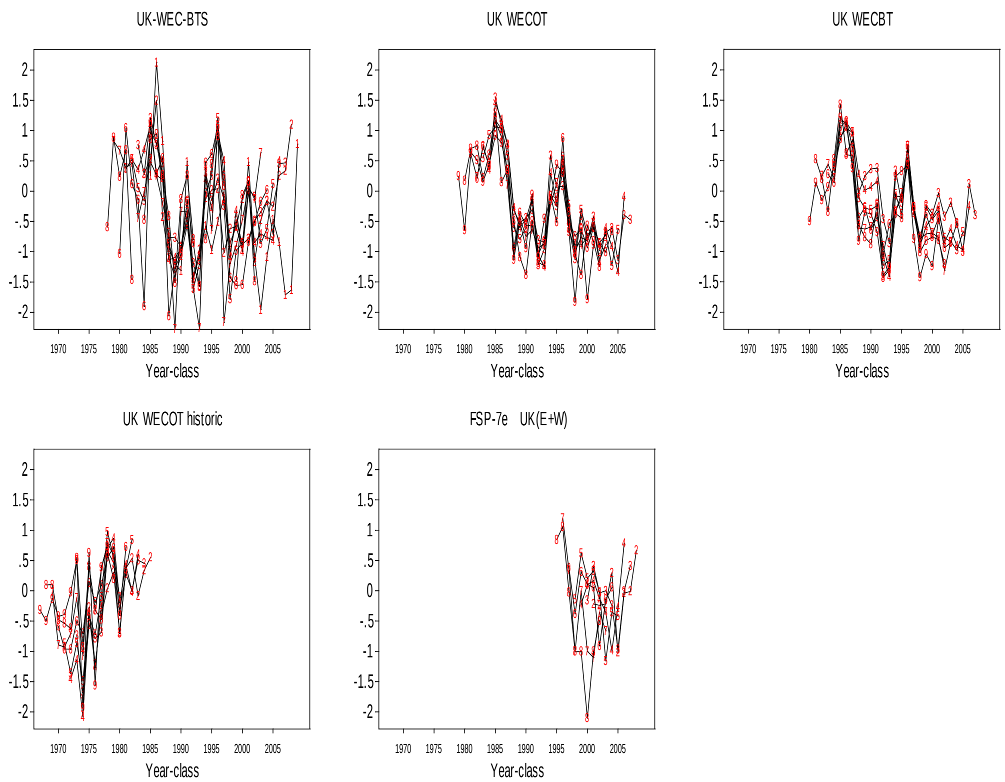


**Figure 8.2.5 (cont.) VIIe Plaice fleet log catchability residuals from the final run**



# Figure 8.2.6 VIIe Plaice – Surba results

Tuning fleets by year-class




Tuning fleets by year

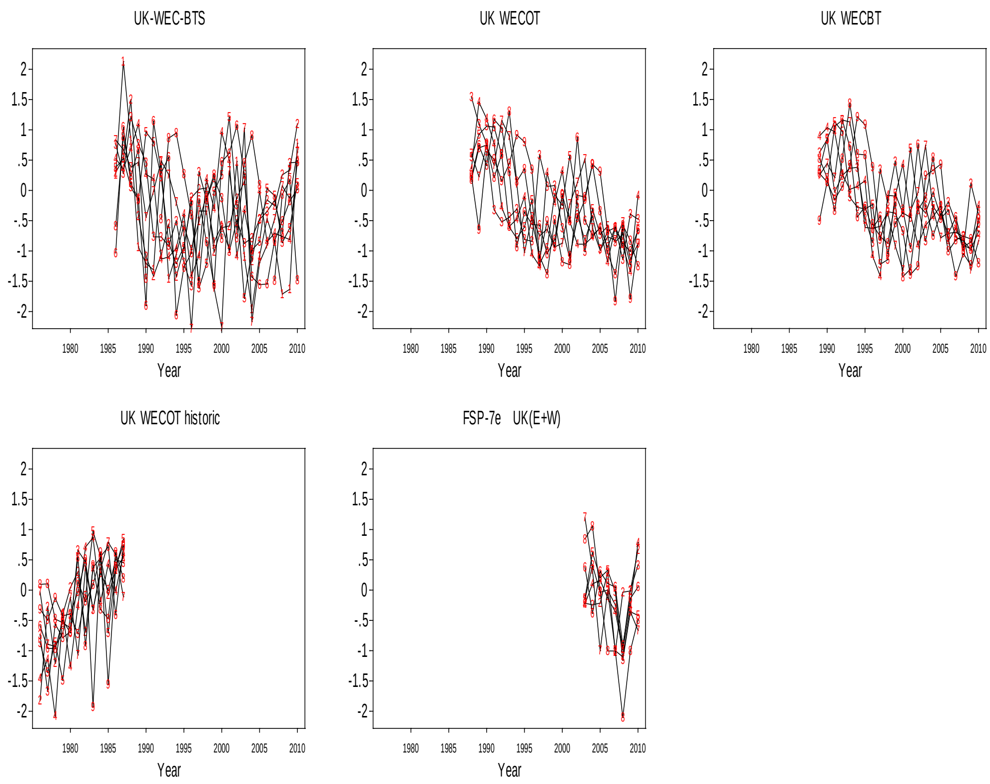
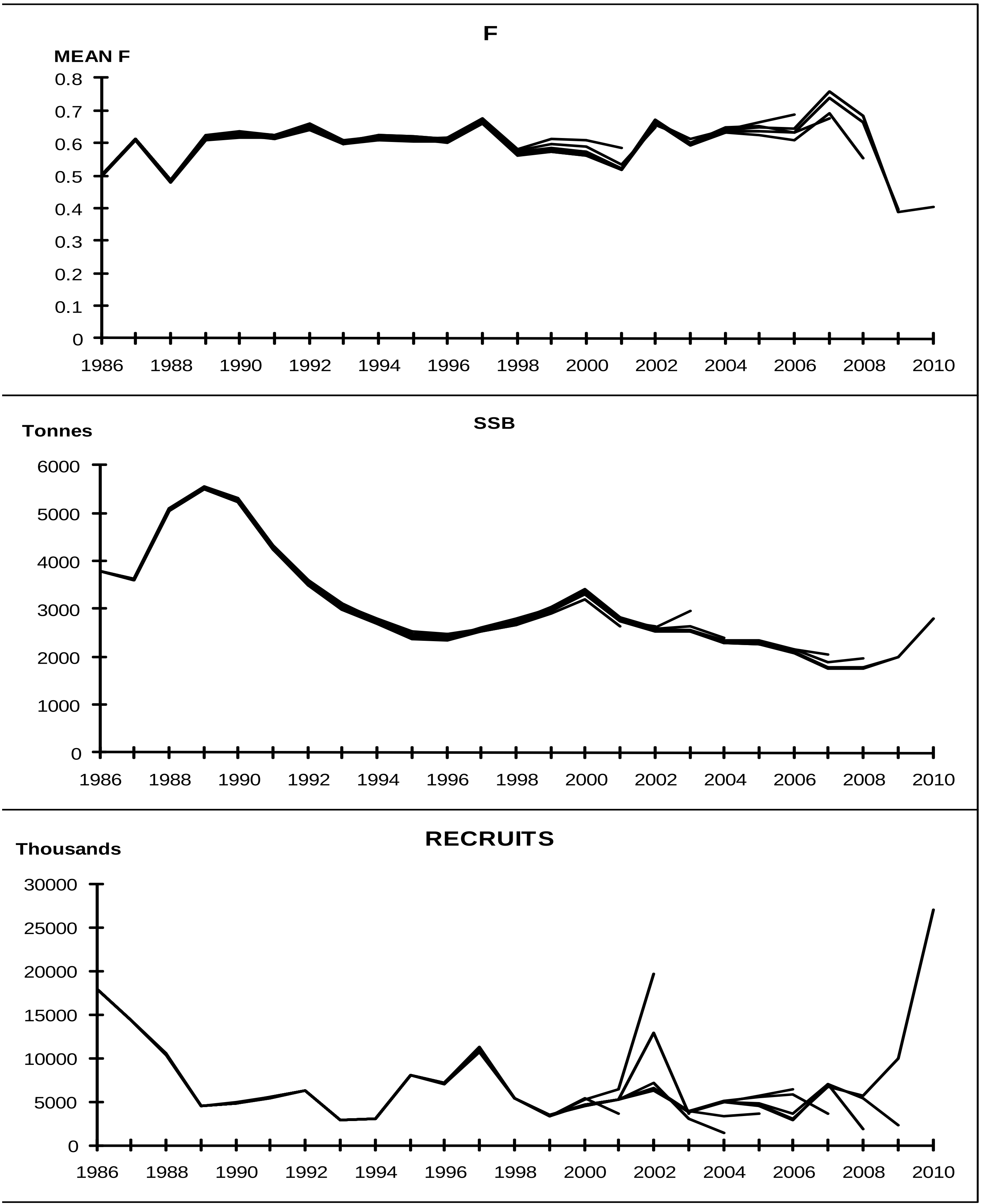


**Figure 8.2.7** **VIIe Plaice: Retrospective XSA results**
**(Shrinkage SE=2.5)**




Note: the retrospective analysis was run without the short FSP survey

**Figure 8.2.8** Plaice in Division VIIe (Western Channel)

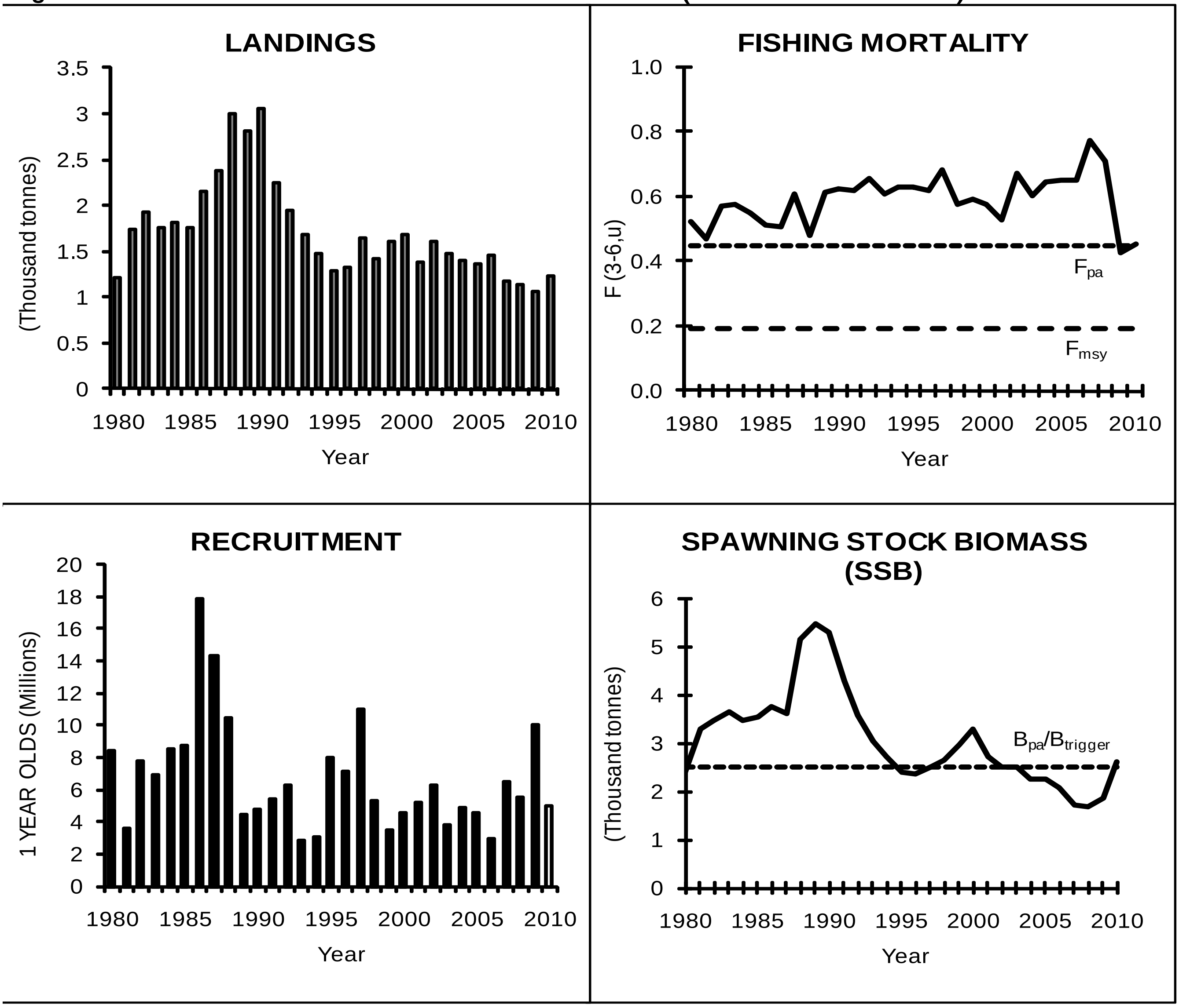
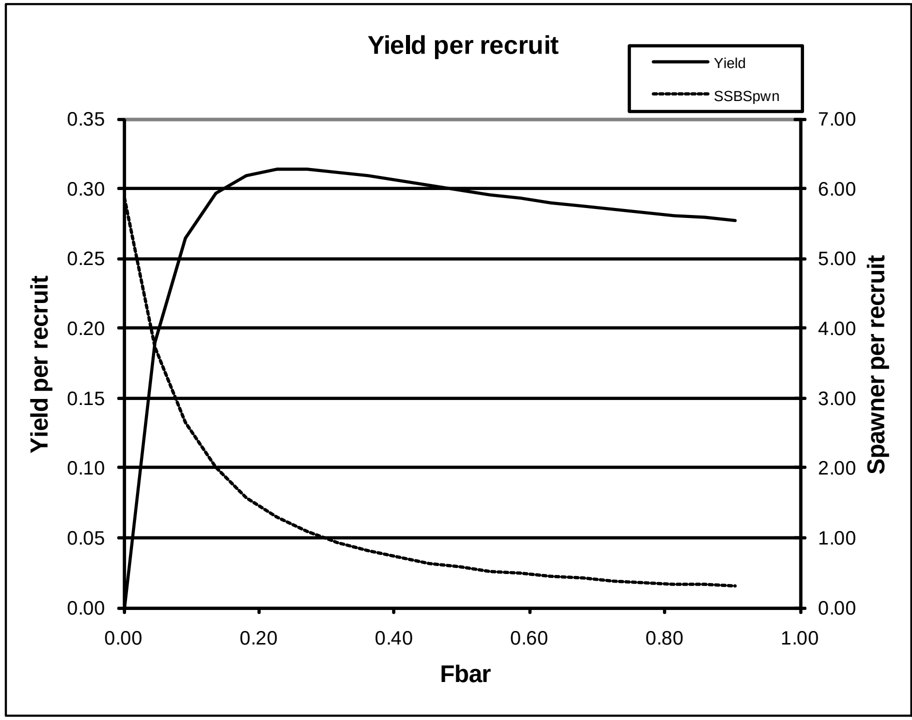
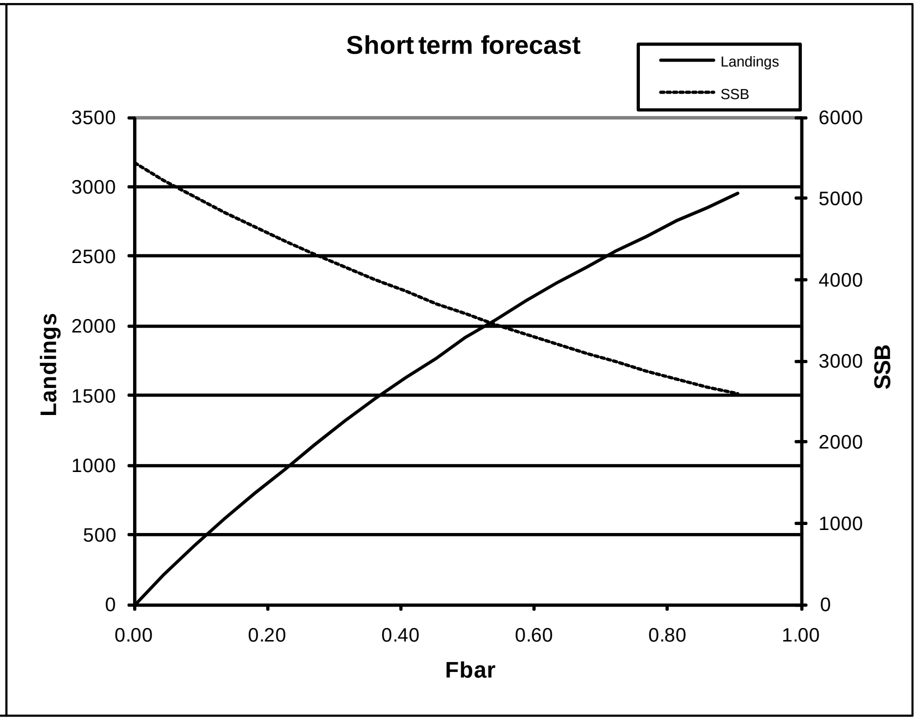


**Figure 8.2.9 VIIe Plaice : Yield per recruit and short term forecast results**




MFYPR version 2a
Run: p7e2011
Time and date: 08:49 15/05/2011

| Reference point | F multiplier | Absolute F |
|---|---|---|
| Fbar(3-6) | 1.0000 | 0.4520 |
| FMax | 0.5465 | 0.2470 |
| F0.1 | 0.2510 | 0.1134 |
| F35%SPR | 0.2889 | 0.1306 |

Weights in kilograms

MFDP version 1a
Run: p7e2011wg
W.CHANNEL PLAICE 2011 WGCSE forecast inputs
Time and date: 18:31 14/05/2011
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

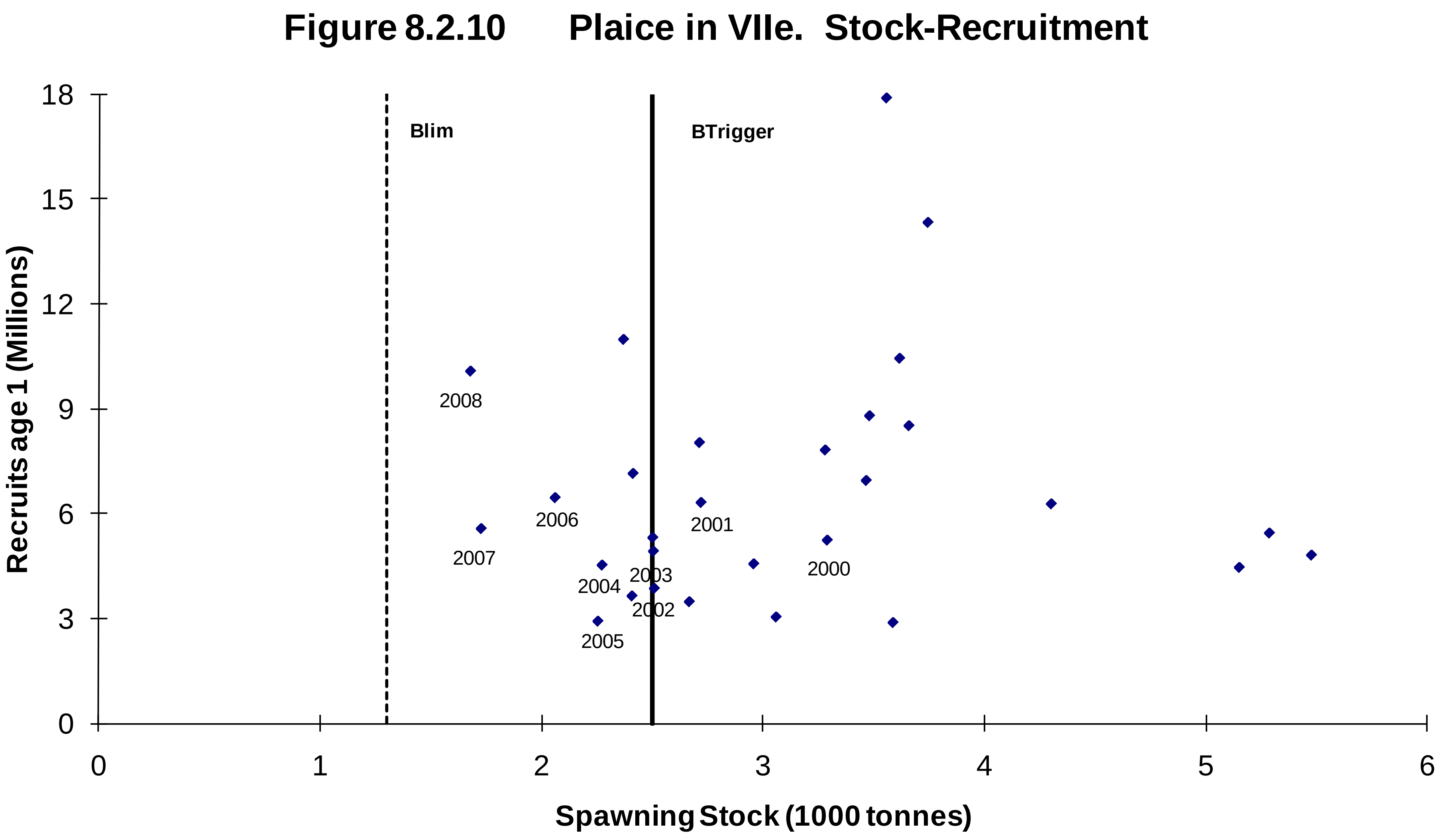


Figure 8.2.10 Plaice in VIIe. Stock-Recruitment
Blim
BTrigger
2008
2007
2006
2004
2005
2003
2002
2001
2000
Recruits age 1 (Millions)
Spawning Stock (1000 tonnes)
0
3
6
9
12
15
18
0
1
2
3
4
5
6

## 8.3 Sole in Division VIIe

### Type of assessment in 2011

This stock was placed on the observational list in 2004 and has been subject to a full assessment in subsequent years. A management plan for this stock was agreed in May 2007 (Council Regulation (EC) No 509/2007).

In 2009 WKFLAT benchmarked this assessment, but failed to develop an update procedure, because it was not possible to address or even elucidate the cause of the substantial and persistent retrospective bias in F and SSB. Consequently the WG only updated data tables, performed an assessment according to previous update setting and commented on useful indicators of stock trends.

The management plan is inoperable in the absence of an analytical TAC estimate. Following a series of analyses an interim constrained model fit to the historic information was developed and is presented as a final assessment.

### ICES advice applicable to 2010

*Precautionary reference points established in 2001 for this stock are no longer valid and there is no accepted assessment.*

*Survey, lpue, and the exploratory assessment suggest low stock size and high fishing mortality relative to historic estimates.*

#### Single stock exploitation boundaries

*ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that fishing effort and catches should be reduced although it is not possible to determine the appropriate scale of such reductions.*

### ICES advice applicable to 2011

Stock status:

| Fishing mortality | 2007 | 2008 | 2009 |
|---|---|---|---|
| $F_{MSY}$ | Above | Above | Below |
| $F_{PA}/F_{lim}$ | Not defined | Not defined | Not defined |

| Spawning-stock biomass (SSB) | 2008 | 2009 | 2010 |
|---|---|---|---|
| MSY $B_{trigger}$ | Below | Below | Below |
| $B_{PA}/B_{lim}$ | Not defined | Not defined | Not defined |

#### *MSY approach*

Following the ICES MSY framework implies fishing mortality to be at 0.24 (14% lower than $F_{MSY}$ because SSB is 14% below MSY $B_{trigger}$). This implies landings of less than 660 t in 2011.

#### *Management plan*

Council Regulation (EC) No. 509/2007 establishes a multi-annual plan for the sustainable exploitation of Division VIIe sole. Years 2007–2009 were deemed a recovery plan, with subsequent years being deemed a management plan. For 20010, 2011, and 2012 the TAC shall be set at the highest value resulting from either a 15% reduction in F compared to average F (2007–2009) or an F of 0.27, with a maximum TAC variation of no more than 15%.

Following the agreed management plan implies an F for 2011 of 0.3 (15% lower than the average F (2007–2009) or 0.85*0.35). Since this would result in a TAC increase of more than 15%, the resulting TAC is the maximum 15% increase of 710 t in 2011. This is expected to lead to a SSB increase of 7% in 2012. This plan has not been evaluated by ICES.

#### Technical consideration

Technical Comments:

- The two commercial tuning fleets show pronounced negative residuals around 2003–2005, associated mainly with the 1998 year class. The WG notes that the commercial fleets indicated a bigger 1998 year class than was indicated by the survey, and suspects this may be a result of mixing between VIIe and VIIfg occurring beyond the western limit of the survey. The WG should consider spatial mapping of cpue data from the different fleets in the English Channel and VIIfg, linking VMS with logbook data and shore-based and at-sea sampling data.
- The WG states that "recruitment estimates are consistent between the single-fleet XSA runs, although the final estimates vary slightly". However the recruitment estimates from the survey and commercial fleets diverge substantially in the final years. The XSA diagnostics show that at ages 3–5, the UK beam trawl survey generates much larger survivors' estimates and lower F estimates than the commercial fleets, with the differences becoming less pronounced at the older ages. Differences are also apparent in the combined-age cpue where the UK beam trawl survey seems stable but noisy whereas lpue in the beam trawl fishery has been declining continuously since the 1990s. The WG should review the appropriateness of the commercial fleets for providing indices for the younger age classes.
- $F_{bar}$ in the report model settings table and stock annex table is age 3–7, however the WG has used an $F_{bar}$ of 3–9 in the assessment and advice sheets.
- The short-term predictions previously used $F_{sq}$ for the interim year (as area misreporting meant the TAC was not limiting). This year a TAC constraint was used for 2010 on the basis that "recent evidence suggests that the TAC is likely to be observed" although the evidence is not described. In practice, the TAC constraint leads to an F in 2010 of 0.24 which is close to the low F estimate of 0.25 for 2009.
- The SEN file Table 8.3.16 includes a figure for N(1) of 2815 that does not represent either the XSA estimate or the GM of 4332. This may have no impact on the $F_{MSY}$ bootstrap computations.

The negative residuals in the single fleet runs for commercial tuning fleets over the period 2003–2005 are apparent for all ages and as such are not associated with a specific year class as implied by the review group. In the final assessment the UK-CBT fleet (not the UK-OBT fleet) does have larger residuals for this cohort but only for three years so cannot be the only cause of the retrospective. The 2002 YC is indicated to be stronger in the survey than in the commercial fleets and this is likely to have contributed also in the index evaluation plots this can be tracked to age 9 at which point it is highly abundant. This supports the idea of a lack of a closed population particularly at recruitment ages as already investigated/shown by WKFLAT 2009. Currently there is no data available to further examine this effect, but the stock is scheduled to be benchmarked in 2012 when information from a new survey will be evaluated.

The WG agrees that the solution is less than ideal, but it is likely the "best compromise" currently possible. The commercial fleet is almost certainly not representative of abundance in the fleet, due to retargeting effort towards areas where other fishing opportunities are available; however sole are still caught in lower numbers as shown by the temporal residual pattern particularly in the UK-CBT fleet. Removing the tuning of the younger ages from the commercial fleets will lead to a larger discontinuity at the transition and a larger retrospective pattern. In any case, given the up-date process it is not possible to change the procedure at this time and it is hoped that the issue can be addressed in the next benchmark process.

The reason for using this new age range is the extensive age distribution with a sizeable portion of the population still found in the plus group even at age 12. WKFLAT 2009 discussed this and came to the conclusion that it would be desirable to cover a larger proportion of the stock. Unfortunately, because the assessment was eventually rejected this change is not documented in the report. The annex has not been updated recently so does not reflect this change. The new age range is also retained in this assessment for consistency with the management plan evaluations used by the commission.

The use of a TAC constraint was associated with the fact that most of the misreporting was historically associated with the UK beam trawl fleet, which last year was constrained from area misreporting by a single area licence scheme. This year the French fleet shows substantial over quota official landings (Table 1), however the most recent assessment indicates that F=0.24 as used by last year's forecast was an appropriate value for $F_{sq}$ (more by luck than reckoning).

The methodology used to estimate $F_{msy}$ is an equilibrium estimate and strips the early results so this has no impact. The sen file was not used in the short-term forecast.

### 8.3.1 General

#### Stock description and management units

The TAC is specified for ICES area VIIe consistent with the assessment area.

Official national landings data as reported to ICES and the landings estimates as used by the Working Group are given in Table 8.3.1.

Official landings in 2010 were 740 t, 20% above the 2010 TAC (618 t). WG landings included information based on French sales slips indicated total international landings were 688 t in 2010, 11% above the TAC. A UK single area licence scheme introduced at the end of 2008 stopped the previous practice of misreporting; previous UK landings estimates have been corrected for area misreporting to ICES Division VIId and has brought UK landings into line with the national quota. Previously landings had been stable at around 1000 t over the previous five years, with the UK taking about 65% of the landings and France reporting the majority of the remainder. **However, in the last two years, the proportion landed by the UK has fallen to around 50% with a similar proportion now landed by France.**

**Management applicable to 2010 and 2011**

*2010 (Council Regulation (EC) No23/2010)*

| Species: Common sole *Solea solea* | | Zone: VIIe (SOL/07E) |
|---|---|---|
| Belgium | 22 | |
| France | 233 | |
| United Kingdom | 363 | |
| EU | 618 | |
| TAC | 618 | Analytical TAC |

In addition, Annex IIc, restricts the number of days at sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet. In November 2008 the UK introduced a single area licence scheme to eliminate the opportunity for UK vessels to misreport catches to Area VIId.

*2011 (Council Regulation (EC) No57/2011)*

| Species: Common sole *Solea solea* | | Zone: VIIe (SOL/07E.) |
|---|---|---|
| Belgium | 25 (1) | |
| France | 267 (1) | |
| United Kingdom | 418 (1) | |
| EU | 710 | |
| TAC | 710 | Analytical TAC |

In addition to this quota, a Member State may grant to vessels participating in trials on fully documented fisheries additional allocation within an overall limit of an additional 5% of the quota allocated to that Member State, under the conditions set out in Article 7 of this Regulation.

In addition, Annex IIc, restricts the number of days at sea to 164 for beam trawlers of mesh size equal to or greater than 80 mm, and for static nets including gillnets, trammelnets and tanglenets, with mesh size less than 220 mm, with an additional twelve days for the UK beam trawl fleet due to a reduction in capacity of the fleet. In November 2008 the UK introduced a single area licence scheme to eliminate the opportunity for UK vessels to misreport catches to Area VIId.

## 8.3.2 Data

### Landings

Levels of landings have been above or near 1000 t for this stock for most of the time-series, but have dropped significantly since 2009 to a level closer to 700 t. Total international landings in 2010 were reported to be 740 t, 8% higher than those landings used by the working group.

There were revisions to the 2009 reported landings (+4.50 t UK; -0.8 t Guernsey; +71 t France), with appropriate revisions made to the estimates used by the WG.

### Data

Total international catch numbers-at-age (Table 8.3.2, Figure 8.3.1), catch weights and stock weights, -at-age (Tables 8.3.3, 8.3.4, Figure 8.3.2) as used in the assessment were derived mostly by the procedure described in the Annex, except in 2009 when some UK age information was used to supplement sparse French age information at larger lengths. This year, France provided modified fleet age composition data for 2009 to cater for differences observed in the length structures for the otter trawlers targeting demersal fish compared to those targeting mollusc. French 2010 data was also provided in this form.

The differences in the length distributions between the different fleets are shown in Table 8.3.5.

Sampling levels are detailed in Section 2 (Table 2.1).

### Discards

Discard data suggests that discarding in 2010 is again minor in this stock (Figure 8.3.3a–e) for both the UK, French and Belgian fleets. Substantial discarding is shown in quarter 1/2 for the UK fleet, but this anomaly is associated with the data from the UK 50% project which last year was shown not to be representative of the discarding in the fleet as a whole, likely due to some incentives that changed fishers behaviour during the trips sampled for this project (WGCSE 2010). Unfortunately, this year the data was not supplied in a way that this information could be separated from other discard data. Following conclusion of the project (quarter 2–4) discarding has dropped to the normal very low levels.

French discarding is also insignificant with respect to its fleet targeting sole, but one fleet (Figure 8.3.3d labelled FRMtrawl) locally targeting cuttlefish inshore in the Baie de Granville has indicated substantial discarding of small sole. The 2nd quarter of 2010, the discard samples are located in only ICES rectangle 26E7, which accounts for 7 tonnes of sole landings and only one of the seven sampled trips by this métier shows significant discarding of small sole. Therefore the special discarding pattern does not change the overall picture of low discarding of sole in the area, but the métier specifically targeting cuttlefish inshore should be monitored closely, and some management or technical measures should be sought in order to avoid such a discarding of sole.

Belgian discard information was provided for the first time this year and also shows only minor discarding of sole.

More generally discarding in the towed gears using 80 mm mesh sizes, which are responsible for the large majority of the landings is very small by number (<5%) and small (5–10%) for the much smaller gillnet fishery. Other spatially or temporally restricted métiers show higher values of discarding (10–40% averaged over years) have very limited effort and hence contribute only a very small percentage to the landings (<5%). The selectivities of the gears used to target sole is highly selective for fish above the MLS, and only a few sporadic cases of high-grading (included in the numbers above) have been observed.

No discard information is included in this assessment as currently it is not possible to provide this information for the entire time-series.

#### Biological

Natural mortality and maturity were used as in previous assessments and described in the stock annex. The review group suggested developing temporally variable maturity data for this stock. However, the surveys, usually used for such estimates due to the much better quality control on staging individuals, occur in October This time of year has been determined to be unreliable for estimating maturity for this species as gonadal development has not commenced. A new quarter 1 survey may provide better data which will be considered at the next benchmark meeting.

#### Survey indices

Aggregated cpue has substantially increased from the low point of the time-series observed in 2005 to the highest values in the time-series. (Table 8.3.6, Figure 8.3.4).

The abundance for the UK-WEC-BTS survey carried out on the chartered beam trawler *FV Carhelmar* is given in Table 8.3.7 and shown in Figures 8.3.5 and 8.3.6, plotted by cohort and by years. The figures show few clear year effects and good year-class tracking for the survey at all ages until about the mid 1990s. Since then, the estimate of year-class strength at age 1 and at ages greater than 7 has deteriorated slightly. This may partly be associated with the change of vessel that occurred in 2002 and 2004 (*RV Corystes* used), but it seems likely this is not the only cause and weather may play a part in the catchability. Notable differences between the commercial and survey tuning-series are the 1998 year class. This is well represented in the commercial data, but much less clearly so in the survey data. This YC was also seen to be very strong in the VIIf&g stock and may represent some overspill of recruitment from that stock in the adjacent western part of VIIe, not covered by the survey. The 2001 YC is also well defined and estimated to be above average in the survey and implied to be strong particularly at the older ages, but lacking in the commercial data.

The UK fisheries science partnership (FSP) again conducted a survey, now in its 9th year, of sole and plaice abundance in the western channel. The results indicate that sole continue to be wide spread in the area and that a large number of cohorts contribute to the stock. Inclusion of this fleet should be reconsidered in the next benchmark.

#### Commercial fleets effort and lpue

Effort for both UK over and under 24 m beam trawlers in hours fished increased until 2000 when it levelled off until 2006 (Table 8.3.6, Figure 8.3.4). Since then >24 m boats have declined in favour of smaller boats due to a combination of the UK decommissioning scheme and the substantial increases in fuel costs, making the larger boats commercially unviable. The decline of the larger boats has resulted in a resurgence of the use of less than 24 m vessels. Given the licence transfer rules currently in force in the UK, restructuring of the fleets will lead to a 10% decrease in the kW day capacity of replaced vessels not withstanding any latent capacity. Otter trawl effort (UK-COT) has been in continual decline since the early 1970s and is currently around the series minimum (shown 1988 onwards in Figure 8.3.4 and Table 8.3.6) at values roughly a third of those seen in the 1970s. Gross registered tonnage corrected effort used in the assessment also shown in Figure 8.3.4 shows a strong decline in effort in the main fleet exploiting the stock in 2009 as vessels moved out of the area as a result of the UK single area licensing scheme (Table 8.3.7, Figure 8.3.4) and this has continued in 2010.

Otter trawl effort, as used in the tuning information has been declining steadily since the late 1990s and is now at historically low levels, but takes only a small proportion of the landings.

Cpue for both over and under 24 m beam trawlers has declined steadily since 1988. Lpue from the survey is variable, but stable across this period, it is representative only of the younger ages in the fishery (1 to ~6) and only a proportion of the area exploited by the fishery.

Age disaggregated commercial abundance indices used in the assessment are the commercial beam trawl fleet (UK-CBT) and the otter trawl fleet (UK-COT) are given in Table 8.3.7, and plotted log converted by cohort and year in Figures 8.3.5 and 8.3.6 (historic fleets are retained for assessment stability). The UK-CBT shows very good year-class tracking indicated by the consistent estimation of strong and weak year classes at different ages, and demonstrates a decline in the abundance-at-age from 1975 to 1990, after which the observed decline continues but at a much smaller rate. There is little indication of year effects in this time-series. The UK-COT fleet also shows good year-class tracking over the middle of the time period and also gives some indication of a decline in lpue in the early 1980s although this is much less clear than in the beam trawl fleet. This is likely in part caused by the strong year effect seen for this fleet in 1991 and to a lesser degree in 2004. The causes of this are not clear from anecdotal evidence, but sampling for the fleet is now at relatively low levels, due to the small size of the fleet and landings.

See also the stock annex for historic fleet data used in the assessment.

#### Information from the fishing industry

The fisheries science partnership, conducted cooperatively between CEFAS and the UK industry has provided evidence of the wide dispersal and wide-ranging age distribution for this stock.

### 8.3.3 Stock assessment

Model used: Reformulated XSA assessment

Software used: FLR – FLXSA (FLCore 1.4-3 - "Golden Jackal" ; R 2.4.1)

Model Options chosen: data as in previous years (See Stock Annex) but with additional shrinkage to stabilise F trends as used for last year's advice.

Input data types and characteristics: catch numbers-at-age without discards, five tuning fleets, one survey, two current commercial cpue series, two historic cpue series.

#### Data screening

Data screening of the catch-at-age, weights, tuning information and ancilliary qualitative information was carried out by the procedures set out in the Annex.

Single fleet XSA's for the current tuning fleets (see Annex for procedures) were run. Residuals for all single fleet runs were generally small (Figure 8.3.7). Residuals of the single fleet runs indicated a small but persistent decreasing trend for the CBT fleet, two large negative residuals in the COT fleet in 1992 and 2003–2004 and more variable, but largely unbiased residuals for the UK-WEC-BTS. The characteristics of the individual tuning fleets are consistent with those shown previously in the screening of the tuning fleet data and hence suggest that all tuning fleets are largely consistent with the available landings data.

Summary plots of the single fleet runs are shown in Figure 8.3.8 indicate F, SSB and recruitment estimates are consistent between the fleets overall. The recent estimates of F are similar between the otter trawlers (UK-COT) and the survey (UK-WEC-BTS), with SSB trends differing only because of a difference in the perception of recent recruitment not yet seen in the commercial fleet which uses ages ≥3. UK-CBT provides the highest F estimates and a commensurate lower SSB estimate and like the UK-OTB fleet misses recent recruitment values because it uses the same age range.

#### Final update assessment

WKFLAT 2009 described the assessment methodology used prior to 2009 as unsuitable for management advice, but failed to develop a more suitable methodology. The management plan is inoperable in the absence of an analytical TAC estimate.

The WG fitted the XSA model using the previous settings, which indicated a much reduced retrospective pattern in the last two years, and considered re-introducing the old assessment methodology. However, the retrospective bias observed in previous years remained apparent and no explanations for the historic pattern can be given. Previous studies by the ICES Working Group on Assessment Methods (ICES 1991, ICES CM1991/Assess:25) established that where retrospective bias patterns are severe, such that estimates are considered unreliable, shrinkage to the mean fishing mortality of the previous years at each age could be used to provide coherent population and fishing mortality estimates that can be taken forward into stock forecasts. An XSA with heavy shrinkage was therefore considered to be the most likely methodology to provide quantitative information suitable for management advice. The results from exploratory runs established that an increased level of shrinkage (0.5 from 1.0) and an increased time period over which this is applied (10 years from 5 years) was optimal for consistent series of estimates. All other settings were maintained as previously and the complete set of settings is shown in the text table below.

Figures 8.3.9–8.3.11 show the residual plots from the final fitted model, a comparison with the 2010 assessment including a run replicating the settings used prior to the benchmark (WKFLAT 2009), and the respective XSA survivor weightings. XSA diagnostic tables, stock number-at-age and fishing mortality-at-age are shown in Tables 3.8.8–3.8.10.

A seven year retrospective analysis was run for the interim assessment (Figure 8.3.12), which still shows some retrospective bias in the earlier period, but confirms that the more recent period is more stable with respect to F and SSB trends.

| | | WG 2011 |
|---|---|---|
| Catch-at-age data | | 1969–2010, 1–12+ |
| Fleets | UK-BTS – Survey | 1988–2010, 1–9 |
| | UK-Inshore – Commercial | 1973–1987, 2–11 |
| | UK-Offshore – Commercial | 1973–1987, 3–11 |
| | UK Combined Beam Trawl - Commercial (UK-CBT) | 1988–2010, 3–11 |
| | UK Otter trawl – Commercial (UK-COT) | 1988–2010, 3–11 |
| | | |
| Taper | | No |
| Ages catch dep. Stock size | | None |
| q plateau | | 8 |
| F shrinkage se | | 0.5 |
| | year range | 10 |
| | age range | 5 |
| Fleet SE threshold | | 0.5 |
| | | |
| Catch data | | Age 1 catches = 0 |
| Plus group | | 12 |
| $F_{Bar}$ Range | | F(3–9) |

### State of the stock

Stock trends are shown in Table 8.3.11 and plotted in Figure 8.3.10.

SSB is estimated to have increased from 1970 to 1980 following successive strong recruitments. Subsequently it has declined until 1993 after which it remained stable for twelve years before declining slightly its lowest level in 2008. There has been an increase in the last two years to just below 2800 t.

The base level of recruitment has remained stable during the whole time-series in the range 4–5 million recruits. The main development has been a reduction in recruitment variability since 1991 with none of the substantial year classes that maintained a higher level of biomass during the early period.

Fishing mortality was stable at a low level until 1977 after which it increased sharply until 1982, remained relatively constant until 2004 (peaking briefly in 1989–1990) and then increased until 2007. F then decreased slightly in 2008 and then sharply to a below 0.3 in 2009 and 2010, commensurate with the improved compliance associated with the single area licensing scheme introduced in the UK.

Information that is consistent with the decrease in fishing mortality in the most recent year is provided by the decline in UK effort (Figure 8.3.4) and landings. International landings are still slightly higher than recent TACs.

The age structure of the VIIe sole stock continues to be more extended than other sole stocks in European waters, implying low mortality rates, with the plus group (at age 12) containing a high proportion of the catches and including some individual of ages 33–38 in recent years.

### 8.3.4 Short-term projections

Last year the WG assumed that the TAC might be observed as the opportunities for the UK beam trawl fleet to area misreport had been eliminated but this year saw another overshoot of the TAC for different reasons. Last year's F forecast for 2010 assumed a TAC constraint, which given the overshoot of the TAC appears inappropriate. Consequently, the WG agreed to use the F pattern observed over the last three years, rescaled to the final year F given the trend in F over the last three years. The mean catch and stock weights-at-age 2008–2010 were also used.

#### Estimating year-class abundance

As implemented previously, the geometric mean recruitment over the entire time-series (1969–2008) was used as there is no evidence of a significant relationship between SSB and subsequent recruitment over the range of SSB values observed in the assessment.

| Year class | Thousands | Basis | Surveys | Commercial | Shrinkage |
|---|---|---|---|---|---|
| 2008 | 2885 | XSA | 62% | - | 38% |
| 2009 | 4301 | GM (1969–2008) | | | |
| 2010 | 4301 | GM (1969–2008) | | | |
| 2011 | 4301 | GM (1969–2008) | | | |

Complete input data for the short-term forecast is shown in Table 8.3.12, and resulting forecast estimates landings in 2011 to be 670 t, 40 t less than the TAC (Table 8.3.13).

SSB estimated at 2570 t in 2011 will rise to 2650 t in 2012 at the current level of F assuming GM (1969–2008) recruitment for the 2009 year class which has been estimated by XSA to be much larger (8910), but this estimate is not thought to be very reliable.

The proportions that the 2008–2012 year classes will contribute to the landings in 2012, and to the SSB in 2013, are given in Table 8.3.14. 27% of the landings for 2012, and 38% of the SSB for 2013 rely on year classes for which GM recruitment has been assumed. The 2009 year class that has been replaced with GM (1969–2008) contributes to 22% of the landings in 2012 and 22% of the SSB in 2013.

A full management options table is provided in Table 8.3.15. The management plan for this stock requires $F_{2012}$ to be 85% of the average $F_{07\text{-}09}$ = 0.288 until such time as the management target ($F_{MSY}$ = 0.27) is reached. This occurred in 2009 so that the 2012 TAC according to the management plan is 777 t. This represents a 9% increase in the TAC from 2011 to 2012 and thus does not exceed the 15% annual increase cap implemented in the plan. 777 t is therefore the TAC consistent with the management plan for 2012.

### 8.3.5 Biological reference points

Biological reference points were rejected by WKFLAT 2009 due to a lack of an appropriate assessment to evaluate their suitability. Reference points should be revised once an appropriate assessment methodology has been fully developed.

WKFRAME2 provided general comments on the appropriate choice of $B_{trigger}$ suggesting the $B_{pa}$ based on $B_{loss}$ are inappropriate as the precaution implied by the $B_{pa}$ is already incorporated with the lower choice of F in the MSY management framework. The WG considered revising current reference points, but suggests that this would be more appropriately carried out during or after the benchmark process has been completed.

In the meantime ICES is moving towards management advice based on MSY reference points. Management of this stock in the short term is likely to be on the basis of the management plan so that a lack of PA reference points is unlikely to significantly impact management decisions in either the short or medium term.

### 8.3.6 MSY evaluation

Stochastic analyses performed by WGSSDS in 2006, assuming no variability in M, suggested that yields of 865 t could be safely extracted from the stock at levels of F=0.27 while the probability of SSB dropping below lowest observed SSB values would remain at less than 5% levels. This value remains consistent with the results of the current assessment and is accepted as the best estimate of $F_{msy}$ available for this stock (WGCSE2010). More elaborate risk based stochastic evaluations of the management plan have been carried out by SG-MOS-1006 (Part C) suggesting that the fundamental stock dynamics or the selection pattern have not changed so that this assessment still represents the best of our knowledge.

### 8.3.7 Management plan

The commission implemented a management plan for the recovery of the stock early in 2007 (Council Regulation (EC) No 509/2007). ICES evaluated the management plan and concluded that:

The long-term management target (F=0.27) is precautionary in the sense that it ensures that there is a less than 5% chance of SSB declining below previously observed levels, as well as maintaining yield within 10% of MSY (*WGCSE note: long-term yield at* $F_{max}$) (WG 2005, WG 2006).

The methodology of reaching the long-term target in 3-year stepped reductions in F is also acceptable. However, the size of further steps is based on observed fishing mortalities within the period of the management plan. This can only have the desired effect if management measures (TAC) are effective and if estimates of recent levels of F from the assessment are accurate. In 2009, newly introduced enforcement measures appear to have resulted in increased compliance with the TAC; continued development of the SSB will be dependent on effective controls of fishing effort.

The WG has provided an interim assessment as a means of providing management advice for 2012, which implies a TAC of 770 t in 2012. Catches at this level are likely to maintain F around the long-term management target.

### 8.3.8 Uncertainties in assessment and forecast

The WG provided a constrained interim assessment due to the need for management advice in relation to the management plan, as the current plan makes no provisions as to how to manage the stock in the absence of a full analytical assessment. The methodology provided is as robust as possible under the currently available understanding of the stock dynamics and at present does not appear to suffer from the retrospective pattern, which led to the rejection of the assessment as suitable for management advice by WKFLAT 2010. However, the retrospective analysis suggest that even the new methodology still retains some retrospective bias in the earlier period so that the uncertainty in the current estimates of F and SSB is likely to be greater than indicated by the assessment output diagnostics.

In addition, this year's short-term forecast suffers from two specific uncertainties the size of which cannot be determined by the assessment. The first is the likely F in 2011. Last year the WG assumed the TAC to be constraining, however the 2010 landings data suggests that this may not have been appropriate as the TAC was overshot by 10%. Given the most appropriate method for estimating $F_{sq}$ (rescaling $F_{bar(08–10)}$ to the final year due to a trend in F) suggests the TAC will be undershot by 5% which seems even less likely. Despite this the WG took this as the only scientifically defensible method for estimating catches with the consequence that if the 710 t TAC is taken in 2011 the forecast will overestimate SSB in 2012. The other uncertainty relates to the size of the 2009 year class estimated to be very strong in the survey, however this has not been seen to be reliable in recent times so that this value has been replaced with $GM_{(69–08)}$ potentially underestimating the yield in 2012 and SSB in 2013. The choice of options means that the uncertainties are opposing, but does suggest that uncertainties in the estimates are larger than those provided by the assessment and forecast.

#### Discarding

Despite the small scale of discarding in this fishery a times-series of available discard information raised to the fleet level should be developed to quantify the scale of assessment uncertainty caused by this practice.

#### Surveys

Currently only one survey index is used in the assessment (UK-WEC-BTS) which provides good stability to the assessment in general. Year-class tracking is internally consistent and agrees well with information from commercial tuning fleets. However, in the recent past there is some question regarding the consistency of the tuning-series due to a vessel effect in 2002 and 2004. In addition in recent years it has become apparent that there are some differences in the year-class consistency between the commercial and survey tuning information. Specifically, the 1998 year class known to have been very strong in VIIf&g is not represented in the survey that operates solely in the eastern part of the area. This suggests that there may be both an open population as well as an incomplete mixing problem in the data contributing to the inconsistency of the assessment.

#### Sampling

Age and length sampling for this stock is mostly adequate. Age data from the largest two sectors prosecuting this fishery (UK and France, together about 95% of landings) are included in the assessment. French age data in 2009 was insufficient at older ages to raise the length compositions, so that UK data was used to cover the larger fish. The use of commercial tuning data is unavoidable, as there is little information available for older ages from the survey.

#### Consistency

The interim assessment provided by the WG is highly consistent with the previous methodology as it uses the same information, but weights the value of the different sources differently. The previous retrospective bias with respect to overestimating F and underestimating SSB is still apparent historically though not observed recently and is likely caused by the difference between the cohort signals in the survey and commercial information. Cohort strength has been relatively even in recent years, but a retrospective pattern may well become apparent again if the 2009 cohort observed in the survey is confirmed in the future.

#### Misreporting

Area misreporting, mainly to area VIId had declined to low levels in recent years, through a combination of enforcement and a substantial increase in the TAC in 2005. There have also been some attempts to prosecute UK fishermen for misreporting to Area VIIh, although to date none of those prosecutions have been successful due to a lack of legally acceptable evidence.

Levels of underreporting are thought to have been serious in the early 1980s prior to the shift to area misreporting. Although it is clear that levels of underreporting are also much lower now, no quantitative information is available on the size of the problem.

Landings of the UK beam trawl fleet, historically the main contributors to area misreporting, in 2009 and 2010 were in line with the TAC, suggesting improved compliance. The decrease in landings is also consistent with a reduction in effort by the main fleet and a reduction in F observed in the plaice VIIe stock, a major bycatch of the sole fishery.

### 8.3.9 Recommendation for the next benchmark

| Year | Candidate Stock | Supporting Justification | Suggested time | Indicate expertise necessary at benchmark meeting. |
|---|---|---|---|---|
| 2011 | VIIe Sole | WKFLAT 2009 could not recommend an appropriate assessment procedure for this stock for the following reasons:<br>Closed population and complete mixing assumptions of the assessment are violated. Tuning data indicate differences in trends in F and recruitment resulting in a serious retrospective pattern in the assessment.<br>Survey information only partially covers the stock area.<br>Effort correction parameters / methodologies may require updating as the main beam trawl fleet has restructured substantially recently.<br>This effort would be greatly enhanced by an internationally coordinated survey that more appropriately covers the management area and is able to assess recruitment dynamics irrespective of the sources of recruitment and environmental drivers. | 2012 | Experts with expertise in spatial modelling of stock dynamics and survey specialist to help evaluate the new stratified random survey in the area. |

### 8.3.10 Management considerations

This stock is subject to a management plan based on reductions in fishing mortality in relation to historic levels of F. Previously both the most recent and the target fishing mortality and population estimates were continually revised by subsequent assessments, which is why the assessment was rejected by WKFLAT 2009.

A constrained interim assessment model has been fitted in order to provide management advice in relation to the management plan, as the current plan makes no provisions as to how to manage the stock in the absence of a full analytical assessment. The model is considered to provide population and mortality estimates that are coherent and suitable for the provision of stock forecasts.

Effort restrictions have not been sufficient to ensure an observable decrease in F in recent years. Decommissioning in the UK fleet in 2007–2008 did not reduce fleet capacity sufficiently. UK single area licensing appear to have been effective since 2009 and resulted in the UK fleet utilising fishing opportunities in other ICES divisions so that effective effort and F in Division VIIe dropped markedly.

Plaice are taken as a bycatch in this fishery, so that management advice for sole must also take into account the advice for plaice. The effort reductions in 2009 have also positively impacted the plaice stock with a sizeable reduction in F indicated for that stock also. Angler fish, cuttle fish, and lemon sole are also important bycatches in this fishery. The UK beam trawl fleet has recently started to land sizeable quantities of gurnards for human consumption.

Estimates of $F_{MSY}$ and its proxies were all considered highly uncertain by WGCSE2010 for this stock and therefore not considered appropriate. The current management plan is considered appropriate to achieving high long-term yields consistent with MSY.

### 8.3.11 Ecosystem considerations

Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Discard rates of non-commercial species and commercial species of unmarketable size are substantial, but total discards are lower compared to some other gears due to the relatively small area swept by the gear.

### 8.3.12 Regulations and their effects

Management of this stock is mainly by TAC. In 2005 effort restrictions were implemented for beam trawlers and entangling gears targeting sole this fishery to enforce the TAC and improve data quality. To date the latter restrictions have not been limiting in this fishery, in part due to the large numbers of days available, but also because in the UK fleet there appears to remain some latent effort/overcapacity in the beam trawl fleet despite decommissioning.

In November of 2008 the UK introduced a single area licensing scheme for beam trawlers, which is thought to be highly effective in eliminating the current practice of area misreporting by this fleet, but will have had little effect on the fishery in 2008. UK landings and effort data indicate that the measure has been effective since 2009.

Mesh restrictions for towed gears are set to 80 mm codends, which correspond well with the minimum landing size of sole at 24 cm. Consequently there is little discarding of sole in this fishery. This view has not changed in spite of the more restrictive TAC on the UK beam trawl fleet.

### 8.3.13 Changes in fishing technology and fishing patterns

The UK industry has applied for MSC certification in 2009 commensurate with which it has started to adopt larger codend meshes and square mesh panels to limit the impact on benthic ecosystems. However these changes appear to minimally affect the catch rates of sole, nor is the degree of uptake of these measures in the fleet clear. Changes in fishing pattern to make the most of available opportunities for other species in this multispecies fishery have undoubtedly changed fleet behaviour. To date the evidence suggests that these effects are more substantial than those associated with changes in the fishing gear, but both will need to be monitored in the future.

### 8.3.14 Changes in the environment

WGRED 2008 overall indicated that there were no consistent environmental drivers altering the ecosystem in Celtic Sea Area, although it did provide some more detailed description of the environmental changes occurring in the system, including climate change, NAO and changes in plankton productivity and species composition.

The winter NAO experienced a strong negative phase in the 1960s, becoming more positive in the 1980s and early 1990s. It remained mainly negative from 1996 to 2004, but became positive in 2005 (6.7 mbar).

Although the assessment only goes back to 1969, relative year class for sole VIIe from catches indicates some very strong recruitment for example in 1963, following which recruitment appears to have declined coinciding with the strong negative phase of the NAO. Positive NAOs in the 1980s and 1990s coincide with some of the highest recruitments seen in the assessment, which have declined since then along with NAO values. Since 2005 the NAO again shows more favourable conditions even though this has not immediately resulted in returns very large year classes, there is some evidence that recruitment is higher now, but more consistent so that we aren't seeing the extreme recruitments seen earlier in the time-series.

This should be investigated further by the next benchmark.

**Table 8.3.1 Sole VIIE Nominal landings (t) as used by the WG**

| Year | Belgium | Denmark | France | Netherlands | Ireland | Jersey | Guernsey | UK E W NI | UK other | Unallocated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | | | 323 | | | | | | | 104 | 427 |
| 1975 | 3 | | 271 | | | | 2 | 215 | | | 491 |
| 1976 | 4 | | 352 | | | | 1 | 259 | | | 616 |
| 1977 | 3 | | 331 | | | | | 272 | | | 606 |
| 1978 | 4 | | 384 | | | | | 453 | | 20 | 861 |
| 1979 | 1 | | 515 | | | | 2 | 663 | | | 1181 |
| 1980 | 45 | | 447 | | 13 | | 1 | 763 | | | 1269 |
| 1981 | 16 | | 415 | 1 | | | 4 | 784 | | -5 | 1215 |
| 1982 | 98 | | 321 | | | | 15 | 1013 | | -1 | 1446 |
| 1983 | 47 | | 405 | 3 | | 2 | 16 | 1025 | | | 1498 |
| 1984 | 48 | | 421 | | | 9 | 14 | 878 | | | 1370 |
| 1985 | 58 | | 130 | | | 9 | 8 | 894 | | 310 | 1409 |
| 1986 | 62 | | 467 | | | 3 | 6 | 831 | | 50 | 1419 |
| 1987 | 48 | | 432 | | | 1 | 5 | 626 | | 168 | 1280 |
| 1988 | 67 | | 98 | | | 0 | 4 | 780 | | 495 | 1444 |
| 1989 | 69 | | 112 | 6 | | | 3 | 610 | | 590 | 1390 |
| 1990 | 41 | 0 | 81 | | | 1 | 3 | 632 | | 556 | 1315 |
| 1991 | 35 | | 325 | | | | | 477 | | 15 | 852 |
| 1992 | 41 | | 267 | | | | 2 | 457 | 9 | 119 | 895 |
| 1993 | 59 | | 236 | | | 1 | | 479 | 18 | 111 | 904 |
| 1994 | 33 | | 257 | | | | | 546 | | -38 | 800 |
| 1995 | 21 | | 294 | | | 1 | 2 | 562 | | -24 | 856 |
| 1996 | 8 | | 297 | | | | | 428 | | 91 | 833 |
| 1997 | 13 | | 348 | | 1 | 13 | 13 | 470 | | 91 | 949 |
| 1998 | 40 | | 343 | | | 17 | 3 | 369 | | 108 | 880 |
| 1999 | 13 | | | | | 18 | 3 | 375 | | 548 | 957 |
| 2000 | 4 | | 241 | | | 22 | 5 | 386 | | 256 | 914 |
| 2001 | 19 | | 224 | | | 20 | 5 | 382 | | 419 | 1069 |
| 2002 | 33 | | 198 | | | 15 | 5 | 289 | | 566 | 1106 |
| 2003 | 1 | | 363 | | 1 | 15 | 5 | 235 | | 458 | 1078 |
| 2004 | 7 | | 302 | | | 7 | 6 | 172 | | 581 | 1075 |
| 2005 | 26 | | 406 | | | 17 | 5 | 505 | | 80 | 1039 |
| 2006 | 32 | | 357 | | | 4 | 4 | 568 | 0 | 56 | 1022 |
| 2007 | 34 | | 384 | | 2 | 2 | | 525 | 4 | 64 | 1015 |
| 2008 | 28 | | 312 | | 0 | 2 | 6 | 464 | | 96 | 908 |
| 2009 | 17 | | 385 | | | 1 | 3 | 374 | 3 | -82 | 701 |
| 2010 | 17 | | 359 | | | 2 | | 362 | 2 | -53 | 688 |

**Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's**

| Age | 1969 | 1970 | 1971 | 1972 |
|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 |
| 2 | 89 | 53 | 51 | 146 |
| 3 | 322 | 232 | 200 | 412 |
| 4 | 80 | 322 | 246 | 167 |
| 5 | 148 | 90 | 198 | 115 |
| 6 | 210 | 83 | 65 | 112 |
| 7 | 21 | 112 | 80 | 14 |
| 8 | 50 | 13 | 156 | 25 |
| 9 | 26 | 35 | 10 | 134 |
| 10 | 20 | 52 | 35 | 38 |
| 11 | 9 | 22 | 54 | 54 |
| +gp | 63 | 113 | 113 | 106 |
| Total | 1037 | 1127 | 1207 | 1323 |
| Landings | 353 | 391 | 432 | 437 |

**Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's** continued

| Age | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 71 | 45 | 82 | 167 | 426 | 250 | 227 | 175 | 245 | 128 |
| 3 | 396 | 349 | 567 | 419 | 318 | 1123 | 803 | 559 | 806 | 1451 |
| 4 | 433 | 220 | 170 | 472 | 384 | 347 | 811 | 497 | 651 | 916 |
| 5 | 89 | 178 | 199 | 161 | 206 | 214 | 250 | 630 | 467 | 553 |
| 6 | 99 | 71 | 115 | 135 | 102 | 189 | 229 | 126 | 389 | 352 |
| 7 | 120 | 80 | 28 | 92 | 70 | 103 | 174 | 183 | 179 | 240 |
| 8 | 17 | 43 | 53 | 46 | 74 | 72 | 103 | 140 | 126 | 136 |
| 9 | 52 | 32 | 26 | 58 | 10 | 77 | 90 | 65 | 76 | 113 |
| 10 | 30 | 24 | 22 | 51 | 24 | 38 | 104 | 56 | 58 | 81 |
| 11 | 4 | 55 | 24 | 14 | 32 | 27 | 28 | 130 | 55 | 61 |
| +gp | 136 | 106 | 171 | 213 | 159 | 203 | 290 | 342 | 211 | 294 |
| Total | 1446 | 1202 | 1456 | 1830 | 1804 | 2644 | 3108 | 2902 | 3262 | 4324 |
| Landings | 459 | 427 | 491 | 616 | 606 | 861 | 1181 | 1269 | 1215 | 1446 |

**Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's** continued

| Age | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 91 | 333 | 287 | 246 | 487 | 443 | 390 | 341 | 450 | 316 |
| 3 | 753 | 663 | 1700 | 1618 | 808 | 1438 | 871 | 902 | 415 | 1434 |
| 4 | 1573 | 826 | 756 | 971 | 1090 | 596 | 1233 | 581 | 482 | 417 |
| 5 | 583 | 758 | 469 | 421 | 427 | 728 | 497 | 553 | 289 | 297 |
| 6 | 351 | 325 | 585 | 321 | 204 | 374 | 509 | 244 | 220 | 115 |
| 7 | 267 | 204 | 179 | 336 | 224 | 153 | 225 | 264 | 93 | 112 |
| 8 | 294 | 129 | 97 | 84 | 229 | 162 | 110 | 143 | 111 | 61 |
| 9 | 119 | 152 | 103 | 75 | 47 | 109 | 107 | 103 | 68 | 74 |
| 10 | 73 | 54 | 85 | 90 | 50 | 39 | 113 | 75 | 37 | 26 |
| 11 | 37 | 28 | 29 | 74 | 41 | 50 | 48 | 85 | 31 | 23 |
| +gp | 262 | 255 | 125 | 127 | 162 | 171 | 214 | 235 | 145 | 90 |
| Total | 4401 | 3727 | 4414 | 4363 | 3770 | 4262 | 4316 | 3525 | 2341 | 2964 |
| Landings | 1498 | 1370 | 1409 | 1419 | 1280 | 1444 | 1390 | 1315 | 852 | 895 |

**Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's** continued

| Age | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 209 | 97 | 95 | 365 | 216 | 265 | 280 | 307 | 145 | 332 |
| 3 | 704 | 657 | 308 | 445 | 831 | 606 | 915 | 599 | 1401 | 1251 |
| 4 | 1107 | 558 | 629 | 364 | 724 | 536 | 500 | 751 | 531 | 843 |
| 5 | 350 | 558 | 427 | 298 | 325 | 336 | 398 | 367 | 497 | 387 |
| 6 | 219 | 112 | 411 | 235 | 180 | 209 | 255 | 229 | 268 | 322 |
| 7 | 151 | 106 | 131 | 257 | 194 | 151 | 114 | 107 | 178 | 129 |
| 8 | 78 | 49 | 101 | 68 | 173 | 80 | 103 | 53 | 100 | 105 |
| 9 | 60 | 57 | 61 | 61 | 44 | 127 | 54 | 68 | 55 | 94 |
| 10 | 56 | 44 | 33 | 49 | 20 | 35 | 107 | 51 | 43 | 33 |
| 11 | 31 | 50 | 18 | 37 | 40 | 34 | 25 | 88 | 42 | 18 |
| +gp | 79 | 99 | 142 | 143 | 88 | 162 | 123 | 91 | 159 | 85 |
| Total | 3045 | 2388 | 2356 | 2321 | 2835 | 2543 | 2874 | 2710 | 3419 | 3599 |
| Landings | 904 | 800 | 856 | 833 | 949 | 880 | 957 | 914 | 1069 | 1106 |

**Table 8.3.2 Sole VIIE Catch Numbers at Age in 000's** continued

| Age | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | geom mean 08-10 | arith mean 08-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| 2 | 598 | 398 | 258 | 500 | 201 | 281 | 166 | 67 | 145.97 | 171.24 |
| 3 | 835 | 1080 | 468 | 786 | 852 | 752 | 540 | 336 | 515.06 | 542.88 |
| 4 | 953 | 448 | 834 | 472 | 755 | 678 | 385 | 388 | 466.07 | 483.57 |
| 5 | 645 | 445 | 449 | 606 | 293 | 376 | 333 | 325 | 343.69 | 344.40 |
| 6 | 130 | 526 | 366 | 250 | 362 | 163 | 202 | 203 | 188.33 | 189.30 |
| 7 | 74 | 164 | 293 | 224 | 179 | 184 | 66 | 127 | 115.59 | 125.73 |
| 8 | 50 | 116 | 113 | 185 | 130 | 105 | 74 | 49 | 72.47 | 75.98 |
| 9 | 58 | 61 | 80 | 85 | 110 | 71 | 37 | 70 | 57.05 | 59.48 |
| 10 | 63 | 54 | 45 | 56 | 55 | 67 | 50 | 21 | 41.06 | 45.99 |
| 11 | 14 | 35 | 24 | 31 | 27 | 39 | 35 | 33 | 35.91 | 36.00 |
| +gp | 61 | 85 | 96 | 87 | 99 | 89 | 65 | 77 | 76.60 | 77.22 |
| Total | 3482 | 3412 | 3027 | 3282 | 3062 | 2805 | 1955 | 1695 | 2102.68 | 2151.78 |
| Landings | 1078 | 1075 | 1039 | 1023 | 1015 | 908 | 701 | 688 | 759.39 | 765.67 |

**Table 8.3.3 Sole VIIE Catch Weights at Age in kgs**

| Age | 1969 | 1970 | 1971 |
|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.113 |
| 2 | 0.188 | 0.187 | 0.151 |
| 3 | 0.245 | 0.223 | 0.222 |
| 4 | 0.332 | 0.294 | 0.296 |
| 5 | 0.329 | 0.314 | 0.367 |
| 6 | 0.367 | 0.354 | 0.350 |
| 7 | 0.522 | 0.434 | 0.359 |
| 8 | 0.455 | 0.498 | 0.431 |
| 9 | 0.463 | 0.442 | 0.455 |
| 10 | 0.606 | 0.512 | 0.476 |
| 11 | 0.647 | 0.528 | 0.388 |
| +gp | 0.660 | 0.593 | 0.653 |

**Table 8.3.3 Sole VIIE Catch Weights at Age in kgs** continued

| Age | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.144 | 0.142 | 0.139 | 0.118 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.194 | 0.203 | 0.183 | 0.181 | 0.170 | 0.197 | 0.180 | 0.187 | 0.189 | 0.174 |
| 3 | 0.227 | 0.224 | 0.224 | 0.214 | 0.217 | 0.248 | 0.241 | 0.237 | 0.254 | 0.226 |
| 4 | 0.272 | 0.262 | 0.281 | 0.299 | 0.286 | 0.302 | 0.303 | 0.327 | 0.343 | 0.322 |
| 5 | 0.369 | 0.310 | 0.379 | 0.358 | 0.323 | 0.356 | 0.390 | 0.423 | 0.389 | 0.382 |
| 6 | 0.408 | 0.381 | 0.434 | 0.403 | 0.390 | 0.399 | 0.439 | 0.460 | 0.525 | 0.478 |
| 7 | 0.458 | 0.414 | 0.372 | 0.435 | 0.454 | 0.502 | 0.377 | 0.468 | 0.560 | 0.515 |
| 8 | 0.495 | 0.459 | 0.464 | 0.497 | 0.413 | 0.463 | 0.486 | 0.477 | 0.609 | 0.534 |
| 9 | 0.402 | 0.466 | 0.475 | 0.591 | 0.475 | 0.517 | 0.489 | 0.565 | 0.646 | 0.599 |
| 10 | 0.454 | 0.537 | 0.487 | 0.651 | 0.478 | 0.484 | 0.488 | 0.522 | 0.655 | 0.620 |
| 11 | 0.508 | 0.654 | 0.474 | 0.535 | 0.583 | 0.552 | 0.540 | 0.569 | 0.600 | 0.710 |
| +gp | 0.600 | 0.561 | 0.731 | 0.676 | 0.628 | 0.681 | 0.670 | 0.725 | 0.783 | 0.661 |

**Table 8.3.3 Sole VIIE Catch Weights at Age in kgs** continued

| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.120 | 0.000 | 0.088 | 0.000 | 0.106 | 0.098 | 0.091 | 0.110 | 0.158 | 0.105 |
| 2 | 0.213 | 0.188 | 0.209 | 0.162 | 0.174 | 0.174 | 0.170 | 0.167 | 0.216 | 0.182 |
| 3 | 0.208 | 0.251 | 0.242 | 0.225 | 0.237 | 0.245 | 0.244 | 0.222 | 0.270 | 0.255 |
| 4 | 0.276 | 0.272 | 0.304 | 0.296 | 0.297 | 0.310 | 0.312 | 0.275 | 0.322 | 0.323 |
| 5 | 0.345 | 0.307 | 0.379 | 0.358 | 0.354 | 0.370 | 0.375 | 0.326 | 0.370 | 0.386 |
| 6 | 0.424 | 0.390 | 0.389 | 0.389 | 0.407 | 0.425 | 0.432 | 0.375 | 0.416 | 0.445 |
| 7 | 0.495 | 0.419 | 0.478 | 0.469 | 0.456 | 0.474 | 0.484 | 0.422 | 0.458 | 0.499 |
| 8 | 0.507 | 0.475 | 0.539 | 0.520 | 0.502 | 0.518 | 0.531 | 0.467 | 0.498 | 0.549 |
| 9 | 0.520 | 0.532 | 0.559 | 0.531 | 0.544 | 0.557 | 0.572 | 0.510 | 0.534 | 0.594 |
| 10 | 0.523 | 0.610 | 0.601 | 0.519 | 0.583 | 0.590 | 0.608 | 0.551 | 0.567 | 0.634 |
| 11 | 0.561 | 0.553 | 0.722 | 0.584 | 0.618 | 0.618 | 0.639 | 0.590 | 0.597 | 0.669 |
| +gp | 0.659 | 0.667 | 0.639 | 0.817 | 0.703 | 0.665 | 0.694 | 0.692 | 0.664 | 0.742 |

**Table 8.3.3 Sole VIIE Catch Weights at Age in kgs** continued

| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.088 | 0.000 | 0.122 | 0.133 | 0.164 | 0.000 | 0.000 | 0.158 | 0.141 | 0.000 |
| 2 | 0.166 | 0.146 | 0.183 | 0.192 | 0.214 | 0.186 | 0.191 | 0.208 | 0.201 | 0.203 |
| 3 | 0.238 | 0.209 | 0.241 | 0.248 | 0.262 | 0.244 | 0.247 | 0.257 | 0.257 | 0.245 |
| 4 | 0.305 | 0.268 | 0.295 | 0.301 | 0.308 | 0.300 | 0.300 | 0.303 | 0.309 | 0.287 |
| 5 | 0.366 | 0.324 | 0.347 | 0.351 | 0.354 | 0.354 | 0.350 | 0.347 | 0.357 | 0.326 |
| 6 | 0.423 | 0.376 | 0.396 | 0.397 | 0.399 | 0.406 | 0.397 | 0.389 | 0.400 | 0.365 |
| 7 | 0.474 | 0.425 | 0.442 | 0.441 | 0.442 | 0.455 | 0.441 | 0.429 | 0.440 | 0.402 |
| 8 | 0.520 | 0.470 | 0.484 | 0.481 | 0.484 | 0.503 | 0.482 | 0.467 | 0.475 | 0.438 |
| 9 | 0.561 | 0.513 | 0.524 | 0.518 | 0.524 | 0.548 | 0.520 | 0.502 | 0.507 | 0.472 |
| 10 | 0.597 | 0.551 | 0.561 | 0.552 | 0.564 | 0.592 | 0.555 | 0.535 | 0.534 | 0.505 |
| 11 | 0.627 | 0.587 | 0.595 | 0.583 | 0.602 | 0.633 | 0.586 | 0.566 | 0.557 | 0.537 |
| +gp | 0.684 | 0.672 | 0.671 | 0.652 | 0.695 | 0.734 | 0.661 | 0.636 | 0.645 | 0.615 |

**Table 8.3.3 Sole VIIE Catch Weights at Age in kgs** continued

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | mean 08-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.123 | 0.101 | 0.122 | 0.123 | 0.106 | 0.117 | 0.147 | 0.094 | 0.000 | 0.080 |
| 2 | 0.181 | 0.173 | 0.176 | 0.180 | 0.168 | 0.183 | 0.197 | 0.176 | 0.168 | 0.180 |
| 3 | 0.236 | 0.241 | 0.230 | 0.235 | 0.226 | 0.244 | 0.245 | 0.252 | 0.257 | 0.251 |
| 4 | 0.290 | 0.306 | 0.282 | 0.289 | 0.280 | 0.299 | 0.292 | 0.322 | 0.338 | 0.317 |
| 5 | 0.342 | 0.367 | 0.334 | 0.342 | 0.331 | 0.350 | 0.337 | 0.385 | 0.411 | 0.378 |
| 6 | 0.391 | 0.425 | 0.385 | 0.393 | 0.378 | 0.395 | 0.382 | 0.443 | 0.475 | 0.433 |
| 7 | 0.439 | 0.479 | 0.435 | 0.443 | 0.421 | 0.436 | 0.425 | 0.494 | 0.532 | 0.484 |
| 8 | 0.485 | 0.530 | 0.485 | 0.492 | 0.461 | 0.471 | 0.468 | 0.540 | 0.579 | 0.529 |
| 9 | 0.529 | 0.577 | 0.533 | 0.539 | 0.497 | 0.501 | 0.509 | 0.579 | 0.619 | 0.569 |
| 10 | 0.570 | 0.620 | 0.581 | 0.585 | 0.529 | 0.526 | 0.549 | 0.612 | 0.650 | 0.604 |
| 11 | 0.610 | 0.660 | 0.628 | 0.629 | 0.558 | 0.546 | 0.588 | 0.639 | 0.673 | 0.633 |
| +gp | 0.705 | 0.746 | 0.756 | 0.746 | 0.667 | 0.616 | 0.652 | 0.702 | 0.699 | 0.685 |

**Table 8.3.4 Sole VIIE Stock Weights at Age in kgs**

| Age | 1969 | 1970 | 1971 |
|---|---|---|---|
| 1 | 0.040 | 0.045 | 0.030 |
| 2 | 0.125 | 0.120 | 0.090 |
| 3 | 0.200 | 0.195 | 0.170 |
| 4 | 0.270 | 0.255 | 0.240 |
| 5 | 0.330 | 0.305 | 0.295 |
| 6 | 0.380 | 0.355 | 0.345 |
| 7 | 0.425 | 0.395 | 0.390 |
| 8 | 0.460 | 0.430 | 0.420 |
| 9 | 0.490 | 0.465 | 0.445 |
| 10 | 0.520 | 0.490 | 0.470 |
| 11 | 0.550 | 0.510 | 0.490 |
| +gp | 0.609 | 0.541 | 0.544 |

**Table 8.3.4 Sole VIIE Stock Weights at Age in kgs** continued

| Age | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.055 | 0.035 | 0.040 | 0.071 | 0.095 | 0.086 | 0.090 | 0.064 | 0.052 | 0.038 |
| 2 | 0.130 | 0.105 | 0.125 | 0.144 | 0.146 | 0.156 | 0.156 | 0.141 | 0.125 | 0.119 |
| 3 | 0.200 | 0.170 | 0.200 | 0.221 | 0.198 | 0.221 | 0.217 | 0.216 | 0.206 | 0.197 |
| 4 | 0.265 | 0.235 | 0.265 | 0.267 | 0.247 | 0.278 | 0.276 | 0.287 | 0.288 | 0.276 |
| 5 | 0.325 | 0.290 | 0.320 | 0.327 | 0.294 | 0.332 | 0.330 | 0.352 | 0.360 | 0.358 |
| 6 | 0.380 | 0.340 | 0.370 | 0.385 | 0.338 | 0.382 | 0.380 | 0.414 | 0.436 | 0.427 |
| 7 | 0.420 | 0.390 | 0.410 | 0.435 | 0.380 | 0.425 | 0.425 | 0.463 | 0.513 | 0.490 |
| 8 | 0.460 | 0.435 | 0.455 | 0.479 | 0.417 | 0.462 | 0.463 | 0.502 | 0.575 | 0.543 |
| 9 | 0.490 | 0.475 | 0.490 | 0.516 | 0.456 | 0.497 | 0.498 | 0.539 | 0.620 | 0.582 |
| 10 | 0.520 | 0.510 | 0.515 | 0.545 | 0.491 | 0.527 | 0.526 | 0.574 | 0.650 | 0.616 |
| 11 | 0.540 | 0.540 | 0.530 | 0.569 | 0.523 | 0.553 | 0.555 | 0.608 | 0.674 | 0.645 |
| +gp | 0.558 | 0.585 | 0.571 | 0.628 | 0.595 | 0.629 | 0.630 | 0.719 | 0.714 | 0.699 |

**Table 8.3.4 Sole VIIE Stock Weights at Age in kgs** continued

| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.038 | 0.040 | 0.032 | 0.095 | 0.071 | 0.058 | 0.050 | 0.081 | 0.128 | 0.065 |
| 2 | 0.117 | 0.120 | 0.108 | 0.150 | 0.140 | 0.137 | 0.131 | 0.139 | 0.187 | 0.144 |
| 3 | 0.195 | 0.195 | 0.192 | 0.204 | 0.206 | 0.210 | 0.208 | 0.195 | 0.243 | 0.219 |
| 4 | 0.265 | 0.250 | 0.268 | 0.258 | 0.268 | 0.278 | 0.278 | 0.249 | 0.296 | 0.290 |
| 5 | 0.335 | 0.307 | 0.339 | 0.311 | 0.326 | 0.341 | 0.344 | 0.300 | 0.346 | 0.355 |
| 6 | 0.398 | 0.365 | 0.400 | 0.364 | 0.381 | 0.398 | 0.404 | 0.350 | 0.393 | 0.416 |
| 7 | 0.455 | 0.420 | 0.453 | 0.416 | 0.432 | 0.450 | 0.459 | 0.398 | 0.437 | 0.473 |
| 8 | 0.506 | 0.475 | 0.501 | 0.468 | 0.480 | 0.497 | 0.508 | 0.444 | 0.478 | 0.524 |
| 9 | 0.536 | 0.520 | 0.545 | 0.520 | 0.524 | 0.538 | 0.552 | 0.488 | 0.516 | 0.572 |
| 10 | 0.562 | 0.570 | 0.577 | 0.571 | 0.564 | 0.574 | 0.591 | 0.531 | 0.551 | 0.614 |
| 11 | 0.585 | 0.615 | 0.607 | 0.621 | 0.601 | 0.605 | 0.624 | 0.571 | 0.583 | 0.652 |
| +gp | 0.632 | 0.709 | 0.696 | 0.790 | 0.691 | 0.659 | 0.687 | 0.675 | 0.654 | 0.731 |

**Table 8.3.4 Sole VIIE Stock Weights at Age in kgs** continued

| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.048 | 0.000 | 0.091 | 0.103 | 0.139 | 0.000 | 0.000 | 0.132 | 0.110 | 0.000 |
| 2 | 0.128 | 0.114 | 0.153 | 0.163 | 0.189 | 0.156 | 0.162 | 0.183 | 0.172 | 0.181 |
| 3 | 0.202 | 0.178 | 0.212 | 0.221 | 0.238 | 0.215 | 0.220 | 0.233 | 0.230 | 0.224 |
| 4 | 0.272 | 0.239 | 0.268 | 0.275 | 0.285 | 0.272 | 0.274 | 0.280 | 0.284 | 0.266 |
| 5 | 0.336 | 0.296 | 0.322 | 0.326 | 0.331 | 0.327 | 0.325 | 0.326 | 0.333 | 0.307 |
| 6 | 0.395 | 0.350 | 0.372 | 0.374 | 0.376 | 0.380 | 0.374 | 0.369 | 0.379 | 0.346 |
| 7 | 0.449 | 0.401 | 0.419 | 0.419 | 0.420 | 0.431 | 0.419 | 0.410 | 0.421 | 0.384 |
| 8 | 0.498 | 0.448 | 0.463 | 0.461 | 0.463 | 0.480 | 0.462 | 0.448 | 0.458 | 0.420 |
| 9 | 0.542 | 0.492 | 0.505 | 0.500 | 0.504 | 0.526 | 0.501 | 0.485 | 0.492 | 0.455 |
| 10 | 0.580 | 0.532 | 0.543 | 0.536 | 0.544 | 0.570 | 0.537 | 0.519 | 0.521 | 0.489 |
| 11 | 0.613 | 0.570 | 0.578 | 0.568 | 0.583 | 0.612 | 0.571 | 0.551 | 0.546 | 0.521 |
| +gp | 0.677 | 0.659 | 0.659 | 0.641 | 0.677 | 0.717 | 0.650 | 0.624 | 0.643 | 0.602 |

**Table 8.3.4 Sole VIIE Stock Weights at Age in kgs** continued

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | mean 08-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.094 | 0.063 | 0.095 | 0.094 | 0.074 | 0.083 | 0.122 | 0.051 | 0.000 | 0.058 |
| 2 | 0.152 | 0.137 | 0.149 | 0.152 | 0.138 | 0.151 | 0.172 | 0.136 | 0.121 | 0.143 |
| 3 | 0.209 | 0.207 | 0.203 | 0.208 | 0.197 | 0.214 | 0.221 | 0.215 | 0.214 | 0.217 |
| 4 | 0.263 | 0.274 | 0.256 | 0.263 | 0.254 | 0.272 | 0.268 | 0.287 | 0.299 | 0.285 |
| 5 | 0.316 | 0.337 | 0.308 | 0.316 | 0.306 | 0.325 | 0.315 | 0.354 | 0.376 | 0.348 |
| 6 | 0.367 | 0.396 | 0.360 | 0.368 | 0.355 | 0.373 | 0.360 | 0.415 | 0.444 | 0.406 |
| 7 | 0.415 | 0.452 | 0.410 | 0.419 | 0.400 | 0.416 | 0.404 | 0.469 | 0.505 | 0.459 |
| 8 | 0.462 | 0.505 | 0.460 | 0.468 | 0.442 | 0.454 | 0.447 | 0.518 | 0.557 | 0.507 |
| 9 | 0.507 | 0.554 | 0.509 | 0.516 | 0.479 | 0.486 | 0.489 | 0.560 | 0.600 | 0.550 |
| 10 | 0.550 | 0.599 | 0.557 | 0.562 | 0.514 | 0.514 | 0.529 | 0.596 | 0.636 | 0.587 |
| 11 | 0.591 | 0.641 | 0.605 | 0.607 | 0.544 | 0.536 | 0.569 | 0.626 | 0.663 | 0.619 |
| +gp | 0.688 | 0.732 | 0.734 | 0.726 | 0.661 | 0.614 | 0.640 | 0.698 | 0.696 | 0.678 |

**Table 8.3.5 Sole VIIE Landings Length Frequency Distributions**

| Length | UK BeamTrawl | UK other | French Nets | French Trawl | French Trawl Mol |
|---|---|---|---|---|---|
| 19 | 0 | 0 | 0 | 109 | 0 |
| 20 | 0 | 0 | 0 | 420 | 0 |
| 21 | 0 | 0 | 971 | 713 | 0 |
| 22 | 174 | 0 | 1359 | 0 | 0 |
| 23 | 57 | 81 | 0 | 707 | 0 |
| 24 | 1286 | 155 | 929 | 1541 | 18081 |
| 25 | 4400 | 595 | 3384 | 3792 | 10791 |
| 26 | 10687 | 2140 | 1262 | 9029 | 8121 |
| 27 | 17713 | 3792 | 6990 | 12953 | 16469 |
| 28 | 27118 | 4796 | 7393 | 12701 | 22936 |
| 29 | 34239 | 5708 | 9195 | 16605 | 34908 |
| 30 | 41375 | 6539 | 6311 | 24071 | 10410 |
| 31 | 50442 | 6696 | 7253 | 19048 | 11411 |
| 32 | 68265 | 8430 | 10557 | 16375 | 4672 |
| 33 | 74818 | 8709 | 7490 | 18869 | 6012 |
| 34 | 71855 | 10829 | 6987 | 18652 | 5733 |
| 35 | 67860 | 7483 | 6248 | 13277 | 9298 |
| 36 | 57578 | 8238 | 4033 | 8871 | 1669 |
| 37 | 48520 | 6151 | 2185 | 6173 | 2664 |
| 38 | 42409 | 4750 | 8567 | 10346 | 3109 |
| 39 | 31253 | 4448 | 2049 | 13405 | 5210 |
| 40 | 20049 | 3786 | 3556 | 9473 | 0 |
| 41 | 16144 | 2332 | 4787 | 6926 | 0 |
| 42 | 10635 | 5646 | 3131 | 9576 | 0 |
| 43 | 7464 | 1404 | 3034 | 1852 | 0 |
| 44 | 8257 | 2761 | 3341 | 5438 | 1551 |
| 45 | 5089 | 912 | 0 | 3050 | 0 |
| 46 | 2802 | 644 | 2208 | 288 | 0 |
| 47 | 1564 | 265 | 0 | 305 | 0 |
| 48 | 707 | 288 | 1189 | 300 | 0 |
| 49 | 497 | 251 | 679 | 0 | 0 |
| 50 | 117 | 29 | 846 | 0 | 0 |
| 51 | 216 | 42 | 251 | 1280 | 0 |
| 52 | 108 | 76 | 316 | 0 | 0 |
| 53 | 0 | 5 | 121601 | 244904 | 173044 |
| 54 | 10 | 0 | 0 | 1280 | 0 |
| 55 | 82 | 0 | 1189 | 0 | 0 |
| 56 | 0 | 0 | 0 | 0 | 0 |
| 57 | 0 | 0 | 0 | 0 | 0 |
| 58 | 0 | 0 | 0 | 0 | 0 |
| 59 | 0 | 0 | 0 | 0 | 0 |
| Total | 723790 | 107981 | 239291 | 492329 | 346089 |

**Table 8.3.6 Sole VIIE landings, effort & mean standardised CPUE data**

| Year | Effort BT u24 000s h | Effort BT o24 000s h | Landings BT u24 t | Landings BT o24 t | Survey CPUE kg 100km | BTu24 LPUE kg hour | BTo24 LPUE kg hour | Survey CPUE MS | BTu24 LPUE MS | BTo24 LPUE MS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 46.33 | 60.90 | 332.79 | 441.99 | 74.24 | 7.18 | 7.26 | 1.24 | 1.52 | 2.01 |
| 1989 | 35.29 | 86.80 | 200.99 | 520.43 | 69.36 | 5.70 | 6.00 | 1.16 | 1.20 | 1.66 |
| 1990 | 36.35 | 78.51 | 238.56 | 474.06 | 43.72 | 6.56 | 6.04 | 0.73 | 1.38 | 1.67 |
| 1991 | 27.93 | 64.94 | 165.12 | 296.01 | 72.58 | 5.91 | 4.56 | 1.21 | 1.25 | 1.26 |
| 1992 | 29.47 | 61.95 | 169.31 | 291.50 | 78.13 | 5.74 | 4.70 | 1.31 | 1.21 | 1.30 |
| 1993 | 31.08 | 65.31 | 199.90 | 281.75 | 49.63 | 6.43 | 4.31 | 0.83 | 1.36 | 1.19 |
| 1994 | 34.77 | 73.47 | 189.29 | 317.87 | 40.66 | 5.44 | 4.33 | 0.68 | 1.15 | 1.20 |
| 1995 | 31.30 | 76.80 | 158.01 | 328.93 | 37.78 | 5.05 | 4.28 | 0.63 | 1.07 | 1.18 |
| 1996 | 33.16 | 94.91 | 164.71 | 300.93 | 48.72 | 4.97 | 3.17 | 0.82 | 1.05 | 0.88 |
| 1997 | 34.15 | 88.68 | 192.26 | 332.09 | 63.11 | 5.63 | 3.74 | 1.06 | 1.19 | 1.03 |
| 1998 | 43.41 | 83.09 | 186.94 | 306.70 | 65.83 | 4.31 | 3.69 | 1.10 | 0.91 | 1.02 |
| 1999 | 42.82 | 73.17 | 185.15 | 271.41 | 54.50 | 4.32 | 3.71 | 0.91 | 0.91 | 1.02 |
| 2000 | 49.07 | 79.58 | 202.29 | 250.02 | 51.94 | 4.12 | 3.14 | 0.87 | 0.87 | 0.87 |
| 2001 | 65.65 | 92.42 | 302.55 | 300.74 | 74.67 | 4.61 | 3.25 | 1.25 | 0.97 | 0.90 |
| 2002 | 61.55 | 92.19 | 293.79 | 298.56 | 43.18 | 4.77 | 3.24 | 0.72 | 1.01 | 0.89 |
| 2003 | 67.25 | 107.01 | 277.64 | 329.50 | 50.28 | 4.13 | 3.08 | 0.84 | 0.87 | 0.85 |
| 2004 | 56.25 | 108.64 | 206.17 | 239.23 | 57.99 | 3.67 | 2.20 | 0.97 | 0.77 | 0.61 |
| 2005 | 51.49 | 107.66 | 198.42 | 255.15 | 35.67 | 3.85 | 2.37 | 0.60 | 0.81 | 0.65 |
| 2006 | 50.87 | 110.87 | 225.31 | 238.63 | 49.10 | 4.43 | 2.15 | 0.82 | 0.93 | 0.59 |
| 2007 | 65.32 | 94.07 | 237.46 | 213.78 | 62.91 | 3.64 | 2.27 | 1.05 | 0.77 | 0.63 |
| 2008 | 76.21 | 83.37 | 222.79 | 170.25 | 73.55 | 2.92 | 2.04 | 1.23 | 0.62 | 0.56 |
| 2009 | 63.66 | 58.99 | 184.35 | 115.31 | 77.38 | 2.90 | 1.95 | 1.30 | 0.61 | 0.54 |
| 2010 | 74.52 | 54.00 | 202.08 | 93.77 | 99.20 | 2.71 | 1.74 | 1.66 | 0.57 | 0.48 |

## Table 8.3.7 Fleet tuning information used in the assessment

W-CHANNEL SOLE 2011 WGCSE, 1-14, SEXES COMBINED,

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UK-CBT

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 3 | 14 | | | | | | | | | | | |
| 107.23 | 747.49 | 382.4 | 497.05 | 225.59 | 71.83 | 70.57 | 66.73 | 14.92 | 24.57 | 15.09 | 31.15 | 7.87 |
| 122.09 | 480.71 | 603.07 | 295.68 | 344.28 | 124.29 | 52.66 | 52.11 | 48.82 | 30.47 | 18.98 | 21.01 | 12.79 |
| 114.86 | 478.16 | 361.27 | 271.68 | 174.70 | 170.90 | 65.40 | 49.23 | 31.81 | 27.42 | 14.67 | 24.04 | 12.60 |
| 92.87 | 229.74 | 240.99 | 186.87 | 121.76 | 52.87 | 67.89 | 37.54 | 17.79 | 12.29 | 22.67 | 5.38 | 9.83 |
| 91.43 | 773.74 | 216.51 | 152.49 | 57.61 | 60.04 | 28.95 | 41.72 | 10.80 | 7.61 | 7.45 | 7.99 | 7.08 |
| 96.39 | 382.12 | 602.61 | 186.88 | 114.16 | 81.18 | 41.21 | 31.94 | 31.52 | 15.68 | 4.58 | 11.85 | 8.02 |
| 108.24 | 443.52 | 361.70 | 347.10 | 69.39 | 62.83 | 30.89 | 34.86 | 26.44 | 29.61 | 14.09 | 10.91 | 5.74 |
| 108.10 | 173.64 | 357.84 | 240.49 | 233.61 | 71.61 | 56.73 | 33.47 | 18.33 | 10.07 | 22.33 | 9.28 | 6.44 |
| 128.07 | 239.43 | 194.61 | 165.43 | 133.04 | 143.67 | 38.10 | 34.80 | 27.59 | 20.80 | 22.58 | 20.66 | 8.37 |
| 122.83 | 474.85 | 387.28 | 181.39 | 95.01 | 104.45 | 92.27 | 23.00 | 10.67 | 21.69 | 8.71 | 10.14 | 7.52 |
| 126.50 | 352.44 | 311.69 | 194.66 | 115.68 | 83.44 | 44.32 | 66.82 | 18.37 | 18.30 | 15.18 | 16.05 | 7.08 |
| 115.99 | 471.41 | 244.17 | 181.40 | 114.13 | 48.08 | 45.38 | 23.67 | 47.22 | 10.45 | 17.65 | 5.01 | 5.30 |
| 128.65 | 308.67 | 374.19 | 177.98 | 110.37 | 53.08 | 26.86 | 31.31 | 23.64 | 41.62 | 4.51 | 6.91 | 2.95 |
| 158.07 | 832.95 | 295.63 | 281.48 | 143.95 | 95.75 | 53.72 | 28.03 | 23.25 | 22.22 | 25.86 | 9.65 | 7.28 |
| 153.74 | 775.07 | 469.78 | 172.07 | 172.99 | 77.14 | 54.40 | 23.91 | 10.98 | 12.98 | 7.28 | 13.62 | 6.31 |
| 174.26 | 425.77 | 550.11 | 423.34 | 69.80 | 59.67 | 33.48 | 43.96 | 21.73 | 7.15 | 6.69 | 10.92 | 9.19 |
| 164.89 | 494.01 | 207.46 | 180.26 | 253.67 | 38.28 | 50.45 | 25.25 | 20.16 | 14.39 | 7.15 | 3.98 | 6.39 |
| 159.15 | 223.71 | 346.97 | 141.36 | 165.05 | 140.46 | 29.15 | 34.66 | 23.97 | 15.14 | 8.83 | 6.32 | 5.14 |
| 161.74 | 380.29 | 188.15 | 245.65 | 86.37 | 109.33 | 107.95 | 37.56 | 20.86 | 13.81 | 13.74 | 6.74 | 3.01 |
| 159.39 | 488.97 | 280.33 | 113.45 | 110.97 | 58.13 | 66.53 | 55.17 | 16.44 | 11.91 | 11.16 | 9.05 | 8.76 |
| 159.57 | 314.87 | 306.44 | 135.02 | 72.71 | 70.10 | 45.39 | 42.38 | 38.92 | 15.58 | 12.62 | 4.60 | 6.40 |
| 122.65 | 190.42 | 183.01 | 153.14 | 89.78 | 26.07 | 27.96 | 13.26 | 16.14 | 12.94 | 4.86 | 3.75 | 1.92 |
| 128.52 | 80.65 | 180.67 | 158.21 | 101.65 | 52.18 | 25.40 | 22.65 | 8.29 | 16.83 | 25.49 | 7.46 | 3.90 |

UK-COT

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | 2010 | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 3 | 14 | | | | | | | | | | | |
| 53402 | 33.38 | 16.95 | 20.78 | 9.30 | 2.75 | 2.75 | 1.98 | 0.38 | 0.82 | 0.43 | 0.93 | 0.27 |
| 54707 | 16.22 | 19.72 | 9.91 | 12.63 | 5.08 | 2.60 | 2.54 | 2.16 | 1.51 | 1.20 | 1.07 | 0.70 |
| 53050 | 19.09 | 13.10 | 9.60 | 6.35 | 5.76 | 2.17 | 1.91 | 1.16 | 0.94 | 0.65 | 1.00 | 0.53 |
| 40789 | 10.04 | 7.04 | 4.12 | 2.46 | 0.96 | 1.44 | 0.42 | 0.41 | 0.24 | 0.27 | 0.08 | 0.18 |
| 39909 | 26.15 | 5.98 | 3.59 | 1.19 | 1.14 | 0.48 | 0.65 | 0.17 | 0.09 | 0.07 | 0.17 | 0.10 |
| 39240 | 12.22 | 17.24 | 5.29 | 3.38 | 2.44 | 1.24 | 0.98 | 0.90 | 0.55 | 0.13 | 0.32 | 0.29 |
| 38768 | 12.67 | 11.69 | 12.60 | 2.55 | 2.65 | 1.25 | 1.38 | 1.05 | 1.20 | 0.63 | 0.46 | 0.27 |
| 35453 | 5.26 | 9.75 | 6.34 | 6.18 | 1.89 | 1.49 | 0.91 | 0.52 | 0.25 | 0.59 | 0.32 | 0.18 |
| 30541 | 9.46 | 6.52 | 4.36 | 3.14 | 3.53 | 0.95 | 0.75 | 0.67 | 0.45 | 0.44 | 0.42 | 0.18 |
| 33281 | 15.05 | 8.74 | 4.75 | 2.81 | 2.88 | 2.52 | 0.62 | 0.28 | 0.43 | 0.31 | 0.26 | 0.27 |
| 29802 | 8.50 | 7.38 | 4.14 | 2.42 | 1.49 | 0.90 | 1.43 | 0.31 | 0.43 | 0.37 | 0.34 | 0.12 |

## Table 8.3.7 Fleet tuning information used in the assessment (continued)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27516 | 11.35 | 5.73 | 4.83 | 2.84 | 1.42 | 1.44 | 0.72 | 1.47 | 0.38 | 0.56 | 0.19 | 0.19 |
| 30493 | 6.40 | 8.07 | 3.87 | 2.53 | 1.19 | 0.57 | 0.77 | 0.59 | 0.95 | 0.09 | 0.20 | 0.05 |
| 31900 | 17.90 | 5.23 | 4.93 | 2.67 | 1.99 | 1.11 | 0.70 | 0.51 | 0.50 | 0.65 | 0.24 | 0.22 |
| 28346 | 9.77 | 6.05 | 2.36 | 2.64 | 1.26 | 0.81 | 0.33 | 0.20 | 0.24 | 0.17 | 0.27 | 0.10 |
| 25060 | 4.49 | 5.72 | 4.67 | 1.01 | 0.83 | 0.47 | 0.52 | 0.26 | 0.12 | 0.15 | 0.22 | 0.17 |
| 25584 | 5.98 | 2.55 | 2.20 | 3.21 | 0.45 | 0.57 | 0.29 | 0.24 | 0.18 | 0.13 | 0.07 | 0.09 |
| 21129 | 6.34 | 9.41 | 3.47 | 4.07 | 3.39 | 0.73 | 0.89 | 0.57 | 0.45 | 0.25 | 0.19 | 0.14 |
| 21058 | 6.85 | 3.24 | 4.08 | 1.34 | 1.61 | 1.73 | 0.59 | 0.30 | 0.20 | 0.19 | 0.12 | 0.05 |
| 22347 | 9.16 | 5.35 | 2.26 | 2.28 | 1.17 | 1.39 | 1.11 | 0.35 | 0.21 | 0.23 | 0.20 | 0.20 |
| 19855 | 5.58 | 4.81 | 2.06 | 1.14 | 1.17 | 0.74 | 0.74 | 0.70 | 0.31 | 0.23 | 0.11 | 0.10 |
| 21412 | 7.94 | 5.45 | 3.91 | 2.16 | 0.64 | 0.82 | 0.39 | 0.52 | 0.44 | 0.18 | 0.12 | 0.08 |
| 26062 | 2.70 | 5.84 | 4.73 | 3.14 | 1.63 | 0.81 | 0.73 | 0.30 | 0.59 | 0.83 | 0.28 | 0.16 |

UK-WEC-BTS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1988 | 2010 | | | | | | | | |
| 1 | 1 | 0.75 | 0.8 | | | | | | |
| 1 | 9 | | | | | | | | |
| 128.2 | 2 | 39 | 129 | 52 | 75 | 22 | 0 | 12 | 3 |
| 165.7 | 5 | 56 | 120 | 107 | 34 | 40 | 17 | 5 | 7 |
| 175.7 | 23 | 52 | 76 | 31 | 24 | 7 | 15 | 3 | 6 |
| 171.7 | 11 | 231 | 79 | 51 | 23 | 21 | 5 | 17 | 4 |
| 196.6 | 5 | 140 | 316 | 44 | 36 | 12 | 7 | 5 | 11 |
| 189.2 | 5 | 54 | 115 | 105 | 14 | 10 | 9 | 3 | 3 |
| 205.9 | 6 | 47 | 106 | 62 | 44 | 5 | 5 | 2 | 3 |
| 187.2 | 14 | 37 | 44 | 42 | 26 | 31 | 4 | 5 | 5 |
| 184.4 | 28 | 112 | 67 | 25 | 32 | 20 | 17 | 3 | 2 |
| 184.7 | 11 | 130 | 126 | 43 | 14 | 16 | 13 | 14 | 5 |
| 185.5 | 11 | 141 | 114 | 76 | 22 | 10 | 14 | 6 | 8 |
| 187.9 | 11 | 97 | 128 | 47 | 23 | 8 | 4 | 4 | 4 |
| 180.4 | 12 | 136 | 70 | 52 | 23 | 16 | 5 | 3 | 5 |
| 178.0 | 9 | 197 | 162 | 52 | 31 | 12 | 12 | 4 | 1 |
| 180.0 | 6 | 37 | 113 | 48 | 27 | 6 | 3 | 2 | 0 |
| 170.7 | 23 | 158 | 57 | 50 | 19 | 4 | 4 | 6 | 1 |
| 164.9 | 16 | 110 | 120 | 24 | 15 | 10 | 16 | 9 | 4 |
| 186.6 | 8 | 110 | 39 | 53 | 12 | 12 | 6 | 2 | 4 |
| 184.7 | 5 | 120 | 95 | 26 | 37 | 10 | 7 | 9 | 0 |
| 181.0 | 7 | 188 | 135 | 50 | 11 | 23 | 3 | 3 | 1 |
| 174.7 | 10 | 85 | 158 | 77 | 40 | 2 | 14 | 3 | 6 |
| 172.0 | 11 | 104 | 126 | 96 | 49 | 13 | 13 | 12 | 1 |
| 179.9 | 20 | 175 | 154 | 84 | 59 | 31 | 20 | 7 | 12 |

## Table 8.3.7 Fleet tuning information used in the assessment (continued)

UK-Inshore

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 1987 | | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | | |
| 2 | 14 | | | | | | | | | | | | |
| 15.76 | 28.3 | 142.9 | 145.8 | 28.7 | 28.7 | 33.8 | 4.9 | 15.2 | 8.4 | 1.0 | 8.4 | 12.7 | 1.2 |
| 12.58 | 17.2 | 117.7 | 67.5 | 51.6 | 18.0 | 19.3 | 11.0 | 8.2 | 5.8 | 12.0 | 3.1 | 4.8 | 2.9 |
| 12.84 | 30.0 | 163.3 | 41.9 | 45.1 | 21.2 | 4.8 | 10.0 | 4.9 | 3.7 | 3.7 | 7.0 | 3.8 | 5.2 |
| 12.58 | 63.6 | 137.5 | 139.9 | 44.9 | 32.6 | 21.4 | 11.4 | 14.4 | 11.7 | 2.9 | 3.7 | 16.0 | 4.6 |
| 14.01 | 169.7 | 106.7 | 114.5 | 57.4 | 24.3 | 15.8 | 18.1 | 2.5 | 5.3 | 6.4 | 3.5 | 4.5 | 8.2 |
| 22.31 | 117.8 | 449.7 | 124.4 | 72.1 | 54.5 | 28.5 | 21.1 | 22.5 | 10.4 | 6.7 | 5.8 | 5.9 | 3.5 |
| 31.15 | 114.2 | 342.9 | 310.5 | 89.6 | 70.2 | 51.1 | 32.4 | 28.1 | 30.2 | 7.3 | 6.8 | 17.3 | 3.6 |
| 42.40 | 131.4 | 322.7 | 221.1 | 257.7 | 36.9 | 46.3 | 37.1 | 18.1 | 13.7 | 32.5 | 9.2 | 7.6 | 8.9 |
| 46.36 | 161.9 | 478.9 | 320.6 | 190.5 | 123.1 | 52.6 | 37.8 | 22.1 | 15.7 | 12.1 | 11.3 | 3.4 | 3.7 |
| 51.68 | 86.0 | 857.6 | 442.0 | 215.7 | 113.5 | 70.6 | 43.0 | 33.6 | 22.2 | 16.7 | 10.3 | 8.2 | 7.6 |
| 51.09 | 76.8 | 353.4 | 623.5 | 210.6 | 80.1 | 78.3 | 94.1 | 33.8 | 26.4 | 5.3 | 6.5 | 34.8 | 5.1 |
| 48.21 | 177.7 | 280.2 | 309.0 | 257.0 | 88.6 | 43.9 | 39.6 | 38.1 | 8.5 | 5.9 | 13.9 | 17.5 | 4.0 |
| 54.87 | 57.7 | 598.4 | 320.7 | 168.7 | 198.1 | 37.2 | 29.9 | 45.9 | 32.4 | 17.7 | 7.6 | 4.2 | 5.6 |
| 53.46 | 103.2 | 823.1 | 361.7 | 111.3 | 82.9 | 87.1 | 23.2 | 9.3 | 7.6 | 17.8 | 4.2 | 5.1 | 9.4 |
| 35.61 | 116.6 | 183.2 | 269.3 | 93.4 | 17.1 | 16.7 | 32.0 | 5.9 | 9.0 | 3.6 | 7.8 | 4.5 | 5.2 |

UK-Offshore

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 1987 | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | | | | | | | | | |
| 3 | 14 | | | | | | | | | | | |
| 5.64 | 24.6 | 37.3 | 8.9 | 13.0 | 16.8 | 2.1 | 6.6 | 4.3 | 0.7 | 4.3 | 4.3 | 0.7 |
| 6.72 | 30.3 | 25.7 | 23.8 | 12.2 | 14.4 | 7.1 | 5.4 | 4.5 | 11.3 | 2.3 | 2.4 | 2.4 |
| 13.94 | 85.2 | 32.5 | 42.1 | 29.2 | 7.3 | 13.1 | 6.4 | 5.8 | 6.9 | 10.8 | 3.8 | 8.7 |
| 7.36 | 38.6 | 58.4 | 22.7 | 24.2 | 17.3 | 8.1 | 10.2 | 9.8 | 2.9 | 3.0 | 8.8 | 4.2 |
| 9.88 | 36.1 | 57.7 | 34.9 | 21.7 | 15.5 | 15.3 | 2.1 | 5.3 | 7.9 | 3.5 | 3.0 | 8.8 |
| 14.50 | 140.5 | 57.7 | 40.4 | 44.9 | 25.8 | 16.6 | 17.9 | 9.7 | 7.7 | 5.3 | 3.6 | 3.5 |
| 20.38 | 107.9 | 145.1 | 50.6 | 58.2 | 46.4 | 25.5 | 22.4 | 28.3 | 8.3 | 6.3 | 10.6 | 3.7 |
| 28.18 | 103.1 | 104.9 | 147.7 | 31.1 | 42.7 | 29.7 | 14.7 | 13.0 | 37.9 | 8.8 | 4.7 | 9.0 |
| 28.75 | 142.8 | 142.1 | 101.9 | 96.6 | 45.3 | 28.2 | 16.7 | 13.9 | 13.1 | 10.0 | 2.0 | 3.5 |
| 39.85 | 317.9 | 243.4 | 143.3 | 110.7 | 75.7 | 39.9 | 31.6 | 24.5 | 22.5 | 11.3 | 5.9 | 9.0 |
| 66.45 | 104.1 | 433.6 | 167.6 | 116.5 | 100.9 | 104.4 | 47.8 | 27.7 | 19.8 | 9.2 | 18.7 | 10.2 |
| 49.07 | 152.8 | 234.7 | 214.8 | 133.2 | 69.9 | 22.9 | 54.3 | 28.5 | 7.8 | 29.7 | 8.2 | 6.7 |
| 47.15 | 245.2 | 130.3 | 110.8 | 211.1 | 75.6 | 26.7 | 31.6 | 15.5 | 7.1 | 0.0 | 7.9 | 6.8 |
| 34.66 | 425.5 | 215.7 | 100.2 | 79.1 | 70.0 | 15.2 | 7.9 | 30.1 | 28.6 | 5.3 | 13.7 | 7.6 |
| 47.41 | 158.4 | 344.2 | 138.8 | 53.3 | 50.7 | 95.7 | 22.7 | 19.0 | 26.1 | 13.8 | 14.2 | 14.6 |

| | | | | |
|---|---|---|---|---|
| Updatedsk | 10/5/10 QA | IDH | 10/5/10 | |
| updated idh | 4/5/11 | | | |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics
FLR XSA Diagnostics 2011-05-19 16:11:26

CPUE data from index.final
Catch data for 42 years. 1969 to 2010. Ages 1 to 12.

| fleet | first age | last age | first year | last year | alpha | beta |
|---|---|---|---|---|---|---|
| UK-CBT | 3 | 11 | 1988 | 2010 | 0 | 1 |
| UK-COT | 3 | 11 | 1988 | 2010 | 0 | 1 |
| UK-WEC-BTS | 1 | 9 | 1988 | 2010 | 0.75 | 0.8 |
| UK-Inshore | 2 | 11 | 1973 | 1987 | 0 | 1 |
| UK-Offshore | 3 | 11 | 1973 | 1987 | 0 | 1 |

Time series weights :
Tapered time weighting not applied

Catchability analysis :
Catchability independent of size for all ages
Catchability independent of age for ages >7

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 10 years or
the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = 0.5
min. S.E. for population estimates derived from each fleet = 0.5

Regression weights
Year

| 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Estimated population abundance at 1st Jan 2011
Age

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 8060 | 2299 | 1299 | 1316 | 1112 | 754 | 403 | 168 | 203 | 57 | 109 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## XSA fleet diagnostics for UK-CBT

Fleet q-residuals

| Age | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 0.510 | 0.397 | 0.470 | 0.159 | 0.434 | 0.274 | 0.431 | -0.191 | -0.414 | 0.286 | 0.082 | 0.192 | -0.106 | 0.063 | 0.194 | -0.093 | -0.268 | -0.334 | -0.253 | -0.037 | -0.370 | -0.447 | -0.980 |
| 4 | 0.421 | 0.522 | 0.439 | 0.243 | 0.269 | 0.334 | 0.271 | 0.441 | -0.127 | 0.287 | 0.039 | -0.020 | 0.088 | -0.181 | -0.294 | -0.018 | -0.551 | -0.364 | -0.302 | -0.297 | -0.289 | -0.504 | -0.407 |
| 5 | 0.494 | 0.531 | 0.407 | 0.434 | 0.203 | 0.521 | 0.055 | 0.276 | -0.055 | 0.273 | 0.026 | 0.002 | -0.013 | 0.086 | -0.262 | -0.134 | -0.633 | -0.455 | -0.242 | -0.289 | -0.541 | -0.311 | -0.375 |
| 6 | 0.573 | 0.528 | 0.668 | 0.382 | -0.327 | 0.335 | -0.110 | 0.078 | -0.006 | -0.125 | 0.361 | 0.069 | -0.108 | 0.118 | 0.222 | -0.852 | -0.071 | -0.195 | -0.378 | -0.432 | -0.170 | -0.202 | -0.357 |
| 7 | 0.139 | 0.444 | 0.442 | 0.202 | 0.162 | 0.393 | 0.103 | 0.382 | -0.134 | 0.311 | 0.203 | 0.165 | -0.313 | 0.073 | 0.095 | -0.454 | -0.960 | -0.043 | -0.062 | -0.109 | -0.299 | -0.421 | -0.319 |
| 8 | 0.294 | 0.187 | 0.443 | 0.162 | 0.007 | 0.133 | -0.290 | 0.450 | 0.051 | -0.140 | -0.110 | 0.183 | -0.025 | -0.081 | 0.060 | -0.436 | -0.144 | -0.705 | 0.218 | -0.029 | 0.346 | -0.493 | -0.083 |
| 9 | 0.207 | 0.323 | 0.694 | 0.574 | -0.029 | 0.398 | 0.175 | 0.073 | 0.201 | -0.065 | -0.177 | -0.340 | 0.149 | 0.252 | -0.406 | 0.134 | -0.323 | -0.015 | -0.012 | 0.021 | -0.085 | -0.058 | -0.404 |
| 10 | -0.329 | 0.152 | 0.387 | 0.411 | -0.306 | -0.095 | 0.495 | -0.163 | 0.051 | -0.621 | 0.030 | -0.102 | -0.112 | 0.090 | -0.127 | -0.060 | -0.150 | 0.086 | -0.021 | -0.321 | 0.110 | -0.422 | -0.151 |
| 11 | 0.544 | 0.654 | 0.125 | 0.105 | -0.022 | 0.341 | 0.008 | -0.112 | 0.114 | 0.233 | 0.209 | -0.079 | 0.046 | 0.014 | -0.082 | -0.214 | 0.205 | 0.053 | -0.018 | -0.055 | 0.190 | -0.331 | -0.065 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 |
|---|---|---|---|---|---|---|---|---|---|
| MeanLogq | -6.8195 | -6.6135 | -6.6083 | -6.6717 | -6.7688 | -6.8413 | -6.8413 | -6.8413 | -6.8413 |
| S.ELogq | 0.3727 | 0.3371 | 0.352 | 0.3666 | 0.3436 | 0.2901 | 0.2876 | 0.2654 | 0.2234 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## XSA fleet diagnostics for UK-COT

Fleet q-residuals

| Age | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 0.338 | 0.051 | 0.261 | 0.091 | 0.116 | -0.030 | 0.142 | -0.333 | 0.028 | 0.380 | 0.043 | 0.144 | -0.302 | 0.063 | -0.249 | -0.466 | -0.579 | 0.361 | 0.009 | 0.191 | -0.079 | 0.361 | -0.542 |
| 4 | 0.332 | 0.235 | 0.225 | -0.138 | -0.161 | 0.009 | 0.196 | 0.283 | 0.241 | 0.131 | 0.071 | -0.003 | 0.021 | -0.285 | -0.625 | -0.314 | -0.757 | 0.378 | 0.005 | 0.039 | -0.029 | 0.058 | 0.087 |
| 5 | 0.379 | 0.301 | 0.199 | -0.196 | -0.354 | 0.217 | 0.128 | 0.118 | 0.105 | 0.299 | -0.016 | 0.178 | -0.039 | 0.005 | -0.498 | -0.339 | -0.814 | 0.219 | 0.061 | 0.122 | -0.277 | 0.129 | 0.073 |
| 6 | 0.428 | 0.372 | 0.472 | -0.351 | -1.031 | 0.061 | -0.040 | -0.093 | 0.028 | 0.006 | 0.286 | 0.161 | -0.098 | 0.077 | 0.077 | -0.802 | -0.231 | 0.468 | -0.159 | -0.006 | 0.105 | 0.163 | 0.108 |
| 7 | -0.077 | 0.399 | 0.173 | -0.636 | -0.625 | 0.136 | 0.313 | 0.211 | -0.058 | 0.375 | -0.028 | 0.430 | -0.322 | 0.149 | 0.020 | -0.441 | -1.191 | 0.601 | 0.107 | 0.299 | 0.041 | -0.034 | 0.159 |
| 8 | 0.072 | 0.307 | 0.136 | -0.542 | -0.937 | -0.146 | -0.144 | 0.251 | 0.120 | -0.108 | -0.235 | 0.497 | -0.112 | -0.034 | -0.130 | -0.437 | -0.437 | -0.047 | 0.449 | 0.393 | 0.640 | 0.050 | 0.394 |
| 9 | -0.288 | 0.430 | 0.544 | -0.770 | -1.036 | 0.139 | 0.299 | -0.091 | 0.123 | -0.047 | -0.249 | -0.067 | 0.210 | 0.489 | -0.673 | -0.038 | -0.601 | 0.668 | 0.200 | 0.405 | 0.277 | 0.487 | 0.083 |
| 10 | -0.976 | 0.163 | 0.174 | -0.211 | -1.302 | -0.426 | 0.621 | -0.285 | 0.093 | -0.629 | -0.281 | 0.193 | -0.037 | 0.197 | -0.116 | -0.220 | -0.391 | 0.692 | 0.102 | 0.120 | 0.502 | 0.215 | 0.451 |
| 11 | 0.167 | 0.778 | -0.149 | -0.682 | -1.304 | 0.215 | 0.155 | -0.367 | 0.040 | -0.056 | 0.230 | 0.371 | 0.032 | 0.146 | -0.055 | -0.036 | 0.013 | 0.882 | 0.112 | 0.198 | 0.683 | 0.359 | 0.506 |

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

| | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 |
|---|---|---|---|---|---|---|---|---|---|
| MeanLogq | -15.9672 | -15.8515 | -15.8784 | -15.926 | -16.0254 | -16.0751 | -16.0751 | -16.0751 | -16.0751 |
| S.ELogq | 0.2871 | 0.2828 | 0.2891 | 0.3608 | 0.4106 | 0.3731 | 0.4518 | 0.4816 | 0.4628 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## XSA fleet diagnostics for UK-WEC-BTS

Fleet q-residuals

| Age | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -1.192 | -0.264 | 0.282 | 0.161 | -0.625 | -0.205 | -0.467 | 0.311 | 1.200 | -0.017 | 0.209 | -0.415 | -0.098 | -0.010 | -0.812 | 1.255 | 0.575 | -0.352 | -0.634 | -0.132 | 0.656 | 0.574 | 0.000 |
| 2 | -0.562 | -0.446 | -0.296 | 0.245 | 0.217 | -0.575 | -0.434 | -0.949 | 0.065 | 0.368 | 0.160 | 0.022 | -0.239 | 0.316 | -0.951 | 0.187 | 0.560 | 0.014 | 0.045 | 0.639 | 0.056 | 0.660 | 0.897 |
| 3 | 0.208 | 0.333 | -0.160 | 0.061 | 0.379 | -0.005 | -0.042 | -0.541 | -0.481 | 0.165 | 0.168 | 0.016 | -0.334 | -0.080 | -0.270 | -0.460 | -0.073 | -0.642 | -0.167 | 0.157 | 0.456 | 0.395 | 0.916 |
| 4 | 0.368 | 0.680 | -0.307 | 0.188 | 0.020 | 0.029 | -0.030 | -0.113 | -0.442 | -0.177 | 0.353 | -0.039 | -0.092 | 0.075 | -0.632 | -0.257 | -0.609 | -0.277 | -0.275 | -0.001 | 0.364 | 0.592 | 0.581 |
| 5 | 0.799 | 0.477 | -0.029 | 0.084 | 0.352 | -0.350 | -0.310 | -0.124 | 0.296 | -0.308 | -0.176 | -0.171 | -0.020 | 0.156 | 0.107 | -0.853 | -0.763 | -0.679 | 0.131 | -0.353 | 0.527 | 0.560 | 0.645 |
| 6 | 0.758 | 0.757 | -0.285 | 0.673 | -0.042 | -0.106 | -0.755 | 0.156 | 0.390 | 0.333 | 0.226 | -0.396 | 0.283 | 0.211 | -0.589 | -1.069 | -0.613 | -0.295 | 0.026 | 0.567 | -1.169 | 0.183 | 0.756 |
| 7 | NA | 0.721 | 0.130 | -0.252 | -0.233 | 0.062 | -0.551 | -0.502 | -0.114 | 0.378 | 0.582 | -0.240 | -0.497 | 0.438 | -0.761 | -0.638 | 0.712 | -0.794 | -0.385 | -0.594 | 0.558 | 1.065 | 0.915 |
| 8 | 0.938 | 0.113 | -0.450 | 0.707 | 0.034 | -0.607 | -1.141 | 0.056 | -0.291 | 0.118 | 0.060 | -0.140 | 0.011 | -0.222 | -0.812 | 0.406 | 0.726 | -0.958 | 0.199 | -0.671 | 0.198 | 0.874 | 0.852 |
| 9 | -0.518 | 0.609 | 0.810 | 0.303 | 0.409 | -0.069 | -0.365 | 0.177 | -0.445 | 0.558 | -0.130 | -0.053 | 0.568 | -0.583 | NA | -1.058 | 0.413 | 0.271 | NA | -1.525 | 0.436 | -0.389 | 1.197 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| | Age1 | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 |
|---|---|---|---|---|---|---|---|---|---|
| MeanLogq | -11.2138 | -8.6941 | -8.3129 | -8.6038 | -8.8514 | -9.2144 | -9.1927 | -9.3017 | -9.3017 |
| S.ELogq | 0.5983 | 0.4936 | 0.3683 | 0.3643 | 0.4488 | 0.5692 | 0.5819 | 0.5927 | 0.6465 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## XSA fleet diagnostics for UK-Inshore

Fleet q-residuals

| Age | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.186 | -0.407 | 0.200 | 1.055 | 1.102 | 0.617 | 0.325 | 0.057 | -0.377 | -0.569 | -0.458 | -0.002 | -1.439 | -0.204 | -0.085 |
| 3 | 0.361 | 0.483 | 0.477 | 0.380 | 0.105 | 0.300 | 0.035 | -0.295 | -0.070 | -0.150 | -0.490 | -0.444 | -0.145 | -0.043 | -0.506 |
| 4 | 0.271 | 0.098 | -0.324 | 0.680 | 0.376 | 0.060 | -0.074 | -0.400 | -0.077 | 0.139 | -0.057 | -0.206 | -0.038 | -0.108 | -0.338 |
| 5 | 0.145 | -0.029 | 0.193 | 0.258 | 0.262 | 0.003 | -0.030 | 0.049 | -0.040 | 0.100 | 0.182 | -0.173 | -0.261 | -0.322 | -0.335 |
| 6 | 0.231 | 0.482 | -0.410 | 0.486 | 0.104 | 0.360 | 0.280 | -0.613 | -0.085 | 0.057 | -0.072 | 0.223 | 0.198 | -0.213 | -1.029 |
| 7 | 0.561 | 0.414 | -0.521 | -0.067 | 0.013 | 0.163 | 0.419 | 0.045 | 0.087 | -0.293 | 0.259 | -0.021 | -0.165 | -0.028 | -0.868 |
| 8 | -0.423 | -0.156 | -0.083 | 0.538 | -0.195 | 0.017 | 0.199 | 0.134 | 0.099 | 0.132 | 0.359 | 0.016 | -0.166 | -0.239 | -0.231 |
| 9 | 0.369 | 0.511 | -0.826 | 0.523 | -0.895 | -0.257 | 0.233 | -0.410 | -0.105 | 0.301 | 0.361 | -0.048 | 0.415 | -0.948 | -0.879 |
| 10 | -0.571 | -0.168 | -0.081 | 0.245 | -0.378 | 0.270 | -0.068 | -0.505 | -0.363 | 0.187 | 0.564 | -0.494 | 0.033 | -0.899 | -0.206 |
| 11 | -0.180 | 0.193 | -0.459 | -0.103 | -0.264 | -0.426 | -0.147 | 0.017 | -0.422 | -0.073 | -0.816 | -0.446 | 0.484 | -0.168 | -0.772 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| | Age2 | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 |
|---|---|---|---|---|---|---|---|---|---|---|
| MeanLogq | -7.3062 | -5.7419 | -5.7276 | -5.9861 | -6.3205 | -6.452 | -6.4199 | -6.4199 | -6.4199 | -6.4199 |
| S.ELogq | 0.6466 | 0.3453 | 0.2878 | 0.1993 | 0.422 | 0.3692 | 0.2521 | 0.5567 | 0.3857 | 0.3397 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## XSA fleet diagnostics for UK-Offshore

Fleet q-residuals

| Age | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 0.352 | 0.475 | 0.467 | 0.368 | 0.093 | 0.290 | 0.025 | -0.305 | -0.080 | -0.160 | -1.253 | -0.346 | -0.163 | 0.453 | -0.216 |
| 4 | 0.279 | 0.104 | -0.317 | 0.686 | 0.384 | 0.066 | -0.067 | -0.393 | -0.069 | 0.147 | -0.339 | -0.155 | -0.443 | 0.152 | -0.035 |
| 5 | 0.135 | -0.043 | 0.175 | 0.245 | 0.246 | -0.012 | -0.044 | 0.034 | -0.055 | 0.084 | -0.176 | -0.237 | -0.397 | 0.139 | -0.092 |
| 6 | 0.178 | 0.432 | -0.460 | 0.436 | 0.052 | 0.309 | 0.229 | -0.663 | -0.138 | 0.004 | -0.248 | 0.325 | 0.125 | -0.114 | -0.467 |
| 7 | 0.514 | 0.373 | -0.559 | -0.119 | -0.033 | 0.119 | 0.371 | -0.003 | 0.040 | -0.339 | -0.126 | 0.051 | 0.320 | -0.188 | -0.419 |
| 8 | -0.376 | -0.100 | -0.028 | 0.599 | -0.147 | 0.074 | 0.250 | 0.187 | 0.151 | 0.184 | 0.067 | -0.683 | -0.261 | -0.361 | 0.445 |
| 9 | 0.429 | 0.587 | -0.775 | 0.581 | -0.853 | -0.188 | 0.298 | -0.343 | -0.041 | 0.366 | 0.312 | 0.156 | 0.060 | -0.811 | 0.049 |
| 10 | -0.347 | 0.072 | 0.153 | 0.471 | -0.162 | 0.498 | 0.158 | -0.282 | -0.140 | 0.413 | 0.216 | 0.565 | -0.686 | 0.777 | 0.122 |
| 11 | 0.357 | 0.626 | -0.051 | 0.300 | 0.162 | 0.011 | 0.273 | 0.446 | 0.002 | 0.352 | 0.105 | -0.318 | -0.411 | 0.607 | 0.790 |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| | Age3 | Age4 | Age5 | Age6 | Age7 | Age8 | Age9 | Age10 | Age11 |
|---|---|---|---|---|---|---|---|---|---|
| MeanLogq | -6.4641 | -6.0716 | -6.119 | -6.0324 | -6.0763 | -6.2867 | -6.2867 | -6.2867 | -6.2867 |
| S.ELogq | 0.4543 | 0.3112 | 0.1808 | 0.3426 | 0.3084 | 0.3338 | 0.4896 | 0.3938 | 0.3386 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2009 at terminal Age 1**

| Source | Age 1 |
|---|---|
| fshk | 1 |
| | 0.0000 |
| UK-CBT | 1 |
| | 0.0000 |
| UK-COT | 1 |
| | 0.0000 |
| UK-WEC-BTS | 8060 |
| | 2.6773 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | NaN | NA | NA | NA | 0 | NA | 0.000 |
| UK-CBT | NaN | NA | NA | NA | 0 | NA | 0.000 |
| UK-COT | NaN | NA | NA | NA | 0 | NA | 0.000 |
| UK-WEC-BTS | 8060 | 0.611 | NaN | NaN | 1 | 1.000 | 0.000 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 8060 | 0.611 | Inf | 1 | Var Ratio | 0.000 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2008 at terminal Age 2**

| Source | Age 1 | Age 2 |
|---|---|---|
| fshk | 1 | 670 |
| | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 |
| | 0.0000 | 0.0000 |
| UK-COT | 1 | 1 |
| | 0.0000 | 0.0000 |
| UK-WEC-BTS | 4083 | 5641 |
| | 2.6054 | 3.8276 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 670 | 0.493 | NaN | NaN | 1 | 0.383 | 0.090 |
| UK-CBT | NaN | NA | NA | NA | 0 | NA | 0.000 |
| UK-COT | NaN | NA | NA | NA | 0 | NA | 0.000 |
| UK-WEC-BTS | 4949 | 0.389 | 0.159 | 0.408 | 2 | 0.617 | 0.013 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 2299 | 0.305 | 1.056 | 3 | Var Ratio | 0.027 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

## Year Class 2007 at terminal Age 3

| Source | Age 1 | Age 2 | Age 3 |
|---|---|---|---|
| fshk | 1 | 1 | 948 |
| | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 487 |
| | 0.0000 | 0.0000 | 3.2099 |
| UK-COT | 1 | 1 | 756 |
| | 0.0000 | 0.0000 | 3.2099 |
| UK-WEC-BTS | 2505 | 2513 | 3247 |
| | 1.9742 | 2.9002 | 3.2099 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 948 | 0.448 | NaN | NaN | 1 | 0.216 | 0.290 |
| UK-CBT | 487 | 0.500 | NaN | NaN | 1 | 0.173 | 0.503 |
| UK-COT | 756 | 0.500 | Inf | Inf | 1 | 0.173 | 0.352 |
| UK-WEC-BTS | 2780 | 0.307 | 0.089 | 0.290 | 3 | 0.437 | 0.109 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 1299 | 0.206 | 0.308 | 6 | Var Ratio | 0.220 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2006 at terminal Age 4**

| Source | Age 1 | Age 2 | Age 3 | Age 4 |
|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 905 |
| | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 842 | 876 |
| | 0.0000 | 0.0000 | 2.4487 | 3.1243 |
| UK-COT | 1 | 1 | 1888 | 1436 |
| | 0.0000 | 0.0000 | 2.4487 | 3.1243 |
| UK-WEC-BTS | 1154 | 1392 | 1953 | 2355 |
| | 1.4875 | 2.1853 | 2.4487 | 3.1243 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 905 | 0.442 | NaN | NaN | 1 | 0.164 | 0.341 |
| UK-CBT | 861 | 0.356 | 0.020 | 0.056 | 2 | 0.228 | 0.356 |
| UK-COT | 1619 | 0.356 | 0.136 | 0.382 | 2 | 0.228 | 0.205 |
| UK-WEC-BTS | 1765 | 0.264 | 0.156 | 0.590 | 4 | 0.379 | 0.190 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 1316 | 0.169 | 0.141 | 9 | Var Ratio | 0.247 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2005 at terminal Age 5**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 |
|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 705 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 768 | 672 | 764 |
| | 0.0000 | 0.0000 | 1.9023 | 2.5383 | 3.1306 |
| UK-COT | 1 | 1 | 1027 | 1178 | 1196 |
| | 0.0000 | 0.0000 | 1.9023 | 2.5383 | 3.1306 |
| UK-WEC-BTS | 590 | 2107 | 1755 | 2010 | 2119 |
| | 1.2006 | 1.7637 | 1.9023 | 2.5383 | 3.1306 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 705 | 0.442 | NaN | NaN | 1 | 0.135 | 0.362 |
| UK-CBT | 733 | 0.294 | 0.044 | 0.149 | 3 | 0.255 | 0.351 |
| UK-COT | 1145 | 0.294 | 0.045 | 0.152 | 3 | 0.255 | 0.238 |
| UK-WEC-BTS | 1746 | 0.238 | 0.197 | 0.829 | 5 | 0.355 | 0.163 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 1112 | 0.148 | 0.143 | 12 | Var Ratio | 0.245 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2004 at terminal Age 6**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 438 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 727 | 565 | 553 | 528 |
| | 0.0000 | 0.0000 | 1.2776 | 1.7130 | 2.4458 | 3.1858 |
| UK-COT | 1 | 1 | 913 | 733 | 858 | 840 |
| | 0.0000 | 0.0000 | 1.2776 | 1.7130 | 2.4458 | 3.1858 |
| UK-WEC-BTS | 531 | 789 | 883 | 1086 | 1321 | 1607 |
| | 0.7534 | 1.1068 | 1.2776 | 1.7130 | 2.4458 | 2.3561 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 438 | 0.446 | NaN | NaN | 1 | 0.129 | 0.364 |
| UK-CBT | 569 | 0.264 | 0.061 | 0.232 | 4 | 0.279 | 0.291 |
| UK-COT | 833 | 0.264 | 0.040 | 0.151 | 4 | 0.279 | 0.208 |
| UK-WEC-BTS | 1114 | 0.233 | 0.144 | 0.620 | 6 | 0.312 | 0.159 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 754 | 0.139 | 0.126 | 15 | Var Ratio | 0.227 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2003 at terminal Age 7**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 |
|---|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 1 | 319 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 313 | 300 | 235 | 330 | 293 |
| | 0.0000 | 0.0000 | 0.7969 | 1.0591 | 1.6277 | 2.3093 | 3.0767 |
| UK-COT | 1 | 1 | 407 | 419 | 306 | 475 | 473 |
| | 0.0000 | 0.0000 | 0.7969 | 1.0591 | 1.6277 | 2.3093 | 3.0767 |
| UK-WEC-BTS | 716 | 409 | 341 | 403 | 683 | 484 | 1007 |
| | 0.4968 | 0.7299 | 0.7969 | 1.0591 | 1.6277 | 1.7080 | 2.1726 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 319 | 0.439 | NaN | NaN | 1 | 0.132 | 0.321 |
| UK-CBT | 293 | 0.247 | 0.057 | 0.231 | 5 | 0.292 | 0.345 |
| UK-COT | 425 | 0.247 | 0.083 | 0.334 | 5 | 0.292 | 0.250 |
| UK-WEC-BTS | 593 | 0.232 | 0.155 | 0.665 | 7 | 0.283 | 0.185 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 403 | 0.135 | 0.078 | 18 | Var Ratio | 0.262 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2002 at terminal Age 8**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 |
|---|---|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 122 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 120 | 124 | 126 | 142 | 110 | 155 |
| | 0.0000 | 0.0000 | 0.5724 | 0.7433 | 1.1133 | 1.6895 | 2.4782 | 3.1335 |
| UK-COT | 1 | 1 | 241 | 169 | 190 | 187 | 163 | 249 |
| | 0.0000 | 0.0000 | 0.5724 | 0.7433 | 1.1133 | 1.6895 | 2.4782 | 3.1335 |
| UK-WEC-BTS | 590 | 295 | 89 | 128 | 118 | 52 | 488 | 395 |
| | 0.3256 | 0.4784 | 0.5724 | 0.7433 | 1.1133 | 1.2496 | 1.7500 | 2.1372 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 122 | 0.443 | NaN | NaN | 1 | 0.126 | 0.322 |
| UK-CBT | 132 | 0.235 | 0.061 | 0.257 | 6 | 0.306 | 0.300 |
| UK-COT | 200 | 0.235 | 0.080 | 0.340 | 6 | 0.306 | 0.209 |
| UK-WEC-BTS | 212 | 0.236 | 0.317 | 1.341 | 8 | 0.263 | 0.198 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 168 | 0.131 | 0.098 | 21 | Var Ratio | 0.244 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2001 at terminal Age 9**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 |
|---|---|---|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 156 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 155 | 141 | 159 | 131 | 150 | 124 | 135 |
| | 0.0000 | 0.0000 | 0.3746 | 0.5066 | 0.7249 | 1.1079 | 1.7015 | 2.4338 | 3.0121 |
| UK-COT | 1 | 1 | 114 | 296 | 215 | 201 | 211 | 213 | 220 |
| | 0.0000 | 0.0000 | 0.3746 | 0.5066 | 0.7249 | 1.1079 | 1.7015 | 2.4338 | 3.0121 |
| UK-WEC-BTS | 90 | 244 | 188 | 154 | 231 | 357 | 354 | 485 | 670 |
| | 0.2217 | 0.3258 | 0.3746 | 0.5066 | 0.7249 | 0.8194 | 1.2015 | 1.6600 | 1.7160 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 156 | 0.434 | NaN | NaN | 1 | 0.128 | 0.353 |
| UK-CBT | 137 | 0.227 | 0.033 | 0.145 | 7 | 0.315 | 0.394 |
| UK-COT | 212 | 0.227 | 0.060 | 0.262 | 7 | 0.315 | 0.272 |
| UK-WEC-BTS | 365 | 0.241 | 0.180 | 0.746 | 9 | 0.241 | 0.167 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 203 | 0.129 | 0.08 | 24 | Var Ratio | 0.283 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 2000 at terminal Age 10**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 42 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 52 | 33 | 36 | 39 | 51 | 81 | 54 | 49 |
| | 0.0000 | 0.0000 | 0.1681 | 0.2365 | 0.3117 | 0.4814 | 0.7242 | 1.2033 | 2.1046 | 2.9834 |
| UK-COT | 1 | 1 | 36 | 27 | 71 | 49 | 77 | 109 | 93 | 90 |
| | 0.0000 | 0.0000 | 0.1681 | 0.2365 | 0.3117 | 0.4814 | 0.7242 | 1.2033 | 2.1046 | 2.9834 |
| UK-WEC-BTS | 57 | 22 | 36 | 31 | 29 | 59 | 32 | 70 | 39 | 1 |
| | 0.1019 | 0.1497 | 0.1681 | 0.2365 | 0.3117 | 0.3560 | 0.5114 | 0.8207 | 1.1990 | 0.0000 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 42 | 0.432 | NaN | NaN | 1 | 0.165 | 0.378 |
| UK-CBT | 53 | 0.241 | 0.081 | 0.334 | 8 | 0.338 | 0.315 |
| UK-COT | 84 | 0.241 | 0.110 | 0.457 | 8 | 0.338 | 0.210 |
| UK-WEC-BTS | 42 | 0.268 | 0.119 | 0.445 | 9 | 0.159 | 0.379 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 57 | 0.142 | 0.068 | 26 | Var Ratio | 0.292 |

Table 8.3.8 Sole VIIE XSA detailed survivor diagnostics continued

**Year Class 1999 at terminal Age 11**

| Source | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 | Age 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| fshk | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 106 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 4.0000 |
| UK-CBT | 1 | 1 | 132 | 107 | 58 | 90 | 102 | 106 | 100 | 71 | 102 |
| | 0.0000 | 0.0000 | 0.2290 | 0.3186 | 0.4751 | 0.6362 | 0.9199 | 1.3165 | 1.8204 | 2.3710 | 3.0969 |
| UK-COT | 1 | 1 | 85 | 79 | 48 | 174 | 121 | 161 | 144 | 135 | 181 |
| | 0.0000 | 0.0000 | 0.2290 | 0.3186 | 0.4751 | 0.6362 | 0.9199 | 1.3165 | 1.8204 | 2.3710 | 3.0969 |
| UK-WEC-BTS | 99 | 149 | 83 | 84 | 51 | 81 | 74 | 56 | 168 | 1 | 1 |
| | 0.1489 | 0.2187 | 0.2290 | 0.3186 | 0.4751 | 0.4706 | 0.6496 | 0.8979 | 1.0371 | 0.0000 | 0.0000 |

| Source | Survivors | int s.e. | ext s.e. | Var Ratio | N | Scaled W | F est. |
|---|---|---|---|---|---|---|---|
| fshk | 106 | 0.440 | NaN | NaN | 1 | 0.130 | 0.262 |
| UK-CBT | 92 | 0.209 | 0.065 | 0.309 | 9 | 0.363 | 0.295 |
| UK-COT | 142 | 0.209 | 0.105 | 0.500 | 9 | 0.363 | 0.202 |
| UK-WEC-BTS | 87 | 0.237 | 0.155 | 0.655 | 9 | 0.144 | 0.310 |

| term. Surv. | int s.e. | ext s.e. | N | Var. Ratio | F |
|---|---|---|---|---|---|
| 109 | 0.126 | 0.044 | 28 | Var Ratio | 0.255 |

**Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's**

| Age | 1969 | 1970 | 1971 | 1972 | 1973 |
|---|---|---|---|---|---|
| 1 | 1610 | 3976 | 2955 | 2619 | 3580 |
| 2 | 2180 | 1456 | 3597 | 2674 | 2370 |
| 3 | 2438 | 1888 | 1267 | 3207 | 2281 |
| 4 | 761 | 1900 | 1488 | 956 | 2510 |
| 5 | 1072 | 613 | 1413 | 1112 | 706 |
| 6 | 1672 | 829 | 470 | 1090 | 897 |
| 7 | 181 | 1313 | 671 | 363 | 879 |
| 8 | 583 | 143 | 1081 | 531 | 315 |
| 9 | 667 | 481 | 118 | 831 | 457 |
| 10 | 298 | 580 | 402 | 97 | 625 |
| 11 | 102 | 250 | 475 | 331 | 51 |
| +gp | 720 | 1291 | 982 | 653 | 1697 |
| Total | 12284 | 14721 | 14919 | 14464 | 16367 |

**Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's** continued

| Age | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3357 | 3143 | 7206 | 5072 | 4714 | 5164 | 8948 | 5157 | 4165 | 6581 |
| 2 | 3240 | 3038 | 2843 | 6520 | 4589 | 4266 | 4673 | 8096 | 4666 | 3769 |
| 3 | 2076 | 2889 | 2671 | 2414 | 5495 | 3914 | 3644 | 4061 | 7093 | 4101 |
| 4 | 1687 | 1547 | 2074 | 2018 | 1881 | 3903 | 2778 | 2765 | 2908 | 5038 |
| 5 | 1859 | 1317 | 1238 | 1428 | 1461 | 1373 | 2760 | 2041 | 1883 | 1760 |
| 6 | 554 | 1513 | 1002 | 967 | 1096 | 1118 | 1005 | 1898 | 1403 | 1177 |
| 7 | 717 | 434 | 1260 | 778 | 777 | 812 | 794 | 789 | 1348 | 935 |
| 8 | 681 | 574 | 366 | 1052 | 638 | 605 | 570 | 545 | 544 | 992 |
| 9 | 269 | 576 | 469 | 287 | 882 | 509 | 450 | 382 | 373 | 363 |
| 10 | 365 | 213 | 497 | 368 | 250 | 725 | 375 | 345 | 274 | 230 |
| 11 | 536 | 307 | 172 | 401 | 311 | 190 | 557 | 286 | 257 | 171 |
| +gp | 1035 | 2171 | 2632 | 1996 | 2311 | 1975 | 1458 | 1101 | 1242 | 1211 |
| Total | 16378 | 17720 | 22430 | 23301 | 24406 | 24554 | 28010 | 27468 | 26156 | 26328 |

**Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's** continued

| Age | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7838 | 4237 | 6451 | 4208 | 4118 | 3148 | 7912 | 4371 | 3806 | 2598 |
| 2 | 5955 | 7092 | 3834 | 5837 | 3807 | 3726 | 2849 | 7159 | 3955 | 3443 |
| 3 | 3324 | 5071 | 6144 | 3235 | 4818 | 3024 | 3001 | 2253 | 6050 | 3279 |
| 4 | 2995 | 2377 | 2971 | 4021 | 2158 | 2992 | 1907 | 1857 | 1644 | 4110 |
| 5 | 3062 | 1924 | 1432 | 1765 | 2601 | 1386 | 1535 | 1173 | 1221 | 1091 |
| 6 | 1038 | 2050 | 1295 | 895 | 1191 | 1661 | 782 | 863 | 786 | 823 |
| 7 | 731 | 630 | 1299 | 866 | 616 | 721 | 1019 | 476 | 571 | 602 |
| 8 | 592 | 468 | 401 | 855 | 571 | 412 | 438 | 670 | 342 | 410 |
| 9 | 617 | 412 | 331 | 283 | 556 | 363 | 268 | 261 | 501 | 251 |
| 10 | 216 | 414 | 275 | 227 | 211 | 399 | 226 | 145 | 171 | 383 |
| 11 | 139 | 144 | 294 | 163 | 158 | 154 | 254 | 134 | 96 | 131 |
| +gp | 1241 | 624 | 504 | 645 | 541 | 689 | 701 | 631 | 374 | 331 |
| Total | 27748 | 25444 | 25230 | 23001 | 21346 | 18675 | 20892 | 19992 | 19518 | 17453 |

**Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's** continued

| Age | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3723 | 4390 | 3666 | 4856 | 3854 | 7102 | 5881 | 4093 | 6015 | 3079 |
| 2 | 2351 | 3369 | 3972 | 3317 | 4393 | 3487 | 6426 | 5321 | 3704 | 5442 |
| 3 | 2917 | 2035 | 2958 | 3247 | 2796 | 3723 | 2889 | 5523 | 4677 | 3036 |
| 4 | 2298 | 2014 | 1548 | 2253 | 2147 | 1954 | 2499 | 2044 | 3665 | 3042 |
| 5 | 2666 | 1548 | 1224 | 1054 | 1351 | 1433 | 1292 | 1547 | 1344 | 2514 |
| 6 | 654 | 1881 | 994 | 825 | 645 | 902 | 918 | 820 | 927 | 849 |
| 7 | 536 | 485 | 1311 | 676 | 575 | 384 | 573 | 612 | 488 | 532 |
| 8 | 401 | 384 | 314 | 942 | 427 | 377 | 239 | 417 | 385 | 319 |
| 9 | 297 | 316 | 252 | 220 | 688 | 311 | 243 | 166 | 282 | 248 |
| 10 | 171 | 214 | 228 | 170 | 157 | 501 | 230 | 156 | 98 | 166 |
| 11 | 294 | 112 | 162 | 159 | 134 | 109 | 351 | 159 | 100 | 57 |
| +gp | 576 | 862 | 633 | 349 | 630 | 541 | 365 | 598 | 463 | 255 |
| Total | 16881 | 17609 | 17263 | 18068 | 17798 | 20823 | 21906 | 21457 | 22146 | 19538 |

**Table 8.3.9 Sole VIIE Stock Numbers at Age in 000's** continued

| Age | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 survivors | geom mean 04-10 | arith mean 04-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4377 | 4885 | 4088 | 3534 | 2379 | 2886 | 4301[a] | 0 | 4082 | 4437 |
| 2 | 2786 | 3960 | 4420 | 3699 | 3198 | 2152 | 2611 | 3891 | 3173 | 3261 |
| 3 | 4355 | 2142 | 3338 | 3524 | 3156 | 2626 | 1790 | 2299 | 2876 | 2990 |
| 4 | 1952 | 2914 | 1493 | 2273 | 2378 | 2140 | 1863 | 1299 | 2105 | 2145 |
| 5 | 1845 | 1340 | 1843 | 902 | 1338 | 1507 | 1570 | 1316 | 1443 | 1478 |
| 6 | 1662 | 1247 | 785 | 1091 | 538 | 853 | 1047 | 1112 | 977 | 1032 |
| 7 | 644 | 1003 | 780 | 472 | 643 | 332 | 580 | 754 | 604 | 636 |
| 8 | 411 | 426 | 629 | 493 | 257 | 407 | 237 | 403 | 389 | 409 |
| 9 | 241 | 261 | 278 | 394 | 323 | 133 | 297 | 168 | 263 | 275 |
| 10 | 170 | 160 | 160 | 171 | 252 | 224 | 85 | 203 | 167 | 175 |
| 11 | 90 | 102 | 103 | 92 | 102 | 163 | 155 | 57 | 112 | 115 |
| +gp | 216 | 403 | 286 | 341 | 229 | 302 | 359 | 360 | 298 | 305 |
| Total | 18748 | 18844 | 18203 | 16985 | 14791 | 13726 | 19501 | | | |

[a] XSA estimate (8907) replaced with GM recruitment69-08

**Table 8.3.10 Sole VIIE Fishing Mortality at Age**

| Age | 1969 | 1970 | 1971 |
|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 |
| 2 | 0.044 | 0.039 | 0.015 |
| 3 | 0.149 | 0.138 | 0.182 |
| 4 | 0.117 | 0.196 | 0.191 |
| 5 | 0.157 | 0.167 | 0.159 |
| 6 | 0.141 | 0.111 | 0.157 |
| 7 | 0.132 | 0.094 | 0.134 |
| 8 | 0.094 | 0.099 | 0.164 |
| 9 | 0.041 | 0.079 | 0.092 |
| 10 | 0.074 | 0.099 | 0.095 |
| 11 | 0.096 | 0.096 | 0.129 |
| +gp | 0.096 | 0.096 | 0.129 |
| $Fbar_{3-9}$ | 0.119 | 0.126 | 0.154 |

**Table 8.3.10 Sole VIIE Fishing Mortality at Age** continued

| Age | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.059 | 0.032 | 0.015 | 0.029 | 0.064 | 0.071 | 0.059 | 0.058 | 0.040 | 0.032 |
| 3 | 0.145 | 0.202 | 0.194 | 0.231 | 0.180 | 0.149 | 0.242 | 0.243 | 0.176 | 0.234 |
| 4 | 0.203 | 0.200 | 0.147 | 0.123 | 0.273 | 0.223 | 0.215 | 0.247 | 0.208 | 0.285 |
| 5 | 0.115 | 0.142 | 0.106 | 0.173 | 0.147 | 0.164 | 0.167 | 0.212 | 0.274 | 0.275 |
| 6 | 0.115 | 0.123 | 0.145 | 0.083 | 0.153 | 0.118 | 0.200 | 0.242 | 0.141 | 0.242 |
| 7 | 0.042 | 0.155 | 0.124 | 0.069 | 0.080 | 0.099 | 0.150 | 0.254 | 0.277 | 0.272 |
| 8 | 0.050 | 0.057 | 0.068 | 0.102 | 0.143 | 0.077 | 0.126 | 0.197 | 0.299 | 0.280 |
| 9 | 0.185 | 0.126 | 0.134 | 0.048 | 0.141 | 0.038 | 0.096 | 0.205 | 0.164 | 0.233 |
| 10 | 0.540 | 0.052 | 0.073 | 0.114 | 0.115 | 0.070 | 0.175 | 0.164 | 0.170 | 0.195 |
| 11 | 0.187 | 0.088 | 0.114 | 0.086 | 0.089 | 0.087 | 0.097 | 0.167 | 0.282 | 0.224 |
| +gp | 0.187 | 0.088 | 0.114 | 0.086 | 0.089 | 0.087 | 0.097 | 0.167 | 0.282 | 0.224 |
| $Fbar_{3-9}$ | 0.122 | 0.144 | 0.131 | 0.118 | 0.160 | 0.124 | 0.171 | 0.229 | 0.220 | 0.260 |

**Table 8.3.10 Sole VIIE Fishing Mortality at Age** continued

| Age | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.029 | 0.026 | 0.061 | 0.043 | 0.070 | 0.092 | 0.130 | 0.117 | 0.135 | 0.068 |
| 3 | 0.242 | 0.214 | 0.235 | 0.435 | 0.324 | 0.305 | 0.376 | 0.361 | 0.380 | 0.215 |
| 4 | 0.402 | 0.398 | 0.343 | 0.407 | 0.421 | 0.336 | 0.343 | 0.568 | 0.386 | 0.319 |
| 5 | 0.370 | 0.428 | 0.301 | 0.296 | 0.369 | 0.294 | 0.348 | 0.473 | 0.476 | 0.300 |
| 6 | 0.306 | 0.376 | 0.399 | 0.356 | 0.302 | 0.274 | 0.401 | 0.389 | 0.397 | 0.312 |
| 7 | 0.207 | 0.358 | 0.347 | 0.354 | 0.318 | 0.317 | 0.303 | 0.398 | 0.319 | 0.230 |
| 8 | 0.305 | 0.374 | 0.261 | 0.247 | 0.249 | 0.330 | 0.354 | 0.329 | 0.419 | 0.191 |
| 9 | 0.383 | 0.421 | 0.299 | 0.304 | 0.274 | 0.193 | 0.231 | 0.371 | 0.515 | 0.320 |
| 10 | 0.370 | 0.405 | 0.306 | 0.242 | 0.421 | 0.262 | 0.215 | 0.353 | 0.427 | 0.311 |
| 11 | 0.285 | 0.257 | 0.242 | 0.236 | 0.307 | 0.306 | 0.402 | 0.393 | 0.432 | 0.276 |
| +gp | 0.285 | 0.257 | 0.242 | 0.236 | 0.307 | 0.306 | 0.402 | 0.393 | 0.432 | 0.276 |
| $Fbar_{3-9}$ | 0.316 | 0.367 | 0.312 | 0.343 | 0.322 | 0.293 | 0.337 | 0.413 | 0.413 | 0.270 |

**Table 8.3.10 Sole VIIE Fishing Mortality at Age** continued

| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.088 | 0.066 | 0.044 | 0.030 | 0.102 | 0.071 | 0.066 | 0.088 | 0.052 | 0.029 |
| 3 | 0.287 | 0.256 | 0.270 | 0.173 | 0.172 | 0.314 | 0.258 | 0.299 | 0.246 | 0.310 |
| 4 | 0.310 | 0.333 | 0.295 | 0.398 | 0.284 | 0.412 | 0.305 | 0.313 | 0.380 | 0.319 |
| 5 | 0.295 | 0.412 | 0.248 | 0.343 | 0.295 | 0.392 | 0.304 | 0.345 | 0.355 | 0.412 |
| 6 | 0.167 | 0.329 | 0.199 | 0.261 | 0.285 | 0.260 | 0.417 | 0.353 | 0.305 | 0.420 |
| 7 | 0.232 | 0.307 | 0.233 | 0.333 | 0.231 | 0.359 | 0.323 | 0.375 | 0.219 | 0.364 |
| 8 | 0.208 | 0.224 | 0.139 | 0.322 | 0.258 | 0.214 | 0.219 | 0.338 | 0.264 | 0.292 |
| 9 | 0.168 | 0.287 | 0.228 | 0.227 | 0.294 | 0.234 | 0.216 | 0.202 | 0.346 | 0.429 |
| 10 | 0.173 | 0.166 | 0.318 | 0.175 | 0.256 | 0.135 | 0.265 | 0.255 | 0.265 | 0.343 |
| 11 | 0.290 | 0.286 | 0.198 | 0.189 | 0.271 | 0.307 | 0.314 | 0.272 | 0.303 | 0.327 |
| +gp | 0.290 | 0.286 | 0.198 | 0.189 | 0.271 | 0.307 | 0.314 | 0.272 | 0.303 | 0.327 |
| $Fbar_{3-9}$ | 0.238 | 0.307 | 0.230 | 0.294 | 0.260 | 0.312 | 0.292 | 0.318 | 0.302 | 0.364 |

**Table 8.3.10 Sole VIIE Fishing Mortality at Age** continued

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | mean $F_{08\text{-}10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2 | 0.099 | 0.123 | 0.163 | 0.071 | 0.127 | 0.059 | 0.097 | 0.085 | 0.027 | 0.070 |
| 3 | 0.330 | 0.341 | 0.302 | 0.261 | 0.284 | 0.293 | 0.288 | 0.244 | 0.220 | 0.251 |
| 4 | 0.277 | 0.400 | 0.276 | 0.358 | 0.404 | 0.430 | 0.356 | 0.210 | 0.247 | 0.271 |
| 5 | 0.360 | 0.314 | 0.292 | 0.435 | 0.424 | 0.417 | 0.350 | 0.264 | 0.245 | 0.286 |
| 6 | 0.455 | 0.176 | 0.404 | 0.369 | 0.408 | 0.429 | 0.383 | 0.287 | 0.228 | 0.299 |
| 7 | 0.325 | 0.159 | 0.312 | 0.367 | 0.358 | 0.508 | 0.358 | 0.235 | 0.262 | 0.285 |
| 8 | 0.339 | 0.179 | 0.353 | 0.328 | 0.369 | 0.324 | 0.559 | 0.213 | 0.244 | 0.339 |
| 9 | 0.431 | 0.281 | 0.307 | 0.388 | 0.389 | 0.348 | 0.264 | 0.349 | 0.284 | 0.299 |
| 10 | 0.432 | 0.513 | 0.410 | 0.347 | 0.454 | 0.419 | 0.331 | 0.267 | 0.293 | 0.297 |
| 11 | 0.215 | 0.292 | 0.532 | 0.288 | 0.383 | 0.362 | 0.524 | 0.257 | 0.256 | 0.346 |
| +gp | 0.215 | 0.292 | 0.532 | 0.288 | 0.383 | 0.362 | 0.524 | 0.257 | 0.256 | 0.346 |
| $Fbar_{3\text{-}9}$ | 0.360 | 0.264 | 0.321 | 0.358 | 0.377 | 0.393 | 0.366 | 0.257 | 0.247 | 0.290 |

**Table 8.3.11 Sole VIIE Summary Table**

| Year | Recruits[000'] | TSB[t] | SSB[t] | Landings[t] | Yield//SSB | FBar3-9 |
|---|---|---|---|---|---|---|
| 1969 | 1609 | 3340 | 2741 | 352.72 | 0.13 | 0.119 |
| 1970 | 3975 | 3601 | 3007 | 389.61 | 0.13 | 0.126 |
| 1971 | 2955 | 3287 | 2750 | 431.92 | 0.16 | 0.154 |
| 1972 | 2618 | 3559 | 2725 | 436.55 | 0.16 | 0.122 |
| 1973 | 3580 | 3897 | 3269 | 458.25 | 0.14 | 0.144 |
| 1974 | 3357 | 4001 | 3225 | 426.52 | 0.13 | 0.131 |
| 1975 | 3142 | 5139 | 4130 | 500.63 | 0.12 | 0.118 |
| 1976 | 7206 | 5587 | 4186 | 614.25 | 0.15 | 0.160 |
| 1977 | 5072 | 6021 | 4340 | 604.58 | 0.14 | 0.124 |
| 1978 | 4714 | 6575 | 4807 | 868.31 | 0.18 | 0.171 |
| 1979 | 5164 | 6749 | 5292 | 1170.17 | 0.22 | 0.229 |
| 1980 | 8947 | 6705 | 5208 | 1268.10 | 0.24 | 0.220 |
| 1981 | 5157 | 6335 | 4764 | 1217.81 | 0.26 | 0.260 |
| 1982 | 4165 | 6224 | 4730 | 1437.95 | 0.30 | 0.316 |
| 1983 | 6581 | 5892 | 4638 | 1503.84 | 0.32 | 0.367 |
| 1984 | 7838 | 5824 | 4552 | 1362.66 | 0.30 | 0.312 |
| 1985 | 4237 | 5973 | 4000 | 1400.09 | 0.35 | 0.343 |
| 1986 | 6451 | 5623 | 3903 | 1418.02 | 0.36 | 0.322 |
| 1987 | 4207 | 5420 | 3968 | 1279.28 | 0.32 | 0.293 |
| 1988 | 4118 | 5157 | 3881 | 1443.13 | 0.37 | 0.337 |
| 1989 | 3148 | 4516 | 3394 | 1389.36 | 0.41 | 0.413 |
| 1990 | 7912 | 5201 | 3251 | 1306.25 | 0.40 | 0.413 |
| 1991 | 4371 | 4484 | 2969 | 852.20 | 0.29 | 0.270 |
| 1992 | 3805 | 4188 | 2836 | 895.68 | 0.32 | 0.238 |
| 1993 | 2598 | 3614 | 2831 | 903.83 | 0.32 | 0.307 |
| 1994 | 3723 | 4235 | 3156 | 800.26 | 0.25 | 0.230 |
| 1995 | 4389 | 4481 | 3233 | 855.85 | 0.26 | 0.294 |
| 1996 | 3666 | 4654 | 3051 | 833.38 | 0.27 | 0.260 |
| 1997 | 4855 | 3790 | 2880 | 949.66 | 0.33 | 0.312 |
| 1998 | 3853 | 3949 | 2919 | 880.05 | 0.30 | 0.292 |
| 1999 | 7101 | 4924 | 2886 | 955.93 | 0.33 | 0.318 |
| 2000 | 5880 | 4921 | 2864 | 911.73 | 0.32 | 0.302 |
| 2001 | 4093 | 4507 | 2923 | 1068.62 | 0.37 | 0.364 |
| 2002 | 6014 | 4789 | 3077 | 1105.32 | 0.36 | 0.360 |
| 2003 | 3078 | 4446 | 3148 | 1078.12 | 0.34 | 0.264 |
| 2004 | 4376 | 4264 | 2934 | 1073.92 | 0.37 | 0.321 |
| 2005 | 4884 | 4354 | 3032 | 1036.77 | 0.34 | 0.358 |
| 2006 | 4087 | 3842 | 2597 | 1015.53 | 0.39 | 0.377 |
| 2007 | 3534 | 3882 | 2613 | 1014.65 | 0.39 | 0.393 |
| 2008 | 2378 | 3659 | 2428 | 908.12 | 0.37 | 0.366 |
| 2009 | 2885 | 3393 | 2599 | 700.48 | 0.27 | 0.257 |
| 2010 | 4301[a] | 3320 | 2759 | 687.51 | 0.25 | 0.247 |

[a] replaced XSA estimate (8907) with GM recruitment69-08

Table 8.3.12 Sole VIIE Short-term Forcast Input Table

2011

| Age | N | M | Mat | PF | PM | SWt | Sel | CWt |
|---|---|---|---|---|---|---|---|---|
| 1 | 4301 | 0.10 | 0.00 | 0.00 | 0.00 | 0.058 | 0.000 | 0.080 |
| 2 | 3891 | 0.10 | 0.14 | 0.00 | 0.00 | 0.143 | 0.059 | 0.180 |
| 3 | 2299 | 0.10 | 0.45 | 0.00 | 0.00 | 0.217 | 0.214 | 0.251 |
| 4 | 1299 | 0.10 | 0.88 | 0.00 | 0.00 | 0.285 | 0.231 | 0.317 |
| 5 | 1316 | 0.10 | 0.98 | 0.00 | 0.00 | 0.348 | 0.244 | 0.378 |
| 6 | 1112 | 0.10 | 1.00 | 0.00 | 0.00 | 0.406 | 0.255 | 0.433 |
| 7 | 754 | 0.10 | 1.00 | 0.00 | 0.00 | 0.459 | 0.243 | 0.484 |
| 8 | 403 | 0.10 | 1.00 | 0.00 | 0.00 | 0.507 | 0.289 | 0.529 |
| 9 | 168 | 0.10 | 1.00 | 0.00 | 0.00 | 0.550 | 0.255 | 0.569 |
| 10 | 203 | 0.10 | 1.00 | 0.00 | 0.00 | 0.587 | 0.253 | 0.604 |
| 11 | 57 | 0.10 | 1.00 | 0.00 | 0.00 | 0.619 | 0.295 | 0.633 |
| 12 | 360 | 0.10 | 1.00 | 0.00 | 0.00 | 0.678 | 0.295 | 0.685 |

2012

| Age | N | M | Mat | PF | PM | SWt | Sel | CWt |
|---|---|---|---|---|---|---|---|---|
| 1 | 4301 | 0.10 | 0.00 | 0.00 | 0.00 | 0.058 | 0.000 | 0.080 |
| 2 | | 0.10 | 0.14 | 0.00 | 0.00 | 0.143 | 0.059 | 0.180 |
| 3 | | 0.10 | 0.45 | 0.00 | 0.00 | 0.217 | 0.214 | 0.251 |
| 4 | | 0.10 | 0.88 | 0.00 | 0.00 | 0.285 | 0.231 | 0.317 |
| 5 | | 0.10 | 0.98 | 0.00 | 0.00 | 0.348 | 0.244 | 0.378 |
| 6 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.406 | 0.255 | 0.433 |
| 7 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.459 | 0.243 | 0.484 |
| 8 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.507 | 0.289 | 0.529 |
| 9 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.550 | 0.255 | 0.569 |
| 10 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.587 | 0.253 | 0.604 |
| 11 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.619 | 0.295 | 0.633 |
| 12 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.678 | 0.295 | 0.685 |

2013

| Age | N | M | Mat | PF | PM | SWt | Sel | CWt |
|---|---|---|---|---|---|---|---|---|
| 1 | 4301 | 0.10 | 0.00 | 0.00 | 0.00 | 0.058 | 0.000 | 0.080 |
| 2 | | 0.10 | 0.14 | 0.00 | 0.00 | 0.143 | 0.059 | 0.180 |
| 3 | | 0.10 | 0.45 | 0.00 | 0.00 | 0.217 | 0.214 | 0.251 |
| 4 | | 0.10 | 0.88 | 0.00 | 0.00 | 0.285 | 0.231 | 0.317 |
| 5 | | 0.10 | 0.98 | 0.00 | 0.00 | 0.348 | 0.244 | 0.378 |
| 6 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.406 | 0.255 | 0.433 |
| 7 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.459 | 0.243 | 0.484 |
| 8 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.507 | 0.289 | 0.529 |
| 9 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.550 | 0.255 | 0.569 |
| 10 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.587 | 0.253 | 0.604 |
| 11 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.619 | 0.295 | 0.633 |
| 12 | | 0.10 | 1.00 | 0.00 | 0.00 | 0.678 | 0.295 | 0.685 |

Table 8.3.13 Sole VIIE Single Option Output

Year=2011 F / F08-10= 0.852 Fbar= 0.247

| Age | F | Catch No | Yield | Stock No | Biomass | SS No | SSB |
|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0 | 0 | 4301 | 248 | 0 | 0 |
| 2 | 0.059 | 213 | 38 | 3891 | 556 | 545 | 78 |
| 3 | 0.214 | 422 | 106 | 2299 | 498 | 1035 | 224 |
| 4 | 0.231 | 255 | 81 | 1299 | 370 | 1144 | 326 |
| 5 | 0.244 | 272 | 103 | 1316 | 459 | 1290 | 449 |
| 6 | 0.255 | 239 | 103 | 1112 | 452 | 1112 | 452 |
| 7 | 0.243 | 155 | 75 | 754 | 347 | 754 | 347 |
| 8 | 0.289 | 96 | 51 | 403 | 205 | 403 | 205 |
| 9 | 0.255 | 36 | 21 | 168 | 92 | 168 | 92 |
| 10 | 0.253 | 43 | 26 | 203 | 119 | 203 | 119 |
| 11 | 0.295 | 14 | 9 | 57 | 35 | 57 | 35 |
| 12 | 0.295 | 88 | 60 | 360 | 244 | 360 | 244 |
| Total | | 1833 | 673 | 16165 | 3625 | 7071 | 2571 |

Year=2012 F / F08-10= 0.852 Fbar= 0.247

| Age | F | Catch No | Yield | Stock No | Biomass | SS No | SSB |
|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0 | 0 | 4301 | 248 | 0 | 0 |
| 2 | 0.059 | 213 | 38 | 3891 | 556 | 545 | 78 |
| 3 | 0.214 | 609 | 153 | 3318 | 719 | 1493 | 324 |
| 4 | 0.231 | 330 | 105 | 1680 | 478 | 1479 | 421 |
| 5 | 0.244 | 193 | 73 | 933 | 325 | 915 | 319 |
| 6 | 0.255 | 200 | 87 | 933 | 379 | 933 | 379 |
| 7 | 0.243 | 160 | 78 | 780 | 358 | 780 | 358 |
| 8 | 0.289 | 128 | 68 | 535 | 272 | 535 | 272 |
| 9 | 0.255 | 59 | 33 | 273 | 150 | 273 | 150 |
| 10 | 0.253 | 25 | 15 | 118 | 69 | 118 | 69 |
| 11 | 0.295 | 35 | 22 | 142 | 88 | 142 | 88 |
| 12 | 0.295 | 69 | 47 | 281 | 191 | 281 | 191 |
| Total | | 2021 | 719 | 17187 | 3834 | 7495 | 2648 |

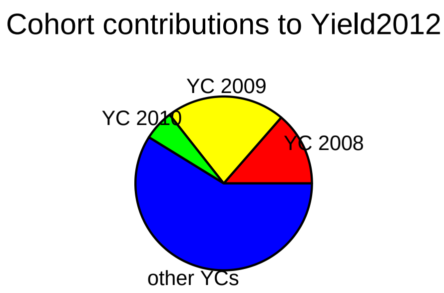
Year=2013 F / F08-10= 0.852 Fbar= 0.247

| Age | F | Catch No | Yield | Stock No | Biomass | SS No | SSB |
|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0 | 0 | 4301 | 248 | 0 | 0 |
| 2 | 0.059 | 213 | 38 | 3891 | 556 | 545 | 78 |
| 3 | 0.214 | 609 | 153 | 3318 | 719 | 1493 | 324 |
| 4 | 0.231 | 477 | 151 | 2425 | 690 | 2134 | 607 |
| 5 | 0.244 | 249 | 94 | 1207 | 420 | 1183 | 412 |
| 6 | 0.255 | 142 | 62 | 662 | 269 | 662 | 269 |
| 7 | 0.243 | 135 | 65 | 654 | 301 | 654 | 301 |
| 8 | 0.289 | 132 | 70 | 553 | 281 | 553 | 281 |
| 9 | 0.255 | 78 | 44 | 363 | 200 | 363 | 200 |
| 10 | 0.253 | 41 | 25 | 192 | 113 | 192 | 113 |
| 11 | 0.295 | 20 | 13 | 83 | 51 | 83 | 51 |
| 12 | 0.295 | 70 | 48 | 286 | 194 | 286 | 194 |
| Total | | 2165 | 763 | 17935 | 4041 | 8147 | 2828 |

input units are in 000's and kg, output in t

**Table 8.3.14 Sole VIIE Contributions and Source of Cohort for Short-term Forecast**

| YC | Source | Yield2011 | Yield2012 | SSB2011 | SSB2012 | SSB2013 |
|---|---|---|---|---|---|---|
| 2008 | XSA | 14.8 | 13.7 | 8.5 | 14.9 | 15.8 |
| 2009 | GM 69-08 | 5 | 21.8 | 2.8 | 12.4 | 22 |
| 2010 | GM 69-08 | | 5.6 | | 2.8 | 12.6 |
| 2011 | GM 69-08 | | | | | 2.9 |
| 2012 | GM 69-08 | | | | | |



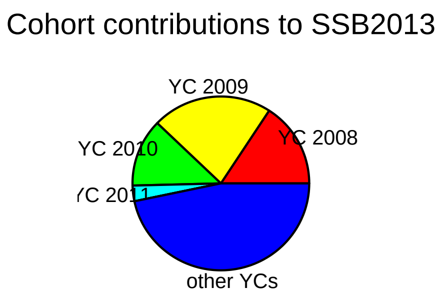



Table 8.3.15 Sole VIIE Management Options Output

| SSB 2012 | TSB 2012 | F-mult | F | basis | Yield 2012 | SSB 2013 | TSB 2013 | %SSB-Change | %TAC-Change |
|---|---|---|---|---|---|---|---|---|---|
| 2648 | 3834 | 0.0 | 0.000 | Fsq | 0 | 3519 | 4778 | 33 | -100 |
| 2648 | 3834 | 0.1 | 0.025 | Fsq | 80 | 3442 | 4697 | 30 | -89 |
| 2648 | 3834 | 0.2 | 0.049 | Fsq | 157 | 3367 | 4617 | 27 | -78 |
| 2648 | 3834 | 0.3 | 0.074 | Fsq | 233 | 3294 | 4539 | 24 | -67 |
| 2648 | 3834 | 0.4 | 0.099 | Fsq | 308 | 3222 | 4463 | 22 | -57 |
| 2648 | 3834 | 0.5 | 0.124 | Fsq | 380 | 3153 | 4388 | 19 | -46 |
| 2648 | 3834 | 0.6 | 0.148 | Fsq | 451 | 3085 | 4316 | 16 | -36 |
| 2648 | 3834 | 0.7 | 0.173 | Fsq | 520 | 3018 | 4245 | 14 | -27 |
| 2648 | 3834 | 0.8 | 0.198 | Fsq | 588 | 2953 | 4175 | 12 | -17 |
| 2648 | 3834 | 0.826 | 0.204 | Fsq | 605 | 2937 | 4157 | 11 | -15 |
| 2648 | 3834 | 0.9 | 0.222 | Fsq | 654 | 2890 | 4107 | 9 | -8 |
| 2648 | 3834 | 0.987 | 0.244 | Fsq | 710 | 2836 | 4050 | 7 | 0 |
| 2648 | 3834 | 1.0 | 0.247 | Fsq | 719 | 2828 | 4041 | 7 | 1 |
| 2648 | 3834 | 1.033777 | 0.255 | Fsq | 740 | 2808 | 4019 | 6 | 4 |
| 2648 | 3834 | 1.093117 | 0.270 | Fsq | 777 | 2772 | 3981 | 5 | 9 |
| 2648 | 3834 | 1.1 | 0.272 | Fsq | 782 | 2768 | 3977 | 5 | 10 |
| 2648 | 3834 | 1.157 | 0.286 | Fsq | 817 | 2734 | 3941 | 3 | 15 |
| 2648 | 3834 | 1.2 | 0.297 | Fsq | 843 | 2709 | 3914 | 2 | 19 |
| 2648 | 3834 | 1.3 | 0.321 | Fsq | 904 | 2651 | 3852 | 0 | 27 |
| 2648 | 3834 | 1.4 | 0.346 | Fsq | 962 | 2595 | 3792 | -2 | 36 |
| 2648 | 3834 | 1.5 | 0.371 | Fsq | 1020 | 2540 | 3733 | -4 | 44 |
| 2648 | 3834 | 1.6 | 0.395 | Fsq | 1076 | 2487 | 3675 | -6 | 52 |
| 2648 | 3834 | 1.7 | 0.420 | Fsq | 1131 | 2434 | 3619 | -8 | 59 |
| 2648 | 3834 | 1.8 | 0.445 | Fsq | 1185 | 2383 | 3564 | -10 | 67 |
| 2648 | 3834 | 1.9 | 0.470 | Fsq | 1237 | 2334 | 3510 | -12 | 74 |
| 2648 | 3834 | 2.0 | 0.494 | Fsq | 1289 | 2285 | 3458 | -14 | 82 |
| 2648 | 3834 | 1.033777 | 0.255 | Fmsy | 740 | 2808 | 4019 | 6 | 4 |
| 2648 | 3834 | 1.093117 | 0.270 | Fmp F | 777 | 2772 | 3981 | 5 | 9 |

Figure 8.3.1 Sole VIIE International Landings Age Compositions

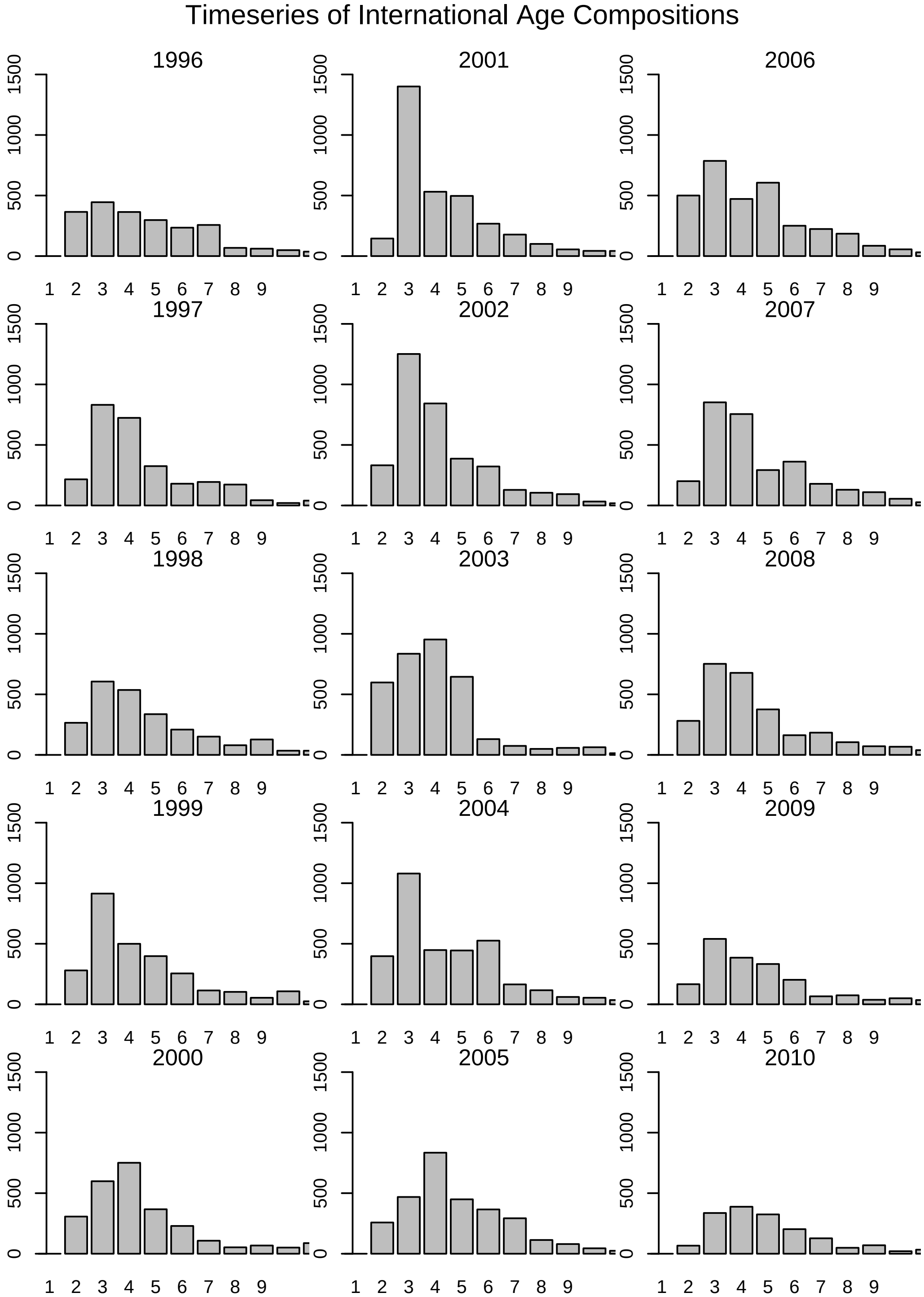
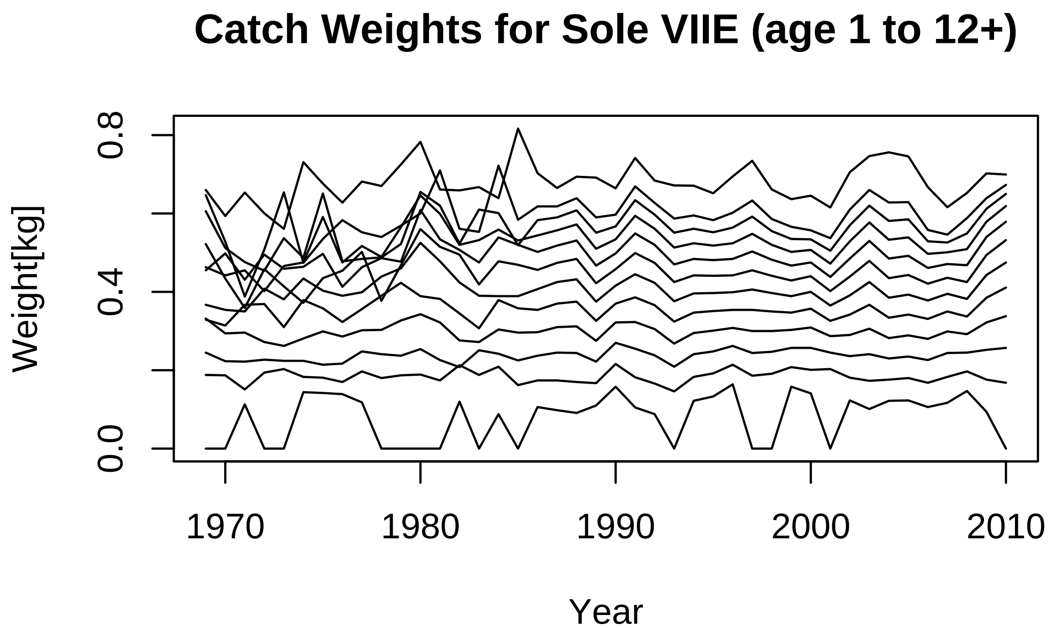


Figure 8.3.2 Sole VIIE Catch and Stock Weights at Age



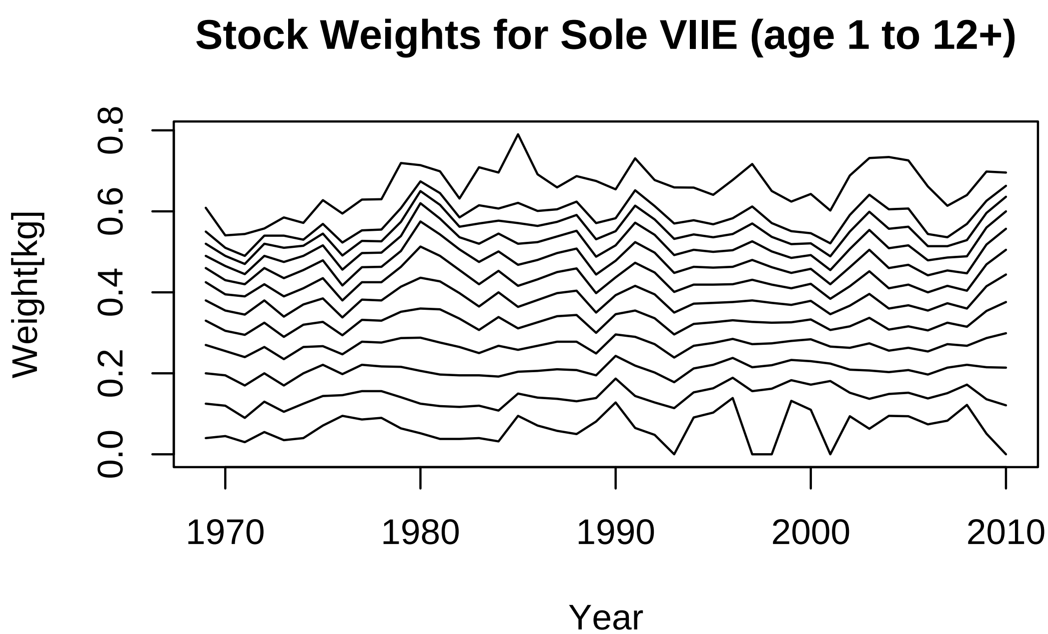



Figure 8.3.3a Sole VIIE Discards by Quarter, Fleet

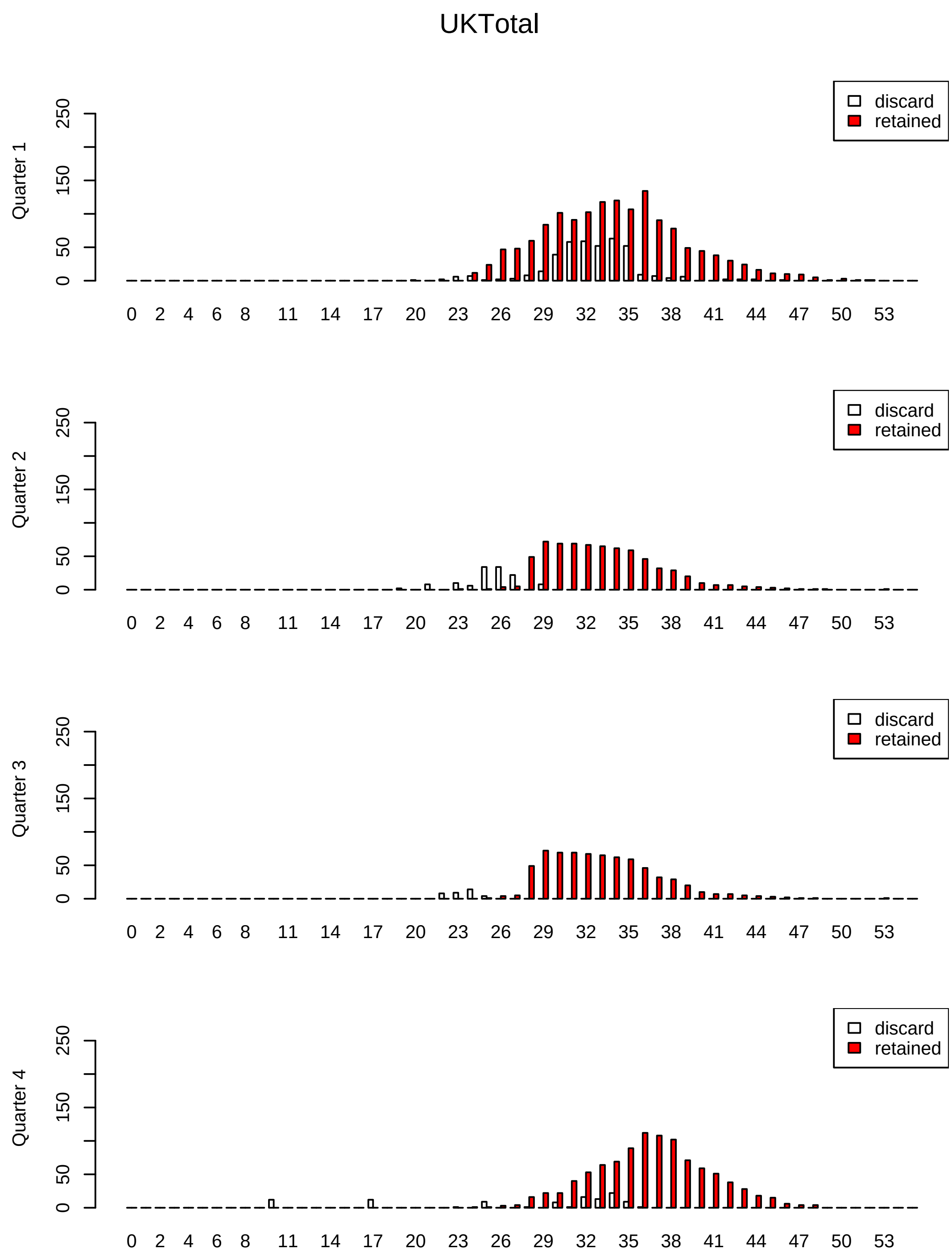


Figure 8.3.3b Sole VIIE Discards by Quarter, Fleet continued

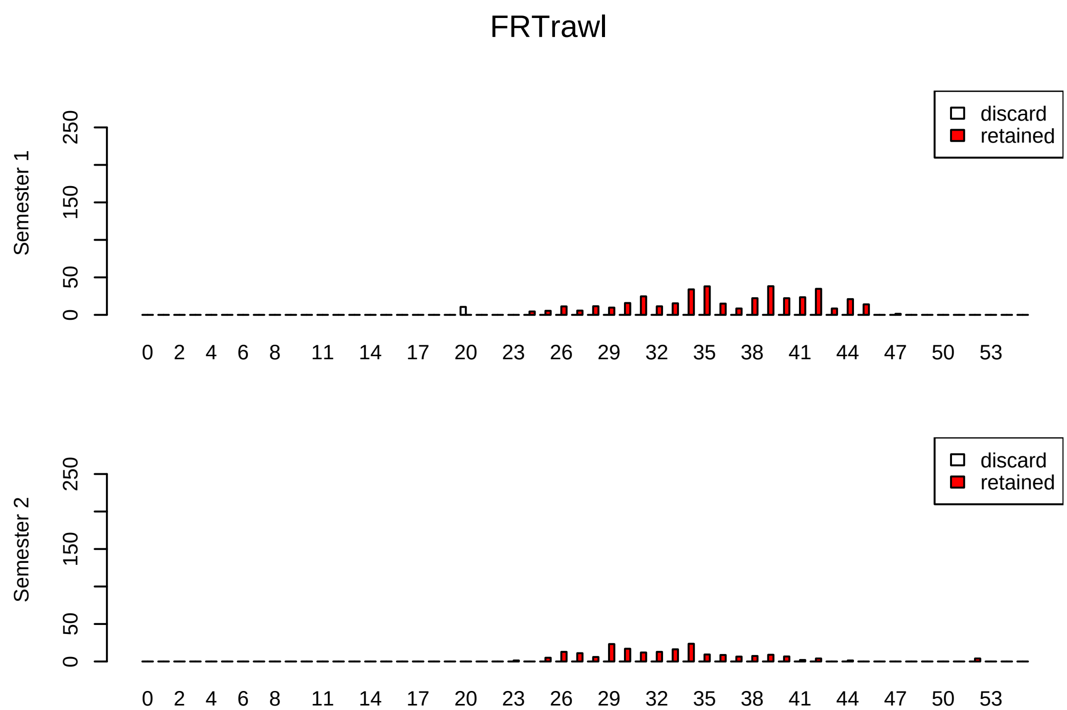


Figure 8.3.3c Sole VIIE Discards by Quarter, Fleet continued

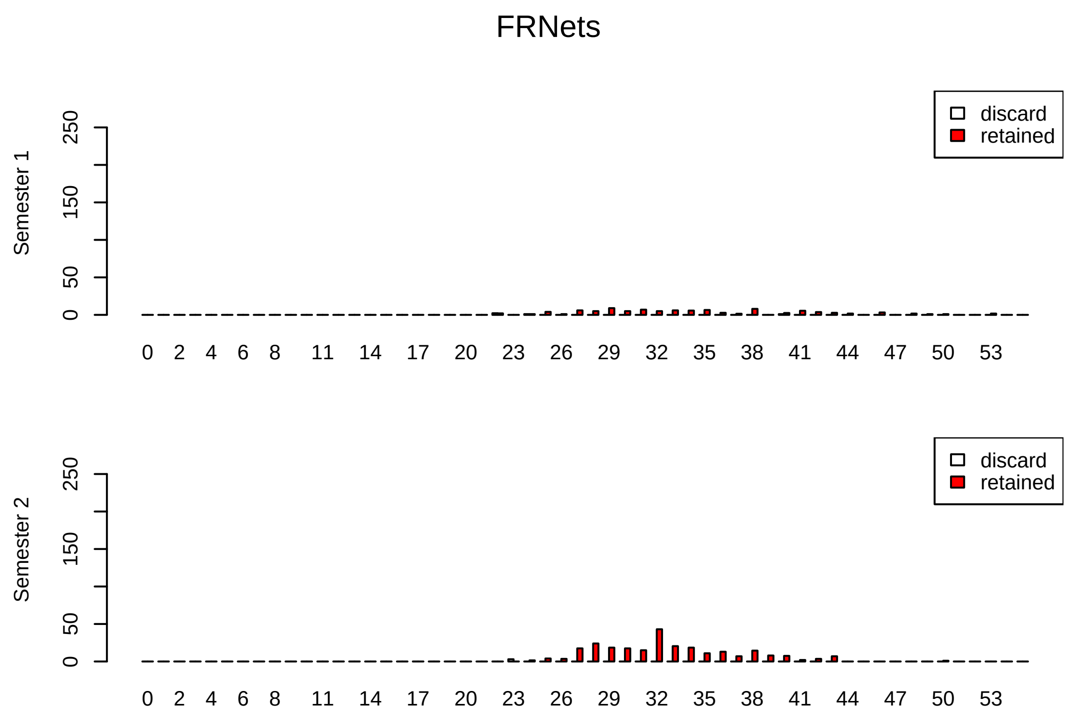


Figure 8.3.3d Sole VIIE Discards by Quarter, Fleet continued

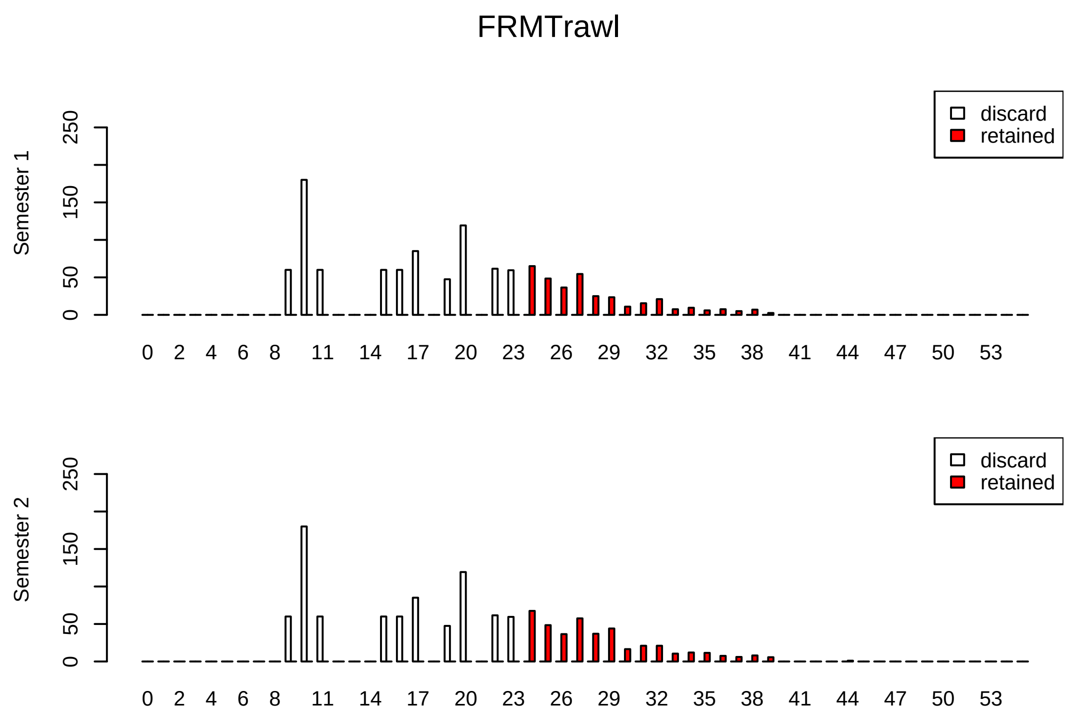


Figure 8.3.3e Sole VIIE Discards by Quarter, Fleet continued

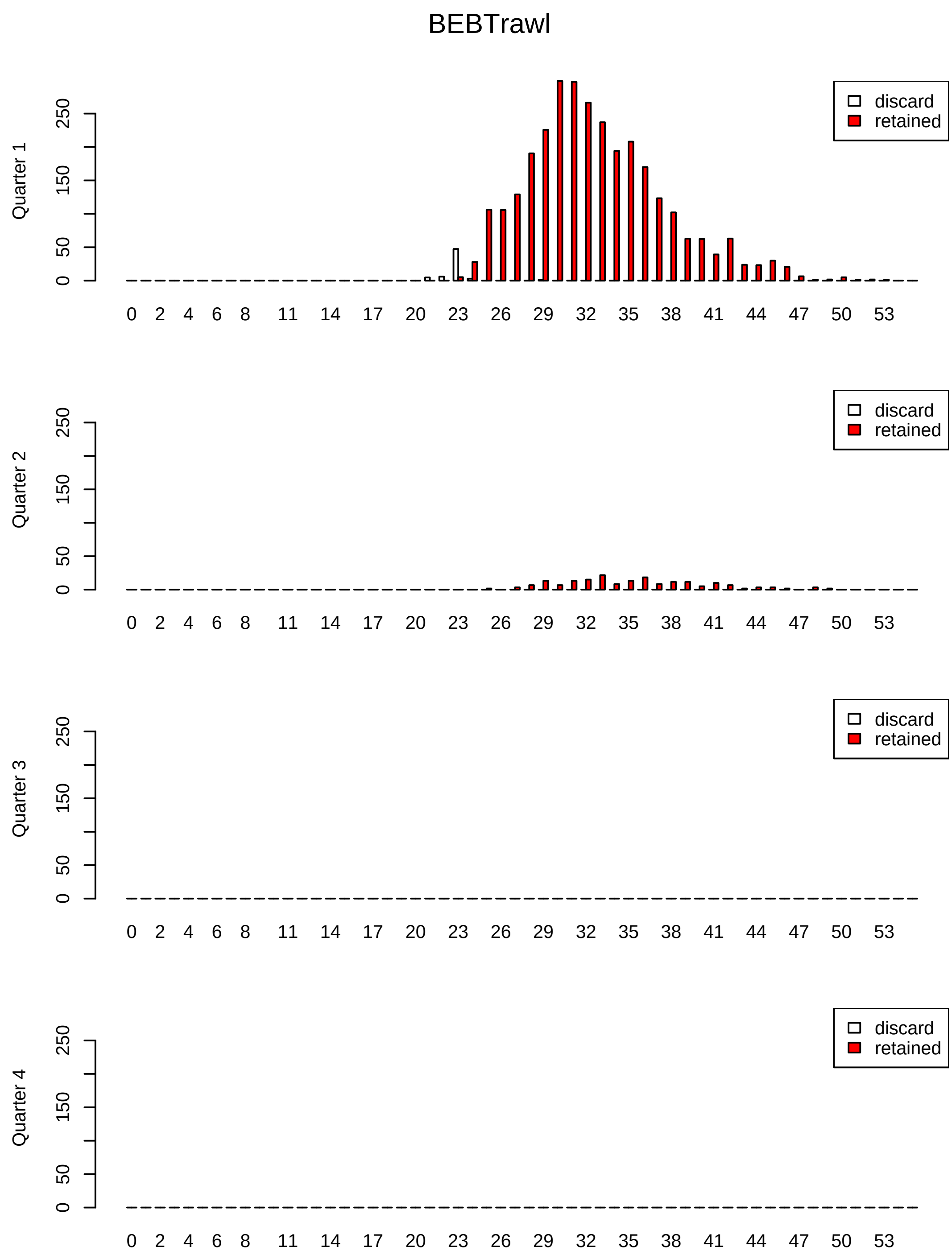
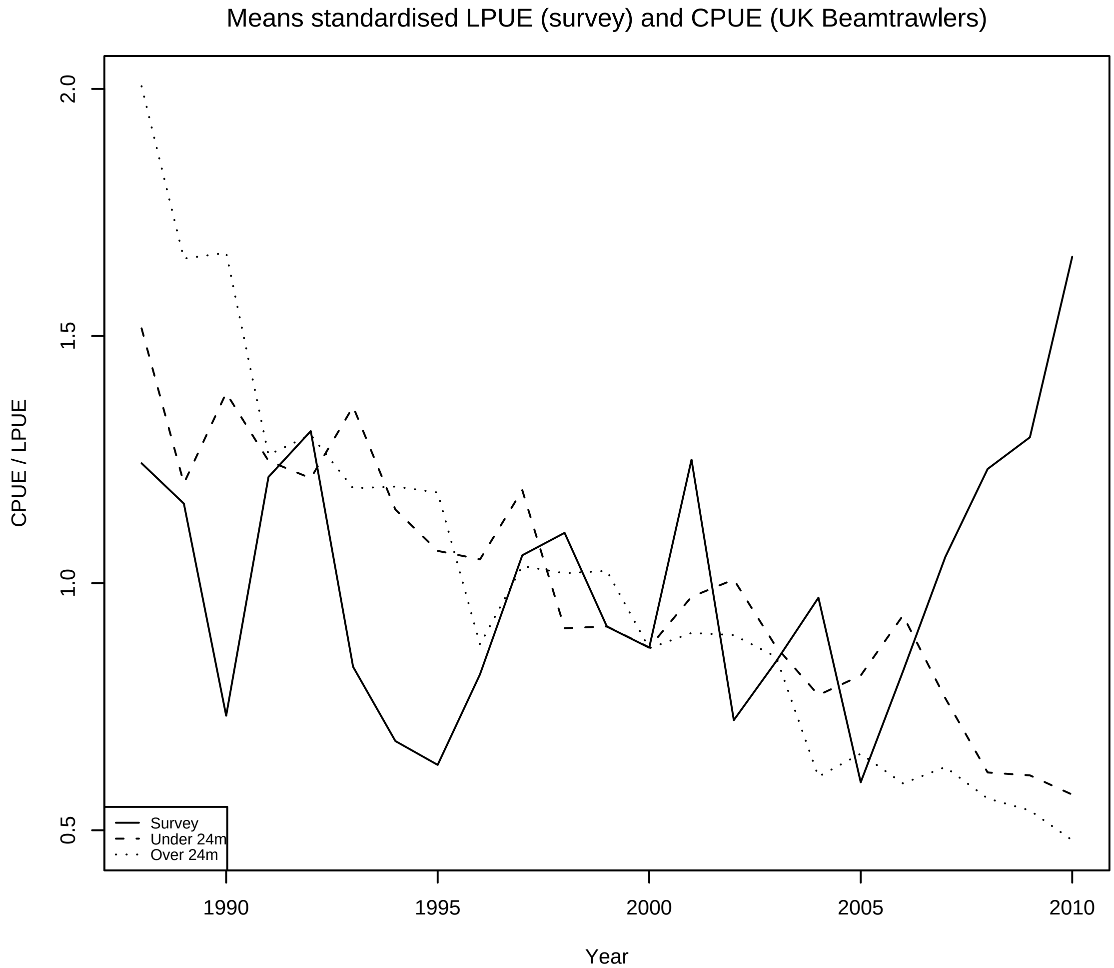


Figure 8.3.4 Sole VIIE LPUE and effort



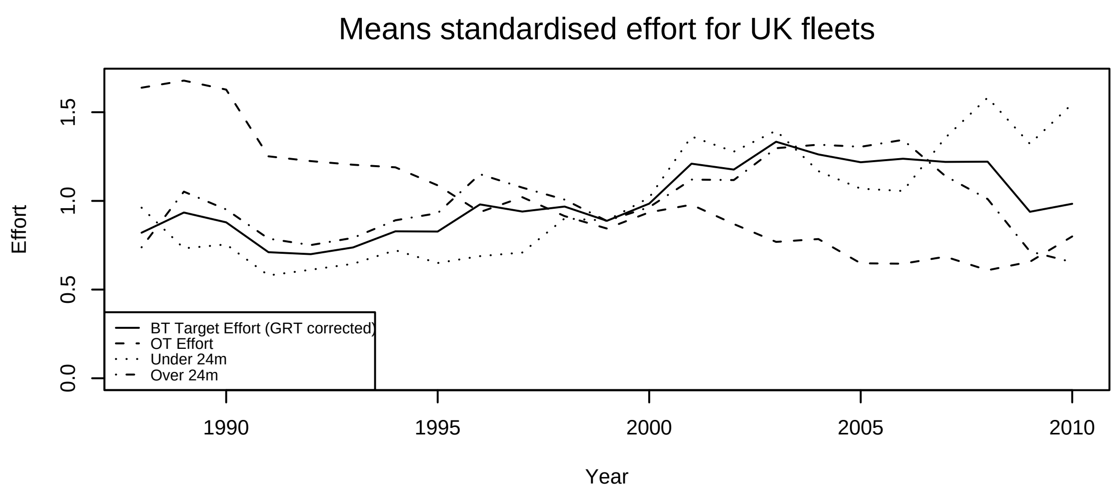



Figure 8.3.5 Sole VIIE Log CPUE by Yearclass

note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

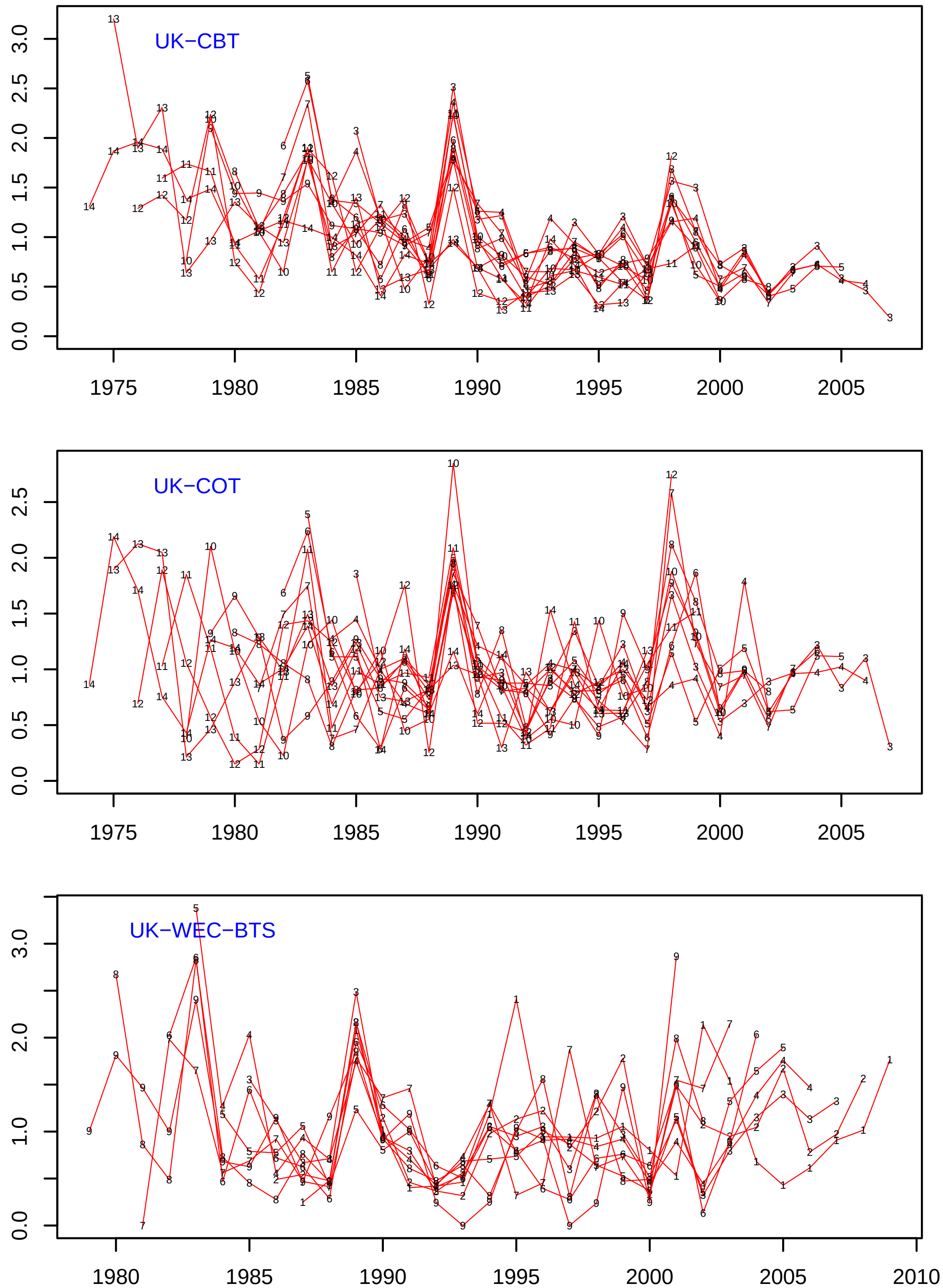


Figure 8.3.6 Sole VIIE Log CPUE by Year

note the cohorts differ on the x-axes due to the differences in the length and age range of the tuning series

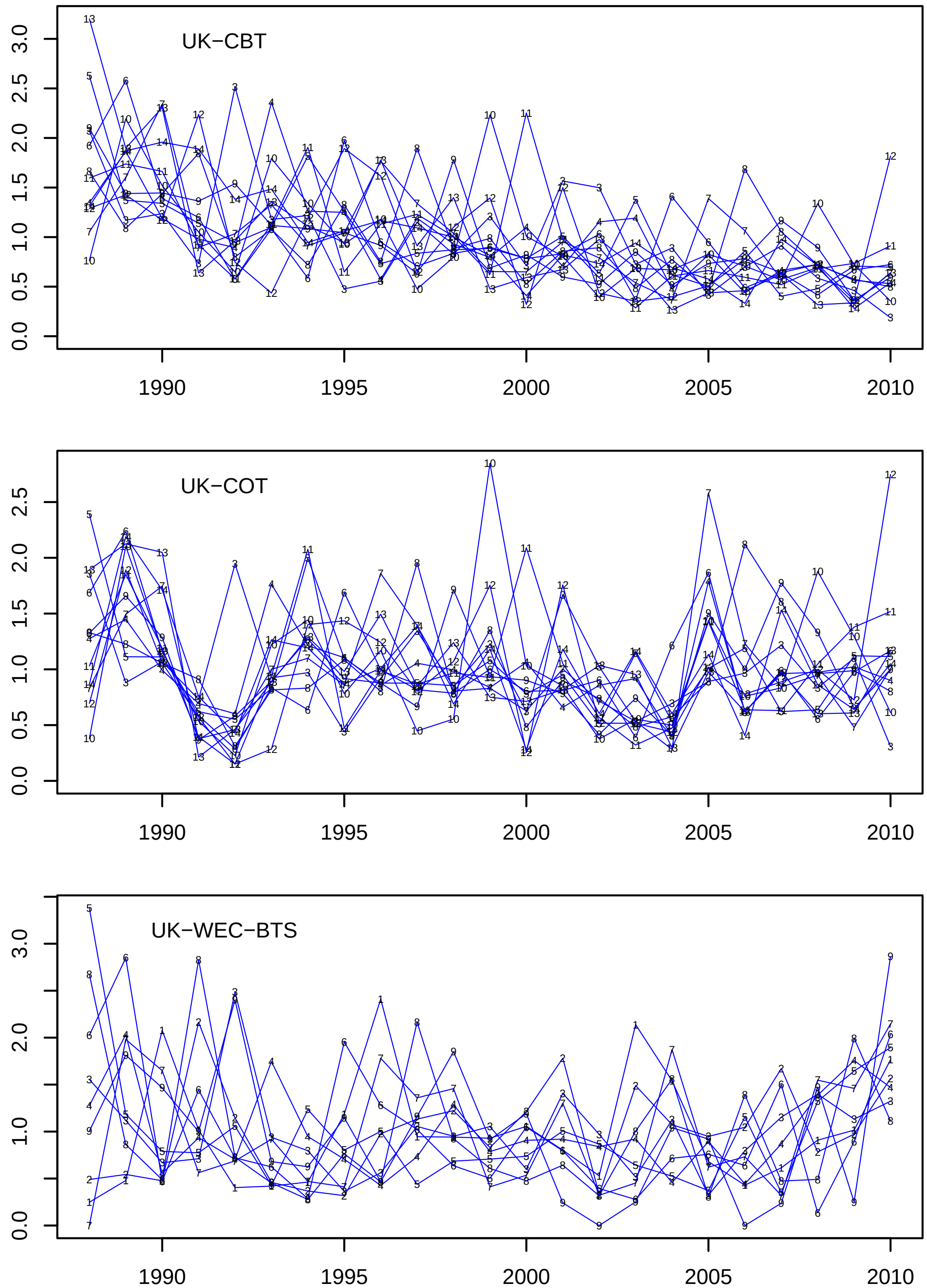


Figure 8.3.7 Sole VIIE Single Fleet log catchability Residuals

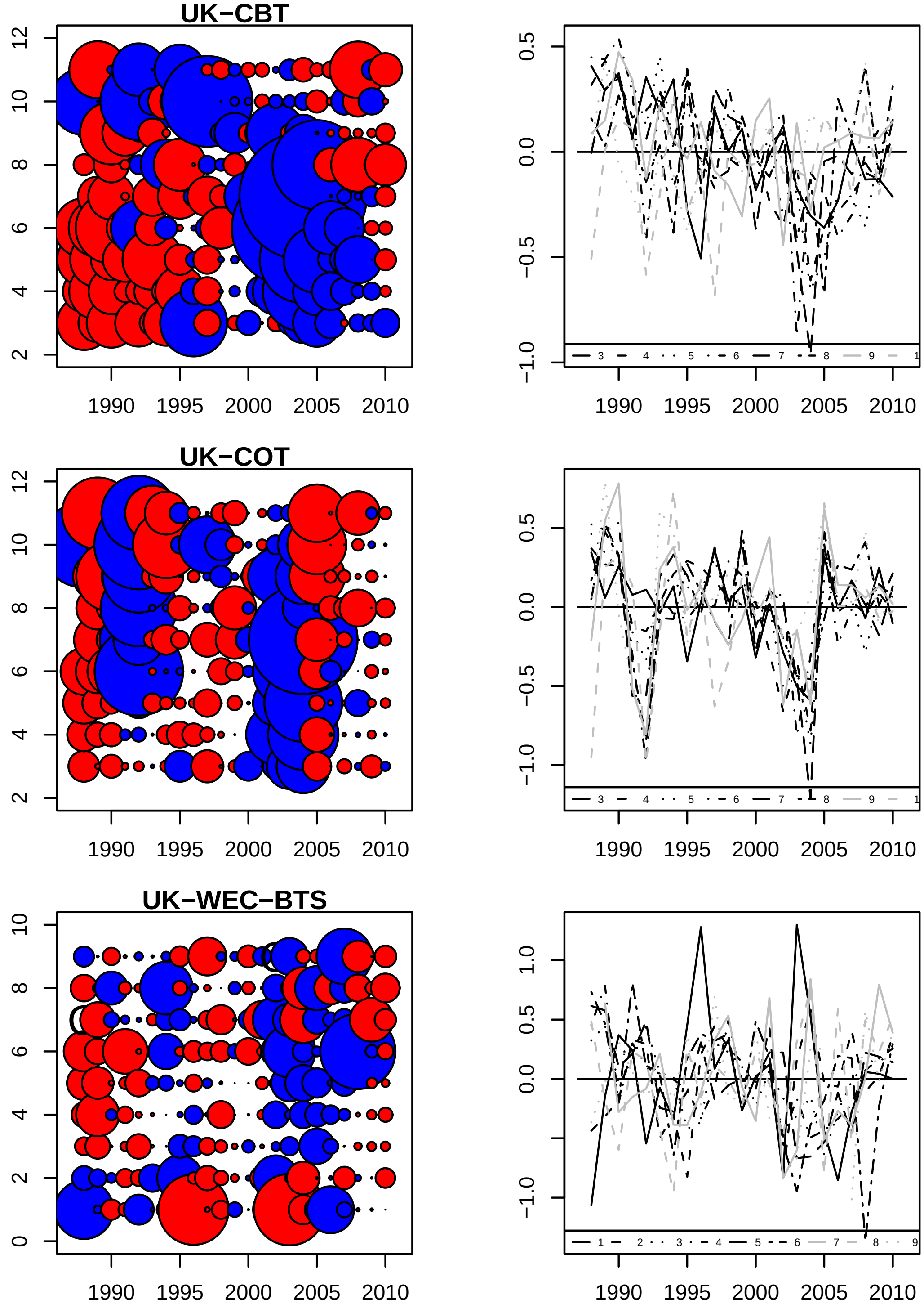


Figure 8.3.8 Sole VIIE Single Fleet Summary

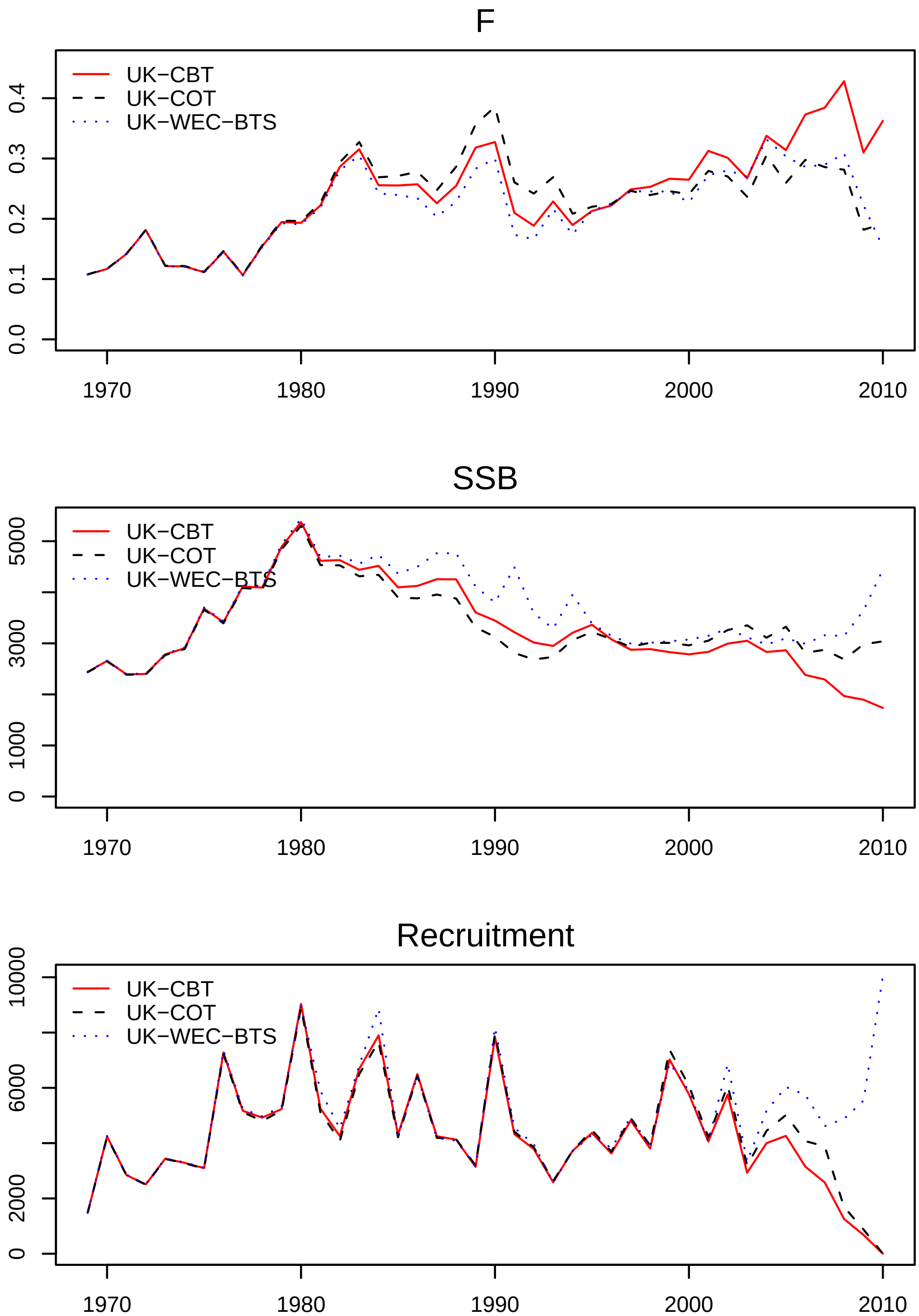


Figure 8.3.9 Sole VIIE Final XSA Fleet log catchability Residuals

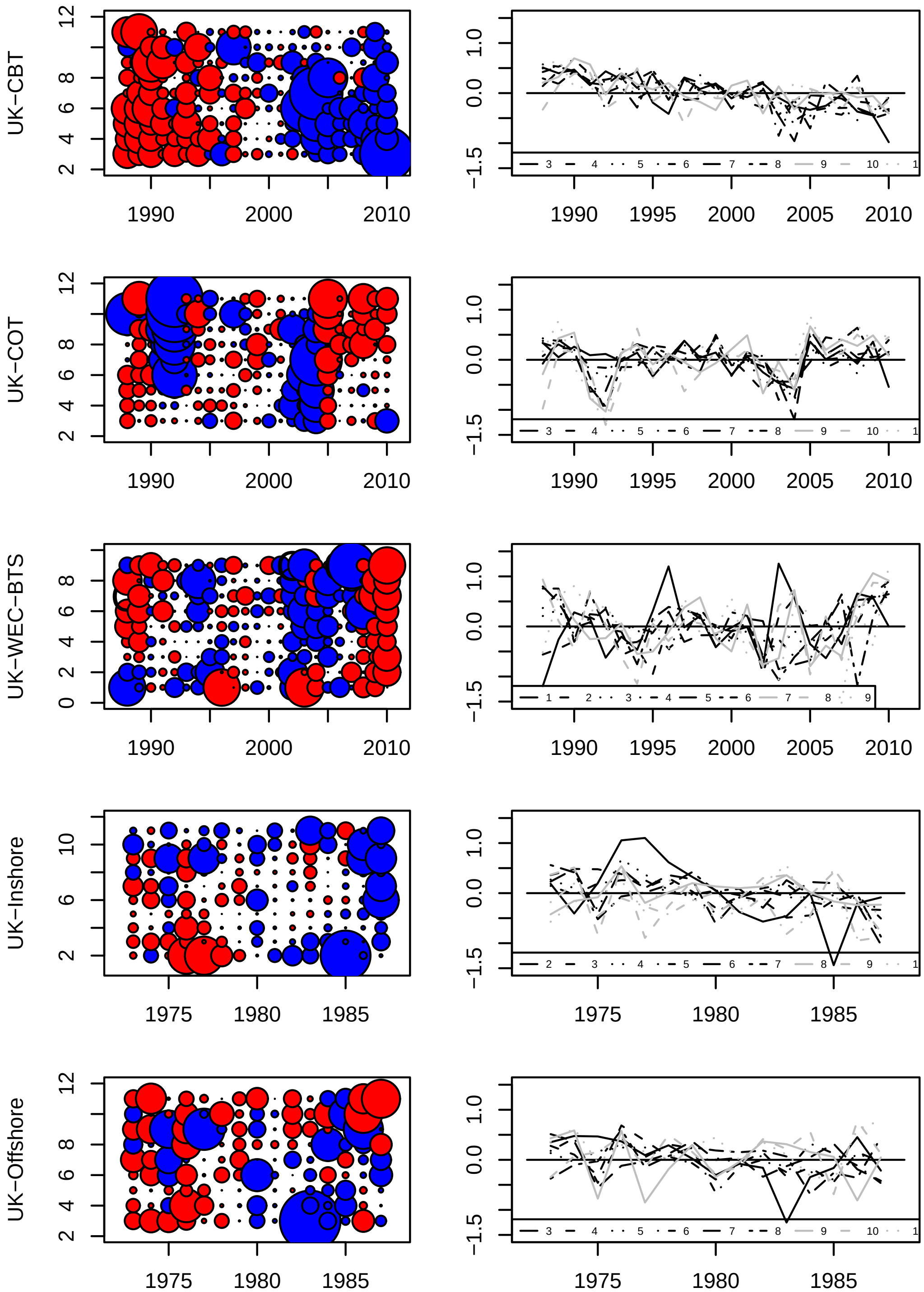
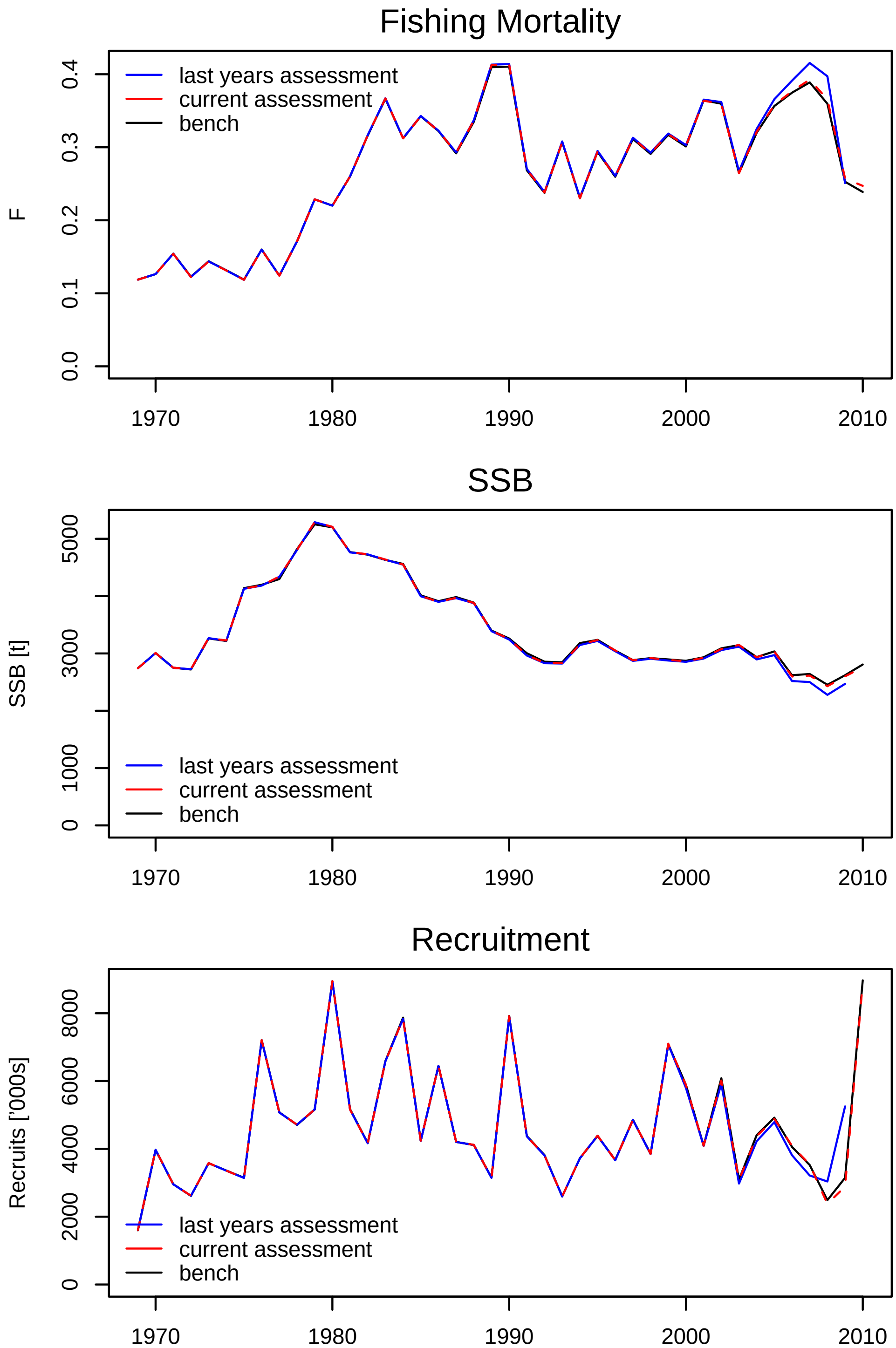


Figure 8.3.10 Sole VIIE Final XSA and previous XSAs



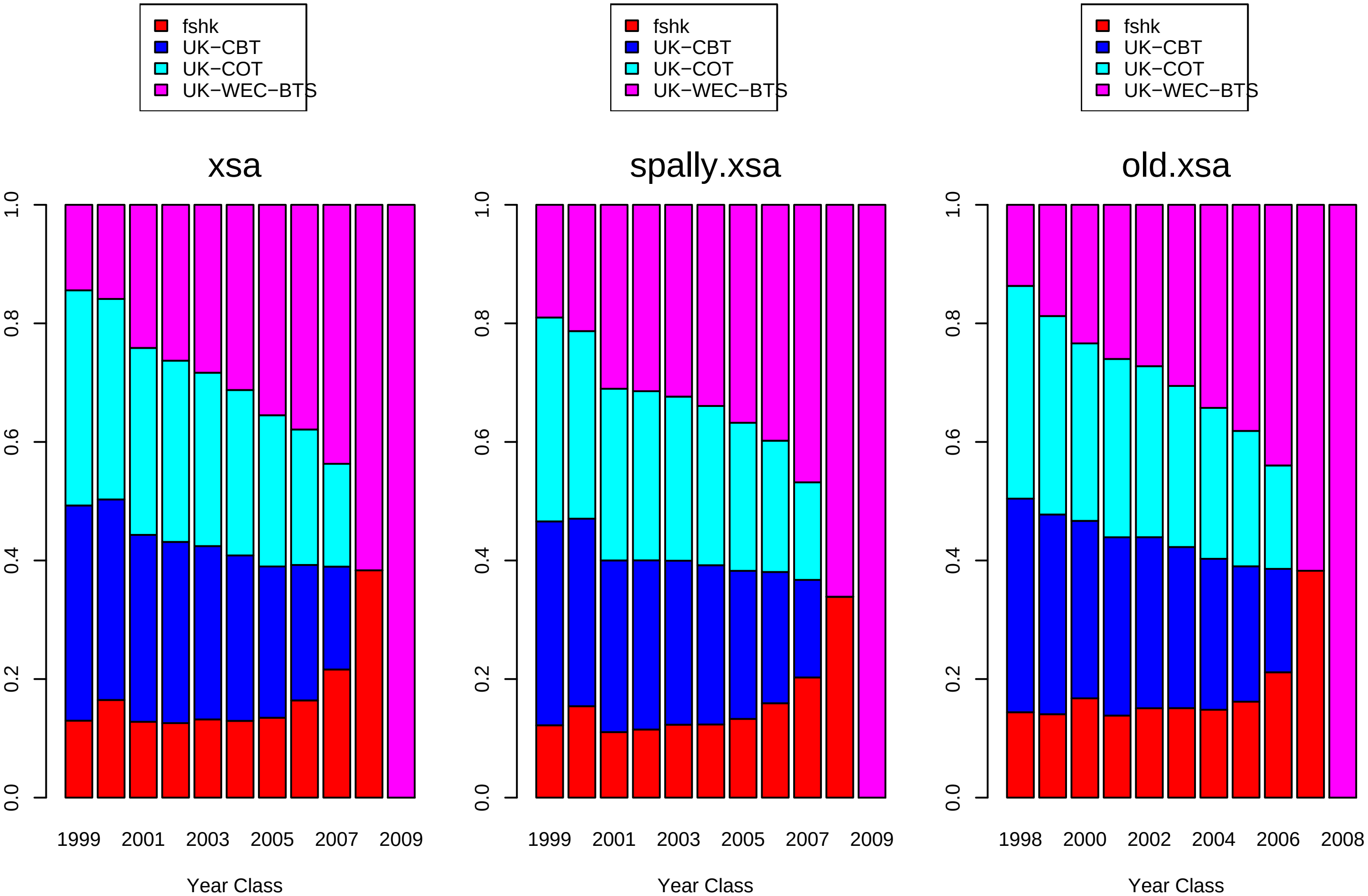
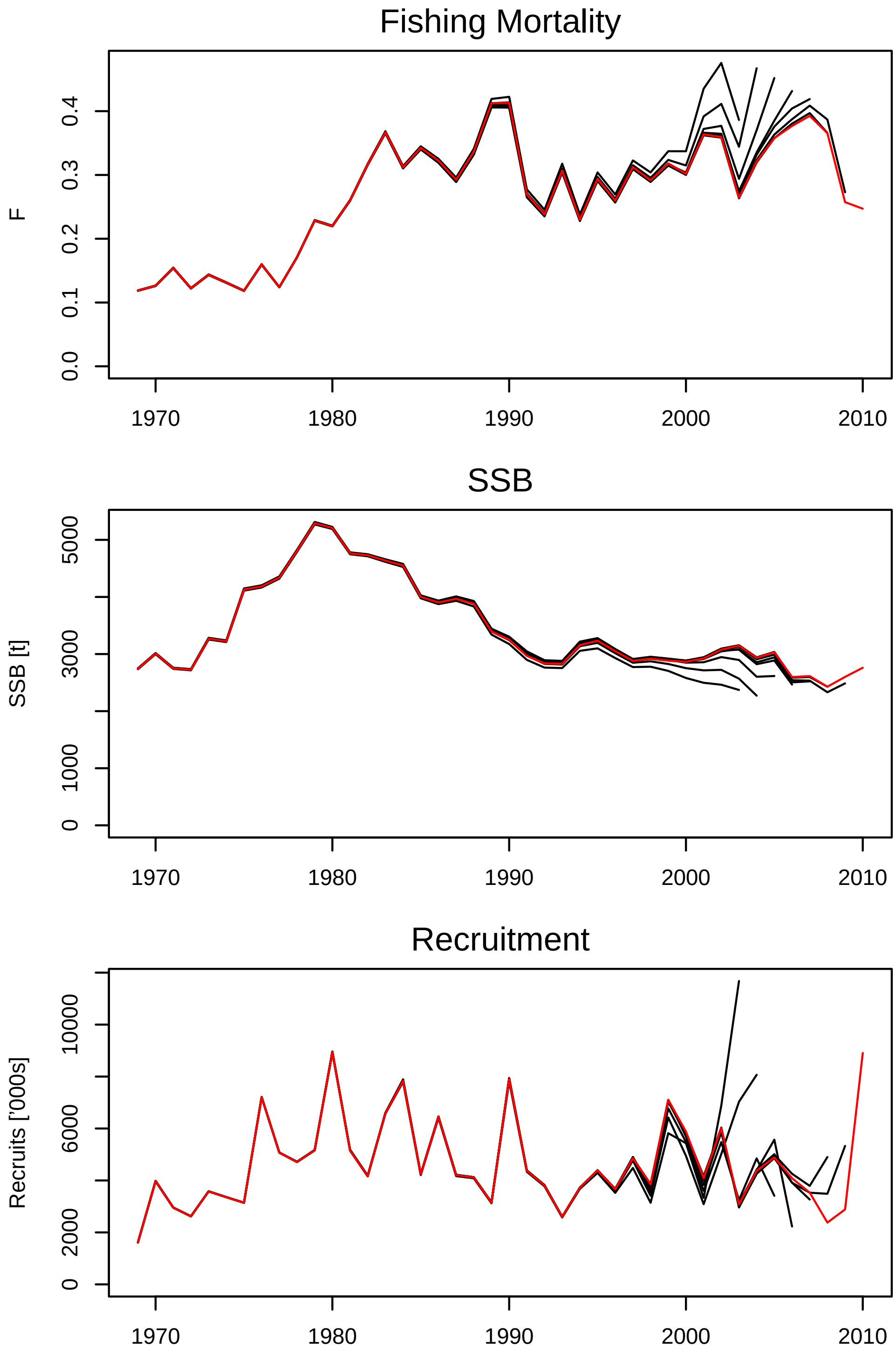



Figure 8.3.11 Sole VIIE Final and previous Assessment weights

Figure 8.3.12 Sole VIIE XSA Retrospective Plots



## 9.2 Pollock in the Celtic Seas (ICES Subareas VI and VII)

### Type of assessment in 2011

No assessment.

### 9.2.1 General

#### Stock identity

This section is not dedicated to a 'stock', it relates to a species in a wider region where data are available. The stock structure of pollock populations in this ecoregion is not clear. ICES does not necessarily advocate that VI and VII constitutes a management unit for pollock, and further work is required.

#### Biology

0-group pollock are found in shallow coastal waters and may therefore be protected from fisheries in the early life stages. Pollock is bentho-pelagic, found mostly close to the shore over hard bottom. It usually occurs at 40–100 m depth but is found down to 200 m. A maximum size of 130 cm, a maximum weight of 18.1 kg and a maximum age of 15 years are reported. Growth is thus fairly rapid, approaching 10 cm per year. There is a migration from the coast to deeper waters as it grows. Maturity occurs at approximately three years and spawning occurs mainly in the first half of the year, at about 100 m depth.

#### The fisheries

Most pollock in the Celtic Sea ecoregions is caught by trawls and gillnets, and other gears come to complement the landings, such as trolling line, seine nets or beam trawls (Figure 9.2.1). The overall gear contribution is unknown due to the lack of complete statistics. In 2010, 98% of the landings originated from the Subarea VII, and Ireland, UK and France together comprised 99% of the official landings.

#### Surveys

Pollock may be caught by bottom-trawl surveys such as EVHOE-WIBTS-Q4 and IGFS-WIBTS-Q4 (Figure 9.2.2). The small number of individuals caught by EVHOE-WIBTS-Q4 makes it hardly informative the trends of abundance indices (Figure 9.2.3).

#### Data

The nominal landings are given in Tables 9.2.1 and 9.2.2 for ICES Subarea VI and VII respectively.

**Table 9.2.1. Landings of pollock in Subarea VI as officially reported to ICES.**

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 1 | - | - | - | - | - | - | - | - | 1 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | - | - | - |
| Germany | - | - | - | - | - | - | - | - | 23 | 6 |
| Ireland | - | - | - | - | - | - | - | - | - | - |
| Netherlands | - | - | 1 | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Portugal | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| Sweden | - | - | - | - | - | - | - | - | - | - |
| UK | 295 | 484 | 503 | 422 | 452 | 566 | 528 | 547 | 710 | 607 |
| Subarea VI | 296 | 484 | 504 | 422 | 452 | 566 | 528 | 547 | 733 | 614 |

| | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 15 | 1 | 2 | 6 | 1 | 1 | 2 | 1 | 5 | 1 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | - | - | - |
| Germany | - | 1 | 8 | 2 | 1 | 1 | - | 1 | 2 | 4 |
| Ireland | - | 125 | 197 | 204 | 130 | 402 | 200 | 263 | 214 | 282 |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | 148 | - |
| Portugal | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| Sweden | - | - | - | - | - | - | - | 1106 | 1012 | 1224 |
| UK | 441 | 259 | 235 | 320 | 368 | 496 | 428 | 413 | 500 | 667 |
| Subarea VI | 456 | 386 | 442 | 532 | 500 | 900 | 630 | 1784 | 1881 | 2178 |

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 2 | 1 | 1 | 2 | 6 | <0.5 | 7 | - | - | - |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | 196 | 196 | 310 |
| Germany | 1 | 5 | 1 | - | - | 1 | - | - | - | - |
| Ireland | 398 | 75 | 127 | - | - | - | - | - | - | - |
| Netherlands | - | - | - | - | 3 | 1 | 1 | 1 | - | - |
| Norway | - | - | - | - | - | 4 | - | 2 | 4 | - |
| Portugal | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| Sweden | 756 | 750 | 779 | - | - | - | - | - | - | - |
| UK | 447 | 256 | 317 | 503 | 359 | 393 | 519 | 493 | 553 | 350 |
| Subarea VI | 1604 | 1087 | 1225 | 505 | 368 | 399 | 527 | 692 | 753 | 660 |

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | - | - | - | - | - | <0.5 | - | - | - | - |
| Denmark | - | - | <0.5 | - | - | - | - | <0.5 | <0.5 | <0.5 |
| France | 36 | 342 | 272 | 331 | 212 | 224 | 145 | 108 | 128 | 111 |
| Germany | - | - | - | - | - | 1 | - | - | - | 1 |
| Ireland | - | - | - | - | - | - | 223 | 103 | 163 | 103 |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Portugal | - | - | - | - | - | - | - | - | - | - |
| Spain | - | 55 | 95 | 86 | 222 | 283 | 2217 | 860 | 1925 | - |
| Sweden | - | - | - | - | - | - | - | - | - | - |
| UK | 233 | 185 | 103 | 148 | 194 | 328 | 187 | 259 | 221 | 179 |
| Subarea VI | 269 | 582 | 470 | 565 | 628 | 836 | 2772 | 1330 | 2437 | 394 |

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | - | - | - | - | - | - | - | - | - | - |
| Denmark | - | - | <0.5 | - | - | - | <0.5 | - | - | - |
| France | 76 | 31 | 21 | 39 | 34 | 64 | 29 | 14 | 21 | - |
| Germany | - | - | - | - | - | 3 | - | 1 | - | - |
| Ireland | 150 | 145 | 23 | 12 | 26 | 83 | 97 | 69 | 60 | 73 |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| Norway | 1 | - | - | - | - | - | 1 | 2 | - | 3 |
| Portugal | - | - | - | - | - | - | - | - | <0.5 | - |
| Spain | - | 4 | - | - | - | - | - | - | - | - |
| Sweden | - | - | - | - | - | - | - | - | - | - |
| UK | 192 | 189 | 203 | 273 | 276 | 354 | 210 | 162 | 147 | 136 |
| Subarea VI | 419 | 369 | 247 | 324 | 336 | 504 | 337 | 248 | 228 | 212 |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| Denmark | - | - | - | - | - | - | - | - | - | - | - |
| France | 11 | 8 | 9 | 3 | 2 | 23 | 3 | 10 | 8 | 6 | 4 |
| Germany | 2 | - | - | - | - | - | - | - | - | - | - |
| Ireland | 62 | 108 | 26 | 88 | 68 | 28 | 25 | 21 | 21 | 5 | 34 |
| Netherlands | - | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | 1 | 1 | - | - | 6 | 1 | - | <0.5 |
| Portugal | - | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | 4 | - | - | - | - |
| Sweden | - | - | - | - | - | - | - | - | - | - | - |
| UK | 116 | 101 | 96 | 111 | 65 | 16 | 5 | 21 | 23 | 25 | 39 |
| Subarea VI | 191 | 217 | 131 | 203 | 136 | 67 | 37 | 58 | 53 | 36 | 78 |

* provisional

## Table 9.2.2. Landings of pollock in Subarea VII as officially reported to ICES.

| | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 93 | 74 | 80 | 34 | 17 | 38 | 67 | 219 | 342 | 158 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | - | - | - |
| Germany | - | 2 | 10 | - | 4 | - | 1 | 6 | 17 | 32 |
| Ireland | - | - | - | - | - | - | - | - | - | - |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| UK | 375 | 380 | 336 | 252 | 365 | 247 | 155 | 367 | 233 | 251 |
| Subarea VII | 468 | 456 | 426 | 286 | 386 | 285 | 223 | 592 | 592 | 441 |

| | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 317 | 268 | 367 | 95 | 299 | 362 | 456 | 417 | 214 | 142 |
| Denmark | - | - | - | - | - | - | - | - | - | - |
| France | - | - | - | - | - | - | - | - | - | - |
| Germany | - | - | 1 | - | - | - | - | - | - | - |
| Ireland | - | 360 | 369 | 411 | 342 | 335 | 438 | 474 | 508 | 794 |
| Netherlands | - | - | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| UK | 267 | 210 | 170 | 176 | 194 | 231 | 175 | 202 | 167 | 161 |
| Subarea VII | 584 | 838 | 907 | 682 | 835 | 928 | 1069 | 1093 | 889 | 1097 |

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 165 | 114 | 142 | 89 | 299 | 295 | 339 | 157 | 186 | 151 |
| Denmark | - | - | - | - | - | - | - | 1 | 21 | 18 |
| France | - | - | - | - | - | - | - | 3569 | 5496 | 5119 |
| Germany | 1 | - | - | - | - | - | - | - | 14 | 76 |
| Ireland | 724 | 673 | 1073 | - | - | - | - | - | - | - |
| Netherlands | - | - | - | 3 | 13 | 17 | 4 | 1 | 8 | 1 |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Spain | - | - | - | - | - | - | - | - | - | - |
| UK | 120 | 116 | 123 | 127 | 223 | 290 | 421 | 465 | 515 | 696 |
| Subarea VII | 1010 | 903 | 1338 | 219 | 535 | 602 | 764 | 4193 | 6240 | 6061 |

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 237 | 244 | 154 | 167 | 207 | 269 | 241 | 149 | 191 | 145 |
| Denmark | 7 | - | - | - | - | - | - | - | - | - |
| France | 5242 | 5814 | 4253 | 6214 | 3927 | 3741 | 4574 | 5213 | 5211 | 3893 |
| Germany | - | - | - | - | - | - | - | - | - | - |
| Ireland | - | - | - | - | - | - | 1335 | 848 | 1066 | 994 |
| Netherlands | 1 | 3 | - | - | - | - | - | - | - | - |
| Norway | - | - | - | - | - | - | - | - | - | - |
| Spain | 1 | 23 | 32 | 26 | 486 | 20 | 17 | 19 | 22 | 18 |
| UK | 769 | 780 | 1022 | 1045 | 1100 | 1022 | 1795 | 2010 | 1740 | 1487 |
| Subarea VII | 6257 | 6864 | 5461 | 7452 | 5720 | 5052 | 7962 | 8239 | 8230 | 6537 |

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 133 | 76 | 62 | 55 | 94 | 88 | 94 | 99 | 92 | 86 |
| Denmark | - | - | - | - | - | 2 | - | - | - | - |
| France | 4831 | 3211 | 2849 | 2325 | 2621 | 2315 | 2684 | 2443 | 2375 | - |
| Germany | - | - | - | - | - | - | - | - | - | - |
| Ireland | 1066 | 1045 | 1014 | 1137 | 921 | 1107 | 1190 | 984 | 886 | 976 |
| Netherlands | - | - | - | - | - | - | 6 | 4 | 1 | - |
| Norway | - | - | - | - | - | - | - | <0.5 | - | 3 |
| Spain | 26 | 22 | 19 | 7 | 8 | 4 | 5 | 7 | 11 | 19 |
| UK | 1914 | 1962 | 1889 | 2135 | 2391 | 2168 | 2519 | 2540 | 2347 | 1703 |
| Subarea VII | 7970 | 6316 | 5833 | 5659 | 6035 | 5684 | 6498 | 6077 | 5712 | 2787 |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belgium | 71 | 100 | 117 | 113 | 104 | 98 | 79 | 91 | 76 | 42 | 35 |
| Denmark | - | - | - | - | - | - | - | - | - | - | - |
| France | 2422 | 2515 | 2481 | 2284 | 1914 | 2198 | 2213 | 1970 | 1579 | 1641 | 1709 |
| Germany | - | - | - | - | - | - | - | - | - | - | - |
| Ireland | 1069 | 1274 | 1308 | 1151 | 1049 | 728 | 809 | 782 | 738 | 828 | 935 |
| Netherlands | - | - | - | - | 1 | 1 | 1 | 3 | 1 | 4 | 2 |
| Norway | - | - | - | - | - | - | - | - | - | - | - |
| Spain | 5 | 9 | 17 | 12 | 13 | 16 | 28 | 1 | 14 | 3 | - |
| UK | 1810 | 1987 | 1999 | 1788 | 1705 | 1684 | 1531 | 1764 | 1453 | 1545 | 1384 |
| Subarea VII | 5377 | 5885 | 5922 | 5348 | 4786 | 4725 | 4661 | 4611 | 3861 | 4063 | 4065 |

* provisional

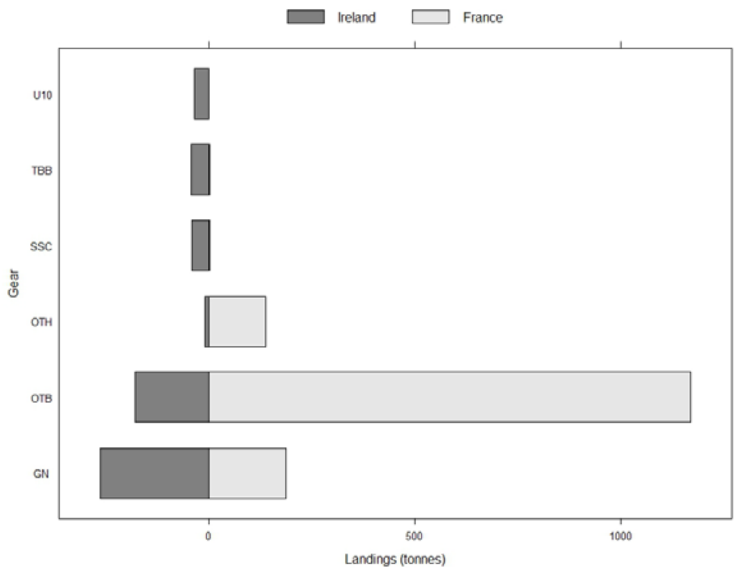



**Figure 9.2.1. Pollock in the Celtic Seas. Catches per gear over the period 2003–2010 for Ireland and France.**

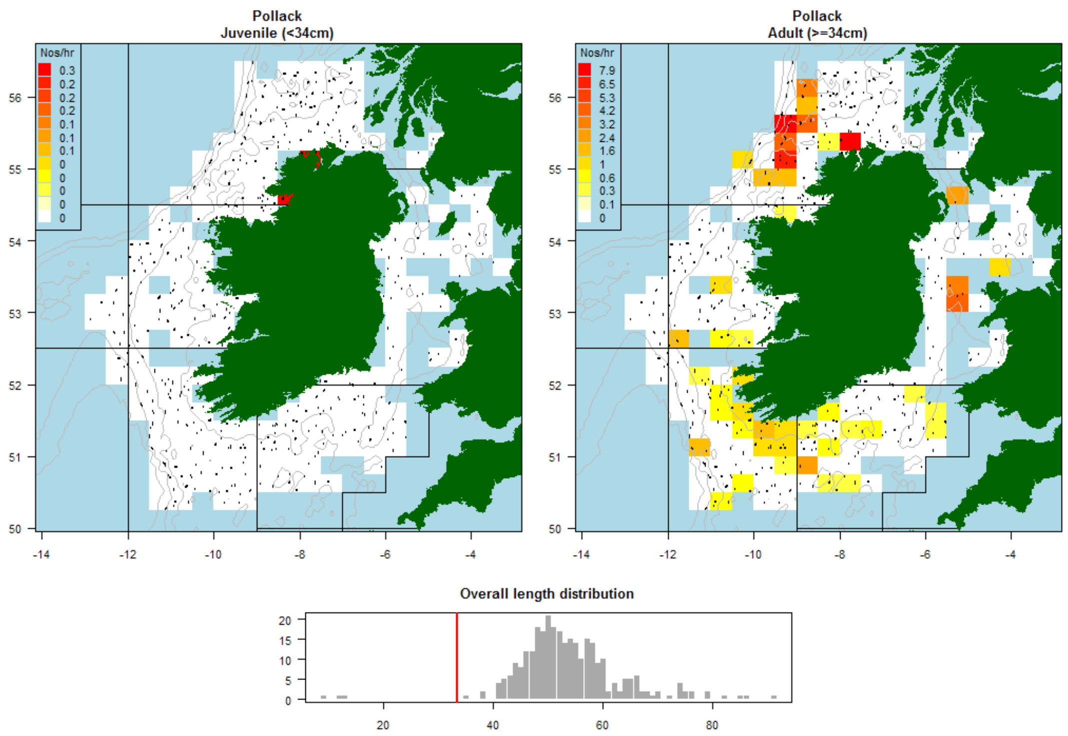



**Figure 9.2.2. Pollock in the Celtic Seas. Distribution of catches and length distribution profile from IGFS-WIBTS-Q4.**

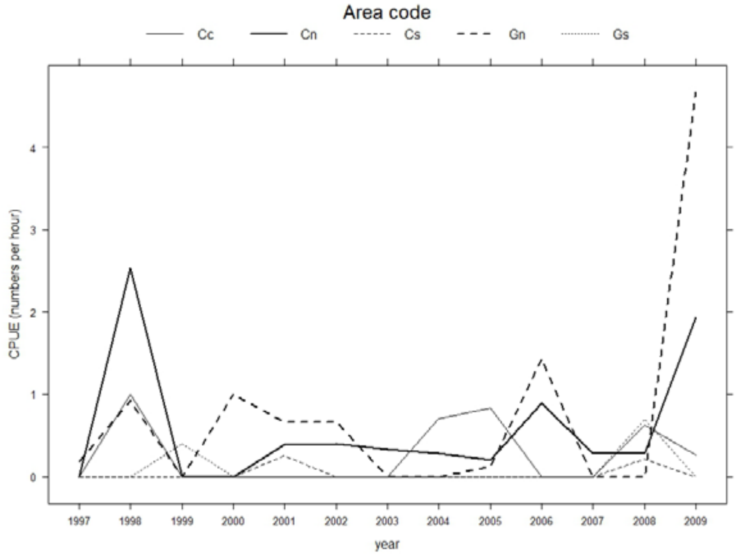



**Figure 9.2.3. Pollock in the Celtic Seas. Abundance index from the EVHO-WIBTS-Q4 survey.**

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# Annex 2: Stock Annexes

## Stock Annex 3.2: Cod VIa

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock: | West of Scotland Cod (Division VIa) |
| Working Group: | Celtic Seas Ecoregion |
| Last updated: | 19 May 2011 |

### A. General

#### A.1. Stock definition

Cod occur mainly in the central and northern areas of Division VIa. Young adult cod are distributed throughout the waters to the west of Scotland, but mainly occur in offshore areas where they can occasionally be found in large shoals. Tagging experiments have shown that in late summer and early autumn there is a movement of cod from west of the Hebrides to the north-coast areas. There is a return migration in the late winter and early spring. There is only a very limited movement of adult fish between the West Coast and the North Sea.

Recent surveys of spawning fish distribution in ICES area VIa (West of Scotland) suggested the persistence of the main spawning concentrations identified over 50 years ago by egg surveys. From 383 cod tagged during the spawning season and recaptured during successive spawning seasons >90% were recaptured within 80 km of coastal release sites, such as the Clyde, Moray Firth and the Minch. Cod released at these coastal spawning grounds also tended to remain in these areas during the summer feeding season implying that they belonged to resident spawning groups, (Wright *et al*., 2006).

#### A.2. Fishery

The minimum landing size of cod in the human consumption fishery in this area is 35 cm.

The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and skate *sp*.. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend. Cod is believed to be no longer targeted in any fisheries now operating in ICES division VIa. Cod are a bycatch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size than the 120 mm mandatory for cod targeted fisheries, but landings of cod are restricted through bycatch regulations.

#### 2000 onwards

Emergency measures were introduced in 2001 to allow the maximum number of cod to spawn (see emergency measures below). Council Regulation No 423\2004 introduced a cod recovery plan affecting Division VIa. The measures only took effect, however east of a line defined in Council Regulation No 51\2006 known as the west of Scotland management line (see Figure A9.1). For 2009 a new line was defined in the cod long-term management plan Council Regulation No 1342\2008 (Figure A9.1).

Vessels operating west of this line and conforming to criteria within the plan can claim extra fishing effort up to specified limits but are now otherwise still under the jurisdiction of the management plan.

From mid September 2003 to mid July 2004 the Irish trawl fishery off Greencastle, Co. Donegal that traditionally targets juvenile cod was closed. The closure was instigated by the local fishing industry to allow an assessment of seasonal closure as a potential management measure. The fishing industry again called for and received statutory instruments closing the fishery from November 2004 until mid February 2005 and from mid November until 14th February 2006. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003 to 2005. The closure was not continued after 2005 because all vessels that fished in the area had been decommissioned. More generally, the days at sea limitations associated with the cod recovery plan and this seasonal closure has lead some of the Irish demersal fleet to switch effort away from VIa.

At the end of 2005 the 'Registration of Buyers and Sellers' regulation (The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005: Statutory Instrument 2005 No. 1605 & The Registration of Fish Sellers and Buyers and Designation of Auction Sites (Scotland) Amendment Regulations 2005: Scottish Statutory Instrument 2005 No. 438) was introduced in the UK and became fully operational from 1st January 2006. This implemented an EU directive as did the Irish 'Sales Notes' legislation. In summary these require that fish processed and sold in the UK and Ireland can be traced through the supply chain.

Because of restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition the probability of misreporting and under reporting in the past is considered to have been high. From 2006 under reporting is expected to have reduced to low or negligible levels due to the 'Buyers and Sellers' and 'Sales Notes' acts.

#### Technical measures

Technical measures regarding demersal fishing gear are laid out in Commission regulation (EC) 850/98 and were amended by regulation (EC) 2056/2001 specifically aimed at aiding cod recovery. Under regulation (EC) 2056/2001 the minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) changed from 100 mm to 120 mm from the start of 2002, with a one-year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002. The increase in minimum mesh size from 100 to 120 mm in 2001/2002 partly caused a shift to *Nephrops* targeted fisheries using 80 mm mesh sizes.

Since mid-2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth. $WGFTFB_{2006}$ report that this has greatly reduced effort at depths greater than 200 m in VIa. The measure was aimed to protect monkfish and deep-water shark and it is unclear what effect it will have on cod.

#### Emergency measures, area closures and Effort limitation

Emergency measures were enacted in 2001, consisting of area closures from 6 March–30 April, in an attempt to maximize cod egg production. These measures were retained into 2003 and 2004.

From mid September 2003 to mid July 2004 the Irish trawl fishery off Greencastle, Co. Donegal that traditionally targets juvenile cod was closed (Irish Statutory Instrument (SI) No. 431 of 2003). In December 2003 the closed area was extended along its eastern edge by amendment to the Statutory Instrument (SI No. 664 of 2003). A new Statutory Instrument (SI No. 670 of 2004) reinstated the closed area from 1st November 2004 until 14th February 2005. The closure was not instigated after 2005. This was because all vessels that fished in the area had been decommissioned.

The following area closures were in effect in 2008:

1 ) A closure in the Clyde for spawning cod from 14th February to 30th April. This closure has been operating since 2001 and was last revised by The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002.
2 ) A closure introduced in 2004 by Council Regulation No. EC 2287\2003, known as the 'windsock'.

The closed areas that remain in force were reviewed by the STECF group on evaluation of closed area schemes (STECF-SGMOS-07–03).

Effort reductions for much of the international fleet to 16 days at sea per month have been imposed since February 2003 (EU 2003\0090). Initially days at sea allowances were defined by calendar month. From 2006 the limit was defined on an annual basis. The maximum number of days a fishing vessel may be absent from port to the West of Scotland varies for particular gears and the allocations since 2003 are given below:

| GEAR | MAXIMUM DAYS ALLOWED | | | | | |
|---|---|---|---|---|---|---|
| | 2003: | 2004: | 2005: | 2006: | 2007: | 2008: |
| | Monthly limit | | | Annual limit | | |
| Demersal trawls, seines or similar towed gears of mesh size ≥ 100 mm except beam trawls1; | 9 | 10 | 9 | | | |
| Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 99 mm except beam trawls1; | 25 | 22 | 21 | | | |
| Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls; | | | | 91 | 85 | 70 |
| Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls; | | | | 91 | 84 | 69 |
| Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls; | | | | 227 | 227 | 227 |
| Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls; | | | | 227 | 227 | 204 |
| Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls. | 23 | 20 | 19 | 228 | 228 | 228 |

[1] **Replaced by new mesh size ranges.**

For 2009 effort limits were changed to be on the basis of a kWdays effort pot assigned per nation per fleet effort category. The baselines assigned in 2009 were based on track record per fleet effort category averaged over 2004-2006 or 2005-2007 depending on national preference. The following table lists the new fleet effort categories and shows how they map to the previous gear groups.

| Gear group (2006–2008) | Gear group 2009 |
|---|---|
| Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls; | TR1 |
| Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls; | TR1 |
| Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls; | TR2 |
| Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls; | TR2 |
| Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls. | TR3 |

The documents listing these days at sea limitations are:

| Year of application | Regulation |
|---|---|
| 2003 | (EC) No 2341/2002–Annex XVII |
| 2004 | (EC) No 2287/2003–Annex V |
| 2005 | (EC) No 27/2005–Annex IVa |
| 2006 | (EC) No 51/2006–Annex IIa |
| 2007 | (EC) No 41/2007–Annex IIa |
| 2008 | (EC) No 40/2008–Annex IIa |
| 2009 | (EC) No 43/2009–Annex IIa |
| 2010 | (EU) No 53/2010-Annex IIA |
| 2011 | (EU) No 57/2011-Annex IIA |

A Commission Decision (C (2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. UK vessels were granted four additional days per month (based on evidence of decommissioning programmes). An additional two days was granted to demersal trawls, seines or similar towed gears (mesh ≥100 mm, except beam trawls) to compensate for steaming time between home ports and fishing grounds and for the adjustment to the newly installed effort management scheme.

Subsequently it has been possible for vessels to qualify for extra days at sea if special conditions (specified in the Annex) are met, (see relevant regulation Annex for details).

The new effort regulations provided an incentive for some vessels previously using >100 mesh in otter trawls to switch to smaller mesh gears to take advantage of the larger numbers of days-at-sea available. This would also require these vessels to be targeting *Nephrops* or anglerfish, megrim and whiting with various catch and bycatch composition limits after EC Regulation No 850/98 Annex I (with additional measures in Reg (EC) 2056/2001).

### Management plan

Council regulation (EC) No 423\2004 set out a multi-annual recovery plan that constrains effort to specified harvest control rules. For stocks above $\mathbf{B}_{lim}$, the harvest control rule (HCR) requires:

1 ) setting a TAC that achieves a 30% increase in the SSB from one year to the next,

2 ) limiting annual changes in TAC to ± 15% (except in the first year of application), and,

3 ) a rate of fishing mortality that does not exceed $\mathbf{F}_{pa}$.

For stocks below $\mathbf{B}_{lim}$ the Regulation specifies that:

1 ) conditions 1–3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{lim}$ in the year of application,

2 ) a TAC will be set lower than that calculated under conditions 1–3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{lim}$ in the year of application.

For 2009 Council regulation (EC) No 423\2004 was repealed and replaced by Council regulation (EC) No 1342\2008. The objective of the plan is to ensure the sustainable exploitation of the cod stock on the basis of maximum sustainable yield while maintaining a fishing mortality of 0.4.

For stocks above $B_{pa}$, but where mortality is above 0.4 the harvest control rule (HCR) requires:

1 ) setting a TAC that achieves a 10% decrease in the fishing mortality in the year of application of the TAC compared to the previous year, or a TAC that achieves a fishing mortality of 0.4, whichever is the higher.

*2 )* limiting annual changes in TAC to ± 20%.

For stocks above $B_{lim}$, the HCR requires:

3 ) setting a TAC that achieves a 15% decrease in the fishing mortality in the year of application of the TAC compared to the previous year, or a TAC that achieves a fishing mortality of 0.4, whichever is the higher.

*4 )* limiting annual changes in TAC to ± 20%.

For stocks below $B_{lim}$ the Regulation requires:

5 ) setting a TAC that achieves a 25% decrease in the fishing mortality in the year of application of the TAC compared to the previous year

6 ) limiting annual changes in TAC to ± 20%.

In addition the plan states

> That if lack of sufficiently accurate and representative information does not allow a TAC affecting fishing mortality to be set with confidence then
>
> If advice is for catches of cod to be reduced to the lowest possible level, the TAC shall be reduced by 25%,

In all other cases the TAC shall be reduced by 15% (unless STACF advises this is not appropriate)

TACs are to be set-net of discards and fish corresponding to other sources of cod mortality caused by fishing.

Initial baseline values for effort shall be set for effort groups defined by the Council and then annual effort and cod catch calculated for those effort groups. For effort groups where the percentage cumulative catch is ≥ 20% of that for all fleets, maximum allowable effort shall be adjusted by the same amount as the TAC.

If STECF advises cod stocks are failing to recover properly the EU Council will set a TAC and maximum allowable effort lower than those derived from the HCR.

#### Cod avoidance measures

In 2008, Scotland introduced a voluntary programme known as "Conservation Credits", which involved seasonal closures, real-time closures (RTCs) and various selective gear options. This was designed to reduce mortality and discarding of cod. The scheme was incentivised by rewarding participating skippers with additional days at sea. The real-time closures system discourages vessels from operating in areas of high cod abundance. The numbers of RTCs implemented throughout the cod recovery plan area were 15, 144 and 165 in 2008, 2009 and 2010 respectively; most of these were located in the North Sea. The number of RTCs west of Scotland was four in 2008, 20 in 2009 and 19 in 2010, representing 27, 14 and 12% of total RTCs in each year. The closures (mandatory in 2009 and 2010) are determined by landings per unit of effort, based on fine scale VMS data and daily logbook records and also by on-board inspections. The small number of RTCs west of Scotland results from few instances of high lpue in the area.

Based on new in-year information on cod movement from tagging the dimensions of the RTCs were increased by four times from July 2010. The use of more species and size selective gears (some trialled by the Marine Laboratory in Aberdeen) formed a further series of options within the scheme. These included the 'Orkney trawl, the use of nets with 130 mm codends and larger meshes in the square meshed panels of *Nephrops* trawls. Out-turn results for 2009 were reviewed by STECF (2010) who concluded that the measures included in Conservation Credits scheme were in the right direction but needed to be strengthened.

#### Decommissioning schemes

Between 2001 and 2003 165 Scottish vessels were decommissioned from the overall Scottish fleet (all areas), representing a 34% reduction in number of vessels compared to 1999. The Scottish Government estimates this represented a 30% reduction in effort by trawls of over 100 mm mesh. It is not known what proportion of these reductions came from Area VIa.

### A.3. Ecosystem aspects

#### Geographic location and timing of spawning

Spawning has occurred throughout much of the region in depths <200 m. However, a number of spawning concentrations can be identified from egg surveys in the 1950s, 1992 and from recent surveys of spawning adult distribution. The most commercially important of these range from the Butt of Lewis to Papa Bank. There are also important spawning areas in the Clyde and off Mull. The relative contribution of these areas is not known. Based on recent evidence there are no longer any significant spawning areas in the Minch. Peak spawning appears to be in March, based on egg surveys (Raitt, 1967). Recent sampling suggests that this is still the case.

The main concentrations of juveniles are now found in coastal waters.

#### Fecundity

Fecundity data are available from West, 1970 and Yoneda and Wright, 2004. Potential fecundity for a given length is higher than in the northern North Sea but lower than off the Scottish east coast (see Yoneda and Wright, 2004). There was no significant difference in the potential fecundity-length relationship for cod between 1970 (West, 1970) and 2002–2003 (Yoneda and Wright, 2004).

## B. Data

### B.1. Commercial catch

#### *B1.1. Landings*

The following table gives the source of landings data for West of Scotland cod:

| | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (catch-in-weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | Matprop (proportion mature-by-age) | Length composition in catch |
| UK(NI) | X | | | | |
| UK(E&W) | X | | | | |
| UK(Scotland) | X | X | X | X | X |
| Ireland | X | X | X | | X |
| France | X | | | | |
| Norway | X | | | | |

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in the requested format to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (Scotland), UK (E/W), UK (NI), France and Ireland .The quarterly estimates of landings-at-age by UK (Scotland) and Ireland are raised to include landings by France, UK (E/W), UK (NI) and Norway (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\cod-iris\input data\xsa_ica**

#### *B1.2. Discards*

EU countries are now required under the EU Data Collection regulation to collect data on discards of cod and other species. To date estimates of discards are available only from UK (Scotland) and Ireland. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES. A table of data made available by year is given below.

| Country | 1978–2003 | 2004–2005 | 2006–2009 | 2010 |
|---|---|---|---|---|
| UK(Scotland) | X | X | X | X |
| Ireland | | X | | X |

The quantity, length and age of cod discarded by Scottish *Nephrops* trawlers are collected during observer trips on board commercial vessels. Cod discarded by boats using other gears (heavy trawl, seine, light trawl and pair trawl) are also collected by Scotland. Cod discarded by otter board trawl and otter board/twin rig gears are collected by Ireland.

### B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years. There are no direct estimates of M.

Proportion mature-at-age is currently assumed constant over the full time-series.

| Age | 1 | 2 | 3 | 4+ |
|---|---|---|---|---|
| Proportion mature-at-age | 0.0 | 0.52 | 0.86 | 1.0 |

### B.3. Surveys

Four research vessel survey-series for cod in VIa have been available to the Working Group since 2005. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2008.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. Ages are reported from 0 to the maximum obtained. The ages reported to ICES are restricted to 1–7. Sex/Maturity-Sex and Maturity (ICES 4-stage scale)-are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced, (by the IRGFS). There were also problems regarding consistency of survey methodology.

- Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2007.

The Scottish quarter four survey was presented to the WG for the first time in 2005. To date it has not been accepted as suitable for inclusion in an assessment.

- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2007.

This survey uses the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomized stations. Effort is recorded in terms of minutes towed.

For surveys existing at the time survey descriptions are given in Appendices 1 and 2 of the report of the 1999 meeting of the Northern shelf working group (ICES CM 2000/ACFM:1). Up to 2008 the WG could not use the IreGFS, IRGFS or ScoGFSQ4 surveys in survey based analyses using the available software, due to insufficient number of ages consistently tracked by these surveys, (both the IreGFS and ScoGFSQ4 surveys track ages 1 and 2 well but not other ages). Therefore, all subsequent analyses were carried out using only the ScoGFSQ1 series.

### B.4. Commercial cpue

The commercial cpue data available consists of the following:

- Scottish seiners (ScoSEI): ages 1–6, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 1–6, years 1978–2005.
- Irish otter trawlers (IreOTR): ages 1–7, years 1995–2005.

Table A9.1 summarize commercial effort and landings-per-unit effort. No commercial cpue data have been used in the final assessment presented by the WG during any meeting since 1999, although the Scottish series were previously used in exploratory and comparative analyses. Irish otter trawl cpue data (IreOTR) were presented for the first time at the 2001 WG meeting. Updated series have been presented to subsequent meetings. Given the current concerns about misreporting of catch and effort, this series has not been considered further as a tuning fleet. No cpue data has been presented for years after 2005.

### B.5. Other relevant data

None.

## C. Historical stock development

Models used: XSA (up to 2001 WG); TSA (2002 and 2003 WG); TSA and XSA (2004 WG); SURBA (2005 WG). SURBA and TSA (2006 and 2007 WG); TSA (2008 WG).

Software used: Lowestoft VPA suite; Marine Lab Aberdeen TSA and SURBA software.

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1978–last data year | 1–7+ | Yes |
| Canum | Catch-at-age in numbers | 1978–last data year | 1–7+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1978–last data year | 1–7+ | Yes |
| West | Weight-at-age of the stock at spawning time. | 1978–last data year | 0–7+ | Yes: |
| Mprop | Proportion of natural mortality before spawning | 1978–last data year | 1–7+ | No – set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1978–last data year | 1–7+ | No – set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1978–last data year | 1–7+ | No – the same ogive for all years |
| Natmor | Natural mortality | 1978–last data year | 1–7+ | No – set to 0.2 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range | Usage |
|---|---|---|---|---|
| Research Vessel Survey | | | | |
| Tuning fleet 1 | ScoGFS-Q1 | 1985–last data year | 1–7 | Used since ???? |
| Tuning fleet 2 | IreGFS-Q4 | 1993–2002 | 0–3 | Not used |
| Tuning fleet 3 | ScoGFS-Q4 | 1996–last data year | 0–8 | Not used |
| Tuning fleet 4 | IRGFS – Q4 | 2003–last data year | 0–3 | Not used |
| Commercial cpue data | | | | |
| Tuning fleet 5 | Scottish Seiners | 1978–last data year | 1–6 | Not used |
| Tuning fleet 6 | Scottish Light Trawlers | 1978–last data year | 1–6 | Not used |
| Tuning fleet 7 | Irish Otter Trawlers | 1995–last data year | 1–7 | Not used |

**XSA**

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages

S.E. of the mean to which the estimate are shrunk = 2.00

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

### TSA

The current set-up of TSA was adopted at $WGNSDS_{2006}$ and reviewed and confirmed at $WGNSDS_{2007}$. The main issues are summarized in the following bullet points while long standing parameter values are given in a text table.

- No persistent trend in survey catchability is included as there is no *a priori* reason to suspect a trend in survey catchability and, without landings data to contrast against, there is no divergence between catch and survey data to measure.
- At $WGNSDS_{2007}$ a TSA run was also performed with catch data excluded for the years 1995-2005 but 2006 catch data included, (i.e. assuming 2006 commercial data to be unbiased). The mean F estimate reduced sharply for the terminal year but the WG concluded that such an approach introduced an inconsistency in the mortality time-series. It was considered the mortality estimate reverted from an estimate of mortality over and above M to one of fishing mortality. The WG also considered that the terminal year estimate combined with the current fixed value of natural mortality would be an underestimate of overall mortality.
- The mean fishing mortality reference points for VIa cod were determined under the assumption of M=0.2. The values of mean F from the current assessments are estimates of mortality over and above M i.e. mortality from fishing plus non fishing mortality which cannot be encompassed within the standard value for natural mortality. For management purposes this combined mortality would still need to fall below the level of $F_{lim}$, as higher levels of mortality over and above M are considered to have led to stock decline in the early 1980s.
- Using TSA run on a reduced set of catch data would allow conventional forecasts based on absolute assessment results (forecasts using relative assessment results were considered of limited use in a previous year) while also producing assessment results that matched (to the greatest extent possible) the SSB trends found from an agreed best SURBA run and which accounted (to a greater or lesser extent) for unallocated mortality.

TSA parameter settings for analyses conducted at 2004, 2005, 2006, 2007 and 2008 WG.

| Parameter | Setting | Justification |
|---|---|---|
| Age of full selection. | am = 4 | Based on inspection of previous XSA runs. |
| Multipliers on variance matrices of measurements. | Blandings(a) = 2 for ages 6, 7+<br>Bsurvey(a) = 2 for age 1, 5, 6 | Allows extra measurement variability for poorly sampled ages. |

| Parameter | Setting | Justification |
|---|---|---|
| Multipliers on variances for fishing mortality estimates. | H(1) = 4 | Allows for more variable fishing mortalities for age 1 fish. |
| Downweighting of particular data points (implemented by multiplying the relevant q by 9) | Landings: age 2 in 1981 and 1987, age 7 in 1989.<br>Discards: age 1 in 1985 and 1992, age 2 in 1998.<br>Survey: age 1 in 2000, age 2 in 1993, age 6 in 1995. Ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins). Age 3 in 2008 (large haul near 4W line).<br>Age 2 in 2011. | Large values indicated by exploratory prediction error plots. |
| Discards | Discards are allowed to evolve over time constrained by a trend. Ages 1 and 2 are modelled independently. | |
| Recruitment. | Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean η1 S exp(−η2 S), where S is the spawning-stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed. | |
| Large year classes. | The 1986 year class was large, and recruitment-at-age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, N(1, 1980) is taken to be normally distributed with mean 5η1 S exp(−η2 S). The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966-1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant. | |

### SURBA

The model settings for the preferred SURBA run in 2005, 2006 and 2007 were:

| | Year range: | 1985–2005 |
|---|---|---|
| 2005 WG | Age range: | 1–6 |
| | Catchability at-age: | 0.0256, 0.1035, 0.4711, 0.7493, 1.0, 0.6685 |
| | Age weighting: | 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, for all ages in all years |
| | Lambda: | 2.0 |
| | Cohort weighting: | Not applied |
| 2006 WG | Year range: | 1985–2006 |
| | Age range: | 1–6 |
| | Catchability at-age: | 0.0304, 0.1045, 0.2092, 0.4443, 0.7217, 1 |
| | Age weighting: | 1.0, 1.0, 0.0, 0.0, 0.0, 1.0 for 2001<br>1.0, 1.0, 1.0, 1.0, 1.0, 1.0 for all other years |
| | Lambda: | 2.0 |
| | Cohort weighting: | Not applied |

| | | |
|---|---|---|
| | **Year range:** | **1985–2005** |
| | Age range: | 1–6 |
| | Catchability at-age: | 0.0256, 0.1035, 0.4711, 0.7493, 1.0, 0.6685 |
| | **Year range:** | **1985–2007** |
| | Age range: | 1–6 |
| | Catchability at-age: | 0.0226, 0.1036, 0.2000, 0.4167, 0.6885, 1 |
| 2007 WG | Age weighting: | 1.0, 1.0, 0.0, 0.0, 0.0, 1.0 for 2001<br>1.0, 1.0, 1.0, 1.0, 1.0, 1.0 for all other years |
| | Lambda: | 2.0 |
| | Cohort weighting: | Not applied |

Values (but not method of determination) of catchabilities-at-age differed between WGs. Catchabilities-at-age were derived by comparing raw survey indices with numbers-at-age estimates from a TSA run. These ratios were then standardized relative to a given reference age. The justification is that even if there are concerns over misreporting of commercial data, so long as the relative catch numbers between ages remain constant the catchabilities generated using a catch-at-age analysis will be valid. A TSA run not allowing a trend in survey catchability and using all years of available catch data is chosen to provide the TSA output.

### D. Short-term projection

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

The following configuration was agreed at $\mathrm{WGNSDS}_{2008}$

Initial stock size: Taken from XSA or TSA for age 1 and older.

Maturity: The same ogive as in the assessment is used for all years.

F and M before spawning: Set to 0 for all ages in all years.

- Natural mortality: Set to 0.2 for all ages in all years.

Weight-at-age in the stock: Average stock weights for last three years. Assumed equal to the catch weight-at-age, (adopted because mean weights-at-age have been relatively stable over the recent past). CVs are calculated from the standard errors on weights-at-age.

Weight-at-age in the catch: Average weight of the three last years.

Exploitation pattern: Average of the three last years. Not partitioned to give landings and discard F as the WG consider the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. Therefore that it was not possible to determine the proportion of the mortality caused by fishing.

Intermediate year assumptions: *Status quo* Z-0.2 (0.2 being the current value assumed for natural mortality at all ages).

Stock recruitment model used: None, recruitment in the intermediate year (terminal year year class at age 1) is taken from the TSA assessment, (the value is based largely on the ScoGFSQ1 survey datum from the terminal year). For the TAC year and following year the short-term (10 years to year before terminal year) geometric mean recruitment-at-age 1 is used.

In 2006–2011 short-term projections were made but it was considered little confidence could be placed in the short-term projections. This was because concerns over the reliability of the commercial catch-at-age data lead to use of a catch-at-age analysis but with landings and discards data removed from 1995 onward. The WG considers the mortality outputs from TSA not to represent F at age but rather estimated total mortality that cannot be accounted for by the standard value used for natural mortality. These mortality values are currently labelled 'Z-0.2' (0.2 being the current value assumed for natural mortality-at-all-ages). Consideration of the diagnostics lead to the conclusion that mean Z-0.2 is estimated with considerable uncertainty (these estimates are based on the age structure indicated by the survey series, which are known to be noisy).

In 2005 projections were attempted using outputs from a survey based assessment and an ad-hoc spreadsheet. Similar concerns over adequate estimation of mortality also apply in this case.

### E. Medium-term projections

Medium-term projections have been carried out in previous years using the Aberdeen software suite.

Medium-term predictions have not been made at any of the 2005 to 2008 working groups on the grounds that recruitment could not be assumed to conform to historical patterns given the stock was at a historic low.

### F. Long-term projections/Yield and biomass-per-recruit

Model used: yield and biomass per recruit over a range of F values.

Software used: MFDP

- Selectivity pattern: mean F array from last three years of assessment (to reflect recent selection patterns).
- Stock and catch weights-at-age: mean of last three years.
- Maturity: Fixed maturity ogive as used in assessment.

Long-term projections have not been performed since 2008 because it is not considered appropriate to do so when the assessment is conducted as an update assessment.

Yield and biomass per recruit are taken from ICES standard graphs.

## G. Biological reference points

| Reference Point | Technical Basis |
|---|---|
| $F_{MSY}$ = 0.19 | $B_{pa}$ |
| $B_{trigger}$ = 22 000 t | Provisional proxy by analogy with North Sea cod Fmax. Fishing mortalities in the range 0.17–0.33 are consistent with $F_{MSY}$ |
| $B_{pa}$ = 22 000 t | Previously set at 25 000 t, which was considered a level at which good recruitment is probable. Since reduced to 22 000 t due to an extended period of stock decline |
| $B_{lim}$ = 14 000 t | Smoothed estimate of $B_{loss}$, (as estimated in 1998) |
| $F_{pa}$ = 0.6 | Consistent with $B_{pa}$. |
| $F_{lim}$ = 0.8 | F values above 0.8 led to stock decline in the early 1980s |

#### MSY Explorations

The same input data files as used for the short-term forecast were used. An alternative run using ten year means for stock weights-at-age and mortality-at-age showed there to be little sensitivity to the averaging period used. Figure A9.5 shows the three stock–recruit relationships fitted by the package; Ricker, Beverton–Holt and smooth hockey-stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships all resamples allowed $F_{MSY}$ and $F_{crash}$ values to be determined. As such, there was no basis to reject any of the recruitment models as unsuitable for this stock. For each of the stock recruit relationships (SRR) Figures a9.6 to a9.8 show box plots of $F_{MSY}$ and $F_{crash}$ together with the values of $F_{pa}$ and $F_{lim}$. For the Ricker and Beverton–Holt SRR the estimated value of $F_{crash}$ was very close to $F_{lim}$. For the smooth hockey-stick SRR $F_{crash}$ was estimated between $F_{lim}$ and $F_{pa}$. The value of $F_{MSY}$ was well defined and considerably lower than $F_{pa}$ for all three SRR. The level of removals possible at the estimated $F_{MSY}$ was poorly defined however. Circles showing the data points show values of Z-0.2 repeatedly in excess of the upper percentile for $F_{crash}$. As expected removals and SSB have declined such that values for both were inside confidence limits for these metrics at the estimated Z-0.2 mortality rates by 2010.

Figure a9.9 shows estimation of yield-per-recruit. $F_{max}$ was well defined for this stock. Comparison of $F_{max}$ to $F_{MSY}$ estimated using the three SRRs (Figures a9.6–a9.8) shows $F_{MSY}$ estimated as lower than $F_{max}$ for the Beverton–Holt model, equal for the smooth hockey-stick and higher than $F_{max}$ in the Ricker model reflecting the downward slope of the stock–recruit relationship at higher SSBs.

In conclusion mortalities from removals in the range 0.17 to 0.33 were considered consistent with $F_{MSY}$.

## H. Other issues

Natural Mortality: A report by the Sea Mammal Research unit (SMRU, 2006) gives estimates of cod consumed by grey seals to the west of Scotland for two years, based on analysis of collected seal scats. The estimated values and their confidence limits are given in the following text table.

| Year | Total consumption (Tonnes) | 95% C.I. | Cod TSB from 2008 assessment (Tonnes) |
|---|---|---|---|
| 1985 | 5372 | 3023–8831 | 30 267.6 |
| 2002 | 7131 | 4128–9920 | 12 789.3 |

These values, although highly uncertain, suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for gadoid species in ICES Division VIa. A working document detailing approaches to quantify the level of mortality caused by seal predation and the results obtained was submitted to $WGNSDS_{2008}$, (Holmes, 2008).

## I. References

Raitt, D.F. S. 1967. Cod spawning in Scottish waters. Preliminary investigations. ICES C. M. 1967/F:29.

West, W. Q-B. 1970. The spawning biology and fecundity of cod in Scottish waters. PhD. thesis, Aberdeen University, Aberdeen.

Wright, P. J., Galley, E., Gibb, I. M. and Neat, F. C. 2006. Fidelity of adult cod to spawning grounds in Scottish waters. Fisheries Research, 77: 148–158.

Yoneda, M. and Wright, P. J. 2004. Temporal and Spatial variation in reproductive investment of Atlantic cod *Gadus morhua* in the northern North Sea and Scottish west coast. Marine Ecology Progress Series, 276: 237–248.

**Table A9.1. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.**

| ScoSEI | Scottish seiners | | | | | |
|---|---|---|---|---|---|---|
| 1978 | 2005 | | | | | |
| 1 | 1 | 0 | 1 | | | |
| 1 | 6 | | | | | |
| 33 617 | 743.00 | 224.48 | 64.14 | 41.83 | 13.01 | 3.72 |
| 38 465 | 120.91 | 128.90 | 197.32 | 25.17 | 19.13 | 5.03 |
| 38 640 | 403.38 | 223.25 | 75.45 | 37.21 | 13.44 | 4.13 |
| 37 208 | 26.53 | 473.12 | 129.81 | 42.39 | 7.95 | 0.88 |
| 36 689 | 405.78 | 139.18 | 137.35 | 31.99 | 14.11 | 3.76 |
| 38 080 | 1205.65 | 509.03 | 65.34 | 58.51 | 14.63 | 4.88 |
| 29 561 | 275.95 | 56.40 | 78.78 | 25.58 | 17.39 | 10.23 |
| 26 365 | 982.36 | 199.94 | 27.31 | 23.41 | 4.88 | 4.88 |
| 19 960 | 348.05 | 84.78 | 30.70 | 6.35 | 4.23 | 1.06 |
| 26 332 | 4461.36 | 552.51 | 48.68 | 67.56 | 18.88 | 4.97 |
| 21 383 | 63.84 | 451.06 | 41.87 | 4.98 | 3.99 | 1.00 |
| 39 350 | 560.31 | 138.71 | 152.45 | 31.07 | 6.74 | 4.16 |
| 23 235 | 99.96 | 566.35 | 31.11 | 60.19 | 11.87 | 2.06 |
| 25 787 | 364.64 | 132.65 | 164.98 | 16.25 | 28.93 | 8.39 |
| 20 273 | 1390.05 | 228.60 | 35.92 | 46.85 | 4.09 | 5.01 |
| 24 315 | 86.98 | 389.31 | 87.56 | 10.26 | 16.08 | 2.90 |
| 21 305 | 175.94 | 138.49 | 145.48 | 23.03 | 5.90 | 4.96 |
| 21 950 | 134.47 | 372.92 | 68.30 | 60.81 | 9.78 | 2.11 |
| 15 205 | 82.21 | 318.54 | 106.62 | 17.28 | 15.61 | 1.30 |
| 11 449 | 317.44 | 102.89 | 77.06 | 23.31 | 12.33 | 13.52 |
| 11 166 | 98.32 | 656.93 | 28.31 | 12.89 | 3.30 | 1.31 |
| 8638 | 40.64 | 60.26 | 58.57 | 2.03 | 1.08 | 0.74 |
| 6431 | 243.84 | 32.99 | 13.49 | 7.36 | 0.39 | 0.35 |
| 5893 | 7.48 | 101.54 | 4.62 | 0.80 | 1.05 | 0.07 |
| 3817 | 32.15 | 25.07 | 26.48 | 2.02 | 0.62 | 0.30 |
| 2370 | 8.76 | 31.65 | 4.56 | 2.22 | 0.07 | 0.01 |
| 1159 | 0.66 | 0.69 | 0.60 | 0.12 | 0.44 | 0.05 |
| 476 | 1.67 | 3.77 | 0.74 | 0.54 | 0.21 | 0.03 |

**Table A9.1. cont. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.**

| | Scottish light trawlers | | | | | |
|---|---|---|---|---|---|---|
| ScoLTR | | | | | | |
| 1978 | 2005 | | | | | |
| 1 | 1 | 0 | 1 | | | |
| 1 | 6 | | | | | |
| 127 387 | 2242.51 | 685.36 | 185.50 | 133.92 | 32.74 | 7.94 |
| 99 803 | 161.44 | 212.39 | 485.00 | 57.12 | 31.06 | 6.01 |
| 121 211 | 694.04 | 699.09 | 328.14 | 129.35 | 34.24 | 10.46 |
| 165 002 | 123.59 | 1588.52 | 524.05 | 183.42 | 31.06 | 3.88 |
| 135 280 | 1623.74 | 367.84 | 616.01 | 163.81 | 46.10 | 5.89 |
| 112 332 | 1634.45 | 1408.23 | 196.00 | 163.65 | 51.38 | 18.08 |
| 132 217 | 974.48 | 593.35 | 419.46 | 85.37 | 93.80 | 30.56 |
| 142 815 | 6421.55 | 1734.74 | 218.21 | 131.35 | 21.19 | 22.25 |
| 126 533 | 1403.22 | 376.19 | 384.35 | 67.13 | 30.32 | 3.25 |
| 131 720 | 23524.40 | 1058.11 | 143.60 | 116.68 | 27.92 | 12.96 |
| 158 191 | 319.66 | 2464.85 | 309.82 | 49.97 | 37.98 | 8.00 |
| 217 443 | 1795.80 | 291.27 | 989.06 | 200.39 | 46.89 | 19.53 |
| 142 502 | 195.62 | 1334.61 | 87.08 | 202.71 | 37.25 | 6.93 |
| 209 901 | 2081.88 | 815.93 | 534.85 | 38.68 | 97.23 | 30.51 |
| 189 288 | 2197.22 | 655.91 | 193.06 | 240.73 | 17.16 | 24.27 |
| 189 925 | 246.98 | 1274.46 | 301.98 | 46.14 | 80.17 | 10.51 |
| 174 879 | 348.87 | 458.79 | 463.67 | 88.90 | 16.55 | 22.76 |
| 175 631 | 488.40 | 839.26 | 188.99 | 168.65 | 21.32 | 4.31 |
| 214 159 | 133.75 | 790.18 | 355.22 | 79.78 | 83.08 | 9.88 |
| 179 605 | 819.38 | 371.40 | 394.35 | 109.46 | 18.88 | 18.82 |
| 142 457 | 181.66 | 1343.76 | 100.25 | 64.43 | 21.22 | 5.63 |
| 98 993 | 129.77 | 226.02 | 433.87 | 20.55 | 19.74 | 11.62 |
| 76 157 | 988.51 | 233.22 | 79.43 | 119.99 | 6.99 | 6.12 |
| 35 698 | 95.85 | 461.23 | 51.31 | 26.92 | 24.54 | 1.39 |
| 15 174 | 219.71 | 85.50 | 183.12 | 15.46 | 5.34 | 6.88 |
| 9357 | 31.84 | 192.04 | 37.63 | 49.04 | 2.22 | 0.82 |
| 7113 | 15.33 | 25.63 | 33.93 | 5.11 | 10.68 | 1.20 |
| 3063 | 12.70 | 37.33 | 14.32 | 15.40 | 2.88 | 2.79 |

**Table A9.1. cont. Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.**

| IreOTR | Irish otter trawlers | | | | | | |
|---|---|---|---|---|---|---|---|
| 1995 | 2005 | | | | | | |
| 1 | 1 | 0 | 1 | | | | |
| 1 | 7 | | | | | | |
| 56 335 | 77 | 453 | 115 | 33 | 6 | 1 | 1 |
| 60 709 | 72 | 200 | 95 | 30 | 15 | 4 | 1 |
| 62 698 | 215 | 120 | 57 | 24 | 6 | 5 | 2 |
| 57 403 | 28 | 138 | 16 | 16 | 7 | 3 | 0 |
| 53 192 | 10 | 65 | 16 | 3 | 2 | 0 | 0 |
| 46 913 | 131 | 42 | 17 | 6 | 1 | 0 | 0 |
| 48 358 | 19 | 90 | 14 | 5 | 3 | 0 | 0 |
| 37 231 | 39 | 32 | 22 | 2 | 1 | 0 | 0 |
| 39 803 | 7 | 37 | 6 | 5 | 1 | 0 | 0 |
| 35 140 | 3 | 7 | 3 | 1 | 1 | 0 | 0 |
| 30 941 | 4 | 8 | 2 | 1 | 0 | 0 | 0 |

**Table A9.2. Cod in Division VIa. Output from srmsymc ADMB package.**

| Stock name | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cod-6a | | | | | | | | | |
| Sen filename | | | | | | | | | |
| sum_and_sen_files/codvia10runspalyhf075hf0563.sen | | | | | | | | | |
| pf, pm | | | | | | | | | |
| 0 | 0 | | | | | | | | |
| Number of iterations | | | | | | | | | |
| 1000 | | | | | | | | | |
| Simulate variation in Biological parameters | | | | | | | | | |
| TRUE | | | | | | | | | |
| SR relationship constrained | | | | | | | | | |
| TRUE | | | | | | | | | |
| | | | | | | | | | |
| Ricker | | | | | | | | | |
| 1000/1000 Iterations resulted in feasible parameter estimates | | | | | | | | | |
| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
| Deterministic | 0.83 | 0.35 | 107615.00 | 33631.40 | 0.77 | 0.32 | 0.86 | 1.22E-05 | 64.52 |
| Mean | 0.79 | 0.34 | 248654.55 | 80885.39 | 0.78 | 0.38 | 0.93 | 1.45E-05 | |
| 5%ile | 0.59 | 0.26 | 42534.56 | 16130.92 | 0.61 | 0.05 | 0.68 | 1.73E-06 | |
| 25%ile | 0.69 | 0.30 | 64432.03 | 23129.35 | 0.70 | 0.18 | 0.80 | 7.03E-06 | |
| 50%ile | 0.78 | 0.33 | 94637.85 | 32832.15 | 0.77 | 0.35 | 0.90 | 1.35E-05 | |
| 75%ile | 0.88 | 0.37 | 176432.50 | 56775.68 | 0.85 | 0.53 | 1.04 | 2.02E-05 | |
| 95%ile | 1.03 | 0.42 | 692590.35 | 217198.55 | 0.97 | 0.82 | 1.32 | 3.16E-05 | |
| CV | 0.17 | 0.15 | 3.43 | 3.41 | 0.14 | 0.65 | 0.21 | 0.65 | |

**Table A9.2. Cod in Division VIa. Output from srmsymc ADMB package.**

| Beverton–Holt | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1000/1000 Iterations resulted in feasible parameter estimates | | | | | | | | | |
| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
| Deterministic | 0.85 | 0.18 | 401035.00 | 66296.50 | 0.39 | 1.31 | 53828.10 | 60405.70 | 64.48 |
| Mean | 0.83 | 0.17 | 830128.89 | 113018.89 | 0.54 | 1.41 | 91481.79 | 119568.27 | |
| 5%ile | 0.59 | 0.11 | 110359.80 | 21448.08 | 0.07 | 1.10 | 18394.14 | 11822.00 | |
| 25%ile | 0.70 | 0.15 | 195133.00 | 35526.05 | 0.28 | 1.26 | 28078.33 | 26150.93 | |
| 50%ile | 0.79 | 0.17 | 322891.50 | 55212.35 | 0.48 | 1.40 | 44006.65 | 47156.45 | |
| 75%ile | 0.91 | 0.19 | 630754.50 | 96558.98 | 0.76 | 1.55 | 76202.40 | 97400.13 | |
| 95%ile | 1.15 | 0.21 | 2769898.00 | 341061.90 | 1.15 | 1.78 | 298192.60 | 417604.45 | |
| CV | 0.25 | 0.21 | 2.78 | 1.97 | 0.65 | 0.15 | 2.22 | 2.75 | |

**Smooth hockey-stick**

1000/1000 Iterations resulted in feasible parameter estimates

| | Fcrash | Fmsy | Bmsy | MSY | ADMB Alpha | ADMB Beta | Unscaled Alpha | Unscaled Beta | AIC |
|---|---|---|---|---|---|---|---|---|---|
| Deterministic | 0.75 | 0.22 | 135085.00 | 27314.90 | 0.45 | 1.54 | 0.37 | 26047.10 | 64.56 |
| Mean | 0.70 | 0.21 | 173441.36 | 30090.20 | 0.47 | 1.58 | 0.38 | 26727.73 | |
| 5%ile | 0.53 | 0.13 | 68545.05 | 17722.69 | 0.37 | 0.99 | 0.30 | 16778.00 | |
| 25%ile | 0.62 | 0.19 | 98326.80 | 23808.10 | 0.42 | 1.33 | 0.34 | 22442.08 | |
| 50%ile | 0.69 | 0.22 | 129465.50 | 28856.20 | 0.46 | 1.58 | 0.37 | 26719.35 | |
| 75%ile | 0.77 | 0.24 | 171332.00 | 34618.58 | 0.50 | 1.87 | 0.41 | 31474.53 | |
| 95%ile | 0.89 | 0.27 | 306434.25 | 46886.99 | 0.58 | 2.17 | 0.47 | 36539.60 | |
| CV | 0.16 | 0.22 | 1.38 | 0.31 | 0.16 | 0.23 | 0.16 | 0.23 | |

**Per recruit**

| | F35 | F40 | F01 | Fmax | Bmsypr | MSYpr | Fpa | Flim |
|---|---|---|---|---|---|---|---|---|
| Deterministic | 0.18 | 0.15 | 0.14 | 0.22 | 7.10 | 1.44 | 0.60 | 0.80 |
| Mean | 0.16 | 0.14 | 0.13 | 0.21 | 8.70 | 1.51 | | |
| 5%ile | 0.06 | 0.05 | 0.06 | 0.13 | 3.97 | 1.07 | | |
| 25%ile | 0.14 | 0.12 | 0.12 | 0.19 | 5.23 | 1.27 | | |
| 50%ile | 0.17 | 0.14 | 0.14 | 0.22 | 6.48 | 1.47 | | |
| 75%ile | 0.20 | 0.17 | 0.16 | 0.24 | 8.31 | 1.66 | | |
| 95%ile | 0.23 | 0.19 | 0.18 | 0.27 | 15.11 | 2.16 | | |
| CV | 0.31 | 0.31 | 0.28 | 0.22 | 1.36 | 0.22 | | |

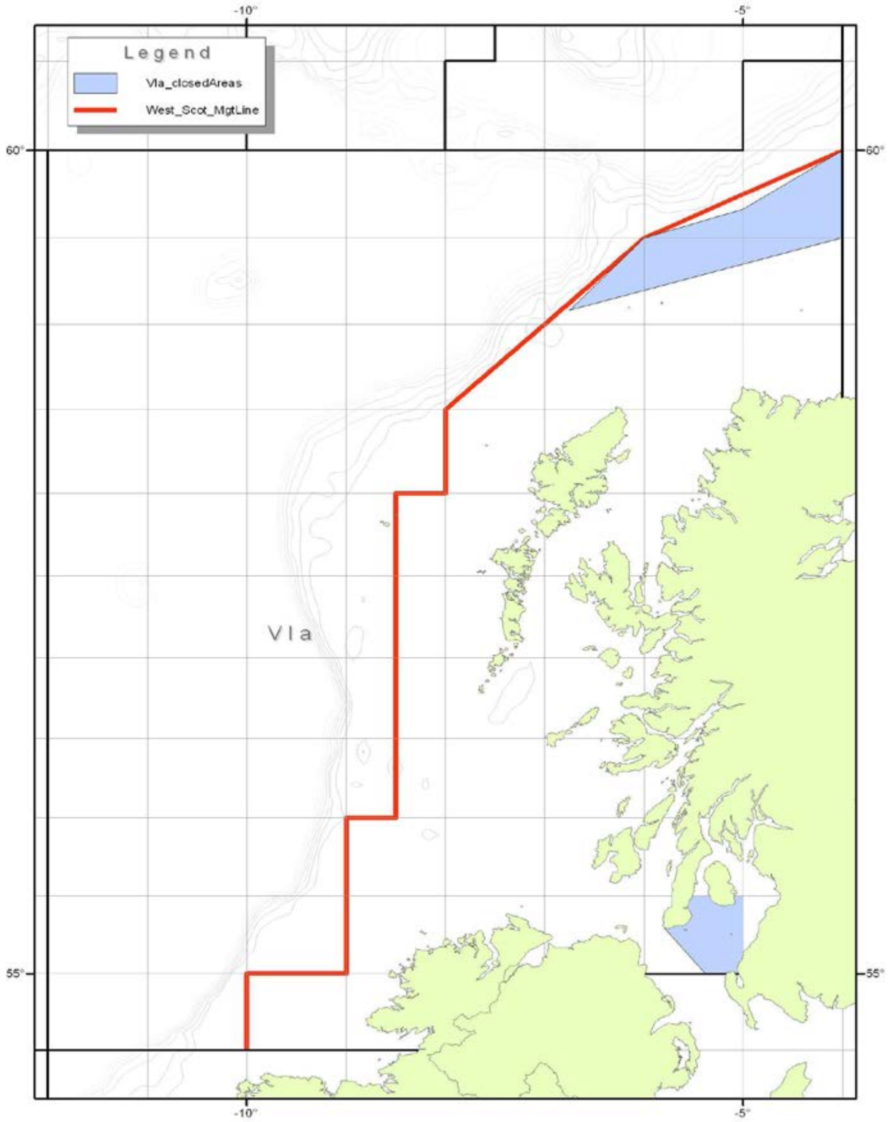


**Figure A9.1. Cod in Division VIa. Map showing closed area in the far northeast of VIa known as the 'windsock' introduced by Council Regulation No 2287\2003 and closed area in the Clyde. The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002. Red line running east of shelf edge is the West of Scotland management line according to Reg (EC) 423/2004 and repealed in 2009.**

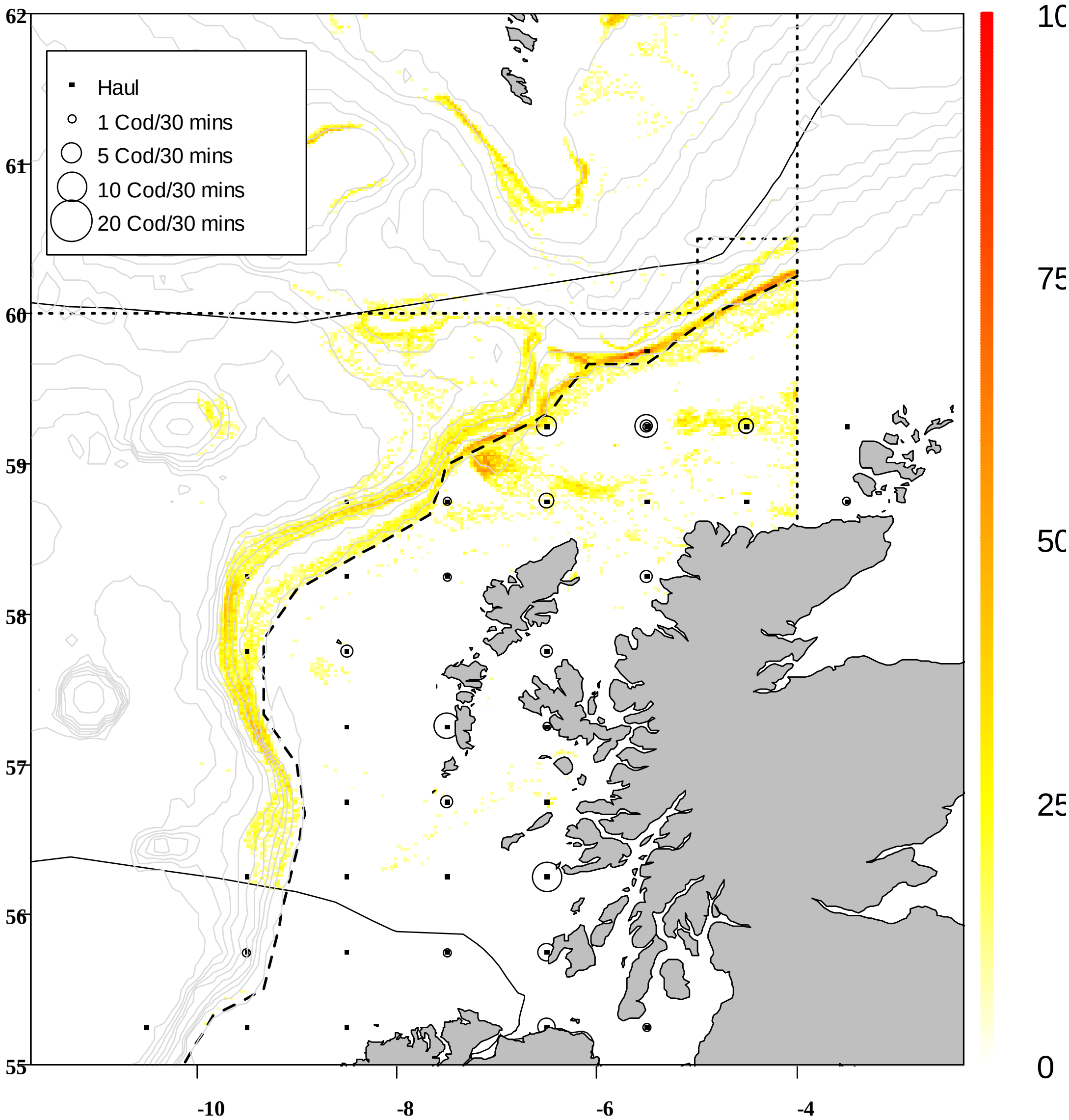


**Figure A9.2. Scottish Q1 2010 Survey cpues of Cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR1 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.**

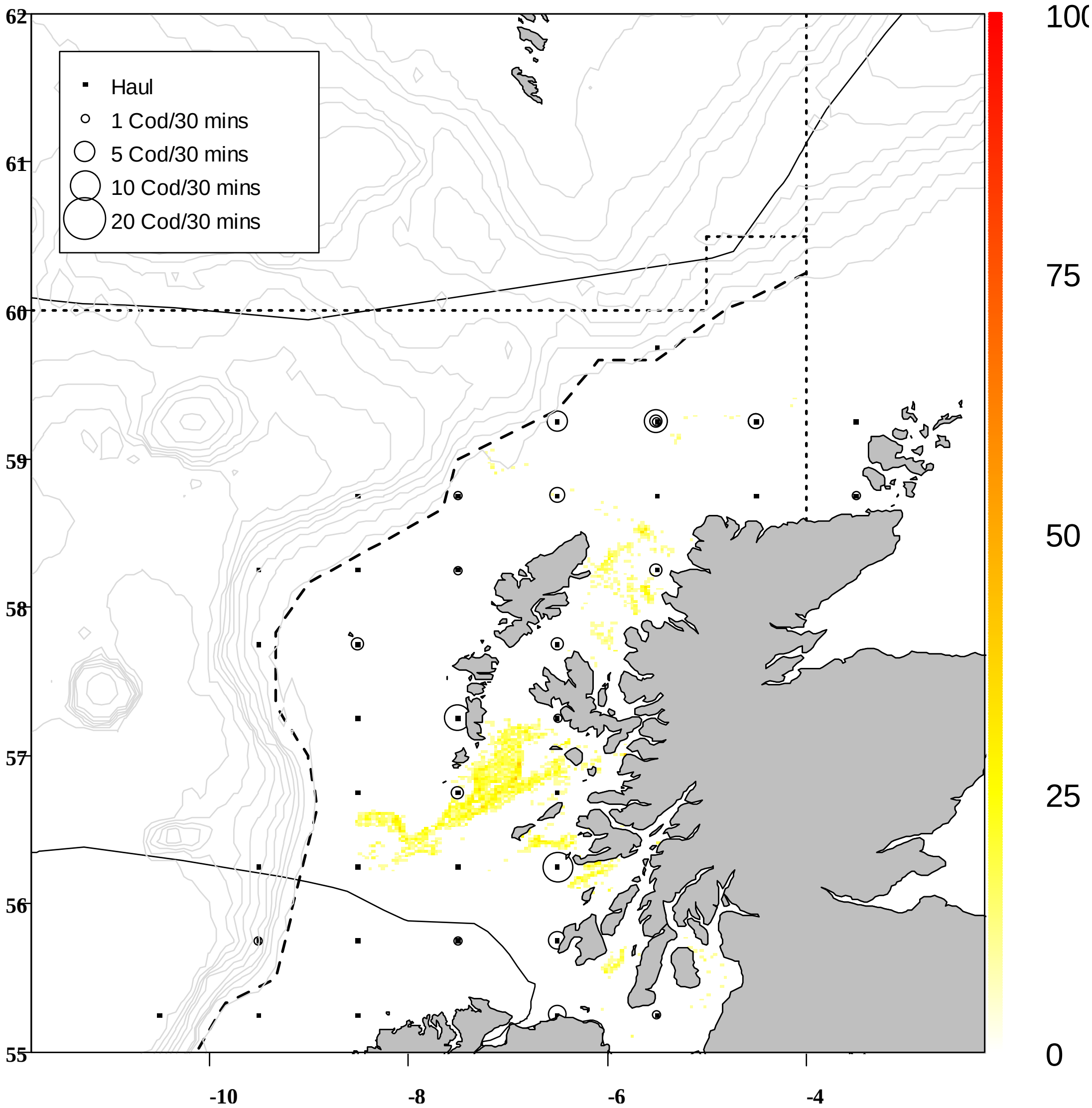


**Figure A9.3. Scottish Q1 2010 Survey cpues of cod plotted over Scottish (and other EU landing into Scotland) VMS data on fishing activity (annual VMS pings per square n.m.) associated with TR2 gear and trips with cod landings. Scottish survey results are centred on the statistical rectangle sampled. Dashed lines show ICES divisions, the broken line represents the cod management line and the solid line shows the limits of the UK EEZ, highlighting the extent of EU waters in Subdivision Vb. Depth contours are at 200 m intervals.**

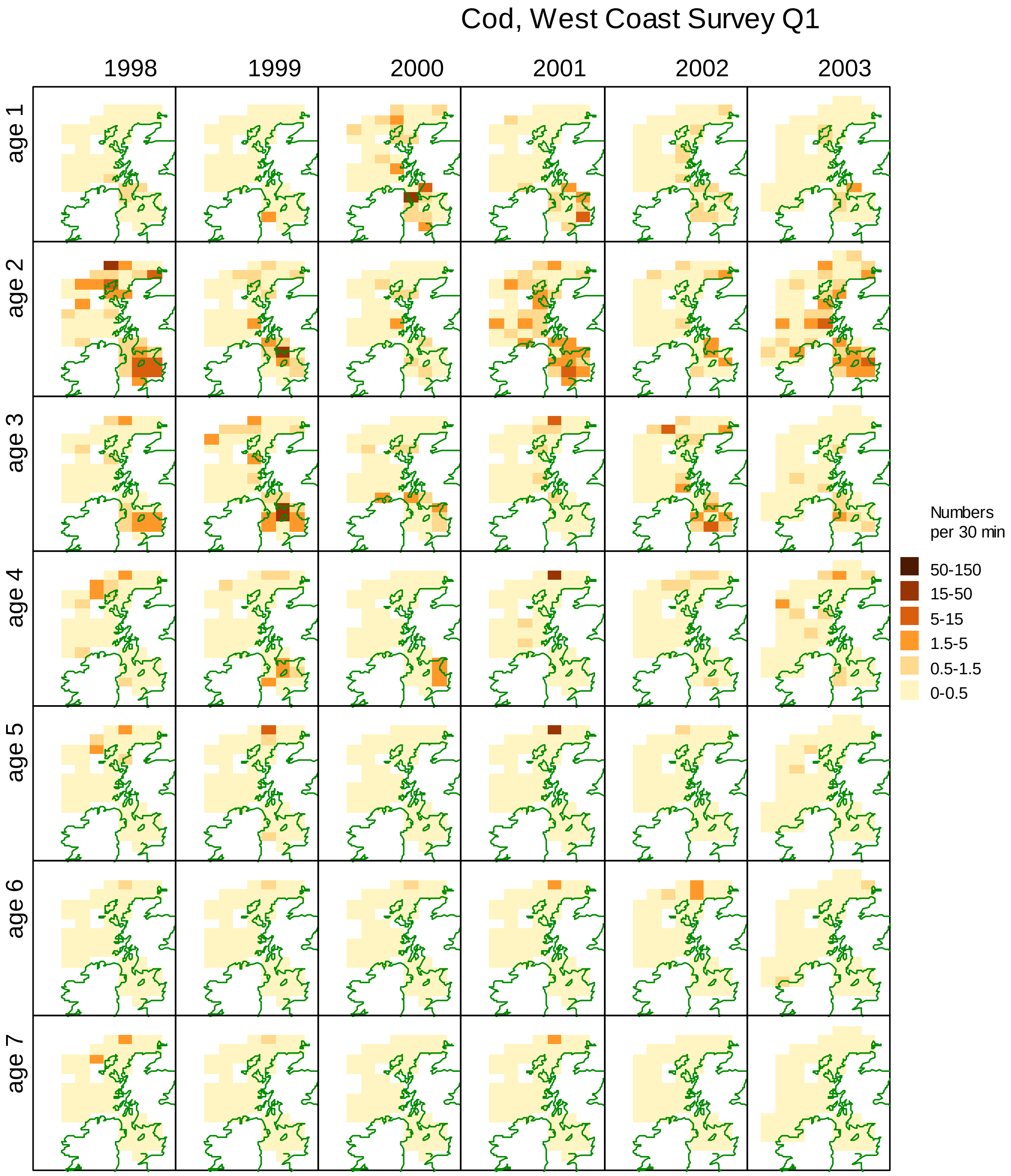


**Figure A9.4. Cod in Division VIa. Cpue numbers-at-age by ICES statistical rectangle resulting from Scottish quarter one groundfish survey (ScoGFSQ1). Cohorts can be followed down diagonals.**

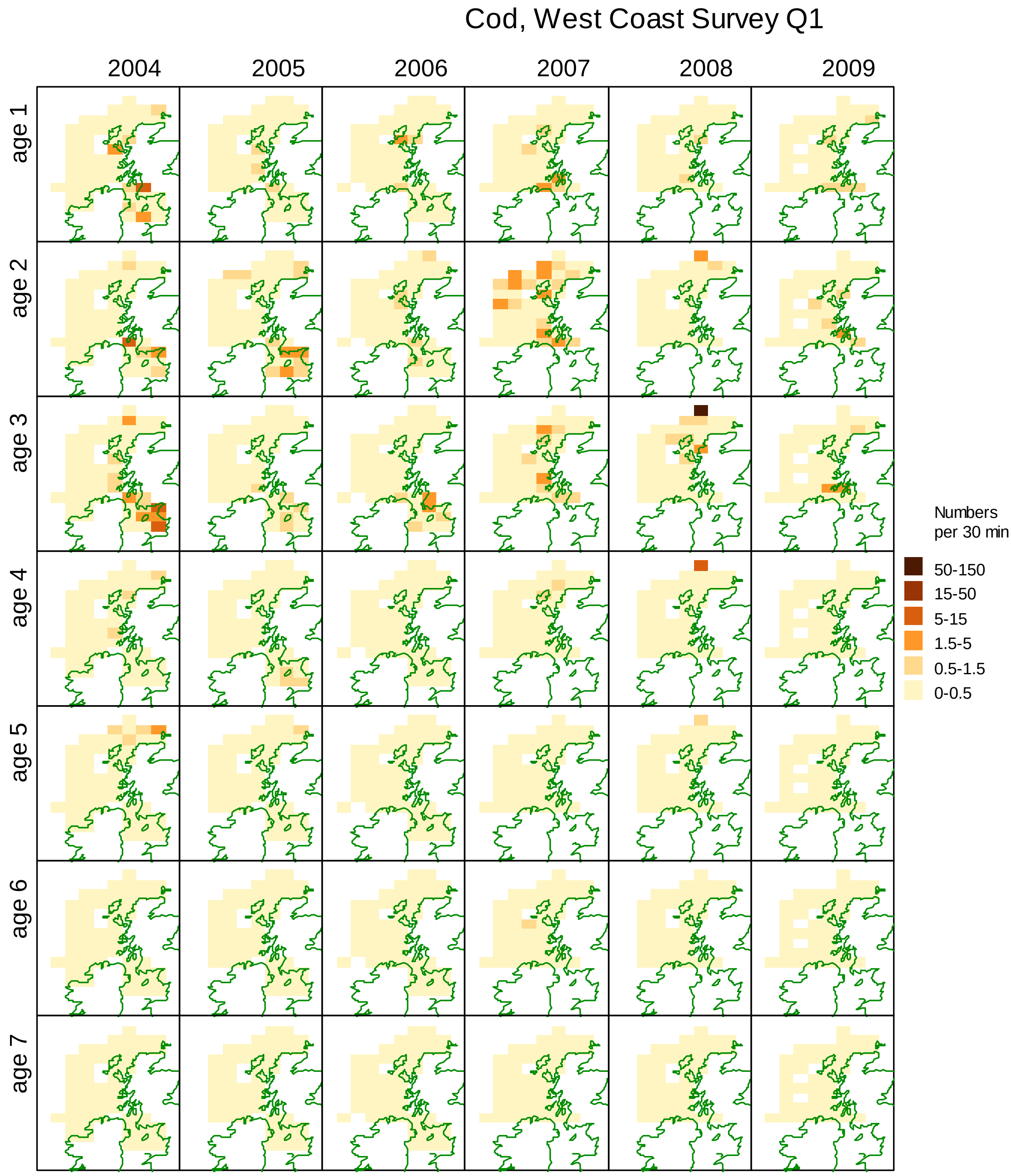


**Figure A9.4. cont. Cod in Division VIa. Cpue numbers-at-age by ICES statistical rectangle resulting from Scottish quarter one groundfish survey (ScoGFSQ1). Cohorts can be followed down diagonals.**

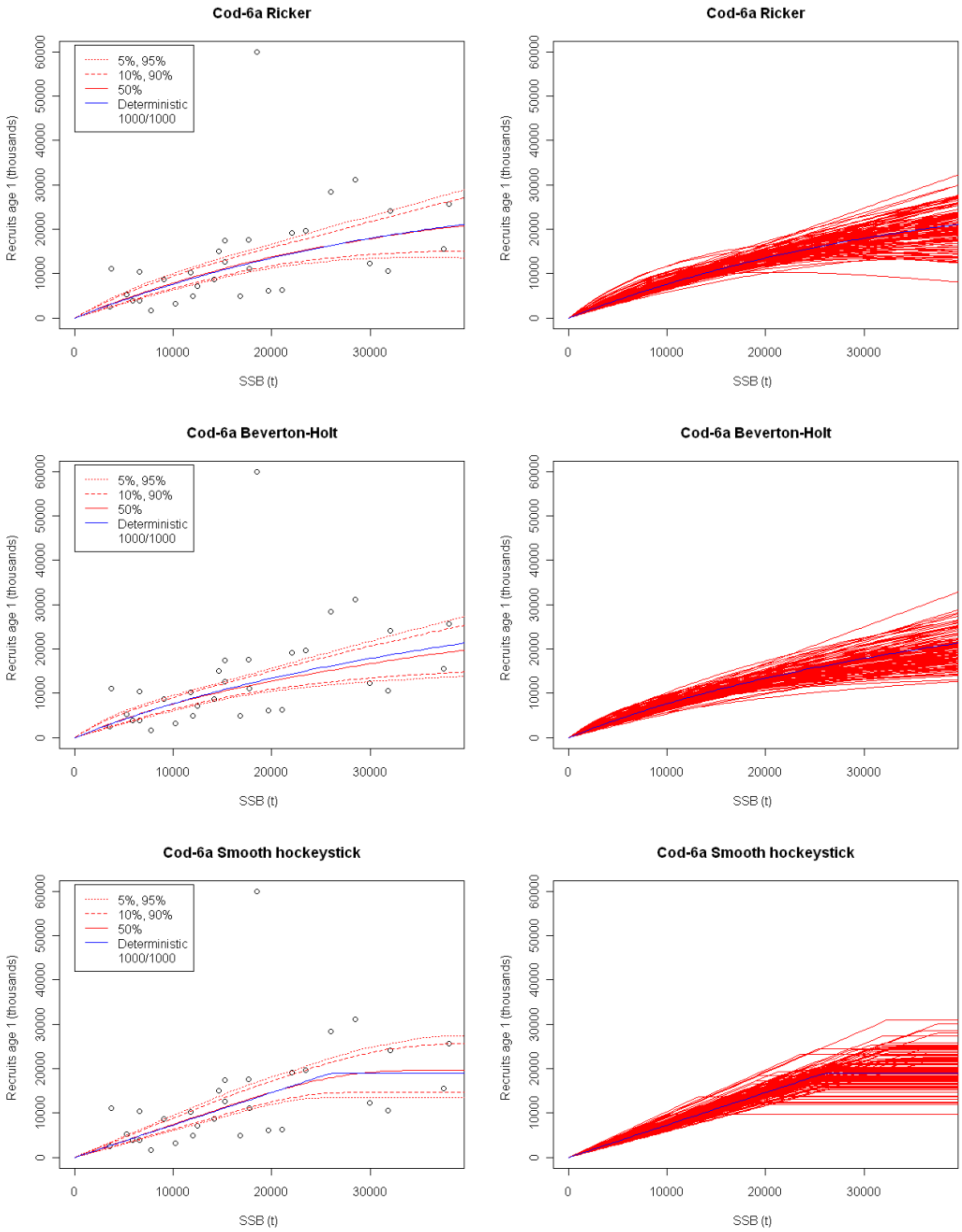


**Figure a9.5. Cod in Division VIa. Stock–recruit relationships fitted by srmsymc package. Models were fitted using 1000 MCMC resamples. Left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. The legends for each recruitment model show it was possible to converge on a value of $F_{MSY}$ and $F_{crash}$ for all 1000 iterations in each case.**

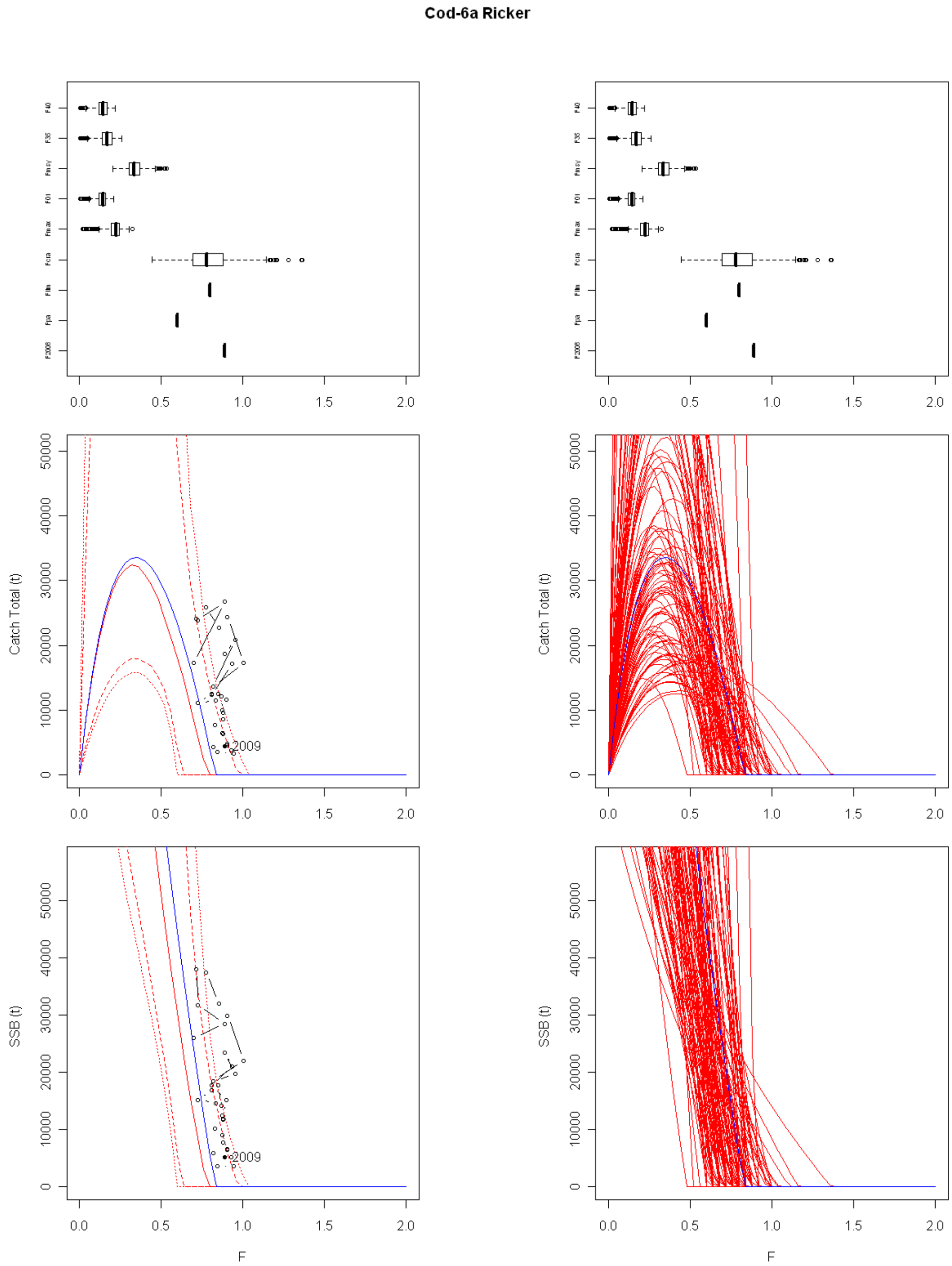


**Figure a9.6. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Ricker recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

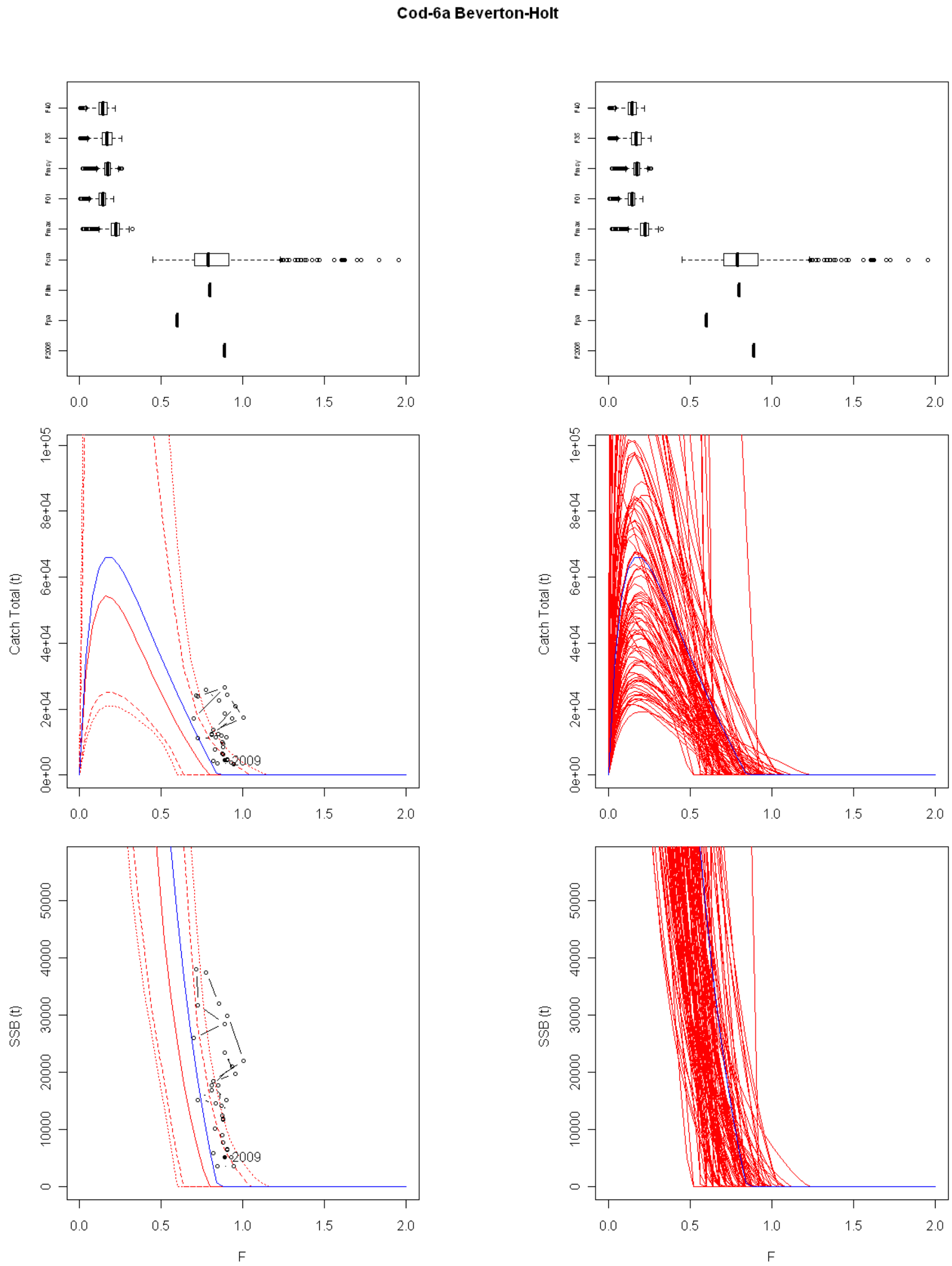


**Figure a9.7. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using Beverton–Holt recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

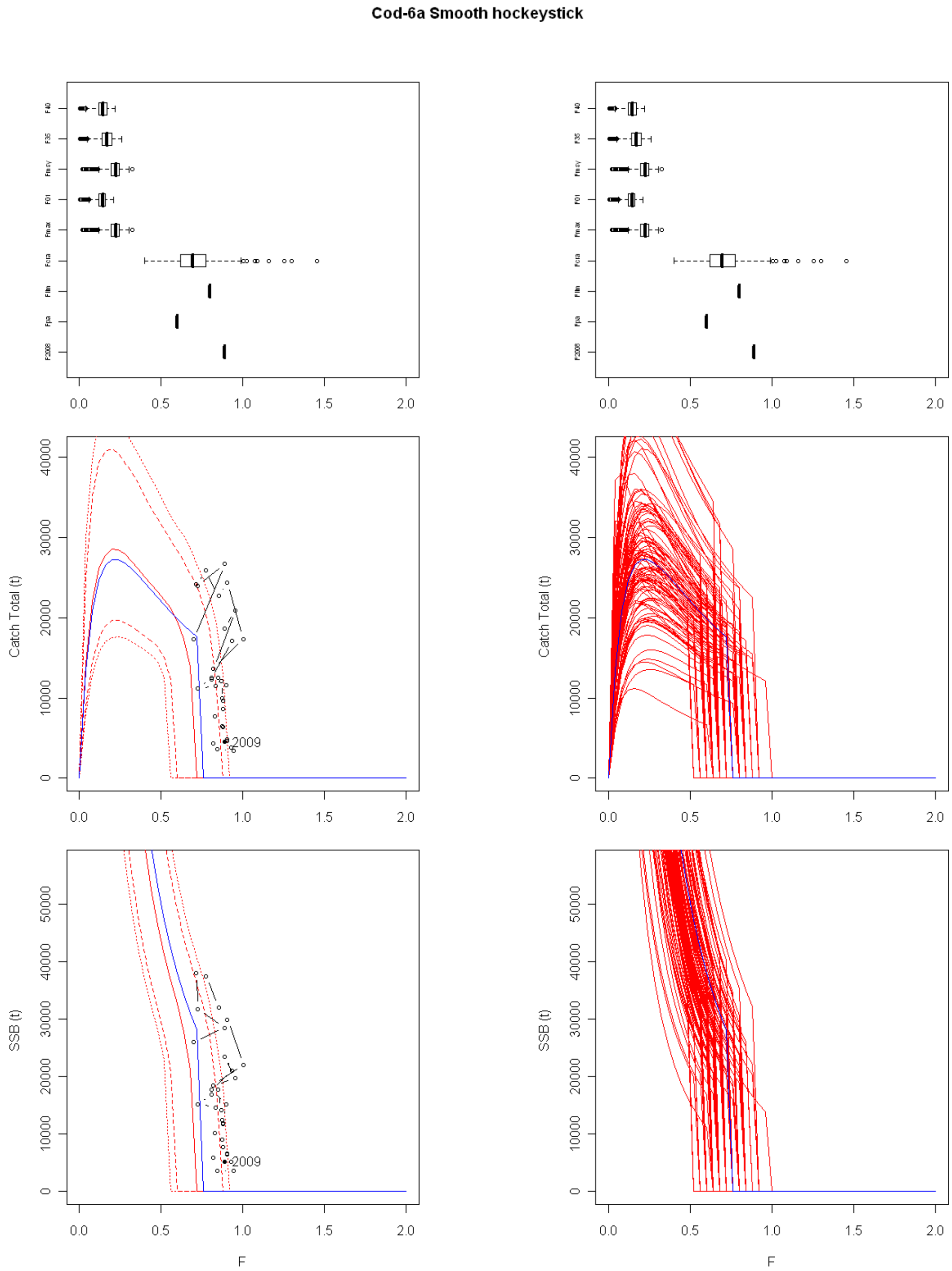


**Figure a9.8. Cod in Division VIa. srmsymc package. Estimation of F reference points and equilibrium yield and SSB against mortality using smooth hockey stick recruitment model. For yield and SSB plots left hand panels illustrate confidence intervals. Right hand panels present curves plotted from the first 100 resamples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain. Circles show data points with the most recent year labelled. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

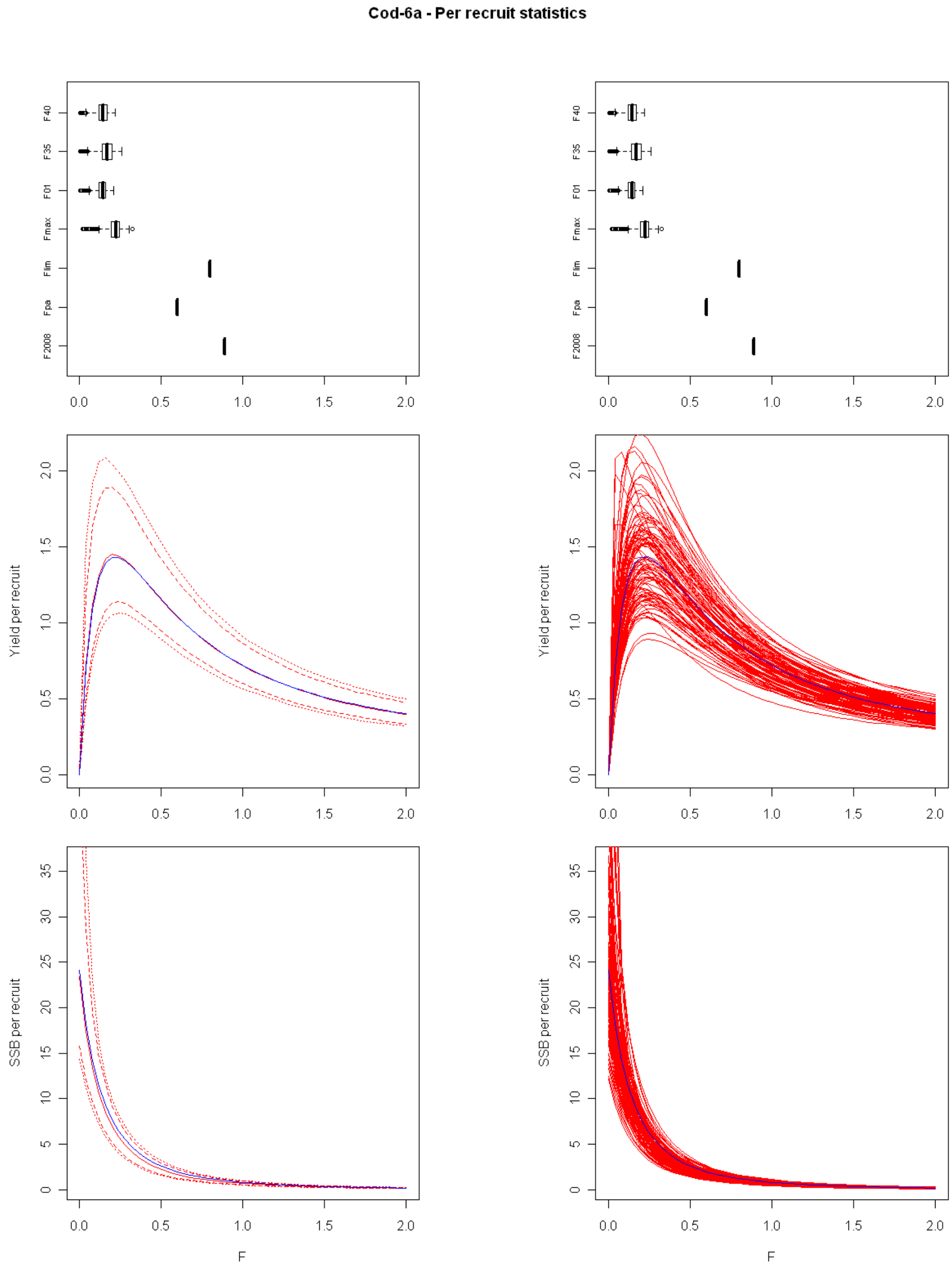


**Figure a9.9. Cod in Division VIa. srmsymc package. F reference points and yield-per-recruit and SSB per recruit against mortality. For VIa cod the model has been run using total removals over and above natural mortality, i.e. the x-axis represents Z-0.2.**

# Stock Annex 3.3: Haddock in VIa

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | West of Scotland Haddock (Division VIa) |
| Working Group | Assessment of Northern Shelf Demersal Stock |
| Last updated | June 2011 |

## A. General

### A.1. Stock definition

The haddock is widely distributed around the west coast of Scotland and can be caught in most areas within the 200 m depth contour. The stocks occurring off the northwest coast of Scotland are usually identified according to the regions which support a fishery, but genetic and biological marker studies suggest the possibility of different populations of haddock. A continuous population of haddock is thought to extend from the west coast around to the north of Scotland. Results from tagging experiments and larval transport studies suggest that there may be links between west coast haddock and those in the North Sea.

### A.2. The fishery

The minimum landing size of haddock in the human consumption fishery in this area is 30 cm.

The demersal fisheries in Division VIa are predominantly conducted by demersal trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and several species of skate. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend.

*2000 onwards*

Emergency measures were introduced in 2001 to allow the maximum number of cod to spawn (see emergency measures below). Council Regulation (EC) No. 423\2004 introduced a cod recovery plan affecting Division VIa. This has been revised and updated (Council Regulation (EC) No. 1342/2008). The measures only take effect east of a line defined in Council Regulation No 51\2006. The days-at-sea limitations associated with the cod recovery plan and this seasonal closure has lead some of the Irish demersal fleet to switch effort away from VIa.

Under Council Regulation (EC) No. 51/2006 the use of gillnets has been banned outside 200 m depth. WGFTFB 2006 report that this has greatly reduced effort at depths greater than 200 m in VIa. The measure was aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on haddock.

*Technical measures*

The minimum mesh size for vessels fishing for haddock in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) changed from 100 mm to 120 mm from the start of 2002. This came under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002.

Since mid-2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth.

*Emergency measures and effort limitation*

Emergency measures were enacted in 2001, consisting of area closures from 6 March–30 April, in an attempt to maximize cod egg production. These measures were retained into 2003 and 2004.

In 2005 the following area closures were in effect:

1) The Greencastle codling fishery from mid-November to mid-February. This closure has been operating since 2003.
2) A closure in the Clyde for spawning cod from 14th February to 30th April. This closure has been operating since 2001 and was last revised by The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002.
3) A closure introduced in 2004 by Council Regulation No. EC 2287\2003, known as the 'windsock'.

Effort reductions for much of the international fleet to 16 days-at-sea per month have been imposed since February 2003 (EU 2003\0090). The maximum number-of-days in any calendar month for which a fishing vessel may be absent from port to the west of Scotland varies for particular gears and the allocations since 2003 are given below:

| Gear | Maximum Days Allowed | | | |
|---|---|---|---|---|
| | 2003: | 2004: | 2005: | 2006: |
| Demersal trawls, seines or similar towed gears of mesh size ≥ 100 mm except beam trawls | 9 | 10 | 8 | 91/12 |
| Demersal trawls, seines or similar towed gears of mesh size between<br>70 mm and 99 mm except beam trawls[1]; | 25 | 22 | 21 | 127/12 |
| Demersal trawls, seines or similar towed gears of mesh size between<br>16 mm and 31 mm except beam trawls. | 23 | 20 | 19 | 128/12 |

**[1]: With mesh size between 80 mm and 99 mm in 2004.**

The documents listing these days-at-sea limitations are,

2004: (EC) No 2287/2003

2005: (EC) No 27/2005-Annex IVa

2006: (EC) No 51/2006-Annex IIa

A Commission Decision (C (2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. UK vessels were granted four additional days-per-month (based on evidence of decommissioning programmes). An additional two days was granted to demersal trawls, seines or similar towed gears (mesh ≥100 mm, except beam trawls) to compensate for steaming time between home ports and fishing grounds and for the adjustment to the newly installed effort management scheme.

For 2006 one extra day was allocated to trawls >=100 mm if the mesh was >120 mm and the net contained a square mesh panel of 140 mm mesh size. Altogether 148 days in the year was allowed for vessels with mesh between 100 and 120 mm if the catch contained <5% cod in 2002. This allowance rises to 160 days in the year if the same 140 mm square mesh panel is used together with a mesh size >120 mm.

The new effort regulations provided an incentive for some vessels previously using >100 mesh in otter trawls to switch to smaller mesh gears to take advantage of the larger numbers of days-at-sea available. This would also require these vessels to be targeting *Nephrops* or anglerfish, megrim and whiting with various catch and bycatch composition limits after EC Regulation No 850/98.

*Decommissioning schemes*. Vessel decommissioning has been underway since 2002. Information on the number of vessels operating in the cod recovery zone to have been decommissioned in Division VIa between 2001 and 2004 was as follows:

| | Total VIa 2001 | Decomm. To 2004 | Percentage |
|---|---|---|---|
| Number of vessels > 10 m | 298 | 96 | 30.2% |

#### A.3. Ecosystem aspects

##### *Geographic location and timing of spawning*

Spawning of haddock usually occurs in February and March and in almost any area where the fish are distributed. There is major spawning between the Butt of Lewis and Shetland. Some larvae from the west coast spawning grounds can be transported to the North Sea, which they enter through the Fair Isle/Shetland Gap or to the north-east of Shetland. Young haddock then spend the first few months of life in the upper water layers before adopting the demersal way of life. The survival rate of young haddock is very variable from year to year.

##### *Fecundity*

The majority of haddock mature-at-age two with usually all mature by age three. However, mature age two haddock spawn fewer eggs for a given size than an age three haddock. A three-year-old female of good size is able to produce around 300 000 eggs in a season and releases her eggs in a number of batches over many weeks.

##### *Diet*

The diet of haddock varies seasonally and according to location and body size. In winter, haddock of all sizes feed mainly on benthic invertebrates, for example, polychaetes, small crustaceans and echinoderms. In spring and summer, fish prey, especially sandeels, are important particularly for larger haddock. Norway pout is also important prey for haddock. During herring spawning seasons, haddock will feed heavily on herring eggs.

### B. Data

#### B.1. Commercial catch

##### *B1.1. Landings*

The following table gives the source of landings data for west of Scotland haddock:

| | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (catch-in-weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | Matprop (proportion mature-by-age) | Length composition-in-catch |
| UK(NI) | X | | | | |
| UK(E&W) | X | | | | |
| UK(Scotland) | X | X | X | X | X |
| Ireland | X | X | X | | X |
| France | X | | | | |
| Norway | X | | | | |

Quarterly landings and length–age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in the requested format to a stock coordinator, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (Scotland), UK (E/W), UK (NI), France and Ireland .The quarterly estimates of landings-at-age by UK (Scotland) and Ireland are raised to include landings by France, UK (NI) and Norway (distributed proportionately over quarters), then summed over quarters to produce the annual landings-at-age.

#### *B1.2. Discards*

EU countries are now required under the EU Data Collection regulation to collect data on discards of haddock and other species. Up to 2003, estimates of discards were available only from UK (Scotland) and Ireland. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES.

The quantity, length and age of haddock discarded by Scottish *Nephrops* trawlers are collected during observer trips on board commercial vessels. Haddock discarded by boats using other gears (heavy trawl, seine, light trawl and pair trawl) are also collected by Scotland. Haddock discarded by otter board trawl and otter board/twin rig gears are collected by Ireland.

Discards from Scottish and Irish boats using several different gear types are estimated by observers.

### B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years. There are no direct estimates of M.

Proportion mature-at-age is currently assumed constant over the full time-series as follows:

| Age | 1 | 2 | 3+ |
|---|---|---|---|
| Proportion mature | 0.00 | 0.57 | 1.0 |

These maturity values were derived from a French survey carried out in Division VIa in 1983. They were first discussed in the 1984 meeting of the North Sea Roundfish Working Group (ICES-NSRWG 1984), and were first used at the 1985 meeting (ICES-NSRWG 1985). Proportions of *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

### B.3. Surveys

Four research vessel survey-series for haddock in VIa were available to the Working Group in 2009. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2009.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistics. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4-stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series. It was discontinued in 2003 and has been replaced by the IRGFS (see below).

- Scottish fourth quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2008.

As is the case for the European IBTS surveys (such as ScoGFS Q1 above) the survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistics. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4-stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2008.

This survey used the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomized stations. Effort is recorded as minutes towed. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 minutes towed.

Plots of the spatial distribution of the ScoGFS Q1 survey mean catch rates per ICES statistical rectangle by age class are given in Figure 1. The numbers caught in the most recent Scottish Groundfish Surveys are indicated in Figure 2.

### B.4. Commercial cpue

Three commercial Scottish cpue series have been made available in recent years. Irish otter trawl cpue data (IreOTR) were presented for the first time at the 2001 WG meeting. Updated series have been presented to subsequent meetings. Given the current concerns about misreporting of catch and effort, this series has not been considered further as a tuning fleet.

The commercial cpue data available consists of the following:

- Scottish seiners (ScoSEI): ages 1–6, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 1–6, years 1978–2005.
- Irish otter trawlers (IreOTR): ages 1–7, years 1995–2005.

Reported effort has declined in recent years to very low levels in both Scottish fleets for which effort data are available to the WG (pairtrawlers and light trawlers; see Table 1). The historical mean levels of lpue (landings-per-unit-effort) for these fleets were more constant, although variable. However, problems with effort recording mean that these estimates are unlikely to be valid: further details are available in the report of the 2000 meeting of the ICES WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak (ICES-WGNSSK 2000). For this reason, commercial Scottish lpue data has not been used in the current assessment. Data are also available (although not updated to 2007) from the Irish trawler fleet (IreOTB; Table 4.1.8), but are not used in the assessment as a consequence of concerns about targeting leading to hyperstability.

#### B.5. Other relevant data

None.

### C. Historical stock development

In 2007 ICES changed its advisory structure: the previous committees (ACE, ACFM and ACME) were merged into a single committee now known as ACOM. Among many of the modifications to accompanying working practices, it was intended that all stock assessments conducted by the Expert Groups from 2008 should be update analyses based on the work conducted by the last benchmark meeting. For west of Scotland haddock, a benchmark assessment *per se* has not taken place for some time. However, at the 2004 WGNSDS, "a full and detailed examination" of the assessment was carried out following concerns of ACFM about the assumptions and parameter settings implemented in the TSA methods used to assess this stock (ICES, 2004). The investigation used Time-Series Analysis (TSA) Extended Survivors Analysis (XSA) and Survey Based Assessment (SURBA) models. Although the results from this investigation were in some ways contradictory, and the WG remained uncertain about the most appropriate model for the stock, subsequent Review Groups concluded that a TSA assessment, using the Scottish Quarter 1 Groundfish Survey and excluding the catch and discard data from 1995 onwards, should be presented as the final assessment in 2005. In 2006 this assessment was modified slightly to incorporate an additional survey, the Scottish Quarter 4 Groundfish Survey (western division bottom-trawl survey). In 2007, concerns were raised about the potential impact on management advice of using a plus-group at-age 8 when the dominant large 1999 year class has reached that age in 2007, and also about the removal in the previous assessment of older ages in the Scottish Q4 Groundfish Survey (ScoGFS Q4). Several exploratory analyses were carried out, from which it was concluded that the same procedure should be used in 2007 as was used 2006, but with two additional ages in the ScoGFS Q4 dataset. In 2008, subject to the ACOM request, an update assessment was carried out using the same procedures as in 2007. In 2009 an update assessment was carried out using the same procedure as in 2008. This used the TSA assessment model and tuning data from the two Scottish Groundfish surveys.

Software used: Lowestoft VPA suite; Marine Scotland Science (Marine Lab Aberdeen) TSA and SURBA software.

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1966 – last data year | 1–8+ | Yes |
| Canum | Catch-at-age in numbers | 1966 – last data year | 1–8+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1966 – last data year | 1–8+ | Yes |
| West | Weight-at-age of the stock at spawning time. | 1968 – last data year | 1–8+ | Yes |
| Mprop | Proportion of natural mortality before spawning | 1978 – last data year | 1–8+ | No; set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1978 – last data year | 1–8+ | No; set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1978 – last data year | 1–8+ | No; the same ogive for all years |
| Natmor | Natural mortality | 1978 – last data year | 1–8+ | No; set to 0.2 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Research Vessel Survey | | | |
| Tuning fleet 1 | ScoGFS-Q1 | 1985–last data year | 1–7 |
| Tuning fleet 3 | ScoGFS-Q4 | 1996–last data year | 1–7 |

Summary of data ranges used in recent assessments:

| Data | 2006 assessment | 2007 assessment | 2008 assessment | 2009 assessment |
|---|---|---|---|---|
| Catch data | Years: 1978–1994<br>Ages: 1–8+ | Years: 1978–1994<br>Ages: 1–8+ | Years: 1978–1994<br>Ages: 1–8+ | Years: 1978–1994<br>Ages: 1–8+ |
| Survey: ScoGFS Q1 | Years: 1985–2006<br>Ages: 1–7 | Years: 1985–2007<br>Ages 1–7 | Years: 1985–2008<br>Ages 1–7 | Years: 1985–2009<br>Ages 1–7 |
| Survey: ScoGFS Q4 | Years: 1996–2005<br>Ages: 1–5 | Years: 1996–2006<br>Ages 1–7 | Years: 1996–2007<br>Ages 1–7 | Years: 1996–2008<br>Ages 1–7 |
| Survey: IreGFS | Not used | Not used | Not used | Not used |

### TSA

TSA parameter settings for the 2003–2009 analyses.

| Parameter | Notation | Description | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|
| | F (1, 1978) | | 0.42 | 0.28 | 0.26 | 0.23 | 0.25 | 0.40 | 0.40 |
| Initial fishing mortality | F (2, 1978) | Fishing mortality at age a in year y | 0.67 | 0.5 | 0.51 | 0.50 | 0.56 | 0.71 | 0.70 |
| | F (4, 1978) | | 0.53 | 0.51 | 0.51 | 0.51 | 0.52 | 0.56 | 0.57 |
| Survey selectivities | Φ(1) | | 3.99 | 2.25 | 2.35 | 2.49 | 2.58 | 2.60 | 2.58 |
| ScoGFS Q1 | Φ(2) | ScoGFS Q1 survey selectivity at age a | 4.84 | 2.71 | 2.45 | 2.55 | 3.01 | 3.07 | 3.01 |
| | Φ(4) | | 2.1 | 1.51 | 2.11 | 2.19 | 2.04 | 1.92 | 1.94 |
| Survey selectivities | Φ(1) | | - | - | - | 1.99 | 1.62 | 1.77 | 1.75 |
| ScoGFS Q4 | Φ(2) | ScoGFS Q4 survey selectivity at age a | - | - | - | 1.99 | 1.76 | 1.88 | 1.84 |
| | Φ(4) | | - | - | - | 2.25 | 2.39 | 2.61 | 2.64 |
| | σF | Transitory changes in overall F | 0.00 | 0.11 | 0.10 | 0.10 | 0.12 | 0.20 | 0.20 |
| Fishing mortality | σU | Persistent changes in selection (age effect in F) | 0.05 | 0.04 | 0.01 | 0.00 | 0.09 | 0.03 | 0.03 |
| standard deviations | σV | Transitory changes in the year effect in F | 0.27 | 0.23 | 0.22 | 0.23 | 0.23 | 0.33 | 0.35 |
| | σY | Persistent changes in the year effect in F | 0.00 | 0.14 | 0.09 | 0.09 | 0.07 | 0.00 | 0.00 |
| | σΩ1 | Transitory changes in ScoGFS Q1 catchability | 0.00 | 0.08 | 0.18 | 0.30 | 0.19 | 0.12 | 0.12 |
| Survey catchability | σβ1 | Persistent changes in ScoGFS Q1 catchability | 0.14 | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* |
| standard deviations | σΩ2 | Transitory changes in ScoGFS Q4 catchability | - | - | - | | 0.16 | 0.20 | 0.19 |
| | σβ2 | Persistent changes in ScoGFS Q4 catchability | - | - | - | | 0.00* | 0.00* | 0.00* |
| | cv landings | Coefficent of variation of landings-at-age data | 0.22 | 0.25 | 0.23 | 0.20 | 0.20 | 0.24 | 0.25 |
| Measurement | cv discards | Coefficent of variation of discards-at-age data | 0.51 | 0.43 | 0.45 | 0.42 | 0.41 | 0.54 | 0.54 |
| coefficients of variation | cv survey | Coefficent of variation of ScoGFS Q1 survey data | 0.40 | 0.34 | 0.53 | 0.57 | 0.33 | 0.35 | 0.36 |
| | cv survey | Coefficent of variation of ScoGFS Q4 survey data | - | - | - | 0.57 | 0.22 | 0.34 | 0.35 |
| | σP | Transitory changes in overall discard proportion | 0.50 | 0.19 | 0.20 | 0.19 | 0.18 | 0.20 | 0.20 |
| Discard curve | σα1 | Transitory changes in discard-ogive intercept | 0.00 | 0.15 | 0.02 | 0.00 | 0.14 | 0.00 | 0.00 |
| parameters | σν1 | Persistent changes in discard-ogive intercept | 0.26 | 0.21 | 0.22 | 0.21 | 0.32 | 0.26 | 0.25 |
| | σα2 | Transitory changes in discard-ogive slope | 0.34 | 0.01 | 0.03 | 0.21 | 0.23 | 0.22 | 0.23 |
| | σν2 | Persistent changes in discard-ogive slope | 0.02 | 0.61 | 0.43 | 0.23 | 0.002 | 0.000 | 0.000 |
| Trend parameters | θν1 | Trend parameter for discard-ogive intercept | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* |
| | θν2 | Trend parameter for discard-ogive slope | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* |
| | η1 | Ricker parameter (slope at the origin) | 9.10 | 9.63 | 9.71 | 9.73 | 9.06 | 11.35 | 11.08 |
| Recruitment | η2 | Ricker parameter (curve dome occurs at 1/η2) | 0.33 | 0.29 | 0.31 | 0.29 | 0.30 | 0.35 | 0.35 |
| | cv rec | Coefficent of variation of recruitment curve | 0.52 | 0.89 | 0.89 | 0.90 | 0.62 | 0.60 | 0.61 |

### D. Short-term projection

TSA produces short-term forecasts as part of every standard model run. The recruitment values used in these forecasts have been discussed above. The model will also forecast fishing mortality rates. It does so by iterating forward the time-series model that had been fitted to historical data. These forecast mortalities therefore retain the time-series characteristics of the preceding data. However, it is not clear to the WG what the precise statistical properties of these mortality forecasts are. It is likely that they follow a pattern of damped oscillation towards an eventual steady state, but without further analysis the WG did not feel confident in using them as the basis for a forecast.

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

- Initial stock size. Taken from XSA or TSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a GM because of a perceived downward trend in recruitment in recent years.
- Natural mortality: Set to 0.2 for all ages in all years.
- Maturity: The same ogive as in the assessment is used for all years.
- F and M before spawning: Set to 0 for all ages in all years.
- Weight-at-age in the stock: based on either of simple three-year means or linear model projections: simple three year means are used for the younger ages (1–2) and linear model projections for the older ages (3–8+).

Weight-at-age in the catch: as above for stock weights.

- Exploitation pattern: Average of the three last years.
- Intermediate year assumptions: *status quo* F.
- Stock–recruitment model used: TSA estimate of recruits-at-age 1 for intermediate year, Ricker model from TSA used for intermediate year +1 and the long-term geometric mean recruitment-at-age 1 is used for intermediate year +2.

### E. Medium-term projections

Stochastic medium-term projections were not produced for this stock. The reliance of the fishery on intermittent large year classes and the fluid nature of the fishery and related management make the usefulness of medium-term projections questionable in any case.

### F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass per recruit over a range of F values.

Software used: MFDP

- Selectivity pattern: mean F array from last three years of assessment (to reflect recent selection patterns).
- Stock and catch weights-at-age: mean of last three years.
- Maturity: Fixed maturity ogive as used in assessment.

### G. Biological reference points

$B_{pa}$ is set at 30 000 tonnes and is defined as $B_{lim}$*1.4. $B_{lim}$ is defined as the lowest observed SSB, considered to be 22 000 tonnes when the current reference points were established in 1998. $F_{pa}$ is 0.5 on the technical basis of a high probability of avoiding SSB falling below $B_{pa}$ in the long term. $F_{lim}$ is not defined. In the 2007 ACFM report, $F_{max}$ was estimated at 0.44 and $F_{0.1}$ was 0.2.

### H. Other issues

In the 2011 assessment two factors dictated that an extra run of the assessment was needed. The extra run was due to the changes in the ScoGFS WCIBTS Q1 survey. The gear was changed from "C" to "D" the length of the sweeps and the survey design was also changed. The review group requested an assessment run without the survey as being more suitable at this time as the impacts of these changes can't be accessed at this point.

From Figure 4 to Figure 10 are the resulting plots from the exclusion of the ScoGFS WCIBTS Q1 (2011) from the assessment. Also, from Table 2 to Table 5 are showed the numbers-at-age, fishing mortality and respective standard errors for this assessment.

### I. References

ICES. 2004. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS). ICES CM 2005/ACFM:01.

**Table 1. Haddock in Division VIa. Commercial effort and tuning-series made available to the WG. Effort (first column) is given as reported hours fished per year; numbers landed are in thousands. Note that a) these data are not used in the final assessment, and b) 2006 data were not available to the WG in 2007.**

**Scottish pair trawl (ScoPTR)**

| | | Age | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Effort** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **1988** | 73448 | 1836.79 | 19333.629 | 2791.134 | 1561.027 | 3555.323 | 132.086 | 47.031 |
| **1989** | 69051 | 358.121 | 622.245 | 6453.549 | 833.344 | 617.05 | 1530.389 | 96.988 |
| **1990** | 24365 | 2656.973 | 1209.336 | 432.811 | 2413.249 | 161.21 | 59.431 | 119.9 |
| **1991** | 33826 | 2528.117 | 3815.61 | 267.76 | 165.98 | 1059.521 | 75.441 | 58.562 |
| **1992** | 24141 | 1531.621 | 1587.775 | 1068.706 | 80.518 | 28.226 | 195.827 | 17.505 |
| **1993** | 23975 | 1784.422 | 8049.086 | 3189.459 | 582.533 | 48.833 | 41.065 | 141.79 |
| **1994** | 21003 | 602.661 | 2354.895 | 2614.523 | 861.39 | 226.916 | 7.311 | 14.371 |
| **1995** | 22848 | 2494.133 | 1573.402 | 3915.253 | 1501.48 | 365.819 | 103.337 | 3.1 |
| **1996** | 22237 | 3993.635 | 7475.948 | 1085.826 | 2281.053 | 1002.653 | 282.516 | 73.796 |
| **1997** | 8552 | 1327.954 | 1136.375 | 3876.218 | 340.837 | 523.864 | 192.329 | 37.903 |
| **1998** | 8425 | 416.432 | 2137.106 | 1315.696 | 2734.416 | 232.941 | 149.879 | 35.896 |
| **1999** | 2483 | 450.826 | 1936.938 | 1521.928 | 399.642 | 641.984 | 47.192 | 34.913 |
| **2000** | 2335 | 1545.384 | 394.239 | 620.963 | 319.038 | 45.263 | 69.646 | 15.32 |
| **2001** | 1342 | 4.767 | 230.091 | 97.936 | 241.187 | 46.188 | 10.688 | 37.264 |
| **2002** | 14 | 31.473 | 115.105 | 120.723 | 2.223 | 2.909 | 1.247 | 0.356 |
| **2003** | 5 | 38.548 | 107.443 | 150.615 | 288.114 | 29.322 | 4.005 | 0.232 |
| **2004** | 88 | 52.807 | 141.598 | 40.075 | 98.517 | 221.673 | 13.792 | 2.687 |
| **2005** | 0 | 9.956 | 22.448 | 31.323 | 22.161 | 32.8 | 106.663 | 0.189 |

**Irish otter trawl (IreOTB)**

| | | Age | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Effort** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **1995** | 56335 | 222 | 298 | 530 | 461 | 92 | 28 | 98 |
| **1996** | 60709 | 165 | 531 | 670 | 281 | 175 | 33 | 12 |
| **1997** | 62698 | 99 | 358 | 515 | 282 | 339 | 133 | 89 |
| **1998** | 57403 | 51 | 1092 | 552 | 312 | 186 | 218 | 232 |
| **1999** | 53192 | 98 | 315 | 437 | 266 | 198 | 109 | 123 |
| **2000** | 46913 | 50 | 131 | 188 | 303 | 158 | 76 | 65 |
| **2001** | 48358 | 14 | 304 | 144 | 101 | 126 | 100 | 44 |
| **2002** | 37231 | 31 | 162 | 388 | 27 | 65 | 97 | 47 |
| **2003** | 42899 | 4 | 36 | 108 | 231 | 29 | 36 | 29 |
| **2004** | 35140 | 0 | 33 | 82 | 71 | 82 | 11 | 13 |
| **2005** | 30941 | 1 | 23 | 41 | 56 | 87 | 29 | 7 |

**Table 1. cont.**

**Scottish light trawl (ScoLTR)**

| | | Age | | | |
|---|---|---|---|---|---|
| **Year** | **Effort** | **2** | **3** | **4** | **5** |
| **1965** | 37387 | 22.091 | 1642.12 | 168.954 | 6.998 |
| **1966** | 40538 | 2.929 | 0 | 702.277 | 20.987 |
| **1967** | 80916 | 1326.106 | 72.823 | 6.981 | 188.483 |
| **1968** | 65348 | 514.409 | 132.176 | 9.014 | 13.019 |
| **1969** | 106586 | 6100.801 | 273.493 | 81.818 | 4.989 |
| **1970** | 129741 | 60.985 | 7188.79 | 93.986 | 17.997 |
| **1971** | 129187 | 426.996 | 323.964 | 7715.896 | 29.996 |
| **1972** | 154288 | 20885.215 | 447.018 | 197.01 | 4635.228 |
| **1973** | 93992 | 1171.622 | 1396.082 | 8.999 | 18.998 |
| **1974** | 88651 | 950.263 | 706.156 | 425.086 | 4.001 |
| **1975** | 132353 | 4525.993 | 476.288 | 360.261 | 320.234 |
| **1976** | 139225 | 11482.937 | 2002.98 | 171.894 | 208.87 |
| **1977** | 143547 | 362.858 | 3581.037 | 660.848 | 94.978 |
| **1978** | 127387 | 205.97 | 157.024 | 1412.263 | 205.04 |
| **1979** | 99803 | 2419.532 | 162.972 | 32.994 | 802.863 |
| **1980** | 121211 | 3869.366 | 1034.891 | 183.982 | 37.996 |
| **1981** | 165002 | 14862.966 | 4468.331 | 423.043 | 40.004 |
| **1982** | 135280 | 958.723 | 17379.104 | 1721.828 | 70.994 |
| **1983** | 112332 | 5747.308 | 1345.07 | 10272.253 | 662.105 |
| **1984** | 132217 | 2210.088 | 3687.112 | 809.84 | 6080.328 |
| **1985** | 142815 | 16310.439 | 905.133 | 691.017 | 214.069 |
| **1986** | 126533 | 2565.893 | 13292.803 | 408.899 | 163.349 |
| **1987** | 131653 | 4040.797 | 2770.494 | 6465.25 | 249.058 |
| **1988** | 158191 | 17326.463 | 2369.239 | 1008.226 | 2273.141 |
| **1989** | 217443 | 1459.316 | 10332.354 | 934.04 | 394.722 |
| **1990** | 131360 | 1293.654 | 541.378 | 3520.472 | 213.722 |
| **1991** | 209901 | 8386.068 | 414.358 | 218.113 | 1814.306 |
| **1992** | 189288 | 3850.242 | 2937.112 | 133.408 | 49.73 |
| **1993** | 189925 | 17312.309 | 6469.671 | 1479.199 | 89.402 |
| **1994** | 174879 | 7106.326 | 6307.283 | 1574.576 | 409.496 |
| **1995** | 175631 | 4850.552 | 9835.464 | 2704.111 | 551.303 |
| **1996** | 214159 | 15882.858 | 2665.141 | 4524.729 | 1511.694 |
| **1997** | 179605 | 4231.875 | 9987.962 | 882.602 | 1119.138 |
| **1998** | 142457 | 6845.462 | 3530.308 | 7753.948 | 573.554 |
| **1999** | 98993 | 6266.816 | 4506.559 | 1124.841 | 2152.395 |
| **2000** | 76157 | 2725.197 | 4725.382 | 2259.356 | 499.511 |
| **2001** | 35698 | 14958.081 | 1246.235 | 2075.946 | 687.201 |
| **2002** | 15174 | 4200.486 | 16918.947 | 400.382 | 421.166 |
| **2003** | 9357 | 2114.331 | 2803.164 | 6108.682 | 76.951 |
| **2004** | 7117 | 3675.178 | 1203.565 | 2307.81 | 3900.374 |
| **2005** | 3063 | 1643.009 | 1317.835 | 787.027 | 955.533 |

**Table 2. Haddock in Division VIa. Estimates of population abundance (in thousands) from the final TSA run excluding the ScoGFS WCIBTS Q1.**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|
| 1978 | 71511 | 7953.4752 | 2466.6573 | 58817.723 | 4399.9717 | 620.54015 | 472.15325 | 1033.2709 |
| 1979 | 152330 | 43262.27 | 3839.6299 | 1076.8068 | 22916.21 | 1546.7218 | 231.59062 | 570.52427 |
| 1980 | 489170 | 86970.534 | 17994.279 | 1493.5997 | 382.12049 | 7631.7704 | 468.74903 | 251.64741 |
| 1981 | 63918 | 318221.22 | 44454.034 | 7284.759 | 581.80203 | 157.17537 | 3025.8694 | 272.31699 |
| 1982 | 70160 | 42795.134 | 188419.33 | 22423.229 | 3527.8024 | 287.43245 | 78.978531 | 1613.3261 |
| 1983 | 45008 | 47419.349 | 25310.571 | 101495.94 | 11555.727 | 1834.9871 | 148.19302 | 882.6174 |
| 1984 | 318687 | 28230.425 | 25364.46 | 11319.778 | 46277.706 | 5274.7842 | 824.04775 | 475.5231 |
| 1985 | 73687 | 195452.91 | 11938.788 | 9613.4372 | 4793.0103 | 19568.215 | 2182.2413 | 537.13964 |
| 1986 | 59942 | 43044.812 | 93789.406 | 4986.6489 | 3995.988 | 2099.7876 | 8166.3103 | 1164.1055 |
| 1987 | 263894 | 39377.097 | 23512.35 | 47644.009 | 2529.5418 | 2051.2944 | 1094.1885 | 4780.0425 |
| 1988 | 21886 | 146013.2 | 14912.295 | 8020.9797 | 16264.165 | 832.60373 | 669.73192 | 1987.1493 |
| 1989 | 17132 | 11324.424 | 61304.242 | 5445.684 | 2811.0486 | 5745.6078 | 300.83283 | 950.2902 |
| 1990 | 97618 | 8508.3511 | 4355.5922 | 22992.159 | 1905.0125 | 935.61648 | 1928.6168 | 423.30689 |
| 1991 | 125985 | 59286.935 | 3434.92 | 1804.4692 | 9453.9793 | 778.90332 | 386.22053 | 961.37077 |
| 1992 | 177127 | 70527.169 | 24089.421 | 1215.8146 | 681.16251 | 3461.2513 | 289.60642 | 496.81973 |
| 1993 | 176515 | 111639.32 | 33294.018 | 10080.114 | 524.96368 | 299.69264 | 1481.652 | 338.94809 |
| 1994 | 58444 | 102117.43 | 41704.757 | 9556.0646 | 3022.1212 | 146.06625 | 82.791715 | 524.97297 |
| 1995 | 203277 | 33184.159 | 48377.828 | 16322.817 | 3549.3537 | 1178.9858 | 57.675828 | 234.89197 |
| 1996 | 109566 | 121118.11 | 15125.276 | 19784.432 | 6332.9812 | 1377.9497 | 468.35997 | 115.15626 |
| 1997 | 127295 | 60405.874 | 50587.788 | 5401.3533 | 7157.1917 | 2209.4954 | 489.96244 | 208.79009 |
| 1998 | 141955 | 71429.546 | 24673.25 | 17860.19 | 1923.5257 | 2577.9139 | 773.10525 | 247.1552 |
| 1999 | 32178 | 79038.396 | 28728.627 | 8700.4878 | 6080.6304 | 691.96806 | 947.98578 | 356.44249 |
| 2000 | 500855 | 17333.064 | 30527.79 | 9692.7928 | 3049.7945 | 1940.078 | 240.37994 | 450.20011 |
| 2001 | 189241 | 256830.93 | 5963.04 | 8740.6736 | 2765.2091 | 910.74311 | 517.6483 | 196.67606 |
| 2002 | 95560 | 115130.85 | 122879.42 | 2544.8936 | 3413.207 | 1083.3432 | 367.51209 | 278.00487 |
| 2003 | 114604 | 63561.211 | 67029.514 | 68073.153 | 1259.5986 | 1683.2593 | 551.76604 | 326.56338 |
| 2004 | 45357 | 73452.95 | 34419.271 | 35576.79 | 30430.606 | 564.99894 | 751.27884 | 396.7983 |
| 2005 | 30639 | 28433.304 | 38762.082 | 17482.662 | 16679.717 | 13678.204 | 249.13664 | 515.08943 |
| 2006 | 94621 | 17625.562 | 13133.957 | 15976.778 | 6492.4124 | 6341.0195 | 4849.5477 | 277.33071 |
| 2007 | 20966 | 60471.134 | 8391.8261 | 6436.0835 | 6986.1193 | 2790.1301 | 2755.6687 | 2177.3353 |
| 2008 | 10158 | 13104.436 | 36378.104 | 4566.5856 | 3328.4838 | 3529.9335 | 1431.7701 | 2523.8814 |
| 2009 | 18365 | 6531.9994 | 8011.8525 | 22917.53 | 2602.1217 | 1929.0403 | 2016.2096 | 2274.1287 |
| 2010 | 81533 | 12664.574 | 4030.31 | 5267.347 | 14160.908 | 1586.1879 | 1182.9705 | 2632.6019 |
| | | | | | | | | |
| 2011 | 95193.534 | 54998.267 | 7764.4203 | 2565.9746 | 3226.4698 | 8478.6461 | 965.21726 | 2316.4433 |
| 2012 | 105073.51 | 64068.359 | 33025.829 | 4830.2377 | 1506.1355 | 1893.8226 | 4976.6627 | 1926.2176 |

**Table 3. Haddock in Division VIa. Standard errors of estimates of population abundance (in thousands) from the final TSA run excluding the ScoGFS WCIBTS Q1.**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|
| 1978 | 8047.816 | 720.02213 | 292.59288 | 368.48748 | 1114.2633 | 199.48067 | 116.71953 | 303.53896 |
| 1979 | 15308.379 | 4200.0915 | 321.9664 | 137.01621 | 1909.3723 | 532.21244 | 102.58537 | 167.67008 |
| 1980 | 41826.973 | 8467.3081 | 2259.1342 | 167.82466 | 64.679394 | 1124.5143 | 254.84345 | 100.37396 |
| 1981 | 7151.0116 | 26840.737 | 5079.7018 | 1148.5223 | 93.084133 | 36.810453 | 637.89165 | 149.62961 |
| 1982 | 7900.8268 | 4840.9195 | 16816.503 | 2696.9709 | 590.08569 | 53.931397 | 21.530754 | 395.92286 |
| 1983 | 6113.5091 | 5307.5322 | 2942.5752 | 8987.6235 | 1342.213 | 312.30536 | 30.77195 | 214.82237 |
| 1984 | 35027.434 | 3471.8591 | 2642.0116 | 1233.0267 | 3526.8804 | 530.63158 | 126.37837 | 88.474553 |
| 1985 | 8314.7465 | 19457.641 | 1535.3836 | 1216.5554 | 480.46793 | 1967.9299 | 312.2743 | 84.934134 |
| 1986 | 6564.9094 | 4566.2118 | 9236.856 | 581.95808 | 497.1424 | 268.7436 | 1182.3987 | 197.89924 |
| 1987 | 34455.227 | 3997.2912 | 2581.071 | 4614.2396 | 278.42778 | 253.10449 | 154.80279 | 709.79358 |
| 1988 | 4285.7269 | 16083.758 | 1523.2368 | 952.53918 | 1751.1453 | 114.42887 | 121.46965 | 343.19652 |
| 1989 | 4056.0757 | 1564.1736 | 6628.4547 | 611.95585 | 358.11404 | 748.85494 | 53.748503 | 177.91478 |
| 1990 | 11743.532 | 1700.4597 | 569.26886 | 2816.1787 | 242.61217 | 160.12583 | 369.41823 | 97.825112 |
| 1991 | 13319.768 | 6728.7407 | 541.72771 | 208.12378 | 1047.2666 | 97.996336 | 69.059769 | 174.77917 |
| 1992 | 17477.556 | 6674.3874 | 2673.4049 | 174.58838 | 71.716278 | 437.08658 | 44.629669 | 85.107193 |
| 1993 | 19126.475 | 10656.266 | 2927.845 | 1092.7485 | 57.304139 | 30.616036 | 195.80065 | 47.290467 |
| 1994 | 11445.441 | 11514.868 | 4152.7617 | 1009.3753 | 290.82597 | 12.875464 | 10.881152 | 67.523694 |
| 1995 | 27361.903 | 6830.3195 | 7186.27 | 2707.4021 | 610.41081 | 192.40582 | 9.8772315 | 44.284317 |
| 1996 | 19933.203 | 18761.41 | 3367.7688 | 3676.4663 | 1264.0729 | 283.95635 | 96.660931 | 25.989949 |
| 1997 | 21784.008 | 11100.228 | 9124.7715 | 1064.85 | 1233.2848 | 439.65034 | 106.2841 | 46.042932 |
| 1998 | 22251.322 | 11588.279 | 4373.3613 | 3144.7812 | 302.28035 | 366.27004 | 140.20554 | 46.31955 |
| 1999 | 9697.6841 | 12619.856 | 4966.4943 | 1409.1149 | 1061.5343 | 105.4437 | 150.01419 | 65.291462 |
| 2000 | 99749.748 | 5313.7587 | 6130.9273 | 1877.6321 | 530.7579 | 437.31598 | 48.979366 | 94.653203 |
| 2001 | 23728.835 | 47224.205 | 1636.952 | 1751.635 | 508.93025 | 157.29416 | 140.86146 | 49.087387 |
| 2002 | 14538.046 | 13149.114 | 19815.713 | 423.65652 | 532.33845 | 152.92911 | 55.261147 | 57.725933 |
| 2003 | 14797.78 | 9359.1337 | 7806.4929 | 10078.225 | 195.6214 | 259.83585 | 81.709469 | 53.775576 |
| 2004 | 6359.8097 | 9525.6149 | 5013.9967 | 4411.447 | 4400.4975 | 94.582143 | 133.02731 | 68.145255 |
| 2005 | 4310.2684 | 3723.8898 | 5487.2049 | 2370.077 | 2045.405 | 2080.8805 | 45.572073 | 91.222077 |
| 2006 | 7762.7082 | 2255.9424 | 1416.0222 | 1814.3702 | 723.64159 | 759.82252 | 825.3342 | 51.529964 |
| 2007 | 3056.4805 | 4828.5479 | 1211.2025 | 709.33563 | 852.99106 | 374.44104 | 429.95394 | 442.51684 |
| 2008 | 3317.4527 | 1787.3493 | 3310.0543 | 631.6582 | 398.57987 | 500.09007 | 233.69894 | 442.72866 |
| 2009 | 6761.1634 | 2241.1756 | 1132.7681 | 2253.5259 | 406.26526 | 271.52157 | 338.19498 | 395.57128 |
| 2010 | 27865.592 | 4874.5738 | 1556.3631 | 865.77603 | 1689.2063 | 289.5536 | 198.21796 | 453.22054 |
| | | | | | | | | |
| 2011 | 52620.084 | 20387.56 | 3314.0283 | 1070.0563 | 630.6655 | 1347.5353 | 211.90094 | 438.97704 |
| 2012 | 58015.433 | 35942.85 | 13332.474 | 2194.1733 | 674.85376 | 478.75295 | 1127.3521 | 480.08213 |

**Table 4. Haddock in Division VIa. Estimates of fishing mortality from the final TSA run, excluding the ScoGFS WCIBTS Q1.**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|
| 1978 | 0.2801407 | 0.4259988 | 0.6256183 | 0.748457 | 0.7517203 | 0.7378178 | 0.7282394 | 0.7328911 |
| 1979 | 0.3607167 | 0.6557689 | 0.7401778 | 0.844548 | 0.8696603 | 0.8560245 | 0.8627367 | 0.8619518 |
| 1980 | 0.241463 | 0.4736201 | 0.6255159 | 0.7071036 | 0.6586505 | 0.6819481 | 0.6787033 | 0.6723439 |
| 1981 | 0.2048262 | 0.3372398 | 0.4752327 | 0.4995819 | 0.4980031 | 0.4862474 | 0.5016633 | 0.4970092 |
| 1982 | 0.1874498 | 0.3216716 | 0.4048949 | 0.4657545 | 0.4585819 | 0.4652356 | 0.4672813 | 0.4582116 |
| 1983 | 0.2854268 | 0.430143 | 0.4364142 | 0.4705608 | 0.4864126 | 0.4932777 | 0.49228 | 0.5055616 |
| 1984 | 0.2915295 | 0.6088407 | 0.739729 | 0.6563878 | 0.6488383 | 0.6777962 | 0.6786875 | 0.6695123 |
| 1985 | 0.3374131 | 0.5329396 | 0.6633582 | 0.6674804 | 0.6247853 | 0.6728626 | 0.6487989 | 0.641802 |
| 1986 | 0.2130673 | 0.4068797 | 0.4707794 | 0.4679124 | 0.4556456 | 0.444357 | 0.4630799 | 0.4643127 |
| 1987 | 0.3919381 | 0.7662297 | 0.8748018 | 0.8738184 | 0.9110475 | 0.9189747 | 0.8939703 | 0.8813878 |
| 1988 | 0.4041582 | 0.6690786 | 0.8068914 | 0.8457092 | 0.840587 | 0.8183077 | 0.8222225 | 0.8307971 |
| 1989 | 0.4070528 | 0.6916005 | 0.7739596 | 0.836685 | 0.8715339 | 0.8751634 | 0.8682541 | 0.8654675 |
| 1990 | 0.2998287 | 0.6669672 | 0.6825961 | 0.6817791 | 0.6865166 | 0.6717372 | 0.6841574 | 0.6833512 |
| 1991 | 0.3672765 | 0.700521 | 0.8119483 | 0.7631985 | 0.8045777 | 0.7810298 | 0.801316 | 0.7854941 |
| 1992 | 0.2362223 | 0.500076 | 0.6584714 | 0.6318142 | 0.5816159 | 0.6161878 | 0.6091012 | 0.6008879 |
| 1993 | 0.3411066 | 0.7377768 | 1.0007849 | 0.9330382 | 0.9074721 | 0.9822204 | 0.9439314 | 0.9511132 |
| 1994 | 0.3703304 | 0.5321287 | 0.7292375 | 0.7887066 | 0.7331227 | 0.724985 | 0.7548749 | 0.7440576 |
| 1995 | 0.3192126 | 0.5788908 | 0.6941574 | 0.7415358 | 0.7431782 | 0.7227438 | 0.7304985 | 0.7318265 |
| 1996 | 0.3939535 | 0.6739112 | 0.8284382 | 0.8163859 | 0.851652 | 0.8327976 | 0.8261324 | 0.8326644 |
| 1997 | 0.3848211 | 0.7001126 | 0.8480591 | 0.8277414 | 0.7903399 | 0.8528204 | 0.8333944 | 0.8303033 |
| 1998 | 0.3868974 | 0.7114993 | 0.8383579 | 0.8805377 | 0.8154444 | 0.7966374 | 0.853627 | 0.8373704 |
| 1999 | 0.4055253 | 0.7471427 | 0.8847201 | 0.8623489 | 0.9210298 | 0.8557984 | 0.8514007 | 0.8773267 |
| 2000 | 0.4653342 | 0.8803753 | 1.050134 | 1.0586355 | 1.0074155 | 1.1136759 | 1.048776 | 1.0583254 |
| 2001 | 0.2833783 | 0.5471881 | 0.7063514 | 0.7447327 | 0.7136201 | 0.6930111 | 0.7486184 | 0.7262055 |
| 2002 | 0.2080154 | 0.3380771 | 0.4168398 | 0.5035448 | 0.5051211 | 0.4734209 | 0.4725187 | 0.488252 |
| 2003 | 0.2447802 | 0.4172415 | 0.4283251 | 0.5999919 | 0.6053099 | 0.6104133 | 0.6030516 | 0.5925732 |
| 2004 | 0.2659952 | 0.4379506 | 0.4817654 | 0.5530988 | 0.5996363 | 0.6185723 | 0.6038554 | 0.5973425 |
| 2005 | 0.3659529 | 0.5898514 | 0.673865 | 0.7922827 | 0.7683985 | 0.8281742 | 0.8171597 | 0.8055306 |
| 2006 | 0.2676572 | 0.5078184 | 0.5087606 | 0.6180234 | 0.6405769 | 0.6295882 | 0.650079 | 0.6264798 |
| 2007 | 0.2539264 | 0.3120421 | 0.4078046 | 0.4582252 | 0.4768448 | 0.4630574 | 0.4665538 | 0.4640192 |
| 2008 | 0.1962177 | 0.2978398 | 0.2588325 | 0.3569122 | 0.3437475 | 0.3572891 | 0.351279 | 0.350951 |
| 2009 | 0.1631909 | 0.2627823 | 0.2163613 | 0.2814186 | 0.293566 | 0.2883315 | 0.2902716 | 0.2860528 |
| 2010 | 0.1937057 | 0.2892568 | 0.2515049 | 0.2901382 | 0.3129344 | 0.2967356 | 0.3008983 | 0.2982318 |
| | | | | | | | | |
| 2011 | 0.1959614 | 0.3100117 | 0.2746561 | 0.3327913 | 0.3327913 | 0.3327913 | 0.3327913 | 0.3327913 |
| 2012 | 0.1959614 | 0.3100117 | 0.2746561 | 0.3327913 | 0.3327913 | 0.3327913 | 0.3327913 | 0.3327913 |

**Table 5. Haddock in Division VIa. Standard errors of estimates of log fishing mortality from the final TSA run, excluding the ScoGFS WCIBTS Q1.**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|
| 1978 | 0.216327 | 0.153943 | 0.155712 | 0.120613 | 0.130479 | 0.141081 | 0.145204 | 0.143505 |
| 1979 | 0.202123 | 0.140957 | 0.131111 | 0.126375 | 0.118933 | 0.132668 | 0.141431 | 0.140081 |
| 1980 | 0.224433 | 0.152603 | 0.152975 | 0.130735 | 0.139576 | 0.13467 | 0.148 | 0.148941 |
| 1981 | 0.225173 | 0.163842 | 0.150697 | 0.140907 | 0.14508 | 0.151609 | 0.151537 | 0.156191 |
| 1982 | 0.216659 | 0.158383 | 0.14789 | 0.135283 | 0.13884 | 0.145465 | 0.153875 | 0.148365 |
| 1983 | 0.194277 | 0.143198 | 0.156403 | 0.128009 | 0.132271 | 0.138251 | 0.147112 | 0.144391 |
| 1984 | 0.232806 | 0.141634 | 0.128653 | 0.133157 | 0.125499 | 0.139923 | 0.146855 | 0.148303 |
| 1985 | 0.200769 | 0.143742 | 0.142702 | 0.127014 | 0.130979 | 0.134517 | 0.145043 | 0.146667 |
| 1986 | 0.216387 | 0.150761 | 0.144573 | 0.136944 | 0.138589 | 0.143369 | 0.148707 | 0.151329 |
| 1987 | 0.205299 | 0.124976 | 0.126174 | 0.109093 | 0.114521 | 0.125986 | 0.13501 | 0.131131 |
| 1988 | 0.211524 | 0.138968 | 0.127091 | 0.11698 | 0.11829 | 0.130548 | 0.138643 | 0.136591 |
| 1989 | 0.217171 | 0.149561 | 0.136678 | 0.118726 | 0.1221 | 0.12731 | 0.140428 | 0.138971 |
| 1990 | 0.208263 | 0.146553 | 0.150216 | 0.129618 | 0.131246 | 0.137839 | 0.144075 | 0.146866 |
| 1991 | 0.201051 | 0.13818 | 0.1446 | 0.120581 | 0.120662 | 0.132102 | 0.140709 | 0.138762 |
| 1992 | 0.210226 | 0.143656 | 0.140723 | 0.129829 | 0.130176 | 0.136727 | 0.146075 | 0.145515 |
| 1993 | 0.202165 | 0.127725 | 0.115375 | 0.108749 | 0.11137 | 0.129772 | 0.132918 | 0.137581 |
| 1994 | 0.242318 | 0.198187 | 0.187114 | 0.167468 | 0.171483 | 0.180166 | 0.183733 | 0.183394 |
| 1995 | 0.33756 | 0.275335 | 0.262188 | 0.243813 | 0.24541 | 0.247962 | 0.250589 | 0.25059 |
| 1996 | 0.327236 | 0.257542 | 0.257135 | 0.233473 | 0.233651 | 0.236275 | 0.238403 | 0.240279 |
| 1997 | 0.314866 | 0.241967 | 0.226215 | 0.210605 | 0.210558 | 0.213039 | 0.217023 | 0.219063 |
| 1998 | 0.320966 | 0.243793 | 0.236193 | 0.211179 | 0.212996 | 0.215219 | 0.218233 | 0.220795 |
| 1999 | 0.331146 | 0.25144 | 0.241304 | 0.224104 | 0.222452 | 0.22462 | 0.226343 | 0.229257 |
| 2000 | 0.32838 | 0.248623 | 0.22406 | 0.212903 | 0.212742 | 0.214346 | 0.218016 | 0.220285 |
| 2001 | 0.333147 | 0.254611 | 0.243596 | 0.222509 | 0.223888 | 0.224306 | 0.226755 | 0.229452 |
| 2002 | 0.343267 | 0.264833 | 0.258365 | 0.236311 | 0.234699 | 0.235574 | 0.235835 | 0.239555 |
| 2003 | 0.340369 | 0.263781 | 0.249304 | 0.230009 | 0.229295 | 0.230862 | 0.23323 | 0.235322 |
| 2004 | 0.346772 | 0.264659 | 0.252693 | 0.236739 | 0.23636 | 0.238408 | 0.239932 | 0.241859 |
| 2005 | 0.322319 | 0.237694 | 0.208644 | 0.192467 | 0.192916 | 0.19758 | 0.202712 | 0.203148 |
| 2006 | 0.242972 | 0.165861 | 0.157021 | 0.131383 | 0.13257 | 0.13732 | 0.145748 | 0.149499 |
| 2007 | 0.249086 | 0.179887 | 0.17255 | 0.142378 | 0.142819 | 0.146655 | 0.154775 | 0.156992 |
| 2008 | 0.255616 | 0.196814 | 0.197231 | 0.15543 | 0.156507 | 0.15796 | 0.166382 | 0.16804 |
| 2009 | 0.264232 | 0.217325 | 0.220137 | 0.172079 | 0.172005 | 0.173316 | 0.180603 | 0.182149 |
| 2010 | 0.306473 | 0.266484 | 0.264087 | 0.20038 | 0.200474 | 0.202711 | 0.208871 | 0.209069 |
| | | | | | | | | |
| 2011 | 0.455873 | 0.406688 | 0.405991 | 0.379917 | 0.379917 | 0.379917 | 0.379917 | 0.379917 |
| 2012 | 0.48177 | 0.435519 | 0.434868 | 0.410632 | 0.410632 | 0.410632 | 0.410632 | 0.410632 |

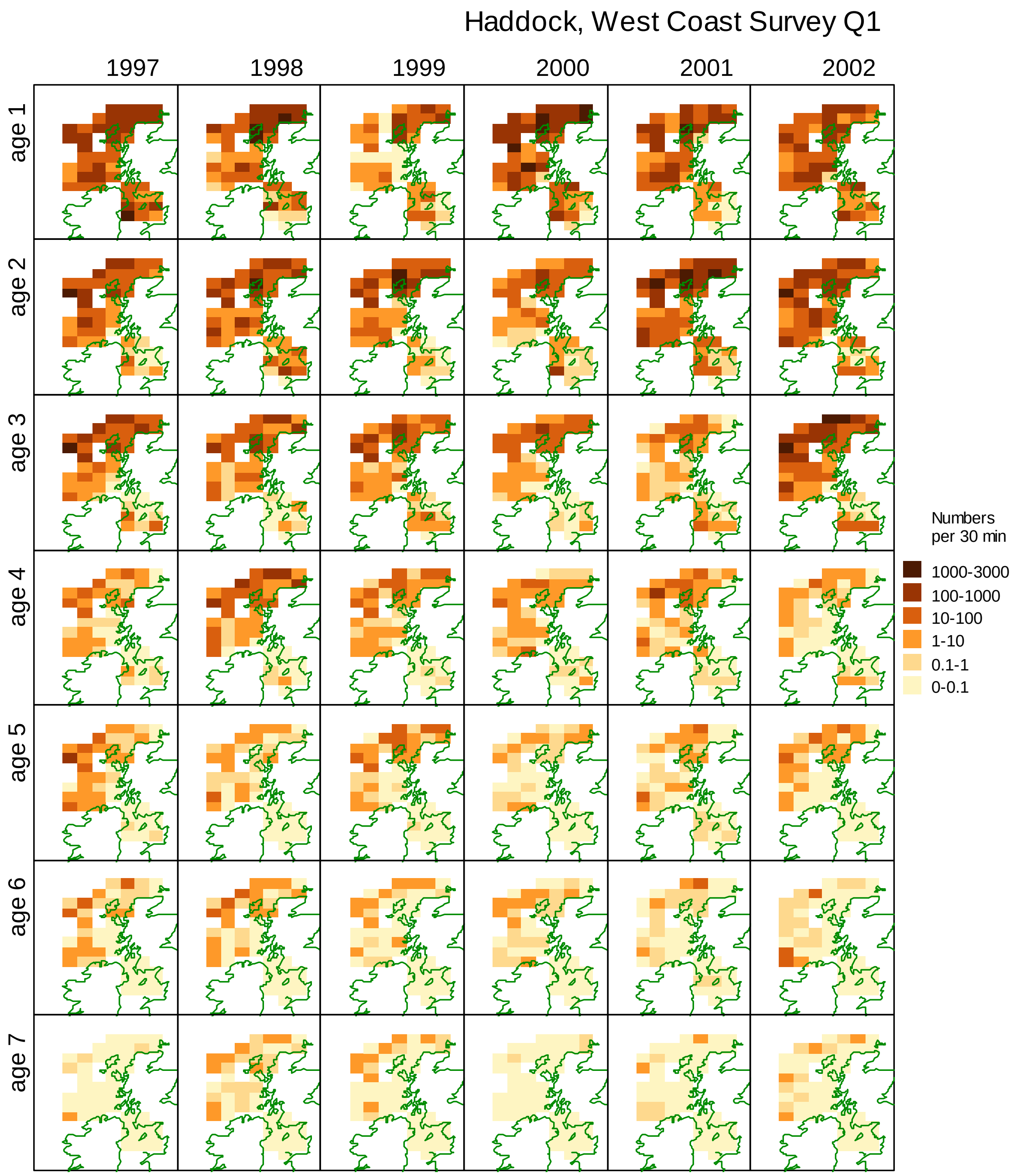


**Figure 1. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 1997–2002, ages 1–7.**

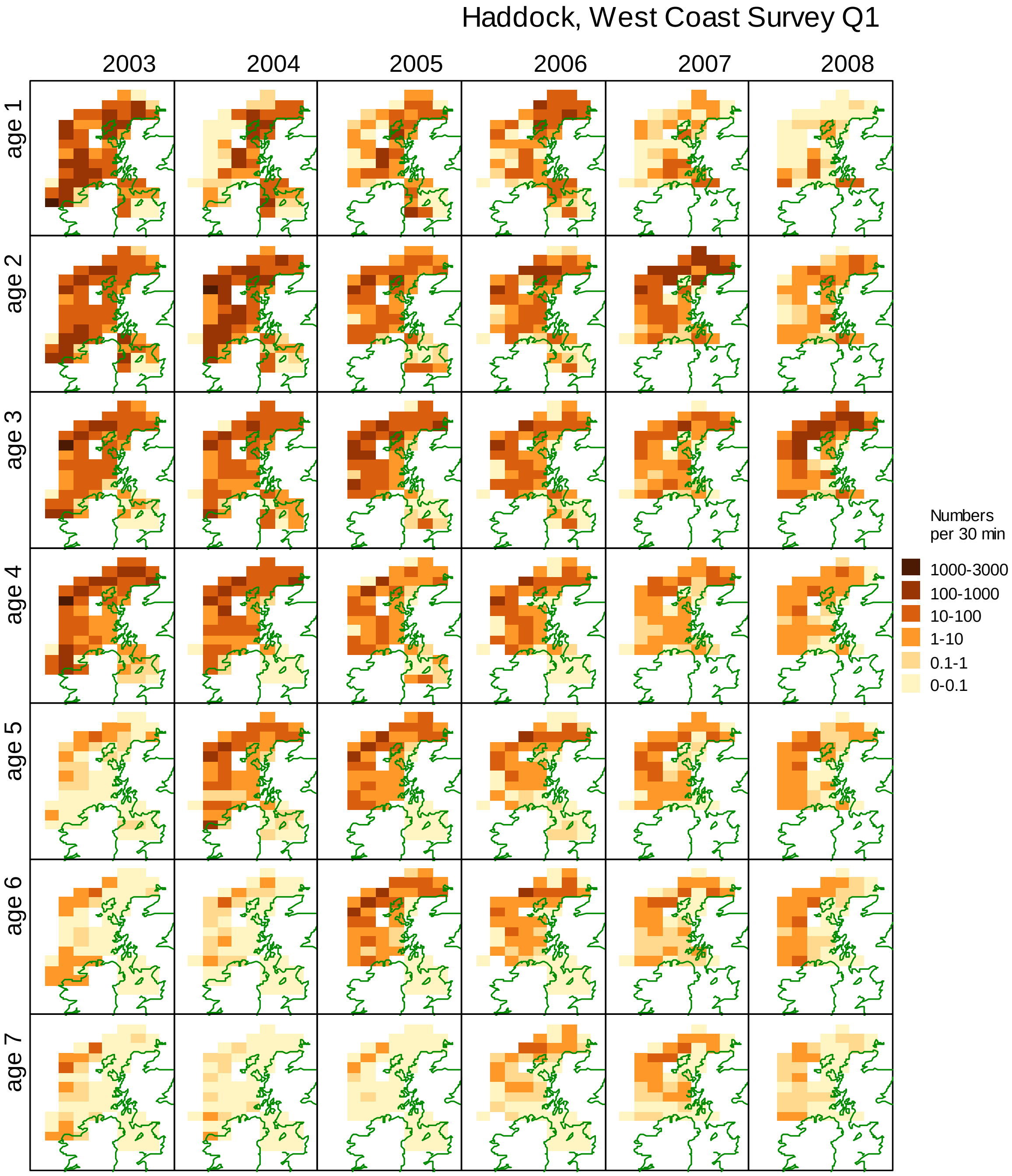


**Figure 1. continued. Haddock in Division VIa. Number per 30 min tow, averaged over ICES statistical rectangles from the west of Scotland groundfish Q1 (IBTS) survey 2003–2008, ages 1–7.**

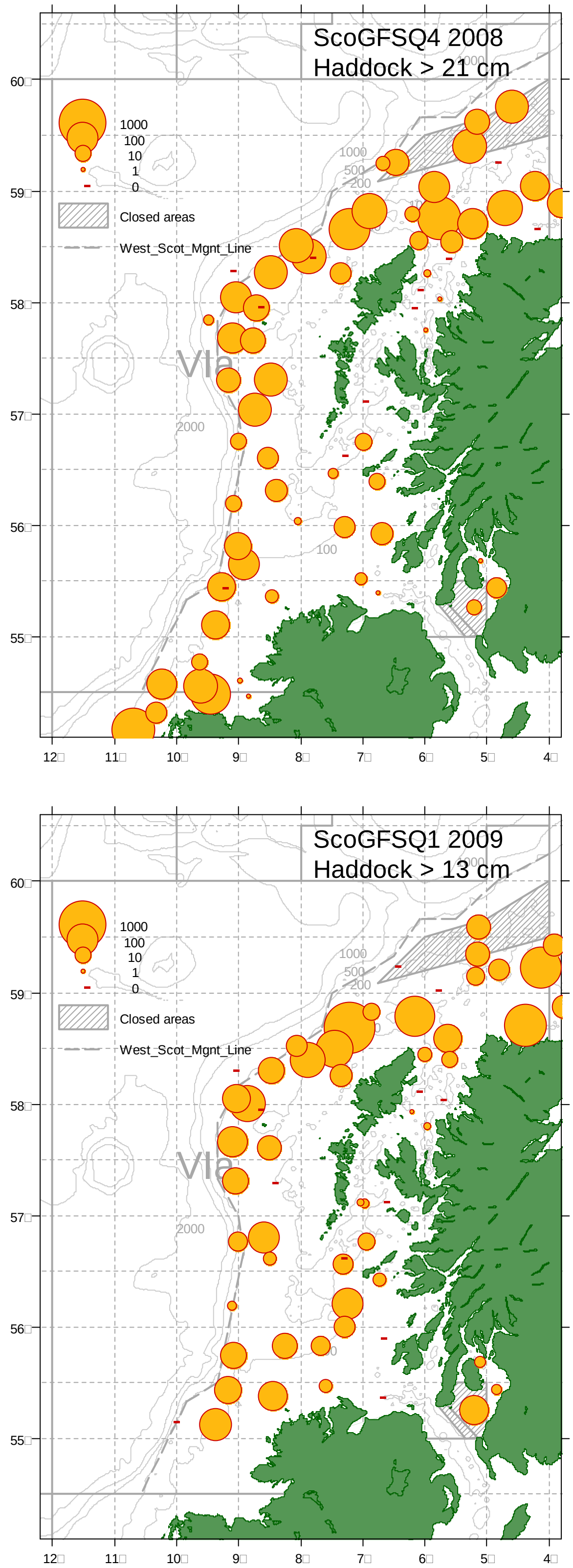


**Figure 2. Haddock in Division VIa. Numbers per 30 min tow from the Scottish groundfish surveys (ScoGFS): Quarter 4 (2008) and Quarter 1 (2009).**

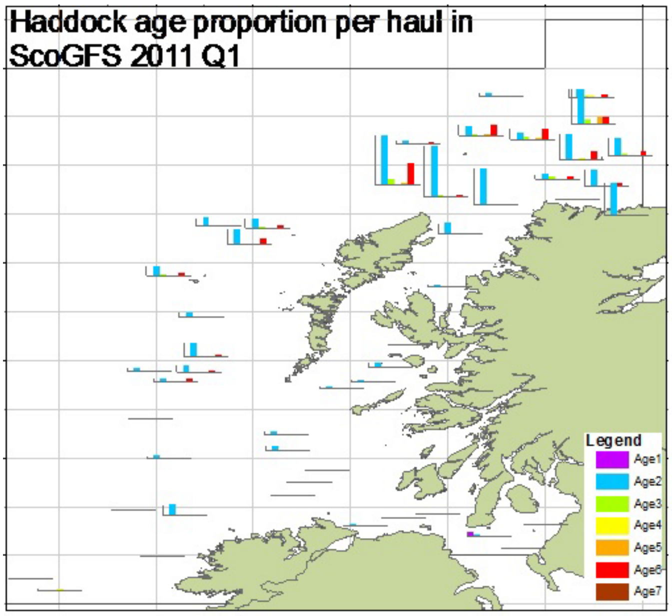


**Figure 3. Haddock in Division VIa. Proportion per haul from the Scottish groundfish surveys (ScoGFS): Quarter 1 (2011).**

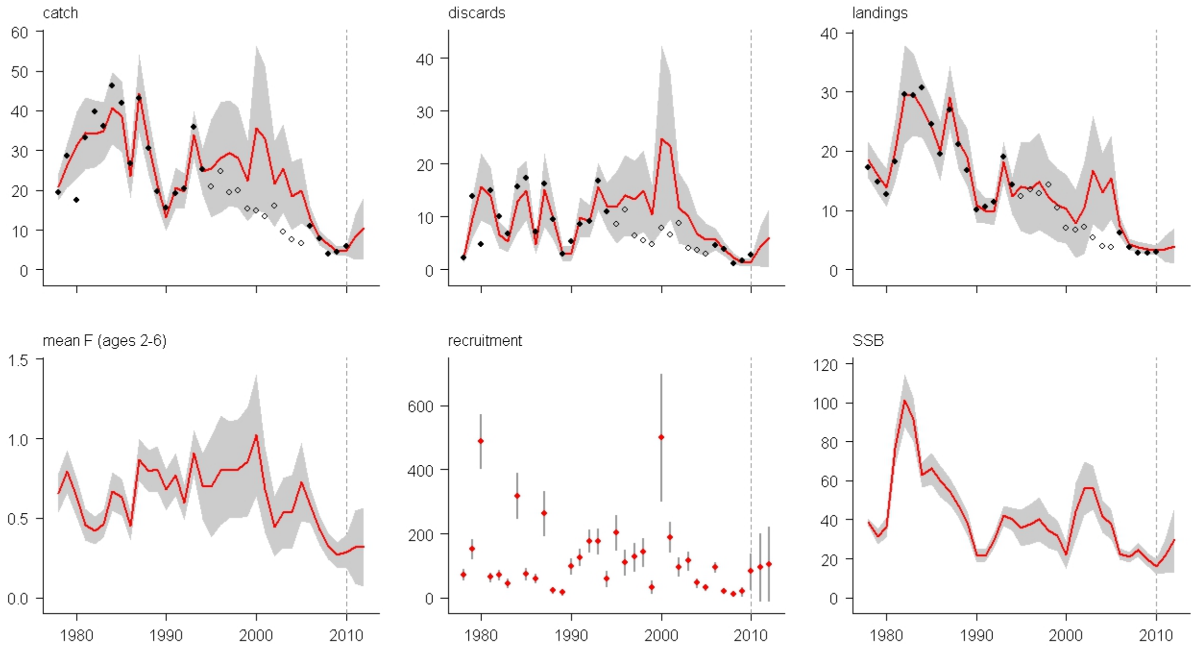


**Figure 4. Haddock in Division VIa. TSA stock summaries from the final run (excluding the ScoGFS WCIBTS Q1 2011) with catch data included 1978–1994 and 2006–2010. Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. Values presented to the right of the vertical dashed line are forecasted by the model.**

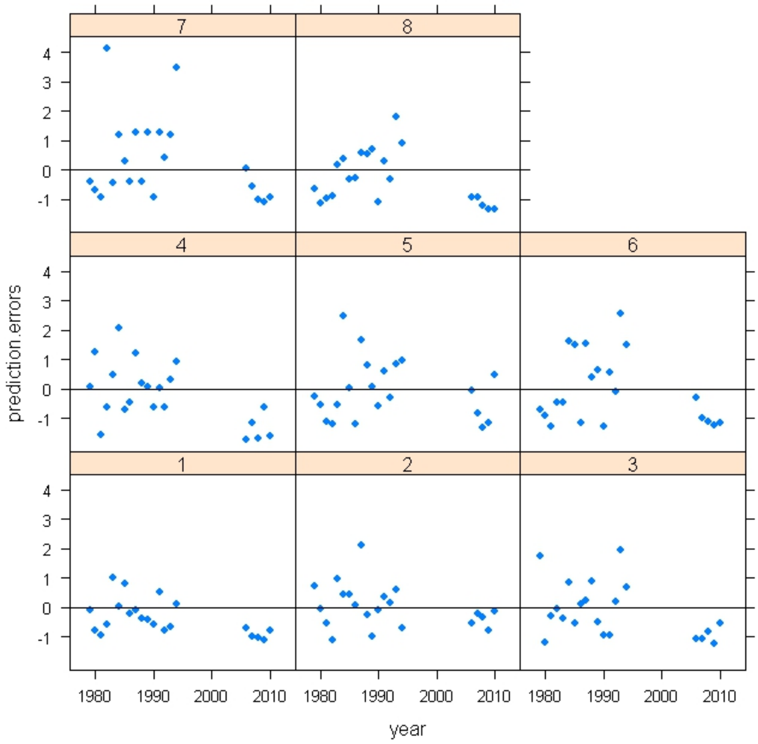


**Figure 5. Haddock in Division VIa. Standardized landings prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).**

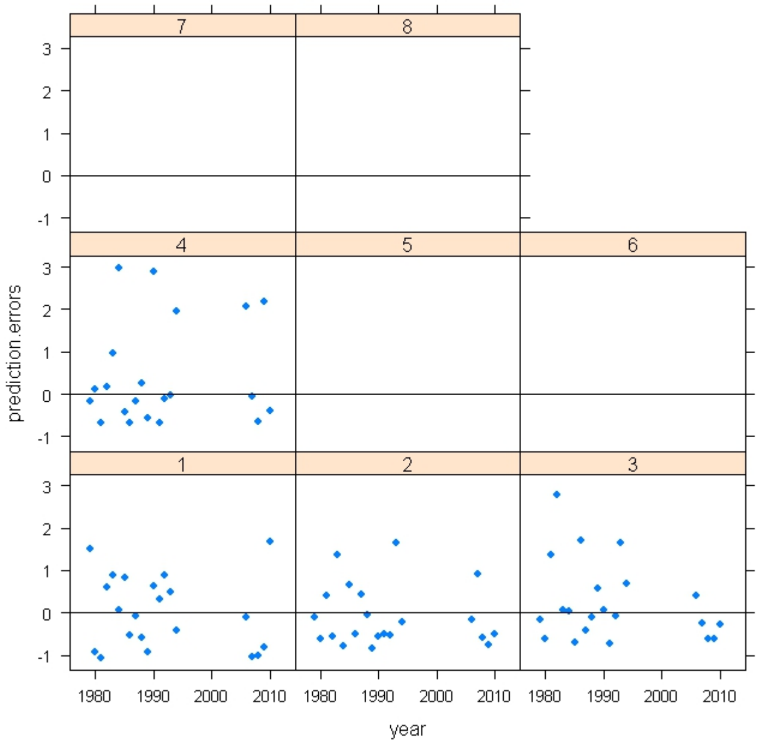


**Figure 6. Haddock in Division VIa. Standardized discards prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).**

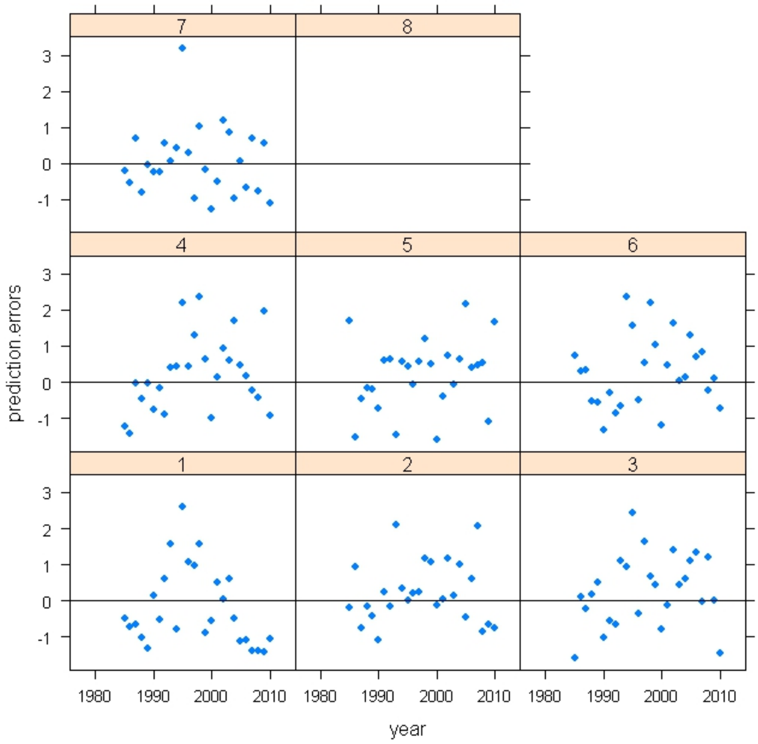


**Figure 7. Haddock in Division VIa. Standardized ScoGFS Q1 prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).**

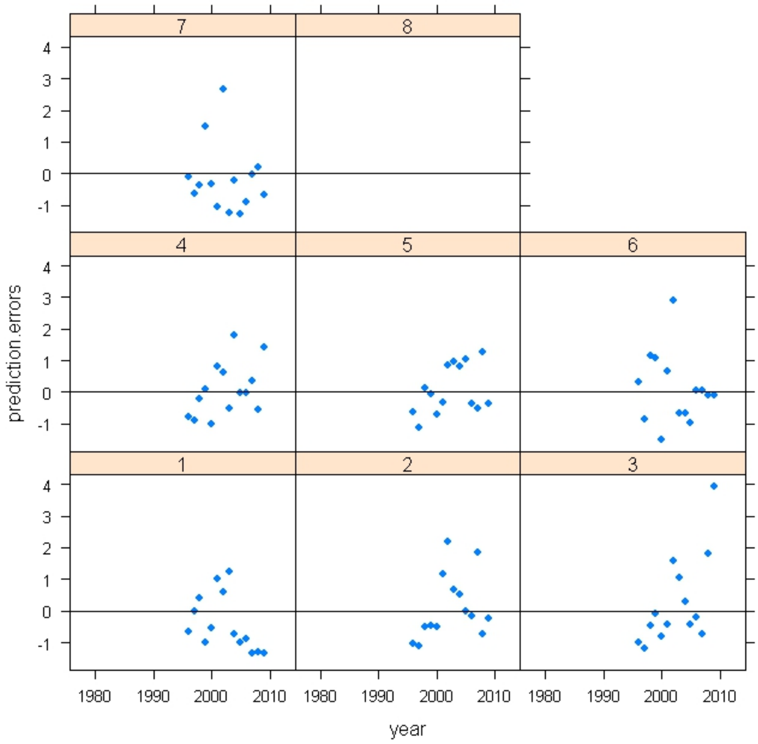


**Figure 8. Haddock in Division VIa. Standardized ScoGFS Q4 prediction errors from the final TSA run, excluding the ScoGFS WCIBTS Q1 (2011).**

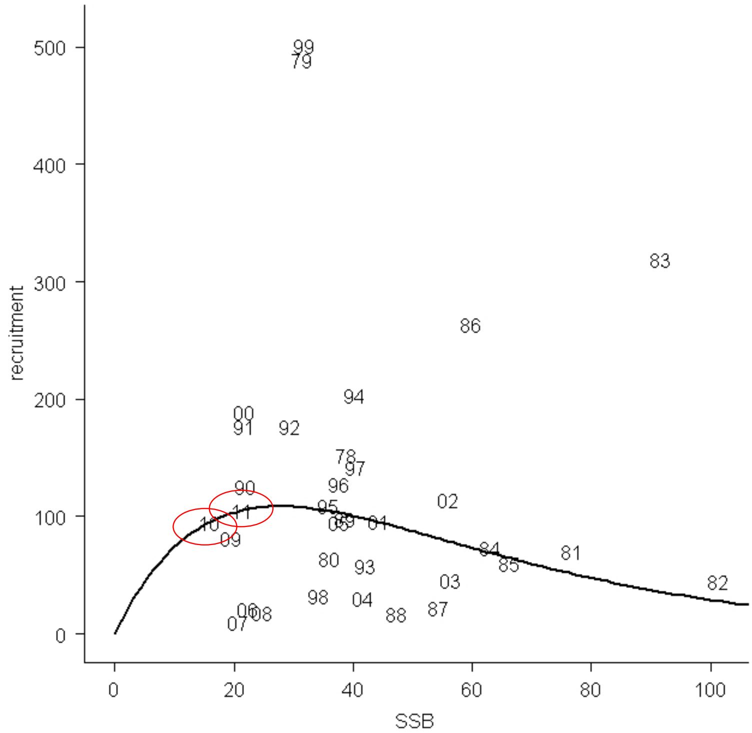


**Figure 9. Haddock in Division VIa. Stock–recruit plot from the final TSA run (excluding the ScoGFS WCIBTS Q1 2011), points labelled as year classes. Predicted recruitments are circled: for the 2009 year-class recruiting in 2010 (using ScoGFS Q1 data); and the 2010 year-class recruiting in 2011 (based on the underlying Ricker model).**

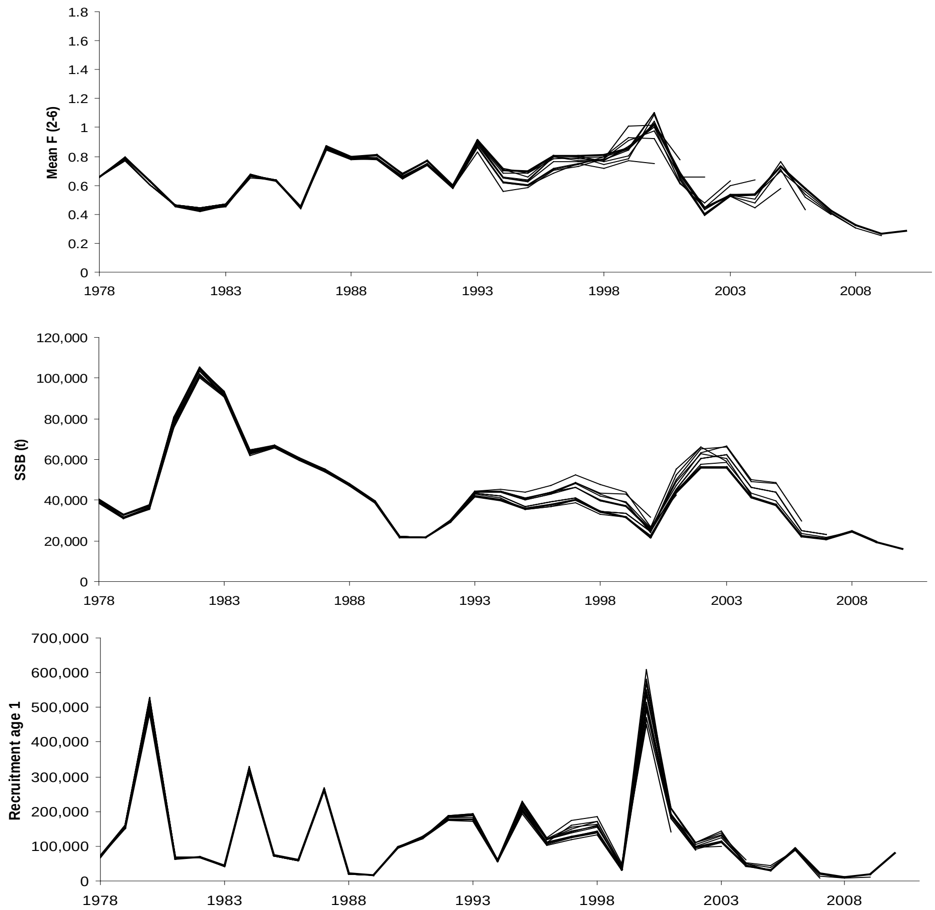


**Figure 10. Haddock in Division VIa. Estimates of Mean $F_{2\text{-}6}$, SSB and recruitment from retrospective TSA runs, excluding the ScoGFS WCIBTS Q1 (2011).**

# Stock Annex 3.4: Whiting in Area VI

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Whiting (Area VI) |
| Working Group | Assessment of Northern Shelf Demersal Stocks |
| Date | 17 May 2007 |
| Last updated | 25 May 2010 (a.jaworski@marlab.ac.uk) |

## A. General

### A.1. Stock definition

Whiting occur throughout Northeast Atlantic waters, in a wide range of depths, from shallow inshore waters down to 200 m. Adult whiting are widespread throughout Area VIa, while large numbers of juvenile fish occur in inshore areas. Whiting are less common in Division VIb, and it is likely these fish are migrants from VIa, rather than a separate stock.

While an exploration of stock identity in the North Sea has been carried out, stock definition in Area VI and surrounding waters remains poorly defined (ICES-SGISIMUW, 2005). Tagging experiments on recruiting fish have shown that whiting stocks west of Ireland are distinct from those in the Minches, Clyde and the Irish Sea. On the basis of preliminary results from FRS project MF0464, there appears to be three putative populations of whiting are found in VIa, between which interchange is limited. These are along the northwest of Scotland, the Stanton Bank region and the Firth of Clyde. Maximum likelihood analysis indicates a high degree of mixing for adult whiting between IVa whiting and the VIa component off the northwest of Scotland. Within VIa, there was little indication of interaction between population components in the south and that off the northwest coast.

### A.2. The fishery

The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish and *Nephrops*, with bycatches of whiting, saithe, megrim, lemon sole, ling and a number of skate species. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend. More recently, days-at-sea limitations associated with the cod recovery plan and the seasonal closure of some areas has lead to some switching of effort away from VIa.

The demersal whitefish fishery in Area VI occurs largely in Division VIa with the UK, Ireland, Spain and France being the most important exploiters. Landings from Rockall (Division VIb) are generally less than 10 t. The whiting fishery in VIa is dominated by the UK (Scotland) and Irish fleets. French whiting landings have declined considerably since the late 1980s.

Landings of whiting in Division VIa are affected by emergency measures introduced in 2001 as part of the cod recovery programme. Council Regulation 423\2004 introduced a cod recovery plan affecting division VIa. The measures only take effect, however east of a line defined in Council Regulation No 51\2006. Measures brought in in 2002, such as a switch from 100 to 120 mm mesh codends at the start of 2002 (Commission Regulation EC2056/2001), are likely to have had some impact on whiting. The

UK implemented a regulation requiring the fitting of a square mesh panel in certain towed gears.

Most catch of whiting comes in non-whiting directed fisheries, particularly the *Nephrops* trawl fishery. The *Nephrops* trawl fishery in VIa discards significant amounts of small whiting, making whiting landings figures a poor indicator of removals due to fishing. The proportion of whiting discarded has been very high and appears to have increased in recent years. Whiting also has a low market demand, which contributes to increased discarding and highgrading.

The minimum landing size of whiting in the human consumption fishery in this area is 27 cm.

There have been some problems regarding area misreporting of Scottish landings during the early 1990s, which are linked to area misreporting of other species such as haddock and anglerfish into Division VIb. More recently there has been area misreporting of anglerfish from VIa to IVa, which may have affected the reliability of whiting landings distribution.

### A.3. Ecosystem aspects

No information.

## B. Data

### B.1. Commercial catch

Monthly length frequency distribution data were available from Scotland for Area VIa. A total international catch-at-age distribution for Division VIa was obtained using the raising procedure described in Section 2.3 to raise this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. The Scottish market sampling length–weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division Via.

| Month | b | a |
|---|---|---|
| 1 | 2.9456 | 0.01 |
| 2 | 2.9456 | 0.0094 |
| 3 | 2.9456 | 0.009 |
| 4 | 2.9456 | 0.0088 |
| 5 | 2.9456 | 0.0088 |
| 6 | 2.9456 | 0.0089 |
| 7 | 2.9456 | 0.009 |
| 8 | 2.9456 | 0.0092 |
| 9 | 2.9456 | 0.0095 |
| 10 | 2.9456 | 0.0096 |
| 11 | 2.9456 | 0.0097 |
| 12 | 2.9456 | 0.0097 |

Discard age compositions are generally available from both Scotland and Ireland, but in recent years (2006 and 2007) lack of access to fishing vessels by Irish observers has meant that no Irish data have been collected. Work is underway to revise the Scottish discard estimates with an aim to reduce bias and increase precision. Such revisions are particularly important for the estimation of total catch for this stock which has very high discards across a wide age range. A working document set out the methodology of this work at the 2004 meeting of WGNSDS (Fryer and Millar, 2004).

### B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife-edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence of substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998, in the Irish Sea.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero. Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year i and age j the following formula is adopted:

$(CW_{i,j} + CW_{i+1,j+1})/2 = SW$ at start of year.

### B.3. Surveys

Four research vessel survey-series for whiting in VIa were available to the Working Group in 2007. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2010.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4-stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–5, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced by the IRGFS.

- Scottish fourth quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2009.

The Scottish quarter four survey was presented to the WG for the first time in 2007.

- Irish fourth quarter west coast groundfish survey (IRGFS); ages 0–6, years 2003–2009.

This survey used the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomized stations. Effort is recorded in terms of minutes towed. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 minutes towed.

Further descriptions of these surveys and distribution plots of whiting catch rates obtained on these surveys can be found in the IBTS WG Report of 2008.

The indices are provided in Table B.1.

The distribution of catches per unit of effort from the surveys in 2008 are given in Figure B.1 for the Scottish fourth quarter west coast groundfish survey (ScoGFSQ4); and Figure B.2 for the first quarter west coast groundfish survey (ScoGFSQ1).

#### B.4. Commercial cpue

Due to a number of concerns regarding the non-mandatory recording of effort in terms of hours fished, the present assessment of the stocks does not make use of commercial catch per unit of effort data. The data are included here for completeness (Table B.2) and include:

- Scottish light trawlers (ScoLTR): ages 1–7 years 1965–2005
- Scottish seiners (ScoSEI): ages 1–6 years 1965–2005
- Scottish *Nephrops* trawlers (ScoNTR): ages 1–6 years 1965–2005
- Irish Otter Trawlers (IreOTB): ages 1–7 years 1995–2005

Data to update these time-series were not available for 2006 or 2007.n

#### B.5. Fecundity

Fecundity data for a number of areas are available from Hislop and Hall (1974), and was estimated at 4.933 $L^{3.25}$ for whiting in Area VI.

### C. Historical stock development

Whiting has never been a particularly valuable species and has tended not to be targeted by commercial fishermen. It tends to be taken more as a bycatch, with other species fished more intensively in Division VIa, such as haddock, cod and anglerfish. As with other gadoids in VIa, whiting stocks have declined steadily since the late 1970s.

### D. Short-term projection

Not done.

### E. Medium-term projections

No medium-term projections are carried out for this stock.

### F. Yield and biomass-per-recruit/long-term projections

Not done.

### G. Biological reference points

Precautionary approach reference points:

> VIa-"Long-term information on the historical yield and catch composition all indicate that the present stock size is low. A survey-based assessment covering the more recent period indicates that the stock is at its lowest level over this time period. Total mortality is at the highest level over the time period. ICES considers that $B_{lim}$ is 16 000 t and $B_{pa}$ be set at 22 000 t. ICES proposes that $F_{lim}$ is 1.0 and $F_{pa}$ be set at 0.6."

VIb-"Landings of whiting from Division VIb are negligible. No assessment has been carried out on this stock."

## H. Other issues

None.

## I. References

J. R. G. Hislop. 1975. The breeding and growth of whiting, *Merlangius merlangus*, in captivity. J. Cons. int. Explor. Mer, 36(2): 119–127.

Hislop, J. and Hall, W. 1974. The fecundity of whiting, *Merlangius merlangius* (L.), in the North Sea, Minch and at Iceland. J. Cons. int. Explor. Mer, 36(1): 42–49.

ICES. 2000. ICES CM 2000/ACFM:1.

ICES-SGSIMUW. 2005. Report of the Study Group on Stock Identity and Management Units of Whiting. ICES CM 2005/G:03.

**Table B.1. Available survey tuning-series. For IreGFS, effort is given as minutes towed, numbers are in units.**

| SCOGFSQ1: Scottish Groundfish Sruvey - Effort in hours - Numbers-at-age | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | |
| Year | (hours) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1985 | 10 | 3140 | 1792 | 380 | 85 | 23 | 156 | 18 |
| 1986 | 10 | 1456 | 1526 | 403 | 68 | 10 | 9 | 10 |
| 1987 | 10 | 6938 | 1054 | 584 | 143 | 36 | 2 | 1 |
| 1988 | 10 | 567 | 3469 | 653 | 189 | 42 | 5 | 1 |
| 1989 | 10 | 910 | 505 | 586 | 237 | 48 | 3 | 0 |
| 1990 | 10 | 1818 | 572 | 122 | 216 | 61 | 4 | 1 |
| 1991 | 10 | 3203 | 277 | 298 | 22 | 39 | 9 | 1 |
| 1992 | 10 | 4777 | 1597 | 410 | 517 | 56 | 18 | 0 |
| 1993 | 10 | 5532 | 6829 | 644 | 91 | 30 | 11 | 2 |
| 1994 | 10 | 6614 | 2443 | 1487 | 174 | 56 | 15 | 6 |
| 1995 | 10 | 5598 | 2831 | 1160 | 370 | 70 | 17 | 32 |
| 1996 | 10 | 9384 | 2238 | 635 | 341 | 135 | 30 | 5 |
| 1997 | 10 | 5663 | 2444 | 1531 | 355 | 102 | 17 | 4 |
| 1998 | 10 | 9851 | 1352 | 294 | 195 | 50 | 14 | 1 |
| 1999 | 10 | 6125 | 4952 | 489 | 103 | 16 | 1 | 0.4 |
| 2000 | 10 | 12862 | 471 | 152 | 34 | 10 | 11 | 0 |
| 2001 | 10 | 4653 | 1954 | 242 | 41 | 8 | 1 | 1 |
| 2002 | 10 | 5542 | 1028 | 964 | 86 | 15 | 1 | 1 |
| 2003 | 10 | 6934 | 746 | 436 | 300 | 32 | 2 | 4 |
| 2004 | 10 | 5888 | 1566 | 189 | 131 | 44 | 9 | 1 |
| 2005 | 10 | 1308 | 723 | 183 | 35 | 8 | 11 | 2 |
| 2006 | 10 | 1441 | 466 | 282 | 77 | 0.3 | 3 | 0.6 |
| 2007 | 10 | 614 | 522 | 127 | 75 | 16 | 3 | 2 |
| 2008 | 10 | 593 | 127 | 77 | 26 | 8 | 3 | 0 |
| 2009 | 10 | 906 | 387 | 103 | 105 | 20 | 9 | 7 |
| 2010 | 10 | 3523 | 340 | 108 | 52 | 40 | 4 | 3 |

| | IR-WCGFS : Irish West Coast GFS (VIa) - Effort (min. towed) - Whiting number-at-age | | | | | |
|---|---|---|---|---|---|---|
| | Effort | Age | | | | |
| Year | (min) | 0 | 1 | 2 | 3 | 4 | 5 |
| 1993 | 2130 | 14403 | 32643 | 11419 | 1464 | 231 | 13 |
| 1994 | 1865 | 264 | 11969 | 4817 | 2812 | 78 | 57 |
| 1995 | 2026 | 34584 | 5609 | 6406 | 734 | 186 | 80 |
| 1996 | 2008 | 376 | 7457 | 3551 | 374 | 232 | 5 |
| 1997 | 1879 | 1550 | 13865 | 8207 | 1022 | 524 | 50 |
| 1998 | 1936 | 1829 | 4077 | 3361 | 663 | 121 | 5 |
| 1999 | 1914 | 3337 | 3059 | 1965 | 322 | 11 | 12 |
| 2000 | 1878 | 682 | 10102 | 2126 | 109 | 109 | 4 |
| 2001 | 965 | 1118 | 5201 | 2903 | 149 | 70 | 3 |
| 2002 | 796 | 594 | 8247 | 9348 | 820 | 280 | 0 |

**(cont). Whiting in VIa. Available survey tuning-series. For ScoGFSQ4, numbers are standardized to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardizing.**

| | IRGFS: Irish groundfish survey - effort in minutes - numbers-at-age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | |
| Year | (min) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 2003 | 1127 | 1101 | 12886 | 2894 | 512 | 290 | 102 | 1 |
| 2004 | 1200 | 6924 | 3114 | 1312 | 104 | 35 | 16 | 1 |
| 2005 | 960 | 910 | 2228 | 1126 | 91 | 5 | 4 | 0 |
| 2006 | 1510 | 99 | 1055 | 921 | 214 | 27 | 3 | 0 |
| 2007 | 1173 | 138 | 1989 | 2380 | 722 | 169 | 251 | 122 |
| 2008 | 1135 | 24 | 4342 | 1328 | 573 | 243 | 123 | 36 |
| 2009 | 1378 | 16906 | 1430 | 989 | 325 | 68 | 21 | 41 |

| | ScoGFSQ4 : Quarter four Scottish groundfish survey - Effort in hours - numbers-at-age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Effort | Age | | | | | | | | |
| Year | (hours) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1996 | 10 | 5154 | 1908 | 1116 | 570 | 188 | 51 | 6 | 1 | 0 |
| 1997 | 10 | 8001 | 2869 | 951 | 323 | 160 | 46 | 12 | 1 | 0 |
| 1998 | 10 | 1852 | 2713 | 1124 | 149 | 100 | 20 | 1 | 0 | + |
| 1999 | 10 | 8203 | 2338 | 582 | 141 | 33 | 24 | 1 | 1 | 0 |
| 2000 | 10 | 4434 | 4055 | 789 | 160 | 9 | 7 | 1 | 0 | 0 |
| 2001 | 10 | 9615 | 1957 | 1420 | 155 | 40 | 12 | 2 | 0 | 0 |
| 2002 | 10 | 14658 | 1591 | 621 | 479 | 30 | 9 | 5 | 0 | 0 |
| 2003 | 10 | 9932 | 3446 | 567 | 338 | 83 | 27 | 4 | 0 | 0 |
| 2004 | 10 | 5923 | 1758 | 940 | 83 | 57 | 62 | 1 | 0 | 0 |
| 2005 | 10 | 2297 | 308 | 318 | 76 | 9 | 4 | 0.9 | 0.7 | 0 |
| 2006 | 10 | 415 | 296 | 140 | 101 | 35 | 8 | 3 | 0.5 | 0 |
| 2007 | 10 | 1894 | 434 | 326 | 99 | 83 | 48 | 0.6 | 0 | 0 |
| 2008 | 10 | 2297 | 208 | 78 | 110 | 28 | 24 | 4 | 0 | + |
| 2009 | 10 | 4833 | 236 | 178 | 50 | 58 | 12 | 6 | 6 | 0 |

**Table B.2. Commercial cpue tuning-series available to whiting in VIa.**

| 2009 WHITING AREA 6A | | | | | | | |
|---|---|---|---|---|---|---|---|
| 108 | | | | | | | |
| SCOLTR: Scottish Light Trawl: Effort in hours: Numbers-at-age (thousands) | | | | | | | |
| 1965 | 2005 | | | | | | |
| 1 | 1 | 0 | 1 | | | | |
| 1 | 7 | | | | | | |
| 37387 | 2011.623 | 469.253 | 3512.923 | 393.473 | 14.925 | 5.445 | 0.909 |
| 40538 | 1036.117 | 926.485 | 162.985 | 5508.27 | 333.46 | 32.68 | 6.196 |
| 80916 | 2539.797 | 4967.604 | 1637.023 | 101.256 | 2456.915 | 133.979 | 12.466 |
| 65348 | 1931.014 | 3404.448 | 1868.458 | 677.298 | 51.295 | 844.125 | 58.939 |
| 106856 | 46.897 | 8823.442 | 2211.584 | 578.006 | 278.879 | 28.188 | 516.892 |
| 129741 | 94.958 | 5275.823 | 8514.611 | 712.848 | 143.241 | 35.554 | 3.428 |
| 137728 | 1566.57 | 4472.064 | 1026.561 | 9818.08 | 337.772 | 63.477 | 25.237 |
| 154288 | 13450.885 | 4637.042 | 1716.159 | 334.786 | 5435.152 | 309.86 | 29.756 |
| 93992 | 4613.649 | 12778.492 | 680.372 | 148.997 | 42.975 | 478.522 | 39.083 |
| 88651 | 7452.711 | 15917.02 | 1773.837 | 159.241 | 17.112 | 6.477 | 78.812 |
| 132353 | 10597.964 | 6684.991 | 10431.537 | 837.283 | 79.71 | 12.155 | 2.811 |
| 139225 | 10858.324 | 15481.895 | 3550.826 | 5483.438 | 412.525 | 13.045 | 4.668 |
| 143574 | 18222.115 | 4276.619 | 5983.177 | 773.244 | 1126.782 | 74.579 | 1.916 |
| 127387 | 9805.191 | 5887.935 | 1561.61 | 1814.903 | 127.832 | 244.126 | 3.76 |
| 99803 | 1846.163 | 9530.148 | 2446.896 | 368.018 | 290.896 | 31.887 | 57.01 |
| 121211 | 1856.938 | 4385.272 | 4359.469 | 1052.873 | 170.989 | 172.29 | 10.997 |
| 165002 | 983.137 | 13544.1 | 4617.56 | 1330.75 | 504.711 | 152.752 | 62.619 |
| 135280 | 8248.806 | 2593.129 | 10934.792 | 1899.759 | 316.934 | 74.891 | 62.409 |
| 112332 | 4809.036 | 4322.894 | 2548.597 | 8292.216 | 1696.241 | 253.9 | 54.475 |
| 132217 | 29865.064 | 4084.418 | 2582.188 | 1149.781 | 5206.862 | 592.972 | 221.473 |
| 142815 | 9243.535 | 11577.551 | 2515.313 | 663.96 | 360.662 | 917.939 | 82.73 |
| 126533 | 3187.288 | 6006.487 | 2693.592 | 621.738 | 98.497 | 50.635 | 93.945 |
| 131720 | 12328.429 | 6004.925 | 2767.12 | 1229.144 | 147.776 | 43.178 | 32.132 |
| 158191 | 5358.52 | 15325.219 | 2988.119 | 1334.433 | 316.668 | 46.956 | 2.997 |
| 217443 | 3161.234 | 1640.767 | 5226.339 | 1473.139 | 434.728 | 129.89 | 14.252 |
| 169667 | 4110.42 | 4152.38 | 972.043 | 1380.502 | 386.872 | 51.478 | 6.092 |
| 209901 | 7018.52 | 2968.053 | 3981.784 | 336.752 | 423.153 | 73.429 | 5.829 |
| 189288 | 9761.596 | 6548.587 | 1727.049 | 2100.437 | 113.974 | 102.439 | 10.66 |
| 189925 | 2623.886 | 10105.623 | 4392.988 | 1169.932 | 1701.769 | 51.678 | 46.841 |
| 174879 | 3251.43 | 6503.608 | 5363.793 | 1739.967 | 333.927 | 291.821 | 13.881 |
| 175631 | 1775.509 | 5661.947 | 5310.813 | 1995.375 | 569.453 | 114.177 | 107.935 |
| 214159 | 2738.034 | 8043.865 | 4647.63 | 2543.265 | 833.461 | 213.15 | 24.196 |
| 179605 | 3107.284 | 3973.701 | 5098.515 | 1858.52 | 532.696 | 95.153 | 39.379 |
| 142457 | 3997.939 | 3171.019 | 2547.76 | 2327.54 | 654.589 | 149.808 | 79.812 |
| 98993 | 559.916 | 3273.961 | 1709.217 | 814.593 | 793.265 | 122.037 | 34.883 |
| 76157 | 4363.101 | 2324.771 | 2202.561 | 627.094 | 169.833 | 201.883 | 8.678 |
| 35698 | 575.281 | 2603.626 | 1358.595 | 783.414 | 117.804 | 37.996 | 5.442 |
| 15174 | 389.652 | 848.153 | 1566.132 | 374.617 | 166.509 | 16.845 | 5.038 |
| 9357 | 565.293 | 207.507 | 273.115 | 578.307 | 100.052 | 41.916 | 0.206 |
| 7116 | 1769.901 | 1215.938 | 242.922 | 199.9 | 221.001 | 27.997 | 3.138 |
| 3063 | 217.522 | 400.094 | 268.966 | 23.085 | 27.158 | 14.318 | 2.462 |

**Table B.2. continued.**

| SCOSEI: Scottish Seine: Effort in hours: Numbers-at-age (thousands) | | | | | | |
|---|---|---|---|---|---|---|
| 1965 | 2005 | | | | | |
| 1 | 1 | 0 | 1 | | | |
| 1 | 6 | | | | | |
| 153103 | 8570.938 | 4534.63 | 19453.707 | 1412.984 | 62.399 | 15.334 |
| 156511 | 2872.249 | 12671.39 | 1491.149 | 13027.566 | 736.15 | 68.22 |
| 158208 | 7058.77 | 23604.969 | 5804.573 | 363.182 | 5528.921 | 304.951 |
| 150094 | 11817.932 | 14128.65 | 4897.227 | 1409.535 | 134.705 | 1651.222 |
| 140718 | 1314.237 | 19167.426 | 4024.433 | 1038.908 | 420.643 | 45.006 |
| 95629 | 979.255 | 2065.056 | 9177.95 | 815.703 | 176.987 | 51.144 |
| 98748 | 3280.938 | 6459.36 | 2466.983 | 14808.06 | 484.003 | 73.488 |
| 70741 | 20563.777 | 7286.501 | 1143.727 | 588.902 | 3139.349 | 112.588 |
| 59596 | 16428.303 | 16410.354 | 1995.231 | 373.15 | 97.243 | 886.47 |
| 56448 | 8764.309 | 28089.33 | 3578.12 | 289.184 | 22.105 | 9.317 |
| 56420 | 15931.473 | 9161.576 | 13093.543 | 585.337 | 37.682 | 9.127 |
| 57090 | 7559.305 | 30718.529 | 6226.15 | 4887.683 | 283.504 | 18.081 |
| 41920 | 14522.98 | 4873.693 | 6783.85 | 584.118 | 1035.664 | 43.296 |
| 33599 | 9880.994 | 4708.252 | 812.33 | 1086.089 | 65.835 | 152.233 |
| 38465 | 3779.036 | 13497.126 | 3739.924 | 473.079 | 392.189 | 16.481 |
| 38700 | 2222.899 | 3686.353 | 4277.55 | 1081.223 | 273.049 | 118.803 |
| 37208 | 789.787 | 9229.84 | 3128.155 | 1025.456 | 426.614 | 90.387 |
| 36689 | 1146.222 | 1977.49 | 9664.041 | 1183.655 | 229.857 | 68.248 |
| 38080 | 3803.96 | 3110.436 | 1942.945 | 5805.497 | 1181.95 | 138.395 |
| 29561 | 3965.733 | 2170.117 | 1220.296 | 382.107 | 2024.552 | 218.843 |
| 26365 | 18813.885 | 6473.455 | 1248.851 | 327.561 | 171.234 | 557.447 |
| 19960 | 1423.965 | 4902.12 | 1815.778 | 359.211 | 53.845 | 24.911 |
| 26332 | 8664.831 | 3706.126 | 2068.674 | 916.903 | 142.281 | 19.137 |
| 21383 | 7392.194 | 8210.657 | 1658.022 | 1078.674 | 218.449 | 22.005 |
| 39350 | 2182.008 | 1845.431 | 4488.746 | 1282.547 | 272.354 | 186.923 |
| 27664 | 2699.332 | 2964.297 | 687.892 | 940.682 | 279.68 | 34.508 |
| 25787 | 4160.412 | 2318.718 | 3285.513 | 305.785 | 290.789 | 53.282 |
| 20273 | 7513.958 | 5370.645 | 1341.721 | 1622.613 | 102.037 | 101.204 |
| 24315 | 1509.725 | 6046.03 | 2291.531 | 675.422 | 789.292 | 22.916 |
| 21305 | 1725.208 | 3310.909 | 2498.717 | 701.186 | 108.245 | 140.133 |
| 21950 | 721.806 | 2616.333 | 2260.832 | 970.329 | 298.966 | 83.208 |
| 15205 | 1270.19 | 2353.781 | 1371.875 | 819.771 | 297.3 | 67.732 |
| 11449 | 1096.1 | 1273.361 | 1933.262 | 696.409 | 187.498 | 33.748 |
| 11166 | 4251.142 | 1659.104 | 1010.394 | 614.297 | 265.65 | 62.355 |
| 8638 | 823.21 | 2152.386 | 706.708 | 294.599 | 179.097 | 43.194 |
| 6431 | 2601.077 | 887.944 | 755.637 | 152.896 | 66.565 | 19.536 |
| 5893 | 728.924 | 1007.442 | 454.373 | 240.788 | 40.285 | 22.082 |
| 3817 | 335.558 | 583.357 | 482.121 | 132.428 | 40.991 | 2.935 |
| 2370 | 3130.339 | 260.924 | 133.135 | 290.007 | 34.543 | 8.6 |
| 1173 | 7323.289 | 758.611 | 165.379 | 83.46 | 77.222 | 2.096 |
| 476 | 676.408 | 225.196 | 143.246 | 10.154 | 15.355 | 3.048 |

**Table B.2. continued.**

| SCONTR: Scottish Nephrops Trawl: Effort in hours: Numbers-at-age (thousands) | | | | | |
|---|---|---|---|---|---|
| 1965 | 2005 | | | | |
| 1 | 1 | 0 | 1 | | |
| 1 | 6 | | | | |
| 101975 | 1659.715 | 453.604 | 1101.02 | 102.448 | 4.875 |
| 116972 | 613.623 | 951.561 | 154.546 | 785.807 | 44.575 |
| 135811 | 1788.967 | 2002.916 | 444.377 | 15.668 | 322.969 |
| 166713 | 1761.346 | 1850.07 | 637.399 | 159.199 | 12.641 |
| 155131 | 736.536 | 2706.572 | 437.098 | 155.072 | 44.263 |
| 144704 | 439.172 | 645.419 | 1379.363 | 127.922 | 31.719 |
| 127638 | 1072.488 | 444.198 | 235.897 | 1405.7 | 60.499 |
| 185397 | 3744.591 | 1908.742 | 232.266 | 70.731 | 730.108 |
| 186342 | 3462.89 | 5445.012 | 486.932 | 168.428 | 24.824 |
| 186342 | 1933.55 | 5427.964 | 650.405 | 87.286 | 11.605 |
| 203053 | 5916.971 | 2730.363 | 2846.712 | 319.449 | 35.425 |
| 224347 | 4061.224 | 4343.339 | 893.637 | 1142.92 | 125.278 |
| 196403 | 3573.612 | 1393.724 | 1431.401 | 168.241 | 289.689 |
| 219562 | 6053.242 | 2596.492 | 417.688 | 570.766 | 110.339 |
| 273713 | 659.614 | 3413.303 | 934.795 | 207.461 | 216.936 |
| 254147 | 1439.22 | 1529.161 | 1377.826 | 281.539 | 44.696 |
| 286461 | 1090.91 | 5250.686 | 1199.303 | 430.934 | 105.108 |
| 288902 | 2882.413 | 422 | 2552.725 | 439.981 | 95.697 |
| 293396 | 2702.936 | 1289.896 | 464.524 | 1258.148 | 205.504 |
| 312947 | 15763.118 | 731.211 | 414.638 | 132.72 | 870.58 |
| 384215 | 14885.186 | 3109.454 | 505.209 | 225.601 | 91.132 |
| 368971 | 2231.072 | 1259.03 | 707.734 | 246.405 | 8.838 |
| 395355 | 12048.819 | 1562.25 | 799.307 | 375.73 | 43.994 |
| 397682 | 19926.506 | 12751.985 | 539.705 | 138.471 | 31.741 |
| 379169 | 9854.602 | 485.161 | 443.582 | 152.424 | 71.883 |
| 390391 | 7434.593 | 1407.942 | 58.831 | 63.502 | 8.758 |
| 414817 | 13745.576 | 1280.079 | 294.651 | 27.112 | 43.958 |
| 391325 | 15245.132 | 3122.017 | 453.21 | 211.635 | 19.575 |
| 406753 | 6063.665 | 2833.312 | 611.27 | 159.111 | 112.856 |
| 380688 | 22785.318 | 4821.332 | 2174.707 | 613.104 | 18.004 |
| 333756 | 14759.284 | 5645.468 | 494.013 | 362.773 | 33.499 |
| 345007 | 14700.369 | 1316.965 | 633.638 | 192.741 | 44.427 |
| 354884 | 7854.017 | 1893.631 | 387.294 | 176.713 | 17.444 |
| 350882 | 13268.769 | 1926.434 | 620.474 | 116.935 | 63.417 |
| 337585 | 7208.116 | 1905.577 | 475.713 | 92.945 | 80.71 |
| 332659 | 31208.406 | 934.503 | 360.23 | 101.447 | 28.855 |
| 305743 | 1743.097 | 1271.809 | 189.3 | 80.436 | 14.844 |
| 258169 | 7281.766 | 1291.392 | 483.271 | 29.948 | 8.517 |
| 255729 | 4468.485 | 586.213 | 191.646 | 197.557 | 41.643 |
| 232356 | 3881.27 | 1310.954 | 239.992 | 157.625 | 102.126 |
| 220936 | 1738.881 | 829.542 | 258.178 | 41.47 | 16.707 |

**Table B.2. continued.**

| IreOTB : Irish otter trawl - Effort in hours - numbers-at-age (thousands) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1995 | 2005 | | | | | | |
| 1 | 1 | 0 | 1 | | | | |
| 1 | 7 | | | | | | |
| 56335 | 222 | 298 | 530 | 461 | 92 | 28 | 98 |
| 60709 | 165 | 531 | 670 | 281 | 175 | 33 | 12 |
| 62698 | 99 | 358 | 515 | 282 | 339 | 133 | 89 |
| 57403 | 51 | 1092 | 552 | 312 | 186 | 218 | 232 |
| 53192 | 98 | 315 | 437 | 266 | 198 | 109 | 123 |
| 46913 | 50 | 131 | 188 | 303 | 158 | 76 | 65 |
| 48358 | 14 | 304 | 144 | 101 | 126 | 100 | 44 |
| 37231 | 31 | 162 | 388 | 27 | 65 | 97 | 47 |
| 39803 | 90 | 294 | 604 | 492 | 131 | 30 | 0 |
| 35140 | 33 | 387 | 266 | 245 | 200 | 28 | 21 |
| 30941 | 23 | 159 | 188 | 78 | 41 | 19 | 2 |

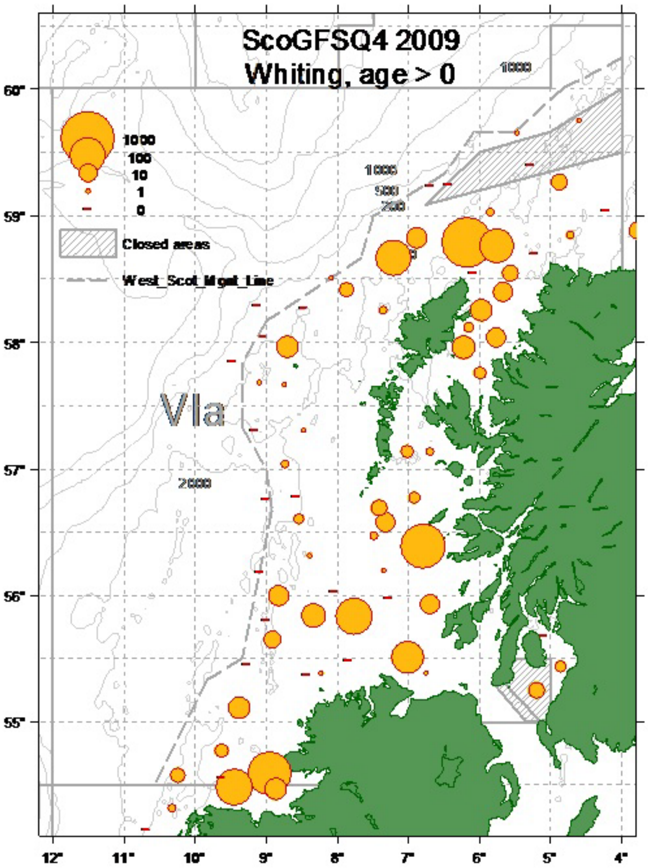


**Figure B.1. Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2009 Scottish fourth quarter west coast groundfish survey. Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend (top left).**

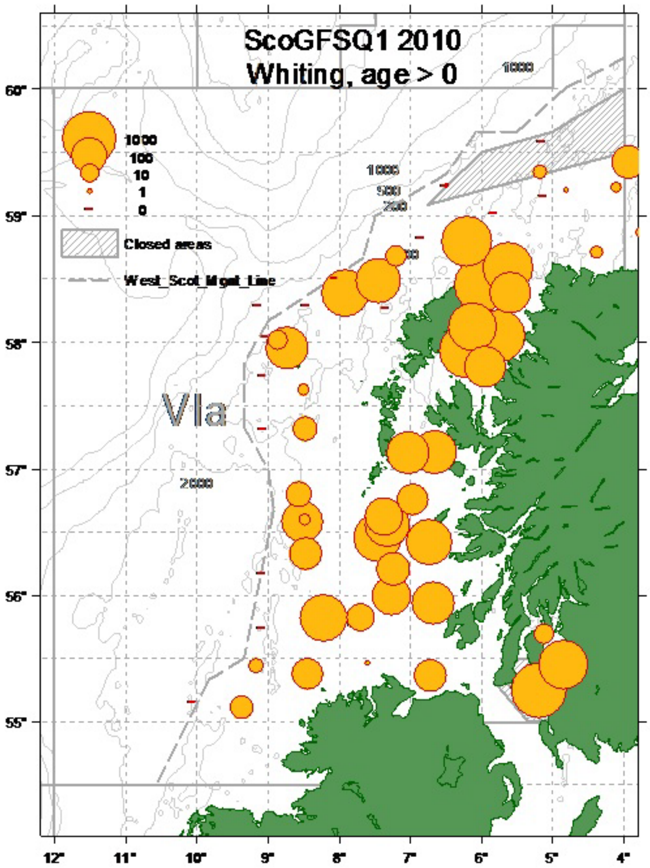


**Figure B.2. Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2010 Scottish first quarter west coast groundfish survey (ScoGFSQ1). Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend (top left).**

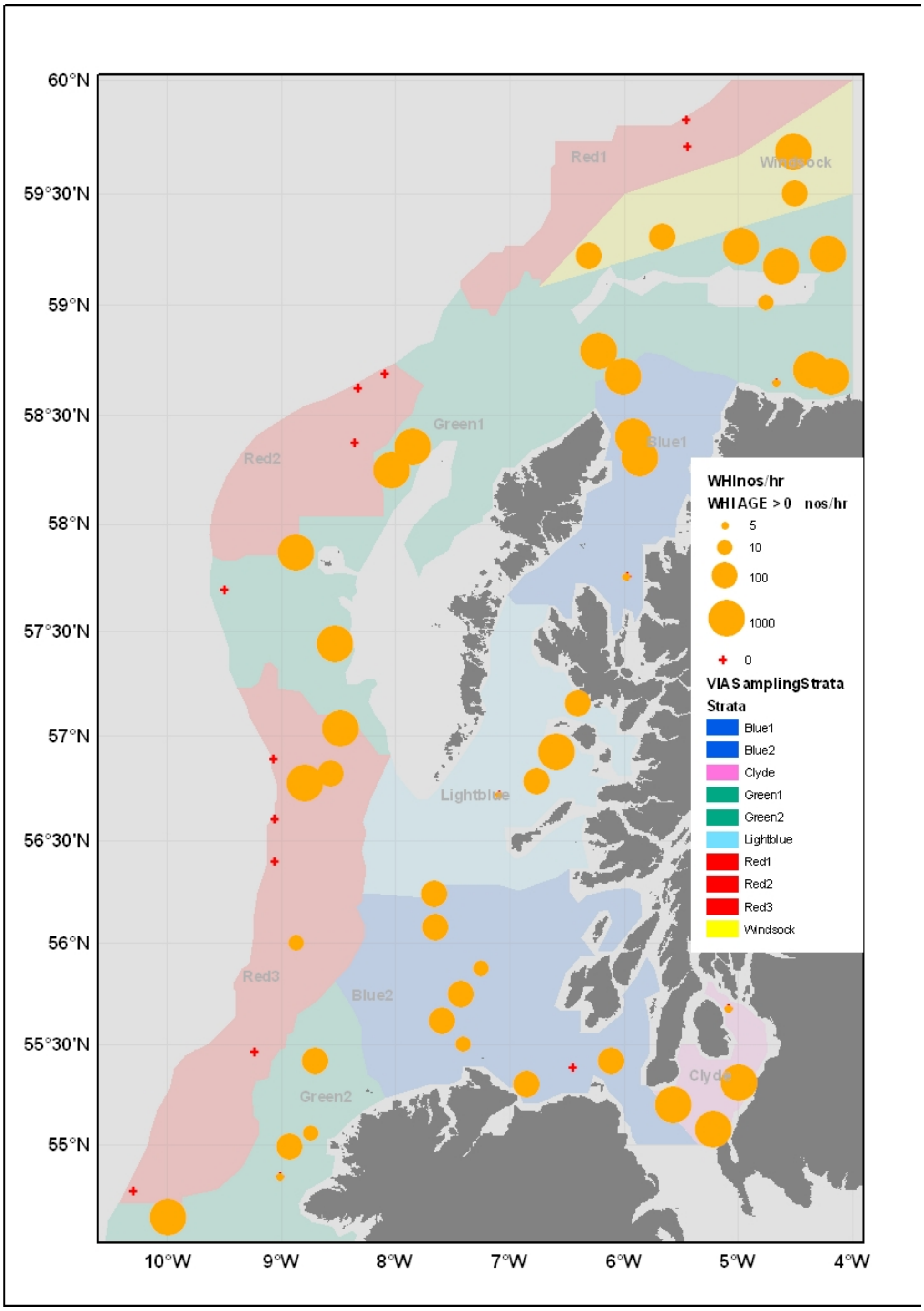


**Figure B.3.** Map of the west coast of Scotland showing the catch per unit of effort of whiting during the 2011 Scottish first quarter west coast groundfish survey (ScoGFSQ1). Each circle is centred on the sample location and the size of the circle is proportional to the number density (n/30 min fished) of whiting at age 1+, according to the legend.

# Stock Annex 4.3: Haddock in Division VIb

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Haddock in Division VIb |
| Working Group: | WGCSE |
| Date | 20 May 2010 |
| Revised by | Vladimir Khlivnoy, Andrzej Jaworski |

## A. General

### A.1. Stock definition

The haddock stock at Rockall is an entirely separate stock from that on the continental shelf of the British Isles (Chuksin and Gerber, 1976; Shestov, 1977; Blacker, 1982; Newton *et al*., 2008). The TAC for haddock VIb was previously (before 2004) set for Subarea Vb, VI, XII and XIV combined, with a limitation on the amount to be taken in Vb and VIa. In 2004, the TAC for Division VI was split and the VIb TAC for haddock was included with Divisions XII and XIV. This combined TAC has been in place since then.

### A.2. Fishery

The development of the Rockall haddock fishery is documented in the 2001 Working Group Report (ICES-WGNSDS, 2001) and in the Report of the ICES Group meeting on Rockall haddock convened in January 2001 (ICES, WGNSDS, 2002). That meeting was set up to respond to a NEAFC request for information on the Rockall haddock fishery. NEAFC agreed to consider regulation of the international fishery in 2001.

The Rockall haddock fishery changed markedly in 1999 when a revision of the EU EEZ placed the southwestern part of the Rockall plateau in international waters. This has opened opportunities for other nations, notably Russia, to exploit the fishery in this area. The table of official statistics includes Russian catches from the Rockall area.

The Russian fleet started fishing operations in international waters at Rockall in May–October 1999. The Russian haddock fishery uses bottom trawls with codend mesh size of 40–100 mm (mainly 40–70 mm) and retains haddock of all length classes in the catch. This fishery targets concentrations of haddock mainly during the spring and the beginning of summer. Russian catches increased from 458 t in 1999 to 2154 t in 2000. In 2001, they were markedly reduced to 630 t due to the introduction of a closed area and low density of fish concentrations. Russian catches increased again in 2002–2004 from 1630 to 5844 t. In 2005–2007, they decreased from 4708 t to 1282 t, and are estimated to be 1669 t in 2008.

Prior to 1999, the UK and Ireland fisheries had been principally summer fisheries but in more recent years the Scottish and Irish fishery was conducted throughout the year with the peak in April–May. This shift in the fishery appears to have followed the discovery of concentrations of haddock in deeper water to the west of Rockall, at depths between 200 and 400 m. High catch rates attracted effort into the area. However, catch rates in 2000 were reported to be poor in deeper water. Anecdotal evidence suggests that increased discarding has been associated with the deeper-water fishery compared to the traditional fishery at northern Rockall. In 2004–2007, a considerable proportion of EU landings were taken in the international waters. Historical fishing patterns of the Scottish fleet at Rockall are presented by Newton *et al*. (2004).

There are some indications that, due to a general decline in catches by the Scottish and Irish fleets in Division VIa, there is an increasing focus in the Rockall fishery in Division VIb (ICES, WGFTFB, 2007). Paired gear (both seine and trawl) are to be tested by some Scottish fishermen, which, if it proves successful, can lead to a considerable increase in effective effort in VIb. The fishery at Rockall seems particularly attractive given the lack of effort restrictions in this area.

Information on the Russian fishery and biological investigations from commercial vessels fishing in Rockall during 2008 are presented in WD11 to WGCSE 2009.

An analysis of the spatial and depth distributions of Rockall haddock in association with oceanographic variables is presented by Vinnichenko and Sentyabov (2004), a WD to WGNSDS 2004. Changes in distribution have occurred over a period coincidental with changes in oceanographic variables. Information on oceanographic conditions on Rockall bank in spring 2005 was presented by Sentyabov at WGNSDS 2005.

### A.3. Ecosystem aspects

In May 2001, the International Waters component of statistical rectangle 42D5, which is mainly at depths less than 200 m, was closed by NEAFC to all fishing activities, except with longlines. That area had the following coordinates:

| Latitude | Longitude |
|---|---|
| 57.000°N | 15.000°W |
| 57.000°N | 14.700°W |
| 56.575°N | 14.327°W |
| 56.500°N | 14.450°W |
| 56.500°N | 15.000°W |

In spring 2002, the EU component of this rectangle, again mostly shallow water, was also closed to trawling activities (EC No 2287/2003). The whole Rockall Haddock Box is bounded by the following coordinates:

| Latitude | Longitude |
|---|---|
| 57°00′N | 15°00′W |
| 57°00′N | 14°00′W |
| 56°30′N | 14°00′W |
| 56°30′N | 15°00′W |

At the 25th Annual Meeting of NEAFC (in November 2006), a closure of three areas on the Rockall Bank to bottom fishery was proposed to protect cold-water corals: Northwest Rockall, Logachev Mounds and West Rockall Mounds (NEAFC AM, 2006). This measure will be in force for the period January 2007–December 2009.

In 2007, ICES prepared advice for NEAFC and arrived at the conclusion about the expediency of establishing a new closed area on the so-called Empress of British Banks and adjusting the boundaries of the currently closed area of Northwest Rockall. At the 26th Annual Meeting of NEAFC (in November 2007), a new closed area (Empress of British Banks) was established, and the boundaries of the Northwest Rockall closure were slightly modified (NEAFC AM, 2007). Due to the complex shape of the boundaries of the Northwest Rockall closure proposed by ICES, which potentially could cause problems with enforcement, the introduced changes differed from the ICES recommendation. NEAFC also requested ICES to continue providing all available new information on distribution of vulnerable habitats in the NEAFC Convention Area and fisheries activities in and in the vicinity of such habitats.

WGDEC supported the ICES conclusion on the necessity of revising the boundaries of the Northwest Rockall area established to protect cold+water corals and recommended to consider proposals at the WGNSDS meeting. These recent proposals greatly simplify the boundaries, which would create better conditions for enforcement (see WD8 to WGNSDS, 2008).

## B. Data

### B.1. Commercial catch

#### *Landings*

Nominal landings as reported to ICES are given in Table 4.3.1 of the main Report, along with Working Group estimates of total estimated landings. Reported international landings of Rockall haddock in 1991–2005 were about 4000–6000 t, except for 2001–2002, when they decreased down to about 2300–3000 t. In 2006, they were also low at 2760 t, but increased slightly to 3348 in 2007, and 4221 t in 2008. Revisions to official catch statistics for previous years are also shown in Table 4.3.1.

Anecdotal evidence suggests that misreporting of haddock from Rockall have occurred historically (which may have led to discrepancies in assessment), but an estimation of overall magnitude is not possible.

Age composition and mean weight-by-age of Scottish and Irish landings were obtained from port sampling. Data on the volume, length-age and weight composition of landings for the period from 1988 to 1998 correspond to values used at this WG.

In 2002, there was no sampling of the Russian catch and therefore the length composition has to be estimated for this year.

In 2002 and 2003, the structure of the Russian fishery on the Rockall Bank was the same: the same vessels were operating with the same gear in the same fishing areas. The relationship between the haddock length composition obtained from the trawl survey and that in the Russian catches is assumed to be the same for 2002 and 2003; i.e. it is assumed that the length dependent selectivity pattern in 2002 is the same as that in 2003 as there no changes to the fishery in these years. The relationship is described as:

$$P_L = S_L p_L \tag{1}$$

where $P_L$ is the proportion of fish with length $L$ in catches, $p_L$ is proportion of fish with length $L$ in the stock (survey), and $S_L$ is the proportion of fish of length $L$ taken aboard. $S_L$ is determined using a theoretical selectivity curve (Stock Annex, Figure 4.3.1) which may be described by the following formula:

$$S_L = \frac{1}{1+\exp(S_1 - S_2 L)}. \tag{2}$$

where SL is the proportion of fish of size L taken aboard, L is the size group, S1 and S2 are coefficients.

The selectivity curve (Stock Annex, Figure 4.3.1), fitted to the data on catch measurements in different periods of the Russian fishery in 2003 is described well by Equation 2 with coefficients S1 = 12.539 and S2 = 0.4951. The estimated length frequency distributions for 2003 are compared with the measured length frequency distributions for this year in Stock Annex, Figure 4.3.2. The size distribution in the Russian catch in 2002 is then estimated by applying the theoretical selectivity curve to the survey length frequency in 2002.

To determine the age composition in Russian catches in 2002, the combined age–length key for all years of Russian catches was used.

*Discards*

The haddock catch estimated by landings is underestimated as a result of unaccounted discarding of small individuals in the Scottish and Irish fisheries in most years. On Russian vessels, the whole catch of haddock is retained on board and therefore, total catch is equivalent to landings.

Haddock discards on board Scottish vessels in 1999 and 2001 and Irish vessels in 1995, 1997, 1998, 2000 and 2001 were determined directly. In other years, indirect estimates of discarding were calculated.

The direct estimates from the Scottish trawlers in 1985, 1999 and 2001 showed a larger proportion of discards of small haddock: from 12 to 75% by weight (Table 4.3.6 in the main report) and up to 80–90% of catch numbers. Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels also reaches considerable values (Table 4.3.7 in the main Report).

Total numbers and weight landed and discarded by age on the Scottish observer trips in 1999 and 2001 are presented in Stock Annex, Tables 4.3.1 and 4.3.2.

The analysis of the discard data collected by Scottish scientists in 1999 and 2001 indicated that only a relatively small proportion of fish taken aboard is landed (Figure 4.2.5). The probability of being retained increases with increasing fish length (Stratoudakis *et al.*, 1999; Palsson *et al.*, 2002; Palsson, 2003; Sokolov, 2003). The relationship between the number of individuals caught and number discarded may be described by the following relationship:

$$ND_L = PD_L \times NP_L \qquad (3)$$

where $ND_L$ is the number of discarded fish with length $L$, $NP_L$ is the number of fish caught at length $L$, $PD_L$ is the portion of discarded fish at length $L$.

The length composition of fish taken on board by Scottish and Irish trawlers was calculated by applying the logistic selectivity curve (Stock Annex, Figure 4.3.3) to the haddock stock length composition obtained from the survey. The selectivity parameters were calculated from Scottish and Irish catches taken by trawls with mesh size that are typical for the fleets of those countries operating at Rockall. The parameters were calculated as $S_1$ = 12.608 and $S_2$ = 0.4360 for the Scottish fleet. $S_1$ = 26.248 and $S_2$ = 0.8524 were used for Irish catches.

The catch-at-length compositions obtained by the theoretical curve of selectivity agree well with available results of catch measurements in 1999 and 2001and the distributions are compared in Stock Annex, Figure 4.3.4.

The proportion of fish discarded from catches at different sizes may be determined and modelled using a logistic curve (Stock Annex, Figure 4.3.5) described by the following equation:

$$PD_L = \frac{1}{1 + \exp(-b(L - DL_{50}))} \qquad (4)$$

where $L$ is size group, $DL_{50}$ is the fish length at which 50% of this size fish caught are discarded and $b$ is a constant reflecting the angle of curve slope. The parameters were determined from research on discards by Scottish vessels (Stock Annex, Table 4.3.3). The following values were used in subsequent calculations: $DL_{50} = 34.66$ cm, $b = -0.8764$. The logistic curve of discards may be found using Equation 2 and the coefficient values: $S_1 = -15.494$ and $S_2 = -0.4565$.

To determine abundance of discards the following procedure was used:

a ) A theoretical catch-at-length distribution (%) was calculated by applying the theoretical selectivity curve to the survey length composition.

b ) An estimate of total catch-at-length was made by summing the reported landings-by-length to the number of discards-at-length calculated from the assumed discard ogive and the landings-at-length data.

c ) An intermediate theoretical catch size distribution in numbers is calculated by dividing the estimate of the total numbers retained (numbers greater than 34 cm) in B by the fraction retained from the theoretical catch length distribution calculated in a).

d ) Theoretical discard size frequency is then calculated by applying the theoretical discard ogive to the intermediate theoretical catch size distribution.

The spreadsheet containing these calculations can be found in the stock file.

Calculations where the discard curve was applied agree well with the results of size composition measurements by Scottish vessels in 1999 and 2001 (Stock Annex, Figure 4.3.6).

Aboard Irish vessels, larger fish are retained (Stock Annex, Figure 4.3.7). The portion of discards was calculated using Equation 2 with coefficients $S_1 = -10.093$ and $S_2 = -0.2459$, from the combined 1995–2002 Irish discard trips.

The Russian fleet fish in the areas covered only partially by the bottom+trawl surveys. However, Russian vessels retain all haddock and therefore there is no need to calculate discards. There is no information on large-scale fisheries of other countries outside the surveyed area. In addition, available data on the real length composition of catches indicate a correspondence between length composition obtained by the results from surveys and commercial catches, including the catches obtained in the parts of Russian fishery (Stock Annex, Figures 4.3.2 and 4.3.6).

The amount of discarded haddock by age was determined using a length–age key derived by the data collected during the trawl survey allowing for selectivity of the fishery (Stock Annex, Figure 4.3.3).

In 1998 and 2000, the trawl survey for haddock in the Rockall Bank area was not carried out. To determine the haddock length composition in these years, the length distribution was calculated from the survey data in the previous and following years.

For this purpose, the length–age matrices characterizing the stock status in the years before and after the missing data year were obtained. The length–age distribution from the year before the missing year was projected forward on the basis of mean growth increment at age and estimated total mortality. Similarly the distribution from the year after was projected backwards. The length composition in the missing year was then calculated from these two estimates.

The total loss ($Z$) used in the calculation described above was determined by minimization of values of deviation square sum between survey age group abundance values in previous and following years by the data from surveys and calculated data. At that, the factor of age effect ($S_a$) was taken into account. The mean growth increment at age was also estimated from the survey data. The method of calculation is explained further in WD8 to WGNSD 2004 and a spreadsheet showing the calculations is in the stock file.

#### B.2. Biological

Age composition and mean weight-at-age of Scottish and Irish landings were obtained from port sampling.

Age composition and mean weight-at-age of Russian landings were obtained by observers on board commercial fishing vessels. In 2002, there was no sampling of the Russian catch and therefore the length composition for that year had to be estimated (for estimation details, see Stock Annex). Observer data from commercial vessels are also available for Norwegian landings for 2006–2008.

In the absence of any direct estimates of natural mortality, M has been set at 0.2 for all ages and years.

Natural mortality coefficient and portion of mature individuals by age used for estimation correspond to those adopted by Working Group before.

Previous Working Groups have adopted a maturity ogive with knife-edge maturity-at-age 3 in assessments of this stock (see the Table below).

| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7+ |
|---|---|---|---|---|---|---|---|
| Proportion mature | 0 | 0 | 1 | 1 | 1 | 1 | 1 |

The data from new Russian histological examination of haddock gonad samples mass sexual maturation occurs at age of two years with length of 25 cm (WGNSDS WD6 2006). These data agree well with the results of recent Scottish research in compliance with which the majority of fish become mature at the age of 2 years (ICES 2003; Newton *et al.*, 2004). Visual estimation of maturity stage of post-spawning haddock on the Rockall Bank in expeditions leads to considerable errors. For more precise estimation of length and age-at-maturity for haddock it is necessary to conduct investigations in prespawning and spawning periods as well as to collect gonads for further histological analysis (see WGNSDS WD6 2006 for further details).

Research on determining more precise values for natural mortality and maturity ogive parameters should be continued and new estimates could be used in future stock assessments.

In the absence of any direct estimates of natural mortality, M has been set at 0.2 for all ages and years. MSVPA estimates for the North Sea haddock stock give estimates of M of 2.05 at age 0, 1.65 at age 1, 0.40 at age 2, 0.25 at ages 2 and 4, and 0.20 at ages 5+ (ICES CM 2003/ACFM:02). Similarly, large values of M at the younger ages at Rockall would have implications for interpretation of fishing mortality patterns from survey-based methods such as SURBA which essentially estimate total mortality conditional upon assumptions regarding survey catchability-at-age.

ACFM in 2001 encouraged the WG to investigate a more realistic maturity ogive for this stock. At the 2002 Working Group combined sex maturity ogives were presented to the WG for Russian sampling in 2000–2001 and Scottish sampling in 2002. In 2003 new sex disaggregated maturity data were supplied to the Working Group for Russian sampling. The results of all these recent studies indicate that a large proportion of both females and males at age 2 were mature.

### B.3. Surveys

There is only one research survey index available for VPA assessment of this stock from the Scottish survey conducted annually in September (Figure 4.2.4, Table 4.2.8). However, from 1997 onwards the Scottish survey was only conducted in alternate years. Due to concerns about the haddock stock at Rockall some extra time was allocated to carry out a partial survey in September 2002. Full surveys have been conducted since 2005 to improve the quality of assessment. The Scottish survey is currently conducted on about 40 (the target number for a survey) standard trawl stations. However, the survey area and number of stations varied in different years. The majority of stations are within the 200 m depth contour. In 2002 the survey was carried out in the central and northern parts of the bank. In 1999 the survey switched from using an Aberdeen 48′ bottom trawl to a GOV trawl and from 60 min tows to 30 min tows. The indices have been adjusted for tow duration, but no calibration has been made for gear changes. A 20 mm mesh size is used on the survey.

In spring 2005, the Russian trawl-acoustic survey (TAS) for haddock on the Rockall Bank was conducted for the first time (Oganin *et al*., 2005). However, no such survey has been carried out in subsequent years. In the 2005 survey, the trawl survey method estimated the total stock number at 190.63 million individuals and its biomass at 43 400 t (see the Table below). The acoustic survey yielded a haddock biomass estimate of 60 000 t with the abundance of 225.9 million (see the WGNSDS 2006 Report for more details of the trawl-acoustic survey). The estimates of haddock abundance and biomass from the two methods are quite similar. The results of the Russian trawl-acoustic survey are summarized in the Table below:

| Survey type | Area component | Area (sq. miles) | Total stock | | Spawning stock | |
|---|---|---|---|---|---|---|
| | | | Abundance (106) | Biomass (103 t) | Abundance (106) | Biomass (103 t) |
| Trawl survey | Whole | 5554 | 190.6 | 43.4 | | |
| Acoustic survey | International waters | 3374 | 144.2 | 41.1 | 133.0 | 38.5 |
| | EU zone | 2180 | 81.7 | 18.9 | 52.4 | 16.3 |
| | Whole | 5554 | 225.9* | 60.0* | 185.4 | 54.8 |

*** Pelagic component estimated to make up 13.7%.**

The Irish Fisheries Board (BIM) and the Marine Institute recently conducted a collaborative series of surveys to assess the length structure of haddock at various locations on the Rockall Bank and tested the selectivity of a number of codend configurations, which are typically used by both the Irish and Russian fleets.

### B.4. Commercial cpue

Commercial cpue series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in VIb. The effort data for these five fleets are shown in Figure 4.2.1 and Table 4.2.7. Commercial cpue series for the different fleets are shown in Figure 4.2.2.

In 2005–2007, the Russian effort in bottom fishery (in hours and number of vessels/days) decreased due to economic reasons. The effort in 2008 increased slightly compared to 2007. Haddock catches varied accordingly with the changes in fishing effort. In 2006–2007, fishing efficiency in the Russian haddock fishery (mainly with trawlers of tonnage class 10) increased compared to previous years. In 2008, with trawlers of class 8 and 9 only, it was still high (on average, 12.2 t per fishing day for trawlers of class 9), but lower than the efficiency in 2007 (on average, 16.9 t per fishing day for a trawler of class 10). In the period of the targeted fishery (April–May), the mean catch of haddock per hour trawling by a trawler of tonnage class 9 was 0.86 t (in 2007, it was 0.88 t for a trawler of class 10) (Figure 4.2.2). The dynamics of catch per unit of effort for this type of vessels agrees well with year-to-year variations in total biomass of haddock (Figure 4.2.3).

The effort data from the Scottish fleets are known to be unreliable due to changes in the practices of effort recording and non-mandatory effort reporting (see the Report of WGNSSK 2000, CM 2001/ACFM:07, for further details). It is unknown what proportion of Scottish and Irish effort was applied directly to the haddock fishery. The apparent effort increase may just be the result of more exact reporting of effort due to VMS, but another suggestion is that it arises from a 'days at sea' measure. Working at Rockall keeps 'days at sea' elsewhere intact (the years in question do correspond to the introduction of the days at sea legislation) and it is possible that vessels are either working extra days in VIb or they are simply reporting extra days from VIb. It is difficult to conclude which of these scenarios is more likely.

The Irish otter trawl effort-series indicated low values between 2002 and 2005 with the lowest value in 2004. In 2006–2008, the effort increased considerably.

The WG decided that the commercial cpue data, which do not include discards and have not been corrected for changes in fishing power despite known changes in vessel size, engine power, fish-finding technology and net design, were unsuitable for catch-at-age tuning.

#### B.5. Other relevant data

### C. Historical stock development

Model used:

The assessment is based on catch-at-age data and one survey index (Scottish Groundfish Survey) and conducted using the XSA method.

Software used:

XSA from Lowestoft suite of VPA programs

Model Options chosen:

Settings for the final XSA assessment in the recent years are shown in the Table below.

| Assessment year | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| Assessment model | XSA | XSA | XSA | XSA | XSA |
| Time-series weights | none | none | none | none | none |
| Model | power | power | power | power | power |
| Catchability dependent for ages < | 4 | 4 | 4 | 4 | 4 |
| Regression type | C | C | C | C | C |
| Q plateau | 5 | 5 | 5 | 5 | 5 |
| Shk se | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Shk age-year | 4 yrs<br>3 ages | 4 yrs<br>3 ages | 4 yrs<br>3 ages | 4 yrs<br>3 ages | 4 yrs<br>3 ages |
| Min se | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Plus group | 7 | 7 | 7 | 7 | 7 |
| $F_{bar}$ | 2–5 | 2–5 | 2–5 | 2–5 | 2–5 |

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1991–2008 | 1–7+ | Yes |
| Canum | Catch-at-age in numbers | 1991–2008 | 1–7+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1991–2008 | 1–7+ | Yes |
| West | Weight-at-age of the spawning stock at spawning time. | 1991–2008 | 1–7+ | Yes |
| Mprop | Proportion of natural mortality before spawning | 1991–2008 | 1–7+ | No, set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1991–2008 | 1–7+ | No, set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1991–2008 | 1–7+ | No, the same ogive for all years |
| Natmor | Natural mortality | 1991–2008 | 1–7+ | No, set to 0.2 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 1 | SCOGFS | 1991–2008 | 1–6 |

### D. Short-term projection

**Model used:** Age-structured

**Software used:** MFDP prediction with management option table and yield-per-recruit routines. MLA used for probability profiles and sensitivity analysis.

**Initial stock size:** Taken from XSA for age 1 and older. The recruitment-at-age 1 in 2009 is estimated using RCT3. For forecasting recruitment in 2010 and thereafter, a geometric mean was used for 1991–2006.

**Natural mortality:** Set to 0.2 for all ages in all years.

**Maturity:** The same ogive as in the assessment is used for all years.

**F and M before spawning:** Set to 0 for all ages in all years.

**Weight-at-age in the stock:** Three-year means (mean weights in the stock are assumed to be the same as catch weights, see below).

**Weight-at-age in the catch:** Three-year means.

**Exploitation pattern:** Average of the three last years. Landings F are varied in the management option table.

**Intermediate year assumptions:** *Status quo* F.

**Stock–recruitment model used:** XSA estimate of recruits at age 1 for intermediate year. RCT3 model. used for intermediate year +1 in 2009 and the long-term geometric mean recruitment-at-age 1 is used for forecasting recruitment in 2010 and thereafter.

**Procedures used for splitting projected catches:** F vectors in each of the last three years of the assessment are multiplied by the proportion landed at age to give partial F for landings. The vectors of partial F are then averaged over the last three years to give the forecast values.

### E. Medium-term projections

**Model used:** Age structured

**Software used:** MLA used for Medium-term projections.

**Initial stock size:** Taken from the XSA for age 1 and older. The recruitment-at-age 1 in 2009 is estimated using RCT3. For forecasting recruitment in 2010 and thereafter, a geometric mean was used for 1991–2006.

**Natural mortality:** Set to 0.2 for all ages in all years.

**Maturity:** The same ogive as in the assessment is used for all years.

**F and M before spawning:** Set to 0 for all ages in all years.

**Weight-at-age in the stock:** Three-year means (mean weights in the stock are assumed to be the same as catch weights, see below).

**Weight-at-age in the catch:** Three-year means.

**Exploitation pattern:** Average of the three last years.

**Intermediate year assumptions:**

**Stock–recruitment model used:** RCT3 model used for intermediate year +1 in 2009.

Uncertainty models used:

1 ) Initial stock size:
2 ) Natural mortality:
3 ) Maturity:
4 ) F and M before spawning:
5 ) Weight-at-age in the stock:
6 ) Weight-at-age in the catch:
7 ) Exploitation pattern:
8 ) Intermediate year assumptions:
9 ) Stock–recruitment model used:

### F. Yield and biomass-per-recruit/long-term projections

**Model used:** Yield and biomass-per-recruit over a range of F values.

**Software used:** MLA and "st graf".

**Maturity:** Fixed maturity ogive as used in the assessment.

**F and M before spawning:** Set to 0 for all ages in all years.

**Weight-at-age in the stock:** Three-year means (mean weights in the stock are assumed to be the same as catch weights, see below).

**Weight-at-age in the catch:** Three-year means.

### G. Biological reference points

Biological reference points for this stock are given below:

$B_{lim}$: 6000 t (lowest observed SSB)

$B_{pa}$: 9000 t ($B_{loss}$ × 1.4)

$F_{pa}$: 0.4 (by analogy with other haddock stocks).

### H. Other issues

None.

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**Table 4.3.1. Scottish landings and raised discards of haddock in 1999 estimates at Rockall from discard observer trips conducted on Scottish vessels.**

| | Age | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
| Landing, N (*1000) | 0 | 0 | 436.9 | 1211.9 | 1069.5 | 849.4 | 1220.6 | 1432.3 | 411.9 | 87.7 | 0.4 | 0 | 1.4 | 6722 |
| Landing, tonnes | 0 | 0 | 135.8 | 432.5 | 420.7 | 383.9 | 646 | 760.7 | 245.5 | 49.6 | 0.5 | 0 | 4.3 | 3079.5 |
| Discards, N (*1000)[1] | 22.4 | 14420.8 | 15276.9 | 6844.7 | 2534.8 | 1516 | 734.3 | 219.4 | 39.6 | 0 | 0 | 0 | 0 | 41609.1 |
| Discards, tonnes[1] | 1.5 | 2284.1 | 3658.2 | 1936.2 | 799.1 | 515.4 | 248.8 | 86.2 | 17.6 | 0 | 0 | 0 | 0 | 9547.2 |
| Discards, N (*1000)[2] | 12.5 | 13306.1 | 15895.9 | 7168.1 | 2588.9 | 1555.7 | 772.5 | 247.9 | 48.6 | 12.2 | 0.7 | 0 | 0 | 41609.2 |
| Discards, tonnes[2] | 0.3 | 2241.2 | 3791.3 | 2035.1 | 821.7 | 538.7 | 268 | 103.8 | 22.7 | 6.3 | 0.5 | 0 | 0 | 9829.6 |

**[1] raised estimates from discard observer trips at Rockall.**

**[2] estimates obtained from a logistic discard curve for 1999.**

**Table 4.3.2. Scottish landings and raised discards of haddock in 2001 estimates at Rockall from discard observer trips conducted aboard Scottish commercial vessels.**

| | Age | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
| Landing, N (*1000) | 0 | 0 | 326.5 | 489.1 | 132.9 | 774.3 | 326 | 223.9 | 113.5 | 22.4 | 3.8 | 0 | 0 | 2412.3 |
| Landing, tonnes | 0 | 0 | 128.6 | 157 | 82.4 | 262.4 | 125.2 | 90.2 | 59.3 | 19.9 | 3 | 0 | 0 | 928 |
| Discards, N (*1000)[1] | 3.1 | 6309.9 | 549.7 | 228.4 | 66.3 | 8.1 | 1 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0 | 7166.8 |
| Discards, tonnes[1] | 0.2 | 967.4 | 126.8 | 58.7 | 17.8 | 2.4 | 0.3 | 0.1 | 0 | 0 | 0 | 0 | 0 | 1173.8 |
| Discards, N (*1000)[2] | 531 | 5987.3 | 436.2 | 162.6 | 46.9 | 2.9 | 0.5 | 0.1 | 0 | 0 | 0 | 0 | 0 | 7167.6 |
| Discards, tonnes[2] | 14.3 | 936.2 | 93 | 38.6 | 11.6 | 0.9 | 0.2 | 0.1 | 0 | 0 | 0 | 0 | 0 | 1094.9 |

**[1] raised estimates from discard observer trips at Rockall.**

**[2] estimates from a logistic discard curve for 2001.**

**Table 4.3.3. Values of $DL_{50}$ by Scottish discard trips in the Rockall area.**

| Year | DL50 | b |
|---|---|---|
| 1999 | 36.62 | –0.5923 |
| 2001 | 31.20 | –0.8238 |
| Theoretical: | 34.66 | –1.2328 |

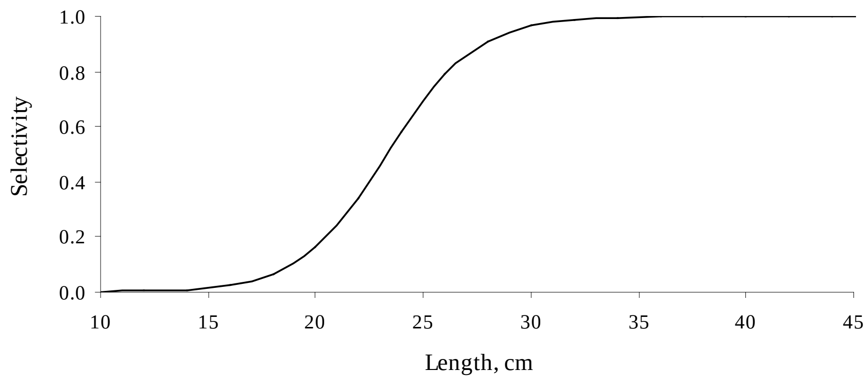


**Figure 4.3.1. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Russian trawlers.**

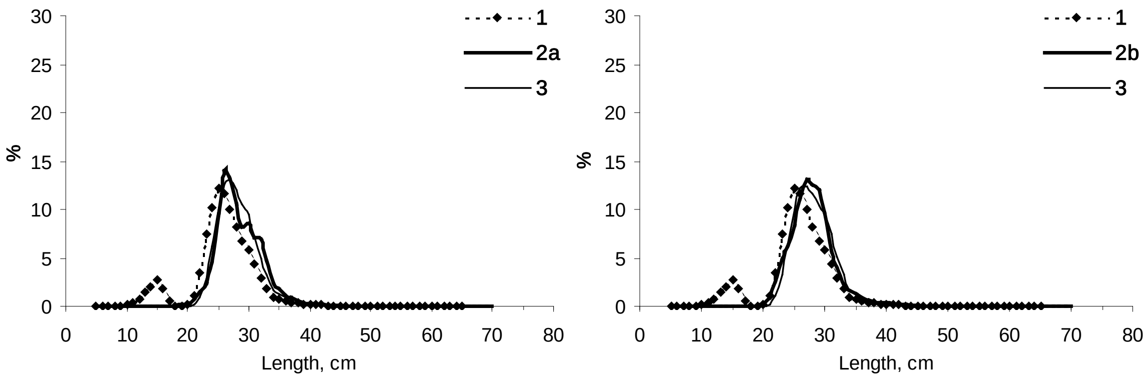


**Figure 4.3.2. Length distribution of haddock in 2003: 1 – by Scottish groundfish survey, 2a – by commercial Russian trawlers in June, 2b – by commercial Russian trawlers in July, 3 – theoretically derived.**

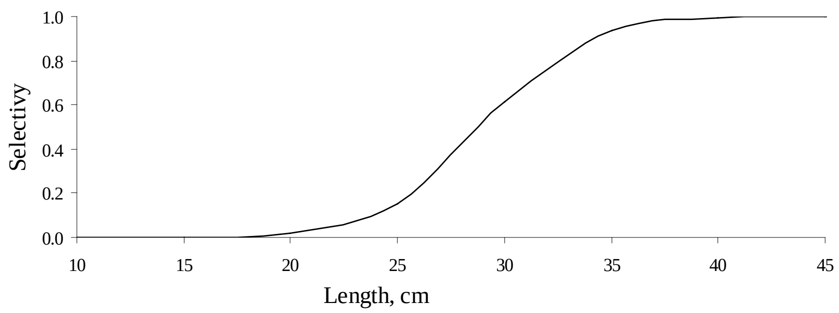


**Figure 4.3.3. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted on board Scottish trawlers.**

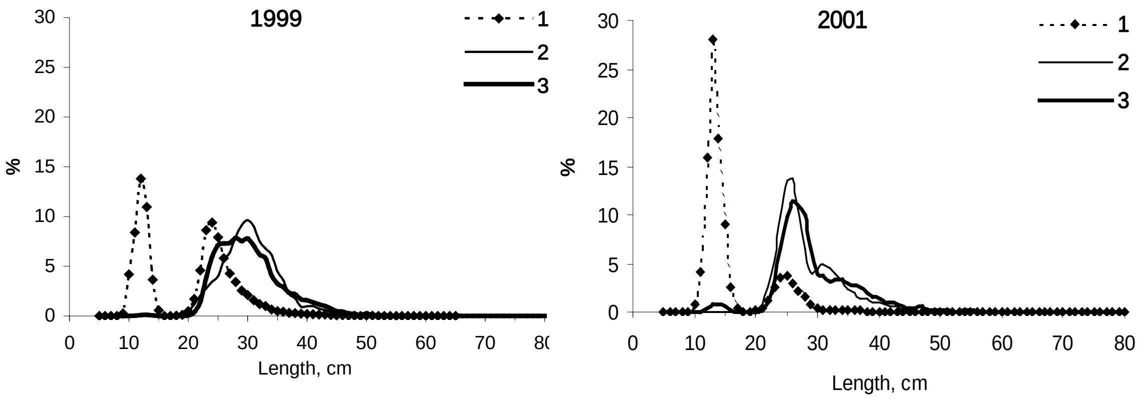


**Figure 4.3.4. Length distribution of haddock in 1999 and 2001: 1 – by Scottish groundfish survey, 2 – by commercial Scottish trawlers, 3 – theoretically derived.**

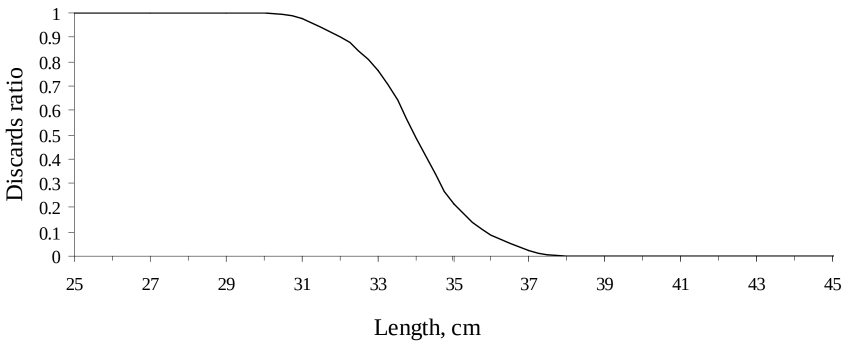


**Figure 4.3.5. Selectivity curve used to estimate the proportion of discarded haddock in catches Scottish trawlers.**

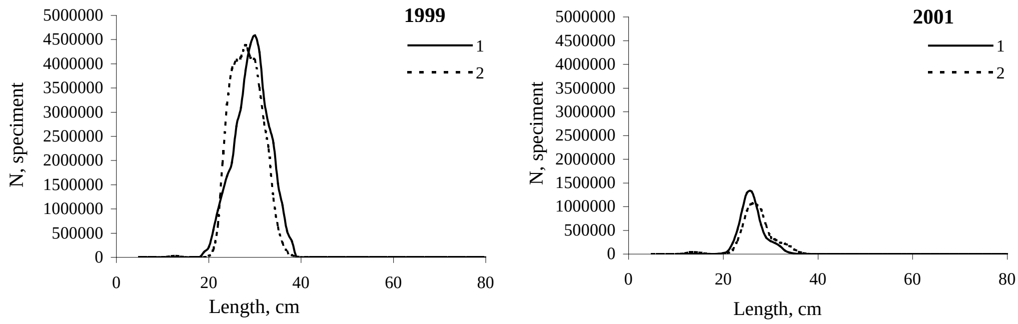


**Figure 4.3.6. Length distribution of discarded haddock in catches Scottish trawlers in 1999 and 2001: 1 – research data; 2 – theoretically derived.**

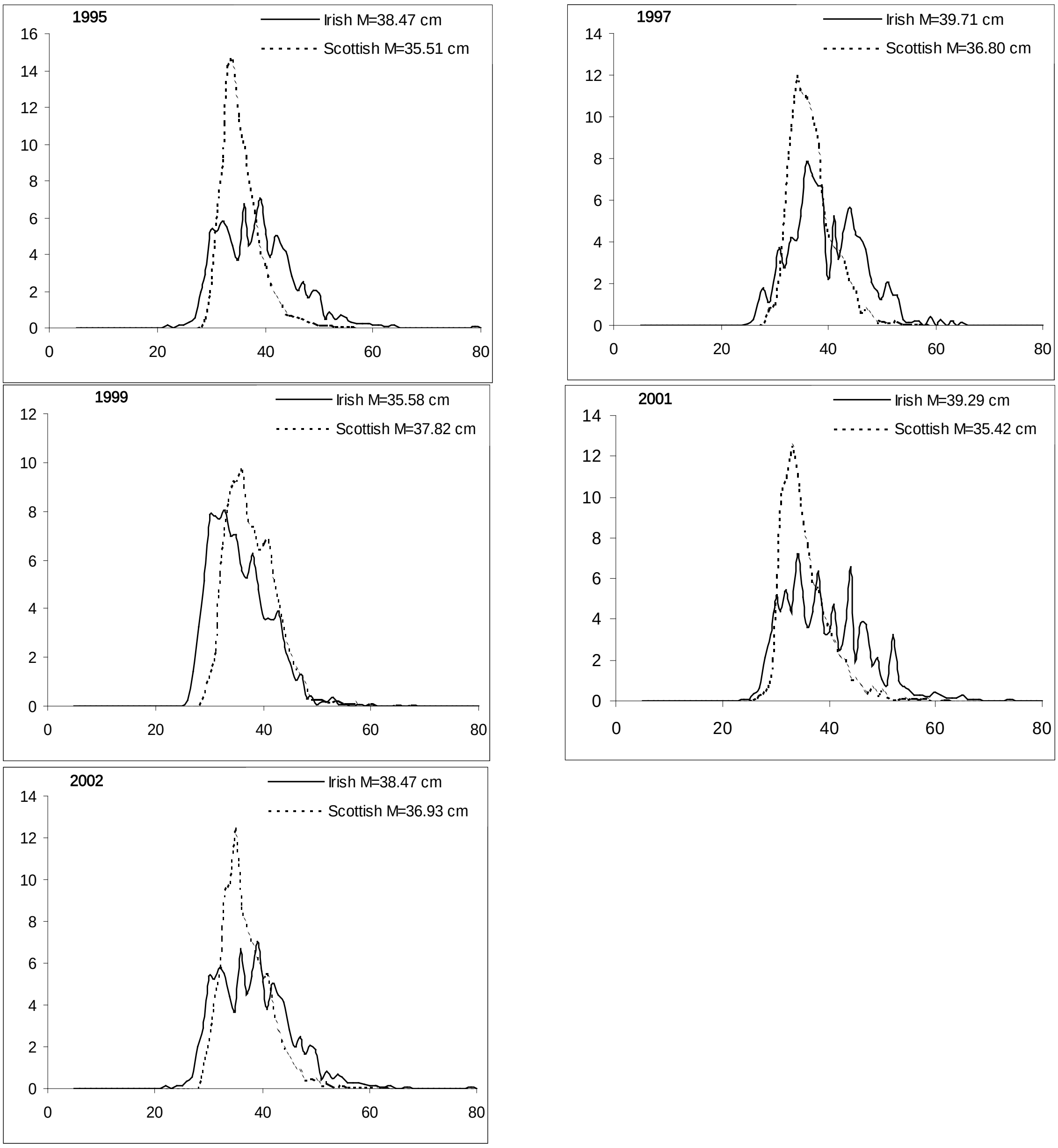


**Figure 4.3.7. Length distribution of haddock landings in VI b (Scottish and Irish data).**

# Stock Annex 5.2: Northern Shelf anglerfish

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Anglerfish (Northern Shelf, Division IIIa, Subarea IV and Subarea VI, and Norwegian Sea, Division IIa) |
| Working Group | Assessment of Northern Shelf Demersal Stocks |
| Date | 17 May 2005 |
| Last updated | 19 May 2008 |

## A. General

### A.1. Stock definition

Anglerfish occur in a wide range of depths, from quite shallow inshore waters down to at least 1000 m. Small anglerfish occur over most of the northern North Sea and Division VIa, but large fish, the potential spawners, are more rarely caught. Little is known about when and where anglerfish spawn in northern European waters and consequently stock structure is unclear. This lack of knowledge is due to the unusual spawning habits of anglerfish. The eggs and larvae are pelagic, but whereas most marine fish produce individual free-floating eggs, anglerfish eggs are spawned in a large, buoyant, gelatinous ribbon which may contain more than a million eggs. Due to this strange behaviour, anglerfish eggs and larvae are rarely caught in conventional surveys.

An EU-funded research project entitled 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' (Anon, 2001) did however, improve our understanding. A particle tracking model was use to predict the origins of young fish and indicates that post-larval anglerfish may be transported over considerable distances before settling to the seabed (Hislop *et al.*, 2001). Anglerfish in deeper waters to the west of Scotland and at Rockall could therefore be supplying recruits to the western shelf and the North Sea. Furthermore, results of microsatellite DNA analysis carried out as part of this project show no structuring of the anglerfish stock into multiple genetic populations within or among samples from Divisions IVa, Division VIa and Rockall. In fact this project also suggested that anglerfish from further south (Subarea VII) may also be part of the same stock. Fish tagged and released around the Shetland Islands (Division IVa) by Laurenson *et al.*, 2005 have occasionally been recaptured in Subarea V and also Division IIa.

The WGNSDS considered the stock structure on a wider European scale in 2004, and found insufficient evidence to indicate an extension of the stock area northwards to include Division IIa. Anglerfish in IIa is at present treated separately by the Working Group.

### A.2. Fishery

#### *A.2.1. Northern Shelf anglerfish fisheries*

UK vessels account for more than 50% of the total reported anglerfish landings from the Northern Shelf area. The Danish and Norwegian fleets are the next most important exploiters of this stock in the North Sea while Irish and French vessels take a significant proportion of the landings to the West of Scotland. The fishery for anglerfish in Subarea VI occurs largely in Division VIa with the UK and France being the most important exploiters, followed by Ireland. Landings from Rockall (Division VIb) are generally less than 1000 t with the UK taking on average around 50% of the total. In the North Sea, the majority of landings are reported in Division IVa which reflects the northerly distribution of the species within the North Sea (Knijn *et al.*, 1993).

A general description of the anglerfish fisheries of the most important nations taking part in this fishery is given below:

#### Scottish (UK) fishery

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed roundfish. The Scottish Light Trawl Fleet (SCOLTR) takes around 60% of landings and the Scottish Heavy Trawl Fleet (SCOTRL) over 20%. Around 10% of landings are bycatch from the *Nephrops* trawlers. The development of a directed fishery for anglerfish has led to considerable changes in the way the Scottish fleet operates. Part of this is a change in the distribution of fishing effort; the development of a directed fishery having led to effort shifting away from traditional roundfish fisheries in inshore areas to more offshore areas and deeper waters. The expansion in area and depth range fished has been accompanied by the development of specific trawls and vessels to exploit the stock. There has been an almost linear increase in landings from Division VIa since the start of the directed fishery until 1996 which has been followed more recently by a very severe decline, indicating the previous increase was almost certainly due only to the expansion and increase in efficiency of the fishery. More recent declines in landings (2002–2004) may have been due to restrictive TACs and the decline is not necessarily representative of the actual landings.

The Scottish fleet operating in VIb consists mainly of large otter trawlers (SCOTRL) targeting haddock and anglerfish at Rockall. Their activity depends on weather and the availability of haddock quota in VIb.

The Scottish fishery for anglerfish in the North Sea is located in two main areas: on the Shelf Edge to the north and west of Shetland and at the Fladen Ground. It expanded in a similar manner since the 1980s to that operating in Division VIa. The fishery to the north and west of Shetland operates as an extension to that in Division VIa and consists mainly of light trawlers targeting mixed round-fish. The highest reported landings in recent years (to 2007) come from the statistical rectangles around Shetland. The light-trawler fleet accounted for approximately 55% of Scottish reported landings in this area in 2007. The landings from the fishery at Fladen are lower but still significant (around 15% of the total) with anglerfish caught as a bycatch in the *Nephrops* fishery which consists of approximately 200 vessels in 2007. A small component of the landings (~10% in recent years) comes from the gillnet fishery which operates on the shelf edge in the far northwest of Division IVa. A large proportion of the landings in the gillnet fishery are taken by Spanish owned, UK registered vessels.

Ahead of the anglerfish STECF Review Group meeting in 2006 (SGRST-06–03), attempts were made to develop descriptions of the main Scottish anglerfish fisheries which were spatially more relevant to the stock distribution and activity of fishing vessels, rather than by ICES area. The descriptions used data on catch rates from various sources, including research vessel surveys, observer trips on board commercial boats, consultation with skippers and analysis of individual trip records. An 'anglerfish fishery' area was defined as the combined area of high abundance (catch-rates) from FRS/industry survey and observer data analysis. A '*Nephrops* fishery' area was assumed to cover the *Nephrops* grounds which are well defined by soft substrate and are described in the appropriate ICES WGs. The areas are mostly separate but where overlaps occur, these are taken to be part of the anglerfish area. A third area is defined to include all other statistical rectangles.

In the Scottish ‘anglerfish’ area, large meshed otter trawlers have the largest contribution to the total landings associated with anglerfish. This métier has a mixed species catch composition with haddock being the most important species and anglerfish and cod the next most important. In the *Nephrops* area the largest overall landings associated with anglerfish come from the <100 mm gear category with the dominant species being *Nephrops*, followed by haddock and anglerfish.

Previous studied have found it difficult to identify a specific anglerfish fishery as catch composition can vary a great deal over a small spatial scale (i.e. less than a statistical rectangle). Further analysis of the main, large mesh trawl operating in the ‘anglerfish area’ is required to provide a more comprehensive picture of catch composition. This has so far been beyond the scope of the WG.

#### Irish fishery

The Irish fleet which takes around 15–20% of the total Division VIa landings is a light trawl fleet targeting anglerfish, hake, megrim and other gadoids on the Stanton Bank and on the slope northwest of Ireland. This fleet uses a mesh size of 80 mm or greater. Irish Division VIa landings come mainly from the Stanton Bank with some landings from Donegal Bay and the slope northwest of Ireland. Since 1996 there has been an increase in the number of vessels using twin rigs in this fleet. There have also been changes to the fleet composition since 2000, with around ten vessels decommissioned and four new vessels joining the fleet. The activity of this fleet is not thought to have been significantly affected by the recent hake and cod recovery plans.

The Irish fleet otter trawl in Division VIb take anglerfish as a bycatch in the haddock fishery on the Rockall Bank. The fleet targeting haddock uses 100 mm mesh and twin rig trawls. Occasionally Irish-Spanish flag vessels target anglerfish, witch and megrim with 80 mm mesh on the slope in VIb. Discarding practices of these vessels are not known although discarding of anglerfish from the fleet targeting haddock in Division VIb is not thought to be significant (Anon, 2001). The fleet composition changed in 2001. Four vessels have recently been decommissioned and two new vessels have joined the fleet that targets haddock. In 2006 and 2007, the effort of the Irish fleet operating at Rockall has increased with the increase in Rockall haddock TAC.

#### Danish fishery

According to logbook records, the majority of Danish anglerfish landings are taken in the northeastern North Sea, in the part constituting the Norwegian Deeps, situated in the Norwegian EEZ of the North Sea. Other important fishing areas for anglerfish are the Fladen Ground (also in IVa) and in the Skagerrak (IIIa). More than 80% of the Danish landings come from ICES Divisions IVa and IIIa. The remaining part is from the most northern part of Division IVb.

The majority of the Danish vessels are taking anglerfish with demersal trawls with over 90% of these vessels in the size range 20–40m.

Fishery definitions by gear type and mesh size as currently used by Danish Fisheries Directorate for the North Sea are given in the following text table:

| Fishery/gear | Mesh size, mm |
|---|---|
| Dem. Trawl | >= 100 mm |
| Nephrops trawl | 70–99 mm |
| Shrimp trawl | 33–69 mm |
| Industrial trawl | < = 32 mm |
| Beam trawl | >= 80 mm |

Note that in the North Sea demersal trawls account for more than 90% of total Danish landings. However, it is necessary to further specify that at present the majority of the Danish catches of anglerfish are taken by fisheries in the Norwegian zone of IVa applying demersal trawls with mesh size >= 120 mm. In 2006, the fishery with demersal trawl in the Norwegian Deeps (in the Norwegian zone) accounted for around 75% of total Danish landings by all gears from the entire North Sea. In the Skagerrak (IIIa) the two main fisheries taking anglerfish are the (mixed) *Nephrops* fishery and the demersal trawl fishery. In both areas minor landings are taken in gillnets and as bycatch in fisheries for shrimp (*Pandalus*).

Information on the species composition of the landings from Danish fisheries taking anglerfish is available from the Danish logbook records and also from the Danish at-sea samples from observers on discard trips. Further details can be found in Section 6.2.1 of ICES WGNSDS 2007. Typically anglerfish constitutes less than 15% by weight of the landings from demersal trawlers fishing in the Norwegian Deeps.

#### Norwegian fisheries

A Norwegian directed gillnet fishery (360 mm mesh size), targeting large anglerfish, carried out by small vessels in coastal waters in the eastern part of the Northern North Sea started in the early 1990s. These vessels are responsible for around 60–70% of the total Norwegian landings from this area and they comprise around 6% of the total landings from Division IVa since 1999. The remaining Norwegian landings in IVa are mostly bycatch in various trawl fisheries. A similar pattern of fishing is found in the Skagerrak (IIIa). The third quarter has in recent years been the most important season for the directed fishery, while the second quarter is apparently most important for other gears.

#### Other fisheries

French demersal trawlers also take a considerable proportion of the total landings from this area. The vessels catching anglerfish may be targeting saithe and other demersal species or fishing in deep water for roundnose grenadier, blue ling or orange roughy.

Since the mid-1990s, a deep-water gillnet fishery targeting anglerfish has been conducting a fishery on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. These vessels, though mostly based in Spain are registered in the UK, Germany and other countries outside the EU such as Panama. Gear loss and discarding of damaged catch are thought to be substantial in this fishery. Until now these fisheries have not been well documented or understood and they seem to be largely unregulated, with little or no information on catch composition, discards and a high degree of suspected misreporting. There are currently (2005) around 16 vessels participating in the fishery, 12 UK registered and four German registered.

In response to the concerns with these gillnet fisheries for deep-water sharks and anglerfish in Subarea VI, the EC banned the setting of gillnets in waters greater than 200 m in 2006 (Council Regulation 51/2006). However, this regulation was reviewed in July 2006 and a new regulation put in place which is a permanent ban, but allows a derogation for entangling nets in waters less than 600 m, not exceeding 100 km in total length with a maximum soak time of 72 hours. (EC Regulation No 40/2008 Annex III, article 8). NEAFC have also introduced an indefinite ban. There is also legislation proposed which will extend the ban to other areas including Division IVa.

In addition, the EU has recently funded a ghost net retrieval programme, DEEP-CLEAN, (coordinated by the Marine Institute, Ireland) which is due to commence in autumn 2007. The intention of this programme is to a) maximize the recovery of lost or abandoned gillnets and b) to quantify the scale and biological consequences.

#### *A.2.2. Division IIa anglerfish fisheries*

In Division IIa most of the anglerfish is caught by small vessels in a directed gillnet fishery close to the coast. The legal mesh size has, since 1995, been 360 mm and maximum 2 days soaking time. Offshore gillnetting, trawls and Danish seines are responsible for the other catches. For the directed gillnet fishery, the area between N 62° and N 64° has been the most important with maximum catches almost reaching 3000 tonnes in 1993. During recent years the catches have varied between 1000–2000 tonnes. A fishery north of N 64° has developed rapidly, with catches reaching 2400 tonnes in 2007, exceeding the level of catches in the southern part of IIa for the first time. For the other gears, catches have increased from around 100 tonnes in the early 1990s to approximately 300–500 tonnes during the last four years. Very low catch figures are reported from other nations north of N 62°.

### A.3. Ecosystem aspects

No information.

## B. Data

### B.1. Commercial catch

#### *B.1.1. Data compilation*

Quarterly length–frequency distribution data were available from Scotland and Ireland for Division VIa and Spain for Subarea VI in the past. A total international catch-at-length distribution for Division VIa was obtained by summing national raised catch-at-length distributions and then raising this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. Since 2001, the Scottish market sampling length–weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division VIa. Length–frequency data availability for VIb has been limited to Scottish and Irish samples.

| Year Range | Formula (L – length in cm, W – weight in g) | Source |
|---|---|---|
| 1992–2000 | W=0.01626L2.988 | Coull *et. al.*, 1989 |
| 2001 onwards | W=0.0232L2.828 | Scottish Market Sampling |

For anglerfish in the North Sea, catch-at-age composition data are available from Scotland for the years 1992 to 2007. In the past the Scottish quarterly age–length keys were applied to the available length–frequency data and non-sampled catches were attributed to age assuming their length–frequency distributions to be equivalent to the combined sampled distribution.

As a first step in assembling assessment data for the North Sea component of the stock, length compositions from Scottish market sampling have been raised to Working Group estimates of total landings in the past. The Working Group estimate of total landings was assumed equal to the landings obtained by national scientists plus official landings as reported to ICES for those countries not providing landings data to the Working Group. The Scottish market sampling data are only available from 1993 onwards, and even for these years the level of sampling has been relatively low. More recently, additional length samples are available from the Danish and Norwegian fisheries since 2002 including samples from Division IIIa.

Total international catch-at-length distribution data for the whole Northern shelf (Division IIIa, Subarea IV and Subarea VI) have previously been obtained by summing the length distributions from the individual areas and assuming that this distribution is representative of the whole Northern Shelf. This was then raised to Working Group estimates of total landings for the Northern Shelf.

In addition, catch-at-length distribution data are available from the Norwegian directed coastal gillnetting in Division IIa from 1993 to 2007, although there are no data from 1997–2001. There are also catch-at-length distribution data from anglerfish caught as bycatch in the offshore gillnetting and longlining fleets for 2004–2007. No attempts have been made to present raised catch-at-length distribution for anglerfish from Division IIa.

#### *B.1.2. Commercial catch data quality*

For a number of years, anglerfish in Subarea VI, XII, XIV and Division Vb (EU zone) were subjected to a precautionary TAC (8600 t), based on average landings in earlier years. In 2002 the TAC was set at 4770 t and was further reduced to 3180 t in 2003 and 2004. The TAC was increased in 2005 to 4686 t and to 5155 t for 2007. At the WG in 2003, it was highlighted that the reduction off the TAC in 2003 to just two-thirds of that in 2002 would likely imply an increased incentive to misreport landings and increase discarding unless fishing effort was reduced accordingly (Section 6.4.6, ICES WGNSDS 2003). Anecdotal information from the fishery in 2003 to 2005 appeared to suggest that the TAC was particularly restrictive in these years. The official statistics for these years are, therefore, likely to be particularly unrepresentative of actual landings.

The absence of a TAC for Subarea IV prior to 1999 means that before then, landings in excess of the TAC in other areas, were likely to be misreported into the North Sea. In 1999, a precautionary TAC was introduced for North Sea anglerfish, but unfortunately for current and future reporting purposes, the TAC was set in accord with recent catch levels from the North Sea which includes a substantial amount misreported from Subarea VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4°W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish.

The Working Group historically (prior to 2005) provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. The correction has been applied by first estimating a value for the true catch in each E6 square and then allocating the remainder of the catch into VIa squares in proportion to the reported catches in those squares. The 'true' catches in the E6 squares are estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean is calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares. Such a reallocation of catches may still inadvertently include some landings taken legally in Division IVa on the shelf edge to the west of Shetland, but these are likely to comprise fish within the distribution of the Division VIa stock component. Due to technical problems associated with changes to the Scottish Executive database and lack of landings data provided to the Working Group by some of the major nations exploiting the fishery, WG estimates of the actual Division VIa landings have not been calculated for recent years (2005–2007).

At the 2010 WGCSE, for data in 2009, this procedure was adjusted to reallocate data to the whole of Area VI: i.e. not just VIa but including Rockall (VIb). This was based on information received from Marine Scotland Compliance indicating that some vessels fishing for anglerfish at Rockall are reporting large catches in the E6 squares from the same voyage. The distribution of landings this new scheme produced was more in keeping with the distribution of the stock as indicated from the anglerfish surveys.

### B.2. Biological

Previous assessments of this stock used the natural mortality rate applied to anglerfish in Division VI adopted by an earlier Hake Assessment WG of 0.15 $yr^{-1}$. This value is once more adopted for all ages and lengths in the absence of any direct estimates for this stock.

Historically, the catch-at-age analysis of anglerfish in Division VIa used the same maturity ogive as that applied to anglerfish in Subareas VII and VIII by the Working Group on the Assessment of Southern Shelf Demersal Stocks. However, a number of more recent maturity studies based on the VIa stock indicate that maturity does not occur until much later than previously estimated. Afonso-Dias and Hislop, 1996 give a length–maturity ogive for this stock, 50% maturity at approximately 74 cm in females, and 50 cm in males. However, this study was based on few samples. New information has become available from the EU-funded project (Anon, 2001) which indicates female 50% maturity at approximately 94 cm and males at 57 cm. The corresponding age-based ogives indicate 50% maturity at approximately age 9 in females and age 5 in males. This has also been supported by more recent studies by Laurenson *et al.*, 2005.

### B.3. Surveys

In previous length-based assessments of this stock, a recruitment index was used which had been obtained from the Scottish March West Coast survey. The index consists of numbers of anglerfish less than 30 cm caught per hour. However, at more recent meetings of this WG it has been concluded that the traditional groundfish surveys are ineffective at catching anglerfish and do not provide a reliable indication of stock size. As a result of this conclusion, and the urgent requirement for fishery-independent data, Marine Scotland Science began a new joint science/industry survey in 2005. This is a targeted anglerfish survey with a scientific design using commercial gear. In 2006, 2007 and 2009 Ireland extended the anglerfish survey to cover the remaining part of VIa (from 54°30′ to 56°39′). Further details of the survey including information on design, sampling protocol and gear and vessel are given in Fernandes *et al.*, 2007 and in annual working documents which describe the survey results.

### B.4. Commercial cpue

#### *B.4.1. Official logbook data*

Previous length-based assessments attempted to use effort data to constrain the temporal trend in fishing mortality. Scottish Light Trawl data, disaggregated into an inshore and offshore component, the latter of which is associated with the anglerfish fishery, for both West of Scotland and Shetland (N Sea) were provided to the Working Group. However, these data are no longer considered to be reliable due to non-mandatory recording of hours fished in the logbook data. Further details of the Scottish fleet effort recording problem can be found in the report of the 2000 WGNSSK (ICES, 2001). Since these data are considered unreliable, they are not presented here.

Irish lpue data in terms of hours fished has been presented to the WG for Division VIa and Division VIb for all fleets up to 2006 (shown in Table B.4.1). The measure of kWdays is believed to be a more reliable proxy for effort than hours fished due to reporting issues and these data are presented in the WG report.

Danish landings and effort data (hours fished) from logbook data are also available to the WG for Division IIIa and Division IVa. Although these data are considered to be reliable (in terms of accuracy of reporting), it is not know to what extent they are useful in providing an indicator of stock size due to management regulations in the Norwegian zone (TAC constraints) and technological creep.

No effort data have been made available to the WG for fisheries operating in Division IIa.

#### *B.4.2. Tallybook data*

Analysis of skippers' personal diary information collected in 2004 and 2005 in an attempt to improve knowledge of the state of the stock and of the Scottish anglerfish fishery provided valuable information to ICES (Bailey, *et al*., 2004) on temporal and spatial trends in catch rate. Following the success of these data collation exercise, ICES advised the process to continue and a more formal scheme was proposed by FRS.

Extensive discussions with the fishing industry during 2005 resulted in FRS implementing the monkfish tallybook project at the start off 2006. The project is part of a long-term approach to providing better information on the monkfish fishery and the state of the stock, and is being operated in conjunction with fishers' organizations (Scottish Fishermen's Federation, Fishermen's Association Limited and Pecheurs de Manche et Atlantique) and the North Atlantic Fisheries College (NAFC) Marine Centre, Shetland. These organizations have been responsible for distributing the tallybooks, coordinating the returns and allocating a vessel code before the anonymised tallybook sheets are forwarded to FRS. The tallybooks are filled in on a haul-by-haul basis to give weight caught by size category and information on haul location, duration and depth in a standardized format as well as gear and mesh being used. Additionally information on mature females has been requested. Data are stored in a database at FRS.

So far, the time-series is relatively short, with the first returns from fishing trips at the end of December 2005 and the most recent from March 2008. Initial participation in the scheme was high with returns received from up to 37 vessels with a wide spatial coverage (across Subarea VI, Division IVa, IIa and Vb) and different target species. Of the 37 vessels which have so far supplied information, two are French and these are operating towards the southern end of the shelf edge in Division VIa northwest of Ireland. The haul depth information collated so far indicates that most of the hauls are taken in depths between 100 and 400 m although there are a significant number of hauls from depths between 600 and 800 m. The records from the deeper water are largely from the French vessels although it does appear that a number of the Scottish vessels make occasional trips into deeper water. Average catch rates are similar to those previously seen in the diary data and observer data (presented in previous WG reports) and range from around 10 kg/hr for boats targeting *Nephrops* to over 100 kg/hr for some whitefish boats.

Analysis of the catch rate data is presented in the WG report and in Dobby *et al.*, 2007.

### B.5. Other relevant data

None.

## C. Historical stock development

Since 2003 the WG has been unable to provide an assessment of anglerfish. This is due to a combination of unreliable commercial data: landings misreporting in some of the main fleets involved in the fishery and uncertain effort data, and poor catchability of anglerfish in traditional research vessel surveys.

Although, the stock status has been classified as uncertain in recent years, TAC increases of 10% occurred in both the West of Scotland and North Sea areas on the basis of advice from the STECF Review Group meeting (SGRST-06–03) which examined trends in commercial catch rate data and fishery information.

In previous years the stock assessment has been conducted using a length-based model for which the settings are outlined below.

> Model used: Catch-at-length analysis (modified CASA-Sullivan *et. al.*, 1990; Dobby, 2002).
>
> Software used: Fortran coded executable-LBAV4_1.

Model Options chosen:

> Sex differentiated von Bertalanffy growth, variability distributed according to a beta function. Parameters taken from Scottish anglerfish survey in 2000: $L_4$(F)=140.5, K(F)=0.117, $L_4$(M)=110.5, K(M)=0.154.
>
> Fishing mortality in 1993=1.0
>
> Historical equilibrium fishing mortality fitted using mean of historical WG estimates of landings which is approximately 18 000 t over 1987–1991.
>
> Logistic exploitation pattern with fitted parameters.
>
> Trend in temporal fishing mortality equal to trend in recent SCOLTR effort data
>
> Total recruitment normally distributed over length classes

Input data types and characteristics:

| Name | Year range | Variable from year to year Yes/No |
|---|---|---|
| Catch in tonnes | 1993–last data year | Yes |
| Catch-at-length in numbers | 1993–last data year | Yes |
| Weight-at-length in the commercial catch | 1993–last data year | Yes/No–2 weight-length relationships: covering 1993–2000, and 2001 onwards |
| Weight-at-length of the spawning stock at spawning time. | 1993–last data year | Yes/No-assumed to be the same as weight-at-length in the catch |
| Proportion mature-at-length | 1993–last data year | No–the same ogive for all years |
| Natural mortality | 1993–last data year | No–set to 0.15 for all lengths in all years |

Auxiliary data:

| Type | Name | Year range | Size range |
|---|---|---|---|
| Recruitment index | Scottish March West Coast survey | 1993–last data year | < 30 cm |

### D. Short-term projection

In previous years the short-term forecast has used a length-structured method with settings outlined below.

Model used: Length-structured

Software used: Fortran coded executable LBForecast.exe

Initial stock size: taken from catch-at-length analysis. The long-term geometric mean recruitment is used in all projection years. Natural mortality: Set to 0.15 for all lengths in all years

Maturity: The same ogive as in the assessment is used for all years

Weight–length relationship: as used in the assessment (Scottish Market sampling)

Exploitation pattern: Fixed exploitation-at-length pattern is estimated in the catch-at-length analysis. This is assumed to apply in all further years.

### E. Medium-term projections

No medium-term projections are carried out for this stock.

### F. Yield and biomass-per-recruit/long-term projections

Previous yield and biomass-per-recruit calculations were carried out on the basis of the results of length-based assessments which are no longer carried out.

### G. Biological reference points

Precautionary approach reference points: "ICES considers that there is currently no biological basis for defining $B_{lim}$ or $F_{lim}$. ICES proposes that $F_{35\%SPR}$ =0.30 be chosen as $F_{pa}$. It is considered to be an approximation of $F_{MSY}$."

The statement included above first appeared in 1998, but the WG has been unable to find the basis of the derivation of this reference point and considers it no longer appropriate to include it.

### H. Other issues

In previous ('catch-at-length') assessments of this stock, the SSB was always estimated to be at a very low level. The length data have been based on the UK landings only (in Subdivisions. IVa and VIa), where very few individuals over 80 cm appear in the catch and therefore the model predicts very few in the population. Since females do not mature until they are over 90 cm in length the SSB is estimated to be very low. The length data from the eastern part of the North Sea (Danish and Norwegian fisheries) for the recent years indicate a higher amount of larger individuals in the catches. Although the Danish and Norwegian landings are small in comparison to the UK landings, the inclusion of the Danish and Norwegian length frequencies in the data used for any future assessment may change the concept of the magnitude of the SSB.

The fact that mature female anglerfish are rarely observed either on scientific surveys or by observers on board commercial vessels supports a very low estimate of spawning–stock biomass, yet there is little evidence of reduction in spatial distribution as fish are still recruiting to relatively inshore areas. It has been hypothesized that females may become pelagic when spawning as they produce a buoyant, gelatinous ribbon of eggs, and would therefore not appear in the catch of trawlers. (Anglerfish have been caught near the surface, Hislop *et al.*, 2000). This would imply different exploitation patterns for males and females: a dome-shaped pattern (decreased exploitation at larger sizes) for females and a logistic pattern for males. It is also not known whether anglerfish are an iteroparous or semelparous species. The latter would also account for the almost complete absence of spawning females in commercial catches or research vessel surveys.

The key features of the species' life history in relation to its exploitation are the location of the main spawning areas, and whether or not there is any systematic migration of younger fish back into the deeper waters to spawn. At present, despite the large increase in catches during the mid 1990s, there is no apparent contraction in distribution; fish are still recruiting to relatively inshore areas such as the Moray Firth in the northern North Sea. The fact that spawning may occur largely in deep water off the edge of the continental shelf may offer the stock some degree of refuge. However, this assumes that the spawning component of the stock is resident in the deep water, and is thus not subject to exploitation. It is not known to what extent this is true, but if such a reservoir exists then the currently used assessment methods which make dynamic pool assumptions about the population are likely to be inappropriate. Nevertheless, it is clear that further expansion of the fishery into deeper water is likely to have a negative effect on the SSB and given the spatial development of the fishery, it cannot be ruled out that the serial depletion of fishing grounds has been occurring. In addition, some life-history characteristics of anglerfish suggest that it may be particularly vulnerable to high exploitation. A detailed discussion of the fishery development and biology can be found in Sections 7.5.4 and 7.5.5 of the 2000 Report of this Working Group (ICES, 2001).

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**Table B.4.1. Anglerfish in Subarea VI. Landings, effort and lpue from the Irish OTB fleet.**

| | IR-OTB-4-6 | | | IR-TBB-4-6 | | | IR-SCC-4-6 | | | IR-GN-4-6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | IV–VI | | | IV–VI | | | IV–VI | | | IV–VI | |
| Year | Landings (t) | Effort (hr) | lpue (kg/h) | Landings (t) | Effort (hr) | lpue (kg/h) | Landings (t) | Effort (hr) | lpue (kg/h) | Landings (t) | Effort (hr) | lpue (kg/h) |
| 1995 | 769.21 | 66.54 | 11.56 | | 0.00 | | 5.70 | 2.65 | 2.15 | 0.87 | 1.57 | 0.55 |
| 1996 | 698.93 | 68.90 | 10.14 | 16.54 | 1.23 | 13.45 | 4.91 | 2.94 | 1.67 | 1.91 | 2.25 | 0.85 |
| 1997 | 680.78 | 72.71 | 9.36 | 2.055 | 1.07 | 1.93 | 7.79 | 3.00 | 2.60 | 3.40 | 1.83 | 1.86 |
| 1998 | 656.23 | 66.40 | 9.88 | 10.381 | 2.36 | 4.41 | 12.72 | 2.95 | 4.32 | 0.95 | 1.22 | 0.77 |
| 1999 | 512.92 | 63.23 | 8.11 | 1.939 | 1.12 | 1.73 | 12.14 | 4.22 | 2.87 | 6.19 | 0.49 | 12.65 |
| 2000 | 471.95 | 63.33 | 7.45 | 0.045 | 0.13 | 0.35 | 4.64 | 3.86 | 1.20 | 0.87 | 0.11 | 7.60 |
| 2001 | 408.46 | 55.99 | 7.30 | 0.12 | 0.12 | 0.98 | 2.95 | 1.31 | 2.26 | 22.23 | 0.43 | 51.69 |
| 2002 | 317.13 | 40.00 | 7.93 | | 0.00 | | 5.06 | 1.58 | 3.20 | 4.94 | 0.23 | 21.48 |
| 2003 | 299.17 | 44.44 | 6.73 | | 0.00 | | 3.84 | 2.22 | 1.73 | 1.86 | 0.54 | 3.45 |
| 2004 | 197.89 | 37.50 | 5.28 | 0.176 | 0.35 | 0.50 | 2.15 | 0.98 | 2.20 | 2.46 | 0.54 | 4.57 |
| 2005 | 350.33 | 34.79 | 10.07 | | 0.04 | 0.00 | 1.07 | 0.69 | 1.56 | 0.00 | 0.04 | 0.00 |
| 2006 | 423.39 | 34.62 | 12.23 | 0.12 | 0.07 | 1.71 | 1.18 | 0.49 | 2.40 | 0.02 | 0.24 | 0.07 |

# Stock Annex 6.3: Haddock VIIa

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Irish Sea Haddock (Division VIIa) |
| Working Group | Celtic Seas Ecoregion |
| Last updated | 19 May 2009 |
| Revised by | P-J. Schön |

## A. General

### A.1. Stock definition

### A.2. Fishery

Directed fishing for haddock in the Irish Sea is mainly carried out by UK(Northern Ireland) midwater trawlers using 100mm mesh codends, particularly targeting aggregations that can be detected acoustically. These conditions prevail mainly during winter and spring when the hours of darkness are longest, and the fish are aggregating on the spawning grounds in the western Irish Sea. Other demersal whitefish vessels from Northern Ireland, Ireland and to a lesser extent Scotland, using single or twin trawls with 100 mm mesh, also target haddock when abundant. (Prior to the introduction of Council technical conservation Regulation 850/98 in 2001, most whitefish vessels in the Irish Sea used 80 mm codends.) Bycatches of haddock are made in the UK(NI) and Irish *Nephrops* fisheries using single nets with 70 mm codends or twin trawls with 80 mm codends. The haddock stock is mainly distributed in the western Irish Sea and south of the Isle of Man, preferring the coarser seabed sediments around the periphery of the muddy *Nephrops* grounds. Juveniles are taken extensively in the otter trawl fisheries in these areas, leading to substantial discarding (see Section B1.2).

The nature of the fishery has been modified by the cod closure since 2000 (Council Regulation (EC) No 304/2000). Targeted fishing with whitefish trawls was prohibited inside the closure from mid February to the end of April. Derogations for *Nephrops* fishing were allowed. Irish *Nephrops* trawlers were involved in an experiment to test inclined separator panels in 2000 and 2001, the object being to minimize the bycatch of cod. Fishing inside a small area of the western Irish Sea closed to all fishing in spring 2000 and 2001 was permitted if separator panels were used. These panels would also have allowed escapement of part of the haddock catch. Closure of the main whitefish fishing grounds in spring 2000 resulted in a shift in fishing activities of midwater trawlers and other UK(NI) whitefish vessels into the North Channel (Area VIIa) and Firth of Clyde (VIa south). A subsequent closure of the Firth of Clyde in spring 2001 under the VIa cod recovery programme (Council Regulation (EC) No 456/2001) resulted in a reduction in reported fishing activity in this region. Several rounds of decommissioning in 1995–1997, 2001 and 2003 have reduced the size of the commercial fleets. UK vessels decommissioned at the beginning of 2002 accounted for 17% of the haddock landings from the Irish Sea in 1999–2001. A further round of decommissioning in 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea at the beginning of 2004, representing a loss of 8% of the fleet by number and 9.3% by tonnage.

Gear specific effort regulations (days at sea) have been introduced in the Irish Sea in 2004. Annex V to Council Regulation (EC) No 2341/2002 regulated the maximum number of days in any calendar month of 2004 for which a fishing vessel may be absent from port in the Irish Sea. Monthly effort limitation under this Regulation is as follows: ten days for demersal trawls, seines and similar towed gears with mesh size >=100 mm, 14 days for beam trawls of mesh size >=80 mm and static demersal nets, 17 days for demersal longlines, and 22 days for demersal trawls, seines and similar towed gears with mesh size 70–99 mm. Additional days are available for vessels meeting certain conditions such as track record of low cod catches. In particular, an additional two days are available for whitefish trawlers (mesh >=100 mm) and beam trawlers (mesh >=80 mm) which spend more than half of their allocated days in a given management period fishing in the Irish Sea, in recognition of the area closure in the Irish Sea and the assumed reduction in fishing mortality on cod.

#### A.3. Ecosystem aspects

## B. Data

### B.1. Commercial catch

#### *B1.1. Landings*

The following table gives the source of landings data for Irish Sea haddock:

| | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (catch in weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | Matprop (proportion mature by age) | Length composition in catch |
| UK(NI) | X | X | X | X | X |
| UK(E&W) | X | | | | |
| UK(Scotland) | X | | | | |
| UK (IOM) | X | | | | |
| Ireland | X | X | X | | X |
| France | X | | | | |
| Belgium | X | | | | |

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in Excel files to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK(E&W), UK(Scotland), Belgium and France and annual landings are provided by UK(IOM). The quarterly estimates of landings-at-age into UK(NI) and Ireland are raised to include landings by France, Belgium, UK(E&W), UK(Scotland), UK(IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the

ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

*B1.2. Discards*

The potential magnitude of discarding was evaluated using limited data from the following fleets:

- Northern Ireland self sampling scheme for *Nephrops*. The fisher self-sampling scheme that provides discards data for VIIa whiting was altered in 1996 to record quantities of other species in the samples. The quantity of haddock discarded from the UK (NI) *Nephrops* fishery is estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of haddock in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of haddock discarded using the haddock:*Nephrops* ratio in the discard samples. Length frequencies of haddock in the samples are then raised to the fleet estimate. No otoliths were collected, but the length frequencies could be partitioned to age class based on appearance of modes and comparison with length-at-age distributions in March and October surveys. The age data from 2001 and 2002 were derived using survey and commercial fleet ALKs. The UK (NI) estimates are available since 1996 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually. There are several limitations to these data: only a small subset of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded-at-age. The WG has not used these data in past assessments.
- Northern Ireland observer sampling (all fleets): Length frequencies from NI (AFBI) observer trips in specified fleet métiers are raised to the trip level, summed across trips during each year or by quarter (if requested) then raised to the annual number of trips per year in the NI fleet in VIIa to give raised annual LFDs for discards. An age–length key from discards trips is then applied to give annual discards by age class and métier.
- Irish otter trawl fleet (IR-OTB). Discards are estimated by observers on Irish trawlers operating in VIIa. Estimates for this fleet are given in the report of the ICES Study Group on Discards and Bycatch Information (ICES CM 2002 ACFM:09). The anomalous high estimate of discards for this fleet in 2001 was a result of an inappropriate raising procedure, and data for this year are not presented. No discard data were available for 2002 due to a very limited number of sampling trips (n=1). This sampling level has increased in 2003, but is still low (n=6). A re-analysis of the Irish discard data

raised to the number of trips, instead of landings, was performed based on methods described by Borges *et al*., 2005 and provided to the WG in 2005.

### B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years, in the absence of a direct estimate of natural mortality of Irish Sea haddock.

A combined sex maturity is assumed, knife-edged at age 2 for all years. Recent research on the changes in maturity of the Irish Sea haddock stock conducted by the UK (NI) showed, using a GLM analysis on the effects of year, region, age, and length on the probability of being mature, that maturity is determined differently for male and female haddock. Maturity was found to be predominantly a function of length in male haddock, while age was the main factor in females. Interannual variation in the proportion mature was mostly confined to the age 2 group, while other age groups were either fully immature or fully mature. Over 99% of 3-year-olds were mature.

The proportion of F and M before spawning are set to zero to reflect a SSB calculation date of 1 January.

Working Groups prior to 2001 used constant weights-at-age over years based on analysis of some early survey data. However, evidence of a decline in mean length of adult haddock over time needed to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights are calculated by fitting a von Bertalanffy growth curve to all available survey estimates of mean length-at-age in March, with an additional vector of parameters estimated to allow for year-class effects in asymptotic length. To increase the number of observations for older age classes, the mean lengths-at-age in UK (NI) first-quarter landings were included for age classes three and over. (Comparisons of survey and landings data showed that values from landings were larger than from the survey at ages 1 and 2 because of selectivity patterns in the fishery, but very similar for ages 3 and over.) Stock weights-at-age were calculated from the model-fitted mean lengths-at-age, using length–weight parameters calculated from all March survey samples (2001 WG) or annual length–weight parameters (since 2002 WG). The time-series of length–weight parameters are listed below:

| | Length–weight parameters | | Expected weight-at-length | |
|---|---|---|---|---|
| Year | a | B | 30 cm | 40 cm |
| 1993 | 0.01132 | 2.972 | 278 | 653 |
| 1994 | 0.00374 | 3.279 | 261 | 669 |
| 1995 | 0.00354 | 3.291 | 257 | 661 |
| 1996 | 0.00565 | 3.156 | 259 | 642 |
| 1997 | 0.00723 | 3.104 | 278 | 680 |
| 1998 | 0.00633 | 3.119 | 256 | 629 |
| 1999 | 0.00449 | 3.208 | 246 | 620 |
| 2000 | 0.00439 | 3.208 | 241 | 606 |
| 2001 | 0.00402 | 3.242 | 247 | 627 |
| 2002 | 0.00369 | 3.268 | 247 | 633 |
| 2003 | 0.00459 | 3.197 | 242 | 607 |
| 2004 | 0.00514 | 3.156 | 236 | 585 |
| 2005 | 0.00489 | 3.174 | 238 | 593 |
| 2006 | 0.00506 | 3.165 | 239 | 595 |
| 2007 | 0.00469 | 3.194 | 244 | 612 |
| 2008 | 0.00523 | 3.159 | 242 | 601 |

The following model was fitted to the length-at-age data:

$L_{t,yc} = LI_{yc} .(1\text{-}\exp(-K(t\text{-}t_0)))$

where $LI_{yc}$ is the estimated asymptotic length for year class yc. Parameters were estimated using Microsoft Solver in Excel by minimizing $\Sigma(\ln(\text{observed } L_t \ / \text{ expected. } L_t))^2$.

The year-class effects show a smooth decline from the mid-1990s coincident with the rapid growth of the stock, and may represent density-dependent growth effects. The year-class parameters effectively remove the temporal trend in residuals around a single von Bertalanffy model fit without year-class effects.

To estimate mean weight-at-age for year classes prior to 1990, represented as older fish in the early part of the time-series, the year-class effect for the 1990 year class and length–weight parameters for 1993 were assumed.

#### B.3. Surveys

Seven research vessel survey-series for haddock in VIIa were available to the Working Group in 2009. In all surveys listed the highest age represents a true age not a plus group.

- UK(NI) groundfish survey (NIGFS) in March (age classes 1 to 6, years 1992–2009)

The survey-series commenced in its present form in 1992. It comprises 45 three mile tows at fixed station positions in the northern Irish Sea, with an additional 12 one mile tows at fixed station positions in the St George's channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. Lough Foyle (1992–2004) and the R.V. Corystes since 2005. The survey designs are stratified by depth and seabed type. The mean numbers-at-length per 3-mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The survey design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.* (2003).

- UK(NI) groundfish survey (NIGFS) in October (age classes 0 to 5; years 1991 to 2008)

Description as for UKNI-GFS-March above.

- UK(NI) Methot–Isaacs–Kidd (MIK) net survey in June (age 0; years 1994–2008)

The survey uses a Methot–Isaacs–Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place end of May/early June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers per unit sea area.

- Republic of Ireland Irish Sea–Celtic Sea groundfish survey (IR-ISCSGFS) in November (ages 0 to 5; years 1997–2002)

This survey commenced in 1997 and is conducted in October–November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard groundgear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area. The survey was terminated in 2002 due to a vessel change.

```
IRE OTB [Irish Otter trawl - Effort in hours numbers-at-age in 1000's]
1995 2002
1 1 0 1
2 5
   80314   262     29      15    1
   64824  1257     33       1    1
   92178    96    191       7    1
   93533  1341     95     110    3
  110275    56    471       7    1
   82690   118     17      31    3
   77541   232    251      10    5
   77863    97    174      22    1
```

- Republic of Ireland groundfish survey (IR-GFS) in autumn (age classes 0 to 6, years 2003–2004)

This survey commenced in 2003 and is an IBTS-coordinated survey, conducted in October–November on the R.V. *Celtic Explorer*. The survey is an extension of a survey covering Divisions VI and VIIb–k. A GOV otter trawl with standard groundgear and a 20 mm codend liner is used. Indices are calculated as arithmetic means of all stations, without stratification by area. The survey operated for only two years within the Irish Sea.

```
IR-GFS Autumn [Irish groundfish survey in Autumn (Celtic Explorer)]
2003  2004
1 1 0.89 0.91
0 6
    1170   5520  1069   406     3   4   0   1
    1030   8132  2062   131    46   7   0   0
```

- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 6, years 1996–2006)

This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (nine stations). The survey extends from the northern limit of the Irish Sea to around 53°30′. The survey was terminated in 2006.

```
SGFS Spring [Scottish groundfish survey in Spring – Effort: numbers
caught/10 hr]
1997  2006
1 1 0.15 0.21
1 4
       1   6581    65   213     9   2   0
       1    564   472     4     9   0   0
       1    246    21   137     2   1   0
       1    819   338     8    15   0   0
       1     62   299    71     6   5   1
       1    944    72   111    16   0   0
       1    318  1420     7    16   3   0
       1   1591   242   355     0   3   0
       1    514   371    41    40   0   0
       1     97   252    91     0   3   0
```

- UK(Scotland) groundfish survey (SCOGFS) in autumn (age classes 0 to 6, years 1996–2004)

The survey covers a similar area to the ScoGFS in Spring, but has only 11–12 stations. The survey was terminated in 2005.

```
SGFS Autumn [Scottish groundfish survey in Autumn – Effort: numbers
caught/10 hr]
1997 2005
1 1 0.83  0.88
0 3
        1     104     437      4     27   1   0   0
        1     291      29     41      2   2   0   0
        1    4988     473      0     22   2   0   0
        1     790     332     38      2   4   0   0
        1    1647     389   1462     27  62  60   7
        1     178     189      2     13   2   0   0
        1     601      86    100      5   2   0   0
        1     394     416     39     18   2   0   0
        1    1399     526    171      9   3   0   0
```

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys are shifted back accordingly in the data files.

#### B.4. Commercial cpue

Only one historic cpue dataseries were provided to the WG for VIIa haddock.

```
IRE OTB [Irish Otter trawl - Effort in hours numbers-at-age in 1000's]
1995 2002
1 1 0 1
2 5
   80314   262     29      15    1
   64824  1257     33       1    1
   92178    96    191       7    1
   93533  1341     95     110    3
  110275    56    471       7    1
   82690   118     17      31    3
   77541   232    251      10    5
   77863    97    174      22    1
```

#### B.5. Other relevant data

None.

### C. Historical stock development

The 2004–2007 Working Group spent a considerable amount of time exploring the possibility of using TSA, ICA and B-Adapt (which allows for years with missing catch data). The results of these models were unsatisfactory. Since the assessment suffers from poor data quality with a relatively short time-series, from 2004 onwards the WG presented assessments of recent stock trends based on survey data only. The 2004 assessment focused on a Time-Series Analysis (TSA), which allows the 2003 commercial catch data to be treated as missing. Since 2005 a Survey Based Assessment (SURBA) was used, which is considered to give a reliable picture of the status of the stock, at least in terms of SSB and recruitment.

Model used: SURBA

Software used: SURBA version 3.0

Model Options chosen:

| | WGNSDS 2005 | WGNSDS 2006 | WGNSDS 2007 | WGNSDS 2008 |
|---|---|---|---|---|
| Year range: | 1992–2005 | 1992–2006 | 1992–2007 | 1992–2008 |
| Age range: | 1–4 | 1–5 | 0–5 | 1–5 |
| Catchability: | 1.0 at all ages | 1.0 at all ages | 1.0 at all ages | 1.0 at all ages |
| Age weighting | 1.0 at all ages | 1.0 at all ages | 1.0 at all ages | 1.0 at all ages |
| Smoothing (Lambda): | 1.0 | 1.0 | 1.0 | 1.0 |
| Cohort weighting: | not applied | not applied | not applied | not applied |
| Reference age | 2 | 2 | 1 | 2 |
| Survey used | NIGFS-Mar | NIGFS-Mar | NIGFS-Mar, NIGFS-Oct | NIGFS-Mar |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 2 | NIGFS-Mar | 1992–(last data year) | 1–5 |

The 2005 WG performed an extensive analysis of survey data for Irish Sea haddock. The effect of smoothing (lambda=1.0 and 0), fitting constant catchability (1.0 for all ages) or variable catchability-at-age and the choice of reference age were explored. The results indicated that the choice of catchability-at-age and using different values for the smoothing parameter had very little effect on the temporal trends in SSB or recruitment, and a lambda value of 1.0 reduces the noise in Z without over-smoothing the trends. Changing the reference age had very little effect on the results.

The VIIa haddock stock has been assessed prior to the 2004 WG using XSA with the following model setting and input data:

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for ages 1–3

Catchability independent of age for ages >= 3

Survivor estimates shrunk towards the mean F of the final 5 years or the oldest age

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1993 – last data year | 0 – 5+ | Yes |
| Canum | Catch-at-age in numbers | 1993 – last data year | 0 – 5+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1993 – last data year | 0 – 5+ | Yes |
| West | Weight-at-age of the stock at spawning time. | 1993 – last data year | 0 – 5+ | Yes: uses growth model from UK (NI) March GFS data |
| Mprop | Proportion of natural mortality before spawning | 1993 – last data year | 0 – 5+ | No – set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1993 – last data year | 0 – 5+ | No – set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1993 – last data year | 0 – 5+ | No – the same ogive for all years |
| Natmor | Natural mortality | 1993 – last data year | 0 – 5+ | No – set to 0.2 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 1 | NIGFS-Oct | 1991–last data year | 0–3 |
| Tuning fleet 2 | NIGFS-Mar (adjusted) | 1991–(last data year-1) | 0–3 |
| Tuning fleet 3 | ScoGFS-Spring (adjusted) | 1996–(last data year-1) | 0–3 |
| Tuning fleet 4 | MIK net May/June | 1994–last data year | 0 |

For details of procedures see WG reports from WGNSDS 1997–2007.

## D. Short-term projection

No short-term forecast has been performed for this stock since 2003.

Short-term inputs prior to 2004 are given below:

Model used: Age structured

Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a short-term GM (1993 onwards).

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: average stock weights for last three years.

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years. Landings F's are varied in the management option table.

Intermediate year assumptions: *status quo* F

Stock–recruitment model used: None, the short-term geometric mean recruitment-at-age 0 is used.

Procedures used for splitting projected catches: F vectors in each of the last three years of the assessment are multiplied by the proportion landed-at-age to give partial Fs for landings. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

### E. Medium-term projections

No medium-term projections are done for this stock as the short time-series of stock and recruitment estimates precluded any meaningful prediction of the medium-term dynamics of the stock.

### F. Yield and biomass per recruit/long-term projections

Last calculations of yield-per-recruit reference points was by WGNSDS (2004) based on the exploitation patterns from XSA fitted to data out to a 5+ group.

Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.

Software used: MFYPR

Selectivity pattern: mean F array from last three years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age: long-term mean (1993 onwards).

Proportion discarded: partial F vectors are the recent average

Maturity: Fixed maturity ogive as used in assessment.

Procedures used for splitting projected catches: None required

### G. Biological reference points

The ACFM view on this stock (ACFM, October 2002) is that there is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period. ACFM proposes that $F_{pa}$ be set at 0.5 by association with other haddock stocks. The absolute level of F in this stock at present is poorly known. The point estimate of F(2–4) for 2002 (0.89), however, is above $F_{pa}$.

### H. Other issues

None.

### I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN) : 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 33pp.

Borges, L., Zuur, A.F., Rogan, E. and Officer, R. 2005. Choosing the best sampling unit and auxiliary variable for discards estimations. Working Document No. 3 submitted to 2005 meeting of the ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 25pp.

# Stock Annex 6.4: Irish Sea East *Nephrops* (FU14)

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Irish Sea East *Nephrops* (FU14) |
| Working Group | Assessment of Northern Shelf Demersal Stocks |
| Date | May 2010 |

## A. General

### A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the eastern Irish Sea the *Nephrops* stock inhabits an area of muddy sediment extending along the Cumbria coast and its fishery contributes to less than 10% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements in the Irish Sea. The two are treated as separate populations since they have differing population characteristics.

### A.2. The fishery

Between 1999 and 2003 the number of vessels fishing for *Nephrops* in FU14 declined by 40% to a fleet of around 50 vessels. This was largely due to the reduction in the number of visiting UK vessels and the decommissioning of part of the Northern Irish and local English fleets. Since then the number of vessels fishing the area has returned to around 80 vessels mainly from Northern Ireland. Currently, around 30 of these vessels, between six and 23 m in length, have their 'home' ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is generally made up of larger vessels from Kilkeel or Portavogie, Northern Ireland.

Between 1987 and 2006, landings from FU14 appeared relatively stable, fluctuating around a long-term average of about 550 t. Landings in 2007, however bucked this trend, and are at their highest level since 1978 at 959 t, this is after landings dropped in 2003 to their lowest apparent level since 1974. The 2008 and 2009 figures of 676 and 694 t respectively are lower than 2007 still remains high, above any other figure recorded since 1990. The introduction of the buyers and sellers legislation in 2006 really precludes direct comparison with previous years as reporting levels are considered to have significantly improved since.

Over the last ten years UK vessels have landed, on average, 87% of the reported annual international landings. ROI vessels increased their share of the landings to 35% in 2002 but it has since declined to 2% in 2009. In 2009, most of the landings were made into England with a large proportion of these landings (67% of the directed landings and 62% of the total landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1993 but has remained relatively stable since 2003 fluctuating around a mean of 13 800 hrs. Changes to recording practices will affect interpretation of the scale of this decline but a decline is real.

The changes to the structure and landing practices of the Northern Irish fleet (see above) will have had some impact on this dataseries. From 2002–2004, fewer of the

Northern Irish fleet were landing in England. The differences between lpue figures for individual vessels suggest that earlier years may have included less truly directed effort. Reductions in quota between 2002 and 2006 for VIIa cod and plaice may have restricted total effort in FU14 thereby reducing the more casual effort on *Nephrops*. Further research is needed to better define the directed fishery. From 2003 the main fleets targeting *Nephrops* include *Nephrops* directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Ireland.

#### Regulations

Regulations introduced as part of a revised package of EC Fisheries Technical Conservation measures in 2000 remain in place. This legislation incorporates a system of 'mesh size ranges' for each of which has been identified a list of target species. In effect, nets in the 70–79 mm mesh size range must have at least 35% of the list of target species (which includes *Nephrops*) and the 80–99 mm mesh size range requires at least 30% of the list of target species. A square mesh panel (SMP) of 80 mm is required for 70–79 mm nets in the Irish Sea. Vessels using twin-rig gear in the Irish Sea must comply with a minimum mesh size of 80 mm (no SMP is required for nets with 80 mm meshes and above).

Other regulations restricting trawling in other fisheries within the Irish Sea will affect effort on these and other stocks. This could either attract local effort or even relocate effort to fisheries in other areas. Although unrestrictive the result of better catch information through the buyers and sellers legislation introduced to the UK from 2006 will have the same effect as quota uptake of stocks which used to be misreported will be quicker.

As well as an Area VII TAC other *Nephrops* conservation measures in the Irish Sea are a minimum landing size of 20 mm CL length (equivalent to 37 mm tail length or 70 mm total length).

In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels between 14th February to 30th April part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

### A.3. Ecosystem aspects

The Working Group has collated no information on the ecosystem aspects of this stock.

## B. Data

### B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea East are estimated from port sampling by England and Wales. Length data from this sampling are applied to catch samples collected at sea and raised to total international landings. Catch–length samples are collected independently of landings–length samples but both are considered representative. The independent raising process means that the final annual catch–length frequency distribution still requires scaling to the reported landings. Using a discard ogive derived from samples collected in the early 1990s an initial estimate of discards is taken from the catch distribution. These are then added to the landings distribution to create a dummy catch distribution. The difference between the numbers-at-length for both the raised sampled and dummy catch distribution was then used to tune a raising factor by minimizing the sums of squares. Once the raising factor is derived, the final discard–length distribution is the difference between the raised catch distribution and the landings distribution and a final catch distribution is a sum of the landings and discard distributions. In 2008 a new discard ogive was calculated from the discard samples collected from 2003 until March 2008 and applied to the 2003 data to date. The lack of discard and catch data between 1995 and 1999 is likely to adversely affect the quality of any analytical assessments. Apparent differences between catch LFDs and discard practices in 1992 to 1994 and 1999 to 2000 are discussed in the Section 5.12 of the 2001 WGNEPH report (ICES, 2001a). 2001 and 2002 catch and landings sampling provided catch compositions to help estimate the LFDs for the missing years. Quarterly discard distributions for the years 1995 to 1999 were estimated by using the discard LFDs for the two preceding and the two following years.

Trial XSAs using these data were attempted at the 2003 WGNEPH. In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of 'slicing'. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method was implemented in the L2AGE programme which automatically generated the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate 'true' as opposed to 'nominal' age classes (ICES, 2001a). The age classes are 'true' to the extent that the first slicing boundary, i.e. lower length boundary for 'age' 0, is the *length-at-age* zero rather than the lowest length in the data. This was to ensure comparability of 'age' classes across stocks.

### B.2. Biological

Mean weights-at-age for this stock are estimated from studies by Bailey and Chapman, 1983.

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature-at-age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

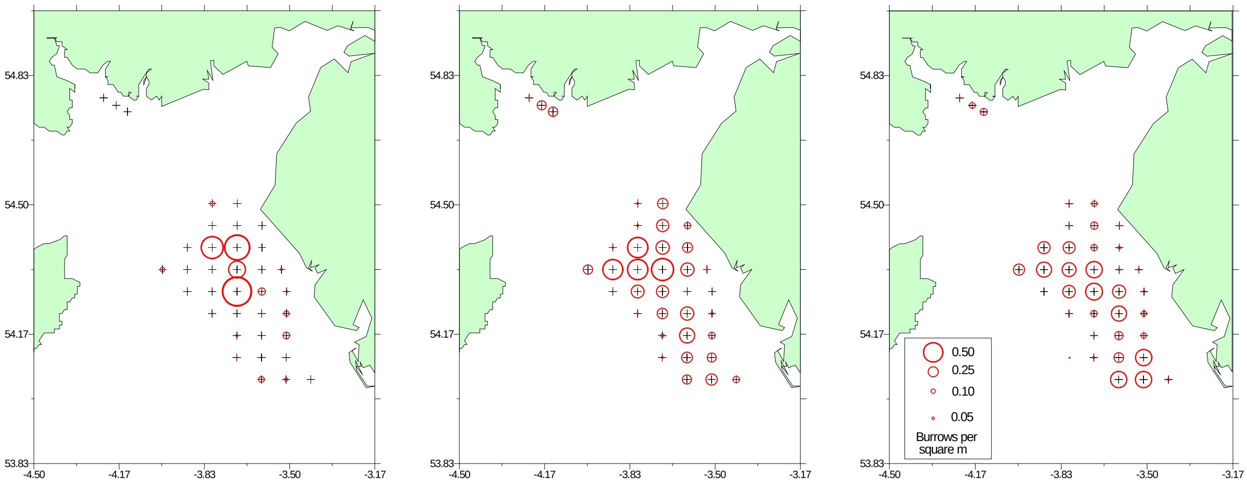
Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

### B.3. Surveys

ACFM recommended that UWTV surveys could provide useful fishery-independent data on the status of *Nephrops* stocks. The UWTV surveys conducted in August 2007 and 2008 are presented here as a preliminary to future assessments. Two previous UWTV surveys were conducted for this fishery in 1997 and 1998 with limited success, because of weather. These surveys and their design were documented at WKNEPHTV (ICES, 2007). The surveys in 2007 and 2008 are consistent but follow a different design to the earlier surveys. For ease of comparison, and consistency, the survey has been based on the current ROI and NI survey in the Western Irish Sea. A randomized fixed grid (3.4 x 3.4 nm) of 34 stations plus a transect of three stations in Wigtown Bay were sampled. Figure B.3.1 shows the distribution of stations in the TV surveys with the size of the symbol reflecting the *Nephrops* burrow density.

The survey protocols used were the same, and followed the standards set by WKNEPHTV (ICES, 2007). In 2007 poor visibility hampered the survey and despite repeated attempts at over 15 stations, turbidity scores precluded the use of some of the counts. On first analysis only 20 were considered usable. The 2008 and 2009 survey was far more successful, sea conditions were far better and the quality of the video data collected was much improved. 35 and 32 stations respectively were considered useable. Table B.3.1 provides the estimates for the burrow density and abundance.

These are the first two of a planned series of surveys. Because of uncertainties about the limits of the stock and characteristics of this fishery and in light of SGSURV and WK*NEPH* (2009) the data will require further analysis and a further survey to qualify the precision of these estimates. These results therefore are only presented as provisional.




**2007** **2008** **2009**

**Figure B.3.1. Station distribution and relative burrow density, from August TV surveys 2007 to 2009.**

**Table B.3.1. Irish Sea East (FU14): Results from NI UWTV survey of *Nephrops* ground.**

| Year | Area | No. stations | Non Zero stations | Mean burrow density | Abundance |
|---|---|---|---|---|---|
| | km² | | | no./m² | millions |
| 2007* | 1043 | 20 | 18 | 0.38 | 393 |
| 2008* | 1043 | 35 | 31 | 0.36 | 334 |
| 2009* | 1043 | 32 | 28 | 0.25 | 257 |

*** provisional**

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on expert opinion on those used in adjacent survey areas which used simulation models, and preliminary experimentation. The biases associated with the estimates of *Nephrops* abundance in the east Irish Sea are:

| | Time period | Edge effect | Detection rate | Species identification | Occupancy | Cumulative bias |
|---|---|---|---|---|---|---|
| FU14: Irish Sea East | <=2009 | 1.3 | 0.75 | 1.15 | 1 | 1.2 |

Edge effect: Same sledge and set up as Western Irish Sea. Larger burrows systems increase the edge effect.

Detection rate: Same sledge and set up as Western Irish Sea and same staff so detection rate maintained.

Species identification: Factor kept the same as Eastern Irish Sea; *Calocaris* spp not a perceived problem on Eastern Irish Sea grounds but *Goneplax* spp. are prevalent across the ground.

#### B.5. Other relevant data

When carrying out the XSA in 2003 the landings per unit of effort time-series for the following fleet was used:

England and Wales *Nephrops* trawl gears. Landings-at-age and effort data from this fishery are used to generate a cpue index. There is also a cpue series from 1995 for Republic of Ireland vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife-edge slicing using growth parameters). Cpue is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* trawlers is raised to landings. Discard sampling commenced in 1992 for this fishery, though some years have been missed as discussed above. There is no account taken of any technological creep in the fleet.

### C. Historical stock development

### D. Short-term projection

### E. Medium-term projections

### F. Yield and biomass-per-recruit/long-term projections

### G. Biological reference points

### H. Other issues

### I. References

Biological input parameters:

| Parameter | Value | Source |
|---|---|---|
| Discard Survival | 0.00 | |
| MALES | | |
| Growth - K | 0.160 | Irish Sea West data ; Bailey and Chapman (1983) |
| Growth - L(inf) | 60 | " |
| Natural mortality - M | 0.3 | Brander and Bennett (1986, 1989) |
| Length/weight - a | 0.00022 | Hossein et al. (1987) |
| Length/weight - b | 3.348 | " |
| FEMALES | | |
| Immature Growth | | |
| Growth - K | 0.160 | Irish Sea West data ; Bailey and Chapman (1983) |
| Growth - L(inf) | 60 | " |
| Natural mortality - M | 0.3 | Brander and Bennett (1986, 1989) |
| Size at maturity | 24 | Briggs (1988) |
| Mature Growth | | |
| Growth - K | 0.100 | Irish Sea West data ; Bailey and Chapman (1983) |
| Growth - L(inf) | 56 | " |
| Natural mortality - M | 0.2 | Brander and Bennett (1986, 1989) |
| Length/weight - a | 0.00114 | Hossein *et al*. (1987) |
| Length/weight - b | 2.820 | " |

## Stock Annex 6.5: Irish Sea West *Nephrops* (FU15)

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Irish Sea West *Nephrops* (FU15) |
| Working Group | WK*NEPH* 2009 (WK*NEPH*2009) |
| Date | 6 March 2009 |

### A. General

#### A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the western Irish Sea the *Nephrops* stock inhabits an extensive area of muddy sediment between the Isle of Man and Northern Ireland and its fishery contributes to more than 90% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements, which is characterized in the west by a gyre, which has a retention affect on both sediment and larvae. The eastern and western *Nephrops* stocks are treated as separate populations as they have different population characteristics.

#### A.3. Ecosystem aspects

A number of studies have examined *Nephrops* larvae distribution in order to examine how recruitment may impinge upon the distribution of a "catchable" (adult) *Nephrops* population and the maintenance of the population. Hillis (1968) found that although generally the larvae occupied the same areas as the adults, there was some evidence of advective losses to the southeastern part of their range, most probably due to tidal currents (White *et al*., 1988). More recent studies in the western Irish Sea have uncovered the existence of a seasonal cyclonic gyre which appears to facilitate retention of larvae over the mud patch (Dickey-Collas *et al*., 1996; Hill *et al*., 1996; Horsburgh *et al*., 2000).

### B. Data

#### B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea West are estimated from port sampling by Ireland and Northern Ireland and Ireland. A lack of cooperation by the Northern Ireland industry prevented sampling commercial catches over the period 2003–2007. The Irish LFDs are therefore raised to the international catch for these years. Northern Ireland sampling resumed in 2008 and these data are combined with those from Ireland for that year. Sample data are used to compute international removals (Landings + dead discards).

Landings per unit of effort time-series are available from the following fleets:

Northern Ireland *Nephrops* trawl gears. Landings-at-age and effort data from this fishery since 1986 are used to generate a cpue index. There is also a cpue series since 1995 for a subset of Republic of Ireland *Nephrops* vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife-edge slicing using growth parameters). Cpue is estimated using officially recorded effort (hours fished). Discard sampling commenced in the mid-1980s by Northern Ireland and the Republic of Ireland. There is no account taken of any technological creep in the fleet.

### B.2. Biological

Mean weights-at-length for this stock are estimated from studies by Pope and Thomas (1955).

A natural mortality rate of 0.3 was assumed for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

Maturity for females is taken as 22.1 mm carapace length (McQuaid *et al*., 2006).

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

### B.3. Surveys

Ireland and Northern Ireland jointly carry out underwater television (UWTV) surveys on the main *Nephrops* grounds in the western Irish Sea (Figure 1) since 2003. These surveys are based on a randomized fixed grid design. The methods used during the survey are similar to those employed for UWTV surveys of *Nephrops* stocks elsewhere and are detailed in WKNEPHTV, 2007 and WKNEPHBID, 2008.

Northern Ireland have carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and length frequency distributions from of stations throughout in the western Irish Sea. These surveys generate data on *Nephrops* size composition, mean size, maturity and sex ratio.

A number of factors are suspected to contribute bias to the UWTV surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Irish Sea West are:

| | Time period | Edge effect | detection rate | species identification | occupancy | Cumulative bias |
|---|---|---|---|---|---|---|
| FU15: Irish Sea West | <=2009 | 1.24 | 0.75 | 1.15 | 1 | 1.14 |

### B.4. Commercial cpue

### B.5. Other relevant data

Table 1 is a summary of available data along with an assessment of its reliability.

Table 2 is a summary of assessment parameters.

### C. Historical stock development

1 ) Survey indices are worked up annually resulting in the TV index.

2 ) Adjust index for bias (see Section B3). The combined effect of these biases is to be applied to the new survey index.

3 ) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

### D. Short-term projection

1 ) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and $F_{max}$. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2 ) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to $F_{max}$, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3 ) Multiply the survey index by the harvest ratios to give the number of total removals.

4 ) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5 ) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Survey Index | Retained number | Landings (tonnes) |
| | 0% | 12 345 | 0 | 0.00 |
| | 2% | " | 247 | 123.45 |
| | 4% | " | 494 | 246.90 |
| | 6% | " | 741 | 370.35 |
| | 8% | " | 988 | 493.80 |
| $F_{0.1}$ | 8.60% | " | 1062 | 530.84 |
| | 10% | " | 1235 | 617.25 |
| | 12% | " | 1481 | 740.70 |
| $F_{max}$ | 13.50% | " | 1667 | 833.29 |
| | 14% | " | 1728 | 864.15 |
| | 16% | " | 1975 | 987.60 |
| | 18% | " | 2222 | 1111.05 |
| | 20% | " | 2469 | 1234.50 |
| | 22% | " | 2716 | 1357.95 |
| $F_{current}$ | 21.5% | " | 2654 | 1327.09 |

## E. Medium-term projections

None presented.

## F. Long-term projections

None presented.

## G. Biological reference points

Harvest ratios equating to fishing at $F_{0.1}$ and $F_{max}$ were calculated in WK*NEPH* (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17 mm and that the supplied length frequencies represented the population in equilibrium.

$F_{0.1}$ = 10.9%

$F_{max}$= 20.2%

## References

Dickey-Collas, M., Gowen, R.J. and Fox, C.J. 1996. Distribution of larval and juvenile fish in the western Irish Sea: Relationship to phytoplankton, zooplankton biomass and recurrent physical features. *Marine and Freshwater Research* 47: 169–181.

Horsburgh, K.J., Hill, A.E., Brown, J., Fernand, L., Garvine, R.W., Angelico, M.M.P. 2000. Seasonal evolution of the cold pool gyre in the western Irish Sea. *Progress in Oceanography* 46: 1–58.

Hill, A.E., Brown, J. and Fernand, L. 1996. The western Irish Sea gyre: a retention mechanism for the Norway Lobster (*Nephrops norvegicus)* *Oceanologica Acta* 19: 357–369.

Hillis, J.P. 1968. Larval distribution of *Nephrops norvegicus* (L.) in the Irish Sea and North Channel. *ICRES C.M*. 1968. Doc. No. K6. (Mimeo).

McQuaid, N., Briggs, R.P. and Roberts, D. 2006. Estimation of the size of onset of sexual maturity in *Nephrops norvegicus* (L.). *Fisheries Research*.

White, R.G., Hill, A.E. and Jones, D.A. 1988. Distribution of *Nephrops norvegicus* (L.) larvae in the western Irish Sea: an example of advective control on recruitment. *Journal of Plankton Research* 10(4): 735–747.

**Table 1. Summary table of available data.**

| FU15 Irish Sea West: Data Available | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Data** | | | | | | | | | | | | | | | |
| **Commercial Data** | pre-1995 | 1994 | 1995 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Landings | | | | | | | | | | | | | | | |
| Effort | | | | | | | | | | | | | | | |
| cpue/lpue | | | | | | | | | | | | | | | |
| Mean size | | | | | | | | | | | | | | | |
| Sex ratio | | | | | | | | | | | | | | | |
| LFDs | | | | | | | | | | | | | | | |
| Catch | | | | | | | | | | | | | | | |
| Landings | | | | | | | | | | | | | | | |
| Discards | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Survey Data** | | | | | | | | | | | | | | | |
| ***Trawl surveys*** | | | | | | | | | | | | | | | |
| Catch rate | | | | | | | | | | | | | | | |
| mean size | | | | | | | | | | | | | | | |
| LFDs | | | | | | | | | | | | | | | |
| Sex ratio | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| ***Camera Surveys*** | | | | | | | | | | | | | | | |
| Density estimate | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Data Quality** | | | | | | | | | | | | | | | |
| Poor | | | | | | | | | | | | | | | |
| Acceptable | | | | | | | | | | | | | | | |
| Reliable | | | | | | | | | | | | | | | |

**Table 2. Biological Input Parameters.**

| Parameter | Value | Source |
|---|---|---|
| Discard Survival | 0.10 | ICES (1991a) |
| Discard rate | 40.2% | 2007 discard sampling. |
| MALES | | |
| Growth - K | 0.160 | Hillis (1979) ; ICES (1991a) |
| Growth - L(inf) | 60 | " |
| Natural mortality - M | 0.3 | Brander and Bennett (1986, 1989) |
| Length/weight - a | 0.00032 | After Pope and Thomas (1955) (data for Scottish stocks) |
| Length/weight - b | 3.210 | " |
| FEMALES | | |
| Immature Growth | | |
| Growth - K | 0.160 | Hillis (1979) ; ICES (1991a) |
| Growth - L(inf) | 60 | " |
| Natural mortality - M | 0.3 | Brander and Bennett (1986, 1989) |
| Size at maturity | 22.1 | McQuaid *et al*., 2006 |
| Mature Growth | | |
| Growth - K | 0.100 | Hillis (1979) ; ICES (1991a) |
| Growth - L(inf) | 56 | " |
| Natural mortality - M | 0.2 | Brander and Bennett (1986, 1989) |
| Length/weight - a | 0.00068 | After Pope and Thomas (1955) (data for Scottish stocks) |
| Length/weight - b | 2.960 | " |

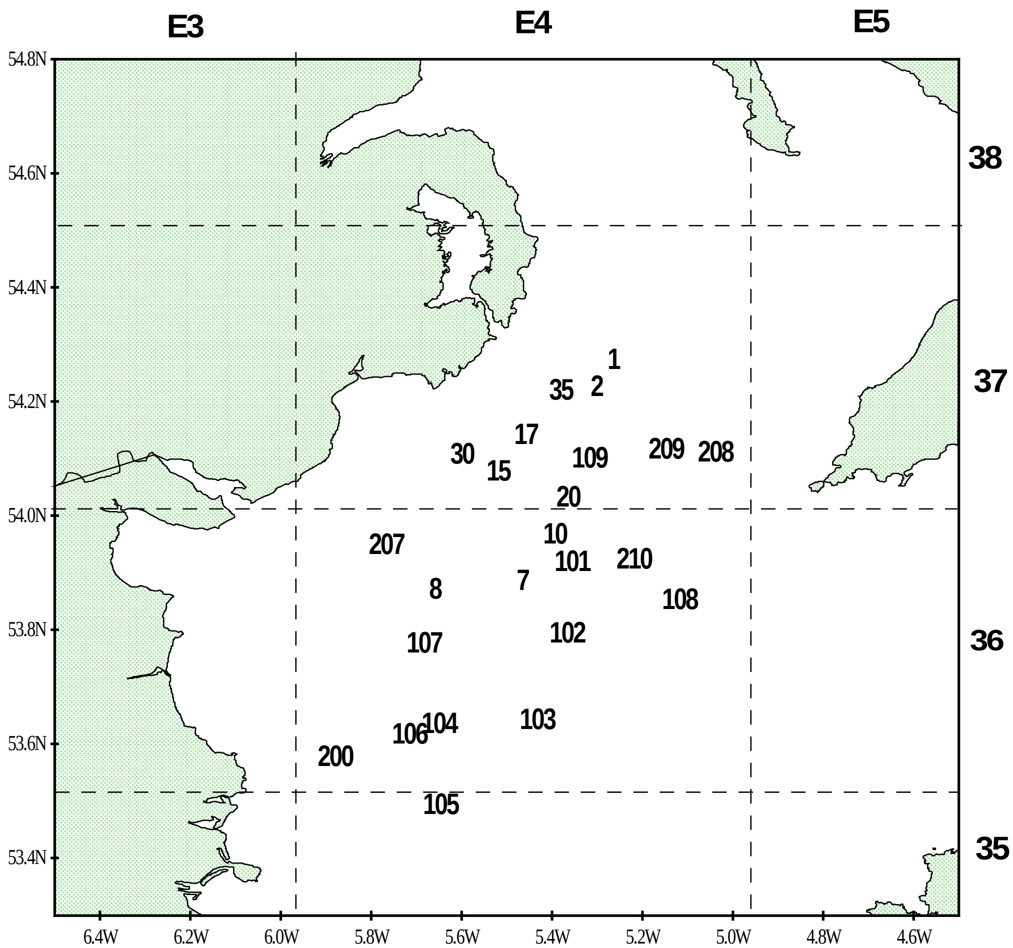



Figure 1: Western Irish Sea Nephrops stations

## Stock Annex 6.6: Whiting VIIa

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Irish Sea Whiting (Division VIIa) |
| Working Group | Assessment of Northern Shelf Demersal Stocks |
| Last updated | WGNSDS 2008 |
| Updates | Inclusion of Fishery Data from Ireland |

### A. General

#### A.1. Stock definition

Whiting in Division VIIa are considered a single stock for management purposes. In 2004 an informal meeting was established to review current knowledge of the distribution, movements and stock structure of whiting in the Irish Sea, and linkages between whiting in the Irish Sea and surrounding management areas. Information on egg and larval, tagging, survey studies was presented as a working document (WD10) in WGNSDS, 2005. The results of this are synopsized below:

UK egg and larva surveys have shown that whiting spawn in spring throughout the eastern Irish Sea and in the coastal waters of the western Irish Sea. This is supported by the distribution of actively spawning fish caught during trawl surveys in March.

Transport of whiting eggs, larvae or pelagic prerecruits from Celtic Sea spawning grounds into the Irish Sea is likely to be impeded by the Celtic Sea thermal front that becomes increasingly established from spring onwards.

Whiting recruitment grounds are in the same general area as the spawning grounds, and young whiting are widespread in the coastal bights of the Irish Sea. The gyre system that becomes established from late spring onwards in the western Irish Sea appears important in retaining larvae and pelagic prerecruits of whiting, as shown by the results of frame-trawl surveys of pelagic prerecruits in the western Irish Sea.

As the whiting become demersal from late summer onwards, they are found throughout the western Irish Sea although densities appear highest around the periphery of the mud patch in coastal waters and along the southern boundary between Ireland and the Isle of Man. This pattern is also noted by fishermen operating in this area. Densities of young whiting in the eastern Irish Sea appear highest off Cumbria and the Solway Firth in autumn, but are more widespread in spring.

Tagging studies in the late 1950s show some seasonal dispersal of whiting from the Irish Coast to as far as the Clyde, Liverpool Bay and the Celtic Sea, with evidence of return migrations. Whiting tagged in these studies ranged from about 20–40 cm, averaging around 30 cm. Whiting recaptured well away from the tagging sites off County Down in the western Irish Sea tended to be several cm larger, on average, than the tagged whiting.

Both the western Irish Sea and the Clyde have historically been characterized bycatches of immature and first-maturing whiting, whereas the eastern Irish Sea has a broader age-range of whiting. This pattern persists to the present day.

The evidence of interchange of whiting between the western Irish Sea and other areas within the Irish Sea precludes treating different areas within the Irish Sea as containing functionally separate stocks. Spatial modelling of the populations would require information on rates of dispersal between areas.

Trawl surveys continue to show that juvenile whiting are very abundant in the coastal waters of the Irish Sea, and that whiting are one of the most abundant fish species taken in the surveys. Hence, there have been no indications of depressed recruitment associated with the apparent steep decline in abundance of large whiting. Length at 50% maturity in female whiting is only 20–21 cm in the Irish Sea and neighbouring management areas, and spawning appears predominantly by young whiting of 1–3 years old.

### A.2. The fishery

Most landings by the Irish and UK(NI) fleet, which take the bulk of the Division VIIa whiting catch, are from the western Irish Sea (ICES CM 2003/ACFM:04) and are made predominately by single- and twin-rig trawlers. A small number of UK pairtrawlers also fish for whiting. The UK(E&W) fleet has declined substantially over time, and the bulk of its landings are from inshore otter trawlers targeting mixed flatfish and roundfish in the eastern Irish Sea. Discarding in this stock is thought to be high in all fleets, particularly in the *Nephrops* fishery. The *Nephrops* directed fishery operates on the main whiting nursery areas in the western Irish Sea, and is particularly intensive in the summer months. The mesh size mainly in use in the fishery is 70 mm in single trawls and 80 mm in twin trawls targeting *Nephrops*. The western Irish Sea fishery for whiting has declined substantially in recent years, and the increase in abundance of haddock has resulted in few vessels targeting whiting.

Vessels operating with 70 mm and 80 mm mesh are required to use square mesh panels. Square mesh panels were introduced as a technical measure to reduce fishing mortality on whiting. Square mesh panels have been mandatory for all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993 and for Irish trawlers since 1994. While the effects of this technical measure have not been formally evaluated, the *Nephrops* fishery still generates substantial quantities of whiting discards. Effort by Irish *Nephrops* trawlers in the main areas of whiting bycatch has shown some reduction during the period of the Irish Sea cod recovery plan closures. However, the summer peak in activity of the *Nephrops* fishery was not affected by the recovery plans. As the activities of the *Nephrops* fleet were not restricted by the cod recovery plan, it is unlikely that the recovery plan was effective in reducing levels of discarding in this stock.

There has been some recent decommissioning of vessels in the Irish Sea. Most recently, Ireland introduced a further decommissioning scheme in 2008, which aims to remove 11 140 GT from the fleet register. This is targeted at vessels over ten years of age and >18 m in length. To date the majority of applications emanate from east and west coast ports from vessels, which traditionally target *Nephrops* with uptake from the southeast also. It is expected that much of the actual effort removed from the decommissioning scheme may be partially negated through the introduction of ~21 modern second-hand vessels (mostly ex-French) into the fleet over the last few years.

The reported landings of whiting in 1999–2001 by UK vessels decommissioned in 2002 amounted to about 7% of the total international landings of whiting in those years.

Whereas few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches of whiting in VIIa. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas. Irish landings of whiting in the southwestern part of VIIa now contribute the bulk of the total Irish landings in the Division (ICES CM 2003/ACFM:04). The difference in grounds in the southern part of VIIa means that whiting in the area are more likely to function as part of the Celtic Sea stock rather than the Irish Sea stock.

Irish otter board trawlers fishing ICES Area VIIa generally use twin-rig gear to fish for *Nephrops*. However there are also localized mixed fisheries both in the north and south ends of VIIa. The Irish Sea *Nephrops* fleet is highly opportunistic and of this fleet, there are only a handful of boats that fish the Irish Sea Prawn Grounds 100% of the time. The rest of the fleet divides its time between the Irish Sea, Smalls, Aran and Porcupine Grounds dependant on tides, weather and market forces. Because of the need to fish further away from their home port and in rougher sea conditions, many of the older and smaller wooden vessels are being replaced with new and second-hand steel vessels. Most of these newer vessels are French-style twin-riggers. To maximize the return on their investment, many of the owners of newer vessels are opting for relief skippers and crews so that the vessels are fishing as much as possible.

In 2006, for the Irish fleet for the first time, *Nephrops* landings from the Smalls grounds (VIIg) have surpassed those from the Irish Sea grounds. This reflects the increasing amount of effort by East Coast vessels in 7g where in general, better prices are obtained for their catch. Two significant fleet movements occurred in 2006 for the Irish fleets. Firstly, there was a brief shift in effort by the *Nephrops* fleet towards the Aran Grounds around October due to reports of good fishing in the area. Also, some of the larger twin-riggers in the fleet switched to tuna fishing in the Bay of Biscay during the summer months.

The main species targeted by the otter trawl fleet are *Nephrops*, cod, ray, haddock, anglerfish and whiting. The Irish beam trawl fleet predominantly targets black sole and other high-quality flatfish and divides its effort between VIIa and VIIg depending on weather, tides and market forces.

For the UK NI fleet decommissioning at the end of 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that used demersal trawls with mesh size >=100 mm. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and four UK(E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size >=100 mm.

### A.3. Ecosystem aspects

Recruitment in Irish Sea whiting appears less variable than in cod and haddock, although there is some similarity in the timing of strong and weak year classes that may indicate a similar response to changes in environmental conditions affecting spawning or early stage survival. The diet of Irish Sea whiting has been examined in some detail since the 1970s using samples collected from research vessels. Cannibalism occurs in adult whiting; however the effect of this on the assessment of the stock has not yet been investigated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

## B. Data

### B.1. Commercial catch

#### *B1.1. Landings*

The following table gives the source of landings data for Irish Sea whiting:

| | Kind of data | | | | |
|---|---|---|---|---|---|
| Country | Caton (catch-in-weight) | Canum (catch-at-age in numbers) | Weca (weight-at-age in the catch) | Matprop (proportion mature-by-age) | Length composition-in-catch |
| UK(NI) | X | X | X | X | X |
| UK(E&W) | X | X | X | | X |
| UK(Scotland) | X | | X | | |
| UK (IOM) | X | | | | |
| Ireland | X | X | X | | X |
| France | X | | | | |
| Belgium | X | | | | |
| Netherlands | X | | | | |

Quarterly landings and length–age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data, and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

The UK(E&W) currently supplies raised quarterly length frequencies of landings but only sporadic age data. The catch and mean weight-at-age are estimated using combined UK(NI) and Irish quarterly length–weight relationships and age–length keys. Quarterly landings are provided by the UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quarterly estimates of landings-at-age into UK(E&W), UK(NI) and Ireland are raised to include landings by France, Belgium, UK(Scotland), UK(IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

#### *B1.2. Discards*

The Irish Sea *Nephrops* fishery takes place on the whiting nursery grounds of the north-western Irish Sea and has traditionally produced high whiting discarding. The quantity of whiting discarded from the UK(NI) *Nephrops* fishery in 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of whiting in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of whiting discarded using the whiting:*Nephrops* ratio in the discard samples. The length frequency of whiting in the discard samples is then raised to the fleet estimate, and numbers and mean weight-at-age of discarded whiting is computed from the age–length key and length–weight parameters for whiting. The UK(NI) estimates are available since 1980 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually.

There are several limitations to these data: only a small subset of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded-at-age. However, the WG has used these data in past assessments because removal of discards data would remove a large fraction of catch from the assessment.

A re-analysis of the Irish discard data raised to the *Nephrops* landings produced estimates of discards from the Irish *Nephrops* fleet that were more consistent with those of the UK(NI) *Nephrops* fleet. However, this method of raising could not be used to recalculate an entire time-series of discard estimates from the Irish *Nephrops* fleet. The quarterly UK(NI) discard ratios were therefore used by the Working Group to estimate the tonnage discarded from the Irish *Nephrops* fishery. Length frequencies and age–length keys from the whiting discarded by the Irish *Nephrops* fleet are used to estimate the numbers discarded-at-age from the Irish *Nephrops* fleet.

At the WGNSDS 2006 revised Irish discard estimates (1996–2005) raised according to the methods described in Borges *et al.*, 2005 were available to the Working Group See Table 1.0. These are available in ICES files. Discard rates in this series were variable compared with previous estimates based on the UK NI self sampling scheme. Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers-at-age can be made. The Working Group did therefore not estimate international discard volumes and numbers-at-age for 2004.

### B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence of substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero.

Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year *i* and age *j* the following formula is adopted:

$(CW_{i,j} + CW_{i+1,j+1})/2$ = SW at start of year.

These values are then smoothed using a three year moving average.

Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in VIIa (funded under the Data Directive Regulation (1639/2001)) took place during a Biological Sampling survey (BBS) in March 2004. Parameter estimates of maturity-at-length indicate the $L_{50}$ for whiting in VIIa for males and females is 13.65 cm and 19.76 cm, respectively. Maturity-at-age for both sexes are similar for most stock area (VIIa, b, j and g) with the notable exception of age 1 males in the Celtic Sea where the estimates are outside the 95% CI bounds for VIIa and considerably lower than VIa. In most areas whiting were mature by age three and most were mature at age two. The sex ratio for whiting tended to increase with length for nearly all the age classes in all areas indicating that females tend to have larger length-at-age than males (Gerritsen, 2005).

Gerritsen *et al.*, 2002 describes the relationships between maturity, length and age of whiting sampled on a length-stratified basis from NI groundfish surveys of the Irish Sea during spawning in spring 1992–2001. Findings show that most one year old females were immature whereas most two year old females were mature, almost all 3 year olds of both sexes were mature. Length at 50 maturity average around 19 cm in males and 22 cm in females.

#### B.3. Surveys

Seven research vessel survey series for whiting in VIIa were available to the Working Group in 2005. In all surveys listed the highest age represents a true age not a plus group.

- UK(England and Wales) Beam Trawl Survey (UK E&W-BTS): ages 0 and 1, years 1988–2002: The survey covers the entire Irish Sea and is conducted in September on the R.V. *Corystes*. The survey uses a 4 m beam trawl targeted at flatfish. The survey is stratified by area and depth band, although the survey indices are calculated from the total survey catch without accounting for stratification. Numbers of whiting at age per km towed are provided for prime stations only (i.e. those fished in most surveys).
- UK(Northern Ireland) October Groundfish Survey (NIGFS-October): ages 0–5, years 1992–2005: The survey-series commenced in its present form in 1992. It comprises 45 three mile tows at fixed station positions in the northern Irish Sea, with an additional 12 one mile tows at fixed station positions in the St George's channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. *Lough Foyle*. The survey designs are stratified by depth and sea-

bed type. The mean numbers-at-length per three mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The strata are grouped into western Irish Sea and eastern Irish Sea, and a separate age–length key is derived for each area to calculate abundance indices by age class. The survey design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.*, 2003.

- UK(Northern Ireland) March Groundfish Survey (NIGFS-March): ages 1–5, years 1992–2006: Description as for UKNI-GFS-October above.
- UK(Northern Ireland) Methot-Isaacs–Kidd Survey (UKNI-MIK): age 0, years 1993–2005: The survey uses a Methot–Isaacs–Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place in June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers-per-unit sea area.
- Ireland's Irish Sea Celtic Sea Groundfish Survey (IR-ISCSGFS): ages 0–5, years 1997–2002: This survey commenced in 1997 and is conducted in October–November on the R.V. *Celtic Voyager*. The $\alpha$ and $\beta$ of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard groundgear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area.
- UK(Scotland) groundfish survey in Spring (ScoGFS-spring): ages 1–8, years 1996–2006: This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (nine stations). The survey extends from the northern limit of the Irish Sea to around 53°30′.
- UK(Scotland) groundfish survey in Autumn (ScoGFS-autumn): ages 0–5, years 1997–2005: The survey covers a similar area to the ScoGFS in Spring, but has only 11–12 stations.
- IRGFS (Ireland): This survey commenced in 2003 aboard the R.V. Celtic Explorer. It is a depth stratified survey using a GOV trawl with a 20 mm mesh liner on the codend. The survey currently covers VIIb, j, g and VIa. Protocols for the survey are governed by the International Bottom-trawl Survey Working Group (IBTS).

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data in an XSA, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys may be shifted back accordingly in the data files.

The following research surveys were available to the 2007 Working group:

- UK (NI) groundfish survey: March 1992–2007.

- UK (NI) groundfish survey: October 1992–2006.
- UK (Scotland) groundfish survey: March 1996–2006.
- UK (Scotland) groundfish survey: autumn 1997–2005.
- Irish groundfish survey: autumn 2003 and 2004.
- UK (NI) MIK net surveys of pelagic-stage 0-group cod, western Irish Sea 1994–2006.
- UK (E&W) beam trawl survey: 0-1 gp cod, 1988–2006.

FSP surveys of Irish Sea round fish: 2004–2007.

Further details of the tuning data are given in Appendix 1 and 2 of the 1999 WG Report.

#### B.4. Commercial cpue

No cpue data have been provided for the French (Lorient) trawl fleet since 1992. Four commercial catch-effort dataseries were available to the WG:

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2002: Effort and cpue data provided for the Irish fleet comprise total annual effort (hours fished, not corrected for fishing power) and total numbers-at-age in landings from otter trawlers. The data were revised to take account of updated logbook information. This fleet operates mainly in the western Irish Sea, targeting *Nephrops* and/or whitefish. The distribution of fishing is concentrated in the western part of the range of the whiting stock in the Irish Sea. Hence the catch rates will represent changes in abundance of whiting in the western part of VIIa. The use of this fleet as a tuning index therefore relies on the assumption that trends in abundance in the west of VIIa reflect those of the entire stock. The catch-at-age data comprise a large proportion of the total international catch. Hence, some correlation of errors can be expected between the tuning dataset and the catch-at-age data. The effect of such correlations has not been evaluated. The otter trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded.
- UK(Northern Ireland) pelagic trawl: ages 2–6, years 1993–2002: The pelagic trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. Bycatches of whiting are currently very small and are heavily discarded due to their low value. The fleet is considered unsuitable for indexing whiting abundance.
- UK(Northern Ireland) single rig otter trawl: ages 0–6, years 1993–2002: This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea). Whiting discards from single-rig trawlers (estimated from fisher self-sampling scheme) are included.
- UK(England and Wales) otter trawl: ages 2–6, years 1981–2000: Estimates up to and including 2000 of commercial lpue from UK(E&W) otter trawlers contain data for landings only. Hence the reliability of the tuning fleet will be limited

for age groups which are heavily discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea) or the main whiting nursery grounds (in the western Irish Sea). Age compositions in most years have been estimated from length frequencies using ALKs that were obtained from sampling of fleets operating mainly in the western Irish Sea. This has introduced additional uncertainties into the data.

#### B.5. Other relevant data

None.

### C. Historical stock development

Model used:

XSA (up to 2002)

SURBA 2.0-2003

SURBA 3.0-2004

SURBA 2.2-2005

Software used:

Lowestoft VPA suite

XSA Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 4

Survivor estimates shrunk towards the mean F of the final five years or the two oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1980–last data year | 0–6+ | Yes |
| Canum | Catch-at-age in numbers | 1980–last data year | 0–6+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1980–last data year | 0–6+ | Yes |
| West | Weight-at-age of the stock at spawning time. | 1980–last data year | 0–6+ | Yes: uses smoothed catch weights adjusted to start of year |
| Mprop | Proportion of natural mortality before spawning | 1980–last data year | 0–6+ | No – set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1980–last data year | 0–6+ | No – set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1980–last data year | 0–6+ | No – the same ogive for all years |
| Natmor | Natural mortality | 1980–last data year | 0–6+ | No – set to 0.2 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 1 | NIGFS-Oct | 1992–last data year | 0–5 |
| Tuning fleet 2 | NIGFS-Mar (adjusted) | 1991–(last data year-1) | 0–4 |
| Tuning fleet 3 | ScoGFS-Spring | 1996–last data year | 1–5 |
| Tuning fleet 4 | UK(E&W) BTS | 1988–last data year | 0–1 |

For analysis of alternative procedures see WG reports from WGNSDS 1997–2005.

### D. Short-term projection

Model used:

Age structured

Software used: MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a short-term GM (1992 onwards) because of a reduction in mean recruitment since then.

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: The same ogive as in the assessment is used for all years.

F and M before spawning:

Set to 0 for all ages in all years.

Weight-at-age in the stock:

average stock weights for last three years.

Weight-at-age in the catch:

Average weight of the three last years.

Exploitation pattern:

Average of the three last years. Discard F's, which are generated by the *Nephrops* fleet as there are no discard estimates for other fleets, are held constant while landings F's are varied in the management option table.

Intermediate year assumptions:

*Status quo* F

Stock–recruitment model used:

None, the short-term geometric mean recruitment-at-age 0 is used.

Procedures used for splitting projected catches:

F vectors in each of the last three years of the assessment are multiplied by the proportion landed or discarded-at-age to give partial Fs for landings and discards. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

### E. Medium-term projections

No medium-term projections are done for this stock due to problems with estimating current F.

### F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass-per-recruit over a range of F values that may reflect fixed or variable discard F's.

Software used: MFY or MLA

Selectivity pattern:

mean F array from last three years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age:

mean of last three years (weights-at-age have declined as the stock has declined since the 1980s; it is not known if this is an environmental effect on growth that is independent of stock size).

Proportion discarded:

partial F vectors are the recent average.

Maturity: Fixed maturity ogive as used in assessment.

## G. Biological reference points

Precautionary approach reference points have remained unchanged since 1999. $B_{pa}$ is set at 7000 t and is defined as $B_{lim}$*1.4. $B_{lim}$ is defined as the lowest observed SSB (ACFM, 1999), considered to be 5000 t. There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. $F_{pa}$ is set at 0.65 on the technical basis of high probabilities of avoiding $F_{lim}$ and of SSB remaining above $B_{pa}$ in the long term. $F_{lim}$ is defined as 0.95, the fishing mortality estimated to lead to a potential stock collapse.

## H. Other issues

None.

## I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 33pp.

Borges, L.; Rogan, E. and Officer, R. 2005. "Discarding by the demersal fishery in the waters around Ireland", Fish. Res. (in press).

Gerritsen, H. 2005. Biological parameters for Irish Demersal Stocks in 2004. WD5 (WGNSDS, 2005)

**Table 1.0. Revised Discard estimates raisesd according to the method outlined in Borges *et al.,* 2005.**

| Age | 1996 Numbers ('000) | 1996 Weight (kg) | 1997 Numbers ('000) | 1997 Weight (kg) | 1998 Numbers ('000) | 1998 Weight (kg) | 1999 Numbers ('000) | 1999 Weight (kg) | 2000 Numbers ('000) | 2000 Weight (kg) | 2001 Numbers ('000) | 2001 Weight (kg) | 2002 Numbers ('000) | 2002 Weight (kg) | 2003 Numbers ('000) | 2003 Weight (kg) | 2004 Numbers ('000) | 2004 Weight (kg) | 2005 Numbers ('000) | 2005 Weight (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5631.20 | 0.015 | 4110.63 | 0.027 | 5073.57 | 0.027 | 187.26 | 0.036 | 7850.12 | 0.033 | 20981.54 | 0.016 | 29017.16 | 0.021 | 1921.76 | 0.016 | 17091.56 | 0.018 | 442.07 | 0.010 |
| 1 | 5925.33 | 0.035 | 8361.19 | 0.044 | 5939.53 | 0.064 | 276.50 | 0.102 | 3098.24 | 0.047 | 8883.11 | 0.054 | 12097.93 | 0.033 | 2419.56 | 0.036 | 7347.29 | 0.034 | 2531.84 | 0.035 |
| 2 | 1802.90 | 0.111 | 3243.45 | 0.120 | 3826.20 | 0.107 | 150.99 | 0.174 | 137.80 | 0.153 | 1413.48 | 0.126 | 576.17 | 0.112 | 1287.21 | 0.178 | 731.35 | 0.101 | 783.68 | 0.091 |
| 3 | 144.34 | 0.217 | 696.18 | 0.200 | 440.05 | 0.185 | 43.70 | 0.235 | 30.31 | 0.229 | 479.38 | 0.133 | 152.95 | 0.105 | 603.20 | 0.246 | 142.50 | 0.165 | 129.28 | 0.159 |
| 4 | 6.02 | 0.206 | 68.71 | 0.241 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 108.64 | 0.268 | 96.30 | 0.218 | 40.12 | 0.154 |
| 5 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 22.95 | 0.136 | 17.66 | 0.123 | 0.00 | 0.000 | 0.00 | 0.000 | 24.48 | 0.371 |
| 6 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| 7 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| 8 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| 9 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| 10 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 | 0.00 | 0.000 |
| OTB Discards (tonnes, whole weight) | | 520.8 | | ##### | | 1010.3 | | 71.6 | | 434.3 | | 1054.5 | | 1100.9 | | 523.6 | | 680.3 | | 201.3 |

| Sampling Information | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Trips | 8 | 8 | 7 | 4 | 10 | 2 | 1 | 9 | 11 | 8 |
| Number of Hauls | 48 | 44 | 58 | 40 | 111 | 34 | 7 | 60 | 122 | 96 |

# Stock Annex 6.7: Irish Sea plaice

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Plaice (Division VIIa) |
| Working Group | Celtic Seas Ecoregion |
| Date | 18th May 2011 |
| By | Christopher Lynam |

## A. General

### A.1. Stock definition

There are considered to be three principle spawning areas of plaice in the Irish Sea: one off the Irish coast, another northeast of the Isle of Man towards the Cumbrian coast, and the third off the north Wales coast (Nichols *et al.*, 1993; Fox *et al.*, 1997; Figure A1). Cardigan Bay has also been identified as a spawning ground for plaice in the Irish Sea (Simpson, 1959).

The level of mixing between the east and west components of the Irish Sea stock appears small. (Dunn and Pawson, 2002). Length-at-age measurements from research surveys as well as anecdotal information from the fishing industry suggests that plaice in the western Irish Sea grow at a much slower rate than those in the eastern Irish Sea. Earlier studies have suggested that the east and west components of the stock are distinct (Brander, 1975; Sideek, 1989). Morphometric differences have been observed between the east and west components of the stock; the 2004 WG indicated that the UK(E&W) beam trawl survey in September (from 1989) catches plaice off the Irish coast that are smaller at-age than those caught in the eastern Irish Sea.

Although considered separate stocks, the stocks of plaice in the Irish Sea and the Celtic Sea do mix during spawning. Tagging studies have indicated a southerly movement of mature fish (or fish maturing for the first time) from the southeast Irish Sea, off North Wales, into the Bristol Channel and Celtic Sea during the spawning season, such that 43% of the new recruits are likely to recruit outside the Irish Sea (Figure A1). While some of these migrant spawning fish will remain in the Bristol Channel and Celtic Sea, the majority (≥ 70%) are expected to return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002).

Very little mixing is considered to occur between the Irish Sea and Channel stocks or between the Irish Sea and North Sea (Pawson, 1995). Nevertheless, time-series of recruitment estimates for all stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) show a significant level of synchrony (Fox *et al.*, 2000). This could indicate that the stocks are subject to similar large-scale environmental forces and respond similarly to them, or alternatively that there are subpopulations that share a common spawning.

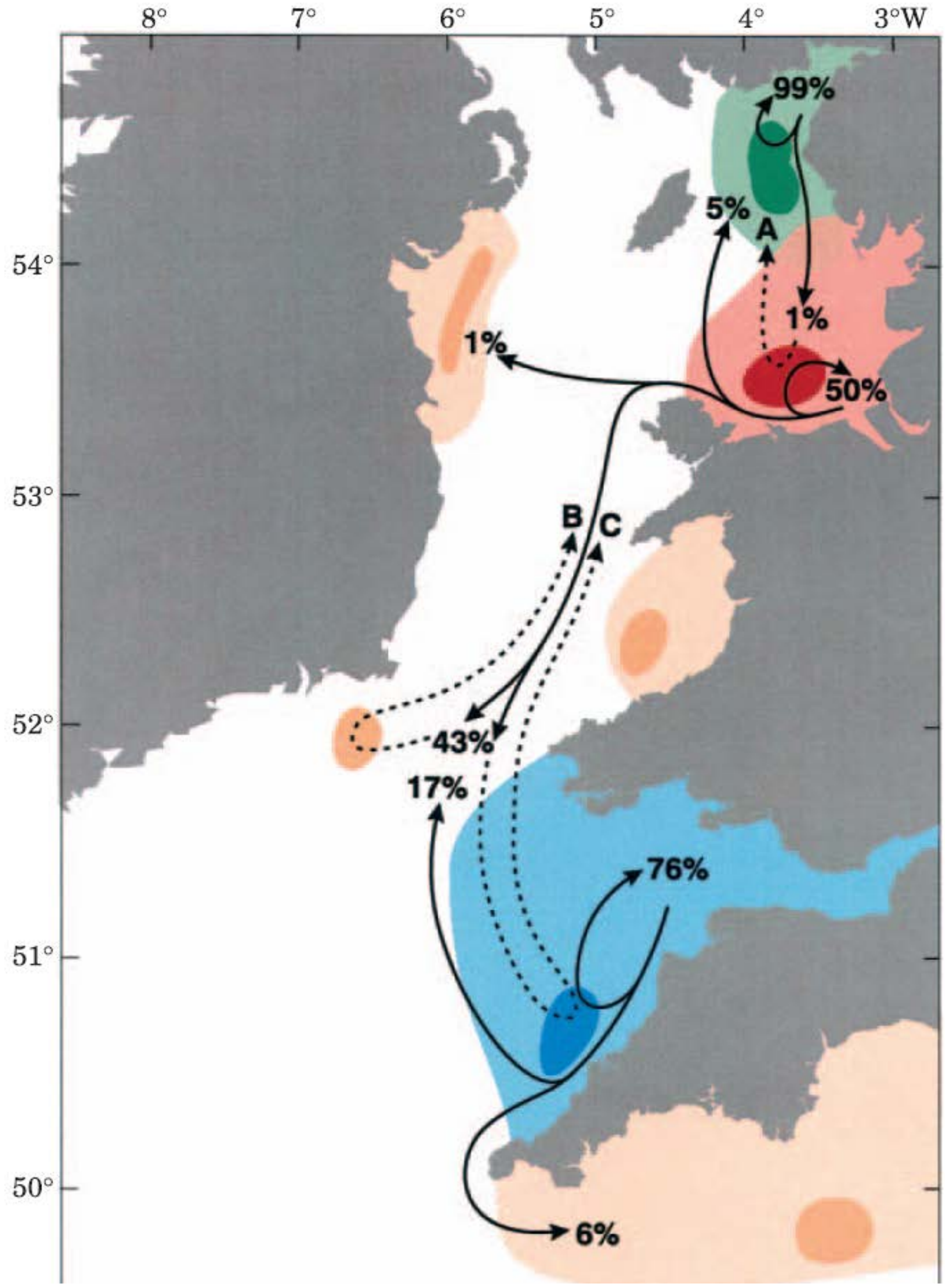



**Figure A.1. Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 were combined based on the assumption that the dispersal patterns of plaice were consistent over time. For each substock, the main feeding area (derived from tag recaptures during April–December; light shading), and the main spawning area (derived from tag recaptures during January–March, and ichthyoplankton surveys; dark shading) are indicated. The substocks tagged have been coloured green, red and blue. The substocks coloured orange are less well determined, with the feeding area around southeast Ireland unknown. Letters represent return migrations, where A ≈ 6%, and B+C ≈ 46%. Reproduced from Dunn and Pawson (2002).**

### A.2. Fishery

The status and activities of the fishing fleets operating in ICES Subdivision VIIa are described by Pawson *et al.*, 2002 and also by Anon, 2002. Following the massive decline in effort (hours fished) by otter trawlers targeting demersal fish in the early 1990s, the majority of fisheries effort in the Irish Sea is now exerted by otter trawlers fishing for *Nephrops* in the western Irish Sea followed by beam trawlers targeting sole in the eastern Irish Sea. Only a small proportion of otter trawlers still target cod, haddock, whiting and plaice with bycatch of angler-fish, hake and sole. From 2001, trawlers for demersal fish adopted mesh sizes of 100–120 mm and other gear modifications depending on the requirements of recent EU technical conservation regulations and national legislation. However, in 2004 the effort exerted by UK trawlers with mesh 100–120 mm declined to low levels. In 2006, the effort by UK trawlers targeting demersal fish with mesh 80–99 mm also declined to low levels. Concomitantly, the effort by UK trawlers targeting *Nephrops* with mesh 80–99 mm increased to record highs. Square mesh panels have been mandatory for UK otter trawlers since 1993 and for Irish trawlers since 1994, but this will have little effect on plaice catches. Four Irish trawlers for *Nephrops* have made use of grids since 2009 and reported 75% drop in fish bycatch. Fishing effort in 2009 by the Irish and UK(E&W) otter fleets targeting demersal fish reached historic lows.

Beam trawling increased in the Irish Sea during the late 1980s, with vessels from England and Belgium exploiting sole. This fishery has important bycatch of plaice, rays, brill, turbot and angler-fish. The fishing effort of the Belgium beam trawl fleet varies according to the catch rates of sole in the Irish Sea relative to the other areas in which the fleet operates. In 2009, effort (hours fished) by the UK(E&W) beam trawl fleet fell to the lowest observed level.

A fleet of vessels primarily from Ireland and Northern Ireland take part in a targeted *Nephrops* fishery using 70 mm meshnets with 75 mm square mesh panels. This fishery takes a substantial bycatch of whiting, most of which is discarded. Some inshore shrimp beam trawlers occasionally switch to flatfish when shrimp become temporarily unavailable. Other gear types employed in the Irish Sea to catch demersal species are gillnets and tanglenets, notably by inshore boats targeting cod, bass, grey mullet, sole and plaice.

The minimum landing size for plaice in the Irish Sea was set in 1980 to 25 cm (Council Regulation (EEC) No 2527/80). This was increased in 1998 to 27 cm (Annex XII of Council Regulation 850/98).

Since 2000, a recovery programme has been implemented to reduce exploitation of the cod spawning stock in the Irish Sea. In 2002 the European Commission regulations included a prohibition on the use of demersal trawl, enmeshing nets or lines within the main cod spawning area in the northwest Irish Sea between the 14th February and 30th April. Some derogations were permitted for *Nephrops* trawls and beam trawlers targeting flatfish.

### A.3 Ecosystem aspects

Plaice are preyed upon and consume a variety of species through their life history. However, plaice have not as yet been included in an interactive role in multispecies assessment methods (e.g. ICES WGSAM 2008). Among other prey items, plaice typically consume large proportions of polychaetes and molluscs.

Other than statistical correlations between recruitment and temperature (Fox *et al.*, 2000), little is known about the effects of the environment on the stock dynamics of plaice in the Irish Sea. Negative correlations between year-class strength of plaice (in either the Irish Sea, Celtic Sea, Channel or North Sea) and sea surface temperature are generally strongest for the period February–June. However, western (North Sea and Channel) and eastern (Irish Sea and Celtic Sea) stocks have been found to respond to different time-scales of temperature variability, which might imply that different mechanizms are operating in these stocks and/or that the Irish Sea and Celtic Sea share common spawning (Fox *et al.*, 2000).

## B. Data

### B.1. Commercial catch

#### *Landings*

International landings-at-age data based on quarterly market sampling and annual landings figures are available from 1964. Since 1978, quarterly age compositions have typically represented around 80–90% of the total international landings. Table B1 details the derivation of international landings for the period since 1978.

Prior to 1983 the stock was assessed on a separate sex basis: the catch numbers of males and females were worked up separately and the numbers of males and females in the stock as estimated from each assessment combined to give a total biomass estimate. Since 1983 a combined sex assessment of the stock has been conducted and the numbers of males and females in the catch have been combined at the international data aggregation level prior to running a single assessment.

#### *Data exploration*

Data exploration for commercial landings data for Irish Sea plaice has involved:

1 ) expressing the total landings-at-age matrix as proportions-at-age, normalized over time, so that year classes making above-average contributions to the landings are shown as large positive residuals (and *vice versa* for below-average contributions);

2 ) applying a separable VPA model in order to examine the structure of the landed numbers-at-age before they are used in catch-at-age analyses, in particular whether there are large and irregular residuals patterns that would lead to concerns about the way the recorded catch has been processed;

Given that discards now represent a larger proportion of the catch than the landings method 1 should be applied to the discard-at-age matrix in addition to the discard-at-age matrix and method 2 is unnecessary.

#### *Discards*

In 1986, the UK fleet was restricted to a 10% bycatch of plaice for almost the entire year. Estimates were made of the increased quantity of plaice that would have been discarded based on comparisons of lpue values for 1985–1986 with those for 1984–1985. The estimated quantity of 250 tonnes was added to the catch. A similar situation arose the following year and 250 tonnes was added to the catch for 1987.

The 10% plaice bycatch restriction was enforced again in 1988 to all UK (E&W) vessels in the 1st quarter and to beam trawlers in the 2nd and 3rd quarters. However, this time the landings were not corrected for discard estimates.

Discard information was not routinely incorporated into the assessment prior to benchmarking by WKFLAT in 2011.

### B.2. Biological

*Weights-at-age*

A number of different methodologies have been employed to determine weights-at-age for this stock. Stock weights and catch weights-at-age were determined on a separate sex basis and remained unchanged from 1978 until 1983. Catch weights were derived from a von Bertalanffy length-at-age fit to Belgian (70–74), UK(E&W) (64–74) and Irish (62–66) catch samples. The estimated lengths-at-age were converted to weights-at-age using a Belgian length–weight dataset (ages 2–15 females; 3–9 males). Stock weights were calculated as the mean of adjacent ages from the catch weights, where catch weights represented 1st July values and stock weights 1st January.

From 1983 weights-at-age have been calculated on a combined sex basis. Catch weights were taken from market sampling measurements combined on a sex weighted basis and smoothed. For the period 1983 to 1987 catch weights were smoothed by eye, from 1988 onwards a smooth curve was fitted using a numerical minimization routine. Stock weights were derived from the smoothed international catch weights-at-age curve with values representing 1st January. In 1985 the stock weights-at-age were adjusted for ages 1 to 4. The difference between the smoothed catch weights and survey (F.V. *Silver Star*) observations were adjusted using the maturity ogive to give "best estimate" stock weights "for ages where growth and maturity differences can bias sampling procedures". The same procedure was adopted in 1986 (when stock weights in 1982 and 1983 were also revised so as to be consistent with this methodology) and 1987. In 1988 however, the *Silver Star* survey was discontinued and stock weights-at-ages 1 to 3 were calculated as means of the three previous years. Correction of the estimated stock weights of the younger age groups did not occur in 1989 or in subsequent years which explains the sudden increase in weight of the younger age groups for this stock from 1988 onwards.

WKFLAT 2011 rejected the use of the polynomial smoother for weights-at-age and suggested that raw annual catch weights are used in future. Raw data back to 1995 was obtained by WKFLAT and used to update the catch weights and stock weights files. Discard weight-at-age were also calculated back to 2004 from UK(E&W) and Belgian data. However, given that the discard weight prior to 2004 were unknown the stock weights file was not updated to include the discard component. This requires further work.

Males are smaller than females and mean weight-at-age and mean length-at-age of both sexes has generally declined since the mid 1990s. Commercial data indicate declines in mean weight-at-age of fish age 4 and older since 1995, particularly since 2004 (Figure A2). Survey data indicate that males of ages 1–5 and females of age 1–3 are generally below minimum landing size (MLS, Figure A3).

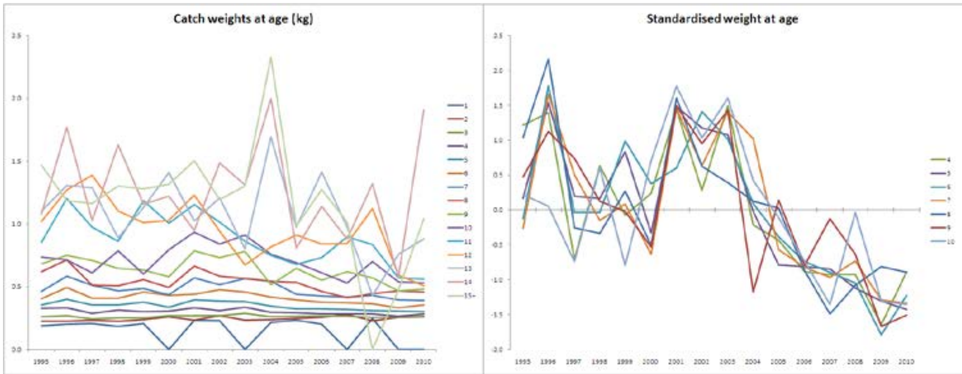



**Figure A2. Commercial weight-at-age data 1995–2010 (raw, left and standardized, right).**

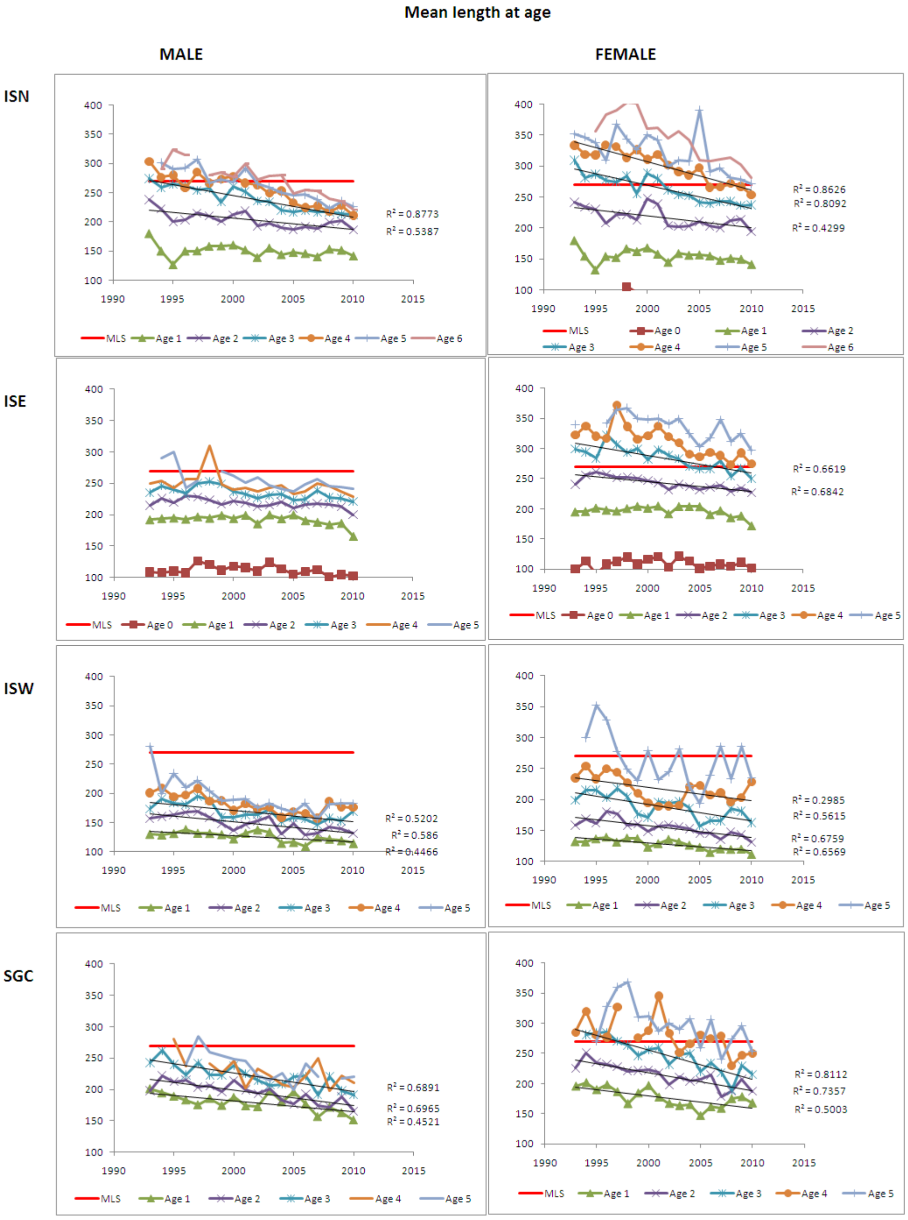



**Figure A3. Mean length (cm)-at-age data 1993–2010 by sex and area within the Irish Sea: Irish Sea North (ISN), Irish Sea East (ISE), Irish Sea West (ISW), St George's Channel (SGC).**

#### *Natural mortality and maturity ogives*

As for the weights-at-age, natural mortality and maturity was initially determined on a separate sex basis. Natural mortality was taken as 0.15 for males and 0.1 for females. In 1983 when a combined sex assessment was undertaken a sex weighted average value of 0.12 was used as an estimate of natural mortality. This estimate of natural mortality has remained unchanged since 1983. The maturity estimates used prior to 1982 are not specified. A new separate sex maturity ogive (Sideek, 1981) was implemented in 1982. This ogive was recalculated as sex weighted mean values in 1983 when the assessment was conducted on a combined sex basis. The maturity ogive was revised again in 1992 based on the results of an EU project. Maturity ogives are applied as vectors to all years in the assessment.

WKFLAT 2011 was unable to update the maturity ogive due to time restraints. However, preliminary analysis indicated that the ogive may have changed over time, in each sector of the Irish Sea, such that plaice mature at a smaller size and age than previously.

**Table A.1. Maturity ogives for Irish Sea plaice used in ICES WGs.**

| Age | WG 1978–1982 | | WG 1983–1992 | WG 1992–2010 |
|---|---|---|---|---|
| | M | F | | |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0.3 | 0.04 | 0.15 | 0.24 |
| 3 | 0.8 | 0.4 | 0.53 | 0.57 |
| 4 | 1.0 | 0.94 | 0.96 | 0.74 |
| 5 | 1.0 | 1.0 | 1.0 | 0.93 |
| 6 | 1.0 | 1.0 | 1.0 | 1.0 |

The proportion of fishing mortality and natural mortality before spawning was originally set to 0. It was changed in 1983 to a value of 0.2 on the grounds that approximately 20% of the catch was taken prior to March (considered to be the time of peak spawning activity). As for Celtic Sea plaice the proportion of F and M before spawning was reset to 0, as it was considered that these settings were more robust to changes in the fishing pattern, especially with respect to the medium-term projections.

### B.3. Surveys

In 1993, the UK(E&W) beam trawl survey-series that began in 1988 was considered to be of sufficient length for inclusion in the assessment. Since 1991, tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997, values for 1988 to 1990 were raised to 30 minute tows. However, data for 1988 and 1989 were of poor quality and gave spurious results: thus, the series was truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the WG in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

In 2011, the UK (E&W) beam trawl survey was re-examined and additional stations sampled in the western Irish Sea and St Georges Channel (Cardigan and Caernarfon Bays) since 1993 were included in the index. The extended index replaced the earlier 'prime stations' index since it was considered more representative of the entire stock (WKFLAT 2011).

An Irish juvenile plaice survey index was presented to the WG in 2002 (1976–2001, ages 2–8). Between 1976 and 1990 this survey had used an average ALK for that period. Serious concerns were expressed regarding the quality of the data for this period and the series was truncated to 1991. The stations for this survey are located along the coast of southeast Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localized survey-series would not be representative of the plaice population over the whole of the Irish Sea. Numerous tests were conducted at the 2002 WG to determine the validity of this and other tuning indices and it was concluded that this survey could be used as an index of the plaice population over the whole of the Irish Sea. This survey is no longer used in the assessment.

The SSB of plaice can be estimated using the Annual Egg Production Method (AEPM) (Armstrong *et al.*, 2002; WD9 WGCSE 2011). This method uses a series of ichthyoplankton surveys to quantify the spatial extent and seasonal pattern of egg production, from which the total annual egg production can be derived. The average fecundity (number of eggs spawned per unit body weight) of mature fish is estimated by sampling adult females immediately prior to the spawning season. Dividing the annual egg production by average fecundity gives an estimate of the biomass of mature females. Total SSB can be estimated if the sex ratio is known. Although substantial discrepancies between absolute estimates of SSB from the Annual Egg Production method (AEPM) and the ICES catch-based assessments were observed, they do confirm that SSB of plaice in the Irish Sea is currently at high levels.

AEPM estimates of SSB for plaice (RSE = relative standard error, as %), based on production of Stage 1 eggs) are shown below (note 1995 and 2000 estimates were revised in 2010 and 2006 and 2008 estimates revised in 2011 see WD9 WGCSE 2011):

**Table A.3. AEPM estimates of SSB for Irish Sea plaice. All estimates from stratified mean (design-based) estimates.**

| | total | | west | | east | |
|---|---|---|---|---|---|---|
| Year | SSB(t) | RSE | SSB(t) | RSE | SSB(t) | RSE |
| 1995 | 9081 | 21 | 3411 | 42 | 5670 | 22 |
| 2000 | 13 303 | 19 | 5654 | 36 | 7649 | 19 |
| 2006 | 14 417 | 16 | 3885 | 29 | 10 532 | 19 |
| 2008 | 14 352 | 19 | 4639 | 43 | 9713 | 18 |
| 2010 | 15 071 | 14 | 3435 | 20 | 11 636 | 18 |

Splitting the SSB estimate by substrata (Figure A4 below) suggests that the perceived increase in plaice SSB is limited to the eastern Irish Sea. This finding agrees with an analysis of NIGFS-WIBTS data and UK (E&W)-BTS-Q3 by substrata, which also indicate increases in biomass limited to the eastern Irish Sea.

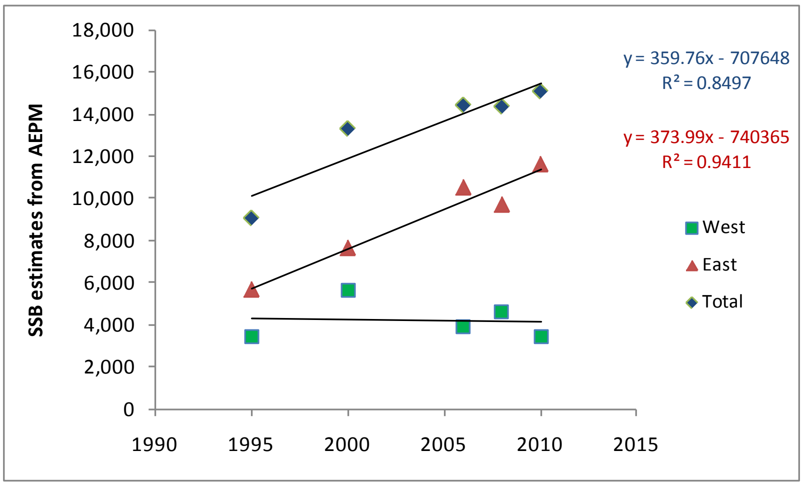



**Figure A.4. AEPM estimates by year and substrata.**

### B.4. Commercial lpue

Prior to 1981 tuning data were not used in the assessment of this stock. A separable assessment method was used and estimates of terminal S and F were derived iteratively based on an understanding of the recent dynamics of the fishery.

In 1981 the choice of terminal F was determined from a regression of exploited stock biomass on cpue. Catch and effort series were available for the UK(E&W) trawl fleet and the Belgian beam trawl fleet for the period 1964 to 1980. In 1994 the Belgian and UK cpue series were combined to provide one mean standardized international index. The UK(E&W) trawl series was revised in 1986 (details not recorded) and in 1987 was recalculated as an age based cpue index enabling the use of the hybrid method of tuning an *ad hoc* VPA.

The UK(E&W) trawl tuning series was revised in 1999 and separate otter trawl and beam trawl tuning series were produced using length samples from each gear type and an all gears ALK. Since the data could only be separated for 1988 onwards the two new tuning series were slightly reduced in length. In 1996 UK(E&W) commercial effort data were re-scaled to thousands of hours so as to avoid numerical problems associated with low cpue values and in 2000 the UK(E&W) otter trawl series was recalculated using otter trawl age compositions only rather than combined fleet age compositions as previously.

Two revised survey indices for the *Lough Beltra* were presented to the WG in 1996 though they were considered too noisy for inclusion in the assessment. They were revised again for the following year and found to be much improved but were again not included because they ended in 1996 and the WG felt that they would add little to the assessment. An Irish otter trawl tuning index was made available in 2001 (1995–2000, age 0 to 15). While this fleet mainly targets *Nephrops*, vessels do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet were approximately 15% of total international landings in 2000 and the WG considered that this fleet could provide a useful index of abundance for plaice.

The effects of vessel characteristics on lpue for UK(E&W) commercial tuning series was investigated in 2001 to investigate the requirement for fishing power corrections due to MAGP IV re-measurement requirements. It was found that vessel characteristics had less effect on lpue than geographic factors and unexplained noise and concluded that corrections were not necessary. However, vessels of certain size tended to fish in certain rectangles. This confounding may have resulted in the underestimation of vessel effects.

Currently, age based tuning data available for this assessment comprise three commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W) OTB, from 1987), the UK(E&W) beam trawl fleet (UK(E&W)BT, from 1989) and the Irish otter trawl fleet (IR-OTB, from 1995). However, as a consequence of inconsistencies in these commercial tuning fleets and surveys in the Irish Sea no commercial tuning information is used in the assessment. The area and HP-correction employed to calculate the UK(E&W) commercial effort indices require re-evaluation since vessels have changed greatly since the relationship was modelled.

Commercial lpue data are no longer used in the assessment.

#### B.5. Other relevant data

Model used: Aarts and Poos (2009) (AP)

Software used: R version 2.10.1

Model Options chosen:

Input data types and characteristics

| ASSESSMENT YEAR | | 2011 WKFLAT |
|---|---|---|
| Assessment model | | AP |
| Tuning fleets | UK-BTS Sept (Trad) | Series omitted |
| | UK(E&W)-BTS-Q3 | 1993–2009, ages 1–6 |
| | UK(E&W)-BTS-Q1 | Survey omitted |
| | UK(E&W) OTB | Series omitted |
| | UK(E&W) BT | Series omitted |
| | IR-OTB | Series omitted |
| | NIGFS-WIBTS-Q1 | 1993–2009 |
| | NIGFS-WIBTS-Q4 | 1993–2009 |
| Selectivity model | | Linear Time Varying Spline at age (TVS) |
| Discard fraction | | Polynomial Time Varying Spline at age (PTVS) |
| Landings num-at-age, range: | | 2–9+ |
| Discards num-at-age, year range, age range | | 2004–2009, ages 1–5 |

## C. Historical stock development

The stock of plaice in the Irish Sea has been assessed by ICES since 1977.

#### Assessment methods and settings

In 1987 the stock was assessed using a Laurec–Shepherd (hybrid) tuned VPA. Concerns about deteriorating data quality prompted the use in 1994 of XSA. A subsequent divergence in commercial cpue and survey data, and the wish to include biomass indices, prompted the use of ICA. The settings for each of the assessments between 1991 and 2009 are detailed in Table B.2. Since 2006, the assessment has been an update ICA assessment with the separable period increased by one year at each assessment working group. In 2009 and 2010, FLICA was used to run the assessment: the R and FLR packages have been documented within the WG report. In 2011, WKFLAT estimated discards at age and proposed that the AP model is used to model the stock.

Over the years, trial runs have explored many of the options with regards XSA settings, including:

- The applicability of the power model on the younger ages was explored in: 1994; 1996; 1998; 1999; 2000 and 2001.
- Different levels of F shrinkage were explored in 1994; 1995; 1997.
- The effect of different time tapers was investigated in 1996.
- The S.E. threshold on fleets was examined in 1996.
- The level of the catchability plateau was investigated in 1994.

ICA settings explored since 2005 have included:

- The length of the separable period.
- The reference age
- The age range of the landings data
- The effect of including hypothetical discard reconstructions in the catch

AP model settings were trialled in 2011

- The various combinations of time-variance for selectivity and discard fraction
- The suitable age range of the discards was investigated

The suitable starting year of the model was investigated with values from 1990 to 1993 trialled.

## D. Short-term projection

Short-term projections are not made for Irish Sea plaice at present. However, the methodology last employed follows for reference by future working groups.

Software: Multi Fleet Deterministic Projection (MFDP)

Age based short-term projections were conducted for a three year period using initial stock numbers derived from ICA analyses. Numbers-at-age 2 were considered poorly estimated and generally overwritten using a geometric mean (GM) of past recruitment values. Population numbers-at-age 3 in the intermediate year (terminal year +1) were also overwritten with the GM estimate depreciated for $F_{sq}$ and natural mortality. Recruitments since 1990 have been estimated to be at a lower level and to be less variable than those earlier in the time-series. Consequently a short-term geometric mean (from 1990 to two years before the terminal year) was used.

Previously, the exploitation pattern is an un-scaled three year arithmetic mean. However, alternative options may be used depending on recent F trajectories and the working group's perception of the fishery. Catch and stock weights-at-age were generally taken as the mean of the last three years and the maturity ogive and natural mortality estimates are those used in the assessment method.

## E. Medium-term projections

Medium-term projections are not carried out for this stock.

Previous Software: MLA miscellany

Input values to the medium-term forecast were the same as those used in the short-term forecast. Although a Beverton–Holt stock–recruit relationship has been assumed previously, a simple geometric mean may now be more appropriate.

### F. Yield and biomass per recruit/long-term projections

Software: Multi Fleet Yield-per-recruit (MFYPR)

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts. Currently the YPR calculations are used as a basis for determining the catch option for advice.

### G. Biological reference points

WKFLAT have rejected the use of reference points given the current trends only assessment and indicated that these will need to be revised. Biological reference points, last used by WGCSE in 2010, were proposed for this stock by the 1998 working group; see below:

| | Type | Value | Technical basis |
|---|---|---|---|
| Precautionary approach | $B_{lim}$ | Not defined. | There is no biological basis for defining $B_{lim}$ as the stock–recruitment data are uninformative. |
| | $B_{pa}$ | 3100 t | $B_{pa} = B_{loss}$. |
| | $F_{lim}$ | Not defined. | There is no biological basis for defining $F_{lim}$ as $F_{loss}$ is poorly defined. |
| | $F_{pa}$ | 0.45 | $F_{pa} = F_{med}$ in a previous assessment, and in long-term considerations. This is considered to provide a high probability of maintaining SSB above $B_{loss}$ in the long term. |
| Targets | $F_y$ | Not defined. | |

*Yield and spawning biomass per Recruit*

*F-reference points:*

| | Fish Mort | Yield/R | SSB/R |
|---|---|---|---|
| | Ages 3–6 | | |
| Average last 3 years | 0.10 | 0.17 | 1.64 |
| $F_{0.1}$ | 0.14 | 0.19 | 1.31 |
| $F_{med}$ | 0.43 | 0.21 | 0.53 |

**Estimated by the WG in 2010.**

MSY reference points were explored by WGCSE 2010 using the Cefas ADMB code presented to WKFRAME (ICES 2010). However, due to the high level of discards in the stock and unreliable estimates of recruitment, MSY reference points were rejected by the working group.

### H. Other issues

None.

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**Table B.1. Data sources and derivation of international landings and, from 2011, discards; where % sampled indicates the percentage of the total landings represented by sampling.**

| Year of WG | Data | Source UK | Belgium | Ireland | Netherlands | Derivation of international landings and discards | % sampled |
|---|---|---|---|---|---|---|---|
| 1978 | Len. comp. | quarterly[1] | quarterly[1] | quarterly[1] | | Irish raised to Irish and N.Irish; UK raised to UK (E&W) and Scotland | 85 |
| | ALK | quarterly[1] | quarterly[1] | quarterly[1] | | Belgian raised to Belgian, Dutch and French | |
| | Age comp. | quarterly[1] | quarterly[1] | quarterly[1] | | UK + Bel + IR combined to total int. separate sex | |
| 1979 | | | | | | | |
| 1980 | Len. comp. | quarterly[1] | quarterly[1] | quarterly[1] | | Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM. | 86 |
| | ALK | quarterly[1] | quarterly[1] | quarterly[1] | | Belgian raised to Belgian, Dutch and French | |
| | Age comp. | quarterly[1] | quarterly[1] | quarterly[1] | | UK + Bel + IR combined to total int. separate sex | |
| 1981 | | | | | | | |
| 1982 | | As for 1980 | As for 1980 | As for 1980 | | As for 1980, separate sex | 92 |
| 1983 | | As for 1980 | As for 1980 | As for 1980 | | As for 1980; sexes combined | 90 |
| 1984 | Len. comp. | quarterly | 2nd qtr | quarterly | | Irish raised to Irish and N.Irish | 90 |
| | ALK | quarterly | 2nd qtr | quarterly | | UK raised to UK (E&W), Scotland, I.O.M., French, Dutch and Belgian | |
| | Age comp. | quarterly | 2nd qtr | quarterly | | UK + IR combined to total int. sexes combined | |
| 1985 | Len. comp. | quarterly | quarterly | quarterly | | Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM | 92 |
| | ALK | quarterly | quarterly | quarterly | | Belgian raised to Belgian, Dutch and French | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + Bel + IR combined to total int. sexes combined | |
| 1986 | Len. comp. | quarterly | quarterly | quarterly | | Irish raised to Irish.,N.Irish and French | 91 |
| | ALK | quarterly | quarterly | quarterly | | UK raised to UK (E&W), Scotland and I.O.M.; Belgian used alone | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + Bel + IR combined to total int. | |
| 1987 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 84 |
| 1988 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 except Irish beam trawl raised using UK age comps | 75 |

| Year of WG | Data | Source UK | Belgium | Ireland | Netherlands | Derivation of international landings and discards | % sampled |
|---|---|---|---|---|---|---|---|
| 1989 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 (Irish beam trawl now sampled) | 86 |
| 1990 | | | | | | | |
| 1991 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 83 |
| 1992 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 83 |
| 1993 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 91 |
| 1994 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 (Belgian samples supplemented with UK data) | 90 |
| 1995 | | | | | | | |
| 1996 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 89 |
| 1997 | | As for 1998 | As for 1998 | As for 1998 | As for 1998 | As for 1998 | 83 |
| 1998 | Len. comp. | quarterly | quarterly | quarterly | quarterly | Irish raised to Irish., N.Irish and French; Belgian and Dutch used alone | 87 |
| | ALK | quarterly | quarterly | quarterly | quarterly | UK raised to UK (E&W), Scotland and I.O.M. | |
| | Age comp. | quarterly | quarterly | quarterly | quarterly | UK + Bel + IR + NL combined to total int. | |
| 1999 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 (except UK raised to include NL landings) | 89 |
| 2000 | | As for 1999 | As for 1999 | As for 1999 | | As for 1999 | 88 |
| 2001 | | As for 1998 | As for 1998 | As for 1998 | As for 1998 | As for 1998 | 87 |
| 2002 | | As for 1986 | As for 1986 | As for 1986 | | As for 1986 | 88 |
| 2003 | Len. comp. | quarterly | 1st qtr | quarterly | | Belgium raised using 1st qtr values | 70 |
| | ALK | quarterly | 1st qtr | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | 1st qtr | quarterly | | UK + Bel + IR combined to total int. | |
| 2004 | Len. comp. | quarterly | quarterly | quarterly | | | 52 |
| | ALK | quarterly | - | quarterly | | UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel | |
| | Age comp. | quarterly | - | quarterly | | UK + IR combined to total int. | |
| 2005 | Len. comp. | quarterly | quarterly | quarterly | | | 81 |
| | ALK | quarterly | qrts 1,2 | quarterly | | UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel | |

| Year of WG | Source | | | | | | |
|---|---|---|---|---|---|---|---|
| | Data | UK | Belgium | Ireland | Netherlands | Derivation of international landings and discards | % sampled |
| | Age comp. | quarterly | qrts 1,2 | quarterly | | UK + IR combined to total int. | |
| 2006 | Len. comp. | quarterly | quarterly | quarterly | | | 92[3] |
| | ALK | quarterly | quarterly | quarterly | | UK raised to Sco and France; Irish raised to Irish, N.Irish and Bel | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + IR combined to total int. | |
| 2007 | Len. comp. | quarterly | quarterly | quarterly | | | 90[3] |
| | ALK | quarterly | quarterly | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + Bel + IR combined to total int. | |
| 2008 | Len. comp. | quarterly | annual | quarterly | | | 94 |
| | ALK | quarterly | annual | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | annual | quarterly | | UK + Bel + IR combined to total int. | |
| 2009 | Len. comp. | quarterly | quarterly | quarterly | | | 89 |
| | ALK | quarterly | quarterly | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + Bel + IR combined to total int. | |
| 2010 | Len. comp. | quarterly | quarterly | quarterly | | | 94 |
| | ALK | quarterly | quarterly | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | quarterly | quarterly | | UK + Bel + IR combined to total int. | |
| 2011 | Len. comp. | quarterly | quarterly | quarterly | | | 100 |
| | ALK | quarterly | quarterly | quarterly | | UK raised to Sco and France; Irish raised to Irish and N.Irish | |
| | Age comp. | quarterly | quarterly | - | | UK + Bel + IR combined to total int. | |
| | Discard len comp | quarterly | quarterly | - | | UK(raised) + Bel combined to total int. | |
| | Discard age comp | quarterly | - | - | | UK(raised) + Bel combined to total int. | |

**1 Assumed – (not explicitly stated in report).**

**2 Revised 2007.**

**3 Revised 2008.**

**Table B.2. Assessment model settings since 1991.**

| Assessment Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assessment Age Range | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ | 1–9+ |
| Fbar Age Range | 3–8 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 | 3–6 |
| Assessment Method | L.S. | L.S. | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA |
| Tuning Fleets | | | | | | | | | | | | | | |
| UK trawl, years: | 81–90 | 82–91 | 76–92 | 76–93 | 76–94 | - | - | - | - | - | - | - | - | - |
| ages: | 1–8 | 1–8 | 1–8 | 1–8 | 1–8 | | | | | | | | | |
| UK otter, years: | - | - | - | - | - | 86–95 | 87–96 | 88–97 | 89–98 | 90–99 | 91–00 | 87–01 | 87–02 | 87–03 |
| ages: | | | | | | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 |
| UK beam, years: | | | - | - | - | - | - | - | 89–98 | 90–99 | 91–00 | 89–01 | 89–02 | 89–03 |
| ages: | | | | | | | | | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 | 2–8 |
| Bel Beam, years: | - | - | - | - | 85–94 | 86–95 | 87–96 | 88–97 | - | - | - | - | - | - |
| ages: | | | | | 2–8 | 3–8 | 3–8 | 3–8 | | | | | | |
| IR otter, years: | | | | | - | - | - | - | - | - | - | 95–01 | 95–02 | 95–03 |
| ages: | | | | | | | | | | | | 2–8 | 2–8 | 2–8 |
| UKBTS Sept, years: | | | 88–92 | 88–93 | 88–94 | 88–95 | 89–96 | 89–97 | 89–98 | 90–99 | 91–00 | 89–01 | 89–02 | 89–03 |
| ages: | | | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–7 |
| UKBTS Mar, years: | | | | | | | | 93–97 | 93–98 | 93–99 | 93–99 | 93–99 | 93–99 | - |
| ages: | | | | | | | | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | 1–4 | |
| IR-JPS, years: | | | | | | - | - | - | - | - | - | 91–01 | 91–02 | - |
| ages: | | | | | | | | | | | | 1–6 | 1–6 | |
| Time taper | | | 20yr tri | 20yr tri | 20yr tri | No | No | No | No | No | No | No | No | No |
| Power model ages | | | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| P shrinkage | | | True | False | True | True | True | True | True | False | False | False | False | False |
| Q plateau age | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| F shrinkage S.E | | | 0.3 | 0.3 | 0.5 | 0.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Number of years | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Number of ages | | | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Fleet S.E. | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

| Assessment year | | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Assessment model | | ICA | ICA | ICA | ICA | ICA | ICA |
| Tuning fleets | UK(E&W)OTB | - | - | - | - | - | - |
| | UK(E&W)-BTS-Q3 | 1989 – 2004 | 1989 – 2005 | 1989 – 2006 | 1989 – 2007 | 1989 – 2008 | 1989 – 2009 |
| | ages: | 1 – 7 | 2 – 7 | 2 – 7 | 2 – 7 | 2 – 7 | 2 – 7 |
| | UK(E&W)-BTS-Q1 | - | - | - | - | - | - |
| | UK(E&W)BT | - | - | - | - | - | - |
| | IR-OTB | - | - | - | - | - | - |
| | NIGFS-WIBTS-Q1 | 1992-2004 | 1992-2005 | 1992-2006 | 1992-2007 | 1992-2008 | 1992-2009 |
| | Biomass index | | | | | | |
| | NIGFS-WIBTS-Q4 | 1992-2004 | 1992-2005 | 1992-2006 | 1992-2007 | 1992-2008 | 1992-2009 |
| | Biomass index | | | | | | |
| Time-series weights | | Full time-series - unweighted | Full time-series - unweighted | Full time-series - unweighted | Full time-series - unweighted | Full time-series - unweighted | Full time-series - unweighted |
| Num years for separable | | 5 | 5 | 6 | 7 | 8 | 9 |
| Reference age | | 4 | 5 | 5 | 5 | 5 | 5 |
| Terminal S | | 1 | 1 | 1 | 1 | 1 | 1 |
| Catchability model fitted | | linear | linear | linear | Linear | linear | linear |
| SRR fitted | | No | No | No | No | No | No |
| Landings number-at -age, range: | | 1 – 9+ | 2 – 9+ | 2 – 9+ | 2 – 9+ | 2 – 9+ | 2 – 9+ |

| Assessment year | | 2011 |
|---|---|---|
| Assessment model | | AP |
| Tuning fleets | UK-BTS Sept (Trad) | Series omitted |
| | UK(E&W)-BTS-Q3 | 1993–2010, ages 1–6 |
| | UK(E&W)-BTS-Q1 | Survey omitted |
| | UK(E&W) OTB | Series omitted |
| | UK(E&W) BT | Series omitted |
| | IR-OTB | Series omitted |
| | NIGFS-WIBTS-Q1 | 1993–2010 |
| | NIGFS-WIBTS-Q4 | 1993–2010 |
| Time-series weights | | n/a |
| Num yrs for separable | | n/a |
| Reference age | | n/a |
| Terminal S | | n/a |
| Catchability model fitted | | n/a |
| SRR fitted | | n/a |
| Selectivity model | | Linear Time Varying Spline at age (TVS) |
| Discard fraction | | Polynomial Time Varying Spline at age (PTVS) |
| Landings num-at-age, range: | | 1–9+ |
| Discards N-at-age, yrs ages r | | 2004–2010, ages 1–5 |

## Stock Annex 6.8: Sole VIIa

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Irish Sea Sole (Division VIIa) |
| Working Group | WGCSE |
| Date | 6 February 2011 |
| Revised by | WKFLAT 2011/Sofie Nimmegeers, Willy Vanhee, Kelle Moreau |

### A. General

#### A.1. Stock definition

Sole occur throughout the Irish Sea, but are found more abundant in depth less than 60 m. Recent information on stock identity, distribution and migration issues is included in the report of WKFLAT 2011. Cuveliers *et al*. (2011) combined the results obtained from ten microsatellite markers (long-term estimate of population structure) with results from otolith microchemistry analyses (short-term estimate of connectivity) on adult sole populations in the Northeast Atlantic area. Major large-scale differentiation was detected between three distinct regions (Baltic transition area, North Sea, Irish/Celtic Seas) with both types of markers. The assignment success of individuals to their collection location was much higher based on otolith edge microchemistry compared to the genetic assignments at all sampling locations, except for the Irish Sea. Only 28.6% of individuals (n=30) caught in the Irish Sea could be assigned to their catch location based on otolith edge microchemistry, whereas this region showed high genetic self-assignment scores (ca. 60% of 91 individuals) suggesting a spawning population that is genetically distinct. 32% of the misclassifications based on otolith microchemistry were allocated to the neighbouring Celtic Sea. These results are consistent with tagging studies of sole in the Irish Sea and Bristol Channel, showing mainly local recruitment and limited movement of sole outside the management areas (Horwood *et al*., 1993). Therefore, the management unit is considered to correspond to the stock unit for Irish Sea sole.

#### A.2. Fishery

There are three main countries fishing for sole in the Irish Sea; Belgium, taking the bulk of the landings (60–80% in recent years). UK and Ireland taking about 20% and 10% respectively of the sole landings. The Netherlands and France take the remainder. Approximately 25 Belgian beam trawlers are operating in the Irish Sea, targeting sole. The UK trawl fleet and the Belgian beam trawls operate predominantly in the eastern part of the Irish Sea (Liverpool Bay and Morecambe Bay). Sole catches from Ireland are mainly coming from bycatches in the *Nephrops* fishery (operation in the northwest of the Irish Sea).

When fishing in VIIa it is prohibited to use any beam trawl of mesh size range 70–90 mm unless the entire upper half of the anterior part of such a net consists of a panel of netting material attached directly to the headline of the net, extending towards the posterior of the net for at least 30 meshes and constructed of diamond-meshed netting material of which no individual mesh is of mesh size less than 180 mm. The Irish otter trawl fleet employs either a 70 mm mesh with square mesh panels or more commonly an 80 mm mesh. Similarly the Belgian and UK(E&W) beam trawls use 80 mm mesh gear. Otter trawlers targeting roundfish have, since 2000, used 100 mm mesh gear.

It was concluded at the 2000 working group and confirmed in 2001 that the cod recovery measures first enacted (EU Regulations 304/2000 and 2549/2000 + revisions in 2001–2003) in 2000 would have had little impact on the sole fishery. The closed area in 2001 covered a reduced area confined to the west of the Irish Sea and therefore is also expected to have had little effect on the level of fishing effort for sole The spawning closure for cod in 2002 is also unlikely to have had an impact on the sole fishery. The effort regulations and maximum daily uptake, implemented in 2003 will delay the uptake of the quota but is also unlikely to be restrictive for the total uptake. It is unlikely that any measures concerning the cod management plan in the Irish Sea had restrictions on the sole fishery after 2003.

Discard are estimated to be minor. Preliminary data indicate ranges from 0 to 2% by weight discarded.

Although no data are available on the extent of misreporting of landings from this stock, it is not considered to be a problem for this stock.

### A.3. Ecosystem aspects

No information.

## B. Data

### B.1. Commercial catch

Quarterly age compositions are available from UK(E&W), Belgium and Ireland, as well as quarterly landings from France and Northern Ireland. The total international age composition is obtained using a combined ALK from UK(E&W), Belgium and Ireland raw data, responsible for 99% of the total international sole landings. The combined ALK is applied to the length distributions of the separate countries to obtain an aggregated age composition.

Catch weights were obtained from the combined AWK (UK(E&W), Belgium and Ireland raw data).

Stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./) that conducts a cohort interpolation of the catch weights.

### B.2. Biological

Currently there are no direct (from tagging) or independent (from survey information) estimates of natural mortality. Therefore, annual natural mortality (M) is assumed to be constant over ages and years, at 0.1 $yr^{-1}$.

The maturity ogive used in this and previous assessments is based on survey information for this stock:

| Age | 1 | 2 | 3 | 4 | 5 | 6 and older |
|---|---|---|---|---|---|---|
| Mat. | 0.00 | 0.38 | 0.71 | 0.97 | 0.98 | 1.00 |

Proportions of M and F before spawning were set to zero, as in previous years.

Males and females of this stock are strongly dimorphic, with males showing much reduced rates of growth after reaching maturity, whereas females continue to grow. Given the minimum landing size of 24 cm the majority of landings represent mature females.

### B.3. Surveys

One survey is used in the assessment of VIIa sole: the UK beam trawl survey (UK (BTS-3Q)).

#### *Area covered*

Irish Sea; 52°N to 55°N; 3°W to 6°30’W.

#### *Target species*

Flatfish species, particularly juvenile plaice and sole. Length data recorded for all finfish species caught; samples for age analysis taken from selected species.

#### *Time period*

1988–2009: September (continuing)

#### *Gear used*

Commercially rigged 4 m steel beam trawl; chain matrix; 40 mm codend liner.

Mean towing speed: 4 knots over the ground. Tow duration: 30 minutes. Tow duration for trips in 1988–1991 was 15 minutes; in 1992 comparative tows of 15 and 30 minutes length were carried out, and subsequent cruises used a standard 30 minute tow. The data from earlier years were converted to 30 minutes tow equivalent using relationships for each species derived from the comparative work in 1992.

Vessel used: R.V. *Endeavour* (Cefas)

#### *Survey design*

Survey design is stratified by depth band and sector (Depth bands are 0–20, 20–40, 40+). Station positions are fixed. Number of stations = 35 in the eastern Irish Sea, 15 in the western Irish Sea, and 16 in St George’s Channel (primary stations). Sampling intensity highest in the eastern Irish Sea, in the main flatfish nursery and fishery areas.

#### *Method of analysis*

Raised, standardized length frequencies for each station combined to give total length distribution for a stratum (depth band/sector). Sector age–length keys applied to stratum length distributions 1988–1994; stratum age–length keys applied 1995 onwards. Mean stratum cpue (kg per 100 km and numbers-at-age per 100 km) are calculated. Overall mean cpue values are simple totals divided by distance in metres (or hours fished). Population number estimates derived using stratum areas as weighting factors.

The September beam trawl survey has proven to estimate year-class strength well, and providing 50% to over 90% of the weighting to the total estimates of the incoming years classes.

#### B.4. Commercial cpue

Cpue and effort series were available from the Belgium beam trawlers, UK(E&W) beam and otter trawlers, the Irish otter trawlers and from two UK beam trawl surveys (September and March).

Cpue for both UK and Belgian beam trawlers has declined since the beginning of the time-series, but has remained relatively constant over the last decade, with a renewed increase over the last few years (2008–2009 for Belgium and 2007–2009 for UK).

Effort from both commercial beam trawl fleets increased from the early seventies until the late eighties. Since then Belgian beam trawl effort has declined over the nineties, increased again in the period 2000–2005 and subsequently dropped to much lower values in 2008–2009 (the lowest values since 1984). In the nineties, the UK beam trawl effort fluctuated around a lower level than the late eighties, and dropped during the 21st century to the lowest value of the time-series in 2009.

Indices of abundance derived from the UK September survey (UK (BTS-3Q)) (data from 1988 onwards) are shown in WGNSDS 2002 (Table 12.2.2). High abundance indices for the UK September survey (UK (BTS-3Q)) can be seen for year classes 1989, 1995 and 1996. The dataseries from the UK March beam trawl survey (UK (BTS-1Q)) is rather short (from 1993 to 1999), and therefore difficult to interpret.

#### B.5. Other relevant data

No information.

### C. Assessment: data and method

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen since 2004:

| ASSESSMENT YEAR | 2004 | 2005 | 2006 | 2007–2010 | WKFLAT 2011 |
|---|---|---|---|---|---|
| Assessment Model | XSA | SURBA | XSA | XSA | XSA |
| Fleets | | | | | |
| BEL-CBT | 1975–2003<br>4–9 | | omitted | omitted | omitted |
| UK-CBT | 1991–2003<br>2–9 | | omitted | omitted | omitted |
| UK (BTS-3Q) | 1988–2003<br>2–9 | 1988–2004<br>1–9 | 1988–rec yr<br>2–7 | 1988–rec yr<br>2–7 | 1988–rec yr<br>2–7 |

| ASSESSMENT YEAR | 2004 | 2005 | 2006 | 2007–2010 | WKFLAT 2011 |
|---|---|---|---|---|---|
| UK (BTS-1Q) | 1993–1999<br>2–9 | | 1993–1999<br>2–7 | 1993–1999<br>2–7 | omitted |
| Time-ser. Wts | tricubic 20yrs | | linear 20 yrs | linear 20 yrs | uniform |
| Power Model | none | | none | none | none |
| Q plateau | 5 | | 5 | 7 | 4 |
| Shk se | 0.8 | | 1.5 | 1.5 | 1.5 |
| Shk Age-yr | 5 yrs<br>5 ages | | 5 yrs<br>3 ages | 5 yrs<br>3 ages | 5 yrs<br>3 ages |
| Pop Shk se | 0.3 | | 0.3 | 0.3 | 0.3 |
| Prior Wting | none | | none | none | None |
| Plusgroup | 10 | | 8 | 8 | 8 |
| $F_{bar}$ | 4–7 | | 4–7 | 4–7 | 4–7 |

Input data types and characteristics:

| TYPE | NAME | YEAR RANGE | AGE RANGE | VARIABLE FROM YEAR TO YEAR YES/NO |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1970–last data year | 2–8+ | Yes |
| Canum | Catch-at-age in numbers | 1970–last data year | 2–8+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1970–last data year | 2–8+ | Yes |
| West | Weight-at-age of the spawning–stock at spawning time | 1970–last data year | 2–8+ | Yes-but based on back calculated catch weights |
| Mprop | Proportion of natural mortality before spawning | 1970–last data year | 2–8+ | No-set to 0 for all ages in all years |
| Fprop | Proportion of fishing mortality before spawning | 1970–last data year | 2–8+ | No-set to 0 for all ages in all years |
| Matprop | Proportion mature-at-age | 1970–last data year | 2–8+ | No-the same ogive for all years |
| Natmor | Natural mortality | 1970–last data year | 2–8+ | No-set to 0.1 for all ages in all years |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 1 | UK (BTS-3Q) | 1988–last data year | 2–7 |

**Note : several other commercial tuning fleets – BEL-CBT (Belgian beam trawl fleet), UK-CBT (UK beam trawl fleet), UK-COT (UK otter trawl fleet), IRL-COT (Irish otter trawl fleet) – and two other surveys (UK (BTS-1Q) and Irish Juvenile Plaice Survey) have been used or made available in the past. A thorough investigation of the utility of these tuning indices was conducted at the 2002 working group. The results are summarized in the Stock Annexes of the reports of WGNSDS 2002–2008 and WGCSE 2009.**

### D. Short-term projection

Model used: Age structured deterministic projection

Software used: MFDP

Initial stock size: Taken from the XSA for ages 3 and older. The recruitment-at-age 2 in the last data year is estimated using RCT3. The long-term geometric mean recruitment (1970–penultimate estimate) is used for age 2 in all projection years.

Maturity: the same ogive as in the assessment is used for all years (see table above)

F and M before spawning: set to 0 for all ages in all years

Weight-at-age in the stock: average weight of the last three years

Weight-at-age in the catch: average weight of the three last years

Exploitation pattern: average of the three last years, scaled to the last year's Fbar (4–7) if a trend in F was detected (not scaled to the last year's Fbar (4–7) if no trend in F was detected)

Intermediate year assumptions: *status quo* F

Stock–recruitment model used: none

Procedures used for splitting projected catches: not relevant

### E. Medium-term projections

Medium-term projections were not conducted at WKFLAT 2011. The last medium-term projections were carried out in 2008. The settings used are described below.

Model used: Age structured

Software used: IFAP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the long-term geometric mean recruitment-at-age 2 is used

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0.2 for all ages in all years
- Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch
- Weight-at-age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC
- Stock–recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long-term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960; 4th last year.

### F. Long-term projections

Model used: age structured deterministic projection

Software used: MFYPR

Inputs as for short-term projection.

### G. Biological reference points

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY | MSY $B_{trigger}$ | 3100 t | Default to value of $B_{pa}$. |
| Approach | $F_{MSY}$ | 0.16 | Provisional proxy based on stochastic simulations assuming a Ricker S/R relationship (range 0.1–0.25). |
| | $B_{lim}$ | 2200 t | $B_{lim}$ = $B_{loss}$. The lowest observed spawning stock (ACFM 1999), followed by an increase in SSB. |
| Precautionary | $B_{pa}$ | 3100 t | $B_{pa\sim}$ $B_{lim}$ * 1.4. The minimum SSB required ensuring a high probability of maintaining SSB above its lowest observed value, taking into account the uncertainty of assessments. |
| Approach | $F_{lim}$ | 0.4 | $F_{lim}$ = $F_{loss}$. Although poorly defined, there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above-average recruitment. |
| | $F_{pa}$ | 0.3 | This F is considered to have a high probability of avoiding $F_{lim}$. |

Precautionary approach reference points have not been changed during 1999–2006. In this period, $F_{pa}$ was set at 0.45 on the technical basis of high probabilities of avoiding $F_{lim}$ and of SSB remaining above $B_{pa}$. In 2007, $F_{pa}$ was changed to 0.3 due to the rescaling of SSB estimates. In 2010, MSY reference points were added by WGCSE.

### H. Other issues

A management plan for Irish Sea sole could be developed, also taking into account the dynamics of the plaice stock in that area.

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## Stock Annex 7.2: Cod in VIIe–k

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Cod in VIIe–k (Celtic Sea cod) |
| Expert Group | Celtic Sea Working Group |
| Date | WKROUND 2009, WGCSE 2009-2010 |
| Revised by | Robert Bellail, Lionel Pawlowski |

### A. General

#### A.1. Stock definition

Since 1997, this assessment has related to the cod in Divisions VIIe–k, covering the Western Channel and the Celtic Sea. The assessed area has gradually increased from VIIfg before 1994 to VIIfgh, to VIIefgh in 1996 and finally to VIIe–k.

Up to 2008, the management area was set in Divisions VIIb–k,VIII, IX, X, and CECAF 34.1.1 which does not correspond to the area assessed.

In 1994, at the request of ACFM, the ICES Working Group on Southern Shelf Demersal Stocks (WGSSDS) studied the possible extension of the area assessed from VIIfg to VIIfgh. Examination of data from surveys and logbooks indicated a continuity of the distribution of VIIg cod into VIIh. Depending on the year, catches in Division VIIh represented 9–15% of the catches in VIIfg, with a coincidence of years of peak or low catches in both areas. Therefore, catches from VIIh were included in the assessment. In 1996, at the request of ACFM, WGSSDS studied the possible extension of the area assessed from VIIfgh to VIIefgh. The population dynamics parameters for VIIfgh and VIIe cod were examined and compared for the period 1988–1994, when independent tuning fleets, international catch-at-age, mean weights-at-age in the landings and in the stocks were available for both areas. Patterns of F were consistent between VIIe and VIIfgh in earlier years (1988–1990), and SSBs trends were similar in the period 1988–1992. The patterns of recruitment (age 1) were found to be fairly consistent through this period 1988–1994, though it cannot be assumed that this consistency was also valid in earlier years when catch-at-age were only available in Divisions VIIf, g, h. It was therefore decided to combine Western Channel Cod with the Celtic Sea Cod assessment for the years 1988–1995, but an independent assessment of Celtic sea Cod in VIIfgh was maintained for the longer period available 1971–1995. This was to allow scaling of the historical (1971–1987) SSBs and recruitments values from VIIfgh to VIIe–h.

At WGSSDS 1997, due to the lack of a long independent series of catch-at-age in Divisions VIIj,k, the estimate of landings from Divisions VIIjk was discussed and it was decided to combine the data of Divisions VIIe,f,g,h and Divisions VIIjk for the period 1993–1996 and to raise the data in Divisions VIIe–h to landings in Divisions VIIe–k for the period 1988–1992. The results of an XSA assessment of this series in Divisions VIIe–k for 1988–1996 had been compared with the results of the assessment in Divisions VIIe–h in terms of trends of F, SSB and recruitment. Patterns of these parameters were found very similar and the merging of Divisions VIIjk with Divisions VIIe–h mainly resulted in a scaling upwards of SSB and recruitment. The new assessment areas comprised cod in Divisions VIIe–k.

At the 1999 WGSSDS meeting, an alternative procedure to the tedious re-scaling of SSB and recruitment of the earlier series 1971–1987 in VIIfgh to VIIe–k every year was proposed (Bellail, 1999, WD3). A long series of landings data from 1971–1987 was reconstructed. An average raising factor (1.24) from VIIfgh to VIIe–k in the period 1988–1997 was applied to VIIfgh landings of the series 1971–1987. Results of assessment in terms of SSB and R were very close to those obtained when these parameters were scaled. ACFM accepted this procedure.

In the past, few biological criteria have been used to justify the widening the stock area. However, recent tagging work by Ireland and the UK supports the idea that there is a resident stock in the Celtic Sea and Western Channel (VIIe–k) and mixing with other areas appears to be minimal. The Irish Sea front, running from SE Ireland (Carnsore point) to the Welsh Coast, appears to act as boundary between the Irish Sea and Celtic Sea stock. Juveniles found close to the SE Irish Coast (south of VIIa) are considered part of the Celtic Sea stock.

Migrations are known to occur in this cod stock. Cod can be caught throughout the English Channel (ICES Areas VIId and VIIe) in autumn (quarter 4) and winter (quarter 1), being more aggregated during the spawning season in January/February. Electronic tagging experiments in the English Channel (VIId and VIIe) have shown that cod tagged on or close to English Channel spawning grounds in quarters 4 and 1 either remain close to the point of release (residency), or move to feeding grounds to the south and/or west. Smaller fish (<50 cm) are more likely to be resident. Migrants tend to move offshore to deeper areas, whereas the habitat selection of residents is less clear cut.

From the migratory phenotypes identified by electronic tagging, historical mark-recapture experiments can be re-evaluated. Although sample size is limited, results from data on the movements of adult cod (>50 cm) show that, after tagging in VIIe (the western Channel) in quarters 1 and 4, 47% of cod (27 of 58) are recaptured in ICES Areas VIIf through VIIj, while 48% are recaptured in VIIe (i.e. are probably resident). In contrast, no adult cod tagged in VIId were recaptured in ICES Areas VIIf through VIIj, 5% moved into VIIe and 51% remain in VIId. Juvenile cod are more likely to be recaptured in the same area that they were tagged in. These figures vary slightly when recaptures are separated into autumn/winter and spring/summer seasons, but are broadly comparable. The data therefore provide evidence that cod in the eastern English Channel and western English Channel might be classed as separate substocks, and that movement of cod between eastern English Channel and the Celtic Sea is limited, whereas movement between the western Channel and the Celtic Sea is frequent.

### A.2. Fishery

Cod in Divisions VIIe–k are mainly taken as components of catches in mixed demersal trawl fisheries with a minor part by gillnets. Landings are made throughout the year but are generally more abundant during the first semester. Constraining TACs set since 2003 and the impact of the Trevose Head Closure applied since 2005 have led the landings to spread across the first three quarters of the year.

WGSSDS has been collating a database of landings and effort for the Celtic Sea. Available data on cod landings are analysed and presented. Effort data are not yet fully available for similar investigations. Recent temporal and spatial patterns in landings distributions for the main fleets catching Celtic Sea Cod are shown in Figure A.2.1 and Figure A.2.2. Highest landings are in quarter 1 when the cod aggregate to spawn. There is an indication that Q1 landings have declined in 2006 and 2007 as a result of the closure of a known spawning area at Trevose Head, although this was not the case in 2005 the first year of introduction of the closure. In most years there is a distinct peak in landings in February or March. The scale of this peak may be related to the relative strength of age 2 fish entering the fishery. The majority of the landings come from VIIg, ~55%, and the relative contributions of different ICES Divisions to the landings has been fairly stable over recent years. In 2002 there were larger than normal landings from rectangle 30E4 in VIIf.

The majority of the landings are made by demersal trawls targeting roundfish (i.e. cod, haddock and whiting), although, in recent years an increasing component have been from gillnets and otter trawls targeting *Nephrops* and benthic species.

### A.3. Ecosystem aspects

No environmental drivers are known for this stock.

## B. Data

### B.1. Commercial catch

*Landings*

On a quarterly basis, France and UK (E+W) have provided catch numbers-at-age and catch weights-at-age for their landings. Ireland has provided with the same data in Divisions VIIg and j separately and estimates of misreporting in VIIg. Landings only are available for Belgium.

Irish data are first aggregated to the landings in VIIe–k and then both datasets for France, UK and Ireland are added and raised to international landings taking into account Belgian data. Then the quarterly datasets are summed up to the annual values.

As a consequence of an update to the French database of landings statistics, some minor revisions (downward) have been applied since 2002 and the updated datasets for international landings.

Nothing is hidden in the aggregating procedure but the level of available data has changed and consequently the aggregation procedures. Compiling the previous reports of the WGSSDS and before the reports of the WGIRCS shows the following datasets available and the history of the aggregation procedures to produce the landings numbers-at-age series:

| Year range | Landings VIIe-k | Length structure (Ls) VIIe-k | Age structure (As) VIIe-k |
|---|---|---|---|
| 1971–1976 | Annual VIIfgh expanded to Annual VIIe-k using the mean landings VIIe-k | UK VII fg raised to international landings in VIIfg | UK alks VIIa to UK Ls VIIfg then UK VIIfg As raised to international landings |

| Year range | Landings VIIe-k | Length structure (Ls) VIIe-k | Age structure (As) VIIe-k |
|---|---|---|---|
| 1977–1980 | 1988-1997 over the mean landings VIIfgh 1988–1997 as a ratio | UK VIIfg + FRVIIfg raised to international landings in VIIfg | UK alks VIIa to UK Ls VIIfg and FR Ls VIIfg then As summed and raised to international landings |
| 1981–1987 | | UK VIIfg<br>FR VIIfg raised to VIIfgh | FR alks VIIfg to UK&FR Ls VIIfg then As summed and raised to international landings |
| 1988–1989 | | UK VIIfg<br>UK VIIe<br>FR VIIfg raised to VIIfgh | FR alks VIIfg to FR Ls<br>UK alks VIIfg to UK Ls<br>UK alks VIIe to UK Ls<br>then As summed and raised to international landings |
| 1990 | | UK VIIfg<br>UK VIIe<br>FR VIIfg raised to VIIfgh<br>IR VIIg | FR alks VIIfg to FR Ls<br>UK alks VIIfg to UK Ls<br>UK alks VIIe to UK Ls<br>IR alks VIIg to IR Ls<br>then As summed and raised to international landings |
| 1991–1998 | | UK VIIfg<br>UK VIIe<br>FR VIIfg raised to VIIfgh<br>IR VIIg<br>IR VIIj annual | FR alks VIIfg to FR Ls<br>UK alks VIIfg to UK Ls<br>UK alks VIIe to UK Ls<br>IR alk VIIg to IR VIIg Ls<br>IR alk VIIj to IR VIIj Ls<br>then sum of As VIIg or VIIfg raised to VIIfgh international,<br>As UK VIIe raised to VIIe international,<br>As IR VIIj raised to VIIjk international landings,<br>(VIIfgh internat+ VIIe internat + VIIjk internat) = VIIek |
| 1999–2001 | | UK VIIfg<br>UK VIIe<br>FR VIIfg raised to VIIfgh<br>IR VIIg<br>IR VIIj quarterly | FR alks VIIfgh to FR Ls<br>UK alks VIIfg to UK Ls<br>UK alks VIIe to UK Ls<br>IR alk VIIg to IR VIIg Ls<br>IR alk VIIj to IR VIIj Ls<br>then sum of As VIIg or VIIfg raised to VIIfgh international,<br>As UK VIIe raised to VIIe international,<br>As IR VIIj raised to VIIjk international landings,<br>(VIIfgh internat+ VIIe internat + VIIjk internat) = VIIek |

| Year range | Landings VIIe–k | Length structure (Ls) VIIe–k | Age structure (As) VIIe–k |
|---|---|---|---|
| 2002–… | | FR-VIIe–k<br>UK VIIe–k<br>IR VIIg<br>IR VIIj | FR alks VIIfgh to FR Ls<br>UK alks VIIfg to UK Ls<br>UK alks VIIe to UK Ls<br>IR alk VIIg to IR VIIg Ls<br>IR alk VIIj to IR VIIj Ls<br>Then sum As UK raised to UK landings in VIIe-k,<br>Sum As IR raised to IR landings in VIIe–k,<br>Then AsUK+As IR+ As FR raised to international landings |

At each step of the aggregations, mean weight-at-age is the weighted mean by numbers-at-age.

***Discards***

Discards data sampled under EU/DCR since 2003 have been generally presented in previous WGSSDS but not used in the assessments as they do not cover all the main fleets and quarters yet.

Due to the annual management system adopted by the French POs since 2003 in response to the quota restrictions, highgrading has occurred in the French fishery, mainly in VIIfgh. On an annual basis, a procedure using both the UK and French landings length data enabled estimation of the French highgrading for the years 2003–2005 (WD 1, WGSSDS 2006). The adjustments were reapplied to improve estimates of French landings from 2003 at ICES WKROUND 2009. This procedure could not be used in later years as highgrading has also occurred in that years.

In 2008 the French self-sampling programme on Celtic Sea cod has produced datasets enabling estimation of discarding and highgrading rates on a quarterly basis. Assuming the same pattern of discarding in recent years, estimates of French discarding and highgrading back to 2006 were also computed. Estimates of highgrading were also calculated for the French tuning fleets used in the analysis (ICES WKROUND, 2009, WD 17). Since the WKROUND, the database of the 2008 self sampling has increased and led to a slight update of the estimates of the level of French highgrading.

***Lpue***

The table below summarizes the available data.

| Name | Area | series |
|---|---|---|
| FR gadoid fleet [1] | VIIfgh | 1983–… |
| FR Nephrops fleet [1] | VIIfgh | 1983–… |
| FR otter trawlers [2] | VIIe | 1983–… |
| FR otter trawlers [2] | VIIfgh | 1983–… |
| FR otter trawlers [2] | VIIe–k | 1983–… |
| UK otter trawlers | VIIe | 1972–… |

| Name | Area | series |
|---|---|---|
| UK otter trawlers | VIIe–k | 1972–… |
| UK beam trawlers | VIIe–k | 1978–… |
| IR otter trawlers | VIIg | 1995–… |
| IR beam trawlers | VIIg | 1995–… |
| IR Scottish seiners | VIIg | 1995–… |
| IR otter trawlers | VIIj | 1995–… |
| IR beam trawlers | VIIj | 1995–… |
| IR Scottish seiners | VIIj | 1995–… |

**[1] For Q2+3+4 for consistency with the Trevose Head Closure since 2005 during the first quarter.**

**[2] Annual values, including the Fr gadoid and *Nephrops* fleets.**

### B.2. Biological

#### *Weights-at-age*

At the 1999 WGSSDS, data for the years 1971–1980 were set to the average 1981–1997. A revision was carried out at 2001 WGSSDS where the values for the period 1971–1980 were set to the average values for 1981–2000. Depending on the annual datasets available by country for the period 1988–2001, catch weights-at-age data were calculated as the weighted means from French, Irish and UK datasets. Since 2002, VIIe–k catch weights-at-age have been calculated as the annual weighted means of French, Irish and UK datasets in VIIe–k.

#### *Maturity*

The maturity ogive applied since 1999, was estimated from the datasets of the UK-WCGFS survey (first quarter) has been used for the overall series. It replaced an assumed ogive used for the year prior to 1999, derived from Irish Sea cod data, when both stocks (VIIa and VIIfg) were assessed in the Irish Sea and Bristol Channel WG up to 1992. Table below summarizes the maturity ogives used.

| Age | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|
| Before 1999 | 0.00 | 0.05 | 1.00 | 1.00 | 1.00 |
| Current | 0.00 | 0.39 | 0.87 | 0.93 | 1.00 |

#### *Natural mortality*

In the assessments, natural mortality is assumed to be constant (M=0.2) for the whole range of years and ages.

### B.3. Surveys

Three survey-series are available. The common range of ages used is 1–5:

The discontinued UK-WCGFS (1986–2004), conducted during the first quarter, is generally truncated into a shorter series (1992–2004) as it showed a strong trend (dome-shaped) when using the full series. This pattern is related to the progressive extension of the studied area of this survey from VIIe to VIIefgh over the years. This time-series only contributes to the estimates at older ages (4 and older). Due to the lack of new data the series is no longer used for calibration.

The FR-EVHOE survey (1997–…), during the fourth quarter, covers the Divisions VIIfghj. The full series is used.

The IrGFS survey (2003–…), during the fourth quarter, in VIIg and VIIj is also used in the assessment. It is the main contributor to the terminal year estimates, partly because this series is short.

The absolute numbers of cods caught in all of these surveys are extremely low.

#### B.4. Commercial cpue

Two French commercial fleets are used for tuning: the French trawlers targeting Gadoids in Divisions VIIf, g, h (FR-GADOIDS) and the French *Nephrops* trawlers in VIIf,g,h (FR-*NEPHROPS*), for which cod is generally a bycatch. Both fleets account on average for ~30% of the international landings from 1988; the series starts in 1983. Other commercial fleets used are the English West Coast otter trawlers (UK-WECOT) in VIIe from 1988 and the Irish 7J otter trawlers (IR-7J-OT) in VIIj from 1995. Both fleets fish throughout the majority of the assessed area.

#### B.5. Other relevant data

*Input from industry*

No new datasets.

### C. Historical stock development

Model used:

The Separable VPA was used at the former Irish Sea and Bristol Channel WG and the Laurec–Shepherd model in the period 1987–1992. The XSA was the model used subsequently. SURBA was also used for survey catch-at-age analysis in 2005–2007.

Corrections for some misreporting estimates have been integrated into the datasets used in the assessment but the change of discarding practices to manage the restricting national quotas may impact the assessment. This also affects the reliability of the commercial tuning fleets used.

In previous assessments (2006, 2007 and 2008), adding a new year of data has generally raised the stock numbers at younger ages (age 1 and 2) resulting in increased estimates of recruitment strength. These upwards revisions are considered a result of the recent highgrading practices. Given this uncertainty and the recent reports from the industry of underreporting the XSA assessment, which assumes unbiased catch data cannot be applied. Improved datasets on landings, recorded and highgrading are required before XSA could be used.

WKROUND (2009) evaluated XSA with adjusted recent catch levels against B-Adapt and the SAM state-space model, which estimate additional unallocated mortality. All models exhibited different patterns in the recent years with a high degree of uncertainty. The Group concluded that no model could be recommended as a basis for providing advice on recent stock trends until further investigations or additional datasets were available to resolve the situation.

### D. Short-term projection

No decision has been taken on the forecast methodology.

### E. Sensitivity analysis and medium-term projections

Medium-term forecasts are not provided for this stock.

### F. Long-term projections

Long-term forecasts are not provided for this stock.

### G. Biological reference points

**Reference points**

| | Type | Value | Technical basis |
|---|---|---|---|
| Precautionary approach | $B_{lim}$ | 6 300 t | $B_{lim} = B_{loss}$.(B76), the lowest observed spawning-stock biomass. |
| | $B_{pa}$ | 8 800 t | $B_{pa} = B_{lim} * 1.4$. Biomass above this value affords a high probability of maintaining SSB above $B_{lim}$, taking into account the variability in the stock dynamics and the uncertainty in assessments. |
| | $F_{lim}$ | 0.90 | The fishing mortality estimated to lead to potential collapse. |
| | $F_{pa}$ | 0.68 | $F_{pa}$ = 5th percentile of $F_{loss}$. This F is considered to have a high probability of avoiding $F_{lim}$ and maintaining SSB above $B_{pa}$ in the medium term (assuming normal recruitment), taking into account the uncertainty assessments. |
| Targets | $F_y$ | Not defined. | |

*(unchanged since: 2004)*

Due to the current uncertainties on the state of this stock, the Benchmark WK is unable to make new proposals for the Reference Points and the 2004 values remain.

### H. Other issues

None.

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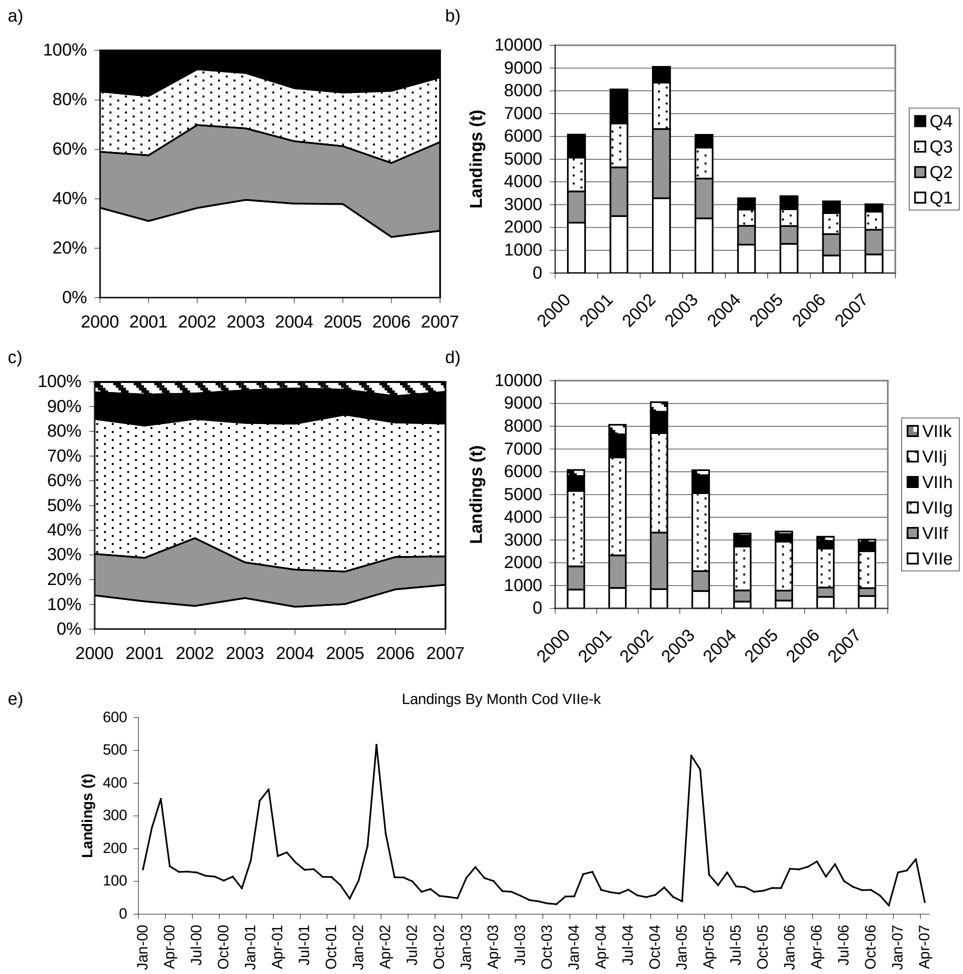
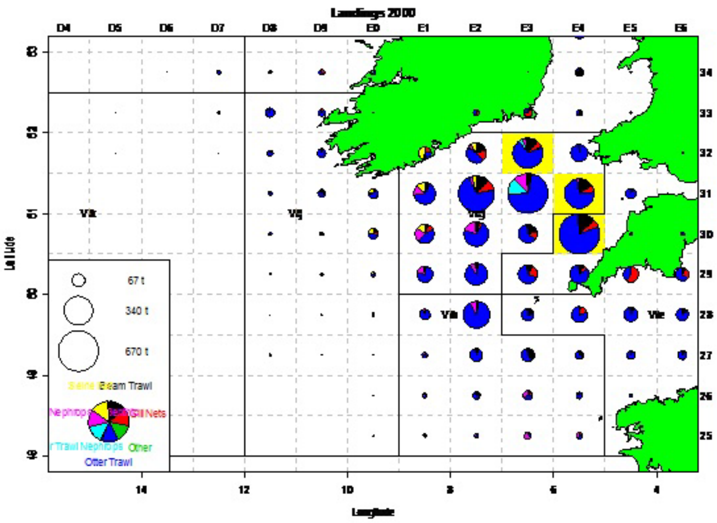



**Figure A.2.1. Temporal and spatial patterns in landings patterns for Celtic Sea cod (VIIe–k).**



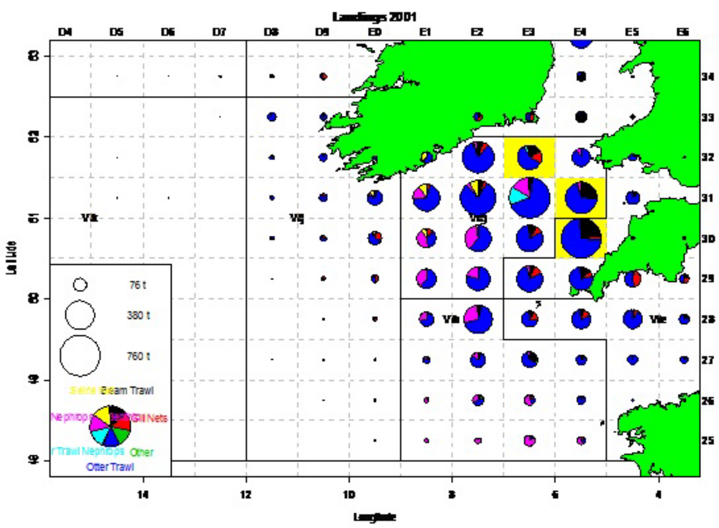
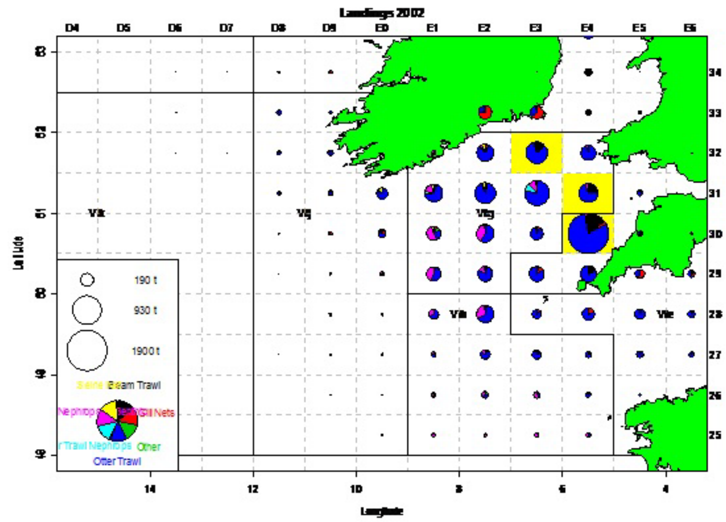




**Figure A.2.2. The spatial and temporal distribution of cod landings from the Celtic Sea, from 2000–2007 by gear type. The closed rectangles are highlighted in yellow. Each year is scaled to, the maximum.**



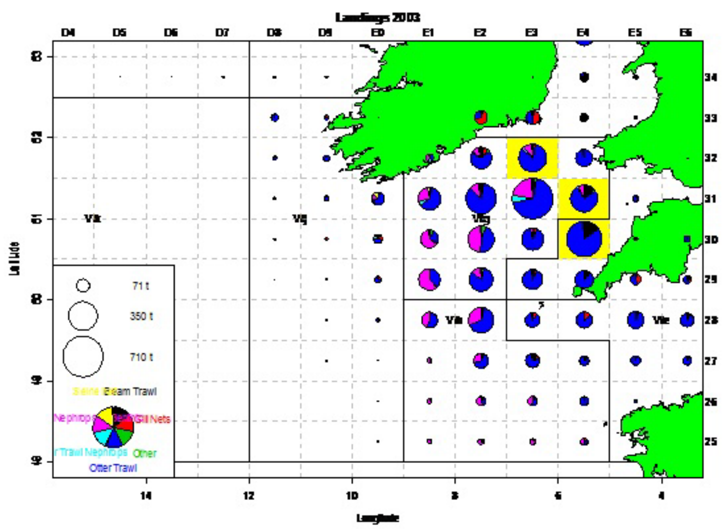
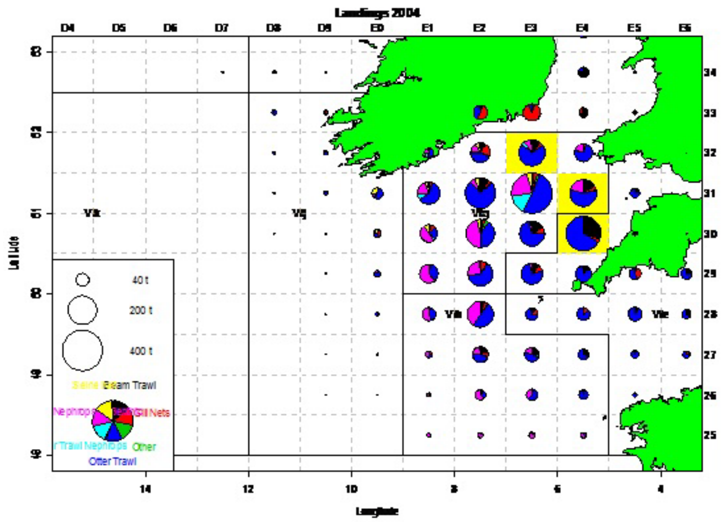




**Figure A.2.2. continued.**



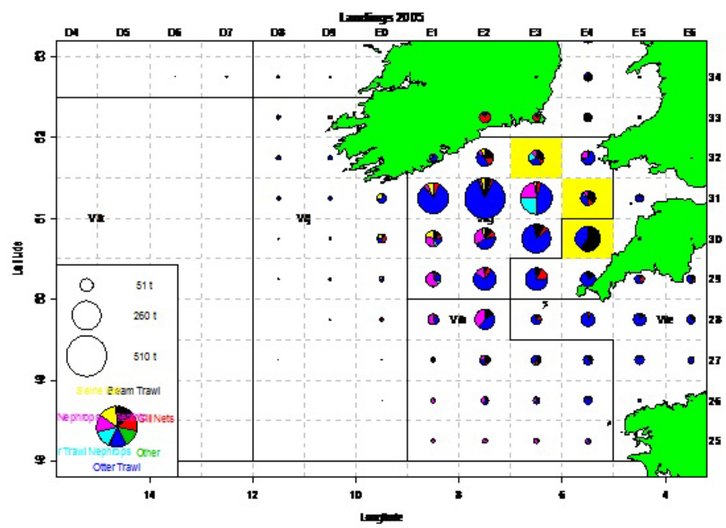
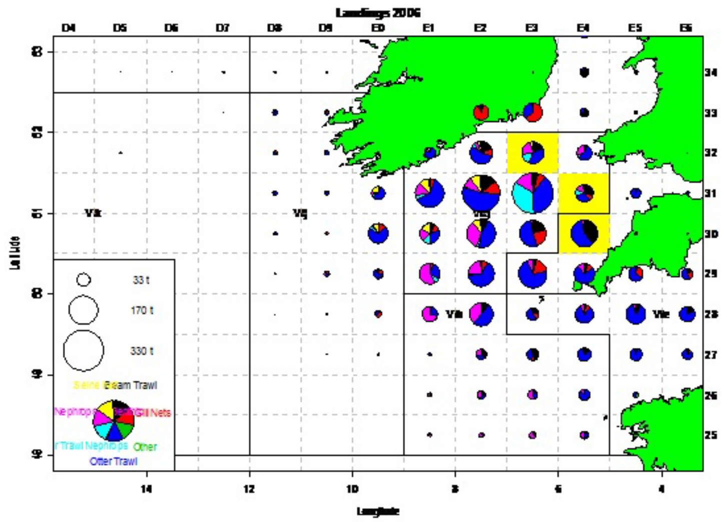


**Figure A.2.2. continued.**



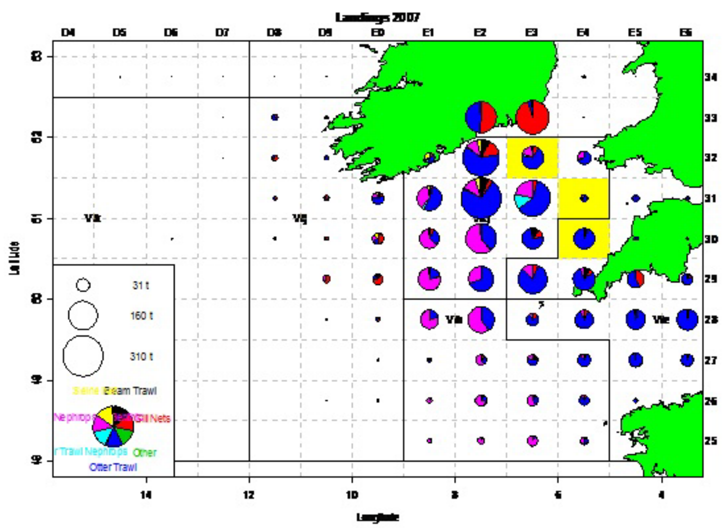




**Figure A.2.2. continued.**

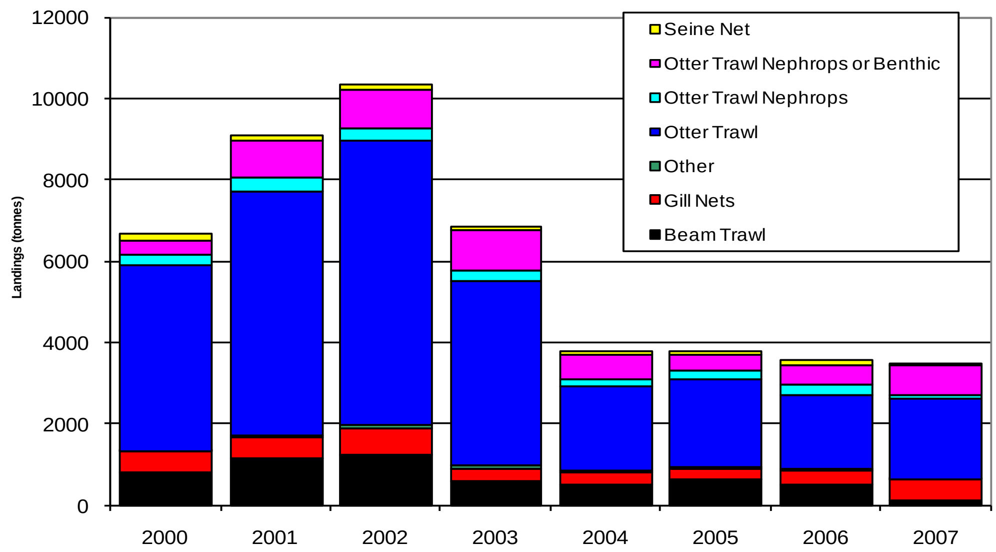



**Figure A.2.2. continued.**

# Stock Annex 7.4: Haddock VIIb–k

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Haddock VIIb–k |
| Working Group | WGCSE |
| Date | last revision 11/05/11 |
| Revised by | Hans Gerritsen |

## A. General

### A.1. Stock definition

For assessment purposes, the stock is defined as VIIb-k excluding VIId. The TAC for haddock is set for VIIb–k, VIII, IX and X. However, official international landings from VIII, IX and X have been less than 2% of all landings in the TAC area in most years since 1973.

Adult haddock appear to be continuously distributed from the north of Biscay along the Irish coasts and the west of Scotland into the North Sea. It is not clear from their distribution if the VIIb–k stock is distinct from the surrounding areas. Irish Otter trawl lpue in the northernmost rectangles of VIIb is relatively high and similar lpue continues into VIa, suggesting that the haddock in the north of VIIb might belong to the same stock as those in VIa (Gerritsen, 2009). The pattern of lpue in the Irish Sea appears to be relatively distinct from VIIb–k with relatively high otter and beam trawl lpue in VIIg, low lpue in VIIa south and high lpue in VIIa north (Gerritsen, 2009). Results from the French EVHOE-WIBTS-Q4 survey suggest that relatively low densities of haddock continue from VIIh into VIIIa. Irish Groundfish Survey (IGFS-WIBTS-Q4) data indicates two distinct nursery areas with high catches of 0-group haddock: one area off the southwest coast of Ireland (VIIb south and VIIj north) and one area off the southeast coast (VIIg north). Catches of older haddock in VIIb are generally low and it is not clear whether the young fish from VIIb move north to VIa or south to VIIj stock (Gerritsen and Stokes, 2006).

### A.2. Fishery

Haddock in Divisions VIIb–k are taken as a component of catches in mixed trawl fisheries. France usually takes about 50–80% of the landings. French landings are made mainly by gadoid trawlers, which prior to 1980 were mainly fishing for hake in the Celtic Sea. Ireland has historically taken about 25–40% of the landings. Fleets from Belgium, Norway, the Netherlands, Spain, and the UK take the remainder of the landings. Landings reported between 1984 and 1995 varied between 2600 t and 4900 t, then increased sharply to 10 300 t in 1997. Since then the landings have varied between 5000 t and 10 000 t without a clear long-term trend.

The vast majority of the landings are taken by otter trawls, most of the remainder of the landings are taken by seines and beam trawls.

### A.3. Ecosystem aspects

Haddock are widely distributed throughout the stock area across a range of habitats. They have a varied diet but do not appear to be cannibalistic (Needle *et al*., 2003).

The mixed trawl fisheries impacts on benthic communities through bottom contact. Other ecosystem impacts result from discarding of non-target, under-size, over-quota or low-value fish.

Recruitment of haddock is highly variable. For North Sea haddock, no link could be found between temperature and recruitment (Cook and Heath, 2005). But parental condition has been linked to recruitment success in Northwest Atlantic haddock (e.g. Friedland *et al*., 2003; Marshall and Frank, 1999).

## B. Data

### B.1. Commercial catch

*Sampling and data raising*

Data on landings-at-age and mean weight-at-age-are available for fleets landing into Ireland since 1993 and from France and the UK since 2002. The UK catch numbers are supplied for the combined VIIe–k area and the landings data from each Division are used to scale the catch numbers to each Division. French VIIf,g,h catch numbers are combined with Irish VIIg data to estimate VIIf,g,h catch numbers. Since 2009, the French catch numbers-at-age are supplied for the whole stock area (VIIb–k). The table below shows the data available and the procedures used to derive quarterly length compositions, age compositions and mean weights-at-age.

| | | Data source: | | | | |
|---|---|---|---|---|---|---|
| **Division** | **Data** | **UK** | **France** | **Ireland** | **Belgium** | **Derivation of international landings** |
| **VII b,c** | Length composition | | | VII b | | |
| | ALK | | | VII b | | |
| | Age Composition | | | VII b | | IRL raised |
| | Mean weight at age | | | VII b | | IRL VIIb |
| | Landings | | VIIb,c | VIIb,c | | |
| **VII e** | Length composition | VIIe-k | | | | Derived from UK VIIe-k |
| | ALK | VIIe-k | | | | Raised to international Landings |
| | Age Composition | VIIe-k | | | | |
| | Mean weight at age | VIIe-k | | | | |
| | Landings | VIIe | VIIe | | VIIe | |
| **VII f,g,h** | Length composition | | VII f,g,h | VII g | | |
| | ALK | | VII f,g,h | VII g | | |
| | Age Composition | | VII f,g,h | VII g | | IRL & FRA raised |
| | Mean weight at age | | VII f,g,h | VII g | | IRL & FRA raised |
| | Landings | VIIf,g | VIIf,g,h | | VIIf,g,h,j,k | |
| **VIIe-h** | Length composition | | | | | VIIf,g,h & VIIe |
| | ALK | | | | | |
| | Age Composition | | | | | |
| | Mean weight at age | | | | | |
| | Landings | | | | | |
| **VII j-k** | Length composition | | | VII j | | IRL raised |
| | ALK | | | VII j | | |
| | Age Composition | | | VII j | | IRL raised |
| | Mean weight at age | | | VII j | | IRL VIIj |
| | Landings | VIIj,k | VIIj,k | VIIk | | |
| **VII b,c,e,f,g,h,j,k** | Length composition | | | | | |
| | ALK | | | | | |
| | Age Composition | | | | | VIIb,c + VIIe + VIIfgh + VIIjk |
| | Mean weight at age | | | | | Weighted mean by numbers caught |
| | Landings | | | | | |

*Weights-at-age*

Previous to the WGSSDS 2004, a three year running average was applied to the stock weights-at-age. In 2004, the working group estimation of stock weights was done using a quadratic function fitted through cohorts to the first-quarter catch weight data. In 2005 the stock weights were modelled using a von Bertalanfy growth equation. The raw stock weight data show significant year-effects and although these might be due to changes in sampling or ageing errors, it is also possible that weights-at-age are subject to interannual variation in condition. As the modelled stock weight did not fit the data very well and because it is not clear whether stock weights-at-age are more influenced by cohort or year effects, it was decided in 2007 to revert to using a three year running average to smooth the data, and constraining the weights in older ages to at least those of the preceding age in the cohort.

### B.2. Biological

In the absence of a direct estimate of natural mortality, a constant value of 0.2 was assumed for all age classes and years. Maturity was assumed to be knife-edged at age 2. Recent Irish Survey data are generally in agreement with this maturity ogive, although males occasionally mature at age one. F and M before spawning were set to 0 for all ages in all years.

### B.3. Surveys and commercial tuning fleets

*Description*

All surveys described below are coordinated by the IBTSWG (International Bottom-trawl Survey Working Group).

The UK7efghjWCS first-quarter annual groundfish survey was carried out on the RV Cirolana until 2003. In 2004 it was carried out on the RV Endeavour and discontinued thereafter. The survey fished fixed station positions allocated by area and depth strata. The survey used a modified Portuguese High-Headline trawl (PHHT) with 350 mm rubber bobbins, a bunt tickler chain and a 20 mm codend liner. The survey was not included in the assessment because it was discontinued and all cohorts are in the converged part of the vpa.

The French 7fghj EVHOE-WIBTS-Q4 annual groundfish is carried out on the RV Thalassa. Age data are available from 2001 onwards. ALK data from the Irish survey were applied to the EVHOE data for the years 1997–2000 to estimate numbers-at-age for these years. The sampling design is a stratified random allocation. The number of hauls per stratum is optimized by a Neyman allocation taking into account the most important commercial species in the area (hake, monkfish and megrim). The fishing gear used is a GOV with an average vertical opening of 4 m and a horizontal opening of 20 m.

The fourth-quarter Irish west-coast groundfish survey (WCGFS) was carried out in VIaS and VIIbj on chartered commercial vessels. The sampling design attempted to allocate at least two stations per rectangle. Stations were selected randomly within each rectangle from known clear tow positions. A Rock-hopper GOV with 12 inch discs was used. The nets were fitted with a 20 mm codend liner.

Between 1999 and 2002 Ireland carried out the fourth-quarter Irish Sea-Celtic Sea Groundfish Survey (ISCSGFS) in VIIag on RV Celtic Voyager. The survey used a GOV Trawl with a mean vertical opening is 6 m and door spread 48 m. In 2003 the ISCSGFS survey was replaced by the fourth-quarter Irish Groundfish Survey (IGFS-WIBTS-Q4) which covers VIaS, VIIbgj. This survey is carried out on RV Celtic Explorer. The IGFS has a random stratified design and uses a GOV (with rock-hopper in VIa) with a 20 mm codend liner. The IGFS-WIBTS-Q4 (7g) index used in the assessment is a combination of the ISCSGFS and IGFS in VIIg. The two survey-series were standardized by swept-area estimates.

The IGFS also provides indices for VIIb and VIIj. (IGFS-WIBTS-Q4(7b) and IGFS-WIBTS-Q4(7j) These indices are currently not used. It is believed that a significant amount of recruitment takes place in VIIb and the north of VIIj, these divisions are not covered by the EVHOE or IGFS-WIBTS-Q4(7g) indices, therefore it would be worth considering including the IGFS-WIBTS-Q4(7b and 7j) indices at the next benchmark assessment.

The commercial IR7bjOTB fleet consists mainly of vessels from 15 to 35 m in length, operating from the west and southwest coast of Ireland.

Vessels of the Irish OTB fleet in VIIg regularly switch between targeting *Nephrops* to targeting whitefish. Significant numbers of new boats have also been added to this fleet, making it unsuitable as a tuning fleet.

The commercial FR7fghGAD fleet consists of French vessels targeting gadoids.

#### *Consistency*

The surveys used in the assessment generally show good internal consistency for ages 0 to age 3 or 4. The current surveys also show reasonably good agreement in the estimated numbers of recruits (age 0). The tuning fleets used in the assessment generally show good consistency from the age of 2 or 3 up to ages 6 or 7.

#### B.4. Commercial cpue

Effort and lpue data are available from the Irish otter trawl fleets operating in Divisions VIIb, VIIj and VIIg since 1995, French gadoid trawlers in VIIfgh since 1993 and effort data are available for the UK beam trawl fleet in VIIe–k and all other trawl gears in VIIe–k since 1983. The effort in the French gadoid fleet has decreased in recent years and is now at a similar level to the Irish and UK fleets. Effort in the Irish OTB VIIg fleet has increased in recent years, while the Irish OTB effort in VIIb and VIIj appears to have levelled off in recent years. The lpue of the French gadoid fleet is still much higher than that of the other fleets. The Irish and UK fleets have seen a minor increasing trend in lpue in recent years.

#### B.5. Other relevant data

*Discard data*

Discard data are available for the Irish otter trawl fleets in VIIbgj since 1995. French discard data are available since 2005 and UK discard data are available since 2003. The French and UK data are not raised to the national level.

Because the Irish discard data cover nearly the entire time-series, these data were used to estimate discard numbers-at-age by raising them to the international level. Otter trawlers account for most of the international effort in VIIb–k, no attempt was made to estimate discards for the other main gears (seine and beam trawl). No discard data were available for 1993–1994, discarding in these years was estimated from the average of 1995–1999, which was a period with relatively low discarding.

Irish otter trawl discard length distributions were raised to the national level of discards by estimating the mean length distribution per trip and multiplying this by the total number of otter trawl trips following recommendations by Borges *et al*., (2005).

Irish discard data from VIIgj were used to estimate international discards by using the ratio of the international effort in VIIe–k to the Irish effort in VIIgj. This approach assumes that Irish discarding in VIIjg is representative of the international discards and does not take differences in vessel power or target species into account.

The age structure of young haddock appears to vary between years and between VIIb and VIIgj It was therefore considered appropriate to apply separate Age–Length Keys (ALKs) to VIIb and VIIgj on an annual basis. For years where age data were insufficient or absent, the average ALK of all years was applied for the relevant area (This was considered appropriate because of the fast growth there is relatively little length-overlap between age classes). For many years, it was possible to clearly identify the youngest cohorts from the length distributions. Based on this, some spurious age readings were adjusted. The following rules were applied to correct the data:

| Area | Year | | Lengths | Change ages from | Change ages to | Observations affected |
|---|---|---|---|---|---|---|
| VIIb | all | | <14 | 1 | 0 | 14 |
| VIIb | | 2003 | >14 | 0 | 1 | 28 |

| | | | | | |
|---|---|---|---|---|---|
| VIIb | 96,97,99,00,01,02,04,05 | >15 | 0 | 1 | 8 |
| VIIb | 2006 | >18 | 0 | 1 | 31 |
| VIIb | all | >25 | 1 | 2 | 110 |
| VIIb | all | <20 | 2 | 1 | 10 |
| VIIgj | all | <22 | 2 | 1 | 28 |
| VIIgj | all | <25 | 3 | 2 | 7 |

The changes affected 236 age observations out of a total of 3021.

## C. Historical stock development

Model used: XSA

Software used: FLR, VPA95

Exploratory data analysis and the assessment were carried out using FLR under R version 2.8.1 with packages FLCore 2.2, FLAssess 2.0.1, FLXSA 2.0 and FLEDA 2.0.. A separable assessment was performed using the Lowestoft VPA95 software to screen for outliers in the catch numbers. The final assessment was performed in R as well as the Lowestoft VPA95 software.

Model settings Separable VPA (data screening only)

| Option | Setting |
|---|---|
| Year range | 1993–current |
| Age range | 1–8+ |
| Year weighting | Default |
| Age weighting | Default |
| Reference age | 2 |
| Terminal F | From previous year's XSA |
| Terminal S | 1.25 |

### *Model settings XSA*

The model settings below have been unchanged since 2007.

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1993–current | 0–8+ | Yes |
| Canum | Catch-at-age in numbers | 1993–current | 0–8+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1993–current | 0–8+ | Yes |
| West | Weight-at-age of the stock at spawning time. | 1993–current | 0–8+ | Yes |
| Mprop | Proportion of natural mortality before spawning | 1993–current | 0–8+ | No |
| Fprop | Proportion of fishing mortality before spawning | 1993–current | 0–8+ | No |
| Matprop | Proportion mature-at-age | 1993–current | 0–8+ | No |
| Natmor | Natural mortality | 1993–current | 0–8+ | No |

A plus group of 8+ was used. Age group 0 was included in the assessment data to allow inclusion of 0-group indices in the XSA runs. However, catch numbers-at-age 0 were set to zero to avoid spurious F-shrinkage effects at this age.

Model Options:

| Option | Setting |
|---|---|
| Ages catch dep stock size | None |
| Q plateau | 4 |
| Taper | No |
| F shrinkage SE | 1.5 |
| F shrinkage year range | 5 |
| F shrinkage age range | 3 |
| Fleet SE threshold | 0.3 |
| Prior weights | No |

There is no evidence to suggest that catchability depends on stock size; the linear regression fits the data well (see regression plots in the report). The effect of releasing the q-plateau was investigated and catchability appeared to level off at age 4. There is no evidence to suggest that the tuning fleets have changed over time, therefore no tapered time weighting was applied. In recent years there has not been a clear retrospective pattern, therefore a relatively high F shrinkage SE was used with a short year and age range. The fleets are relatively well behaved so an SE threshold of 0.3 was applied.

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Survey | IR7bjWCGFS | 1993–2002 | Not used |
| Survey | UK7efghjWCS | 1996–2004 | Not used |
| Survey | FR7fghjEVHOE | 1997–current | 0–5 |
| Survey | IR7gSAGFS | 1999–current | 0–5 |
| Survey | IR7bIGFS | 2003–current | Not used |
| Survey | IR7jIGFS | 2003–current | Not used |
| Commercial | IR7bjOTB | 1995–current | 2–7 |
| Commercial | FR7fghGAD | 2002–current | 2–6 |

The age ranges used in the assessment were based on an analysis of internal consistency and residuals. The surveys catch few fish over the age of 5 and the commercial fleets discard most fish under the age of 2 as well as a considerable number of 2-year-olds. These were retained in the fleets because they do show good internal consistency as well as agreement with other fleets.

History of previous assessments, changes are highlighted using bold font.

| | | 2002 XSA | 2003 XSA | 2004 XSA | 2005 XSA | 2006 XSA | 2007-current XSA |
|---|---|---|---|---|---|---|---|
| Catch data | Years | 93–01 | 93–02 | 93–03 | 93–04 | 93–05 | 93–06 |
| | Ages | 1–8+ | 1–8+ | 0–8+ | 3–8+ | 3–8+ | 0–8+ |
| Survey tuning fleets | | | | | | | |
| IR7bjWCGFS | Years | 93–01 | 93–02 | 93–02 | 93–02 | 93–02 | Not used |
| | Ages | 1–1 | 1–1 | 0–3 | 3–3 | 3–5 | |
| UK7efghjWCS | Years | 98–01 | 98–02 | 98–03 | Not used | 98–03 | Not used |
| | Ages | 1–3 | 1–3 | 1–5 | | 3–5 | |
| EVHOE-WIBTS-Q4 | Years | Not used | Not used | 97–03 | 97–04 | 97–05 | 97–current |
| | Ages | | | 0–3 | 3–3 | 3–5 | 0–5 |
| IGFS-WIBTS-Q4(7g) | Years | Not used | Not used | Not used | Not used | Not used | 99–current |
| | Ages | | | | | | 0–5 |
| IR7gISCSGFS | Years | Not used | Not used | 97–03 | 97–04 | Not used | Not used |
| | Ages | | | 0–3 | 3–3 | | |
| Commercial tuning fleets | | | | | | | |
| IR7bjOTB | Years | 95–01 | 95–02 | 95–03 | 95–04 | 95–05 | 95–current |
| | Ages | 1–7 | 1–7 | 1–7 | 3–7 | 3–7 | 2–7 |
| FR7fghGAD | Years | Not used | Not used | Not used | Not used | Not used | 02–current |
| | Ages | | | | | | 2–6 |
| Model options | | | | | | | |
| Ages catch dep stock size | | None | None | None | None | None | None |
| Q plateau | | 4 | 4 | 4 | 4 | 4 | 4 |
| Taper | | No | No | No | No | No | No |
| F shrinkage SE | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| F shrinkage year range | | 5 | 5 | 5 | 5 | 5 | 5 |
| F shrinkage age range | | 3 | 3 | 3 | 3 | 3 | 3 |
| Fleet SE threshold | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Prior weights | | No | No | No | No | No | No |

### D. Short-term projection

Model used: Multifleet Deterministic Projection. Landings and discards are modelled as separate fleets.

Software used: MFDP1a

Initial stock size: Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a long-term GM (omitting the last two years).

Natural Mortality: 0.2 for all ages in all years as used in XSA

Maturity: knife-edge at age 2 for all years as used in XSA

F and M before spawning: Set to 0 for all ages in all years as used in XSA

Weight-at-age in the stock and catch: average from last three years

Exploitation pattern average from last three years (from XSA)

Intermediate year assumptions: *status quo* F.

Stock–recruitment model used: None, the long-term GM recruitment-at-age 0 is used.

$F_{bar}$ range: ages 2–5

Rescale to last year: No

### E. Medium-term projections

None.

### F. Yield and biomass per recruit

MSY estimates were evaluated using the srmsymc ADMB package See report of WGCSE 2010 for a description of the yield-per-recruit analysis.

### G. Biological reference points

It is not possible to derive precautionary reference points for this stock from the short time-series of information available.

### H. Other issues

None.

### I. References

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# Stock Annex 7.5: *Nephrops* in VIIb FU17, Aran Grounds

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Aran Grounds *Nephrops* (FU17) |
| Date | 06 March 2009 (WK*NEPH* 2009) |
| Revised by | Colm Lordan (WGCSE, 2011 to address RGCSE 2010 comments) |

## A. General

### A.1. Stock definition

*Nephrops* is limited to muddy habitat, and requires sediment with a silt and clay content of between 10–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* probably only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In FU17, the main *Nephrops* stock inhabits an extensive area of muddy sediment known as the Aran Grounds which lie to the west and southwest of the Aran Islands, there are also smaller discrete mud patches in Galway Bay and Slyne Head.

### A.2. Fishery

In recent years the *Nephrops* stock in FU17 are almost exclusively exploited by Irish vessels. Figure A.2.1 shows the spatial distribution of landings and lpue for Irish otter trawl vessels in 2005 using logbook and VMS data linked together to give finer spatial resolution. The Aran groundfishery is clearly highlighted.

The *Nephrops* fishery 'at the back of the Aran Islands' can be considered the mainstay of the Ros a Mhíl fleet. Without this *Nephrops* fishery the majority of vessels in the fleet would cease being economically viable (Meredith, 1999). The Irish fishery consists of entirely of otter trawl vessels. The majority of vessels use twin-rigs and 80 mm. Smaller vessels do use 70 mm with a SMP. Some vessels have using 90 mm. Vessels from Ros a Mhíl, Dingle, Union Hall, Dunmore East, Clogherhead and Kinsale mainly exploit the fishery.

The number of Irish vessels reporting *Nephrops* landings from FU17 has fluctuated around 50/yr (Figure A.2.2). Around 18 vessels report landings in excess of 10 t. These are the main vessels in the fishery accounting for around 85% of the total landings. The majority of these vessels are between 20–22 m overall length (Figure A.2.3). There has been a slight shift to lager vessels over time. The majority of vessels are in the power range of 200–400 KW (Figure A.2.4). There has also been a shift to more powerful vessels over time with the introduction of twin-rigs to the fishery in the early 2000s. Most of the larger boats move freely between the *Nephrops* fisheries in FUs 15, 16, 20-22 and other areas depending on the tides and weather.

The fishery shows a distinctive seasonal pattern with highest landings, catches, lpue and cpue in April–June and October–November. The monthly landings time-series with the average pattern is shown in Figure A.2.5. The first period of elevated landings is associated with the emergence of females from their burrows post-hatching of their eggs. The sex ratio during this period is biased towards females (Figure A.2.6). Females mature quickly during the early summer and spawning occurs in July and August. This is coincident with a decline in landings and cpue in the fishery. The Ros a Mhíl fleet traditionally tie up in August each year for maintenance and refurbishment.

The following TCMs are in place for *Nephrops* in VII (excluding VIIa) after EC 850/98: Minimum Landing Sizes (MLS); total length >85 mm, carapace length >25 mm, tail length >46 mm. Mesh Size Restrictions; Vessels targeting *Nephrops* using towed gears having at least 35% by weight of this species on board will require 70 mm diamond mesh plus an 80 mm square mesh panel as a minimum or having at least 30% by weight of *Nephrops* on board will require 80–99 mm diamond mesh.

### A.3. Ecosystem aspects

#### *Physical oceanography*

The Aran Ground is coincident with a pool of oceanic water, which is rich in nutrients and low in dissolved oxygen. The currents throughout the water column over the ground are generally weak although there is a well-documented bottom density front on the eastern flank of the ground (Nolan and Lyons, 2006). This is a seasonal feature, which establishes in May and persists until autumn. The front causes a persistent jet like flow from south to north close to the seabed through the *Nephrops* ground. The mean position of jet varies from year to year by up to 30 km. Timing and position of the jet may influence recruitment and settlement success of post-larval *Nephrops* since it could potentially advect larval from the area. Salinity differences, due to over winter freshwater input, are thought to heavily influence the density structure and location of this front. Until a time-series of recruitment and jet dynamics is established it is not possible to draw any firm conclusions about the impact of this ecosystem feature on the stock and fishery. Potential sinks for advected larvae include Slyne head and possibly Galway Bay.

#### *Temperature and salinity time-series*

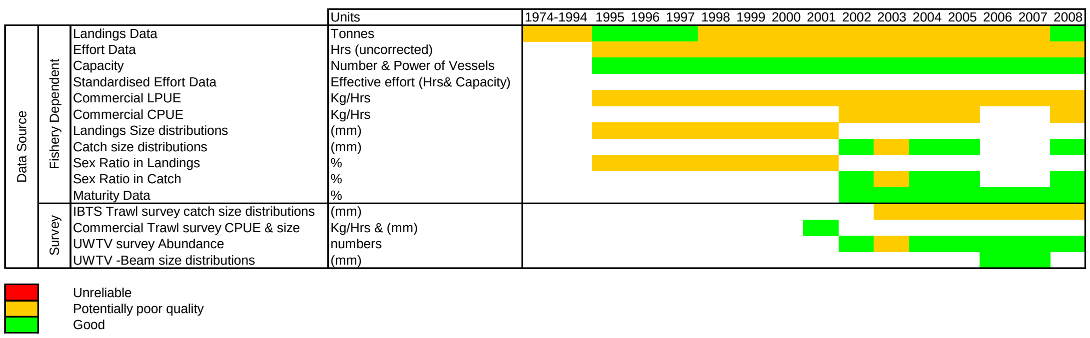
An emerging time-series of temperature and salinity data are available for a transect through the Aran Grounds (Nolan and Lyons, 2006). In all years since 1999 (except 2001) the 53°N section has exhibited positive anomalies in temperature of between 0.2°C and 2°C (Figure A.3.1). In 2001, the temperature anomaly from the long-term climatology was zero. Years with lower temperature anomalies seem to coincide with years of strongly negative salinity anomalies (e.g. 2001 and 2005, 2006) perhaps reflecting the limited influence of ENAW on the section in those years as the section is dominated by coastal discharges from the Loire and Shannon. Salinity anomalies along 53°N range from -0.3 to +0.1 psu over the period. The freshest years were 2001, 2005 and 2006. In 2000, 2003 and 2004 ENAW has a stronger influence on the salinity structure and positive anomalies in salinity from the long-term climatology are the result. The higher UWTV abundance in 2003 and 2004 is coincident with the warmest anomaly but the time-series remains too short to draw definitive conclusions.

#### *Sediment distribution*

There is a growing body of information on the spatial extent of the sediment suitable for *Nephrops* from UWTV surveys, seabed mapping programmes and the fishing industry. Figure A.3.1 depicts contour and post plots of the a) mean size (phi) and classification based on the Friedman and Sanders (1978) scales and b) sorting ($\sigma_g$) of the sediments on the Aran Grounds based on PSA results from samples collected from 2002–2006 UWTV surveys. The majority of the ground has similar mean particle size at around 4–5 μm. There are some patches of softer silt towards the middle of the ground. Figure A.3.2 is bathymetry of the Aran grounds obtained from seabed mapping programmes. The eastern flank of the ground shallows up quickly but the majority of the ground is gradually deepening from around 100 m to 110 m with the deepest parts to the southwest.

### B. Data

The table below summarizes the available data for this stock and attempts to quantify the quality subjectively.




#### B.1. Commercial catch

Prior to 1988 landings data for this fishery are only available to the WG for France. Since 1988 reported landings data for the Irish fleet were obtained from EU logbooks. The quality of landings data is not well known. In earlier, years there are no landings from Ireland although there was probably some catch. The Irish landings have been close to quota for this TAC area since around 1997 (Figure B.1.1). In more recent years (2003–2005 and 2008) there are a few observations of both under and over reporting but it is not possible to correct landings using these as it is not known how representative they might be.

Landings length and sex compositions were estimated from port sampling by Ireland (between 1995–2001). There was a perception during this period that that discarding was not significant. In 2002 a new catch self-sampling programme was put in place. This involves unsorted catch and discard samples being provided by vessels or collected by observers at sea on discard trips. The catch sample is partitioned into landings and discards using an on-board discard selection ogive derived for the discard samples (Table B.1.1). Sampling effort is stratified monthly but quarterly aggregations are used to derive length distributions and selection ogives. The length–weight regression parameters given in Table B.2.1 are used to calculate sampled weights and appropriate quarterly raising factors. The sampling intensity and coverage has varied over the time-series (Table B.1.1). The quality of the sampling has not yet been qualitatively assessed in terms of precision and accuracy.

*Nephrops* landings and discards from the Aran Grounds have not been sampled for the majority of 2006 and all 2007 due to a lack of cooperation by the industry. However, sampling resumed in 2008 and the intensity and coverage is considered the best to date.

Fish and other bycatches in the fishery have been collected by on-board observers since 1994. The number of trips is variable over time with a gap in the series in 2006 and 2007.

### B.2. Biological

Biological parameters for this stock are outlined in Table B.2.1.

#### *Length–weight*

Mean weights-at-age for this stock are estimated from studies on Scottish stocks by Pope and Thomas (1955). This relationship was examined in 2003 and it seemed appropriate. Given the variability of length–weight parameters found in Allan *et al*., 2009 it would be worth monitoring these more closely in future.

#### *Natural mortality*

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation. The accuracy of these assumptions is unknown. Cod are not common on the Aran Grounds but other potential predators include dogfish, monkfish megrim and gurnards. Stomach contents data on the Irish GFS could be used to examine this in future.

#### *Maturity*

The $L_{50}$ of females using a macroscopic visual maturity scale is known to vary depending sampling month (Lordan and Gerritsen, 2006). The $L_{50}$ in July was chosen as the most appropriate estimate given the maturity schedules observed (Figure B.2.1). It is worth mentioning that commercial vessel surveys in November 2001 and in June 2002 demonstrated considerable differences between the maturity schedules of female *Nephrops* sampled in shallower waters of Galway Bay compared with the Aran Grounds.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning–stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

#### *Discard survival*

Given the trip durations (~5 days average) and behaviour of the fleet the majority of discards on the Aran Grounds are returned to the sea over suitable sediment. The proportion scavenged by birds is probably quite low. Tow durations, volume of catches, prolonged sorting on deck and relatively high density of *Nephrops* on the seabed probably results in relatively low discard survival. This is estimated to be around 10%.

#### B.3. Surveys

Since 2002 Ireland has conducted underwater television survey (UWTV) annually on the main *Nephrops* grounds-Aran grounds. Indicator camera stations are also carried out on the adjacent grounds of Galway Bay and Slyne Head weather and time permitting. The surveys were based on a randomized fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere and are documented by WKNEPHTV (ICES, 2007).

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Aran Grounds are:

| | Time period | Edge effect | detection rate | species identification | occupancy | Cumulative bias |
|---|---|---|---|---|---|---|
| FU17: Aran | <=2009 | 1.35 | 0.9 | 1.05 | 1 | 1.3 |

#### B.4. Commercial cpue

Prior to 1988 landings data for this fishery are only available to the WG for France. Since 1988 reported landings data for the Irish fleet were obtained from EU logbooks (Table B.4.1).

Effort data for FU17 is available from 1995 for the Irish otter trawl *Nephrops* directed fleet (Table B.4.2). A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the catches and effort of this fleet. This threshold was based on an analysis of the trip-by-trip catch compositions. In 2007 this fleet accounted for ~90% of the landings and compared with an average of 70% over the time period. These data have not been standardized to take into account vessel or efficiency changes during the time period. Landings per unit of effort (lpues) have been fluctuating around an average of 39 kg/hr with an increasing trend since 2004, to the highest observed (59 kg/hr) in the time-series in 2007 (Figure B.4.1).

#### B.5. Other relevant data

### C. Historical stock development

Age structured XSA assessment for this stock was carried *Nephrops* WG in 2003 (ICES, 2003). The results were considered unreliable for several reasons most importantly; inadequate historical sampling of catch, growth and natural mortality assumptions and concern about accuracy of tuning data. Since then the focus has been on developing a time-series of UWTV survey data as the basis of assessment and advice for this stock.

The 2009 Benchmark decided on the following procedure:

1 ) Survey indices are worked up annually resulting in the TV index.

2 ) Adjust index for bias (see Section B.3). The combined effect of these biases is to be applied to the new survey index.

3 ) Generate mean weight in landings. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in future).

### D. Short-term projection

1 ) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and $F_{max}$. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the stock annexes.

2 ) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to $F_{max}$, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3 ) Multiply the survey index by the harvest ratios to give the number of total removals.

4 ) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the stock annex.

5 ) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

| | | | Implied fishery | |
|---|---|---|---|---|
| | Harvest rate | Survey Index | Retained number | Landings (tonnes) |
| | 0% | 12345 | 0 | 0.00 |
| | 2% | " | 247 | 123.45 |
| | 4% | " | 494 | 246.90 |
| | 6% | " | 741 | 370.35 |
| | 8% | " | 988 | 493.80 |
| $F_{0.1}$ | 8.60% | " | 1062 | 530.84 |
| | 10% | " | 1235 | 617.25 |
| | 12% | " | 1481 | 740.70 |
| $F_{max}$ | 13.50% | " | 1667 | 833.29 |
| | 14% | " | 1728 | 864.15 |
| | 16% | " | 1975 | 987.60 |
| | 18% | " | 2222 | 1111.05 |
| | 20% | " | 2469 | 1234.50 |
| | 22% | " | 2716 | 1357.95 |
| $F_{current}$ | 21.5% | " | 2654 | 1327.09 |

### E. Medium-term projections

None presented.

### F. Long-term projections

None presented.

### G. Biological reference points

The time-series of available length frequencies were insufficient to generate reliable estimates of $F_{0.1}$ and $F_{max}$.

### H. Other issues

### I. References

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Colm Lordan and Hans Gerritsen. 2006. The accuracy and precision of maturity parameters from sampling of female *Nephrops* from stocks around Ireland. WD6 in the Report of the Workshop on *Nephrops* stocks. ICES CM 2006/ACFM:12.

Nolan, G. D. and Lyons. 2006. Ocean climate variability on the western Irish Shelf, an emerging time-series., K., *Proceedings of ICES Annual Science Conference*, Theme Session C, C:28.

**Table B.1.1.** ***Nephrops*** **in FU17 (Aran Grounds) Landings and discard numbers by year and sex.**

| | Female Numbers '000s | | Male Numbers '000s | | Both sexes |
|---|---|---|---|---|---|
| Year | Landings | Discards | Landings | Discards | % Discard |
| 2001 | 18,665 | 12,161 | 29,949 | 13,250 | 34% |
| 2002 | 23,105 | 9,374 | 31,256 | 8,326 | 25% |
| 2003 | 14,530 | 9,577 | 29,538 | 8,744 | 29% |
| 2004 | 16,109 | 7,068 | 12,930 | 4,282 | 28% |
| 2005 | 20,280 | 11,383 | 21,828 | 8,967 | 33% |
| 2006 | No Sampling | | | | |
| 2007 | | | | | |

**Table B.2.2. Numbers of samples and numbers measured for the FU17** ***Nephrops*** **Stock by year.**

| Number of Samples | | | | Total numbers of *Nephrops* measured | | | |
|---|---|---|---|---|---|---|---|
| Year | Graded Landings | Catch | Discards | Year | Graded Landings | Catch | Discards |
| 1990 | 24 | | | 1990 | 10451 | | |
| 1991 | 20 | | | 1991 | 8260 | | |
| 1992 | 0 | | | 1992 | 0 | | |
| 1993 | 0 | | | 1993 | 0 | | |
| 1994 | 0 | | | 1994 | 0 | | |
| 1995 | 13 | | | 1995 | 6370 | | |
| 1996 | 3 | | | 1996 | 1440 | | |
| 1997 | 11 | | | 1997 | 5203 | | |
| 1998 | 12 | | | 1998 | 5388 | | |
| 1999 | 16 | | | 1999 | 6944 | | |
| 2000 | 5 | | | 2000 | 2255 | | |
| 2001 | 32 | 5 | 5 | 2001 | 13 231 | 3194 | 3891 |
| 2002 | | 13 | | 2002 | | 9399 | |
| 2003 | 1 | 9 | 9 | 2003 | | 6284 | 4829 |
| 2004 | | 14 | 14 | 2004 | 578 | 12934 | 13 167 |
| 2005 | | 13 | 9 | 2005 | | 8729 | 7559 |
| 2006 | | 2 | 0 | 2006 | | 767 | 436 |
| 2007 | | 0 | 0 | 2007 | | | |
| 2008 | | 19 | 18 | 2008 | | 4944 | 8701 |

**Table B.2.1. Biological Input Parameters for FU17 *Nephrops* Stock.**

| Parameter | Value | Source |
|---|---|---|
| Discard Survival | 10% | WK*NEPH* 2009 |
| MALES | | |
| Growth - K | 0.16 | based on FU15 |
| Growth - L(inf) | 60 | based on FU15 |
| Natural mortality - M | 0.3 | assumed, in line with other stocks |
| Length/weight - a | 0.000322 | based on Scottish data (Pope and Thomas, 1955) |
| Length/weight - b | 3.207 | " |
| FEMALES | | |
| Immature Growth | | |
| Growth - K | 0.16 | based on FU15 |
| Growth - L(inf) | 60 | based on FU15 |
| Natural mortality - M | 0.3 | assumed, in line with other stocks |
| Size at maturity (L50) | 22 | ICES 2006 (Lordan and Gerritsen) |
| Mature Growth | | |
| Growth - K | 0.1 | based on FU15 and FU16 |
| Growth - L(inf) | 56 | based on FU15 |
| Natural mortality - M | 0.2 | assumed, in line with other stocks |
| Length/weight - a | 0.000684 | based on Scottish data (Pope and Thomas, 1955) |
| Length/weight - b | 2.963 | " |

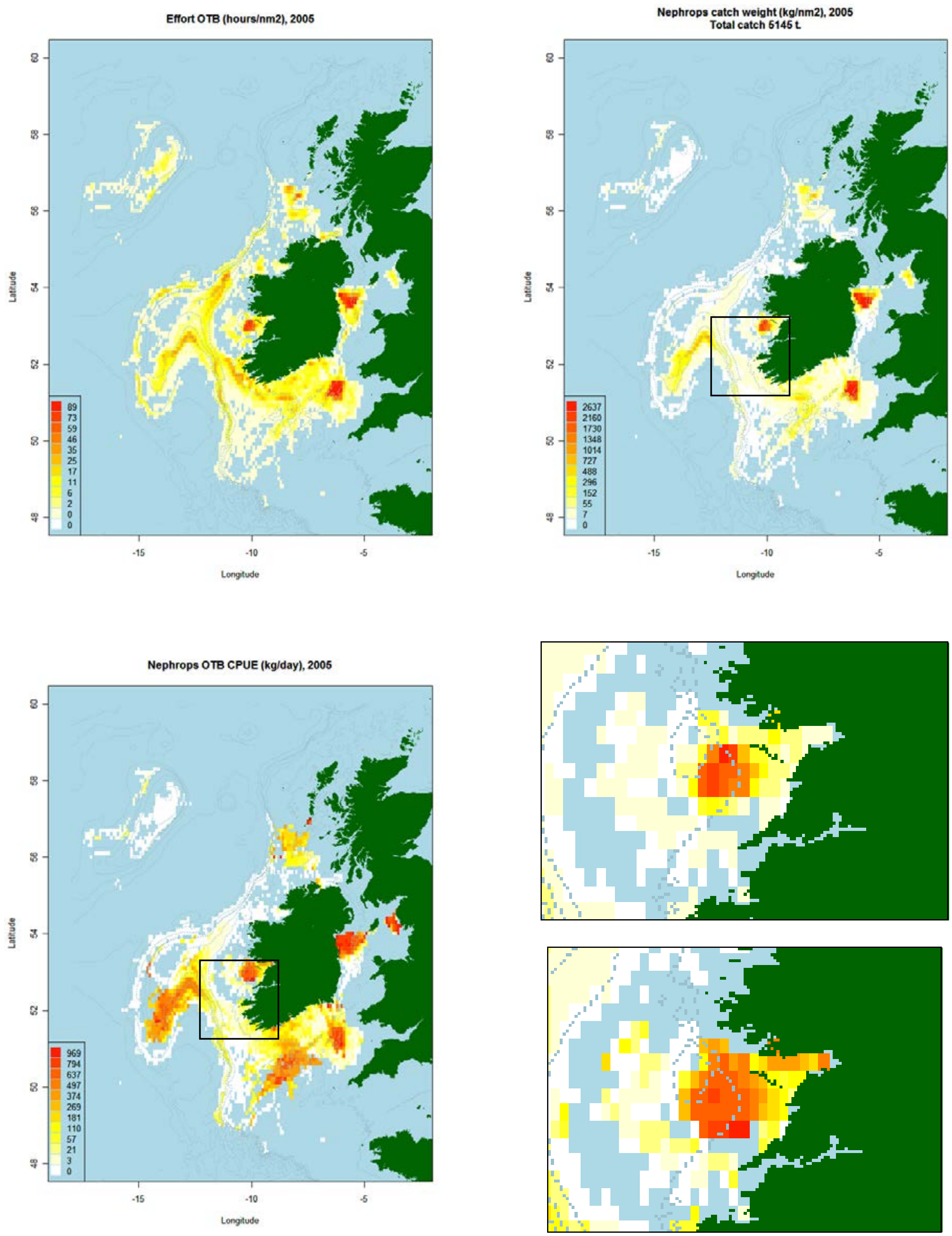



**Figure A.2.1. Effort, catch and catch per unit of effort for *Nephrops*, Irish otter trawlers in 2005. The boxed and zoomed in plots show a zoomed in view of landings and lpue from the fishery on the Aran Ground.**

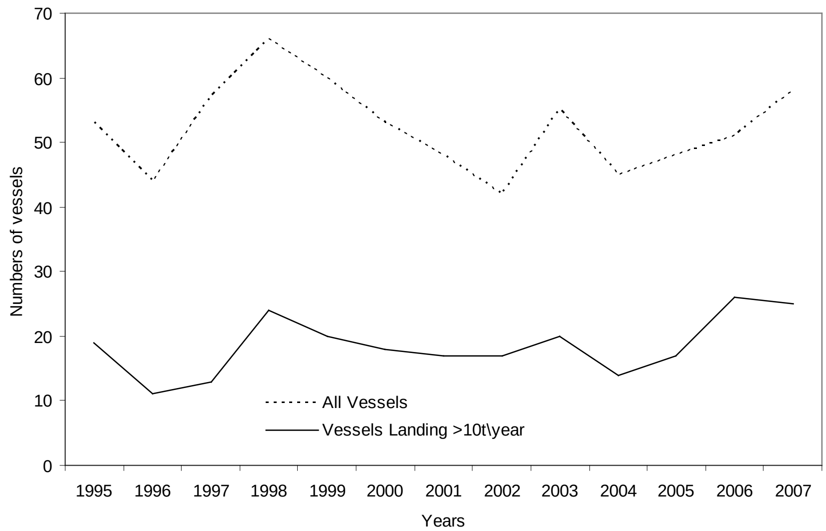



**Figure A.2.2. Time-series of the number of Irish vessels reporting landings of *Nephrops* from FU17. The vessels with annual landings >10 t/yr can be considered the main participants in the fishery these general account for ~85% of the total landings.**

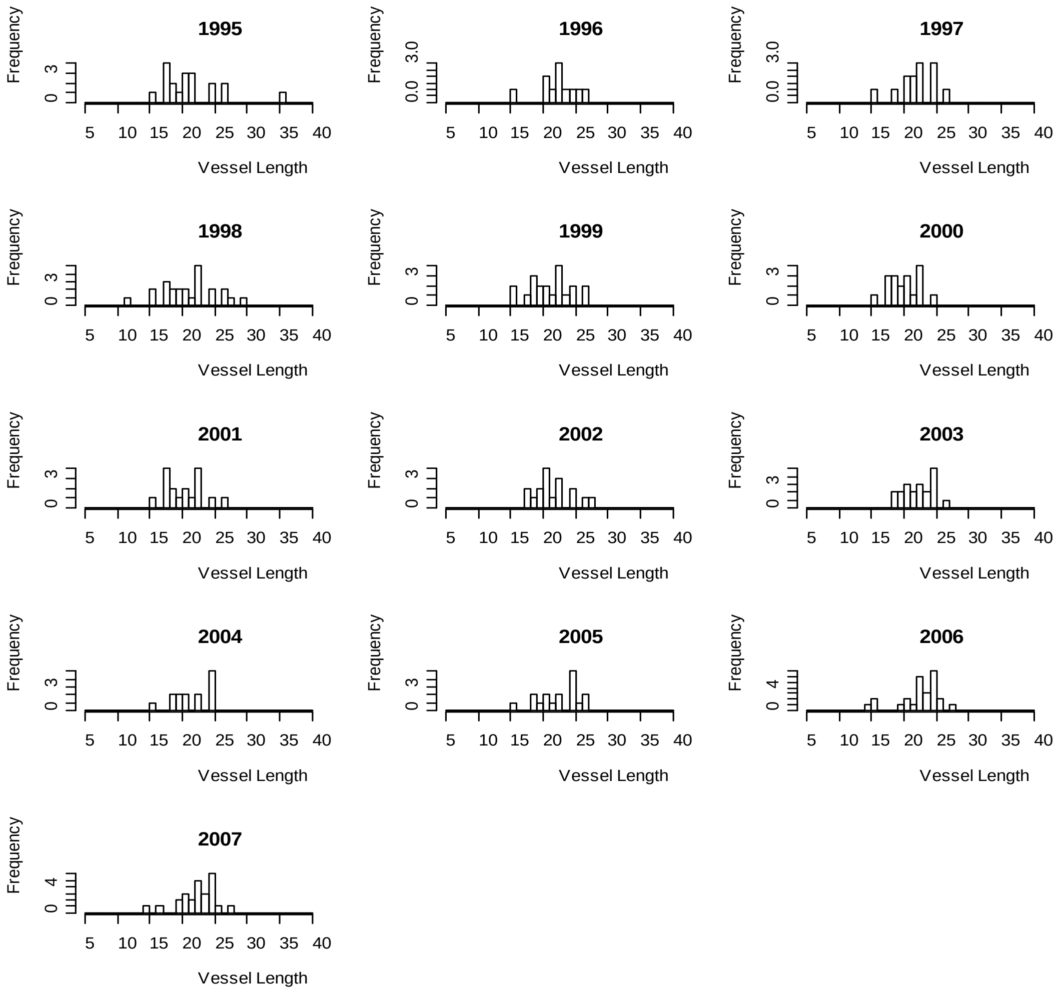



**Figure A.2.3. The time-series of length distributions of Irish vessels landing >10 t of *Nephrops* from FU17.**

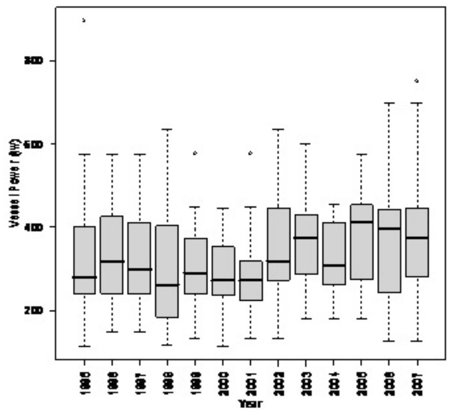



**Figure A.2.4. Box plot of the time-series of vessel power in KW of Irish vessels landing >10 t of *Nephrops* from FU17.**

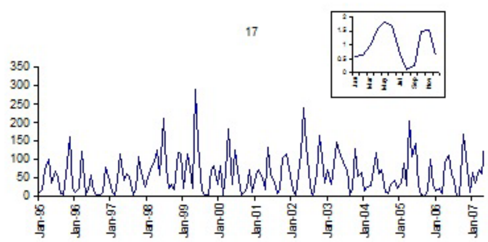
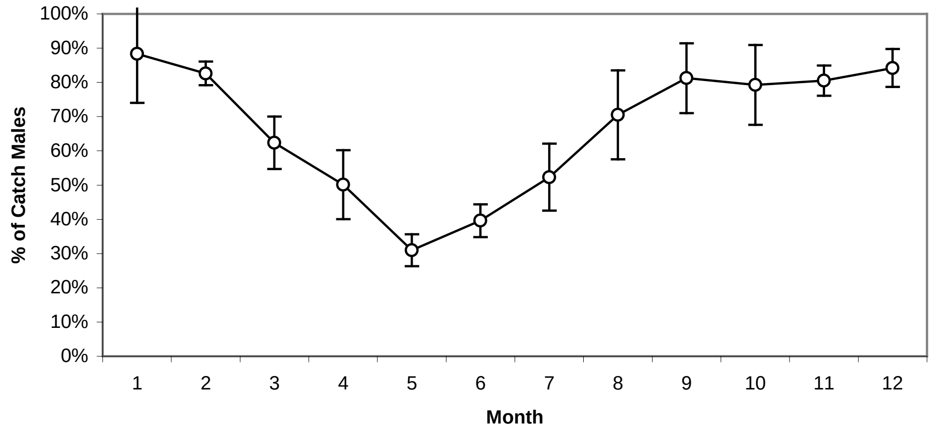



**Figure A.2.5. Monthly landings of *Nephrops* from FU17 from 1995–2007. The inset shows the average pattern for all years.**



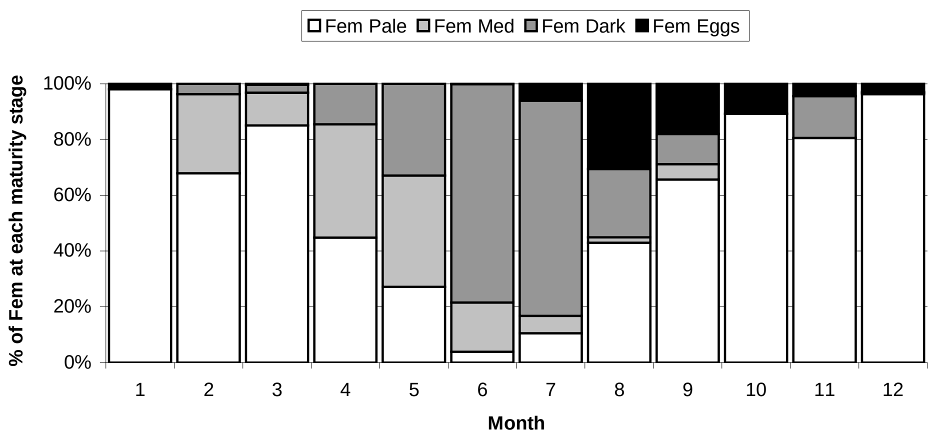




**Figure A.2.6. The upper panel shows the sex ratio in sampled catches 2003–2008 (error bars = 95% confidence intervals). The low panel shows the female maturity schedule i.e. percentage at each maturity stage by month.**

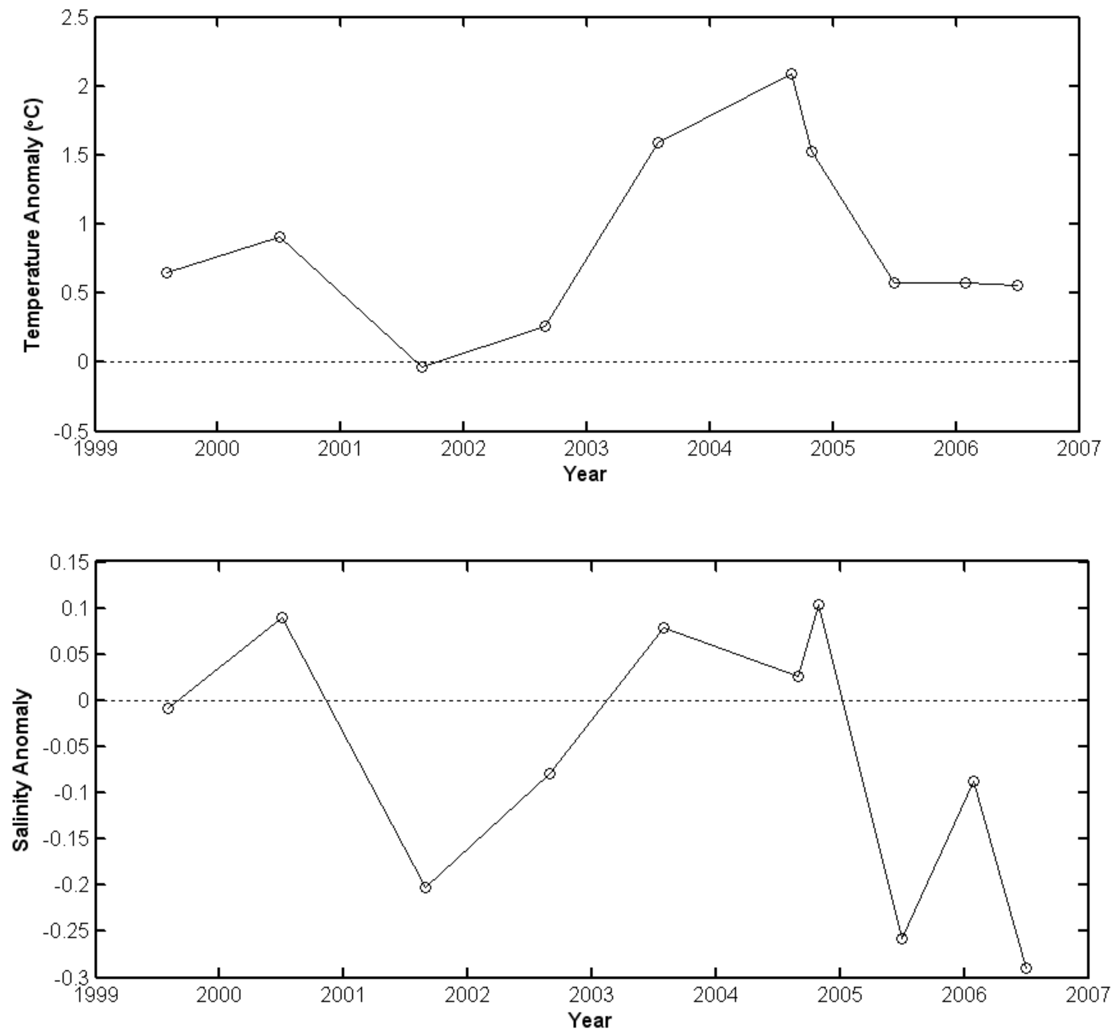
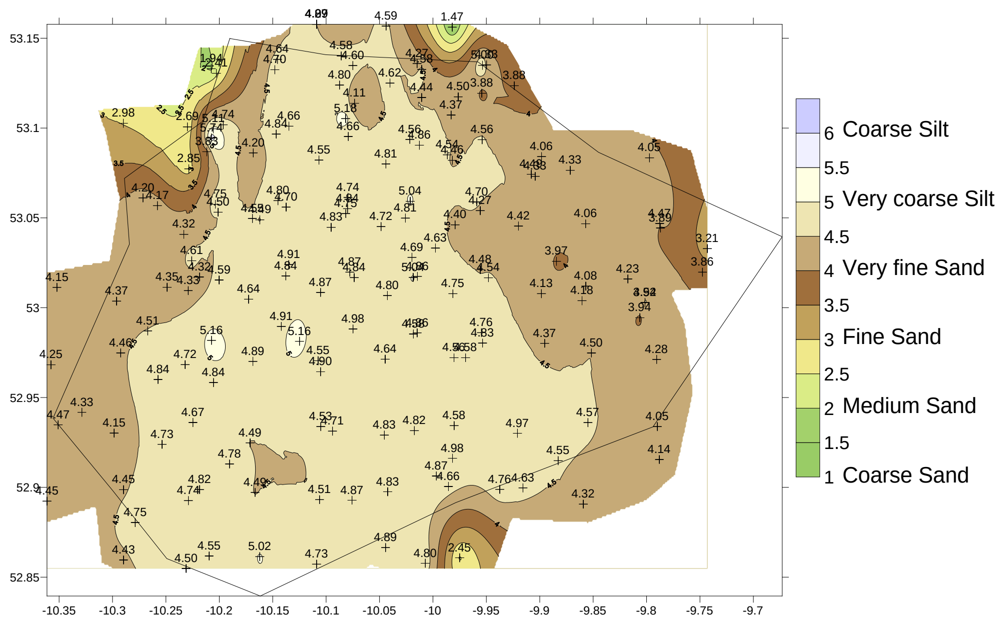



**Figure A.3.1. Anomalies in temperature (upper panel) and salinity (lower panel) for the 53°N section running through the Aran Grounds (1999–2006).**

**a)**




**b)**

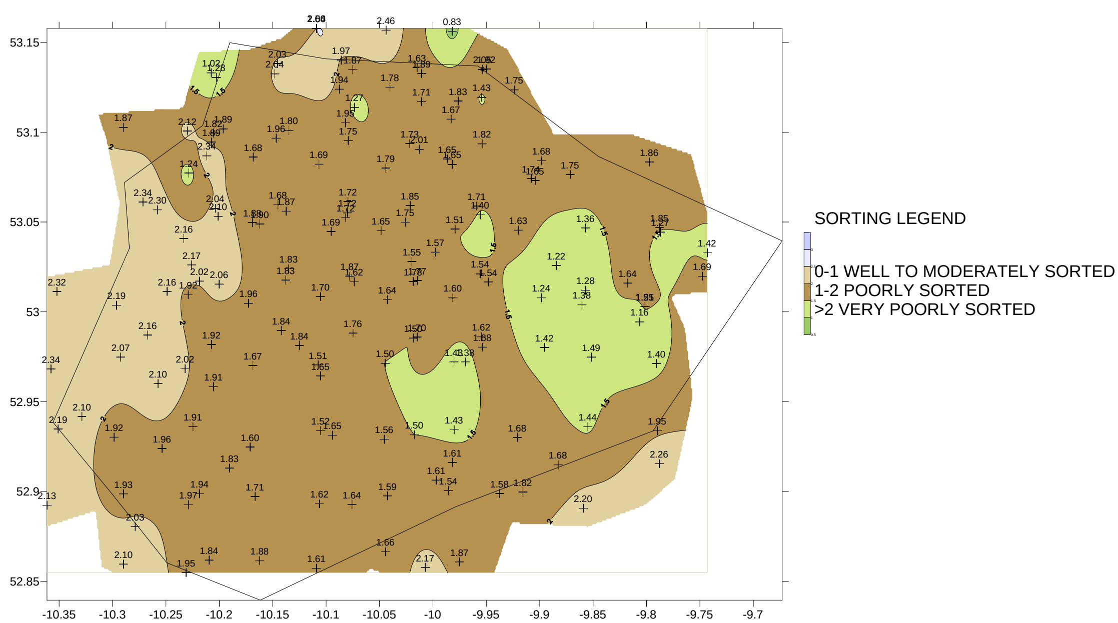



**Figure A.3.1. Contour and post plots of the a) mean size (phi) and classification based on the Friedman and Sanders (1978) scales and b) sorting ($\sigma_g$) of the sediments on the Aran Grounds based on PSA results from samples collected from 2002–2006.**

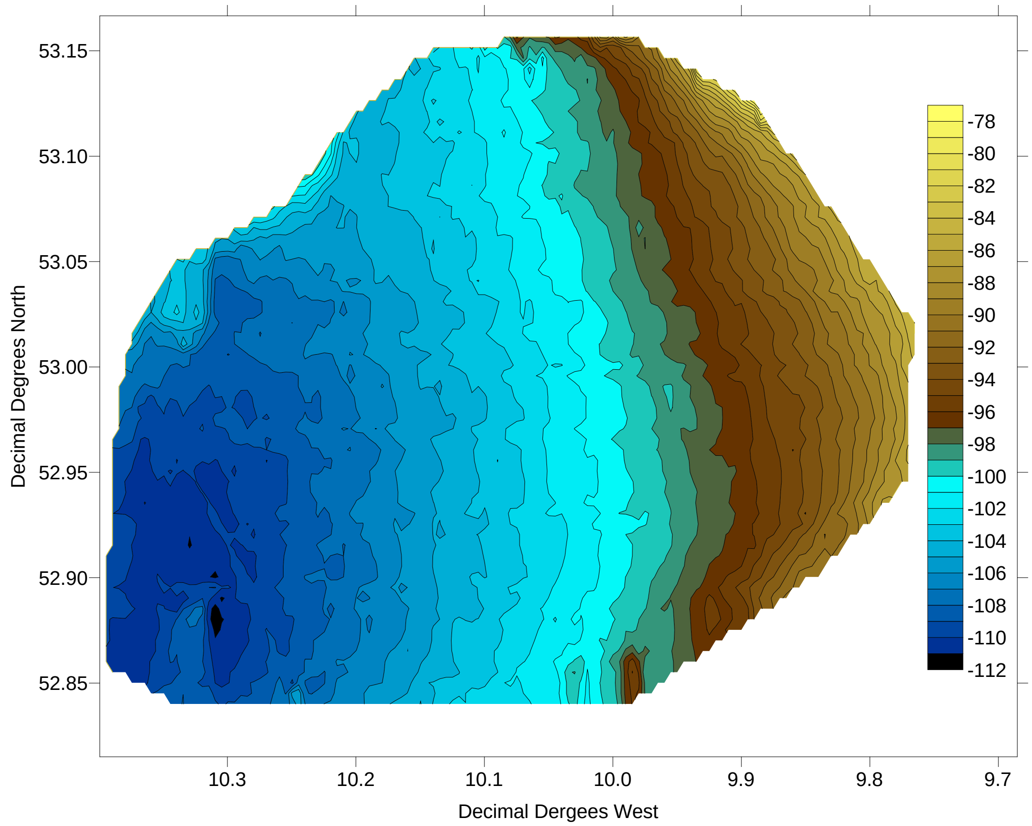



**Figure A.3.2. The bathymetry of the Aran grounds.**

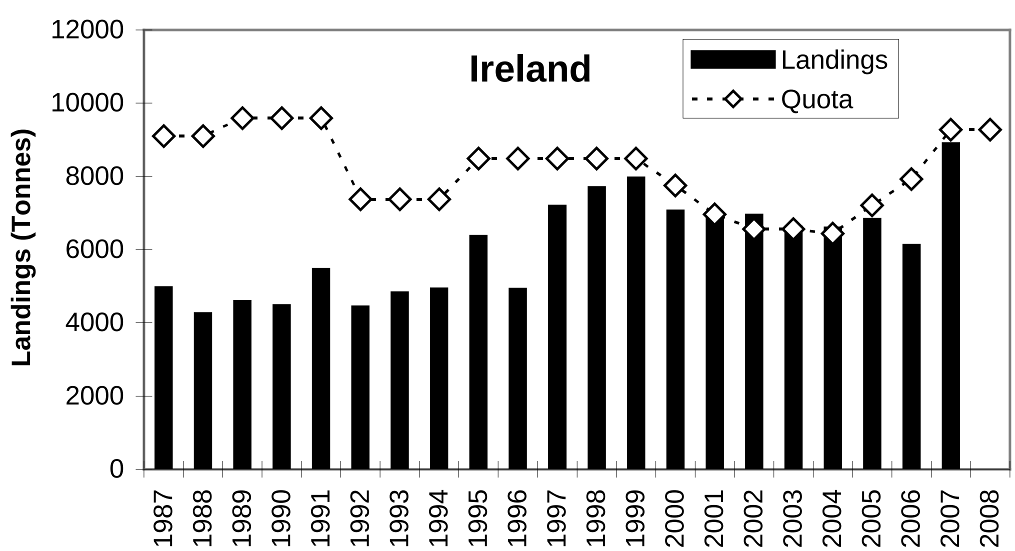



**Figure B.1.1. *Nephrops* landings and quota for Ireland since the introduction of TACs in 1987.**

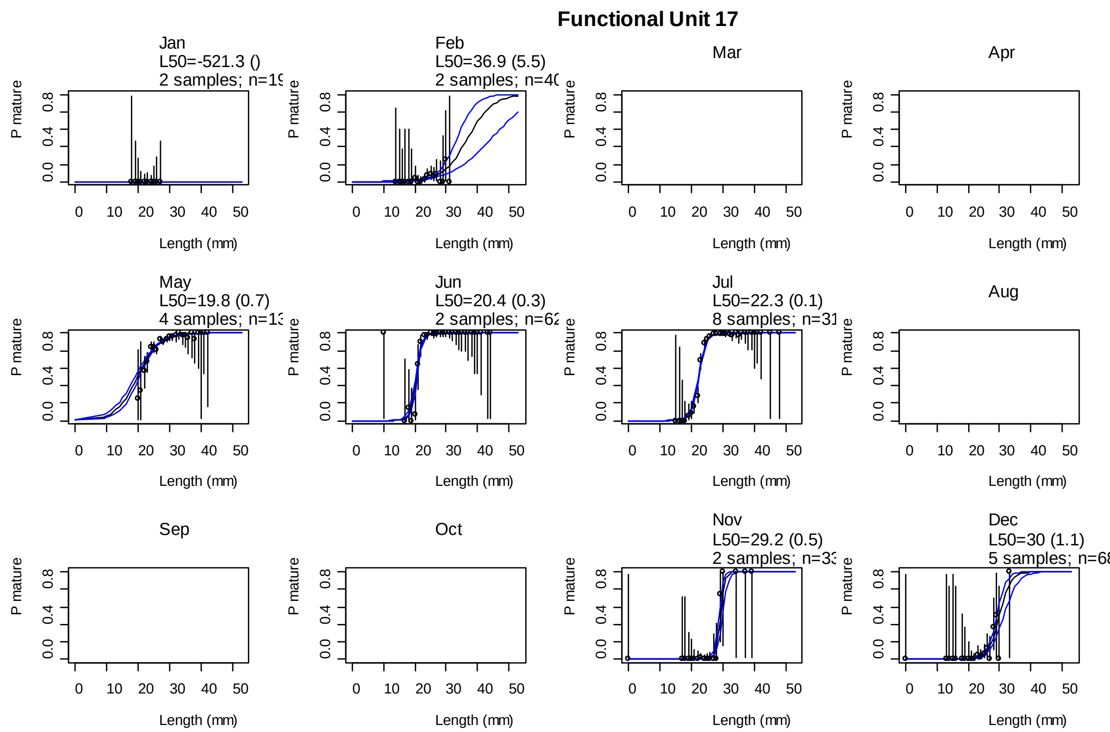



**Figure B.2.1. Female proportions mature-at-length for FU17. The 95% confidence limits of the proportions mature-at-length are indicated by the vertical bars. The black curve indicates the model and its standard errors are given by the blue lines. The $L_{50}$ is the estimated length at 50% maturity and its standard error is given between brackets. Blank plots indicate no sampling took place.**

## Stock Annex 7.6: *Nephrops* in VIIb FU16, Porcupine Bank

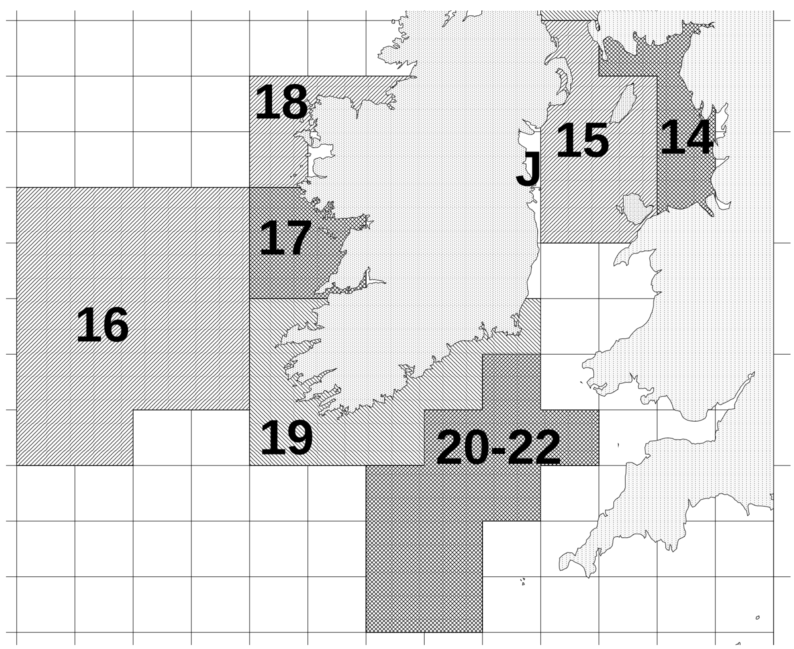
Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | FU16, Porcupine Bank |
| Working Group | WGCSE 2010 |
| Date | Version 1, 04/05/2010 |
| Revised by | Jennifer Doyle |

### A. General

#### A.1. Stock definition

The Functional Unit for assessment includes some parts of the following ICES Divisions VIIb,c,j,k. The exact stock area is shown on the map below includes the following ICES Statistical rectangles: 31–36 D5–D6; 32–35 D7–D8.




#### A.2. Fishery

##### *France*

The French fleet fishing *Nephrops* in FU16 also fishes in Division VIIg–h and was described in detail in the 1999 WGNEPH Report (ICES, 1999a). The French fleet only lands large *Nephrops* from this FU. Investigation of the landings data by statistical rectangle carried out by WGNEPH in 2002. These indicated that the majority of the French landings between 1999–2000 were from the south of the Porcupine Bank.

#### *Ireland*

The fishery is mainly seasonal taking place mainly between April and July; landings for the remainder of the year are minimal. Most of the Irish vessels are multi-purpose trawlers and are relatively large (between 20 and 35 m in total length). Irish vessels land both whole prawns and tails depending on markets from this FU and the sizes of the Irish landings are significantly smaller than those for the French and Spanish fleets. The Irish vessels are mainly using twin-rig trawls. Fishing is often weather dependent (particularly for the smaller vessels), with trip duration varying between seven and ten days. Investigation of the landings data by statistical rectangle provided to the WGNEPH in 2002 indicates that the majority of the Irish landings between 1995 and 2001 were from the south central area of the Porcupine Bank.

The recent spatial distribution of the fishery is shown in Figure 1.

#### *Spain*

The Spanish fishery in the Porcupine area is a typical multispecies fishery, targeting different demersal species, among which *Nephrops*. The fleet, which consists of about 35 vessels, is composed of side trawlers and is part of the so-called '300 fleet' in the Adhesion Treaty of Spain to the EEC in 1986. Within the Porcupine fleet, two components can be distinguished: one consisting of vessels fishing with finfish trawls (average engine power 980 hp), and the other fishing with *Nephrops* trawls (average engine power 680 hp). The average duration of their trips is 15 days, of which 10–12 are actual fishing days. The major landing port is La Coruña.

The target species for the finfish directed fleet are hake, megrim and anglerfish, with *Nephrops* as a valued bycatch. Vessels fishing with *Nephrops* trawls are much more directed towards *Nephrops* (especially in spring and summer), and fish is a bycatch. These two fleets not are currently disaggregated in the time-series.

### A.3. Ecosystem aspects

Productivity of deep-water *Nephrops* stocks is generally lower that those on the shelf although individual *Nephrops* grow to relatively large sizes.

A persistent Taylor column circulation around Porcupine Bank provides an important mechanizm for the retention of pelagic eggs and larvae of the various marine species spawning in the area. (Mohn, *et al*., 2002). The *Nephrops* stock on the Porcupine Bank is distributed on mud patches in relatively deep waters 200–600 m. It is not know how larvae are retained over these grounds but the Taylor column may help with larval retention.

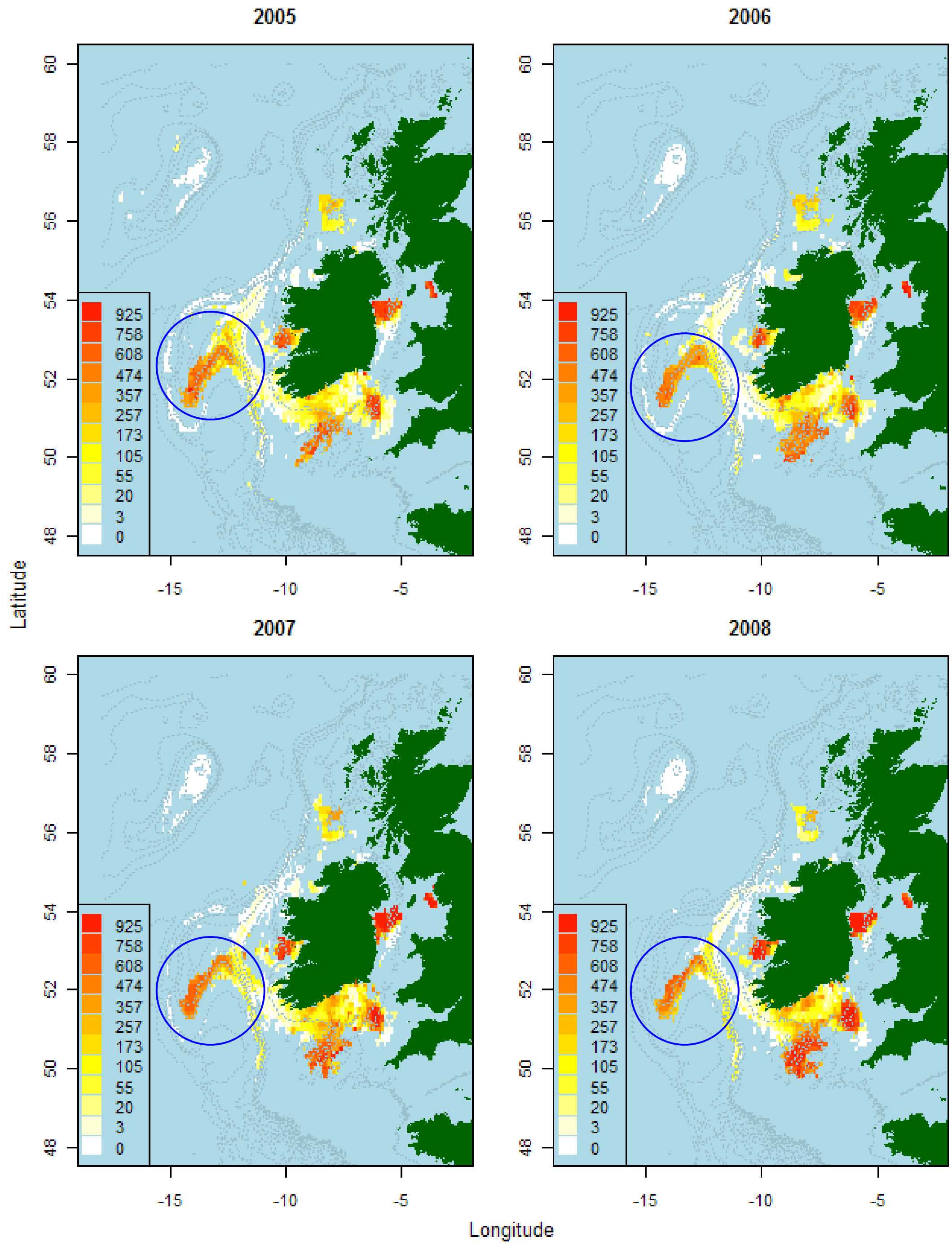



**Figure 1. The spatial distribution of lpue of *Nephrops* caught by Irish otter trawlers between 2005–2008 derived using integrated VMS and logbook records.**

## B. Data

### B.1. Commercial catch

Commercial catch and effort data are supplied by Ireland, France, Spain and the UK. These are the countries exploiting the stock.

### B.2. Biological

| BIOLOGICAL PARAMETERS | | |
|---|---|---|
| Parameter | Value | Source |
| Discard Survival | | Discards considered negligible |
| MALES | | |
| Growth - K | 0.140 | based on values in other areas (Anon., 1991) |
| Growth - L(inf) | 75 | based on maximum sizes observed in samples |
| Natural mortality - M | 0.2 | Anon, 1990 (estimated) |
| Length/weight - a | 0.00009 | based on Celtic Sea (FU20–22) |
| Length/weight - b | 3.550 | " |
| FEMALES | | |
| Immature Growth | | |
| Growth - K | 0.140 | Not applicable |
| Growth - L(inf) | 75 | |
| Natural mortality - M | 0.2 | |
| Size at maturity | 26.2 | Fariña and González Herraiz (2001) |
| Mature Growth | | |
| Growth - K | 0.160 | Anon, 1991 |
| Growth - L(inf) | 60 | based on maximum sizes observed in samples |
| Natural mortality - M | 0.2 | As for males |
| Length/weight - a | 0.00009 | " |
| Length/weight - b | 3.550 | " |

### B.3. Surveys

The only fishery-independent source of data is the Spanish Porcupine trawl survey which commenced in 2001. Further information on this survey is provided in the IBTS Report (ICES, 2010) and in previous IBTS reports. Figure 2 and 3 give gear parameters and spatial distributions of *Nephrops* catches on the Spanish Porcupine survey.

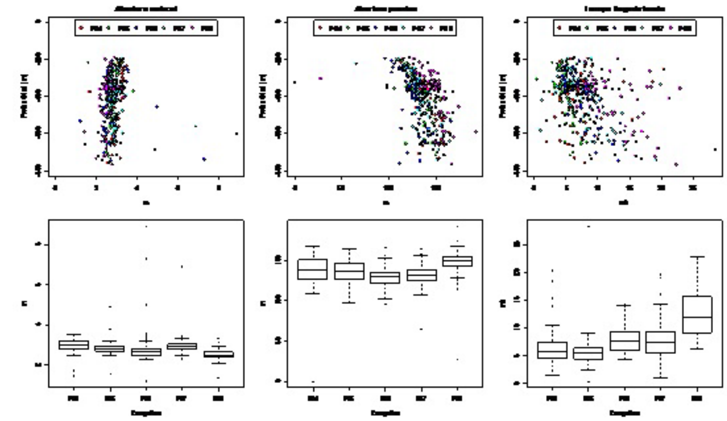


**Figure 2. Door spread, vertical opening and time to settle on the ground between 2004 and 2008.**

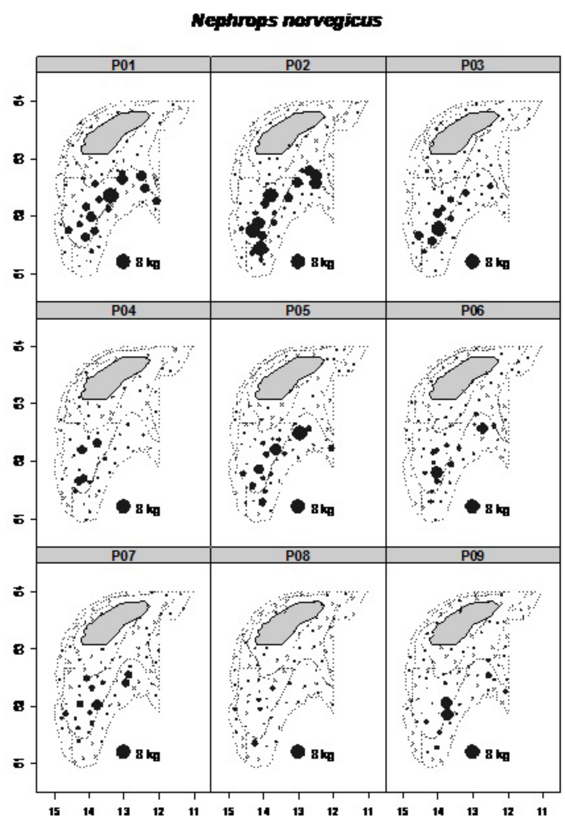



**Figure 3. Distribution of *Nephrops norvegicus* catches in biomass in Porcupine surveys between 2001 and 2009.**

### B.4. Commercial lpue

The *Nephrops* fishery on the Porcupine Bank is both seasonal and opportunistic with increased targeting during periods of high *Nephrops* emergence and good weather.

Effort and lpue data are not standardized, and hence do not take into account vessel capabilities, efficiency, seasonality or other factors that may bias perception of lpue abundance trend over the longer term. The available effort time-series are summarized below:

| Country | First year of effort data | Units | Comment |
|---|---|---|---|
| France | 1983 | Hours | For trips where *Nephrops* constituted 10% of the landed value |
| Ireland | 2005 | Hours | For trips where *Nephrops* constituted 30% of the landings in weight |
| Spain | 1971 | ay*BHP/100 (x1000) | |

Only commercial landings data are available for all countries involved in the fishery.

#### B.5. Other relevant data

### C. Historical stock development

An experimental age structured assessment for this stock was carried out by the *Nephrops* WG in 1993 (ICES, 1993), in 2003 (ICES, 2003) and by the WGHMM (ICES, 2005) in all cases the assessments being considered inadequate. This conclusion was based on poor quality, and unexplainable inconsistencies in the input data. Unknown growth rates and concern about the utility of age based assessment models impeded progress to an accepted assessment. In addition the lack of a time-series of reliable standardized cpue data was also perceived as a problem. This problem has been solved with the developing Porcupine trawl survey-series.

Model used: XSA, LCA

Software used: n/r

Model Options chosen: No Final model was accepted

### G. Biological reference points

No reference points have been proposed or used for this stock.

### H. Other issues

None.

### I. References

Gerritsen, H. 2009. Working Document 1 ICES Working Group for the Celtic Seas Ecoregion 13–19 May 2009.

# Stock Annex 7.7: *Nephrops* in VIIfgh FU20–22 (Celtic Sea)

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | *Nephrops* (*Nephrops norvegicus*) : Division VIIfgh |
| Working Group | WGCSE (Working Group for Celtic Seas Ecoregion) |
| Date created | June 2007 |
| Last updated | May 2009 |

## A. General

### A.1. Stock definition

The management area for this stock is delimited in Area VIIfgh (FU20–22; Figure 1). The management unit is pertinent because of the sedentary feature of *Nephrops*. However, the sources of recruits are much more poorly defined. There is no evidence that the whole exploited area belongs to the same stock or that there are several patches linked in meta-population sense.

### A.2. Fishery

*Nephrops* present particular ground features and in the FU20–22 are known to occur in several areas of muddy sediment and the stock structure is uncertain. The *Nephrops* fisheries target different areas and have very different size structures in *Nephrops* catches and landings. These fisheries also have differences in non-*Nephrops* bycatch composition.

As for all crustaceans, *Nephrops* grow by successive moults which are to a large extent tied to reproduction. For this species moult occurs twice a year, in spring and autumn until sexual maturity. Once males are sexually mature, they continue to moult twice a year while females moult only once a year in the latter spring/summer right after the hatching of their eggs. In previous references (1970–1980s), it is pointed out that maturation of females happens at a median size of 31 mm CL (10 cm of total length) which corresponds to 3.5 years old individuals. There is no specific reference for the sexual maturation of males in the FU20–22, but biological references on close areas with similar hydrological conditions (FU15; Western Irish Sea) indicate a first size of functional maturity of 29–31 mm CL.

As reported by the WG*NEPH* 2004 and the WGSSDS 2005 and 2006, *Nephrops* in FU20–22 is mainly exploited by trawlers from France, Republic of Ireland and UK although the contribution of other countries is lower. The spatial distribution of landings by statistical rectangles are provided below (Figure 2–5). It indicates heterogeneous spatial behaviour of the main fleets.

#### *France*

No major changes have taken place in the fishery for more than fifteen years apart from the implementation of a new mesh regulation in 2000 which increased the minimum codend mesh size from 80 to 100 mm (in fact, the regulation involves to 90 mm mesh size, but 100 mm meshes are adopted aiming to avoid problems with bycatch composition).

The 100 mm mesh size also allows them to switch to finfish (cod, whiting, haddock) when *Nephrops* catch rates are low (e.g. because of diurnal and seasonal variations of catchability for this species or during periods of bad weather). The MLS applied by the French Producers' Organizations is fixed at 11.5 cm total length (i.e. 35 mm CL). The total number of vessels from the harbours of the South Brittany remains stable (more than 90 declared *Nephrops* catches from the Celtic Sea in recent years, but around 70 are actually targeting this species). A part of these units (15–20) switch to other *Nephrops* stocks (FU16; Porcupine bank; Figure 1) mainly in 2nd and 3rd quarters when the meteorological conditions are favourable. At the opposite, many trawlers (20–30) move towards the FU19 *Nephrops* (SE and SW Irish coast) mainly in autumn and winter according to difficulties due to weather.

Analytical investigations were carried out on the data collected in 2006 and 2007 involving in the French trawlers. Global indices for fishing effort and lpue provided by this fleet (97 trawlers composed by 73 exclusive in Celtic Sea, 15 switching to Porcupine Bank i.e. FU16 and eight also targeting *Nephrops* in the Bay of Biscay i.e. FU23–24) seem to be pertinent: 99% of vessels*months registered for sales at auction can also be found in logbooks (94% of French landings in 2007). In 2006, almost 50% of French landings occurred in two ICES rectangles (29E2, 30E2; the rectangle 30E2 during the 2nd quarter concentrated 21% of yearly landings). In 2007, the contribution of the two rectangles 29E1 and 30E2 was 41% of yearly landings. In 2008, the rectangles 28E1 and 30E2 were represented by 44% of yearly landings. The peak of production is observed during the 2nd quarter of the year (Figure 4): in 2006, the maximum landings are obtained in June whereas a shift occurred in 2007 (maximum value in May which may be caused by bad meteorological conditions in June). In 2008, the shape of French landings vs. month was bi-modal (May and July were the mostly represented months).

The historical review of French landings shows that the contribution of the rectangle 31E3 (concentrating the major part of Irish landings) declined over the last ten years: from 41% of total French landings registered in 1999 this contribution is currently less than 10% (Figure 3). During the last ten years, the most productive rectangle for French trawlers was 30E2 mainly during the late 2000s: the average annual contribution of this rectangle was around 15% in the early 2000s, but this proportion reached more than 30% during the recent years. It seems that the French fleet moved gradually from 31E3 to 30E2 under the steeply increasing concentration of Irish trawlers on the "traditional" *Nephrops* grounds (Smalls, Labadie).

#### *Republic of Ireland*

More than 60 Irish vessels target *Nephrops* in the Celtic Sea. In 2007, 95 Irish trawlers were registered as landing *Nephrops*, but 63 of them exceeded threshold of 10 t (Figure 6). In 2008, 99 Irish vessels reported landings from this area whereas 67 of them landed more than 10 t. The fishery presents a more typical seasonal profile than the French vessels and most of the landings are made between March and July. These vessels are mid-size multipurpose trawlers, with a length of 18–23 m and engine power between 250 and 350 kW. Many of the vessels switch between FU15 and FU20–22, depending on the tides in the Irish Sea. Other vessels switch from targeting finfish in the winter to *Nephrops* in the spring and early summer. The mesh size used by Irish vessels is 80 mm, and increasingly these vessels are using twin trawls. The MLS applied by Irish trawlers is the European one fixed at 8.5 cm total length (i.e. 25 mm CL).

The Irish landings seem to be more concentrated spatially than the French. During the period 2003–2006, 63–67% of the Irish nominal landings were provided by one ICES rectangle (31E3). The Irish fishing effort is located more northerly than the French one.

#### *UK*

The UK fishery in the Celtic Sea has generally remained unchanged. Since the early 2000s, the number of UK *Nephrops* directed vessels has increased from around 10 to 15, but their contributions in total landings remains minor (usually less than 50 t of landings). The maximum historical value of UK landings is reported in 2008 (242 t).

### A.3. Ecosystem aspects

*Nephrops* occur in discrete patches where the sediment is suitable for them to construct their burrows. There is a larval phase of long duration where there may be some mixing with *Nephrops* from other areas depending on the oceanographic conditions, but the mechanizms for this in the Celtic Sea are not currently known.

Cod has been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation on *Nephrops*.

## B. Data

### B.1. Commercial catch

Landings are reported mainly by France and the Republic of Ireland. French landings fluctuated between 2000 and 3800 t. Irish landings rose from around 500 to more than 2000 t in the last 15 years. The highest value of Irish landings is observed in 2007 (more than 3200 t). A part of this trend is due to greater accuracy of reporting mainly after the end of the late 1990s. The contribution of French landings has gradually decreased from 80–90% at the end of 1980s to 50–60% at the beginning of 2000s. Between 2004 and 2005, French landings remained stable whereas Irish landings steeply increased and the total harvested quantity was the highest during the last decade. For the first time, in 2007, the Irish ladings exceeded the French ones (3230 t against 2080 t). This may be caused by constraints linked to the international context affecting fuel prices for fishing vessels. The overall fishing profile remains typically seasonal with a dominance of the 2nd and 3rd quarters (60–70%; the other quarters are less productive because of meteorological conditions and of less accessibility of females due to burrowing).

During the recent years, the evolution of the French fishing effort and lpue was sometimes considerably different from the evolution of the same indicators for the Irish fleet (e.g. between 2004 and 2005: -5% of fishing effort and +2% of lpue for French trawlers against +50% of fishing effort and +25% of lpue for Irish trawlers). In 2007, an increase occurred for lpue values of both main fleets: a slight upwards trend of French trawlers (+13% associated to a strong reduction of the fishing effort: -25% whereas the total number of vessels remained almost stable) and a steep one for the Irish fleet (+36% coinciding with +31% of the fishing effort which was displayed by an increasing number of trawlers operating in the Celtic Sea: +19% between 2006 and 2007). This underlines the divergence of features of the targeting vessels for each country and indicates the great heterogeneity of the area. A direct comparison between both countries cannot be undertaken because the fishing effort is not available in the same unit (France: otter trawlers getting at least 10% of their total landings by targeting this species; Ireland: otter trawl vessels where >30% of monthly landings in live weight were *Nephrops*). Furthermore, the actual fishing areas are different and the Irish fleet is more restricted spatially as already reported by WGSSDS 2005–2008.

#### B.2. Biological

*Natural mortality and maturity-at-age*

A natural mortality of 0.3 is applied to all *Nephrops* males whereas the mortality of females changes at the size of first maturity (occurring at 31 mm CL as explained previously): a value of 0.2 is usually applied on mature individuals.

The L2AGE slicing programme usually applied on *Nephrops* stocks allocates length classes into age groups by assuming von Bertalanffy model of individual growth. This slicing is applied to length distributions by sex. All parameters, $L\infty$ and K by sex, calculated mean sizes by age for each sex, natural mortality and maturity by sex (assumed to be knife-edged for males and s-shaped for females) and combined are given below.

**Table 1. *Nephrops* FU20–22 (Celtic Sea). Individual growth, natural mortality, maturity parameters by sex.**

| Males and immature females: L∞=68, K=0.17; mature females: L∞=49, K=0.10 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| age | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
| Size (CL mm) mm | males | 11 | 20 | 27 | 34 | 39 | 44 | 47 | 51 |
| | females | 11 | 20 | 27 | 32 | 33 | 35 | 36 | 37 |
| M | males | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| | females | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | combined | 0.3 | 0.3 | 0.3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Maturity | males | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | females | 0 | 0 | 0 | 0.5 | 1 | 1 | 1 | 1 |
| | combined | 0 | 0 | 0.5 | 0.75 | 1 | 1 | 1 | 1 |

*Biological sampling*

*Landings*: The total French landings have been available since 1983 (on quarterly basis since 1987) whereas the Irish series began in 1987 (on quarterly basis since 1995).

*Lpue and fishing effort*: Lpue series are provided since 1987 in France while Irish data are available over 1996. It has to be noted that the French and Irish method of calculation of the fishing effort are not carried out by the same way (threshold of 10% in weight for *Nephrops* on total landings applied for French trawlers whereas 30% is the threshold used for Irish fleet), thus a direct comparison of those indices is not appropriate.

*DLF of landings*: French sampling plan at auction started in 1983, but only after 1986 the data can be used on quarterly basis. The Irish plan as written previously began in 2002 (in fact, only 2003 has been entirely sampled in the FU20–22 area; 2002 data involving the whole Management Area M: see processing by WGSSDS 2006; two quarters were not sampled in 2004 and 2005: see processing by WGSSDS 2006). For French landings, the increasing proportion of tailed individuals (see below) and the inappropriate method of sampling before the end of 2007 provided

*DLF of discards*: French estimation of discards occurred only in three separate years (1985, 1991 and 1997), but only the data collected in 1997 can be included in analytical investigations. The available dataset is given for only one year of discard sampling (1997) because of unavailable quarterly data for landings for the first year of discard sampling (1985) whereas data collected in 1991 were considered as unreliable (samples sorted by fishermen). Irish sampling has been undertaken since 2002 (lack of information for two quarters in 2004; see processing by WGSSDS 2006).

Length compositions of the landings by sex are provided for the two main fleets, but the time-series are different. Sampling of French landings since 1984 has provided length frequencies by sex on a monthly basis. Due to uncertainty of the older datasets, the data for 1984–1986 were omitted from further analysis. The Irish sampling programme was launched in 2002 under the EU DCR and gave length frequencies for the period 2002–2006 (after simulation undertaken for some missing information in 2004 as explained during WGSSDS 2006).

French estimation of discards occurred only in several separate years (1985, 1991 and 1997; in 2005, samples for two quarters, 3rd and 4th, were also provided), but only the data collected in 1997 can be included in analytical investigations because of unavailable quarterly data on landings for the first year of discard sampling (1985) whereas data collected in 1991 were considered as unreliable (samples sorted by fishermen not representative of the discarding behaviour of the whole fleet). The 1997 French plan on board showed high spatial and temporal variability of discard size-composition vs. that of landings (CV>30%). The Irish sampling launched under DCR gave results as presented by Table 2.

The heterogeneity of the dataset in addition to that of the harvested area by each country affects the discard rate by fleet: it was higher for French vessels: 65% in 1997 against 37% for Irish in 2003 (the only one year with sampling, but only 11% during the quarters 2 and 3 in 2004) and by sex (stronger for females growing less quickly).

**Table 2. FU 20–22 Irish Sampling Summary.**

| | | Number of samples | | | Numbers Measured | | |
|---|---|---|---|---|---|---|---|
| Year | Quarter | Catch | Discards | Landings | Catch | Discards | Landings |
| 2003 | 1 | 1 | 1 | | 186 | 417 | |
| | 2 | 5 | 5 | | 4057 | 3016 | |
| | 3 | 3 | 3 | | 2535 | 3638 | |
| | 4 | 2 | 1 | | 996 | 528 | |
| 2004 | 1 | 0 | 0 | | 0 | 0 | |
| | 2 | 3 | 2 | | 1634 | 2781 | |
| | 3 | 7 | 6 | | 4284 | 7171 | |
| | 4 | 0 | 0 | | 0 | 0 | |
| 2005 | 1 | 1 | 1 | | 1330 | 2271 | |
| | 2 | 2 | 2 | | 2208 | 3238 | |
| | 3 | 2 | 0 | | 1634 | 0 | |
| | 4 | 2 | 0 | | 1627 | 0 | |
| 2006 | 1 | 2 | 1 | 2 | 1891 | 1152 | 2252 |
| | 2 | 10 | 2 | 2 | 7241 | 1049 | 363 |
| | 3 | 5 | 1 | 0 | 3178 | 1101 | 0 |
| | 4 | 9 | 0 | 0 | 8266 | 0 | 0 |
| 2007 | 1 | 1 | 3 | 0 | 767 | 770 | 0 |
| | 2 | 12 | 0 | 0 | 9648 | 0 | 0 |
| | 3 | 15 | 4 | 2 | 7784 | 1862 | 411 |
| | 4 | 6 | 5 | 0 | 1959 | 1417 | 0 |
| 2008 | 1 | 2 | 5 | | 680 | 1758 | |
| | 2 | 10 | 13 | | 3409 | 5333 | |
| | 3 | 3 | 2 | | 878 | 546 | |
| | 4 | 4 | 4 | | 1356 | 1573 | |

**Extrapolations**

***Landings: DLF of tailed Nephrops***

The WGCSE 2009 pointed out a significantly increasing proportion of tailed individuals in French landings whereas this proportion was already high for Irish trawlers. In 2008, 20% of total French landings involved in tailed *Nephrops* (19% in 2007, 15% in 2006 and 11% in 2005; less than 5% until the beginning of 2000s). The overall upwards trend is illustrated by the Figure 7 presenting also monthly tailed fractions (after conversion of weight of tails to total one).

The seasonal variability of tailed *Nephrops* may be explained by biological features of the species (two peaks appear by year corresponding to the two moulting periods, spring and winter) and by the particular conditions of trips (12–15 days) compromising the conservation of *Nephrops*. As regards to the annual increasing proportion of tails (96% explained by using an exponential function), industry explained it by the economic difficulties of the vessels because of the rapidly increasing fuel prices. Tailed individuals are intended to compensate this loss for the crew participation at the total investment by trip. As the European MLS for FU20–22 *Nephrops* is fixed at 8.5 cm of total length (25 mm CL) and the MLS retained by the French Producers' Organizations is equal to 11.5 cm (35 mm CL), it was expected that tailed individuals should be comprised between these two sizes.

Before the end of 2007, the tailed *Nephrops* could not be sampled at auction and, as the sampling on board remains difficult to apply routinely (long trip duration for French trawlers), the problem was partially tackled by apportioning tailed individuals to the smallest category of landings at auction. Since the end of 2007, new biometric relationships established during the EVHOE survey have been used: they allow fitting CL *vs*. 2nd abdominal segment of tail by sex (Figure 8). The DLF of French landings for 2008 were estimated by two ways: one using the extrapolations from tails to CL, the other apportioning tails to the small category as for previous years. The resulting difference appears relevant (Figure 9): in 2008, 46 million *Nephrops* were provided by the previous method whereas 58 million were estimated by including tails (+28%). Almost 30% of landed individuals were below the French Producers' Organization MLS, but no *Nephrops* was undersized compared with European MLS. Moreover, the sex ratio seems to be affected by the tailing practice: 13% of *Nephrops* (7.4 million) were females although this percentage would be 7% (3.2 million) under the previous method. The mean size of French landings for 2008 decreases at around 2.5–5 mm CL by sex when tails are involved by sampling. However, the mean CL for 2008 remains larger than the Irish one.

**Table 3. *Nephrops* in VIIfgh. Mean sizes (CL in mm) of French and Irish landings for 2008. French values are calculated (1) including the samples involving in tailed individuals and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire *Nephrops* at auction).**

| French sampling | | | Irish sampling | | |
|---|---|---|---|---|---|
| Males | Females | Total | Males | Females | Total |
| 37.6 | 34.7 | 37.2 | 32.0 | 29.7 | 31.1 |
| 40.1 | 39.6 | 40.1 | | | |

This result emphasizes the WGSSDS 2008 conclusion that the size composition may be overestimated when raised to the composition of entire individuals.

### Discards: years with no sampling on board

#### *Generalities*

As the sampling plan for both countries was not routinely undertaken, the whole time-series of landings by quarter either for the French fleet (years 1987–2007) or for the Irish one (years 1995–2007, years 1987–1994 are only represented by annual landings) misses information. Therefore, a methodology of extrapolation from sampled data to years or quarters with no information was developed (see WD 1; WGSSDS 2007).

The main concepts of the derivation (back-calculation) are summarized as:

1 ) The first step involves applying hand-sorting selection of retained catches which is explained by s-shaped (logistic) function vs. size. As statistically

tested by fleet, the hand-sorting function is stable within-quarter for given parameters of the exploitation pattern (if mesh size and MLS remain constant within period).

2 ) The second step consists in removing undersized individuals unusual in landings which can generate unreliably extreme values of discards due to sampling problems (very high CV of landings for the extreme size classes). Hence, size classes less than a tested threshold (e.g. 1 or 5% of cumulative landings) were eliminated.

3 ) The third step allows the generation of missing size classes by applying a probability density function which can be symmetrical or not. The whole calculation is based on multiple maximum likelihood function according to the number of missing years. Relationship as between mean sizes of landings and of discards tested on the FU23–24 *Nephrops* (Bay of Biscay; WGHMM) can also be included in the final fitting.

#### Particularities for FU20–22 *Nephrops* stock

The approach summarized above was already developed on the FU23–24 *Nephrops* stock (Bay of Biscay) and its validation was investigated during the WGHMM 2007 (Figure 10–14). The WGSSDS 2007 examined statistical formulation and validation of this method on French (years 1987–2006) and Irish (years 2002–2006, investigation by quarter) discards for FU20–22. There are some differences from the calculation applied on the Bay of Biscay as:

1 ) The available French dataset is given for only one year of discard sampling (1997). It means that the hand-sorting s-shaped curves by quarter are calculated on only one year[1] instead of six for the Bay of Biscay stock.

2 ) The cumulative percentage level for removing of undersized generated discards (see above: 2nd stage) is fixed at 5% for French data and 1% for Irish data (also 1% for the Bay of Biscay *Nephrops* stock). In the case of the French fishery in Celtic Sea, this can be justified by the high variability of landing samples between trips (higher coefficients of variation at auction because of higher heterogeneity of the fished area and of long duration of trips i.e. 12–15 days and, hence, less availability of samples at auction).

3 ) For the French discards, with only one year of discard sampling, the initial value of the parameter Lm cannot be assumed to be equal to any expected mean size of discards *vs.* mean size of landings (see above 3rd stage). Furthermore, the interval in which Lm should be contained is not statistically calculable. Hence, Lm is initially introduced as the size corresponding to the maximum number of discarded individuals as provided by the 2nd stage of calculation (i.e. after removing extremely high values of discards obtained after the 1st stage: hand-sorting logistic function). Its interval is built by using an *a priori* coefficient of variation around the initial Lm (CV of 0.10 and 0.20 were

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[1] The six trips sampled in 2005 provided new s-shaped curves of hand-sorting for Q3 and Q4 which were used for simulations of the recent period since 2000 i.e. since the mesh size change.

tested). For the Irish data, no constraint on relationship between mean sizes of discards and landings was set because of lack of any information on that due to the short time-series.

4 ) The large mesh size of the French vessels in the FU20–22 area indicates that the distribution of length frequencies of discards is probably no symmetrical because of selectivity effects which should be more significant than for the FU23–24 stock or for the Irish trawlers in the FU20–22.

5 ) For French discards, the absence of reference about any relationship between mean sizes of landings and discards at the opposite of the Bay of Biscay, implies that the final fitting aims to provide the more linear as possible relationship (after log-log transformation) with only one reference point (year 1997). Hence, the optimization is more based on geometric concept than on statistical one.

#### *1st stage: the s-shaped hand-sorting curve*

Let j be a year with no dataset on discards. By quarter k, the number of discarded individuals by sex (m or f) and by size L, $ND_{jklm}$ (or $ND_{jklf}$), is not calculated on data provided from other years, but from the number of landed individuals $NL_{iklm}$ (or $NL_{iklf}$) during the same year, quarter k, sex (m or f) and size L:

$$ND_{jklm} = NL_{jklm}.\exp(-\alpha_k.(L-L50_k))$$

or

$$ND_{jklf} = NL_{jklf}.\exp(-\alpha_k.(L-L50_k)) \qquad [1]$$

$\alpha_k$ and $L50_k$ are the parameters of the s-shaped curve (logistic model) fitted by quarter k describing the commercial *Nephrops* hand-sorting on board. For this fitting, both sexes are combined and the dependent variable is expressed by the number of landed individuals for size L and the independent one is the total number of catches by size L for the years with discard sampling on board.

The estimates $\alpha_k$ and $L50_k$ were calculated by assuming the stability of hand-sorting process on board if mesh size and MLS remain unchanged. The short Irish time-series 2002–2006 was considered as a common dataset, but, for the French trawlers, the overall time-series was divided into three periods:

1 ) *Years 1987–1990*: The results of sampling carried out in 1985 are not available on computing support. Thus, there is no formal information if the hand-sorting on board could be approximated by the more recent parameters of 1990s. $\alpha$ and L50 were not got fixed, but their values were estimated by the multiple likelihood function as for the parameters of the probability density by year (see below).

2 ) *Years 1991–1999*: The hand-sorting was fitted on data from 1997 (1991 data were not representative of the whole fleet). The missing data of years 1991–1996 and 1998–1999 were therefore estimated.

3 ) *Years 2000–2006*: Because of the mesh size change, the hand-sorting should be different from 1997 sampling data. However, there is no new information for the 1st and 2nd quarters (the 2005 sampling plan provided relevant results only for the 3rd and 4th quarters). Hence, $\alpha$ and L50 for the first two quarters

were fixed equal to 1997 parameters, but the simulation for the other two quarters is based on 2005 data.

*2nd stage: removing of unreliable size classes of discards*

This derivation approach reduces interdependence between yearly datasets which may induce lack of contrast in recruitment time-series. Despite that, some inconveniencies of the new approach have to be taken into account: (1) the hand-sorting on board s-shaped curve implies that, for a given size class, no calculation of discards is possible while there is no landed individuals and (2) the exponential expression gives extremely unreliable high values of discards when undersized individuals are sampled in landings (mainly because of hand-sorting deviation due to sampling rate not representative for extreme size classes).

1 ) *Undersized individuals unusual in landings*. As written previously, undersized *Nephrops* sampled in landings should produce unreliable high discarded amounts by size because of the exponential calculation. All size classes representing less than a minimum cumulative percentage level in landings by year were removed (5% for French landings, 1% for Irish landings).

2 ) *Discarded individuals by size exceeding observed mean ratios discards/landings*. Generated discarded numbers were removed when the calculated ratio discards/landings by size (decreasing function vs. size) exceeded observed mean ratios by size[2]. Almost all size classes involved by (2) were already removed by (1). This operation was added at the aim of elimination of not normally high ratios discards/landings for large sizes (which has a little impact on total discarded number due to the s-shaped function of hand-sorting).

This calculation process retains only a part of the initial hand-sorting generated distributions of discards mainly the decreasing part of discarded individuals.

*3rd stage: simulation of densities of probability of discarded individuals (yearly distribution for French and quarterly for Irish discards)*

Finally, the assumed distribution of discards for the whole range of sizes was calculated from the descending part. This process needs to input the probability density of discards given by:

$$\varphi(L) = \frac{\alpha}{1 + \exp(\beta.(L - Lm)} \qquad [2]$$

where $\alpha$, $\beta$, Lm are coefficients of the distribution ($\phi(L)=\alpha/2$ when L=Lm).

Because of the assumed skewness for the French discard distribution, as explained above, the whole function of the probability density is approximated by:

$$\varphi(L) = \frac{\alpha}{1 + \exp(-\gamma\beta.(L - Lm)} \quad \text{for } L \leq Lm$$

[2] This procedure is performed only on Irish dataset whereas it is not pertinent for French data (only one year dataset).

$$\varphi(L) = \frac{\alpha}{1 + \exp(\beta.(L - Lm)} \quad \text{for L>Lm} \qquad [3]$$

with a complementary coefficient $\gamma$: if $\gamma$=1 the whole probability density is symmetrical, if $\gamma$<1 the skewness of the distribution is positive if $\gamma$>1 the skewness is negative ($\gamma$=1 for Irish discards, $\gamma \neq 1$ for French discards).

The fitting of $\phi$(L) is processed on two stages:

- *Lm and $\alpha$ are fixed*: $\alpha$ is initially fixed at 2*$\phi$max which is the maximum frequency retained after the 2nd stage of calculation (see above), Lm is fixed at the size corresponding to the maximum number of discarded individuals as provided by the 2nd stage of calculation (see previously) and, hence, $\beta$ is given by:

$$\beta = \frac{1}{n} \sum_{L=L\min}^{L\min+n-1} \ln\left[2.\frac{\varphi\max}{\varphi(L)} - 1\right]^{\frac{1}{L-Lm}} \qquad [4]$$

($L_{min}$= first size represented by not null individuals and n= number of total size classes with discards different from zero).

*All parameters are estimated*: $\alpha$, $\beta$, Lm got obtained by the 1st stage are input for the final calculation using Newton cancellation of gradient and assuming stochastic approach for Lm. Lm is assumed to be included in the interval defined accordingly to an *a priori* CV of Lm (see above) [3].

Otherwise, the final run includes constraints as:

- The sum of frequencies for descending part of distribution is equal to that calculated by the model i.e. the retained values of the 2nd stage of calculation described previously are assumed to be reliable.
- $L_m \geq L_{min}$ [$L_{min}$=(1-$Z_{1-\alpha/2}$.CV)*Lm] (usually: $\alpha$=0.05=>$Z_{1-\alpha/2}$=1.96)
- $L_m \leq L_{max}$[$L_{max}$=(1+ $Z_{1-\alpha/2}$.CV)*$L_m$]
- For French discards, the coefficient of determination of the relationship between the mean sizes of landings and the mean sizes of discards for missing years has to be as close as possible to 1 (with no possibility of statistical test because of only one year dataset).

### Statistical formulation and validation

#### *Calculation of variances*

##### *Matrix of variances–covariances of model parameters*

The Generalized Reduced Gradient and the Complex method do not give an estimate of the matrix of variances-covariances of the four (three for Irish) parameters. In this case, it is usually recommended to apply non-parametric techniques such as the Bootstrap method. The calculation can also be carried out according to parametric procedure (Lin,

[3] For French discards, are also included in the optimisation algorithm, the parameters $\alpha$ and L50 of the first period (1987–1990) which remained unknown.

1987; Fifas and Berthou, 1999; Fifas *et al.*, 2004) using Jacobian matrix (i.e. matrix of partial derivatives of the objective).

The matrix of variances-covariances is obtained by the following relationship:

$[M] = s^2.[I]^{-1}$ [5]

with:

[M]= matrix of variances-covariances; $[I]^{-1}$= inverse of matrix of information; $s^2$= sum of mean residual squares of the fitted function ($s^2$=SCE/DDL [4]):

$$SCE = \sum_{i=1}^{Lj<Lm} \left[\varphi(L_i) - \frac{\alpha}{1+\exp(-\gamma\beta.(L_i - Lm))}\right]^2 + \sum_{i=j+1}^{Lj>=Lm} \left[\varphi(L_i) - \frac{\alpha}{1+\exp(\beta.(L_i - Lm))}\right]^2$$

[6]

The matrix of information is obtained by:

$[I] = [J]'.[J]$ [7]

[J] is the Jacobian matrix (nc rows and four columns for French data, three for Irish):

$$[J] = \begin{bmatrix} \frac{\partial\varphi(L_1)}{\partial\alpha} & \frac{\partial\varphi(L_1)}{\partial\beta} & \frac{\partial\varphi(L_1)}{\partial\gamma} & \frac{\partial\varphi(L_1)}{\partial Lm} \\ \frac{\partial\varphi(L_2)}{\partial\alpha} & \frac{\partial\varphi(L_2)}{\partial\beta} & \frac{\partial\varphi(L_2)}{\partial\gamma} & \frac{\partial\varphi(L_2)}{\partial Lm} \\ . & . & . & . \\ \frac{\partial\varphi(L_{nc})}{\partial\alpha} & \frac{\partial\varphi(L_{nc})}{\partial\beta} & \frac{\partial\varphi(L_{nc})}{\partial\gamma} & \frac{\partial\varphi(L_{nc})}{\partial Lm} \end{bmatrix}$$

[8]

[J]' is the transpose of [J], the partial derivatives of the equation [8], also defined as *absolute coefficients of sensitivity of order 1* written as a(α), a(β), a(γ), a(Lm) are given below:

$$\frac{\partial\varphi(L)}{\partial\alpha} = \frac{\varphi(L)}{\alpha}$$ [9]

$$\frac{\partial\varphi(L)}{\partial\beta} = \gamma.(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} \leq \text{Lm}$$ [10a]

$$\frac{\partial\varphi(L)}{\partial\beta} = -(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} > \text{Lm}$$ [10b]

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.(L - Lm).\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} \leq \text{Lm}$$ [11a]

$$\frac{\partial\varphi(L)}{\partial\gamma} = 0 \text{ if L} > \text{Lm}$$ [11b]

$$\frac{\partial\varphi(L)}{\partial Lm} = -\beta.\gamma.\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} \leq \text{Lm}$$ [12a]

$$\frac{\partial\varphi(L)}{\partial\gamma} = \beta.\varphi(L).(1 - \frac{\varphi(L)}{\alpha}) \text{ if L} > \text{Lm}$$ [12b]

[4] DDL is equal to nc-4 for French discards, but equal to nc-3 for Irish data (parameter γ is omitted).

#### Uncertainty of simulated discards

The matrix of variances-covariances of the four (three for Irish) parameters of the model and the use of partial derivatives of order 1 provide an approximate calculation of the variance of the variable Ψ(L) corresponding to simulated discards vs. size L. This procedure is based on limited developments of order 1 in Taylor's series (called Delta methods: Laurec, 1986; Laurec and Mesnil, 1987; Chevaillier, 1990; Chevaillier and Laurec, 1990; Fifas and Berthou, 1999; Fifas *et al.*, 2004).

By using Taylor's polynomial on a function Φ against parameters $\theta_1, \theta_2, \ldots, \theta_k$ it is possible to present the variance of Φ by:

$$V[\Phi] \approx \sum_{i=1}^{k}\left(\frac{\partial\Phi}{\partial\theta i}\right)^2.V[\theta_i] + 2.\sum_{i=1}^{k-1}\sum_{j=i+1}^{k}\frac{\partial\Phi}{\partial\theta i}.\frac{\partial\Phi}{\partial\theta j}Cov[\theta_i,\theta_j] \qquad [13]$$

Then, the variance of simulated discards vs. size, V[Ψ(L)], is written as:

$$V[\Psi(L)] \approx a(\alpha)^2.V[\alpha] + a(\beta)^2.V[\beta] + a(\gamma)^2.V[\gamma] + a(Lm)^2.V[Lm] + 2.a(\alpha).a(\beta).Cov[\alpha,\beta] + 2.a(\alpha).a(\gamma).Cov[\alpha,\gamma] + 2.a(\alpha).a(Lm).Cov[\alpha,Lm] + 2.a(\beta).a(\gamma).Cov[\beta,\gamma] + 2.a(\beta).a(Lm).Cov[\beta,Lm] + 2.a(\gamma).a(Lm).Cov[\gamma,Lm] \qquad [14]$$

where the absolute coefficients of sensitivity of order 1 (partial derivatives) are defined above (equations [9] to [12]).

#### Validation

The generated by simulation values are tested against discards estimated by sampling. This procedure is undertaken on French data of 1997 and also on available Irish set (all quarters of 2003, 2004-Q2, 2004-Q3, 2005-Q1, 2005-Q2, 2006 apart from Q4 i.e. 11 quarters). As performed for the Bay of Biscay *Nephrops* stock, this validation involves in three main stages (Figure 10–14): (1) Examination of the total amount of discards calculated by simulation that should not be significantly different from that obtained by sampling. (2) Test by linear regression performed on simulated numbers vs. size as dependent variable against sampled numbers as independent one. The slope of this relationship should not be significantly different from 1 (bisecting line) and the intercept should not be significantly different from 0. (3) Test of cumulative frequencies of the sets, sampled and simulated, using non parametric approaches such as Kolmogorov–Smirnov.

#### Results

##### *Hand-sorting s-shaped curves*

The French and Irish hand-sorting logistic curves estimated by sampling are provided by Figure 15. In the Table 4, are also presented the French parameters involving in years 1987–1990 (simulated by the multiple likelihood function applied for probability density of discards; see above).

**Table 4. Summary of parameters of s-shaped hand-sorting curves.**

| | FR (years 1987–1990) | | FR (year 1997) | | IRL (years 2003–2005) | |
|---|---|---|---|---|---|---|
| quarter | $\alpha$ | L50 | $\alpha$ | L50 | $\alpha$ | L50 |
| Q1 | 0.797 | 32.685 | 1.006 | 32.776 | 0.480 | 25.876 |
| Q2 | 0.494 | 35.573 | 0.718 | 36.019 | 0.426 | 26.016 |
| Q3 | 0.331 | 32.227 | 0.851 | 33.654 | 0.559 | 25.785 |
| Q4 | 0.697 | 31.138 | 0.815 | 32.381 | 0.412 | 24.886 |

These values indicate the high heterogeneity between the two fleets which accentuates the *a priori* high spatial heterogeneity of the targeted resource. Some weak differences are observed between the simulated values $\alpha$ and L50 of the first French period (1987–1990) and the sampling of 1997. Nevertheless, these parameters are given by deterministic way; therefore, there is no possibility of further statistical comparison.

*Estimates of French discards*

Estimates of French discards (1987–2006), total number of discarded individuals, parameters $\alpha$, $\beta$, $\gamma$ and Lm and corresponding coefficients of variation (CV, in %), are given below (Table 5). The Table 6 and Figure 16 present discard rates by sex and combined for the overall time-series.

**Table 5. French *Nephrops* trawlers, Celtic Sea (FU20–22). Estimates of discards, coefficients of model and coefficients of variation of parameters.**

| year | disc | CV(disc) | Lm | CV(Lm) | α | CV(α) | β | CV(β) | γ | CV(γ) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 125 752 | 4.62 | 30.278 | 3.25 | 25773 | 13.79 | 0.293 | 32.11 | 0.768 | 44.61 |
| 1988 | 425 396 | 4.88 | 28.917 | 5.28 | 59518 | 16.97 | 0.260 | 39.24 | 0.534 | 56.57 |
| 1989 | 99 536 | 4.02 | 31.061 | 4.36 | 14417 | 13.86 | 0.221 | 33.01 | 0.740 | 45.69 |
| 1990 | 81 530 | 8.74 | 30.579 | 8.28 | 12219 | 28.86 | 0.221 | 61.77 | 0.866 | 92.51 |
| 1991 | 389 726 | 5.69 | 29.479 | 5.70 | 57932 | 18.85 | 0.218 | 40.78 | 0.868 | 60.75 |
| 1992 | 377 075 | 18.48 | 30.752 | 14.57 | 61039 | 58.97 | 0.314 | 142.51 | 0.534 | 193.98 |
| 1993 | 118 210 | 199.42 | 31.299 | 147.10 | 20679 | 612.24 | 0.258 | 1356.53 | 0.879 | 1956.90 |
| 1994 | 93 687 | 7.62 | 31.438 | 6.77 | 14384 | 24.84 | 0.232 | 54.91 | 0.830 | 79.80 |
| 1995 | 131 541 | 136.57 | 31.808 | 95.39 | 25096 | 418.52 | 0.273 | 880.20 | 0.808 | 1323.18 |
| 1996 | 82 811 | 6.05 | 32.357 | 5.61 | 12121 | 20.20 | 0.255 | 49.20 | 0.637 | 66.91 |
| 1997 | 96 612 | 6.21 | 32.403 | 2.11 | 18050 | 15.36 | 0.673 | 46.01 | 0.397 | 55.62 |
| 1998 | 30 494 | 7.62 | 31.393 | 10.98 | 3453 | 28.85 | 0.161 | 61.94 | 0.893 | 94.65 |
| 1999 | 36 900 | 12.14 | 31.827 | 10.67 | 5618 | 40.01 | 0.236 | 84.90 | 0.791 | 127.28 |
| 2000 | 22 234 | 46.41 | 33.790 | 56.24 | 2655 | 171.90 | 0.175 | 359.92 | 0.863 | 552.62 |
| 2001 | 98 962 | 5.59 | 31.766 | 7.43 | 11594 | 20.94 | 0.191 | 46.64 | 0.682 | 69.25 |
| 2002 | 34 283 | 18.42 | 33.466 | 21.52 | 4223 | 66.86 | 0.193 | 150.64 | 0.762 | 217.87 |
| 2003 | 59 692 | 4.73 | 34.452 | 3.48 | 9659 | 15.04 | 0.285 | 36.31 | 0.638 | 49.26 |
| 2004 | 29 493 | 9.36 | 33.546 | 9.20 | 4050 | 32.24 | 0.202 | 69.23 | 0.874 | 103.22 |
| 2005 | 15 097 | 18.92 | 34.739 | 17.57 | 2098 | 65.03 | 0.205 | 136.51 | 0.873 | 206.98 |
| 2006 | 17 286 | 6.86 | 36.327 | 7.29 | 2350 | 24.93 | 0.238 | 64.77 | 0.530 | 85.17 |

**__Note__: the sampled year 1997 is given in bold and italic fonts whereas in coloured fonts are presented the years for which the model based on the probability density seems to be inappropriate (years 1993, 1995, 2000; extremely high CV of parameters and discarded numbers). The total discarded number cited for 1997 is the value obtained by sampling.**

**Table 6. French *Nephrops* trawlers, Celtic Sea (FU20–22). Discard rate (%) by year.**

| year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| total | 65.0 | 83.8 | 58.6 | 51.2 | 86.2 | 82.0 | 60.9 | 55.8 | 63.4 | 54.3 | 65.4 | 40.1 | 40.3 | 31.7 | 64.9 | 37.4 | 49.3 | 40.7 | 28.8 | 28.7 |
| males | 46.5 | 67.0 | 38.5 | 32.8 | 73.7 | 65.3 | 40.7 | 37.0 | 44.2 | 33.6 | 45.6 | 23.0 | 23.8 | 19.8 | 46.4 | 21.0 | 30.0 | 24.0 | 16.6 | 18.2 |
| females | 86.7 | 96.5 | 86.1 | 79.6 | 96.0 | 96.3 | 90.2 | 82.3 | 88.3 | 88.1 | 94.7 | 75.0 | 72.9 | 55.6 | 85.5 | 80.8 | 90.6 | 81.4 | 68.8 | 48.9 |

As presented above, the model based on probability density with skewness gives generally adequate results (see parameters' CV) except for three years on twenty of the overall time-series. Nevertheless, the provided CV are estimated by the model and do not necessarily reflect the actual uncertainty because of complex organization of samples (subsampling stratified plan applied on board). This is illustrated by the sampled year 1997 which showed high spatial and temporal variability of discard size-composition vs. that of landings (CV of samples>30%) although the estimated by the model CV seems unlikely (weak value of 6.21%). Moreover, the generated by the model total number of discarded *Nephrops* for 1997 was underestimated (66 millions i.e. 68% of the total number estimated by sampling: 97 millions). The use of the coefficient $\gamma$ in the model was justified by the expected skewness of discard distributions due to the selectivity effect: in fact, all values of $\gamma$ do not exceed 1. However, using the simulated model for the year 1997 with assumed symmetrical distribution of discards and with no constraint on relationship between mean sizes in discards and in landings provided more satisfactory results (Figure 17). The symmetrical simulation gave un estimate of 83 millions of discards i.e. 86% of the 97 millions calculated by sampling closer than the value generated with skewness. Moreover, the CV of parameters $\alpha$, Lm and mainly $\beta$ are less strong.

There is no current statistical evidence of choosing symmetrical or not distribution for simulations and there is no possibility to validate any relationship between mean sizes in discards and landings while the actual sampling is limited to only one complete year.

However, as underlined in the Stock Annex, the generated by model cpue (including discards calculated by the probabilistic simulation with skewness) show a good agreement with EVHOE groundfish survey indices for the period 1997–2005 ($R^2$=0.65) whilst the relationship between lpue and EVHOE indices seems more sparse ($R^2$=0.36). As also reported by WGSSDS 2007, throughout the overall time-series, some high (years 1988, 2001) or low (year 1990) values of simulated discard rates coincide with increase or decrease of lpue for 1–2 years later (increase in 1989–1990 and 2002–2003, decrease in 1991–1992). It is noticeable that no constraint was set for back-calculations on the relationship between discard rate (year i) and lpue (years i+1/i+2).

#### *Estimates of Irish discards*

Estimates of Irish discards by quarter (since 2002), total numbers of discarded individuals, parameters $\alpha$, $\beta$ and Lm and corresponding coefficients of variation (CV, in %), are provided below (Table 7).

A first examination of results shows an overall better statistical adequacy than for French discards. Except for one sampled quarter (coloured fonts; 2005-Q2), the coefficients of determination are strong and the CV of model parameters remain relatively low. Despite this initial overview, the adequacy of the probabilistic approach will be tested as regards the procedure developed for the Bay of Biscay stock.

The Table 8 and Figure 18 present quarterly discard rates by sex and combined for the overall time-series. Discard rates by sampling and by simulation can be directly compared for 11 quarters (Table 8): it seems that the average simulated discard percentage is slightly lower than the sampled one (26.0% against 27.3%), but for 8 quarters on 11, the simulated values are underestimated.

The Table 9 and Figure 19 give comparisons between sampled and simulated discarded numbers. Two sampled years (2003 and 2005) for the 1st quarter give low correlations between sampled and simulated discards. Despite more good correlation levels (9 on 11), the overall conclusion is that the null hypothesis (slope=1) is refused apart from one example (2004-Q2) which although provides biased results of simulated discards (very high ratio Nexp/Nobs). It is worth noting that the descending part of simulated DLF of discards seems to be more coherent with the sampled DLF than the ascending one (except for one case on 11, 2005-Q2 which is denoted by the less good statistical consistency of simulation in regards with the low value of $\varrho^2$: Table 7). Introduction of some constraint between mean sizes in discards and in landings as for the French example may give different results for the ascending DLF.

**Table 7. Irish *Nephrops* trawlers, Celtic Sea (FU20–22). Estimates of discards, coefficients of model and coefficients of variation of parameters (bold characters=sampled quarters).**

| year | Q | disc | Lm | CV(Lm) | α | CV(α) | β | CV(β) | ρ² |
|---|---|---|---|---|---|---|---|---|---|
| 2002 | Q1 | 2664 | 26.039 | 0.95 | 1282 | 13.89 | 0.674 | 18.09 | 0.990 |
| 2003 | Q1 | 6318 | 20.994 | 1.97 | 1476 | 11.52 | 0.319 | 15.53 | 0.855 |
| 2004 | Q1 | 2208 | 24.743 | 1.34 | 998 | 18.48 | 0.625 | 24.42 | 0.960 |
| 2005 | Q1 | 7613 | 25.929 | 0.88 | 3764 | 13.27 | 0.691 | 17.29 | 0.994 |
| 2006 | Q1 | 11279 | 25.218 | 0.68 | 4594 | 8.56 | 0.564 | 11.32 | 0.929 |
| 2002 | Q2 | 1670 | 27.891 | 1.10 | 666 | 14.69 | 0.555 | 19.37 | 0.950 |
| 2003 | Q2 | 10236 | 25.119 | 0.72 | 4204 | 8.98 | 0.571 | 11.84 | 0.980 |
| 2004 | Q2 | 4953 | 24.685 | 1.05 | 1003 | 6.39 | 0.278 | 8.59 | 0.951 |
| 2005 | Q2 | 23437 | 25.139 | 1.42 | 3701 | 6.79 | 0.214 | 9.27 | 0.608 |
| 2006 | Q2 | 15977 | 26.854 | 0.35 | 7902 | 5.61 | 0.688 | 7.35 | 0.987 |
| 2002 | Q3 | 729 | 27.444 | 0.77 | 363 | 13.40 | 0.686 | 17.73 | 0.982 |
| 2003 | Q3 | 15985 | 22.042 | 0.43 | 5780 | 4.04 | 0.504 | 5.33 | 0.940 |
| 2004 | Q3 | 1291 | 28.143 | 0.26 | 571 | 3.90 | 0.615 | 5.13 | 0.969 |
| 2005 | Q3 | 4795 | 24.751 | 0.64 | 2562 | 10.55 | 0.739 | 13.85 | 0.960 |
| 2006 | Q3 | 2518 | 25.484 | 0.44 | 1144 | 6.48 | 0.626 | 8.60 | 0.927 |
| 2002 | Q4 | 11343 | 24.442 | 0.56 | 5197 | 7.89 | 0.631 | 10.46 | 0.990 |
| 2003 | Q4 | 2166 | 24.284 | 0.83 | 630 | 7.23 | 0.402 | 9.64 | 0.967 |
| 2004 | Q4 | 1561 | 27.543 | 0.93 | 713 | 14.91 | 0.630 | 19.77 | 0.992 |
| 2005 | Q4 | 9249 | 24.318 | 0.67 | 4603 | 10.22 | 0.687 | 13.49 | 0.992 |
| 2006 | Q4 | 10394 | 25.289 | 0.67 | 5666 | 11.50 | 0.753 | 15.11 | 0.990 |

**Table 8. Irish *Nephrops* trawlers, Celtic Sea (FU20–22). Discard rate (%) by quarter and year (for the sampled quarters: the cited percentages in bold correspond to the sampling results; those in brackets are obtained by the simulation).**

| year | 2002 | 2003 | 2004 | 2005 | 2006 | 2002 | 2003 | 2004 | 2005 | 2006 | 2002 | 2003 | 2004 | 2005 | 2006 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| quarter | Q1 | Q1 | Q1 | Q1 | Q1 | Q2 | Q2 | Q2 | Q2 | Q2 | Q3 | Q3 | Q3 | Q3 | Q3 | Q4 | Q4 | Q4 | Q4 | Q4 |
| total | 7.3 | 26.9 | 15.4 | 35.3 | 41.1 | 2.6 | 37.6 | 11.5 | 21.4 | 29.5 | 1.2 | 41.2 | 10.1 | 11.1 | 19.5 | 9.9 | 26.4 | 2.3 | 54.3 | 7.2 |
| | | (41.6) | | (24.5) | (32.4) | | (29.9) | (16.5) | (28.8) | (24.1) | | (40.6) | (9.0) | | (15.6) | | (22.9) | | | |
| males | 6.6 | 22.1 | 13.7 | 37.9 | 34.5 | 2.5 | 34.0 | 11.1 | 19.3 | 22.9 | 1.3 | 42.2 | 9.3 | 5.2 | 17.0 | 10.9 | 20.7 | 4.3 | 47.0 | 8.0 |
| females | 8.9 | 75.1 | 18.7 | 34.0 | 56.8 | 2.7 | 40.5 | 11.7 | 22.7 | 32.7 | 1.2 | 40.6 | 11.4 | 40.0 | 20.9 | 6.5 | 59.1 | 0.2 | 71.2 | 3.8 |

It would also be interesting to re-examine the comparisons after assuming skewness of discards distributions (use of coefficient $\gamma \neq 1$ as for the French fleet). It is noticeable that for 5 quarters on 11 (Figure 19) the DLF of samples deviates from the assumed symmetry of simulations, then small sized individuals are underestimated (however, the overestimation of the small *Nephrops* by the simulation occurs less often, but provides extremely divergent results). Although, there is no current basis for further analysis of this point because there is no evidence of any particular effect of some biological feature affecting the symmetry of distributions i.e. moulting which occurs in spring and autumn (example examined in the French fishery of the Bay of Biscay). The short time-series and the low sampling rate do not allow generalizing this first overview.

**Table 9. Irish *Nephrops* trawlers, Celtic Sea (FU20–22). Relationships between discarded numbers by sampling (Nobs) and by simulation (Nexp).**

| year/quarter | | Nexp=Ψ(Nobs) | $\rho^2$ | p(slope) | Nexp/Nobs |
|---|---|---|---|---|---|
| 2003 | Q1 | Nexp=0.87*Nobs+84.99 | 0.44 | 0.41 | 194% |
| 2005 | Q1 | Nexp=0.60*Nobs-2.72 | 0.72 | 0.00* | 60% |
| 2006 | Q1 | Nexp=0.72*Nobs-12.49 | 0.89 | 0.00* | 69% |
| 2003 | Q2 | Nexp=0.72*Nobs-3.87 | 0.84 | 0.00* | 71% |
| 2004 | Q2 | Nexp=0.94*Nobs+45.90 | 0.85 | 0.38 | 152% |
| 2005 | Q2 | Nexp=0.78*Nobs+267.45 | 0.85 | 0.00* | 148% |
| 2006 | Q2 | Nexp=0.83*Nobs-39.77 | 0.94 | 0.00* | 76% |
| 2003 | Q3 | Nexp=0.89*Nobs+32.24 | 0.94 | 0.00* | 97% |
| 2004 | Q3 | Nexp=0.86*Nobs+0.92 | 0.97 | 0.00* | 88% |
| 2006 | Q3 | Nexp=0.80*Nobs-2.90 | 0.91 | 0.00* | 77% |
| 2003 | Q4 | Nexp=0.74*Nobs+5.79 | 0.88 | 0.00* | 83% |

**Note: *=significant result (1-$\alpha$=0.95).**

### Conclusion

The biological sampling on board for *Nephrops* FU20–22 stock remains poor for both main fleets. The duration of trips for French trawlers (12–15 days) restricts possibilities of regular participation of observers. Moreover, in agreement with results of sampling design applied in 1997, the long duration of trips implies a high spatial variability of harvested areas by trip and a low total number of trips sampled by quarter. Thus, the CV of discarded numbers estimated by sampling remains high. By the way, the simulations developed on French discards are hampered by the sampling of only one year throughout a long time-series. The discard practices during the whole period may change, but there is no current possibility to test the effect of such a modification on the hand-sorting on board. Despite that, some discard rates by year agree overall with independent indices as EVHOE groundfish survey indices (as pointed by last year's WG) and with the most notable changes in terms of lpue during the whole time-series.

The Irish dataset takes more promising because of a shorter duration of trips. Hence, conceptual problems of sampling design inherent to the French fleet should not affect the Irish data. As the Irish fleet seems to be more recruitment directed, the indices provided by the sampling on board should improve the diagnostic accuracy. In the meantime, the simulation based on the probabilistic approach indicated an overall consistent reconstitution of discards for more sampled quarters. Many further investigations have to be carried out in the order to validate extrapolations from French catches to Irish for the period before 2002.

### B.3. Surveys

Direct *Nephrops* assessment by trawling is inappropriate because of notable diurnal variations of availability which is higher during dawn and dusk. The most adapted way is based on transect with video and TV runs of burrows (combined with hauls on area and geo-statistical analysis of catches with the aim of separating burrows of *Nephrops* from those of squat lobster), but it needs heavy preliminary arrangements because the spatial heterogeneity of resource requires to well define the survey area and the sampling plan in order to avoid biased results. The current situation will be improved in future once a data time-series has been collected by the Irish specifically designed survey programme launched in 2006. However, the Irish and French exploited areas are different. On FU20–22 the French groundfish survey EVHOE while not focusing on *Nephrops* does provide an indication of the length distributions and the strength of recruitment (Figure 20). An Irish groundfish survey giving size composition of *Nephrops* catches has also been carried out since 2003. Moreover, a UK bottom-trawl survey had occurred on the same area between 1984 and 2004, but only two sampling stations were within FU20–22 area.

A comparative analysis conducted between lpue and cpue of French and Irish vessels with EVHOE indices shows a good agreement between commercial French cpue and EVHOE series for the period 1997–2005 ($R^2$=0.65) whilst the relationship is more sparse ($R^2$=0.36) when the commercial French lpue are used (Figure 21). The Irish data are not significantly linked to the French dataset probably due to the difference of harvested area and the short time-series.

The results of the UWTV survey initiated by Republic of Ireland in 2006 involving in the three first years, 2006–2008, are shown by Figures 20–25 and Tables 10–11. It is noticeable that the strongest values of this short time-series (2006) coincide with the highest level on "Smalls" as reported by Irish industry in 2007. In a time frame of around 2–4 years, this survey should provide valuable information to tune data for the FU20–22 *Nephrops* stock especially on the "Smalls" ground where are located more than the ²/₃ of the total Irish yearly production. Nevertheless, the historical longer series of French landings in the Celtic Sea is less involved by the area covered by UWTV (the contribution of the rectangle 31E3 in the total French production fell from 41% in 1999 at less than 10% in 2008). This implies the necessity to tune data for the whole area.

### B.4. Commercial cpue

Between 2006 and 2007, the French fishing effort declined notably by -25% and the lpue increased (+13%) although the evolution of the same indicators for the Irish fleet was different (+31% of fishing effort and +36% of lpue). It is noticeable that the decrease of the French fishing effort was caused by the reduction of the number of trips by vessel whereas the total number of vessels remained almost stable. The evolution of the Irish fishing effort involves either in increase of the fishing vessels (95 Irish trawlers were listed in 2007 against 80 for 2006) or in increase of the number of trips by vessel.

Between 2007 and 2008, the effort of the French trawlers decreased slightly i.e. 99 789 h against 101 980 h for 2007 whereas the Irish fishing effort remained stable (59 727 h against 59 899 h in 2007). Lpue of both fleets increased mainly for French trawlers (+22%: 22.6 kg/h against 18.5 kg/h for 2007) and, to a lesser degree, for Irish (+11%: 55.2 kg/h against 49.4 in 2007).

### C. Historical stock development

There is no currently specific development for analytical assessment of the stock. By the WG*NEPH* 2003, the FU20–22 *Nephrops* stock was analytically assessed by XSA (software VPA; Darby and Flatman, 1994). Because of the lack of long and consistent Irish series (before DCR), the analysis was limited on the male component involved by French trawlers (see input parameters: Table 1).

### D. Short-term projection

No short-term projection is performed for this stock.

### E. Medium-term projections

No medium-term projection is performed for this stock.

### F. Long-term projections

No long-term projection is performed for this stock.

### G. Biological reference points

There is no biological reference point for this stock.

### H. Other issues

None.

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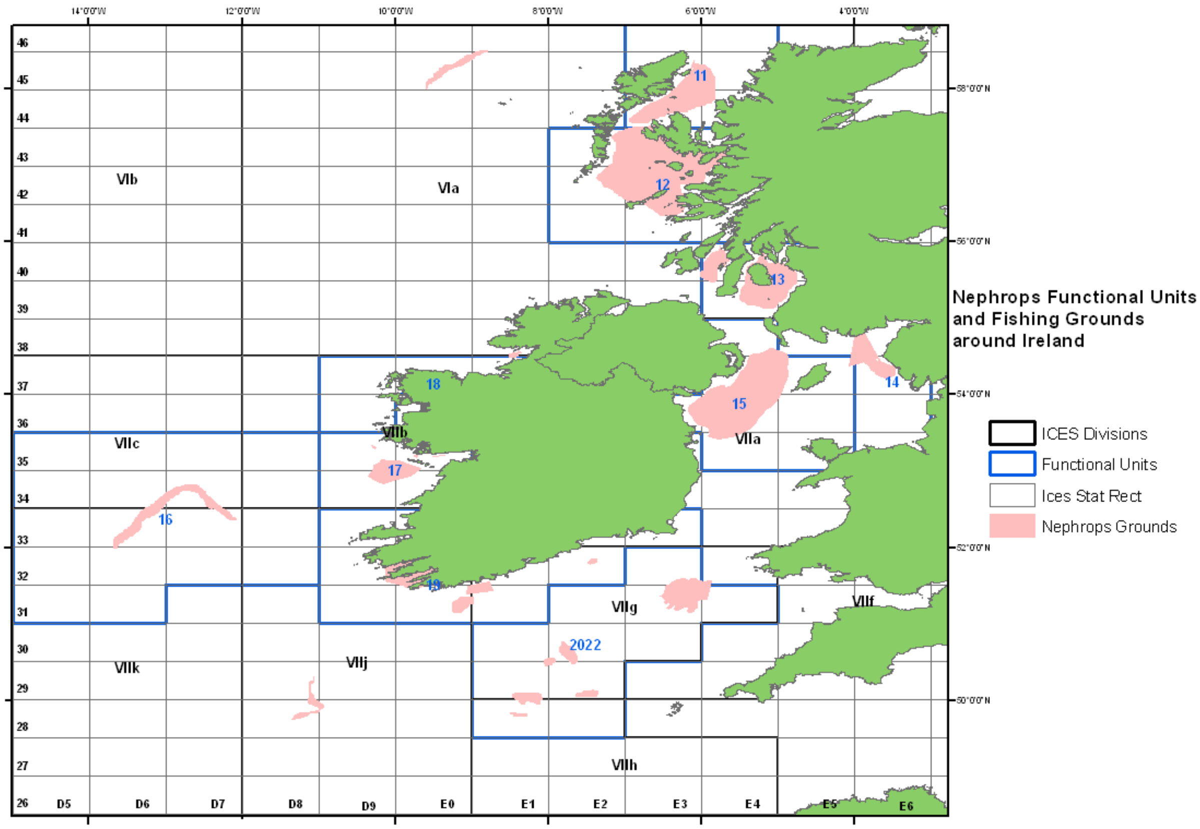



**Figure 1. Functional units 20–22 (*Nephrops* grounds in Celtic Sea).**

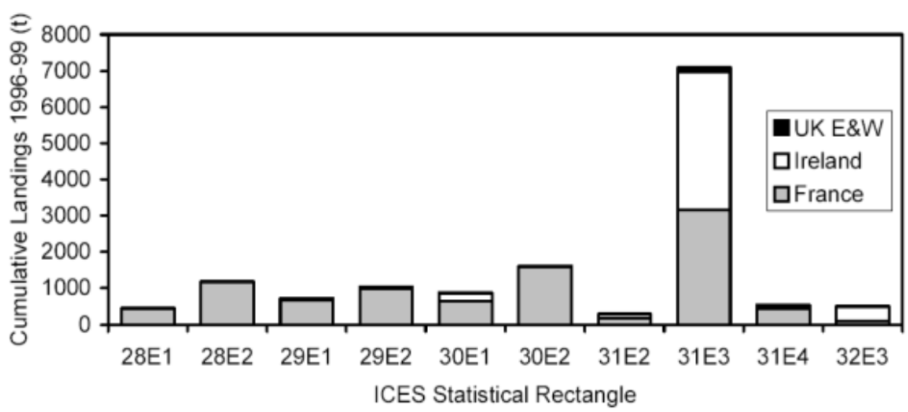
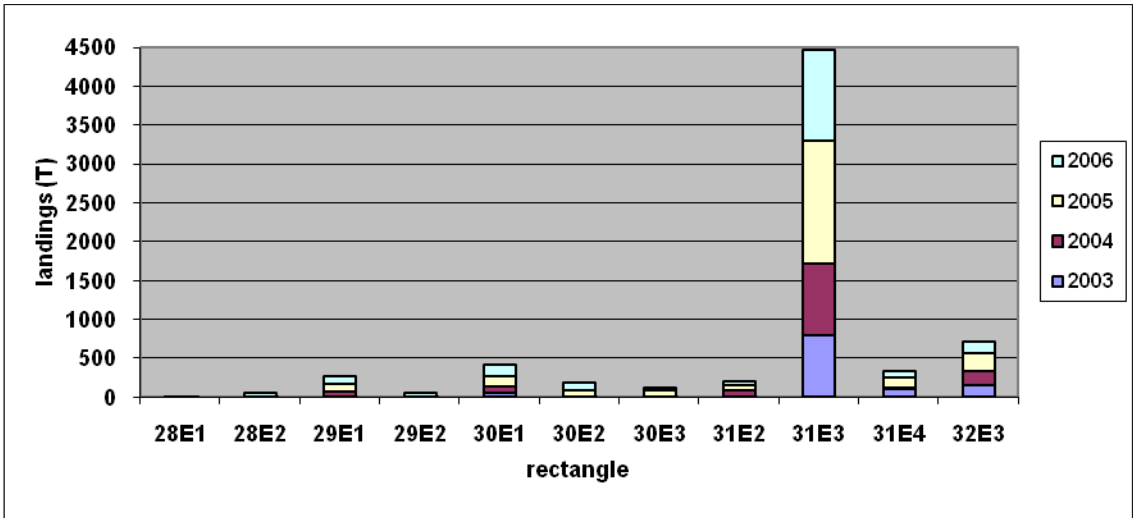



**Figure 2. *Nephrops* FU20–22 (Celtic Sea). Spatial distribution of landings of the main fleets (average value of the period 1996–1999).**



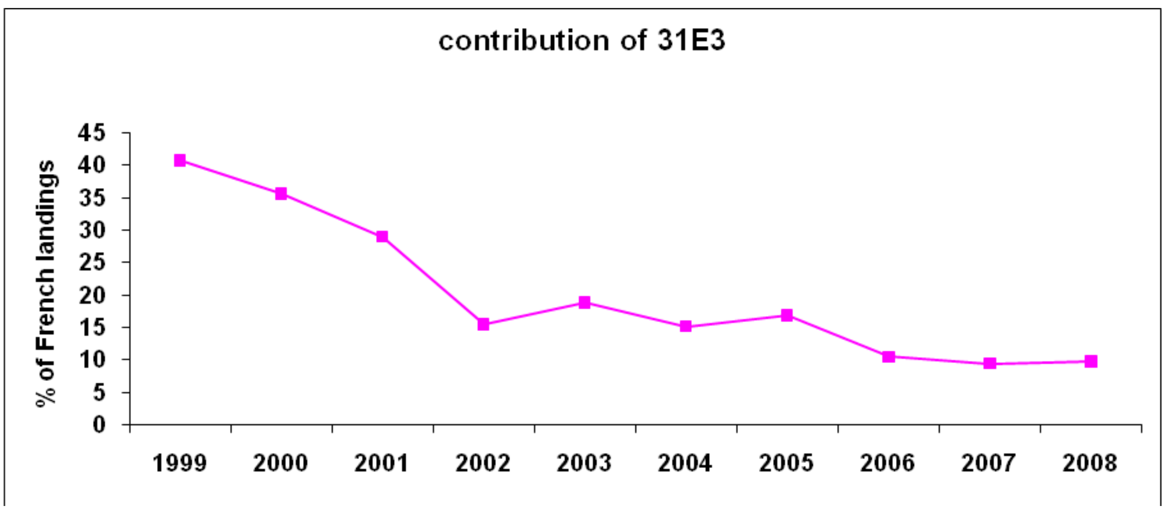
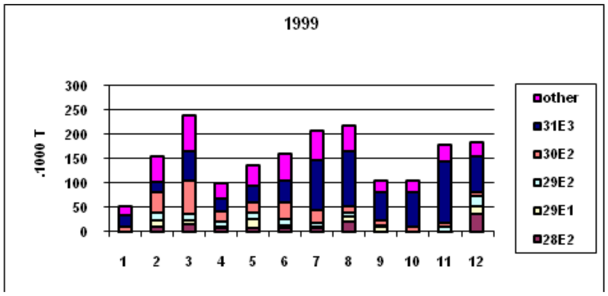




**Figure 3.** ***Nephrops*** **FU20–22 (Celtic Sea). Above: Spatial and by year distribution of Irish landings. Below: Contribution of the rectangle 31E3 (concentrating more than 2/3 of the total Irish production) in the total French landings. Years 1999–2008.**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other
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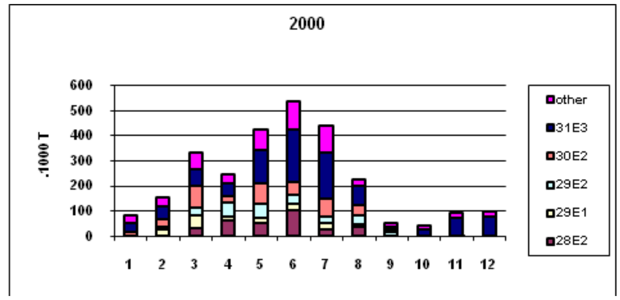
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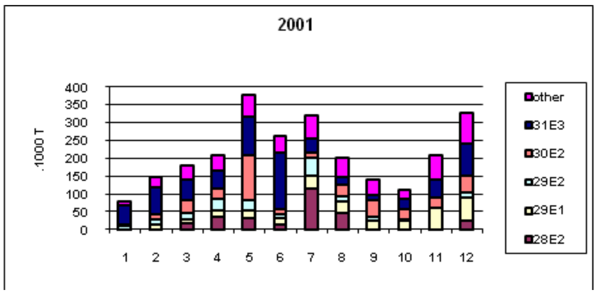
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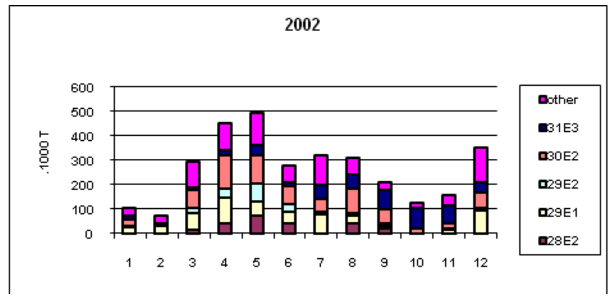
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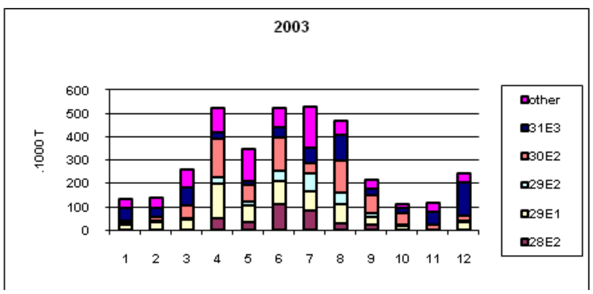
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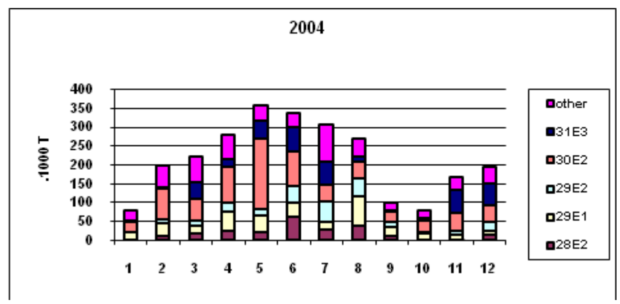
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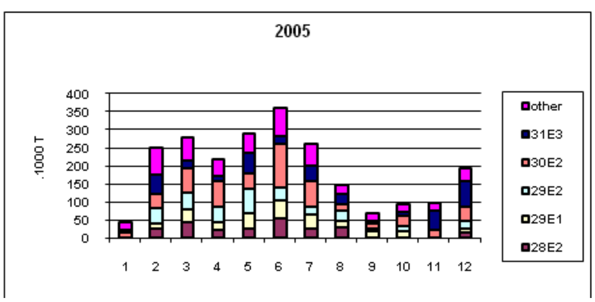
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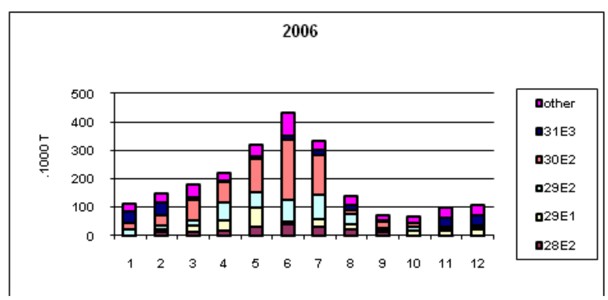
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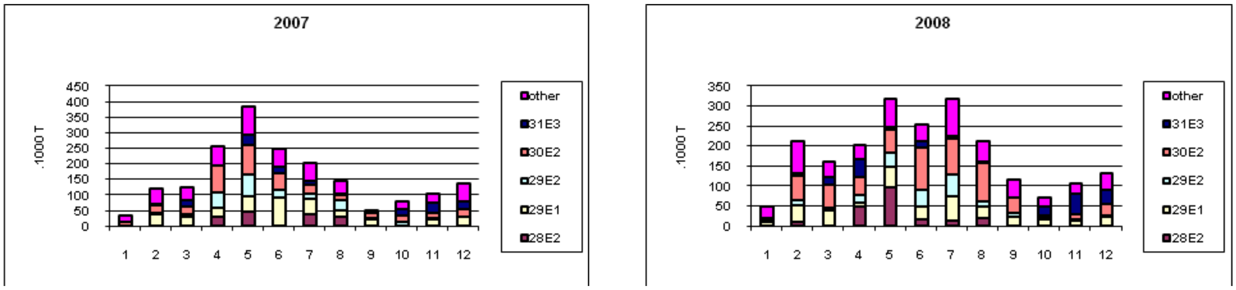



**Figure 4. *Nephrops* FU20–22 (Celtic Sea). Spatial and monthly distribution of French landings.**

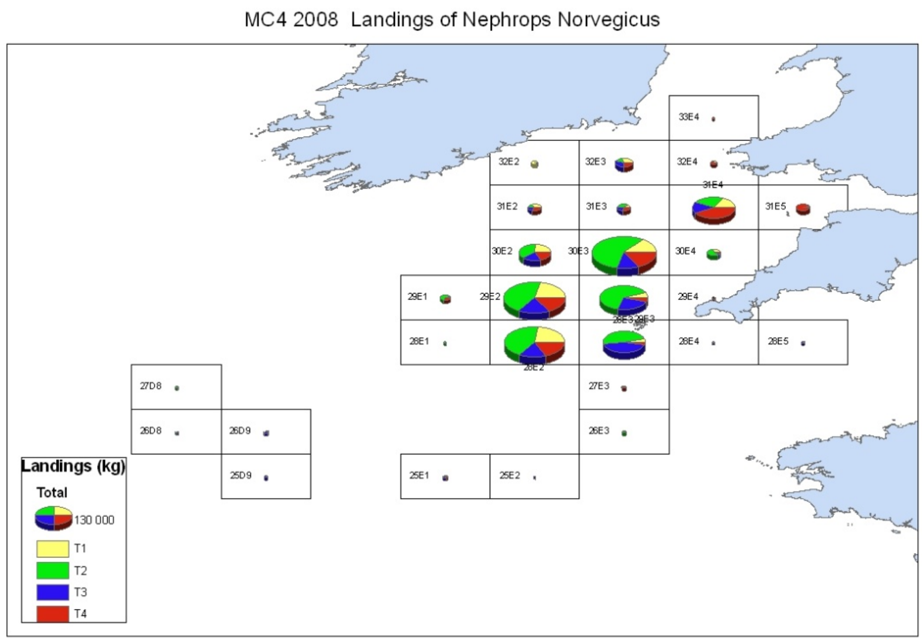



**Figure 5. *Nephrops* FU20–22 (Celtic Sea). Spatial distribution of French landings in 2007.**

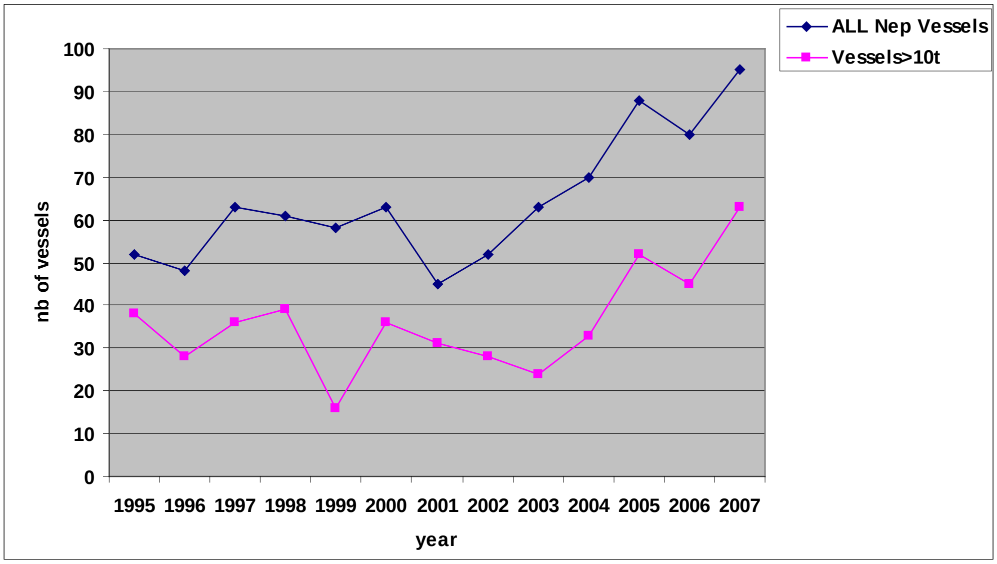



**Figure 6.** ***Nephrops*** **FU20–22 (Celtic Sea). Number of Irish trawlers involving** ***Nephrops*** **landings.**

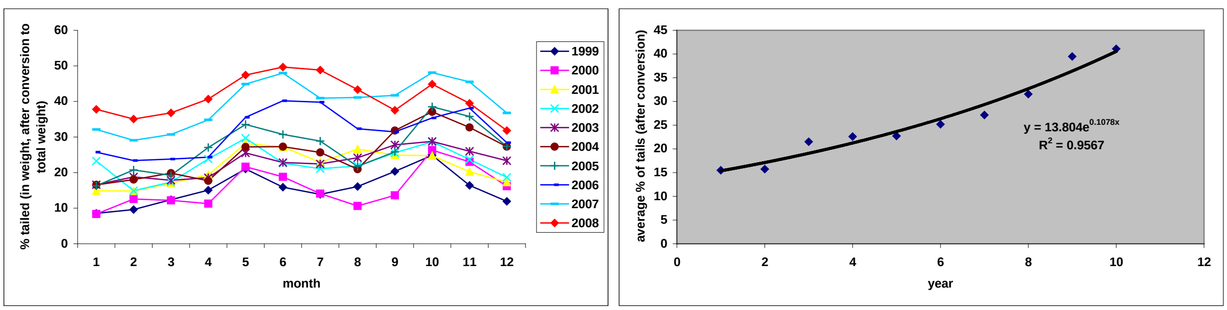



**Figure 7.** ***Nephrops*** **FU20–22 (Celtic Sea). Tailed proportion (in converted weight) in landings by month (left) and by year (right).**

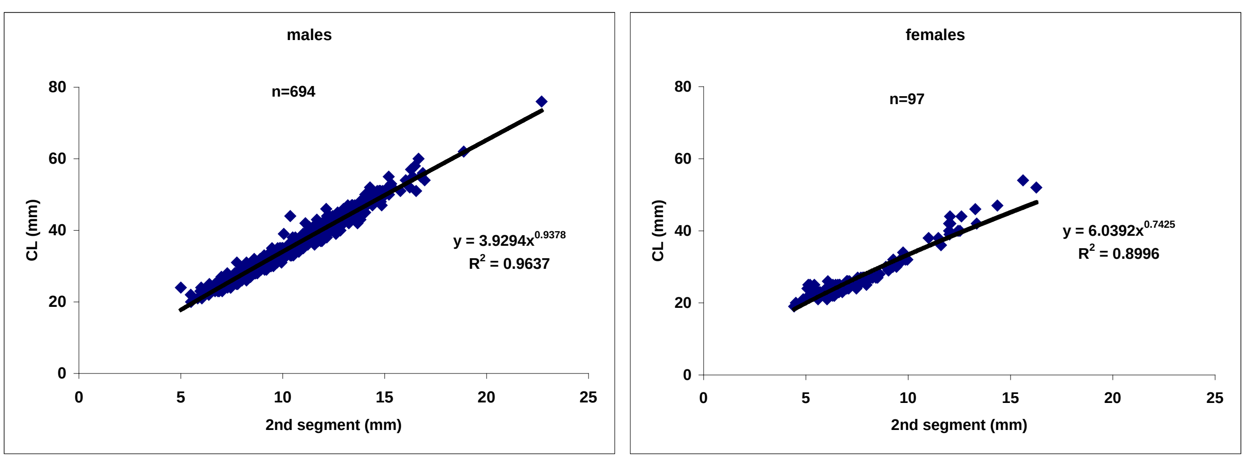



**Figure 8.** ***Nephrops*** **of the Celtic Sea (VIIfgh, FU20–22). Biometric relationships (CL vs. 2nd abdominal segment by sex). Data harvested during the survey EVHOE 2007.**

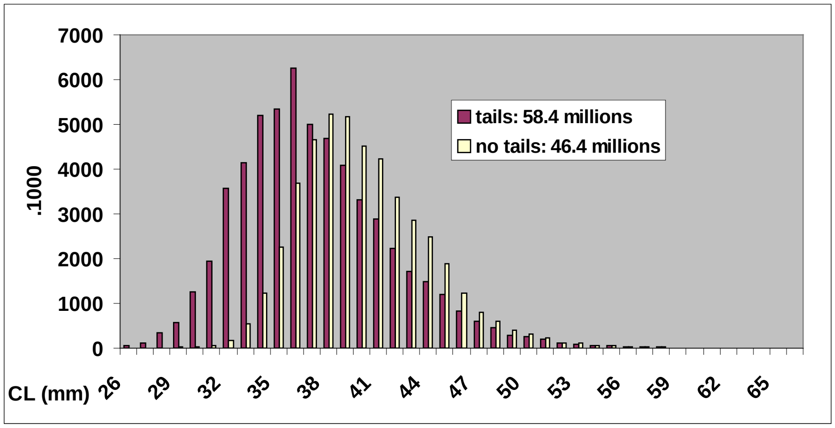



**Figure 9.** *Nephrops* **of the Celtic Sea (VIIfgh, FU20–22). French landings for 2008. Length distributions (1) including the data on tails and (2) using the previous method (no sampling of tails; the total tailed proportion was apportioned in the smallest category of entire** *Nephrops* **at auction).**

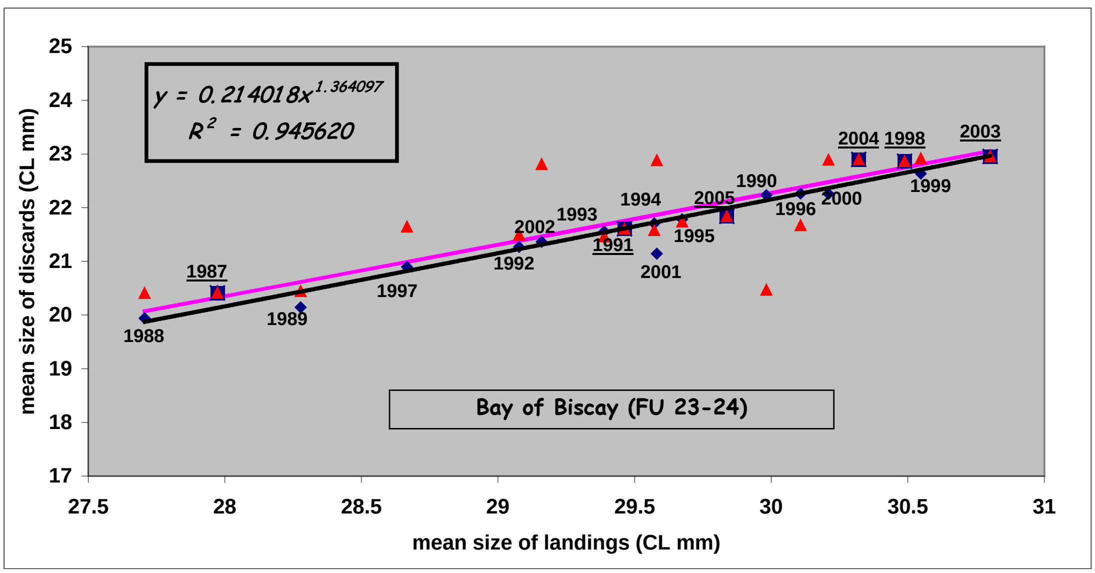



**Figure 10.** *Nephrops* **of FU23–24 (Bay of Biscay). Final results of logistic derivation of discards. Relationship between mean sizes of landings and discards. The triangular fonts represent the results of the** *status quo* **(proportional derivation) method. The underlined years correspond to the available datasets of sampling on board. The rhombus fonts correspond to the logistic derivation. The dark curve is provided by the final fitting on the whole time-series. The bright curve is the result of the fitting on the years with available data.**

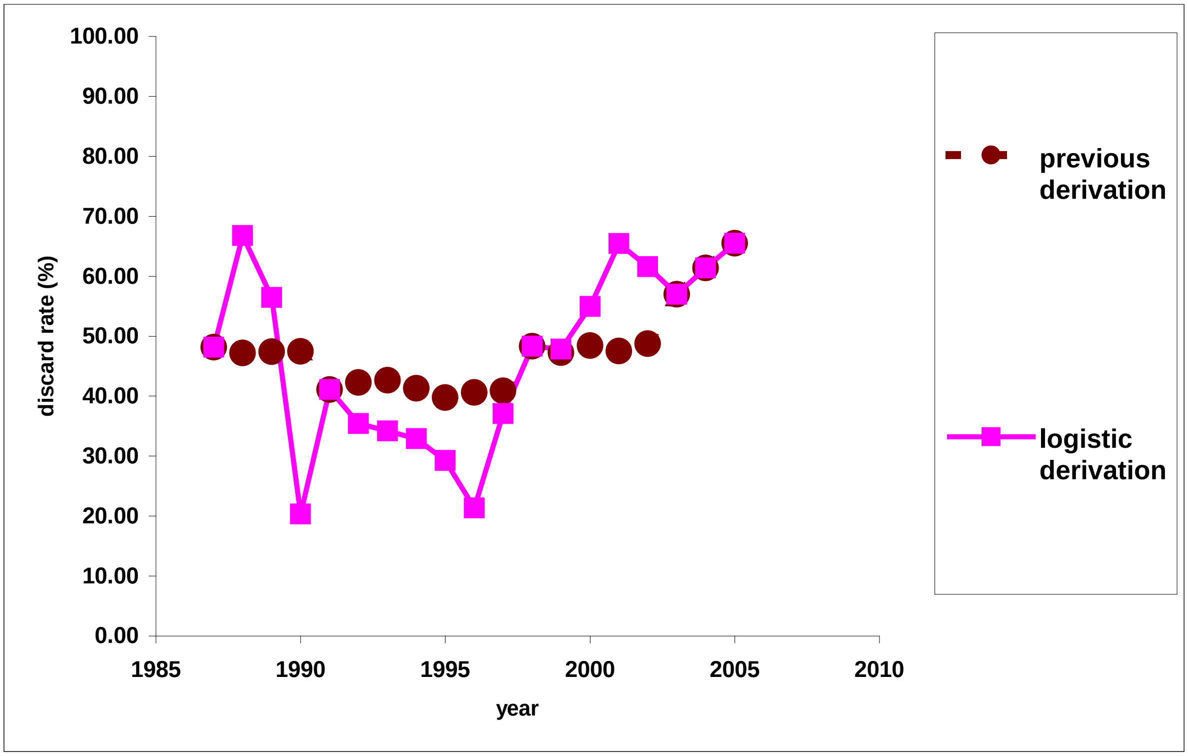



**Figure 11.** ***Nephrops*** **of FU23–24 (Bay of Biscay). Comparison between discard rates obtained by previous (proportional) derivation and by logistic derivation. Combined sexes and whole year datasets.**

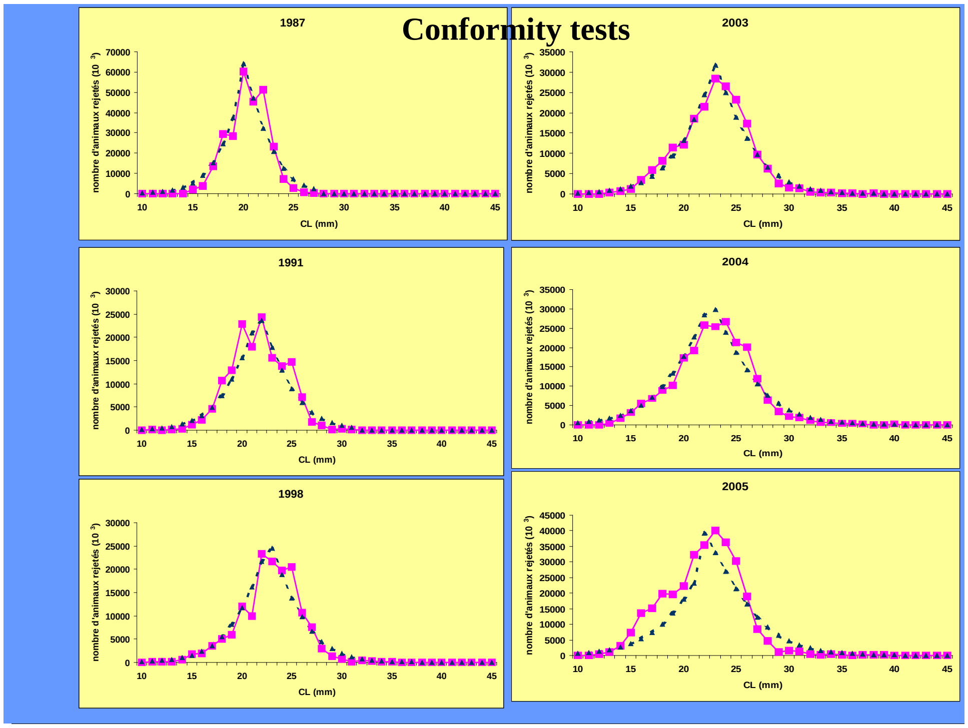



**Figure 12.** *Nephrops* **of FU23–24 (Bay of Biscay). Comparison between distributions of length frequencies (carapace length, CL in mm) of discards obtained by sampling and by simulation (broken lines).**

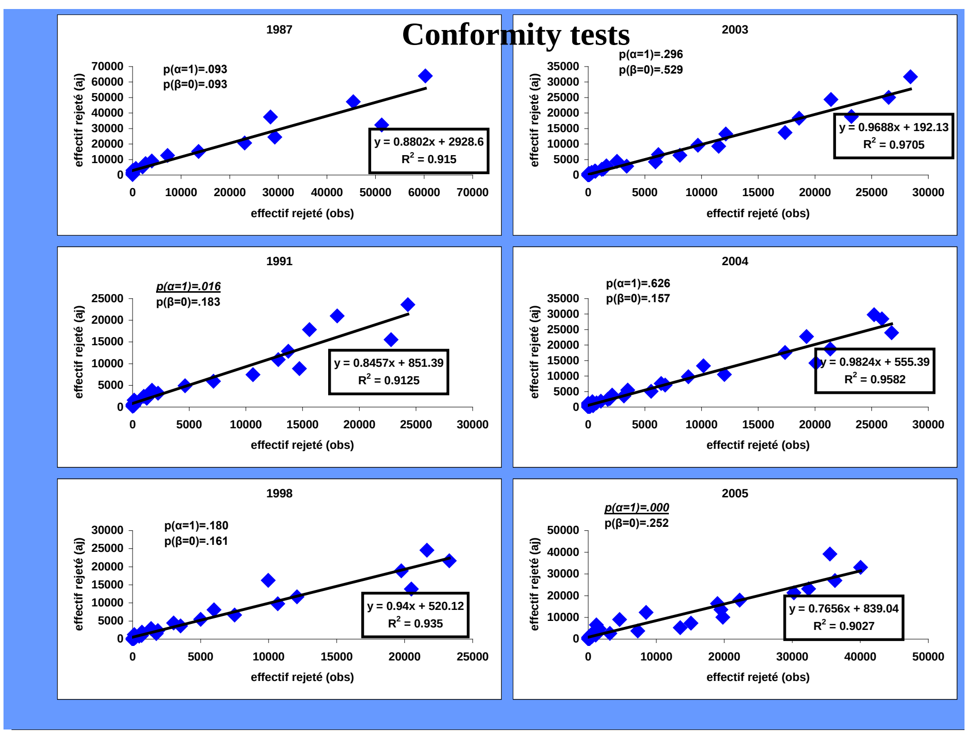
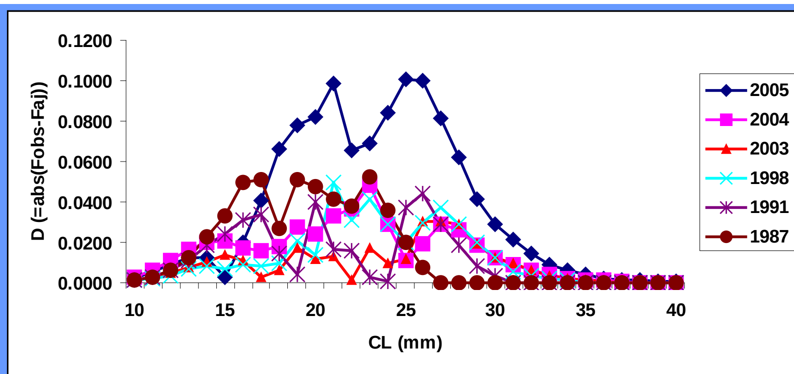



**Figure 13.** *Nephrops* **of FU23–24 (Bay of Biscay). Comparison between discarded numbers of individuals obtained by simulation (y-axis) and by sampling (x-axis). Statistical tests on linear regressions of Y vs. X by year.**




| year | Da | Dobs | % |
|---|---|---|---|
| 2005 | 0.113 | 0.101 | 85 |
| 2004 | 0.127 | 0.048 | 107 |
| 2003 | 0.135 | 0.031 | 100 |
| 1998 | 0.154 | 0.049 | 106 |
| 1991 | 0.157 | 0.044 | 97 |
| 1987 | 0.115 | 0.052 | 108 |

**Figure 14.** ***Nephrops*** **of FU23–24 (Bay of Biscay). Statistical test (Kolmogorov–Smirnov) between cumulated frequencies of sampled and simulated discards by year.**

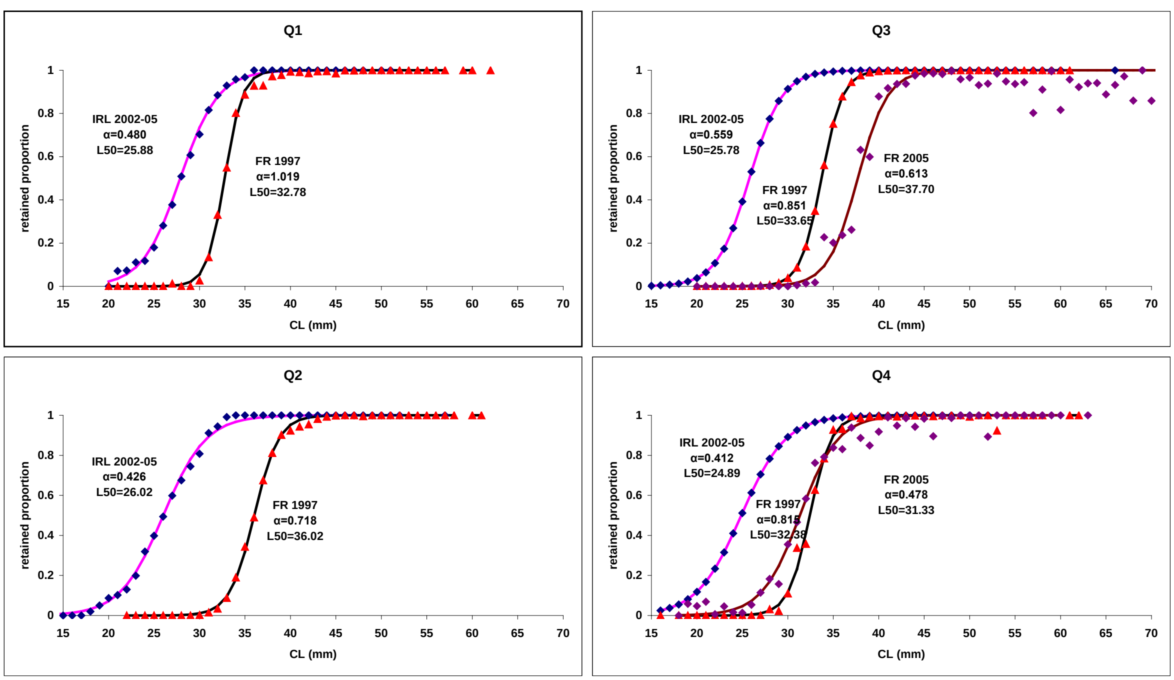



**Figure 15.** ***Nephrops*** **FU20–22 (Celtic Sea). Different hand-sorting logistic curves by quarter, country and dataset. In 2005 no sample was collected in France during the 1st quarter and 2nd quarter providing inconsistent results.**

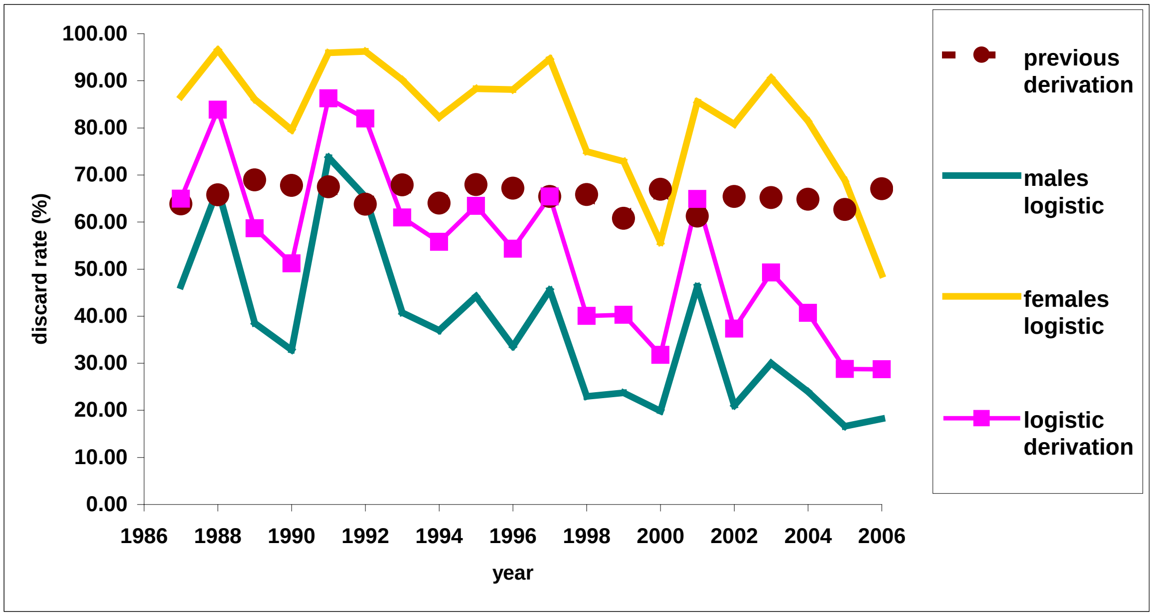
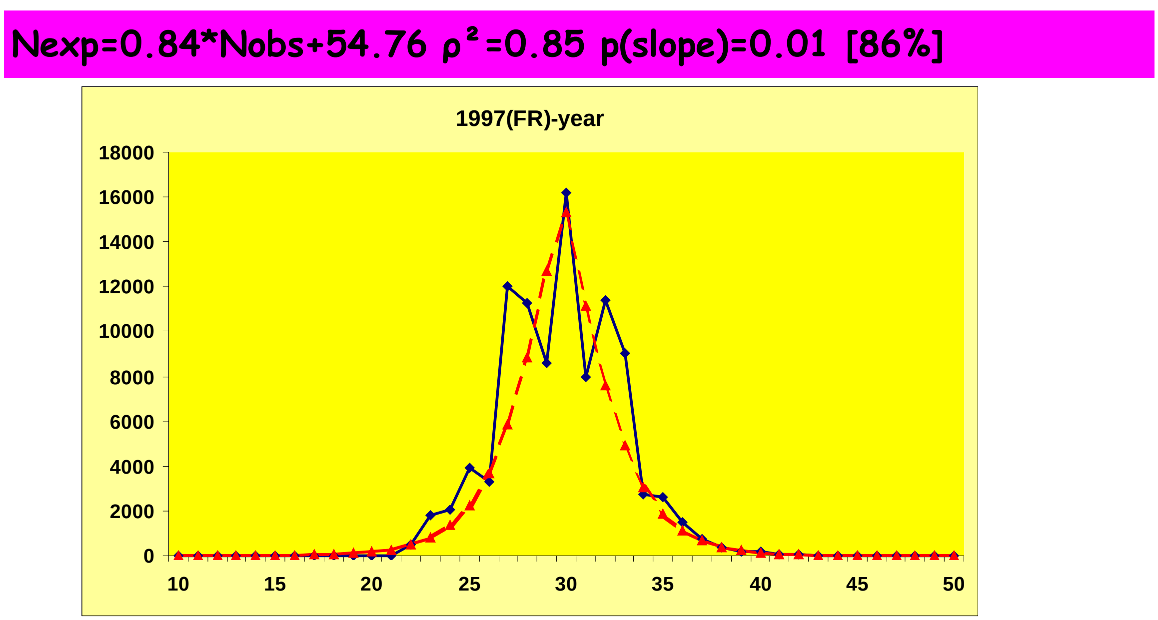



Figure 16. *Nephrops* of FU20–22 (Celtic Sea). Comparison between discard rates obtained by previous (proportional) derivation (used by WGNEPH until 2004) and by logistic derivation. Combined sexes and whole year datasets.




| year | disc | Lm | CV(Lm) | α | CV(α) | β | CV(β) | ρ² |
|---|---|---|---|---|---|---|---|---|
| 1997 | 83 306 | 29.807 | 1.29 | 32 335 | 9.42 | 0.538 | 6.43 | 0.913 |

Figure 17. *Nephrops* of FU20–22 (Celtic Sea). French fleet. Results of the discard simulation on the year 1997. The distribution is assumed symmetrical and no constraint was set on relationship between mean sizes in discards and landings. Simulated number (Nexp) illustrated by broken line are compared to sampled one (Nobs).

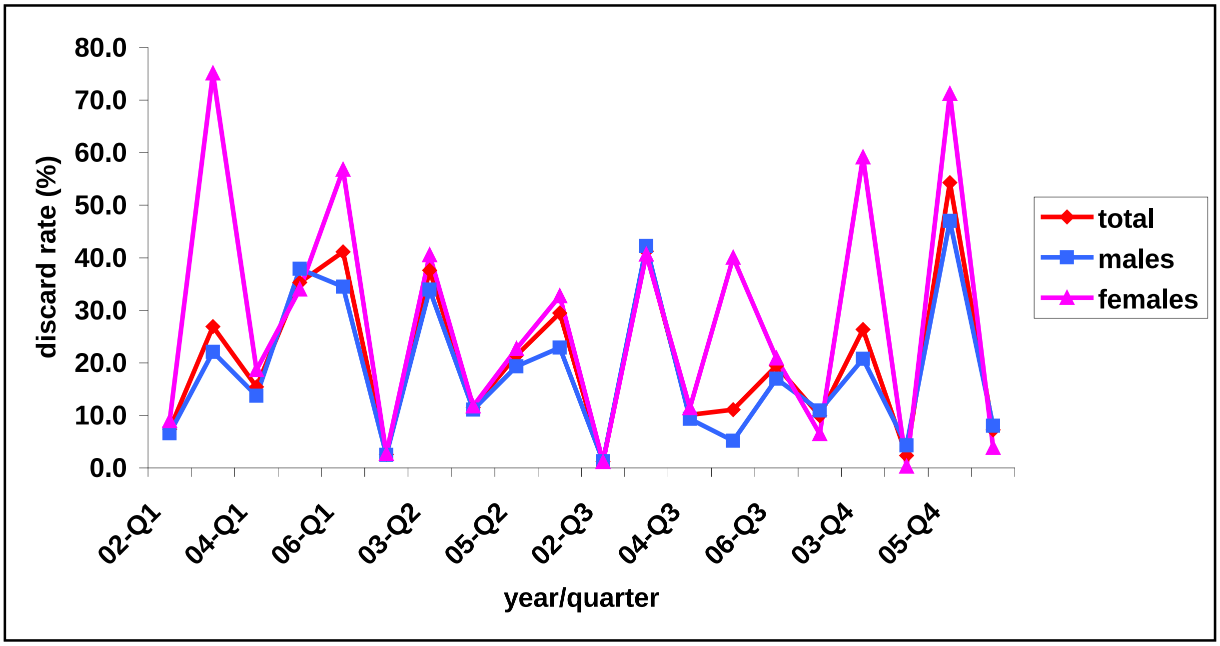



**Figure 18.** ***Nephrops*** **of FU20–22 (Celtic Sea). Discard rate (%) of Irish trawlers by year and quarter.**

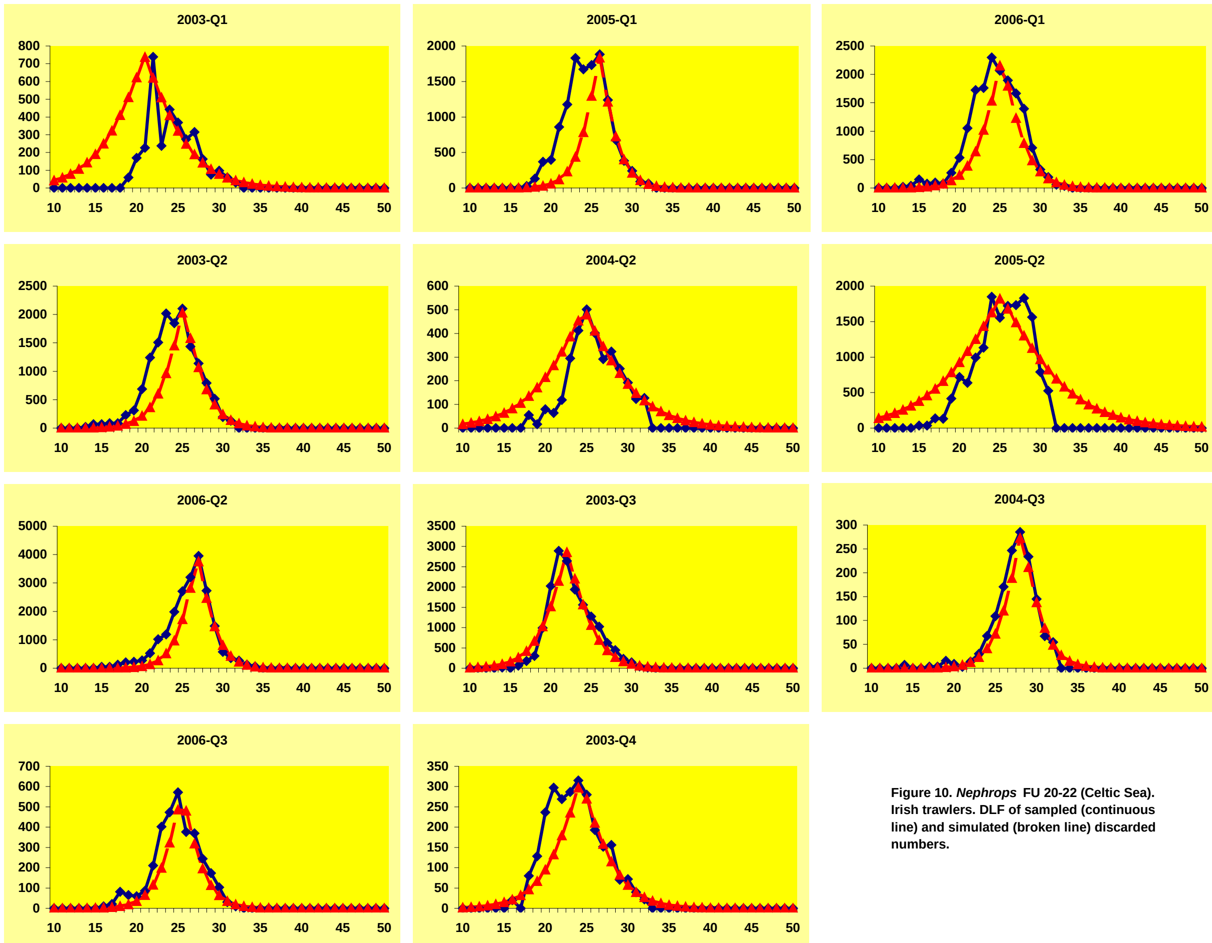



**Figure 19.** ***Nephrops*** **FU20–22 (Celtic Sea). Irish trawlers . DLF of sampled (continuous line) and simulated (broken line) discarded numbers.**

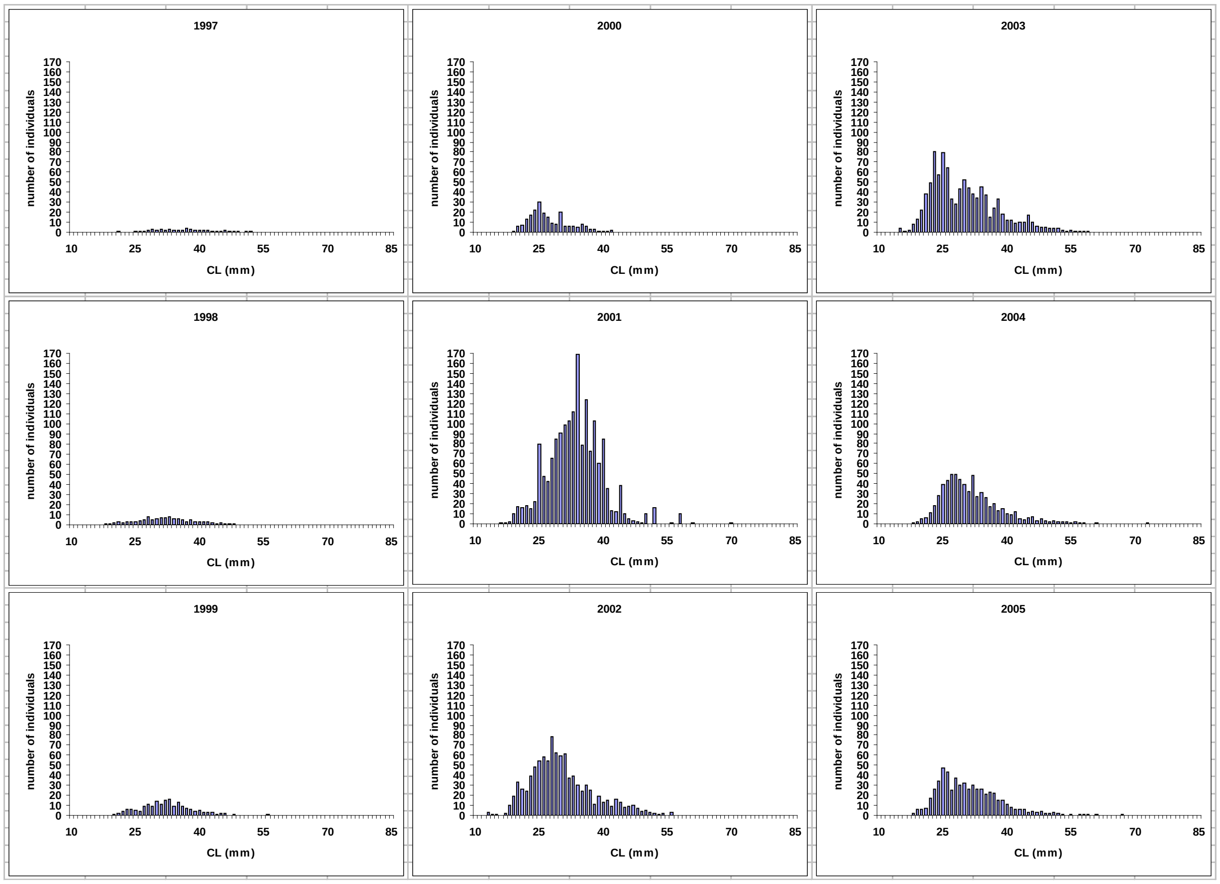



**Figure 20.** ***Nephrops*** **FU20–22. Indices of the French groundfish survey EVHOE.**

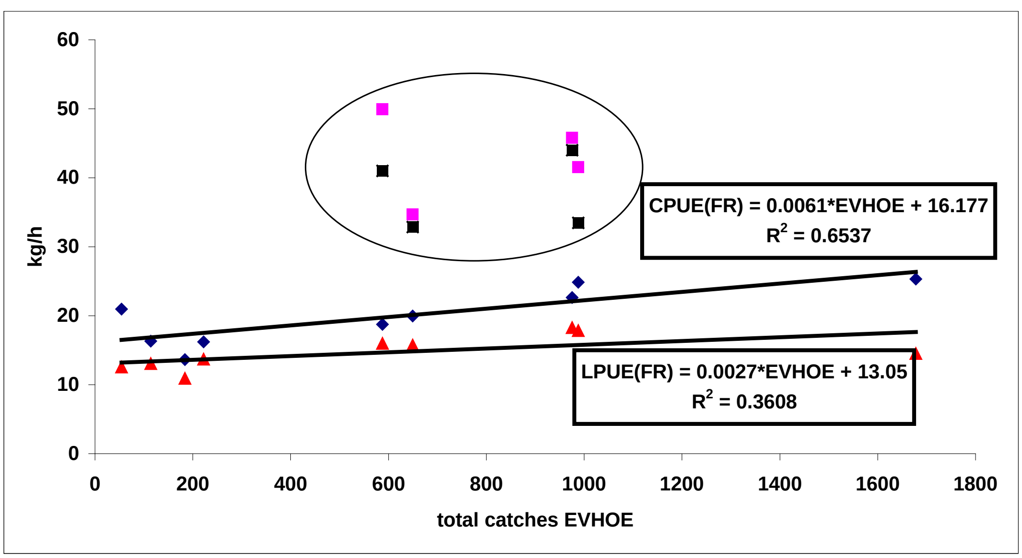



**Figure 21.** ***Nephrops*** **FU20–22. Comparison of indices EVHOE and of commercial lpue and cpue for French and Irish trawlers.**

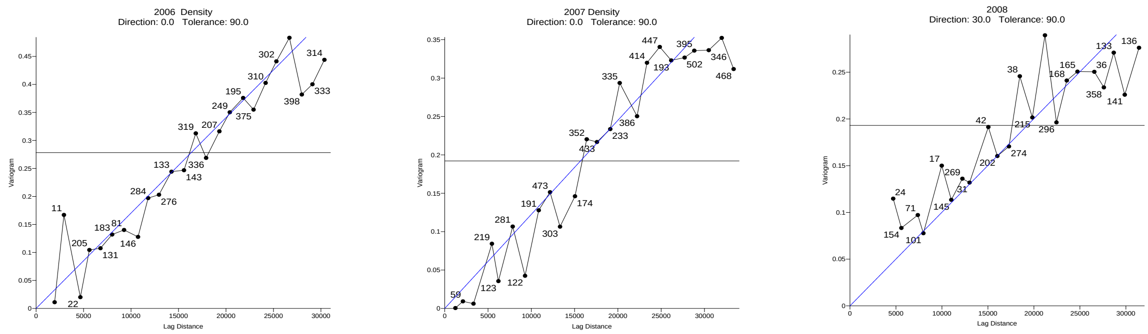



**Figure 22. Omnidirectional mean variograms for the Celtic Sea FU20–22 by year from 2006–2008.**

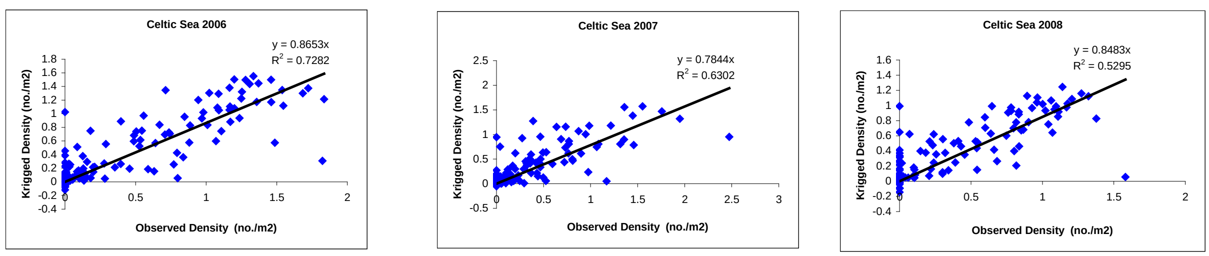



**Figure 23. Cross validation plots for the Celtic Sea FU20–22 by year from 2006–2008.**

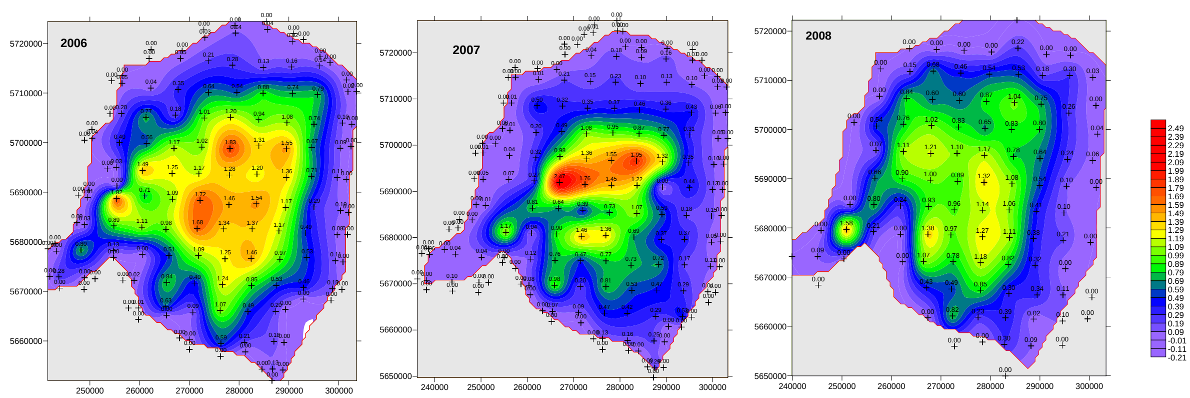



**Figure 24. Contour plots of the krigged density estimates for the Celtic Sea FU20–22 by year from 2006–2008.**

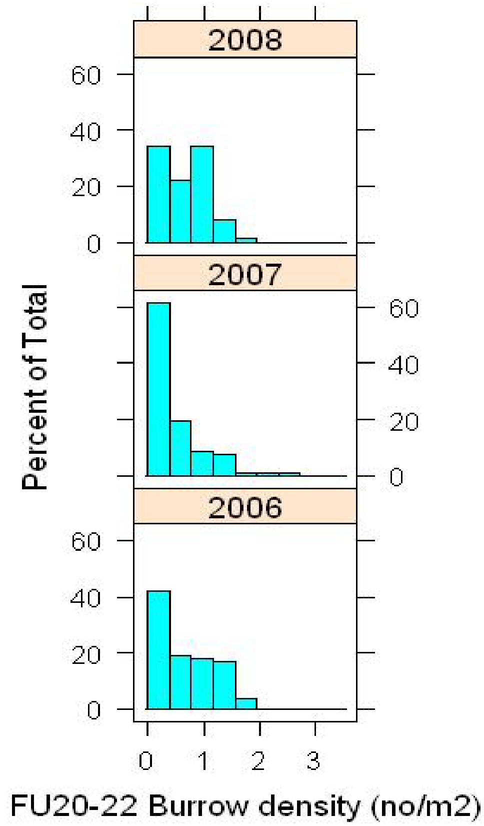



**Figure 25. Burrow density distributions for the Celtic Sea FU20–22 by year from 2006–2008.**

**Table 10. Summary geostatistics for the *Nephrops* UWTV surveys of the Celtic Sea from 2006–2008.**

| Ground | Year | Number of stations | Number of boundary points | Mean Density (No./M2) | Standard Deviation | CVgeo (%) | Var | Domain Area (m2) | Raised abundance estimate (million burrows) |
|---|---|---|---|---|---|---|---|---|---|
| Smalls | 2006 | 100 | 50 | 0.62 | 0.50 | 80% | 0.25 | 2847 | 1914 |
| Smalls | 2007 | 107 | 63 | 0.46 | 0.44 | 96% | 0.19 | 2915 | 1402 |
| Smalls | 2008 | 76 | 31 | 0.47 | 0.40 | 85% | 0.16 | 2698 | 1448 |

**Table 11. Summary statistics for the *Nephrops* UWTV survey indicator stations of the Labadie and Nymphe Bank and Seven Heads Grounds from 2006–2008.**

| Ground | Year | Number of stations | Mean Density (No./M2)* | Area Surveyed (M2) | Burrow count | Standard Deviation | 95%CI | CV |
|---|---|---|---|---|---|---|---|---|
| Labadie Bank | 2006 | 9 | 0.42 | 1,322 | 760 | 0.37 | 0.28 | 29% |
| | 2007 | - | - | - | - | - | - | - |
| | 2008 | - | - | - | - | - | - | - |
| Nymphe Bank | 2006 | 2 | 0.27 | 195 | 89 | 0.39 | 3.47 | 100% |
| | 2007 | - | - | - | - | - | - | - |
| | 2008 | - | - | - | - | - | - | - |
| Seven Heads | 2006 | 7 | 0.23 | 995 | 293 | 0.25 | 0.23 | 41% |
| | 2007 | - | - | - | - | - | - | - |
| | 2008 | - | - | - | - | - | - | - |

*random stratified estimates are given for the Labadie Bank, Nymphe Bank and Seven Heads grou

- Area not surveyed in 2007 to 2008 due to weather

# Stock Annex 7.10: Celtic Sea plaice

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Plaice (Division VIIf&g) |
| Working Group | Celtic Seas Ecoregion |
| Date | March 2011 |
| By | Chris Darby |

## A. General

### A.1. Stock definition

The degree of separation between the stocks of plaice in the Celtic Sea and the Irish Sea is unclear. Historical tagging studies indicate a southerly movement of mature fish (or fish maturing for the first time) from the southeast Irish Sea, off North Wales, into the Bristol Channel and Celtic Sea during the spawning season (Figure A1). While some of these migrant spawning fish will remain in the Bristol Channel and Celtic Sea, the majority are expected to return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002).

Very little mixing is considered to occur between the stocks (Pawson, 1995). Nevertheless, time-series of recruitment estimates for all stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) show a significant level of synchrony (Fox *et al*., 2000). This could indicate that the stocks are subject to similar large-scale environmental forces and respond similarly to them.

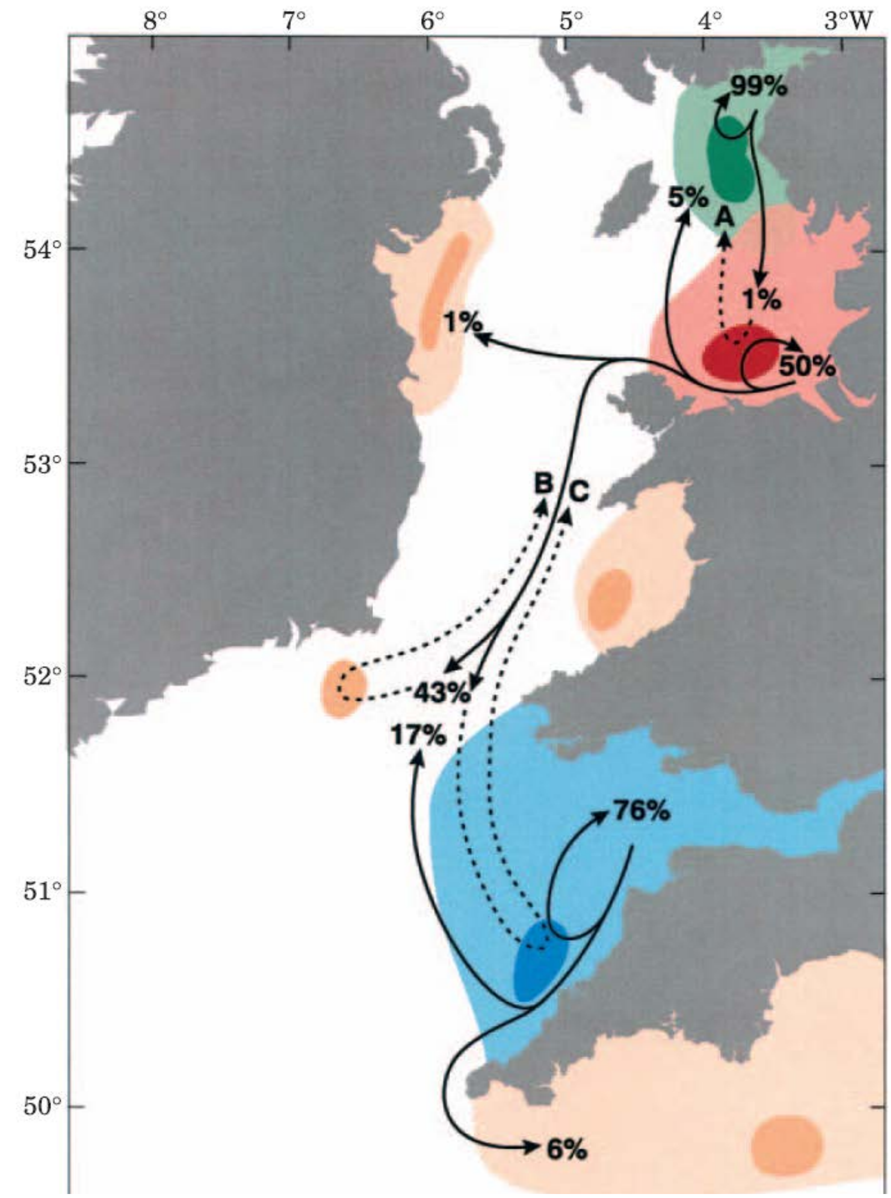



**Figure A.1. Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 were combined based on the assumption that the dispersal patterns of plaice were consistent over time. For each substock, the main feeding area (derived from tag recaptures during April–December; light shading), and the main spawning area (derived from tag recaptures during January–March, and ichthyoplankton surveys; dark shading) are indicated. The substocks tagged have been coloured green, red and blue. The substocks coloured orange are less well determined, with the feeding area around southeast Ireland unknown. Letters represent return migrations, where A ≈ 6%, and B+C ≈ 46%. Reproduced from Dunn and Pawson (2002).**

### A.2. Fishery

The main fishery is concentrated on the Trevose Head ground off the north Cornwall coast and around Land's End. Although plaice are taken throughout the year, heaviest landings are in March, after the peak of spawning, with a second peak in September. The fisheries taking plaice in the Celtic Sea mainly involve vessels from Belgium, France, England and Wales.

### A.3. Ecosystem aspects

Plaice are preyed upon and consume a variety of species through their life history. However, plaice have not as yet been included in an interactive role in multispecies assessment methods (e.g. ICES WGSAM 2008). Among other prey items, plaice typically consume large proportions of polychaetes and molluscs.

Other than statistical correlations between recruitment and temperature (Fox *et al*., 2000), little is known about the effects of the environment on the stock dynamics of plaice in the Irish Sea. Negative correlations between year-class strength of plaice (in either the Irish Sea, Celtic Sea, Channel or North Sea) and sea surface temperature are generally strongest for the period February–June. However, western (North Sea and Channel) and eastern (Irish Sea and Celtic Sea) stocks have been found to respond to different time-scales of temperature variability, which might imply that different mechanizms are operating in these stocks and/or that the Irish Sea and Celtic Sea share common spawning (Fox *et al*., 2000).

## B. Data

### B.1. Commercial catch

*Landings*

International landings-at-age data based on quarterly market sampling and annual landings figures are available from 1977. Landings rose to a maximum in the late 1980s, declined during the early 1990s, and then fluctuated around 1000 t. The decline reach a low at 390 t in 2005 following which there has been a gradual increase. Estimates of the level of discarding have been collected since 2004 and have shown a consistent increase, apart from 2007 when a substantial increase occurred by all fleets, followed by a return to the previously lower levels.

For the period 1991 to 2005 quarterly age compositions have typically represented around 70% of the total international landings, though in 2002 this fell to around 25% when age compositions were not available for the Belgian fleet. Belgian age sampling in 1993 was at a reduced level and was augmented with UK data. There was no UK sampling in the 4th quarter of 1994 and landings of 1 year olds by the UK otter trawl fleet may be underestimated in this year. Sampling levels during the earlier years in the time-series are considered to be low for all fleets and the quality of the catch data, particularly for older ages, up until around 1992 is believed to be poor. In 1995 UK age compositions for the period 1984-88 were revised using new ALKs which used data from adjacent time periods where necessary. In the 2005 benchmark assessment, it was noted that numbers-at-age 1 in the landings data were very sparse and variable, reflecting the selection on this age (and especially considering the probable substantial discarding), so the values were replaced by zero to avoid fitting to noise. Keeping age 1 in the assessment allows the survey data at age 1 to contribute.

*Discards*

Discard information was not routinely incorporated into the assessment prior to 2011. WG estimates of the combined, raised, level of discards are available from 2004, they have shown a consistent increase apart from 2007 when a substantial increase occurred in the discarding by all fleets followed by a return to the previously lower levels. Recent discard rates, although variable, are substantial in some fleets/periods. Total raised discard information is available for some fleets, and data raised to sampled vessels for others.

**B.2. Biological**

*Weights-at-age*

*Landings*

Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. In 2011 WKFLAT decided not to continue with this approach, following concerns raised by WGCSE that the quadratic smoothing was resulting in the youngest ages having heavier weights than older ages. WKFLAT 2011 rejected the use of the polynomial smoother for weights-at-age and suggested that raw catch weights are used in future. Raw data back to 1995 was obtained by WKFLAT and used to update the catch weights and stock weights files.

*Discards*

Discard weight-at-age data were available for Belgium and UK(E+W). The UK weight-at-age data were derived from data collected by Cefas for each year (2002–2009). The Belgian weight-at-age data were derived using estimates of total catch biomass and total numbers-at-age for years 2004–2009. These values were used to derive a weight-at-age matrix in grammes for an individual fish. The two national weight-at-age matrices were 'combined' to a total international matrix by weighting the individual weights-at-age for each year, by the total discard tonnages from the two countries for that year. Where only one estimate of weight was available for an age/year, then that estimate was used.

The above processes also produced estimates of discard numbers-at-age for the two countries. The UK estimates were raised to incorporate equivalent levels of discards for the 'un-sampled' countries of France, Ireland and N Ireland (on the basis of similar gear types). A raising factor based on tonnages 'landed' for these countries was calculated and applied to the UK(E+W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium to give total international discard numbers-at-age estimates.

*Stock weights*

For the years 2004–2009 where discard estimates were available, a revised set of stock weights-at-age were calculated. The stock weights-at-age based on landings, with SOP correction but no 'fitting,' were combined with the international discard weights-at-age data. These were weighted by the relative landed or discarded international annual tonnages. The international annual discard tonnage was not readily available, as the 'unsampled' countries did not have estimates. These were derived using the ratio of UK(E+W) tonnages of landings and discards and this ratio was applied to these unsampled nations landings to produce an estimate of total discard biomass for each of these countries. For the years prior to 2004, a revised set of stock weights-at-age data based on the international landings only was produced. These new values were based on the 'observed' weight data, but were SOP corrected. For this series of data, the 'smoothing' of the data by fitting a curve through the observed data was removed.

#### *Natural mortality and maturity ogives*

Initial estimates of natural mortality (0.12 yr all years and all ages, from tagging studies) and maturity were based on values estimated for Irish Sea plaice. A new maturity ogive based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

| Age | 1 | 2 | 3 | 4 | 5+ | |
|---|---|---|---|---|---|---|
| Historic maturity | | 0 | 0.15 | 0.53 | 0.96 | 1.00 |
| Revised maturity | | 0 | 0.26 | 0.52 | 0.86 | 1.00 |

The proportion of mortality before spawning was originally set at 0.2 since approximately 20% of the total catch was taken prior to late February–early March, considered to be the time of peak spawning activity. The proportion of F and M before spawning was changed to zero at the request of ACFM in 1996 as it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium-term projections. No updated information was provided to WKFLAT and the estimates were retained.

### B.3. Surveys

Indices of abundance are available from the UK (BTS-Q3) beam trawl survey in VIIf and the Irish Celtic Explorer IBTS survey (IBTS-EA-4Q).

The UK(E&W) beam trawl survey-series that began in 1988; since 1991, tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997, values for 1988 to 1990 were raised to 30 minute tows. However, data for 1988 and 1989 were of poor quality and gave spurious results: thus the series was truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the WG in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

Recent data have shown less correlation between ages than the historic time-series which should be monitored in case it is a developing problem. The log catch curves show good consistency over time and the reduction through time of the negative slope indicates that mortality rates have been declining.

The IGFS is a demersal trawl survey which started in 2003. It is coordinated through ICES International Bottom Trawl (IBTS) working group, providing annual indices of abundance for commercially exploited groundfish stocks on the Irish continental shelf

(ICES VIa, VIIb,g,j) for Q3–4. Plaice are caught by the survey off the SE coast up to, and just over, the border of VIIg with VIIa (ICES rectangles (32E2, 32E3).

Year effects in the survey catch rates dominate the abundance indices. The year-class and catch curve plots illustrates that the consistency of plaice year-class abundance estimates at each age is relatively poor. The survey was not fitted within the assessment model, but will be monitored as the time-series progresses.

#### B.4. Commercial lpue

Commercial tuning indices of abundance from the UK(E&W) beam trawl and otter trawl data are used in the assessment to provide information on the oldest ages in the population. Historically, only ages 4–8 have been used to calibrate the assessment because of concerns about the level of discarding at the youngest ages. The data show good historical consistency of year-class estimates throughout the time-series, especially for the beam trawls, with more noise resulting from two major year effects in the otter trawl data.

### C. Stock assessment

Historically the stock was assessed using XSA, under the assumption that discarding had a minimal effect on the estimates. Recent increases in the level of discarding led to this assumption being untenable and so at the 2011 WKFLAT discard estimates were introduced to the assessment fitted using the AP model. The settings and data for the model fits are set out in the table below:

| ASSESSMENT YEAR | | 2011 WKFLAT |
|---|---|---|
| Assessment model | | AP |
| Catch data | | Including discards<br>1990–2009 |
| Tuning fleets | UK(E&W)-BTSurvey | 1990–2009 ages 1–5 |
| | UK commercial beam trawl | 1990–2009 ages 4–8 |
| | UK commercial otter trawl | 1990–2009 ages 4–8 |
| | Ire GFS Q3/4 | Series omitted |
| Selectivity model | | Linear Time Varying Spline-at-age (TVS) |
| Discard fraction | | Polynomial Time Varying Spline-at-age (PTVS) |
| Landings num-at-age, range: | | 1–9+ |
| Discards num at age, year range, age range | | 2004–2009, ages 1–8+ |

Three AP models which could not be distinguished in terms of the AIC, similar residual patterns and fits to the dataseries; the TI_PTVS, TI_TVS and TV_PTVS models. WKFLAT 2011 concluded that the TV_PTVS model, which allows for variation in time in the selection patterns of both landings and discards, was the most plausible model; given the known changes in gear types and discarding. However, it was not statistically distinguishable from the models which maintain the landings selection pattern as constant throughout the time-series.

Comparison of the management and stock metrics from the three model fits showed very similar time-series trends in the estimates of fishing mortality, SSB and total estimated discards. WKFLAT therefore concluded that:

1 ) Due to the change in estimated fishing mortality when discards are included within the model fit, that discards should be retained within the assessment model structure.
2 ) Given that the time-series of discard data to which the models are fitted is short and that, consequently, there are likely to be changes in the management estimates as discard data are added in subsequent years, no definitive model structure can be recommended at this stage in the development process.
3 ) The most flexible of the models TVS_PTVS should be used as the basis for advice; in terms of relative changes in estimated total fishing mortality and biomass.
4 ) The other two models which provide similar structures should continue to be fitted at the WG to provide sensitivity comparisons.
5 ) As the dataseries are extended a final model selection can be then determined.

### D. Short-term projection

For short-term forecasts based on the revised assessment it is recommended that the current methods be applied to the populations and fishing mortalities (separated into discard and landings mortalities) derived from the PV_TVS model (assuming that the previously discussed sensitivity analyses do not indicate a change of model); in order to provide indications of the expected trends in discards, landings and spawning biomass.

### E. Medium-term projections

Medium-term projections are not carried out for this stock.

### F. Yield and biomass per recruit/long-term projections

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts. Currently the YPR calculations are used as a basis for determining the catch option for advice.

### G. Biological reference points

The addition of discards increases the estimates of spawning biomass in the most recent years following the increased estimates of discards in time. Similarly fishing mortality averaged across ages 3–6, which include ages that are discarded also increases. Previous BRPs may therefore not be consistent with new assessment methodology and should not be used until the assessment methodology is considered sufficiently stable (a longer time-series of discard data) to evaluate new reference levels.

### H. References

Fox, C.J., Planque, B.P., and Darby, C.D. 2000. Synchrony in the recruitment time-series of plaice (*Pleuronectes platessa* L) around the United Kingdom and the influence of sea temperature. Journal of Sea Research 44: 159–168.

Pawson, M.G. 1995. Biogeographical identification of English Channel fish and shellfish stocks. Fisheries Research Technical Report No. 99. MAFF Directorate of Fisheries Research, Lowestoft. http://www.cefas.co.uk/Publications/techrep/tech99.pdf

Sideek. 1981. The estimation of natural mortality in Irish Sea plaice (*Pleuronectes platessa* L.) using tagging methods. 206 pp.

# Stock Annex 7.15: Whiting VIIe–k

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Whiting VIIe–k |
| Working Group | Celtic Sea Ecoregion |
| Date | 17 May 2010 |
| Revised by | Sarah Davie |

## A. General

### A.1. Stock definition

The degree of separation of whiting stocks between the Irish Sea, and ICES Divisions VIIb–c from the Celtic Sea, is currently unclear. SAMFISH (EU Study Contract 99-009, Improving sampling of western and southern European Atlantic Fisheries) described the stock unit as follows:

The main spawning areas of whiting in the Western Channel and Celtic Sea are off Start Point, off Trevose Head and southeast of Ireland. The spawning season is from February to May, and the larvae are found in midwater before moving to live near the seabed by September. For the next two years, juvenile whiting are found in shallow coastal and estuarine areas, being particularly abundant around Start Point. Nearly 4000 adult whiting were tagged and released off Start Point during August 1958 and 1960. Most returns were within three months of release and demonstrated little indication of movement. Subsequent recaptures indicated more movement of whiting into the Celtic Sea than between the western and eastern Channel. Whiting released in summer between 1957 and 1961 near Carmarthen Bay moved south and west towards the two spawning grounds off Trevose and southeast of Ireland. There was no evidence of emigration out of the Celtic Sea area. Returns of whiting tagged and released in the County Down spawning area in the Irish Sea demonstrate more movement south into the Celtic Sea than north to the west of Scotland.

### A.2. Fishery

Whiting in Divisions VIIe–k are taken as a component of catches in mixed trawl fisheries. Whiting landings through the mid 1980s totalled between 10 000 t and 15 000 t, through the mid to late 1990s landings were elevated to around 20 000 t. Since the turn of the century, landings have been in decline and are now below 10 000 t. Through the 1980s and early 1990s France accounted for around 60–85% of landings. While Ireland accounted for between 10% and 20% of landings, the UK 10%, and Belgium had minimal contribution (1–2%). Landings from both the UK and Belgium have remained at similar levels over time. Since the early 1990s Ireland has accounted for a greater proportion of landings. Proportions since 2004 have been similar to France whose landings have been falling since the turn of the century.

French landings are made mainly by gadoid trawlers, which prior to 1980 were mainly fishing for hake in the Celtic Sea. Irish demersal trawlers from Dunmore East and Castletownbere and other ports in southwest Ireland have traditionally targeted Celtic Sea whiting in a mixed trawl fishery. In response to poor catches in other areas vessels have been attracted into this fishery in recent years from County Donegal.

A detailed description of the Irish fishery is given in the annual WD to WGSSDS: 'A summary of the Irish Fishery and Sampling of Whiting in VIIe–k'.

### A.3. Ecosystem aspects

No relevant information has been made available to the Working Group.

## B. Data

### B.1. Commercial catch

Data on international landings-at-age and mean weight-at-age are available for Irish, French and UK fleets from 1999 to present. The following procedures have been applied to aggregate the data for the areas VIIe, VIIfgh and VIIj,k and build the database for VIIe–k. UK VIIe–k data were used to scale catch numbers according to the landings for each area. French VIIf,g,h data were used with Irish VIIg data to scale VIIf,g,h catch numbers. Irish VIIj data were used to scale VIIj,k catch numbers. The table below demonstrates the data available and the procedures used to derive quarterly length compositions, age compositions and mean weights-at-age.

| | | Data source: | | | | |
|---|---|---|---|---|---|---|
| Division | Data | UK | France | Ireland | Belgium /Other | Derivation of international landings: |
| VII e | Length composition | VIIe–k | | | | |
| | ALK | VIIe–k | | | | |
| | Age Composition | VIIe–k | | | | UK raised |
| | Mean weight-at-age | VIIe–k | | | | UK VIIe–k |
| | Landings | VIIe | VIIe | VIIe | VIIe | |
| VII f,g,h | Length composition | VIIe–k | VIIf,g,h | VIIg | | |
| | ALK | VIIe–k | VIIf,g,h | VIIg | | |
| | Age Composition | VIIe–k | VIIf,g,h | VIIg | | (UK + FR+ IRL) raised to international landings |
| | Mean weight-at-age | VIIe–k | VIIf,g,h | VIIg | | Weighted mean by numbers caught |
| | Landings | VIIf,g,h | VIIf,g,h | VIIf,g,h | VIIf,g,h | |
| VII j,k | Length composition | | | VIIj | | |
| | ALK | | | VIIj | | |
| | Age Composition | | | VIIj | | IRL raised |
| | Mean weight-at-age | | | VIIj | | IRL VIIj |
| | Landings | VIIj,k | VIIj,k | VIIj,k | VIIj,k | |
| VII e,f,g,h,j,k | Length composition | | | | | |
| | ALK | | | | | |
| | Age Composition | | | | | VIIe + VII fgh + VIIjk |
| | Mean weight-at-age | | | | | Weighted mean by numbers caught |
| | Landings | | | | | VIIe + VII fgh + VIIjk |

### B.2. Biological

Age group 0 is included in the assessment data to allow inclusion of 0-group indices in the XSA, although in most years, no landings are recorded. Very small landings of 0-group whiting were not included in the catch-at-age datafile to avoid spurious F-shrinkage effects at this age. Mean weights-at-age in the catch were derived by combining French, Irish and English data, weighted by the numbers landed at-age.

Mean weight-at-age in the stock are taken as mean weights-at-age in the quarter 1 catch. Where age 1 was poorly represented in quarter 1 landings, quarter 2 values were used as estimates of mean weight-at-age 1 in the stock. Stock weights-at-age are smoothed using a three year rolling average across ages to dampen the noise exhibited by the stock weight dataset. This approach is also used in Irish Sea whiting and Celtic Sea haddock.

Natural mortality is assumed to be 0.2 over all age groups and years.

Maturity data collected in the Celtic Sea in November 2002 during the French EVHOE survey were presented to the WG (Working Document 1: WGSSDS 2003). Results indicated 13% of age 1 fish are mature, 97% at-age 2, and 100% at-age 3 and older. These results are similar to previous assumptions of knife-edged maturity at-age 2. Exploratory analyses indicated that use of the French maturity ogive made little impact on the assessment. The WG therefore retained the assumptions of knife-edged maturity at-age 2. Since 2006 the knife edge maturity ogive has been replaced with indices calculated based on data from the UK WCGFS (Working Document 3: WGSSDS 2006) but a fixed vector is still used. Maturity sampling by Ireland and the UK on dedicated surveys confirms the use of this ogive but is insufficient to provide annual data.

The proportions of F and M before spawning were both set to zero to reflect the SSB calculation date of 1 January.

The knife edge maturity ogive was replaced with new indices calculated based on data from the UK WCGFS as detailed in WD 3, WGSSDS, 2006.

| Age | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| Maturity | 0 | 0.39 | 0.90 | 0.99 | 0.99 | 1.00 |

### B.3. Surveys

The following surveys are available as survey tuning data input for the assessment of whiting VIIe–k:

- UK-WCGFS, 1987–2004

  The March UK groundfish survey was extended in 1992 to provide better coverage for gadoids in VIIf,g. The whiting tuning data calculated from this survey is for VIIf,g. The survey was carried out on the RV Cirolana until 2003. In 2004 it was carried out on the RV Endeavour and discontinued thereafter. The survey fished fixed station positions allocated by area and depth strata. The survey used a modified Portuguese High-Headline trawl (PHHT) with 350 mm rubber bobbins, a bunt tickler chain and a 20 mm codend liner. The mean log standardized index by year demonstrated some evidence of positive catchability in the last three years of the survey (2002–2004) and cohort tracking in the mean standardized index up to then was very noisy in the last three years. These years were not included in the final assessment.

- UK-BCCSBTS-S, 1988–2001

  The Autumn UK Bristol Channel beam trawl survey (VIIf) is commercially rigged (1989 style) with 4 m beam trawl fitted with a chain mat, flip-up ropes, and a 40 mm codend liner. The gear is towed at 4 knots (ground speed) for 30 minutes. This survey provides information for age 0 and age 1 whiting.

- FR-EVHOE, 1997–present

This fourth-quarter annual groundfish is carried out on the RV Thalassa. Age data are available from 2001 onwards. The sampling design is a stratified random allocation. The number of hauls per stratum is optimized by a Neyman allocation taking into account the most important commercial species in the area (hake, monkfish and megrim). The fishing gear used is a GOV with an average vertical opening of 4 m and a horizontal opening of 20 m.

- IR-WCGFS, 1993–2002

The fourth-quarter Irish west-coast groundfish survey (WCGFS) was carried out in VIaS and VIIbj on chartered commercial vessels. The sampling design attempted to allocate at least two stations per rectangle. Stations were selected randomly within each rectangle from known clear tow positions. A Rock-hopper GOV with 12 inch discs was used. The nets were fitted with a 20 mm codend liner. This survey was discontinued after the 2002 survey, giving way to a new Irish groundfish survey on board the RV *Celtic Explorer*.

- IR-ISCSGFS, 1997–2002

Ireland commenced a Celtic Sea research vessel survey on board the RV *Celtic Voyager* in 1997 carried out in VIIa and VIIg. The survey used a GOV Trawl with a mean vertical opening is 6 m and door spread 48 m. Data from this survey (IR-ISCSGFS) were presented for the first time to the 2003 WG. The data made available were from prime stations only in a limited area of Division VIIg. The survey was discontinued after the 2002 survey, giving way to a new Irish groundfish survey on board the RV *Celtic Explorer*.

- IR-GFS 7g and j, 2003–present

Ireland commenced a new fourth quarter survey in 2003 on board the RV *Celtic Explorer* which covers VIaS, VIIbgj as part of the internationally coordinated, Quarter 4 IBTS survey programme. The IGFS has a random stratified design and uses a GOV (with rock-hopper in VIa) with a 20 mm codend liner. This is a substantially different design to the Irish Sea/Celtic Sea groundfish survey (IR-ISCSGFS) it replaces. Data from this survey (IR-GFS) were presented for the first time to the 2004 WG.

- IR-IGFS Swept Area, 1999–present

This survey index constitutes a combination of the IR-ISCSGFS and IR-GFS surveys in the area of overlap between them (VIIg). The two surveys were standardized using a swept-area estimate of catches, described in WD 5 (WGSSDS 2006). This survey was presented for the first time to the 2006 WG. The mean standardized index by year demonstrated good tracking of the strong 1999 year class to age 7 with the exception of age 4 in 2003. Although the source data were checked, this is probably an anomaly of the year effect in 2003. This point has been removed from recent assessments to ensure the survey gets higher scaled weight in further runs. This compromise is not ideal but given the short time-series of the survey and apparently good performance otherwise the WG considered that the survey should be a good index for this stock.

### B.4. Commercial cpue

Information on effort, and whiting landings and lpue are available from a number of commercial fleets. This includes two French (gadoid and *Nephrops* directed) since 1983, four Irish (VIIj, and VIIg otter trawlers, and Scottish seines) since 1995, in addition to effort only from UK England and Wales VIIe–k beam trawlers and VIIe–k otter trawlers since 1983.

Across the majority of commercial fleets lpue has fallen over time, as is the case with landings. In the mid 1990s at the start of the Irish Scottish seine dataseries lpue was high, falling steeply over several years. Lpue continues to remain at these lower levels with some annual fluctuation. In relation to otter trawlers, the French gadoid directed fleet consistently revealed the highest lpue. This too has declined over the period of data available to levels half those of the early 1980s. The Irish VIIg otter trawl fleet is the only one to demonstrate an overall increasing lpue trend although the increase has been relatively small.

### B.5. Other relevant data

No other relevant data to report.

## C. Historical stock development

Data screening: Exploratory data analysis carried out using FLR. A separable VPA was performed using the Lowestoft VPA95 software to screen for outliers in the catch numbers.

Model used: XSA

Software used: FLR under R version 2.4.1 in conjunction with FLCore 1.4–3, FLAssess 1.4.1, FLXSA 1.4–2 and FLEDA 1.4–2

Lowestoft VPA95 software also for XSA and separable VPA

Model Options:

| Option | Setting |
|---|---|
| Ages catch dep stock size | None |
| Q plateau | 5 |
| Taper | No |
| F shrinkage SE | 1.00 |
| F shrinkage year range | 5 |
| F shrinkage age range | 3 |
| Fleet SE threshold | 0.50 |
| Prior weights | No |

Input data types and characteristics:

| Type | Name | Year range | Age range | Variable year to year |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1982–current | 0–7+ | Yes |
| Canum | Catch-at-age in numbers | 1982–current | 0–7+ | Yes |
| Weca | Weight-at-age in the commercial catch | 1982–current | 0–7+ | Yes |
| West | Weight-at-age of the stock at spawning time | 1982–current | 0–7+ | Yes: |
| Mprop | Proportion of natural mortality before spawning | 1982–current | 0–7+ | No |
| Fprop | Proportion of fishing mortality before spawning | 1982–current | 0–7+ | No |
| Matprop | Proportion mature-at-age | 1982–current | 0–7+ | No |
| Natmor | Natural mortality | 1982–current | 0–7+ | No |

Tuning data:

| Type | Name | Year range | Age range |
|---|---|---|---|
| Tuning fleet 1 | FR-Gadoid Late | 1993–current | 3–6 |
| Tuning fleet 2 | FR-*Nephrops* | 1993–current | 3–6 |
| Tuning fleet 3 | FR-EVHOE | 1997–current | 0–4 |
| Tuning fleet 4 | UK-WCGFS | 1987–current | 1–6 |
| Tuning fleet 5 | IR-IGFS Swept area | 1999–current | 0–6 |

Settings for each assessment since 1999 are detailed in Table 1. Trial runs have, over the years, explored most of the options with regards XSA settings. This stock has not had a benchmark assessment; however exploratory assessments have been carried out within the WGSSDS up until 2007.

### D. Short-term projection

Model used: Multi Fleet Deterministic Projection

Software used: MFDP1a

Initial stock size: initial stock numbers derived from XSA analyses. Numbers-at-age 0 are not considered to be well estimated and are replaced with a geometric mean of the full time-series (1982–2007). Recruitment has been at a low level since 1995 with the exception of the 1999 year class. The two most recent years have displayed good recruitment, with last year’s being revised downward. Recruitment is solely estimated from the FR-EVHOE and IR-GFS7gSweptArea surveys, in recent years the French survey estimates have been far higher than those of the Irish survey. Because of these reasons the geometric mean is used.

Natural mortality: That used in the assessment

Maturity: Maturity ogive used in the assessment

F and M before spawning: Those used in the assessment method

Weight-at-age in the stock: Unscaled 3 year arithmetic mean

Weight-at-age in the catch: Unscaled 3 year arithmetic mean

Exploitation pattern: Unscaled 3 year arithmetic mean (though alternative options may be used depending on recent F trajectories and the Working Group's perception of the fishery).

Intermediate year assumptions: *Status quo* F

Stock–recruitment model used: Geometric mean of full time-series (1982 to present-1) for age 0 recruitment

$F_{bar}$: That used in the assessment

### E. Medium-term projections

None.

### F. Long-term projections

Model used: Multi Fleet Yield-per-recruit

Software used: MFYPR2a

Yield-per-recruit calculations are conducted using the same input values as those used for the short-term forecasts.

### G. Biological reference points

A summary of reference point proposals to date, their technical basis and currently adopted reference points is given in the text Table below:

| | WG 1998 | ACFM 1998 | WG 2000 | ACFM 2000 |
|---|---|---|---|---|
| $F_{lim}$ | No Proposal | No Proposal | 1.18 ($F_{lim}=F_{loss}$) | No Proposal |
| $F_{pa}$ | No Proposal | No Proposal | 0.72 ($F_{pa}=F_{lim} \times e^{-1.645 \times 0.3}$) | No Proposal |
| $B_{lim}$ | 15,000 t | 15,000 t | 15 000 t ($B_{lim}=B_{loss}$) | 15,000 t ($B_{lim}=B_{loss}$) |
| $B_{pa}$ | 18,000 t | 21,000 t | 21 000 t ($B_{pa}=B_{loss} \times 1.4$) | 21,000 t ($B_{pa}=B_{loss} \times 1.4$) |

The technical basis of ACFM's 1998 $B_{pa}$ proposal is given below (1999 WG text):

$B_{pa} = B_{lim} \times 1.4 = 21\,000$ t. In the past the WG have selected MBAL as 18 000 t based on evidence of reduced recruitment at SSB's <18 000 t. However this MBAL is driven by a period of low recruitments at low SSB in the earlier years of the time-series (1982–1985) when the data are probably not reliable. Examination of the stock–recruit plot provides no compelling evidence of reduced recruitment below SSB of 18 000 t.

The technical basis of the WG's 2000 $F_{lim}$ and $F_{pa}$ proposals are given below:

On the basis of results obtained from a LOWESS fitted non-parametric stock and recruitment relationship and the derived equilibrium SSB and yield curves with the original data trajectories the 2000 Working Group considered that $F_{pa}$ and $F_{lim}$ could be defined because $F_{loss}$ appeared reasonably estimated. However, taking into account the uncertainties in the data the 2000 Working Group decided to use 0.3 as the SE in calculation of $F_{pa}$ from $F_{loss}$. The technical basis for the proposed reference points are defined below:

$F_{lim} = F_{loss}$ (1.18 in this year's assessment)
$F_{pa} = F_{lim}$ x e-1.645*0.3 = 0.72

The currently adopted reference points are as follows:

| | Current Reference Points | |
|---|---|---|
| **$F_{lim}$** | No Proposal | |
| **$F_{pa}$** | No Proposal | |
| **$B_{lim}$** | 15,000 t | ($B_{LIM} = B_{LOSS\ 1983}$, $ACFM_{1998}$) |
| **$B_{pa}$** | 21,000 t | ($B_{PA} = B_{LOSS\ 1983}$ x 1.4) |

## H. Other issues

No other issues.

## I. References

**Table 1. Model settings/Input data/Tuning data.**

| | | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Catch date range:*** | ***Years*** | 82-98 | 82-99 | 82-00 | 82-01 | 82-02 | 82-03 | 82-04 | 82-05 | 82-06 | 82-07 | 82-08 |
| | ***Ages*** | 1-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ | 0-7+ |
| ***Assmnt Method:*** | | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA |
| ***Fbar Age Range:*** | | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 | 2-5 |
| ***Time taper:*** | | No | No | No | No | No | No | No | No | No | No | No |
| ***Q plateau age:*** | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 |
| ***F shrinkage S.E:*** | | 0.8 | 2.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1 | 1 | 1 |
| | ***Num yrs*** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | ***Num ages*** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| ***Fleet S.E:*** | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ***Commercial Tuning Fleets:*** | | | | | | | | | | | | |
| *FR-Gadoid* | *Yrs* | 89-98 | 90-99 | 93-00 | 82-92 | 82-92 | 82-92 | 83-92 | 83-05 | | | |
| | *Ages* | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | 3-6 | | | |
| *FR-Gadoid Late* | *Yrs* | | | | 93-01 | 93-02 | 93-03 | 93-04 | | 93-06 | 93-07 | 93-08 |
| | *Ages* | | | | 3-6 | 3-6 | 3-6 | 3-6 | | 3-6 | 3-6 | 3-6 |
| *FR-Nephrops* | *Yrs* | 89-98 | 90-98 | 93-00 | 93-01 | 87-02 | 87-03 | 87-04 | 87-05 | 93-06 | 93-07 | 93-08 |
| | *Ages* | 2-6 | 4-6 | 2-6 | 2-6 | 2-6 | 2-6 | 2-6 | 3-6 | 3-6 | 3-6 | 3-6 |
| *IR-7g&j-OT* | *Yrs* | | | 95-00 | 95-01 | 95-02 | 95-03 | 95-04 | 95-05 | | | |
| | *Ages* | | | 1-6 | 1-4 | 1-4 | 1-4 | 1-4 | 3-4 | | | |
| ***Survey Tuning series:*** | | | | | | | | | | | | |
| *FR-EVHOE* | *Yrs* | | | 97-00 | 97-01 | 97-02 | 97-03 | 97-04 | 97-05 | 97-06 | 97-07 | 97-08 |
| | *Ages* | | | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 | 0-4 |
| *UK-WCGFS* | *Yrs* | 92-98 | 92-99 | 93-00 | 92-01 | 92-02 | 92-03 | 92-04 | 92-04 | 87-01 | 87-01 | 87-01 |
| | *Ages* | 1-6 | 1-6 | 2-6 | 2-4 | 2-4 | 2-4 | 2-4 | 1-6 | 1-6 | 1-6 | 1-6 |
| *UK-BCCSBTS* | *Yrs* | 89-98 | 90-99 | 89-00 | 89-01 | 89-02 | 89-03 | 89-04 | 89-05 | | | |
| | *Ages* | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | 0-1 | | | |
| *IR WCGFS* | *Yrs* | | | 93-00 | | | | | | | | |
| | *Ages* | | | 1-1 | | | | | | | | |
| *IR-IGFS Swept area* | *Yrs* | | | | | | | | 99-05 | 99-06 | 99-07 | 99-08 |
| | *Ages* | | | | | | | | 0-6 | 0-6 | 0-6 | 0-6 |

## Stock Annex 8.2: Western Channel plaice in VIIIe

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Western Channel plaice (VIIe) |
| Date | 4th March 2010 (last revised at WKFLAT 2010)<br>updated time-series, I Holmes May 2011 |
| Revised by | I Holmes, S Kupschus and C Lynam (Cefas-Lowestoft). |

### A. General

#### A.1. Stock definition

The management area for this stock is strictly that for ICES Area VIIe called the western Channel, although the TAC area includes the larger component of VIId (eastern Channel).

Between 1965 and 1976, more than 5500 plaice were tagged and released around Start Point. Previous analysis of the recaptures from plaice tagged whilst spawning in the Channel (eastern and western areas) during January and February showed that 20% spent the summer in the western Channel, 24% in the eastern Channel, and approximately 56% migrated to the North Sea after spawning (Pawson, 1995). Few of the plaice tagged in the western Channel during April and May were recaptured outside the Channel however, suggesting that there is a resident stock that does not migrate to the North Sea after spawning in the Channel.

The main spawning areas are south of Start Point and south of Portland Bill. Spawning takes place between December and March with a peak in January and February. Figure A shows the spawning areas for VIIe plaice.

The spawning habitat in VIIe is much smaller than that in VIId and tagging studies have estimated that 87% of the recruits to the western Channel (VIIe) come from outside the area (34% from the eastern Channel VIId and 53% from the North Sea, Pawson 1995). Similarly, 38% of recruits to the eastern Channel are estimated to have come from the North Sea. The historic tagging data on which these studies were based also show that there is substantial mixing of adult plaice between the western and eastern Channel and between the English Channel and the North Sea, but very limited exchange between the Channel and the Celtic and Irish Seas (Burt *et al*., 2006).

The stocks of plaice in the Channel and North Sea are known to mix greatly during the spawning season (January-February). At this time many western Channel and North Sea plaice may be found in the eastern Channel (Pawson, 1995). The comparable lack of spawning habitat in the western Channel alone suggests that this migration from VIIe to VIId during the first quarter may be of considerable importance. North Sea (IV) plaice have been shown to spawn in VIId during January-February and subsequently return to the North Sea (Hunter *et al*., 2004). This migration is tracked by the international fleets fishing in the area: landings peak in January over the spawning grounds, when migrant fish are present, and track the movement towards the North Sea in February and March. A similar migration of plaice from the smaller VIIe stock into VIId during quarter 1 is believed to take place. Once fish have moved into VIId to spawn they are then subject to fishing, largely by the Belgian and French trawlers that take the majority of their annual catch in January and February.

Conventional tags inform the recapture position and date of a tagged fish (with known release point) and such data has been investigated to estimate the likely movement rates of fish from VIId in quarter 1 into VIIe and IV. The movement rates can then be used to determine the proportion of the catch in VIId during quarter 1 that is due to immigrant spawning fish. The resulting estimates of the catch of fish from VIIe and IV that are caught in VIId can then be reallocated to the appropriate catch-at-age matrix.

WKFLAT re-analysed data from historical tagging experiments on plaice, which were archived in the Cefas 'Tagfish' database (Burt *et al.*, 2006). The tags were captured through the fisheries and most are returned to Cefas within a few months of release; however these fish have had little chance to migrate. Therefore data from tagged fish with <6 months at liberty were excluded from further analysis. In order to focus on movement rates of fish that are available to the fishery only fish greater than the minimum landing size were considered for further analysis. Since tags are returned via the fishery the probability that a tag will be caught depends on the catch of plaice in an area: the greater the catch taken the more likely the tag to be caught. However, the more fish that are present within an area the less likely a tag is to be caught. Therefore the probability that a tag is caught in an area (Number recaptured / Number released) in a particular period must be weighted by the ratio of biomass/catch in that area and year so that probabilities can be comparable between areas and years. The resulting weighted proportions of tags returned from each area provide estimates of the movement probabilities between areas (table below).

| | | | | | WEIGHTED BY INTN CATCH AND SSB | | | |
|---|---|---|---|---|---|---|---|---|
| **Release Information** | | **period** | | | **pr(recap) after 6 or more months at liberty** | | | |
| **DIV** | **Sex** | **Release** | **Recapture** | **N** | **7A** | **7E** | **7D** | **4** |
| **VIIe** | B | ALL | | **564** | 0.001 | **0.90** | 0.06 | 0.04 |
| | M | Jan-Mar | | **2** | 0 | **0.74** | 0.26 | 0 |
| | F | | | **3** | 0 | **0.60** | 0.40 | 0 |
| | M | Apr_Dec | | **180** | 0 | **0.91** | 0.05 | 0.03 |
| | F | | | **224** | 0.001 | **0.93** | 0.03 | 0.04 |
| | M | Jan-Mar | Apr_Dec | **17** | 0 | **0.66** | 0.11 | 0.23 |
| | F | | | **8** | 0 | **0.67** | 0.24 | 0.09 |
| | M | Apr_Dec | Jan-Mar | **68** | 0 | **0.83** | 0.12 | 0.05 |
| | F | | | **62** | 0 | **0.88** | 0.07 | 0.06 |
| **VIId** | B | ALL | | **990** | 0.00 | 0.10 | **0.54** | 0.36 |
| | M | Jan-Mar | | **31** | 0 | 0.04 | **0.73** | 0.22 |
| | F | | | **86** | 0 | 0.08 | **0.58** | 0.34 |
| | M | Apr_Dec | | **144** | 0 | 0.10 | **0.76** | 0.14 |
| | F | | | **180** | 0 | 0.09 | **0.79** | 0.12 |
| | M | Jan-Mar | Apr_Dec | **144** | 0 | 0.14 | **0.35** | 0.52 |
| | F | | | **305** | 0 | 0.09 | **0.33** | 0.58 |
| | M | Apr_Dec | Jan-Mar | **31** | 0 | 0.20 | **0.57** | 0.23 |
| | F | | | **63** | 0 | 0.11 | **0.72** | 0.17 |
| **IVc** | B | ALL | | **812** | 0 | 0.01 | 0.06 | **0.93** |
| | M | Jan-Mar | | **54** | 0 | 0 | 0.03 | **0.97** |
| | F | | | **17** | 0 | 0 | 0.28 | **0.72** |
| | M | Apr_Dec | | **172** | 0 | 0.01 | 0.06 | **0.92** |
| | F | | | **235** | 0 | 0.01 | 0.04 | **0.95** |
| | M | Jan-Mar | Apr_Dec | **102** | 0 | 0 | 0 | **1** |
| | F | | | **38** | 0 | 0 | 0 | **1** |
| | M | Apr_Dec | Jan-Mar | **54** | 0 | 0.02 | 0.05 | **0.93** |
| | F | | | **71** | 0 | 0.01 | 0.18 | **0.80** |

Summary of estimated movement probabilities for plaice (≥ 270 mm) recaptured after 6 or more months at liberty, for data collected between 1960 and 2006.

The best estimates of the proportion of fish in quarter 1 in VIId that would return, if not caught by the fishery, to VIIe and IV are circled in red in the table above. So 14%

of males and 9% of females would migrate to VIIe, while 52% of males and 58% of females would migrate to IV. To the nearest 5%, this suggests that 10 to 15% of the catch in Q1 in VIId should be allocated to VIIe, while between 50 and 60% of the catch in Q1 in VIId should be allocated to IV. These estimates are in agreement with previous analyses (based on the same data) reported by Pawson (1995), which suggest that 20% of the plaice spawning in VIIe and VIId spend the summer in VIIe, while 56% migrate to the North Sea. Given the assumptions involved in these calculations and the relatively small numbers of adult tags returned the estimates of movement rates are subject to great variability. The limitations of the data do not permit an estimate of annual movement probabilities. Recent studies based on data storage tags suggest that the retention rate of spawning plaice tagged in the eastern Channel is 28%, while 62% of spawning fish tagged were recaptured in the North Sea (Kell *et al*., 2004).

WKFLAT 2010 adopted a 15% movement of catches from VIId into VIIe in Q1 and similarly an additional 50% movement in Q1 from VIId to IV.

### A.2. Fishery

In the western Channel, plaice are taken largely as a bycatch in beam trawls directed at sole and anglerfish. The main plaice fishery is concentrated to the south and west of Start Point. Although plaice are taken throughout the year, landings are usually heaviest during February/March and October/November. The fisheries taking plaice in the western Channel mainly involve vessels from the bordering countries: UK, France and Belgium.

#### *Main métiers*

There are ten main métiers that exploit important fish and shellfish stocks in the Channel. Otter trawling accounts for a wide range of target species in season - cuttlefish, anglerfish, gurnard, rays, cod, whiting, plaice, sole, squid and lemon sole - and involves boats from France (600), England (470), Belgium (15) and the Channel Islands (11). Beam trawling is also important for boats from the three former nations (26, 83 and 65 respectively), targeting sole, anglerfish and plaice, with up to 25 of the Belgian boats extending this fishery into the Bay of Biscay. Many boats from France (626) and England (80) join two Channel Islands vessels dredging for scallops and taking a valuable bycatch of sole and anglerfish. The other main towed gear is midwater trawls, used either for the small pelagic species - mackerel, sprat, pilchard and herring - or for bass and black bream with a bycatch of gadoids by French (40) and English (25) boats. Purse-seines are used by eight UK vessels to take mainly mackerel and pilchard in the western Channel.

The fixed netting métier in the Channel is really composed of several métiers using specific net gears and mesh sizes depending on target species, the most important being with gillnets and trammelnets (580 French and 380 English boats) for sole, cod, ling, pollock, hake, plaice, bass and spider crab. Rays, anglerfish, turbot, crabs, lobster and crawfish are also taken in tanglenets (305 Fr., 300 Eng. and 7 CI).

Similarly, potting (960 Fr., 275 Eng and 560 CI) uses several distinct gears to catch brown (edible) crabs, spider crabs, cuttlefish, lobsters and whelk, both inshore and offshore, and there are zones in the western Channel partitioning potting and towed gears for alternating periods. Longlining has been replaced by fixed net in many cases, but conger eel, sharks, rays and bass are still taken (260 Fr., 60 Eng and 13 CI). Handlines are used for mackerel, bass, pollock and ling by small boats working along both the English (390) and French (120 Fr and 90 CI) coasts of the Channel. This information is accurate as at WG07.

### A.3 Ecosystem aspects

Other than statistical correlations between recruitment and temperature (Fox *et al.*, 2000), little is known about the effects of the environment on the stock dynamics of VIIe plaice. Environment influences were considered by WKFLAT by incorporating sea surface temperature into the XSA model as a tuning fleet for age 1 catch numbers i.e. as an index of recruitment (ICES Working Document 4.3). Although the large recruitment signal in the late 1980s was partly tracked by the temperature time-series little information was gained, other than a mean recruitment level, for the recent period.

There is some anecdotal evidence of changes in the range of some species such as langoustine, triggerfish, and black sea bream from warmer parts of the Atlantic.

## B. Data

### B.1. Commercial catch

*Landings*

The fisheries that take plaice in the western Channel mainly involve vessels from the bordering countries: UK vessels report about 68%, France 24% and Belgium 8% of the total plaice landings from ICES Division VIIe (based on 2007/2008). Although plaice are taken throughout the year, landings are usually heaviest during February/March and October/November. Landings reached a peak of around 2600 tonnes in 1990 after a series of good recruitments in the late 1980s. Landing levels then declined rapidly once recruitment levels returned to average levels. Since 1994, landings have been stable at around 1200 tonnes; however, in 2007 and 2008 landings have been below this level.

Most of the landings are made by beam trawlers with around 70% of the UK landings being reported by these vessels and another 25% being landed by otter trawlers. The unallocated landings reported in the WG landings table in recent years are generally additional French landings derived from sales note information.

*Sampling and data raising*

Quarterly age compositions were available only from UK(England and Wales) landings for the years 1995–2010 (and 1989), which accounted for approximately 68% of total international landings. The total international age composition was obtained by raising the combined gears quarterly UK(England and Wales) age compositions to include the landings of the Channel Isles, France and Belgium, and summing to give an annual total.

For the earlier years of 1990–1994, French age compositions were also available. For these years, the UK(England and Wales) age compositions were raised to UK(Total) by including landings from the Channel Islands. Finally, UK(Total) and French age compositions were combined and raised to include Belgian landings. For the years 1981–1988 Prior to this, the stock data were aggregated for area of VIId and VIIe. For these years, Belgium also provided age compositions data and this was combined with UK(Total) and French age compositions. French age compositions were based on age data provided by the UK.

WKFLAT 2010 recommended a 'migration' model; this model reassigns 15% of the first quarter Belgian, French and UK catch in VIId to the VIIe catch-at-age matrix and similarly raises the landings by including 15% of the first quarter landings in VIId for each country. During the meeting, quarterly data for Belgium and France were available back to 1998 and UK data to 1997. In order to extend the time-series back to 1980 the first quarter landings and catch-at-age matrix for each country were inferred from the total annual international landings and catch-at-age data (which begin in 1980 for VIId). Total annual international catch-at-age at-age data (1980–1997 for France and Belgium and 1980–1996 for UK) were down-raised using the average proportion of catch at each age in the first quarter by each country over the period in which quarterly data were available. Similarly, SOP corrected Q1 landings for each country were calculated back to 1980 using the mean (calculated over the period in which quarterly data were available) proportion of the annual landings that were landed in Q1.

Age data representing French landings were available for 2002 and 2003, but were not used in the assessment.

Table A shows the national data availability for VIIe plaice stock for the time period 1981–2010.

Table B shows a time-series of CVs of numbers-at-age for sampling; UK(E+W) all fleets combined.

#### *Weights-at-age*

Total international catch and stock weights-at-age were calculated as the weighted mean of the annual weight-at-age data supplied (weighted by landed numbers), and smoothed using a quadratic fit:

[e.g. : $Wt = (0.1109*Age) - (0.0004*(Age^2)) - 0.008$ ; $R^2 = 0.98$]

where catch weights-at-age are mid-year values (age = 1.5, 2.5, etc.), and stock weights-at-age are 1st January values (age = 1.0, 2.0, etc.). Catch weights-at-age have been scaled to give a SOP of 100%, and the same scaling has been applied to stock weights-at-age.

This technique has been used for many years (at least since stock has been assessed by the Southern Shelf Demersal WG. In early years in the time-series, weights-at-age were averaged over a period of years, and derived from separate-sex mean weights-at-age.

WKFLAT 2010 recommended a 'migration' model that alters the catch-at-age data. However, this model does not alter the weight-at-age matrix since it is not possible to distinguish which weight measurements in VIId are from VIIe migratory spawners.

### B.2. Biological

The main spawning areas for plaice in the western Channel are south of Start Point and Portland Bill. Spawning takes place from December to March, with a peak in January and February.

On average, about a quarter of plaice in the western Channel are mature at age 2, half are mature at age 3 and all are mature at age 5. The majority of plaice landed in the western Channel in 2001, for example, were at ages 2–5, and therefore 73% of those landed were mature.

*Natural mortality and maturity ogives*

Initial estimates of natural mortality (0.12 $^{yr}$ all years and all ages) and maturity were based on values estimated for Irish Sea plaice (Siddeek, 1981). A new maturity ogive based on UK(E&W) VIIfg survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

| AGE | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|
| Old Maturity | 0 | 0.15 | 0.53 | 0.96 | 1.00 |
| New Maturity | 0 | 0.26 | 0.52 | 0.86 | 1.00 |

The proportion of mortality before spawning was originally set at 0.2 since approximately 20% of the total catch was taken prior to late February–early March, considered to be the time of peak spawning activity. The proportion of F and M before spawning was changed to zero prior to the 1994 Southern Shelf Demersal Working Group as it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium-term projections.

### B.3. Surveys and survey tuning data

An annual 4 m beam trawl survey has taken place in the Lyme Bay area of the western Channel since 1984, initially aboard chartered fishing Vessels (MV BOGEY 1 and latterly MV CARHELMAR) and more recently aboard the Cefas research vessel CORYSTES, coming back to MV CARHELMAR in 2005.

Appendix 1 provides a history of the survey and details the survey methodology and objectives.

The western Channel beam trawl survey data are used to calculate assessment tuning data for both VIIe plaice and sole. Indices of abundance-at-age for years 1986 to the present, and for ages 1–5 have been used. Since 2007, this age range has been extended to include data for ages 1–8. Appendix 1 also describes how these indices of abundance-at-age are derived.

Since 2003 a Fisheries Science Partnership (FSP: Cefas-UK industry cooperative project) has been conducting a survey using commercial vessels with scientific observers and following a standard grid of stations extending from the Scilly Isles to Lyme Bay. The survey covers a substantially larger area than the current survey (UK-WECBTS) and is thought to be more representative of the stock in UK waters. This dataset was first included in the 2007 assessment, and the exploratory analysis can be seen in that report (ICES, 2007; Section 3.2.5). However, recently the vessel(s) used for the survey have changed from the FV Nellie and the FV Lady T, to the FV Carhelmar. In 2008, in addition to the vessel changes there have been other sample protocol changes, notably the change to using 4 m 'survey' beam trawls from the commercial 12 m beam trawls previously used by the other vessels. The working group, WGCSE 2009, decided to leave out the 2008 data from the FSP survey since it had an undue influence on estimates of SSB and F.

### B.4. Commercial lpue

The UK(E+W) commercial lpue data are calculated for two gear groups (beam trawl, and otter trawlers both over 40 ft) and for three sectors within VIIe (VIIe north, VII south and VIIe west) made up of 'collections' of ICES rectangles. The lpue values are corrected for fishing power using a given relationship between fishing power and gross tonnage and are calculated using the total effort for a month/sector not species-directed effort. This relationship is FP=0.0072*GRT+0.6017 and this is standardized fit to pass through the mean GRT of Irish Sea trawlers in 1979 (Brander, unpublished).

Beam trawl lpue in the North of VIIe reached a peak in 1990, fell sharply to 1994 and is now fluctuates at low levels. The south and west sectors both peaked in the early 1990s but have steadily declined since. Otter trawl lpue in north of VIIe peaked in 1988 before falling sharply until 1995. Since then it has remained at these much lower levels. Lpue in the south is generally lower, but fluctuates to high peaks throughout the time-series, whereas in the west it has remained stable at a lower level for the duration of the time-series.

UK beam trawl effort has increased rapidly over the time-series, reaching record high levels in 2003 and has remained at this high level since. UK trawl effort has slowly decreased over the time-series, reaching a record low level in 2008. Effort is calculated as fishing power corrected using GRT.

Figures B and C show plots of UK effort for 1998–2008 by ICES rectangle for otter trawl and beam trawl gears, respectively.

#### *Commercial tuning data*

Commercial tuning information for this stock comprises of the UK(E&W) otter trawl fleet and the UK(E+W) beam trawl fleet. These fleets have been used by Working Groups for a number of years, and initially contained data for years back to 1976 (otter) and 1978 (beam). However in the most recent assessments carried out for this stock, otter trawl fleet data are currently used only for years 1988 to the present and for ages 3–9 and beam trawl fleet is currently used for years 1989 to the present, and ages 3–9. Since 2004, an historic otter trawl fleet (1976–1987) has been reintroduced using ages 2–9 only and this is calculated differently from the later data.

WKFLAT proposed a 'migration' model for western Channel plaice. If this is not acceptable and the 'truncated' model is taken forward then the commercial beam trawl and commercial otter trawl fleets should be truncated so that the first year of the time-series is 1998 and the last year is the most recent year. The 'truncated' model does not use the historic commercial otter trawl fleet, but has F-shrinkage increased from 2.5 to 1.0 to compensate for the increased variability of estimates of F.

### B.5. Other relevant data

#### *Discarding*

Discard length summary data from the UK(E+W) and French discard sampling programmes has been made available to ICES working groups for the period 2002–2010. In addition, in 2010, Belgian quarterly discard length compositions were also available. All data indicate that discarding is at its highest in quarters 1 and 2 in this fishery, but is still low compared to other plaice stocks. No attempt has previously been made to raise these estimates to total landings.

For the 2010 benchmark meeting (WKFLAT), an analysis was carried out to determine the true level of discarding including trends in sampling effort, discarding patterns and an attempt to raise the sampling to an estimate of total discards. This work was presented to the meeting as ICES WKFLAT 2010, Working Document 4.4 'Western Channel (VIIe) plaice discard data availability, trends and raising estimates to total landings, and comparisons with the trends of adjacent plaice stocks. The summary points made were as follows:

- Previous assumptions made by the Working Group that discarding is small compared to other plaice stocks, and that most discarding takes place in Quarter 1 and 2 appear robust. VIIe discard rates range from 9% in 2003 to 24% in 2008 with an average of 16%. Discarding is at its heaviest in quarters 1 and 2 with 26% and 19% discarded in these quarters and around 5% discarded in the remainder of the year.
- The discard rates appear to be increasing over time but are still at relatively low levels. Discard rates for VIIe plaice stock (16%) are much less than those for adjacent plaice stocks in VIId (57%) and VIIfg (73%).
- Sampling effort on discards is very good for the VIIe plaice stock and discard sampling effort is increasing. Most of the sampling effort has been carried out on beam and otter trawlers.
- Most discard sampling was carried out on vessels of length 10<20 m and with engine power between 100<300 Kw.
- Around 10% by weight, are discarded and this measure is increasing. The proportion discarded by weight has increased steadily from 5% in 2002 to around 13% in 2008. This compares favourably with the adjacent stocks that have rates of around 40% in VIId and around 60% in VIIfg (in 2008).
- There is no evidence of seasonal differences in the proportions discarded-at-length. The proportions of fish discarded-at-length for this stock shows good levels of consistency over the time period and in addition the L50 values for each year are very close. This is not the case for the VIId and VIIfg stocks but for these stocks, the inconsistencies may be a feature of lower sample numbers.
- Around 60–70% of fish discarded are regarded as immature.
- Raising the discard sample data is possible by using either landings or effort but neither method is perfect. The main problem encountered was the limited availability of age data at the smaller/larger lengths.
- Most discards are at age 2 and age 3, where an estimated 28% and 5% respectively would be added to the landings age composition. For 2008, the resulting age compositions from both raising methods were almost identical although this may not be the case for other years.
- The total weight of the discarded catch in 2008 was estimated to be approximately 55 t amounting to around 6% of the commercial landings.

On reflection, the workshop considered the possible effects of the lack of discards included in this assessment and recommended that further investigations are conducted to include discard information in future assessments, but not to include the preliminary information available as it may reduce the management of the exploited portion of the stock. The data suggests discarding is minor in the years it has been raised to the fleet level. It was therefore concluded that the effect of including these data in the assessment would at best change the level of F and SSB over the whole time-series and at worst obscure the trends now seen because of the short and variable time-series of discard data available.

*Potential discard raising methods*

Two methods were used to raise the discard sample data to total discards.

1 ) Using landings. Sample data for the two main gear groups of beam trawl (gear 1) and otter trawl (gears 2,3,7) and the remaining gears (other) were

extracted by quarter. For each gear group and quarter, the weight of the total catch from the sampled trips was calculated by quarter using the formula (W=aL^b * N) where 'a' and 'b were quarterly condition factors for the stock in use within Cefas stock processing. The discarded Length Distributions (LD's) were then raised to total catches using the ratio of total reported catch/weight of discard trip catches.

An Age–Length Key (ALK) was applied to each raised quarterly LD to produce quarterly Age Compositions (AC) for each gear group/quarter. The ALK data used was taken from the age samples from the discard programme. Due to the small quantity of discard age data available, the ALK used was at the annual level. However even the ALK at this level only had small numbers of fish and did not cover the full length range of the discard LDs. In these instances, the discard ALK was supplemented by supplements by annual ALK data from the relevant commercial landings samples. At the smallest lengths without age data, an assumption about the age structure was made, but these were generally considered to be age 1.

These discarded ACs were then combined across gears and then across quarters to give an annual estimate of discarded catches.

2 ) Using effort data. Given the recognized difficulties is assessing the 'true' effort levels of gears such as gillnetters and longlines, discard sample data only for the two main gear groups of beam trawl (gear 1) and otter trawl (gears 2,3,7) were extracted by quarter. The discarded LDs were raised to total catches using the ratio total reported effort (hours fished) catch/hours fished on sampled trips.

The same ALK as constructed above was applied to the quarterly raised LDs to give quarterly age compositions by gear/quarter. At the quarterly level, the two age compositions were combined and then raised to include the catches form the 'other' gears. These ACs were then combined across gears and then across quarters to give an annual estimate of discarded catches.

## C. Historical stock development

This stock was assessed by ICES Southern Shelf Demersal WG from 1992 to 2008. For years 2009–present, this stock was assessed at ICES Celtic Seas Ecoregion Working Group. The stock has been managed by a TAC since 1984. The TAC is applicable to VIId (Eastern Channel) and VIIe combined, although in 1997 there was a separate limit for landings from VIIe. This was unpopular with the industry due to the national split being based on VIId and VIIe combined reported landings for the reference period, and has not been repeated since.

### Benchmark 2010

This stock was 'benchmarked' at the WKFLAT 2010 meeting where the main issue under review was to overcome the problematic retrospective pattern that meant that forecasts had not been possible for some years. Solutions explored included making an 'allowance' for migration patterns between the two channel plaice stocks, termed the 'migration model'; this clearly had a knock-on effect on the eastern Channel stock and the North Sea where there was also migration issues. Another option considered (the 'truncate model') involves truncating the commercial otter and commercial beam fleets back to 1998 but this was thought to only temporarily hide the underlying problem. Additionally, the 'truncate' model excludes the commercial historical otter trawl time-series and increases F-shrinkage from 2.5 to 1.0. WKFLAT 2010 recommends that the $F_{bar}$ range is altered to 3–6 since very few age 7 fish are caught by the fishery (<4% of the catch numbers). The age range of the FSP survey was reduced to 2–8 since very few age 9 are caught by the survey and that age created positive residuals in catchability for every year.

Outcome – The workshop considered making an allowance for migration between the two channel plaice stocks. Having further examined tagging evidence available it was agreed that an 'allowance' of 15% of quarter 1 catches (both landings and the catch numbers-at-age) from VIId needed to be added into quarter 1 of the VIIe. This was required from all contributing nations.

The combination of the two Channel plaice stocks was examined. It was agreed that this would require further investigation as the inclusion of the North Sea stock would also need to be considered. Any combining of stocks would a have a wide ranging impact on the assessment and any subsequent management.

The issue of including discard estimates was also considered, but based on the short time-series of data available and the 'limited' impact on the assessment outcome, this inclusion was deferred until a longer time-series of data was available.

#### Technical measures in force

Technical measures currently in force in the western Channel are a minimum mesh size of 80 mm for otter and beam trawlers and 70 mm for *Nephrops* trawlers. Panels of 75 mm square mesh are compulsory in all *Nephrops* fisheries in ICES Subarea VII.

There is also a minimum landing size (MLS) on 27 cm in force.

Model used: XSA

Software used: Lowestoft VPA suite

Model Options chosen: Input data types and characteristics:

| Type | Name | Year range | Age range | Variable from year to year Yes/No |
|---|---|---|---|---|
| Caton | Catch in tonnes | 1976–2008 | - | Yes |
| Canum | Catch-at-age in numbers | 1976–2008 | 1–15 | Yes |
| Weca | Weight-at-age in the commercial catch | 1976–2008 | 1–15 | Yes |
| West | Weight-at-age of the spawning–stock at spawning time. | 1976–2008 | 1–15 | Yes |
| Mprop | Proportion of natural mortality before spawning | 1976–2008 | 1–15 | No |
| Fprop | Proportion of fishing mortality before spawning | 1976–2008 | 1–15 | No |
| Matprop | Proportion mature-at-age | 1976–2008 | Age 1–0%; Age2–26% Age3–52%,Age4–86% Age 5+ 100% | No |
| Natmor | Natural mortality | 1976–2008 | 1–15 (0.12) | No |

Tuning data: 'migration model'

| Type | Name | Year range | Age range |
|---|---|---|---|
| Survey fleet 1 | UK Western beam trawl survey (UK-WEC-OT) | 1986–2008 | 1–8 |
| Commercial fleet 1 | UK Western Channel Otter Trawl (UK-WECOT) | 1988–2008 | 3–9 |
| Commercial fleet 2 | UK Western Channel Beam Trawl (UK-WECBT) | 1989–2008 | 3–9 |
| Commercial fleet 3 | UK Western Channel Otter Trawl - Historic (UK-WECOT historic) | 1980–1987 | 2–9 |
| Survey fleet 2 | UK FSP Survey (UK(E+W) FSP) | 2003–2007 | 2–8 |

Tuning data: 'truncated model'

| Type | Name | Year range | Age range |
|---|---|---|---|
| Survey fleet 1 | UK Western beam trawl survey (UK-WEC-OT) | 1986–2008 | 1–8 |
| Commercial fleet 1 | UK Western Channel Otter Trawl (UK-WECOT) | 1998–2008 | 3–9 |
| Commercial fleet 2 | UK Western Channel Beam Trawl (UK-WECBT) | 1998–2008 | 3–9 |
| Commercial fleet 3 | UK Western Channel Otter Trawl - Historic (UK-WECOT historic) | excluded | |
| Survey fleet 2 | UK FSP Survey (UK(E+W) FSP) | 2003–2007 | 2–8 |

#### History of assessment methods and settings investigations

The standard settings for a catch data screening run using a separable VPA are reference age of 4; F set to 0.7 and S set to 0.8.

In 1991 the stock was assessed using a Laurec–Shepherd tuned VPA. Concerns about deteriorating data quality prompted the use in 1992 of XSA.

Trial runs have, over the years, explored most of the options with regards XSA settings:

- The effect of the power model on the younger ages was explored in 1994; 1995; 1996; 1998, 2004 and 2010.
- The use of P shrinkage was investigated in 2001; 2004.
- Different levels of F shrinkage were explored in 1994; 1995; 2000; 2002; 2004 and 2010.
- The level of the + group was examined in 1995, 2004 and 2010.
- The effect of different time tapers was investigated in 1996.
- The S.E. threshold on fleets was examined in 1996; 2001 and 2007.
- The level of the catchability plateau was investigated in 1994; 1995; 2002; 2004 and 2010.

Table C shows the history of VIIe plaice assessments and details the parameters used.

### D. Short-term projection

Standard ICES software is used for the short-term projections – MFDP.

No short-term forecast has been provided since 2006 as the review group deemed it unhelpful in the management of the stock given the strong retrospective bias in F.

However WKFLAT was able to carry out a forecast following the removal of the strong retrospective bias in F.

The diagnostics suggest that estimation of the recruiting year class (age 1) is poorly estimated in the assessment, both because catchability is very low in the commercial fisheries and because the surveys are very noisy at this age. Consequently, estimation of survivors from the recruiting age is poorly estimated and should not be used in the forecast. It was deemed more appropriate to estimate survivors at age 2 on the basis of the geometric mean abundance of historic recruitment. The time period chosen should be consistent with that chosen for estimating future recruitment. Currently this could be formulated as.

The short-term forecast uses:

1 ) the survivors at age 3 and greater from the XSA assessment;
2 ) N at age 2 = mean(ln(recruitment (1998–current year-1))*exp –(0.12 + mean(F(age 1)));
3 ) Stock and Catch weights = average stock and catch weights over the preceding three years, unless there is an indication that there are strong trends in these, in which case they will be need to be dealt with appropriately by WGCSE;
4 ) The F vector used will be the average F-at-age in the last three years, unless there is strong indication of a significant trend in F. In the latter case the average selectivity pattern will be rescaled to the final F in the series.

This procedure is in line with the convention used at WGCSE and the historic treatment of the short-term forecast for this stock.

### E. Medium-term projections

### F. Yield and biomass per recruit/long-term projections

Standard ICES software is used for the long-term projections–MFYPR.

As with most plaice stocks, there is no clear stock–recruitment relationship evident.

Not carried for this stock between 2006–2009. YPR projections run for 2010–2011.

### G. Biological reference points

#### WGCSE 2010-FMSY evaluation

To derive an $F_{MSY}$ estimate the SRMSYMC package was employed and $F_{msy}$ was calculated based on the three common stock–recruit relationships; Ricker, Beverton–Holt and smooth Hockey-stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships (SRR), all resamples allowed $F_{MSY}$ and $F_{crash}$ values to be determined. All three models show that there is little evidence of a stock–recruitment relationship with only limited information as to the trends at extreme levels of SSB.

The smooth hockey-stick model showed a 'break-off' point in the SRR that was inconsistent with the data and as such was rejected. The yield-per-recruit estimates were highly uncertain with high CV's. Therefore these estimates were also rejected. The two SRR models have very different levels of estimated $F_{MSY}$. Full diagnostics for all model fits can be found in the WGCSE 2010 report.

| Stock–recruit relationship Model | $F_{MSY}$ | $F_{Crash}$ |
|---|---|---|
| Ricker | 0.312 | 0.750 |
| Beverton–Holt | 0.143 | 0.781 |

Therefore, the suggested level of $F_{MSY}$ for this stock is F's within the range of 0.14 and 0.31.

$F_{MSY}$ (and PA) reference points in use after the WGCSE2010.

| | Type | Value | Technical basis |
|---|---|---|---|
| MSY Approach | MSY $B_{trigger}$ | 2500 t | $B_{pa}$ |
| | $F_{MSY}$ | 0.19 | Provisional proxy by analogy with plaice in the Celtic Sea. Fishing mortalities in the range 0.14–0.31are consistent with $F_{MSY}$ |
| Precautionary Approach | $B_{lim}$ | 1300 t | $B_{lim}$=$B_{loss}$ The lowest observed spawning–stock biomass. |
| | $B_{pa}$ | 2500 t | MBAL, biomass above this affords a high probability of maintaining SSB above $B_{lim}$, taking into account the uncertainty in assessments. |
| | $F_{lim}$ | Not defined. | |
| | $F_{pa}$ | 0.45 | This F affords low probability that (SSBMT< $B_{pa}$). |

However the Working Groups since 2004 had considered the precautionary reference points for this stock as unreliable for the following reasons:

- The stock–recruitment relation shows no evidence of reduced recruitment at low stock levels;
- The basis for $B_{pa}$ is weak, and heavily dependent on two consecutive points (1985 and 1986);
- $F_{pa}$ is based on $B_{pa}$, and then this reference point is also rejected.

In 2010, WKFLAT examined the stock dynamics provided by the new preferred XSA model based on migration at length to determine appropriate biological reference points for this stock on the basis of the new assessment. It concluded that the historic reference points for this stock were no longer appropriate as the new assessment indicated significant changes to the historical perspective of the stock caused by the inclusion of catches from VIId in the VIIe plaice stock.

In the event that alternate assessment models be used, these reference point discussions will need to be repeated on the basis of the alternative model, as our understanding of stock dynamics are likely to be different for such a model.

Examination of the Biomass reference points indicated with some certainty that recruitment to the stock was not negatively impacted by SSB levels greater than 2200 t ($B_{loss}$ (1996) following which a significant recovery in SSB of the stock had been observed, MBAL.), but there was little or no evidence of stock collapse at lower SSB levels Consequently, the group had difficulty in deciding whether this should be considered a limit reference point or a precautionary reference point. Dependent on this choice $B_{pa}$ would either be 2200 t (with a commensurate $B_{lim}$ set at 1600 t), or 3100 t ($B_{lim}$ = 2200 t) on the basis that there should be a 40% buffer between the two reference points (procedure consistent with the development of reference points in WGCSE).

F reference points consistent with these biomass reference points based on a short-term recruitment-series were calculated on the basis of the yield-per-recruit calculations and shown in the table below as option 1 and 2. Bold numbers indicate the basis of the reference points for each option.

| | Option 1 | Option 2 | Option 3 |
|---|---|---|---|
| $B_{lim}$ | 1600 | 2200 | 2100 |
| $B_{pa}$ | 2200 | 3100 | 3000 |
| $F_{lim}$ | 0.55 | 0.7 | 0.60 |
| $F_{pa}$ | 0.40 | 0.55 | 0.42 |

Option 1 indicates that $B_{lim}$ is lower than the observed spawning–stock biomass for this stock, whilst option 2 suggests that $F_{lim}$ is higher than levels of F observed in the stock, therefore both sets of reference points would move to areas of stock dynamics not previously observed which the group considered risky. The new assessment indicates that the trend in F has been relatively flat since the late 1980s at levels around 0.6. Over this period SSB has increased and declined in response to recruitment, but without causing a collapse in the stock. It might therefore be considered as a limit reference point ($F_{lim}$), option (3).

The problem with this stock is that we have an insufficient understanding of the stock dynamics outside the relatively small range of F's and little or no response in recruitment to the range of SSB's observed. Consequently, each of the choices made in considering the calculation of the other reference points is also precautionary so that the final set of reference points invariably is ultra precautionary. The group could not come to a consensus with regards to suitable precautionary reference points but clearly stated that $F_{sq}$ is currently too high and should be reduced, whilst biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly understood.

The group felt more confident in using the 2200 t as a $B_{trigger}$ in the new advisory framework based on MSY based management targets, provided that the management intervention at this level of SSB was sufficient to move the stock away from this level of SSB with considerable certainty. It is deemed unlikely that low levels of SSB near $B_{trigger}$ would be reached if long-term management aimed to attain F levels near an appropriate proxy of $F_{MSY}$.

No appropriate proxy was developed for $F_{MSY}$ given the current uncertainty over the basis for such advice, however the WKFLAT 2010 commented that because plaice are taken largely in conjunction with sole in Area VIIe it is important that the target levels between the stocks are consistent especially because a management plan has been agreed for sole VIIe.

Previous biological reference points proposed for this stock by the 1998 working group have been in use until 2009 (as below).

| | | | | | |
|---|---|---|---|---|---|
| $F_{lim}$ | Not defined | | $F_{pa}$ | 0.45 | (low probability that SSBMT<Bpa) |
| $B_{lim}$ | 1300 t | (equal to Bloss) | $B_{pa}$ | 2500 t | (equal to MBAL) |

The recent Working Groups view of these reference points had been that they were considered unreliable.

## H. Other issues

## I. References

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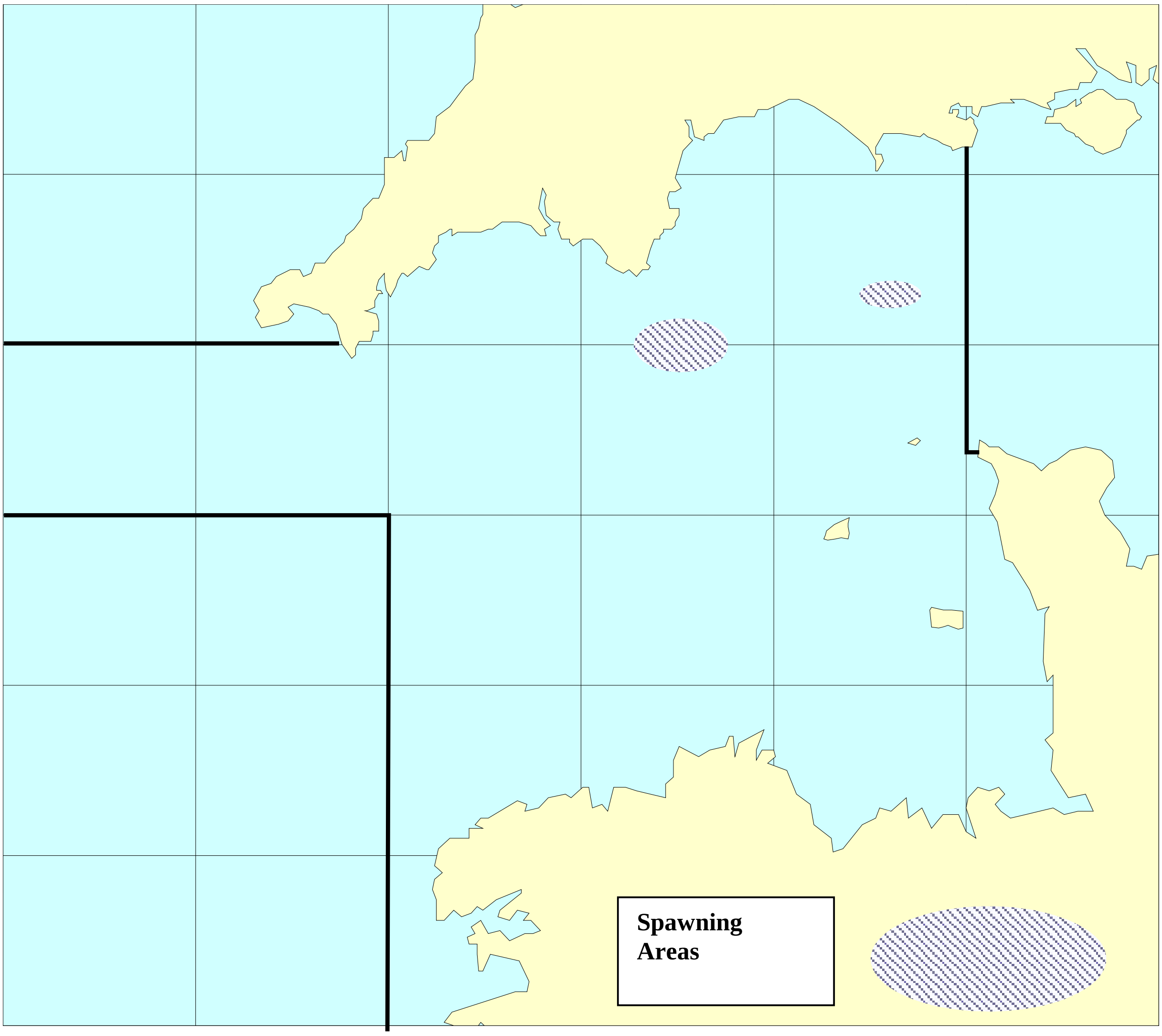



**Figure A. Map of spawning areas for VIIe plaice.**

**Table A. VIIe plaice - Catch Derivation table for assessment years 1981–2008 * stock assessed as VIId,e plaice.**

| | | source | | | | |
|---|---|---|---|---|---|---|
| Year of WG | Data | UK | Belgium | France | derivation of international landings | % sampled |
| 1981* | length composition | quarterly | quarterly | quarterly | UK ALK used with French LDs | 100 |
| | ALK | quarterly | quarterly | - | UK+Belgium+France combined to total international | |
| | Age composition | quarterly | quarterly | - | No analytical assessment carried out | |
| 1982* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1983* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1984* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1985* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1986* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1987* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1988* | | As for 1981 | As for 1981 | As for 1981 | As for 1981 | 100 |
| 1989* | length composition | quarterly | - | - | UK raised to total international | 70 |
| | ALK | quarterly | - | - | | |
| | Age composition | quarterly | - | - | | |
| 1990 | length composition | quarterly | - | quarterly | UK+France raised to total international | 96 |
| | ALK | quarterly | - | quarterly | | |
| | Age composition | quarterly | - | quarterly | | |
| 1991 | | As for 1990 | - | As for 1990 | As for 1990 | 97 |
| 1992 | | As for 1990 | - | As for 1990 | As for 1990 | 97 |
| 1993 | | As for 1990 | - | As for 1990 | As for 1990 | 98 |
| 1994 | length composition | quarterly | - | quarterly | UK ALKs applied to French LDs | 96 |
| | ALK | quarterly | - | - | UK+France raised to total international | |
| | Age composition | quarterly | - | - | | |
| 1995 | | As for 1989 | - | - | As for 1989 | 83 |
| 1996 | | As for 1989 | - | - | As for 1989 | 82 |

| | source | | | | |
|---|---|---|---|---|---|
| 1997 | As for 1989 | - | - | As for 1989 | 78 |
| 1998 | As for 1989 | - | - | As for 1989 | 79 |
| 1999 | As for 1989 | - | - | As for 1989 | 75 |
| 2000 | As for 1989 | - | - | As for 1989 | 72 |
| 2001 | As for 1989 | - | - | As for 1989 | 72 |
| 2002 | As for 1989 | - | - | As for 1989 | 78 |
| 2003 | As for 1989 | - | - | As for 1989 | 81 |
| 2004 | As for 1989 | - | - | As for 1989 | 79 |
| 2005 | As for 1989 | - | - | As for 1989 | 74 |
| 2006 | As for 1989 | - | - | As for 1989 | 74 |
| 2007 | As for 1989 | - | - | As for 1989 | 68 |
| 2008 | As for 1989 | - | - | As for 1989 | 70 |
| 2009 | As for 1989 | - | - | Migration correction added equal to 15% of Q1 VIId | 78 |
| | | | | Landings from UK, Belgium and France. In addition, 15% | |
| | | | | Of Q1 Age comps added to the VIIe international AC. | |
| | | | | Also –back calculated for years 1985-2008. | |
| 2010 | As for 1989 | - | - | As 2009 – with Netherlands VIId Q1 component added | 78 |

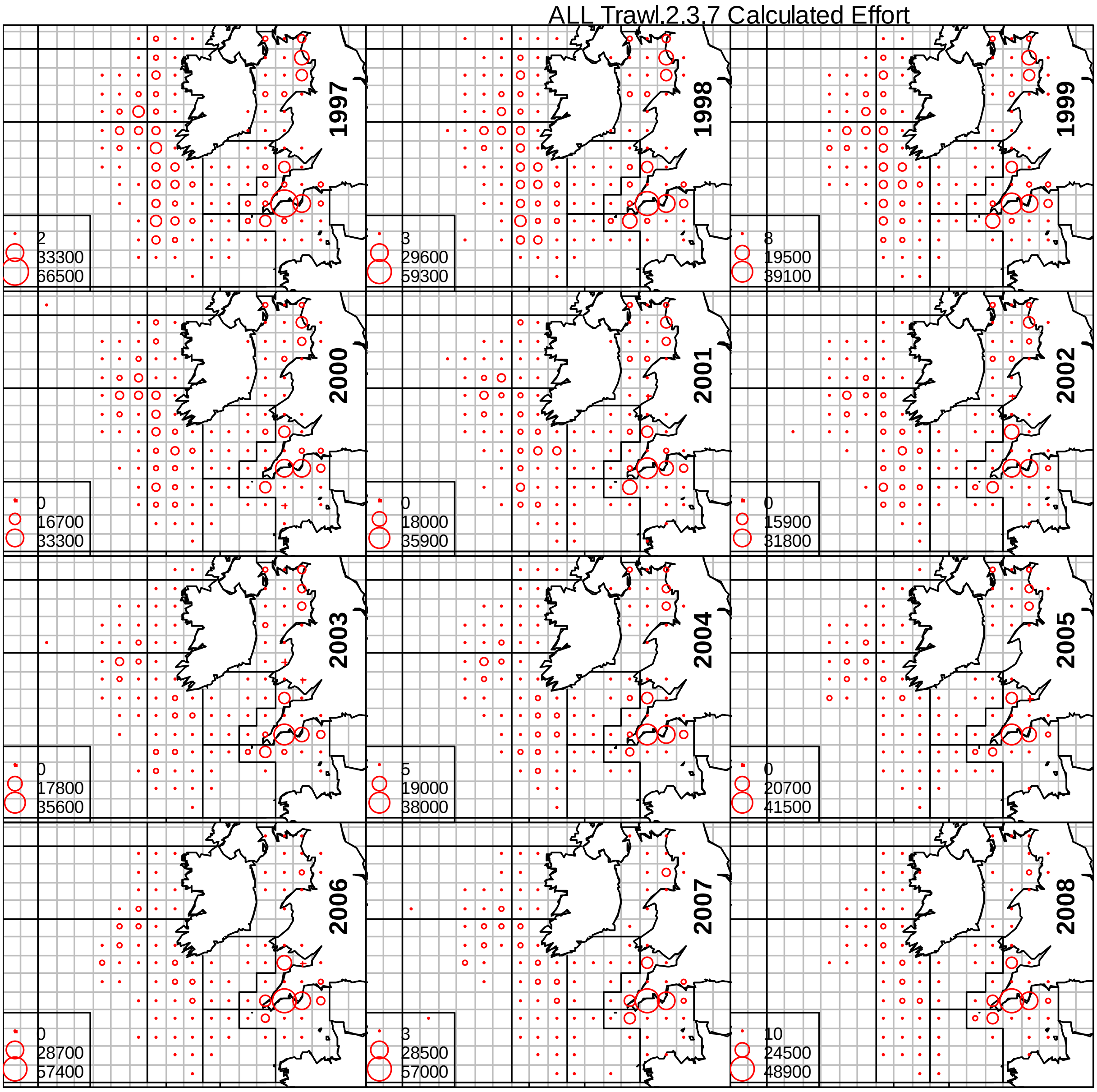



**Figure B. UK(E+W) Otter trawl fleet effort (hours fished); based on demersal landings.**

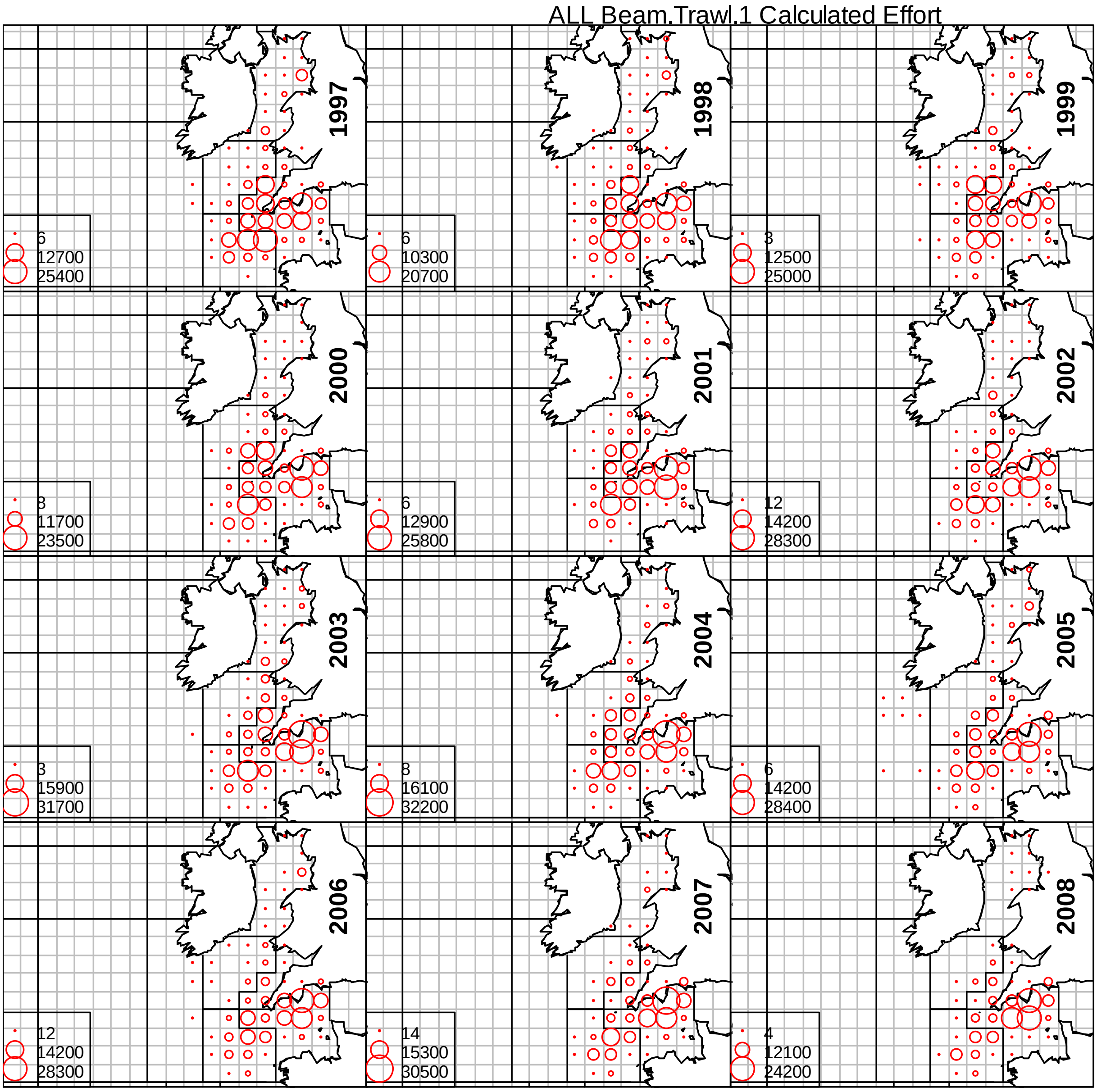



**Figure C. UK(E+W) Beam trawl fleet effort (hours fished); based on demersal landings.**

**Table B. CV of numbers-at-age for commercial sampling.**

| | | CV by AGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | COUNTRY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2005 | UK(E+W) | 18% | 3% | 3% | 3% | 6% | 7% | 11% | 10% | 9% |
| 2006 | UK(E+W) | 21% | 4% | 3% | 5% | 5% | 8% | 10% | 15% | 14% |
| 2007 | UK(E+W) | 42% | 5% | 3% | 4% | 6% | 6% | 9% | 13% | 20% |
| 2008 | UK(E+W) | 42% | 4% | 4% | 5% | 6% | 8% | 8% | 10% | 14% |
| 2009 | UK(E+W) | 39% | 5% | 3% | 6% | 7% | 9% | 11% | 11% | 16% |
| 2010 | UK(E+W) | 17% | 4% | 3% | 3% | 7% | 9% | 14% | 26% | 23% |

**Table C. History of VIIe plaice assessments.**

VIIe plaice - Assessment parameters used (1991–2010)

| | | | | | | | | | | | | | | | | | | | Benchmark | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1991* | 1992* | 1993* | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2010 | 2011 |
| Assessment Age Range | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ |
| Fbar Age Range | 3-8 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-6 | 3-6 | 3-6 |
| Assessment Method | LS/Trad VPA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA |
| Tuning Fleets : | | | | | | | | | | | | | | | | | | | | | | |
| UK trawl yrs | 76-90 | 76-91 | 76-92 | 84-93 | 84-94 | 86-95 | 87-96 | 88-97 | 88-98 | 88-99 | 88-00 | 88-01 | 88-02 | 88-03 | 88-04 | 88-05 | 88-06 | 88-07 | 88-08 | 88-09 | 88-09 | 88-10 |
| Ages | 1-9 | 1-9 | 1-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 |
| UK trawl (historic) yrs | | | | | | | | | | | | | | 76-87 | 76-87 | 76-87 | 76-87 | 76-87 | 76-87 | 80-87 | 80-87 | 80-87 |
| Ages | | | | | | | | | | | | | | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 |
| UK beam yrs | 78-90 | 78-91 | 78-92 | 84-93 | 84-94 | 86-95 | 87-96 | 89-97 | 89-98 | 89-99 | 89-00 | 89-01 | 89-02 | 89-03 | 89-04 | 89-05 | 89-06 | 89-07 | 89-08 | 89-09 | 89-09 | 89-10 |
| Ages | 1-9 | 1-9 | 1-9 | 2-9 | 2-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 |
| UK b/trawl survey yrs | | 86-91 | 86-92 | 86-93 | 86-94 | 86-95 | 87-96 | 88-97 | 86-98 | 86-99 | 86-00 | 86-01 | 86-02 | 86-03 | 86-04 | 86-05 | 86-06 | 86-07 | 86-08 | 86-09 | 86-09 | 86-10 |
| Ages | | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 |
| UK FSP survey yrs | | | | | | | | | | | | | | | | | 03-06 | 03-07 | 03-07 | 03-09 | 03-09 | 03-10 |
| Ages | | | | | | | | | | | | | | | | | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 |
| Time taper | | 20yr tri | 20yr tri | 20yr tri | 20yr tri | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None |

| VIIe plaice - Assessment parameters used (1991–2010) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | Benchmark | | |
| | 1991* | 1992* | 1993* | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2010 | 2011 |
| Power model ages | | 1 | 1 | 1 | 1-3 | 1-3 | 1-3 | 0 | 1 | 1-5 | 1-5 | 1-5 | 1-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P shrinkage | | TRUE | TRUE | TRUE | TRUE | TRUE | TRUE | FALSE | TRUE | TRUE | TRUE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| Q plateau age | | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| F shrinkage S.E | | 0.3 | 0.3 | 0.3 | 0.8 | 1.5 | 1.5 | 1.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Num yrs | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Num ages | | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Fleet S.E. | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 |

*** Early version of XSA/VPA and tuning fleet age/year ranges used not specified. Assumed all years used but age range used uncertain.**

## VIIe plaice - Assessment parameters used (1991-2010)

| | 1991* | 1992* | 1993* | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 Benchmark | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assessment Age Range | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ |
| Fbar Age Range | 3-8 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-7 | 3-6 | 3-6 | 3-6 |
| Assessment Method | LS/Trad VPA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA |
| Tuning Fleets : | | | | | | | | | | | | | | | | | | | | | | |
| UK trawl yrs | 76-90 | 76-91 | 76-92 | 84-93 | 84-94 | 86-95 | 87-96 | 88-97 | 88-98 | 88-99 | 88-00 | 88-01 | 88-02 | 88-03 | 88-04 | 88-05 | 88-06 | 88-07 | 88-08 | 88-09 | 88-09 | 88-10 |
| Ages | 1-9 | 1-9 | 1-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 |
| UK trawl (historic) yrs | | | | | | | | | | | | | | 76-87 | 76-87 | 76-87 | 76-87 | 76-87 | 76-87 | 80-87 | 80-87 | 80-87 |
| Ages | | | | | | | | | | | | | | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 |
| UK beam yrs | 78-90 | 78-91 | 78-92 | 84-93 | 84-94 | 86-95 | 87-96 | 89-97 | 89-98 | 89-99 | 89-00 | 89-01 | 89-02 | 89-03 | 89-04 | 89-05 | 89-06 | 89-07 | 89-08 | 89-09 | 89-09 | 89-10 |
| Ages | 1-9 | 1-9 | 1-9 | 2-9 | 2-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 |
| UK b/trawl survey yrs | | 86-91 | 86-92 | 86-93 | 86-94 | 86-95 | 87-96 | 88-97 | 86-98 | 86-99 | 86-00 | 86-01 | 86-02 | 86-03 | 86-04 | 86-05 | 86-06 | 86-07 | 86-08 | 86-09 | 86-09 | 86-10 |
| Ages | | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 |
| UK FSP survey yrs | | | | | | | | | | | | | | | | | 03-06 | 03-07 | 03-07 | 03-09 | 03-09 | 03-10 |
| Ages | | | | | | | | | | | | | | | | | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 | 1-8 |
| Time taper | | 20yr tri | 20yr tri | 20yr tri | 20yr tri | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None | None |
| Power model ages | | 1 | 1 | 1 | 1-3 | 1-3 | 1-3 | 0 | 1 | 1-5 | 1-5 | 1-5 | 1-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P shrinkage | | TRUE | TRUE | TRUE | TRUE | TRUE | TRUE | FALSE | TRUE | TRUE | TRUE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| Q plateau age | | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| F shrinkage S.E | | 0.3 | 0.3 | 0.3 | 0.8 | 1.5 | 1.5 | 1.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| Num yrs | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Num ages | | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Fleet S.E. | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 |

* Early version of XSA/VPA and tuning fleet age/year ranges used not specified. Assumed all years used but age

# Appendix A. Beam trawl surveys in the western Channel (VIIe)

## 1. History of the survey

Complaints from the fishing industry in the southwest about the lack of scientific investigation and knowledge of the local sole stock provided the catalyst for the survey in VIIe. Following enquiries of the local fishery officers and normal tendering procedures, a skipper-owned 300-hp beam trawler, the Bogey 1, was selected. The first year (1984) the survey consisted of a collection of tows on the main sole grounds. In 1989 the Bogey 1 was replaced with the Carhelmar and the survey continued unchanged until 2002 when R.V. Corystes took over the survey as an extension to its 'near-west groundfish survey'.

Due to the changes occurring through the time-series, the surveys completed on R.V. Corystes (2002 onwards) will be described separately to the 'previous' surveys (pre 2002).

## 2.a. Survey objectives (1984 to 2001, and 2005 onwards)

To provide independent (of commercial) indices of abundance of all age groups of sole and plaice on the west channel grounds, and an index of recruitment of young (1–3 year old) sole prior to full recruitment to the fishery.

## 2.b. Survey objectives (2002 to 2004)

The primary objectives of the Irish Sea beam trawl survey are to (a) carry out a 4 m beam trawl survey of groundfish to i) obtain fisheries independent data on the distribution and abundance of commercial flatfish species, and ii) derive age compositions of sole and plaice for use in the assessment of stock size; and (b) to collect biological data, including maturity and weight-at-age, for sole, plaice, lemon sole and other commercially important species. The epibenthic bycatch from these catches has been quantified, and these surveys are also used to collect biological samples in support of other Cefas projects and training courses.

## 3.a. Survey methods (1984 to 2001, and 2005 onwards)

For the years 1984–1988 the vessel was unchanged and was equipped with two 6 m chain mat beam trawls with 75 mm codends. For the survey hauls one of the codends was fitted with a 60 mm liner. In 1989 the Bogey 1 was replaced by the latest design 24 m 300 hp (220 kw) beam trawler Carhelmar. In 1988 two commercial chain mat 4 m-beam trawls (measured inside the shoe plates) were purchased by MAFF as dedicated survey gear. Both beams were fitted with the standard flip-up ropes and 75 mm codend. For years 1989 and 1990 only one codend was fished with a 40 mm liner but from 1991 with the introduction of 80 mm codends both were fitted with 40 mm liners. The vessel and gear has remained unchanged since 1991.

Between 1989 and 2001 the survey remained relatively unchanged apart from small adjustments to the position of individual hauls to provide an improved spacing. In 1995 two inshore tows in shallow water (8–15 m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed of 4 knots in an area within 35 miles radius of Start Point. The survey design is stratified by 'distance from the coast' bands, in contrast to the VIIa,f,g survey that is stratified by depth bands. The reason for this is that the coastal shelf with a depth of water less than 40 m is relatively narrow and in addition is often fished with fixed gear. The survey bands (in miles) are 0–3, 3–6, 6–12, 12+ inshore, and 12+offshore.

### 3.b. Survey methods (2002 to 2004)

The standard gear used is a single 4 m beam trawl with chain mat, flip up rope, and a 40 mm codend liner to retain small fish. The gear is towed at 4 knots (over the ground) for 30 minutes, averaging 2 nautical miles per tow. Fishing is only carried out in daylight, shooting after sunrise and hauling no later than sunset, as the distribution of some species is known to vary diurnally.

Once on board the catch is sorted to species level, with the exception of small gobies and sandeels, which are identified to genus. Plaice, sole, dab, and elasmobranchs are sorted by sex, all fish categories weighed, and total lengths are measured to the full centimetre below, or half centimetre if the species is pelagic. Area stratified samples of selected species are sampled for weight, length, sex, maturity, and otoliths or scales removed for ageing.

The standard grid of 58 stations was fished in 2002 and 2003 (see map), and although other stations have been fished in this period, they were for exploratory purposes and were not included in the assessment.

## 4. Abundance index calculation

Plaice and sole abundance indices are calculated by allocating the appropriate ages to the fish that are caught. This gives the age composition (AC) of the catch, and this is used in the appropriate working group analysis.

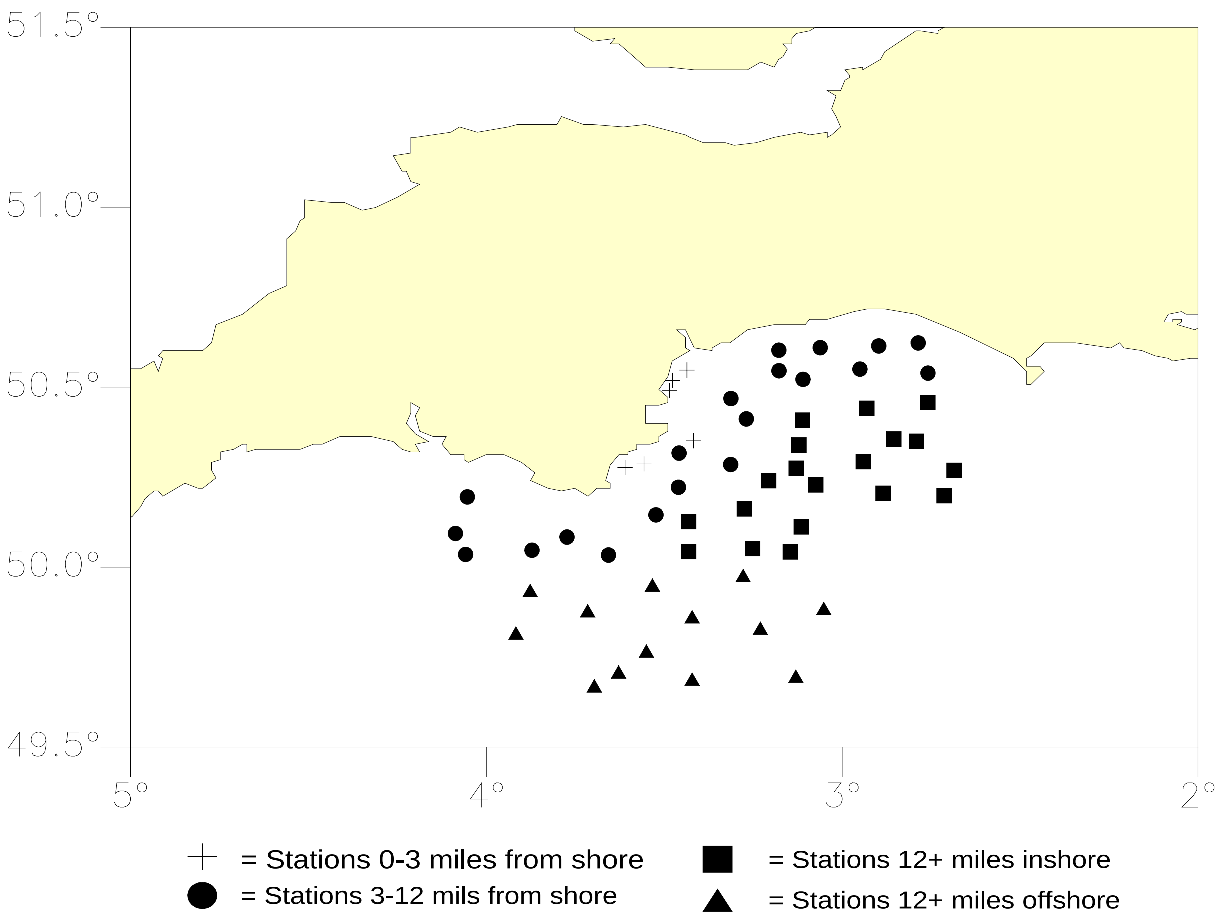
The AC's are calculated by proportioning a length distribution (LD) to an appropriate age–length key (ALK). To account for possible population differences within ICES Division VIIe, biological samples are taken from sectors stratified by distance from shore (see map). The survey bands (in miles) are 0–3, 3–12, 12+ inshore, and 12+ offshore. Where appropriate the ALK's are separated by sex, and this allows a particular 'sector, depth-band and sex' ALK to be raised to the corresponding LD to give an accurate AC for that particular habitat. The AC's can then be combined as required to give results in the form of 'numbers-at-age, per distance or time'.

Between 1984 and 1990 a total survey age–length key was applied to the 'grid' length distribution, but from 1990 onwards stratum stratified age–length keys were used.

The table below show the stratifications currently used to calculate the 'near-west groundfish survey' abundance indices.

## 5. Map of survey grid

Additional stations have been fished throughout the time period, but as these stations are not consistently fished, they are excluded from this map.




## 6. Summary

| Area covered | ICES Division VIIe |
|---|---|
| Target species | Flatfish, particularly prerecruit plaice and sole |
| Time period | September-October. 1988 to present. |
| Gear used | 1984–1988 – 2 * 6 m beam trawls |
| | 1989–2001 – 2 * 4 m beam trawls |
| | – 1* 4 m beam trawl |
| | 2005–Present – 2 * 4 m beam trawls |
| Mean towing speed | 4 knots over the ground |
| Tow duration | 30 minutes |
| Vessel used | 1984–1988 - F.V. Bogey 1 |
| | 1989–2001 - F.V. Carhelmar |
| | 2002–2004 - R.V. Corystes |
| | 2005–Present - F.V. Carhelmar |

## Stock Annex 8.3: Sole in Division VIIe

Stock-specific documentation of standard assessment procedures used by ICES.

| | |
|---|---|
| Stock | Sole in Division VIIe (Western Channel) |
| Date: | 19/02/2009 |
| Revised by | Sven Kupschus (WKFLAT) |

### A. General

#### A.1. Stock definition

The management area for this stock is strictly that for Area VIIe. Biologically speaking however the picture is much less clear. Sole in general are relatively sedentary, once settled they perform a seasonal inshore offshore movements during their spawning migration with a random longshore component. Therefore the management unit of the stock is well defined for mature fish. There is good evidence to suggest that the stock is split into two biological stocks on either side of the Hurd Deep. If this prevents complete mixing of the stock it an assessment methodology capable of taking account of this should be applied. This could explain differences in the trends representative of stock dynamics in the different fisheries. The two main fisheries on the UK coast around Lyme Bay and the Start as well as the fishery on the coast in the eastern part of the management area are clearly separated by the deeper waters of the channel, so that the fishery covers only about half of the management area so that incomplete mixing may be a problem in this stock.

The source of recruitment to the stock is not clear either as little is known about spawning and nursery grounds in the management area. Additionally, tagging information suggests that during years of strong sole recruitment in Area VIIf,g some juveniles may migrate to VIIe. The stock boundary to VIId is also likely to be poorly defined as it represents no natural boundary to sole movement. During periods of strong recruitment in VIId a substantial portion of the VIId recruits (up to 30%) may move into VIIe where their impact will be felt very strongly as a consequence of the much smaller stock size in the latter region. The ingress of juveniles from other areas may explain the lack of a suitable stock–recruitment relationship for this stock.

The assessment method used until 2008 does not deal with uncertainty about stock boundaries.

#### A.2. Fishery

The principal gears used for sole in the Western Channel are otter- and beam trawls, for the UK fleet and entanglingnets and otter trawls for the French fleet. In recent years, UK vessels have accounted for around three quarters of the total international landings, with France taking approximately a quarter and Belgian vessels the remainder. UK landings were low and stable between 1950 and the mid-1970s, but increased rapidly after 1978 as a consequence of the replacement of otter trawlers by beam trawlers. Because the UK fleet is the major component of the international landings, they follow a similar trend. Sole is the target species of an offshore beam trawl fleet, which is concentrated off the south Devon and Cornish coasts, and also catches plaice and anglerfish. In recent years a winter fishery targeting cuttlefish has developed for the English beam trawl fleet in the Western Channel, lasting from November to the end of March. This has taken some of the reliance of the fleet away from sole, but sole still represents a substantial portion of the catch during this time so it is not clear to what degree the switch to cuttlefishing has reduced fishing mortality on sole.

Discarding of sole in this fishery is thought to be minor, supported by the time-series (2002–2008) of discard information for the UK fleet shown in Figure A.2.1. Landings of sole reached a high level above 1400 t in the 1980s, boosted initially by high recruitment in the late 1970s, followed by an increase in exploitation. Landings declined between 1988 and 1991, following the recruitment of 3 below-average year classes (1986–1988); since 1991 they have fluctuated between 800 t and 1100 t. Substantial quantities of sole caught in VIIe have been reported to two rectangles in VIId in order to avoid quota restrictions. Corrections for this misreporting were first made during the 2002 WG, but misreporting to other areas has been more difficult to identify. In addition, black landings are likely to have occurred to various degrees since quotas became restrictive in the late 1980s. No estimates of the scale of the problem exist so that this uncertainty has not been incorporated into the assessment process.

### A.3. Ecosystem aspects

Little is known with regards of the effect of the environment on the stock dynamics of VIIe sole. Certainly the division is on the convergence between the Celtic Sea proper and the Channel/North Sea ecosystem. If predicted increases in temperature were to materialize changes to the stock dynamics of this and other species in the division would be expected. To date there is good evidence of a sizeable increase in the abundance of bass in the area, a species with a similar pan European distribution as sole. In addition there is some anecdotal evidence of changes in the range of some species such as langoustine, triggerfish, and black sea bream from warmer parts of the Atlantic. In the North Sea it has also been suggested that cold periods immediately prior to spawning have a tendency to increase year-class strength and there is some indication of this for this stock, but no statistical analysis has been carried out to date.

Beam trawling is known to have a significant impact on the seabed. It is understood though that those areas affected continue to be productive in terms of the target species. After the initial degradation of the habitat usually associated with the loss of sessile macro fauna, continued use of beam trawls seems to have few further impacts.

## B. Data

### B.1. Commercial catch

UK (>60%) and France (>30%) together provide almost all the catches for this stock. UK Landings data are based on EU logbook data for 7e catches. In 2002 the UK industry indicated that there had been substantial misreporting of landings to two rectangles in Area VIId. It was possible to identify the misreported landings spatially and by reported lpue. Having identified misreported landings, data were corrected back to 1985 by the 2002 WG. This method of correction is ongoing. French official landings statistics have been poor since 1997, but since 1997 landings data have been calculated much more accurately using buyer and sellers notes. France has provided corrected landings information to the Working Group since 2002.

Numbers-at-age prior to 1994 are calculated by raising the UK age composition to UK and Channel Island Catches, adding the French age composition data, and finally raising the resulting age composition to the total international landings. From 1995 WG to 2005 WG the International landings for the stock were based entirely on

English quarterly sampling effort then raised to quarterly international landings. Since 2006 WG French age data from 2003 onwards have been included.

Numbers-at-age 1 in the catch are low or zero in most years and most likely reflect variation in the sampling, rather than variation in the stock itself. Therefore, these were not considered to add useful information and are replaced by zeros.

Table A demonstrates the history of the derivation of catch numbers-at-age.

### B.2. Biological

#### *Weights-at-age*

Total international catch and stock weights-at-age for each year's catch data are calculated as the weighted mean of the annual weight-at-age data (weighted by catch numbers), and smoothed in-year using a quadratic fit so that:

$$Wt = a + b*Age + c* Age^2$$

where catch weights-at-age are mid-year values, and stock weights-at-age are 1 January values. Following the estimation of the weights-at-age catch-numbers are adjusted to so that the sum of products of the weights and catches sum to the estimated Landings (SOP correction). Catch numbers-at-age 1 are replaced by zeros, but the catch weights-at-age 1 were retained because they are part of the smoothing procedure and do not affect the assessment. They are also essential if a medium-term forecast is performed.

A smoother is applied to sampled catch weights-at-age to adjust for variation in the weight-at-age that may result from low levels of sampling rather than differences in growth rate between cohorts. It also allows estimation of the stock weights-at-age by extrapolation of the curve rather than by using quarter 1 samples, which may be sparse. However this smoother is applied through the plus group and the age range in the plus group is such that this will tend to overestimate the weights at the younger ages. This needs to be corrected as soon as possible.

#### *Natural mortality and maturity-at-age*

Natural mortality is assumed constant over ages and years at 0.1. This is consistent with the natural mortality estimates used for sole by other ICES working groups (WGNSSK: IV, VIId, WGNSDS: VIIa, WGSSDS: VIIfg, VIIIa,b) and consistent with estimates of M reported in Horwood, 1993 for VIIfg sole as well as other stocks and papers cited therein.

Assessments prior to 1997 had use knife edge maturity-at-age 3. This was changed in 1997 to a maturity ogive from Area VIIf,g according to Pawson and Harley (WD presented to WGSSDS in 1997), which is applied in all years, 1969 to present, since the 1997 WG.

| Age | 1 | 2 | 3 | 4 | 5 | 6,7, ...12+ |
|---|---|---|---|---|---|---|
| Prop. Mature | 0.00 | 0.14 | 0.45 | 0.88 | 0.98 | 1.00 |

Proportions of F and M before spawning are both set to zero to reflect the SSB calculation date of 1 January.

### B.3. Surveys

Currently the only available survey for this stock is the Western Channel Beam trawl Survey conducted by the UK in late September, early October (UK-BTS). The survey covers a relatively small area of VIIe from Start Point through to the middle of Lyme Bay and out to the edges of the Hurd Deep covering the immediate area of fishing for the Brixham and Plymouth fleets. Sampling started originally in 1984 on the chartered commercial fishing vessel 'Bogey One', replaced in 1988 by the 'Carhelmar' and moved to the research vessel 'Corystes' in 2002 to 2004. Concerns were raised regarding differences in catchability between the Carhelmar and Corystes, and in 2003 the survey was carried out on both vessels. The results of the comparison convinced Cefas to return the survey to the long-serving Carhelmar and to replace the 2003 data with the data from the comparison trials in order to improve consistency. Consequently, the time-series has been largely recovered, with only 2002 and 2004 data coming from the RV Corystes.

The survey cpue demonstrates a decline from 1986 to 1995 in line with the commercial data, after which SSB seems to have largely stabilized at lower levels. The abundance indices at-ages 1 and 2 demonstrate little overall trend, but ages 3 to 6 indicate a decline over the middle part of the series, despite intermittent peaks and troughs. The 1989 year class is indicated to be strong at all ages and this year class can also be traced through the catch-at-age matrix. More recently the 1998 year class can be tracked reasonably consistently.

Appendix 1 provides a history of the survey and details the survey methodology and objectives.

### B.4. Commercial cpue

In the early part of the 20th century the fishery for VIIe sole was largely prosecuted by otter trawlers and inshore netters. During the mid to late 1970s landings sharply increased with a considerable increase in nominal effort as the beam trawl fleet developed. Otter trawl effort declined with levels in 2002 being about half that of effort found in the late seventies. Beam trawl effort in hours fished has continued to rise since 1988, but at a slower rate than previously as a consequence of licensing and quota restrictions, but boat size and power as well as beam sizes have also increased suggesting that the effective effort has continued to rise more sharply than suggested by the effort data alone.

Lpue has declined since the late eighties in both the otter and beam trawl fleets suggesting a marked decline in the SSB of this stock. Interestingly the catch-at-age information for these fleets does not suggest a marked decline in the age structure over this time suggesting the decline may be associated with environmental impacts rather than fishing, but given the uncertainty in current landings data, it is difficult to distinguish between the potential causes of the discrepancy between the lpue and catch-at-age data. Little information is currently available regarding the development of the French fishery on this stock on the southern side of the Channel.

The UK beam trawl fleet in recent years has been landing large quantities of cuttlefish during winter. Investigations of the landings data indicated that misreporting was particularly high during the period of the cuttlefish fishery indicating that lpue was unlikely to be substantially lower than during the remainder of the year, justifying the inclusion of all trips in the lpue time-series. Similarly, there was no indication of differences in lpue for those trips split between divisions (misreporting to VIId) so that trips reporting to VIIe as well as those reporting to the two adjacent rectangles in VIId were included in the derivation of the tuning fleets.

UK beam trawl effort has climbed markedly since 1992. Otter trawl effort has stabilized following its decline during the 1980s and early 1990s.

For the purpose of the lpue tuning effort used in the assessment until 2008 a subset (vessels greater than 13.27 m) of the boats operating in VIIe is taken and their combined landings over the period are used to calculate lpue. The commensurate effort figure in kWh for their effort is used for each individual landing. The relationship between the kWh and the landings is then used to determine the relationship between lpue and power, and a correction made to effort values for changes in the fleet composition. A map of the areas corresponding to the lpue series exploring spatial changes in the distribution of effort is shown in Figure B4.1. The latter procedure is now very dated and should be look at with some urgency, as it may be contributing to the retrospective pattern.

For the calculation of lpue, landings misreported to VIId (see catch data section) are corrected in the same manner as the catch data. No corrections are made to the effort statistics, as the time spent in VIId for the purposes of misreporting has been negligible.

### B.5. Other relevant data

None.

## C. Historical stock development

WKFLAT 2009 concluded that at the present time it is not possible to perform a quantitative assessment on the stock that could be seen to be representative of recent trends in F and SSB. Therefore no assessment, short-term forecast or sensitivity analysis can be performed. Some suitable information is available from the survey (Appendix 1) that could be used for management until such time that a suitable assessment model can be developed.

Although this stock has been exploited historically for a long time at low levels, official landing statistics and catch-at-age data are available from 1969 onwards. At this time landings were 353 t mainly attributable to otter trawlers and netters. The development of a beam trawl fleet in UK waters lead to rapid increases in landings from the stock in the late 1970s which resulted in a commensurate decline in SSB after an initial increase in stock size to its maximum in 1980 as a consequence of particularly good recruitment in 1976. The decline as assessed by XSA occurred despite subsequent good recruitment in 1980, 1984, 1986 and 1990 leading to an apparently depressed recruitment period since 1991. It is unclear whether this reduction in recruitment is linked to the decline in SSB, environmental effects, or is an artefact of the misreporting of landings as a consequence of the TAC constraints introduced in 1987, and becoming restrictive in 1989.

Key uncertainties with regards to the data quality/assessment quality of this stock are the uncertainty regarding the degree of mixing between this and adjacent stock, particularly with regards to recruitments, the fact that the survey covers only a small portion of the stock the lack of a discernible stock–recruit relationship which does not allow us to determine reference points with any certainty.

Table B demonstrates the history of VIIe sole assessments and details the assessment model used (XSA) and the parameters and settings used in each year's assessment until 2008.

### D. Short-term projection

In lieu of an assessment no short-term prediction is carried out.

### E. Medium-term projections

Not applicable for the time being.

### F. Long-term projections

Not applicable for the time being.

### G. Biological reference points

Biological reference points in this stock were originally set in 1998 as described in the Table below along with the reasoning and amended in 2001 to take account of a change to the assessment methodology.

| | WG(1998)/ACFM(1998) | since WG(2001)/ACFM (2001) |
|---|---|---|
| | | Age range extended from 1–10+ to 1–12+ |
| $\mathbf{F}_{lim}$ | 0.36 ($\mathbf{F}_{loss}$ WG98) | 0.28 ($\mathbf{F}_{loss}$ WG01) |
| $\mathbf{F}_{pa}$ | 0.26 ($\mathbf{F}_{lim}$*0.72) | 0.20 ($\mathbf{F}_{lim}$*0.72) |
| $\mathbf{B}_{lim}$ | 1800 t ($\mathbf{B}_{loss}$= $B_{73}$ WG98) | 2000 t ($\mathbf{B}_{loss}$= $B_{00}$ WG01) |
| $\mathbf{B}_{pa}$ | 2500 t ($\mathbf{B}_{lim}$*1.4) | 2800 t (Historical development) |

The assessment methodology that formed the basis for these precautionary reference points is rejected by WKFLAT and these reference points are therefore no longer considered appropriate. The reference point table will therefore be updated as follows:

| | Type | **Value** | **Technical basis** |
|---|---|---|---|
| Precautionary approach | $B_{lim}$ | Undefined | |
| | $B_{pa}$ | Undefined | |
| | $F_{lim}$ | Undefined | |
| | $F_{pa}$ | Undefined | |
| Targets | $F_{mgt}$ | 0.27 | EC Multi-annual plan. |

**(unchanged since 2009).**

Once a new assessment methodology has been accepted its implications on reference points will need to be evaluated.

### H. Other issues

A management plan was agreed for VIIe sole in 2007:

Council Regulation (EC) No 509/2007 establishes a multi-annual plan for the sustainable exploitation of VIIe sole. Years 2007–2009 are deemed a recovery plan, with subsequent years being deemed management plan. For 2008 the TAC is required to be at a value whose application will result in a 20% reduction in F compared with $F_{bar}$ (03–05). If this value exceeds a 15% change in TAC, a 15% change in TAC shall be implemented.

## I. References

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**Table A. VIIe Sole. Catch derivation table for assessment years 1981–2007.**

| | | source | | | |
|---|---|---|---|---|---|
| Year of WG | Data | UK | France | derivation of international landings | % sampled |
| 1981 | length composition | quarterly | quarterly | UK ALKs applied to French LDs | 95 |
| | ALK | quarterly | - | UK+France raised to total international | |
| | Age composition | quarterly | - | | |
| 1982 | | As for 1981 | As for 1981 | As for 1981 | 99 |
| 1983 | | As for 1981 | As for 1981 | As for 1981 | 92 |
| 1984 | | As for 1981 | As for 1981 | As for 1981 | 96 |
| 1985 | | As for 1981 | As for 1981 | As for 1981 | 96 |
| 1986 | | As for 1981 | As for 1981 | As for 1981 | 96 |
| 1987 | length composition | quarterly | quarterly | UK+France raised to total international | 95 |
| | ALK | quarterly | quarterly | | |
| | Age composition | quarterly | quarterly | | |
| 1988 | | As for 1987 | As for 1987 | As for 1987 | 96 |
| 1989 | | As for 1987 | As for 1987 | As for 1987 | 95 |
| 1990 | | As for 1987 | As for 1987 | As for 1987 | 94 |
| 1991 | | As for 1987 | As for 1987 | As for 1987 | 96 |
| 1992 | | As for 1987 | As for 1987 | As for 1987 | 97 |
| 1993 | | As for 1987 | As for 1987 | As for 1987 | 94 |
| 1994 | length composition | quarterly | quarterly | UK ALKs applied to French LDs | 92 |
| | ALK | quarterly | - | UK+France raised to total international | |
| | Age composition | quarterly | - | | |

| | | source | | | |
|---|---|---|---|---|---|
| Year of WG | Data | UK | France | derivation of international landings | % sampled |
| 1995 | length composition | quarterly | - | UK raised to total international | 81 |
| | ALK | quarterly | - | | |
| | Age composition | quarterly | - | | |
| 1996 | | As for 1995 | - | As for 1995 | 78 |
| 1997 | | As for 1995 | - | As for 1995 | 73 |
| 1998 | | As for 1995 | - | As for 1995 | 64 |
| 1999 | | As for 1995 | - | As for 1995 | 57 |
| 2000 | | As for 1995 | - | As for 1995 | 56 |
| 2001 | | As for 1995 | - | As for 1995 | 59 |
| 2002 | | As for 1995 | - | As for 1995 | 60 |
| 2003 | length composition | As for 1995 | quarterly | UK and French raised to total international | ~95% |
| | ALK | As for 1995 | biannually | | ~95% |
| 2004 | | As for 1995 | As for 2003 | As for 2003 | ~95% |
| 2005 | | As for 1995 | As for 2003 | As for 2003 | ~95% |
| 2006 | | As for 1995 | As for 2003 | As for 2003 | ~95% |
| 2007 | | As for 1995 | As for 2003 | As for 2003 | ~95% |
| 2008 | | As for 1995 | As for 2003 | As for 2003 | ~95% |

**Table B. History of VIIe sole assessments.**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assmnt Age | 1-9+ | 1-9+ | 1-9+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-10+ | 1-12+ | 1-12+ | 1-12+ | 1-12+ | 1-12+ | 1-12+ | 1-12+ | 1-12+ |
| Fbar Age Range | F(3-8) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) | F(3-7) |
| Assmnt Method | L.S. | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA | XSA |
| Tuning Fleets | | | | | | | | | | | | | | | | | | |
| UK Inshore beam | 1983-92 | 1973-92 | 1973-92 | 1973-93 | 1973-93 | 1986-95 | 1987-96 | 1983-97 | 1984-98 | 1986-99 | 1986-00 | | | 1973-87 | 1973-87 | 1973-87 | 1973-87 | 1973-87 |
| Ages | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-9 | 2-11 | | | 2-11 | 2-11 | 2-11 | 2-11 | 2-11 |
| UK Offshore beam | 1983-92 | 1973-92 | 1973-92 | 1973-93 | 1973-93 | 1986-95 | 1987-96 | 1983-97 | 1984-98 | 1986-99 | 1986-00 | | | 1973-87 | 1973-87 | 1973-87 | 1973-87 | 1973-87 |
| Ages | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-9 | 3-11 | | | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 |
| UK < 24m beamtr | | | | | | | | | | | | 1989-01 | | | | | | |
| Ages | | | | | | | | | | | | 2-11 | | | | | | |
| UK > 24m beamtr | | | | | | | | | | | | 1988-01 | | | | | | |
| Ages | | | | | | | | | | | | 2-11 | | | | | | |
| UK combined beam | | | | | | | | | | | | | 1988-02 | 1988-03 | 1988-04 | 1988-05 | 1988-06 | 1988-07 |
| Ages | | | | | | | | | | | | | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 |
| UK otter trawl | | | | | | | | | | | | 1988-01 | 1988-02 | 1988-03 | 1988-04 | 1988-05 | 1988-06 | 1988-07 |
| Ages | | | | | | | | | | | | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 | 3-11 |
| UK BTS yrs | | 1984-91 | 1984-92 | 1984-93 | 1984-94 | 1986-95 | 1987-96 | 1983-97 | 1984-98 | 1984-99 | 1984-00 | 1984-01 | 1988-02 | 1988-03 | 1988-04 | 1988-05 | 1984-06 | 1988-07 |
| Ages | | 2-6 | 2-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-9 | 1-9 | 1-9 | 1-9 | 1-9 |
| Time taper | | 20yr tri | 20yr tri | 20yr tri | 20yr tri | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Power model ages | | 1 | 1-2 | 1-4 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | 1-6 | No | No | No | No |
| P shrinkage | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Q plateau age | | 8 | 5 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 |
| F shrinkage S.E | | 0.3 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 | 1.0 | 1.0 | 1.0 |
| Num yrs | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 4 | 5 | 5 |
| Num ages | | 5 | 3 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Fleet S.E. | | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 |

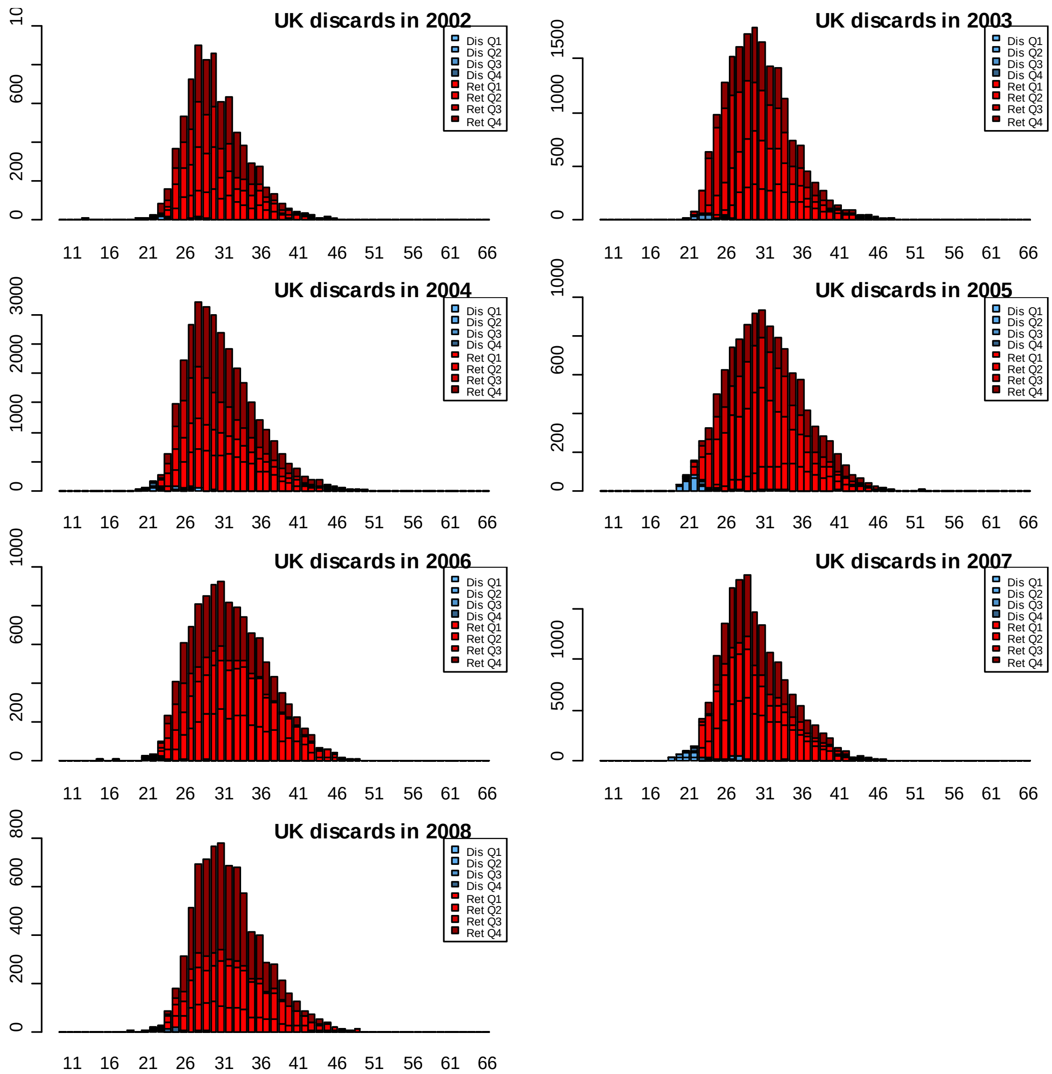



Figure A.2.1. Time-series of UK discard data raised to trip information.

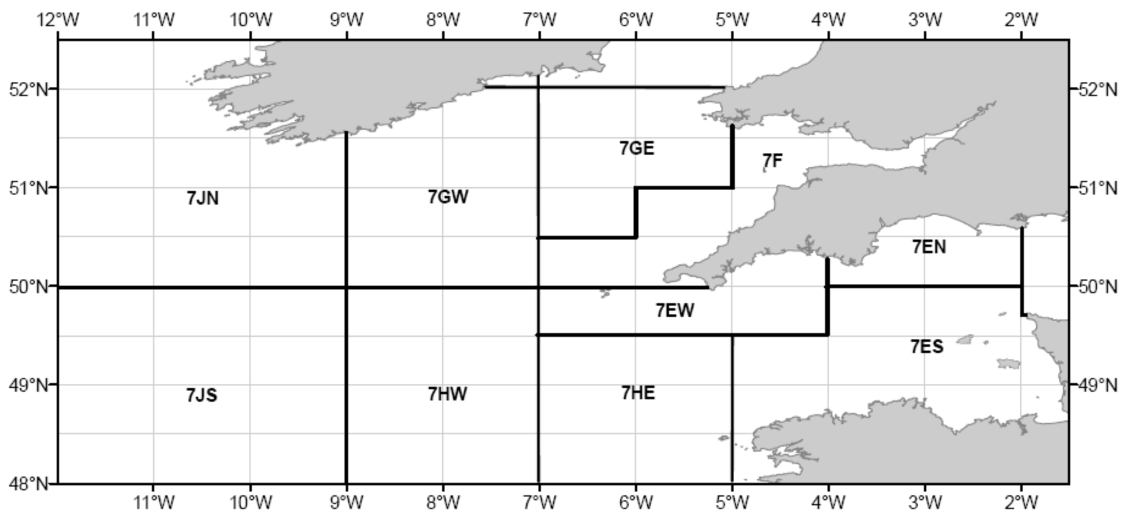



Figure B4.1. Areas used for the calculation of lpue time-series exploring temporal changes in the distribution of stock and effort.

## Appendix 1: Beam trawl surveys of the western English Channel (ICES Division VIIe)

### 1. History of the survey

Complaints from the fishing industry in the southwest about the lack of scientific investigation and knowledge of the local sole stock provided the catalyst for the survey in VIIe. Following enquiries of the local fishery officers and normal tendering procedures, a skipper-owned 300 hp beam trawler, the Bogey 1, was selected. The first year (1984) the survey consisted of a collection of tows on the main sole grounds. In 1989 the Bogey 1 was replaced with the Carhelmar and the survey continued unchanged until 2002 when R.V. Corystes took over the survey as an extension to its 'near-west groundfish survey'.

As a consequence of the changes occurring through the time-series, the surveys completed on R.V. Corystes (2002 onwards) will be described separately to the 'previous' surveys (pre 2002).

### 2.a. Survey objectives (1984 to 2001)

To provide independent (of commercial) indices of abundance of all age groups of sole and plaice on the west channel grounds, and an index of recruitment of young (1–3 year old) sole prior to full recruitment to the fishery.

### 2.b. Survey objectives (2002 to present)

The primary objectives of the Irish Sea beam trawl survey are to (a) carry out a 4 m beam trawl survey of groundfish to i) obtain fisheries independent data on the distribution and abundance of commercial flatfish species, and ii) derive age compositions of sole and plaice for use in the assessment of stock size; and (b) to collect biological data, including maturity and weight-at-age, for sole, plaice, lemon sole and other commercially important species. The epibenthic bycatch from these catches has been quantified, and these surveys are also used to collect biological samples in support of other Cefas projects and training courses.

### 3.a. Survey methods (1984 to 2001)

For the years 1984–1988 the vessel was unchanged and was equipped with two 6 m chain mat beam trawls with 75 mm codends. For the survey hauls one of the codends was fitted with a 60 mm liner. In 1989 the Bogey 1 was replaced by the latest design 24 m 300 hp (220 kw) beam trawler Carhelmar. In 1988 two commercial chain mat 4 m beam trawls (measured inside the shoe plates) were purchased by MAFF as dedicated survey gear. Both beams were fitted with the standard flip-up ropes and 75 mm codend. For years 1989 and 1990 only 1 codend was fished with a 40 mm liner but from 1991 with the introduction of 80 mm codends both were fitted with 40 mm liners. The vessel and gear has remained unchanged since 1991.

Between 1989 and 2001 the survey remained relatively unchanged apart from small adjustments to the position of individual hauls to provide an improved spacing. In 1995 two inshore tows in shallow water (8–15 m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed of 4 knots in an area within 35 miles radius of Start Point. The survey design is stratified by 'distance from the coast' bands, in contrast to the VIIa,f,g survey that is stratified by depth bands. The reason for this is that the coastal shelf with a depth of water less than 40 m is relatively narrow and in addition is often fished with fixed gear. The survey bands (in miles) are 0–3, 3–6, 6–12, 12+ inshore, and 12+ offshore.

## 3.b. Survey methods (2002 to present)

The standard gear used is a single 4 m beam trawl with chain mat, flip up rope, and a 40 mm codend liner to retain small fish. The gear is towed at 4 knots (over the ground) for 30 minutes, averaging 2 nautical miles per tow. Fishing is only carried out in daylight, shooting after sunrise and hauling no later than sunset, as the distribution of some species is known to vary diurnally.

Once on board the catch is sorted to species level, with the exception of small gobies and sandeels, which are identified to genus. Plaice, sole, dab, and elasmobranchs are sorted by sex, all fish categories weighed, and total lengths are measured to the full centimetre below, or half centimetre if the species is pelagic. Area stratified samples of selected species are sampled for weight, length, sex, maturity, and otoliths or scales removed for ageing.

The standard grid of 58 stations was fished in 2002 and 2003 (see map), and although other stations have been fished in this period, they were for exploratory purposes and were not included in the assessment.

## 4. Abundance index calculation

Plaice and sole abundance indices are calculated by allocating the appropriate ages to the fish that are caught. This gives the age composition (AC) of the catch, and this is used in the appropriate working group analysis.

The AC's are calculated by proportioning a length distribution (LD) to an appropriate age–length key (ALK). To account for possible population differences within ICES Division VIIe, biological samples are taken from sectors stratified by distance from shore (see map). The survey bands (in miles) are 0–3, 3–12, 12+ inshore, and 12+ offshore. Where appropriate the ALK's are separated by sex, and this allows a particular 'sector, depth-band and sex' ALK to be raised to the corresponding LD to give an accurate AC for that particular habitat. The AC's can then be combined as required to give results in the form of 'numbers-at-age, per distance or time'.

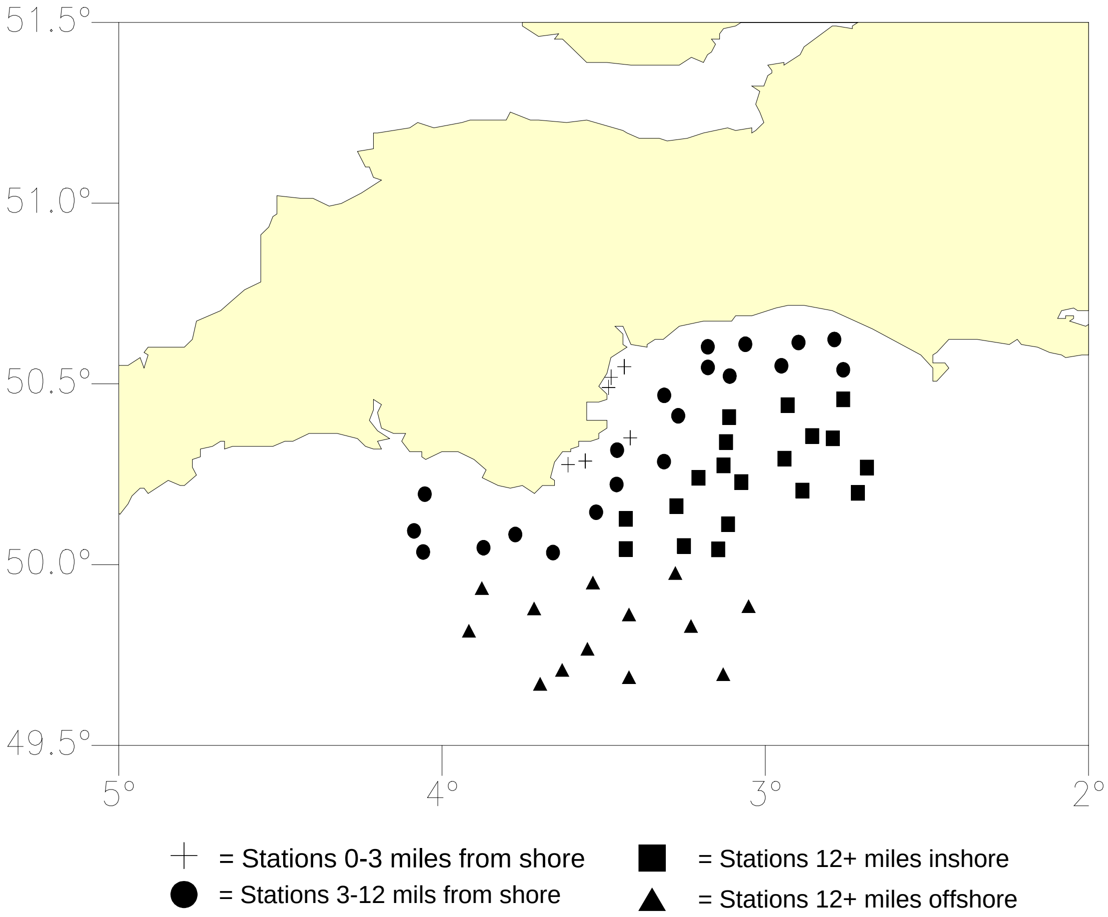
Between 1984 and 1990 a total survey age–length key was applied to the 'grid' length distribution, but from 1990 onwards stratum stratified age–length keys were used.

The Table below demonstrates the stratifications currently used to calculate the 'near-west groundfish survey' abundance indices.

| | | ALK stratified by | | | LD stratified by | | | |
|---|---|---|---|---|---|---|---|---|
| **Species** | **Sector** | **Sector** | **Depth band** | **Sex** | **Sector** | **Depth band** | **Sex** | **Used in assessment?** |
| **Plaice** | VIIe | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Sole** | VIIe | ✓ | ✓ | X | ✓ | ✓ | X | ✓ |

## 5. Map of survey grid

Additional stations have been fished throughout the time period, but as these stations are not consistently fished, they are excluded from this map.




## 6. Summary

| **Area covered** | **ICES Division VIIe** |
|---|---|
| Target species | Flatfish, particularly prerecruit plaice and sole |
| Time period | September-October. 1988 to present. |
| Gear used | 1984–1988 – 2 * 6 m beam trawls |
| | 1989–present , except 2002,2004 – 2 * 4 m beam trawls |
| | 2002, 2004 – 1* 4 m beam trawl |
| Mean towing speed | 4 knots over the ground |
| Tow duration | 30 minutes |
| Vessel used | F.V. Bogey 1 1984–1988 |
| | F.V. Carhelmar 1989–2001, 2003 and 2005–present |
| | R.V. Corystes 2002 and 2004 |

# Annex 3: Summary of Working Documents presented to WGCSE 2011

## WD01 Discarding of Haddock in VIIb–k; Comparison between the Irish and French discard data 2005–2010

Hans Gerritsen, Marine Institute, Ireland

A large proportion of haddock catches up to age three are discarded. Because recruitment is highly variable and the stock is relatively short-lived, it is important to take these discards into account in the assessment. Discard data are available from the Irish otter trawl fleets in VIIbgj from 1995 onwards. French discard data are available from 2005 onwards. Although the French do not appear to catch significant numbers of one-year-olds and the Irish do, discard ogives appeared to be similar and the assessment did not seem to be sensitive to the absolute number of one-year-olds. Therefore it looks likely that the Irish discarding pattern can be used to estimate historic discards and that French discard data should be included from 2005 onwards (This would require the data to be disaggregated by age and raised to the French fleets). For data before 2005 it may be advisable to raise the discard numbers of one-year-olds only to the Irish fleets whereas the older fish should be raised to the international fleet.

## WD02 Distribution of Juvenile Haddock in VIIb–k based on IGFS and EVHOE WIBTS; 4Q surveys

Hans Gerritsen, Marine Institute, Ireland

The 2009 year class of haddock VIIb–k appears to be the largest since the time-series began in 1993. In response to the assessment performed by the WGCSE in 2010 the review group commented that "A key question is where in the Celtic Seas this abundance of small haddock will be located, and hence where would measures to avoid discarding be best targeted. The WG should monitor the distribution of these fish through surveys and observer data and provide managers with this information". Both juvenile and are widely distributed throughout VIIb and g and the north of VIIj. The survey results of 2010 demonstrate a similar distribution of juveniles to the average of all years, so there is no reason to conclude that the 2009 cohort is distributed differently to young haddock in other years. Juveniles are particularly abundant in VIIb. The area with the highest abundance of juveniles in VIIb has a relatively low fishing effort, which may offer some protection from discarding. There are also some areas in VIIg and j with large numbers of juveniles. The fishing effort in these areas is moderate, which may result in significant levels of discarding.

## WD03 Irish fisheries–science research partnership trawl survey of the Porcupine Bank *Nephrops* Grounds; July 2010

Dave Stokes and Colm Lordan, Marine Institute, Ireland

## WD04 Update on the 2010 UWTV survey of the western Irish Sea *Nephrops* Grounds (FU15)

Colm Lordan, Jennifer Doyle and Richard Briggs (AFBI)

Since 2003 a joint UWTV survey has been carried out by the Marine Institute (Ireland) and AFBI (Northern Ireland). For the first time in 2009 this survey was used to develop catch options for the stock using a bias corrected survey estimate as an absolute measure of stock size and recent discard rates and mean weight to forecast catch as set out by the benchmark process in 2009. This report details the results of the 2010 survey for the western Irish Sea *Nephrops* stock and also PRESENTS individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009.

## WD05 Update on the 2010 UWTV survey of Aran, Galway Bay and Slyne Head *Nephrops* Grounds (FU17)

Colm Lordan and Jennifer Doyle, The Marine Institute, Ireland

This is the ninth data point in a time-series of UWTV surveys on the 'Aran grounds'. The survey covers three distinct mud patches; the Aran Ground, Galway Bay and Slyne Head. These have approximate areas of 940, 41 and 26 km$^2$ respectively. For the first time in 2009 this survey was used to develop catch options for the stock using a bias corrected survey estimate as an absolute measure of stock size and recent discard rates and mean weight to forecast catch (ICES, 2009a). This report details the results of the 2010 survey and updates the catch option table using the most recent survey estimate and also presents individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009. There was also a minor data revision to survey years 2006 and 2008 due to the amalgamation of survey data to a SQL server. This revision did not change the overall perception of the survey-series.

## WD06 Gadoid abundance from the 2010 west coast industry-science survey

P. G. Fernandes, R. Watret, I. Penny and F. McIntyre, Marine Scotland Science, UK.

## WD07 Preliminary assessment of Northern Shelf megrim (*Lepidorhombus* spp. in VIa-IVa) using Bayesian state space surplus production models

C´oil´ın Minto and Norman Graham

## WD08 Celtic Sea Cod Survey 2010 Report

Eoghan Kelly, Norman Graham and Macdara Ó Cuaig

## WD09 Egg production survey estimates of spawning-stock biomass of cod, haddock and plaice in the Irish Sea: 1995–2010

Mike Armstrong[1], Steven Beggs[2], Freya Goodsir[1], Lorraine Greenwood[1], David Maxwell[1], Steve Milligan[1], Enda O'Callaghan[2], Angelika Prael[2], Sam Roslyn[1], Alison Walton[1], Oliver Williams[1], Elaine Warren[2] and Peter Witthames[3]

**[1] Cefas, Lowestoft [2] Agri-Food and Biosciences Institute, Belfast [3] Consultant (*Fecund Fish*)**

## WD10 Update on the 2010 UWTV survey on the Celtic Sea *Nephrops* Grounds

Colm Lordan and Jennifer Doyle, The Marine Institute, Ireland.

This is the fifth in a time-series of UWTV surveys on the 'Smalls grounds'. The 2006 survey covered the distinct mud patches of the Smalls Grounds and also indicator stations on the Labadie Bank, Nymphe Bank and Seven Heads, whereas the 2007 to 2010 survey covered the Smalls grounds only due to poor weather and time constraints. This report details the results of the 2010 survey for the Smalls ground *Nephrops* stock and discusses the background to calculating the bias correction factor to the UWTV survey estimate, using mean weight in the landings, mean proportions of the catch retained and harvest ratios at different reference points from an SCA analysis to calculate landings options. It also presents individual's counting performance against the reference counts as measured by Linn's concordance correlation coefficient (CCC) as recommended by SGNEPS 2009. There was a minor data revision to survey years 2006 and 2007 due to the amalgamation of survey data to a SQL server. This revision did not change the overall perception of the survey-series.

## WD12 Standardised lpue time-series for the Irish Porcupine *Nephrops* fleet

Hans Gerritsen and Colm Lordan, The Marine Institute, Ireland

The main fishers operating on the Porcupine Bank (FU16) expressed concern that the Irish *Nephrops*-directed otter trawl lpue time-series may be biased due to changing fishing practices. The fishery, particularly by the freezer vessels, has become increasingly selective in targeting behaviour. Targeting behaviour has shifted from high volumes of smaller prawns to lower volumes of large prawns. The fishing effort has also become less seasonal with larger freezer vessels operating throughout the year. A GLM analysis indicated significant vessel effects throughout the time-series. A range of other explanatory variables also demonstrated significant effects (month, windspeed, ICES rectangle). However, after vessel effects were included in the model, other explanatory variables did not influence the standardised lpue estimates noticeably. The main concern raised by industry i.e. that vessels are now targeting more selectively for larger *Nephrops* has not been explicitly tested in the model because spatially explicit sampling data at the resolution required does not exist. It remains possible that the long lpue trend is biased in the past and not reflective of stock abundance.

# Annex 4: Technical Minutes

## Celtic Sea Review Group 1 Report

- RGCS1
- By correspondence 7 June 2011
- Participants: Asgier Anglen (Chair), Rick Officer and Rainer Oberst, Pieter-Jan Schön and Joël Vigneau (WG Chairs), Cristina Morgado, Barbara Schoute and Mette Bertelsen (Secretariat)
- Working Group: WGCSE

### Review process

The roundfish stocks and the *Nephrops* stocks were reviewed by RGCS2.

RGCS1 considered the following stocks:

| Fish stocks | Perform assessment | Advice |
|---|---|---|
| Anglerfish (*Lophius piscatorius* and *L. budegassa*) in IIa–VI | Y | Update |
| Megrim (*Lepidorhombus* spp) in Subarea VI and IV | Y | Update |
| Plaice in Division VIIb,c (West of Ireland) | Y | Update |
| Plaice in Divisions VIIh,k (Southwest of Ireland ) | Y | Same advice as last year |
| Plaice in Divisions VIIf,g (Celtic Sea) | Y | Update |
| Plaice in Division VIIe (Western Channel) | Y | Update |
| Plaice in Division VIIa (Irish Sea) | Y | Update |
| Sole in Division VIIb, c (West of Ireland) | N | Catch statistics only |
| Sole in Divisions VIIh-k (Southwest of Ireland) | Y | Same advice as last year |
| Sole in Divisions VIIf,g (Celtic Sea) | Y | Update |
| Sole in Division VIIe (Western Channel) | Y | Update |
| Sole in Division VIIa (Irish Sea) | Y | Update |

These were reviewed along with four herring stocks and one sprat stock from HAWG, and stocks of megrim and anglerfish from WGHMM. The Review Group conducted its work by correspondence. The reviews have been carried out according the Guidelines provided by ICES. This involved:

- Checking that update assessments have been correctly implemented using the methods described in the Stock Annexes;
- Checking that the assessments have been implemented correctly;
- Ensuring the assessment results and forecast results are carried over correctly to the advice sheets and advising ICES of any errors detected;
- Evaluating the ability of the stock assessments for providing credible management advice, and suggesting alternative advice where assessments do not appear appropriate;
- Providing recommendations to the Working Group to help with future development of the assessments through benchmarking.

The list of stocks was shared so that each reviewer wrote a first draft for a number of stocks. Then the two other reviewers gave their comments.

### General comments

The WG report is well organized and readable. The SharePoint site is well updated and structured, although not fully completed at the starting date of the review.

## Anglerfish (*Lophius piscatorius* and *L. budegassa*) in Division IIa, IIIa, Subarea IV and VI (report Section 5.2)

1 ) Assessment type: Update
2 ) **Assessment: T**rends. No analytical assessment is presented
3 ) **Forecast:** Not presented
4 ) **Assessment model:** None presented. Trends in abundance and biomass derived from surveys are presented as relative indicators of stock status.
5 ) **Consistency:** No analytical assessment has been conducted on this stock since 2004. Survey-series 2005–2008 revised.
6 ) **Stock status:** Survey-derived trends suggest that recent biomass is similar to the previous three years, but that abundance has declined by >25% over the survey period.
7 ) **Man. Plan.:** There is no management plan is in place for the stock.

### General comments

An age-structured analytical assessment is not available due to inadequate sampling, difficulties in age estimation, and the absence of a time-series of age data.

The previous assessment (2004) was length-structured. A length-structured assessment is also precluded by poor quality data.

As an alternative, a dedicated anglerfish survey was initiated in 2005 with the aim of estimating absolute abundance. Trends in biomass and abundance derived from these survey data appear to be a useful indicator of relative stock status. However, the catchability of the survey (and hence its ability to estimate absolute abundance) remain uncertain.

The WG Report does not provide any ecosystem information and the Stock Annex reports that ecosystem aspects were not considered. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

### Technical comments

Endeavours to understand the catchability of the Scottish industry–science partnership survey are noted and encouraged. Given the difficulties in tracking age classes in the survey, and in estimating age at all, it may be more fruitful to develop biomass-related survey indicators rather than age-disaggregated indices.

### Conclusions

Even if the ageing and sampling difficulties besetting this stock are quickly overcome a time-series of catch-at-age data will not be available for several years. Further development of alternative methods of stock assessment (such as the preliminary Bayesian biomass dynamic surplus production model proposed for Northern Shelf megrim) is strongly encouraged.

There is currently no accepted analytical basis for management advice. The status of the stock in relation to MSY and PA indicators is unknown. In the absence of an analytical assessment, trends in biomass and abundance derived from survey data appear to be the only available indicators of relative stock status.

## Megrim (*Lepidorhombus* spp) in Subarea VI (West of Scotland and Rockall) and Subarea IV (North Sea) (report Section 5.3)

1 ) **Assessment type**: Update
2 ) **Assessment:** No analytical assessment is presented.
3 ) **Forecast:** Not presented
4 ) **Assessment model:** None presented. Trends in mortality and biomass levels derived from surveys are presented as relative indicators of stock status.
5 ) **Consistency:** No analytical assessment has been conducted on this stock since 1999. The assessment data are consistent with those available to the most recent Benchmark meeting (WKFLAT, February 2011).
6 ) **Stock status:** Trends in mortality and biomass levels derived from surveys are presented as relative indicators. The absolute state of the stock is unknown. Relative to levels in 2005, survey data suggest that biomass has increased, and that fishing mortality has fallen. Fishing effort for several fleets catching megrim has also fallen over this period.
7 ) **Man. Plan.:** No management plan is in place for this stock. The TAC and assessment areas for this stock are different.

### General comments

An age-structured analytical assessment is not available due to inadequate sampling, difficulties in age estimation, and the absence of a time-series of age data.

As an alternative, WKFLAT (2011) considered a preliminary assessment based on a biomass dynamic surplus production model, tuned to survey data from Divisions IVa and VIa & b. Trends in biomass and exploitation rate derived from the surplus production model appear to be a useful indicator of relative stock status.

The WG Report does not provide any ecosystem information and the Stock Annex reports that ecosystem aspects were not considered. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

### Technical comments

The preliminary Bayesian biomass dynamic surplus production model developed for this stock is tuned to several survey time-series from Divisions IVa and VIa & b. These survey data are reasonably consistent over recent years.

For the Scottish industry–science partnership survey, posterior estimates of catchability of around 0.4 are indicated with greatest probability (*q*5 and *q*6 in Figure 3 of the Working Document: Minto, C. and Graham, N. Preliminary assessment of Northern Shelf megrim (*Lepidorhombus* spp. in VIa–IVa) using Bayesian state–space surplus production models). This survey is intended to provide absolute estimates of abundance, and hence catchability estimates should be close to one. Catchability values of around 0.4 suggest that the abundance estimates derived from this survey are overestimated 2.5 fold within the preliminary surplus production model, or that the survey abundance estimates represent around 40% of the absolute abundance.

### Conclusions

Even if the ageing and sampling difficulties besetting this stock are quickly overcome a time-series of catch-at-age data will not be available for several years. Further development of alternative methods of stock assessment (such as the preliminary Bayesian biomass dynamic surplus production model) is strongly encouraged.

There is currently no accepted analytical basis for management advice. The status of the stock in relation to MSY and PA indicators is unknown. In the absence of an analytical assessment, trends in biomass and exploitation rate derived from survey data appear to be a useful indicator of relative stock status.

## Plaice in Division VIIb,c (West of Ireland) (report Section 7.9)

1 ) **Assessment type**: No assessment
2 ) **Assessment**: None
3 ) **Forecast**: None
4 ) **Assessment model**: None
5 ) **Consistency**: -
6 ) **Stock status**: -
7 ) **Man. Plan**.: None

### General comments

Only landings are presented for this stock stock, and uncertainty due to the exchange between Division VIa and VII b,c are discussed without quantification.

### Technical comments

The unit of the landings in Table 7.9.1 is not defined (as in last year's report).

## Plaice in Divisions VIIh,k (Southwest of Ireland ) (report Section 7.11)

1 ) **Assessment type:** SALY, based on catches and sampling in VIIjk in 1993–2010
2 ) **Assessment**: trends
3 ) **Forecast**: none
**4 )** **Assessment model**: catch curve analysis and yield-per-recruit analysis
**5 )** **Consistency:** Same approach as last year
6 ) **Stock status**: Unknown
7 ) **Man. Plan**.: None

### General comments

The WG addressed the TORs by updating the tables and catch-curve analysis.

The WG considers that plaice in VIIh is likely to be a different stock. Sampling in VIIh is incomplete. Only sampling in VIIjk has been analysed and raised to landings in VIIjk. This is a small fishery, with a noticeable decline in landings over time. No information is provided on discard patterns.

Catch-curve estimates of Z varied between 0.6 and 1.2. The estimate for Z appears to be quite variable. These levels of Z are quite high compared to other plaice stocks. There is a possibility that this can be the consequence of declining catchability-at-age due to age-related shifts in distribution and/or seasonal migrations.

In the YPR curve, $F_{max}$ is estimated to be 0.24. Recent values of Z ranged from 0.6 to 1.2, with M=0.12 this would result in an F of between 0.48 and 1.08. This is well above $F_{max}$, however the catch-curve Z's may be biased.

It appears that no survey covers this stock, as no information on this is provided in the report.

### Technical comments

Trends in fishing effort would be valuable supporting information.

### Conclusions

The RG agrees that the analysis could indicate that recent F is well above $F_{max}$ and $F_{0.1}$.

## Plaice in Divisions VIIf,g (Celtic Sea) (report Section 7.10)

1 ) **Assessment type:** Update, changed model
2 ) **Assessment**: analytical
3 ) **Forecast**: no forecast
4 ) **Assessment model:** AP tuned with one surveys and three commercial time-series
5 ) **Consistency:** The assessment model was changed from XSA to AP. In addition, settings of the model were changed, but, the settings were not compared with the values of 2010.
6 ) **Stock status:** Recruitment and $F_{bar}$ significantly differed between the estimates of 2010 and 2011, especially for the last years. SSB is above $B_{pa}$=1800 t.
7 ) **Man. Plan.**: No

### General comments

The migration of plaice in Division VIIa is presented in the stock annex and documented migration into VIIfg and VIIe. On the other hand the stock annex of Division VIIe presents another picture. It is suggested that the migration structure of plaice in the different stock annexes should be compared und unified.

The WG describes the problem of discards and change the assessment models to reconstruct the historical discard rates. However, effects of migration were not discusses in the report.

The WG provides an update assessment, but the assessment method was changed from 2010 to 2011 from XSA to AP to incorporate estimates of discards before 2004. Furthermore, settings of the model were changes. Estimates of Recruitment and $F_{bar}$

significantly changed from the estimations in 2010 to 2011. Different approaches were presented related to advice applicable to 2011.

The WG Report and the Stock Annex do not provide any ecosystem information. Management plan is also not provided.

The recruitment based on the new assessment in 2011 was significantly higher than the estimates in 2010, but the estimates are uncertain.

### Technical comments

The use data in combination with the used assessment method only provide relative trends of the stock development. The estimates of the assessments in 2010 and 2011 differ for the last years of the time period.

RG proposed detailed evaluation of the survey design and the estimation procedure to improve the usability of the estimates and the understanding of the stock dynamics which further can be improved by the incorporation of the migration intensity between the different stocks.

### Conclusions

The change of the assessment model between 2010 and 2011 in combination with change of model settings makes it difficult to understand the reasons for the changed recruitment and $F_{bar}$ for the last years off the time-series. The RG agrees with the WG that only trends of the stock development can be provided due to the reasons of uncertainty (discards, survey indices, migration pattern).

Additional studies are proposed to investigate the reasons of the high discard level although the total catch was significantly lower than the TAC due to the low demand of the market. There are many options to reduce the discard by the fishermen (changes of the mesh sizes on the codend, change of the catch intensity in areas and seasons with high discard rates, etc.), especially if the TAC is not a limitation factor.

## Plaice in Divisions VIIe (Western Channel) (report Section 8.2)

1 ) **Assessment type:** Update, Benchmarked in 2010 (WKFLAT 2010)

2 ) **Assessment**: Analytical

3 ) **Forecast:** Short-term forecast provided

4 ) **Assessment model:** XSA tuned by three commercial fisheries and two surveys**.** SURBA was used for examining tuning series. Separable VPA was used for screening catch-at-age.

5 ) **Consistency:** The assessment was made the same settings as last year as defined by stock annex. Retrospective pattern seem fine.

6 ) **Stock status:** Estimated fishing mortality declined sharply from around 0.7 in 2004–2008 to 0.43 in 2009 and 0.45 in 2010. This relates to reduced fishing effort in 2009 and 2010 compared to previous years. The SSB has increased from the lowest observed (1144 t) in 2008 to 3371 t in 2011. This is above the proposed MSY $B_{trigger}$ (2500 t) and also above the 1980–2010 average. The estimated F in 2010 is above the proposed $F_{MSY}$ of 0.14–0.31. Recent recruitments are above average, and the stock is expected to further increase at $F_{sq}$ or lower. The earlier precautionary reference points are not considered relevant, but have not been replaced by new values.

7 ) **Man. Plan.**: None

#### For consideration in the ADGCSE

The reference to the existing PA reference points should be considered removed from the advice document. The 2010 benchmark led to an upward adjustment of SSB throughout the series caused by the addition of VIId data. WKFLAT 2010 concluded that the basis for the previous $B_{lim}$ and $B_{pa}$ is no longer valid. (The $B_{lim}$ value now lies well below all historic SSB values in the assessment). In addition, the WG has since 2004 argued that the PA points did not reflect the stock–recruit pattern for the stock. WKFLAT 2010 could not come to a consensus with regards to suitable precautionary reference points but clearly stated that $F_{sq}$ is currently too high and should be reduced, while biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly understood. The Stock Annex contains several proposals for PA points, but they are all considered unreliable by the WGCSE 2011. They question whether PA points are urgently needed within the MSY-framework.

#### General comments

There is no EU management plan for this stock. The catch of this stock is managed by a TAC applied to Division VIId and VIIe combined.

The RG found no errors in the implementation of the assessment and forecast, and the results were carried over correctly to the advice sheets. Catch options and advice under PA approach need to be clarified at the ADG.

An important mixed fishery issue is the bycatch of plaice in the sole fishery in VIIe, which is subject to the sole management plan. A key finding last year was that F on both sole and plaice declined sharply by about the same amount between 2008 and 2009 (just under 40% reduction), although this is greater than the 23% reduction in beam trawl effort in VIIe between 2008 and 2009. For plaice the 40% F reduction between 2008 and 2009 is confirmed by the 2011 assessment.

Last year the RG suggested that raised discards estimates should be tabulated and a quantitative evaluation made of the likely fishing mortality rate due to discarding. This is not done, but the report states that “As the time-series of data expands, the WG will be able to better determine how to include these data in the assessment appropriately”. Several informative graphs show the available data on discards by length groups.

#### Technical comments

None.

#### Conclusions

The RG accepts the assessment as a basis for management advice.

### Plaice in Division VIIa (Irish Sea) (report Section 6.7)

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: no forecast
4) **Assessment model:** AP (Aarts and Poos) tuned with one survey (numbers-at-age) and two survey biomass indices
5) **Consistency:** The assessment model was changed from FLICA to AP. In addition, settings of the model were changed like number of tuning fleets

and used age groups. SSB and $F_{bar}$ significantly differed between the estimates of 2010 and 2011, especially for the last years.

6 ) **Stock status:** SSB estimates for 2009 and 2010 are above $B_{pa}$ (3100 t) and F is below $F_{pa}$ (0.45)

7 ) **Man. Plan**.: No

### General comments

The migration of plaice in Division VIIa is presented in the stock annex and documented migration into VIIfg and VIIe. On the other hand the stock annex of Division VIIe presents another picture. It is suggested that the migration structure of plaice in the different stock annexes should be compared und unified.

The WG describes the problem of discards and change the assessment models to reconstruct the historical discard rates. However, effects of migration were not discussed in the report.

The WG provides an update assessment, but the assessment method was changed from 2010 to 2011 from FLICA to AP to incorporate estimates of discards before 2004. Furthermore, settings of the model were changes. Estimates of SSB and $F_{bar}$ significantly changed from the estimations in 2010 to 2011.

The WG Report and the Stock Annex do not provide any ecosystem information. Management plan is also not provided.

### Technical comments

The used data in combination with the used assessment method only provide relative trends of the stock development. The estimates of the assessments in 2010 and 2011 differ for the last years of the time period.

The survey indices used on the assessment model do not presents similar trends. Detailed evaluation of the survey design and the estimation procedure can improve the usability of the estimates and the understanding of the stock dynamics which further can be improved by the incorporation of the migration intensity between the different stocks.

### Conclusions

The change of the assessment model between 2010 and 2011 in combination with change of model settings makes it difficult to understand the reasons for the changed SSB and $F_{bar}$ for the last years of the time-series. The RG agrees with the WG that only trends of the stock development can be provided due to the reasons of uncertainty (discards, survey indices, migration pattern).

Additional studies are proposed to investigate the reasons of the high discard level although the total catch was significantly lower than the TAC due to the low demand of the market. There are many options to reduce the discard by the fishermen (changes of the mesh sizes on the codend, change of the catch intensity in areas and seasons with high discard rates, etc.), especially if the TAC is not a limitation factor.

## Sole in Division VIIb, c (West of Ireland) (report Section 7.12)

1 ) **Assessment type**: no advice

2 ) **Assessment**: not presented

3 ) **Forecast:** not presented

4 ) **Assessment model**: none
5 ) **Consistency**:
6 ) **Stock status**: unkown
7 ) **Man. Plan**.: none

### General comments

Only landings are presented for this stock and uncertainty due to the exchange between Division Via and VIIb,c are discussed without quantification. The landings and lpue of Sole in VIIbc appear to have been more or less stable since the start of the logbooks time-series in 1995.

Sole in VIIb are mainly caught by Irish vessels.

### Technical comments

The unit of the landings in Table 7.9.1 is not defined as in the year before.

### Conclusions

There are no suitable data on which to base meaningful advice.

## Sole in Divisions VIIh-k (Southwest of Ireland)) (report Section 7.14)

1 ) **Assessment type:** SALY, based on catches and sampling in VIIjk in 1993–2010
2 ) **Assessment**: None
3 ) **Forecast**: None
**4 ) Assessment model:** catch curve analysis; Yield-per-recruit analysis
**5 ) Consistency:** Same approach as last year
6 ) **Stock status:** The recent F is indicated to be moderate.
7 ) **Man. Plan**.: None

### General comments

The WG addressed the TOR by updating the catch data and Z estimates.

Area VIIh is considered part of the stock for assessment purposes (management unit) yet it is not believed to be part of the biological stock. Only sampling in VIIjk has been analysed and raised to landings in VIIjk.

The estimated Z is variable. The Z was peaking in 2003 and on its lowest in 2007. The WG estimate of landings does not show a similar trend but is rather stable in this period.

In the YPR curve, $F_{max}$ is estimated to be 0.32 and $F_{0.1}$ to be 0.15. Recent (2006–2010) values of Z ranged from 0.15 to 0.45, with M=0.10 this corresponds to an F between 0.05 and 0.35. This is about the same level as $F_{max}$.

### Technical comments

Are there any data on fishing effort of fleets taking the bulk of the sole catch? Does this suggest any trend in F?

Typos: Section 7.14.2; “the remainder of Section 7.14 concerns Irish data only in VIIgjk”...should be VIIjk? Section 7.14.3(second last line); M=1.0, should be 0.1?

### Conclusions

The RG agrees that the analysis indicates that recent Fs are at or below $F_{max}$.

## Sole in Division VIIf,g (Celtic Sea) (report Section 7.13)

1 ) **Assessment type**: Update
2 ) **Assessment**: Analytic
3 ) **Forecast**: Presented
4 ) **Assessment model:** XSA tuned with one survey, and two commercial cpue series
5 ) **Consistency:** The assessment data and model formulation used are consistent with the approach adopted since 2006
6 ) **Stock status:** The stock status is consistent with the previous assessment. SSB remains relatively steady at a level close to the long-term average, and well above $B_{pa}$ (2200 t). Fishing mortality ($F_{4-8}$) remains near the lowest levels observed in the time-series, lower than $F_{pa}$ (0.37) and $F_{MSY}$ (0.31). Model estimates of recent recruitment are consistent with the long-term geometric mean recruitment. However the most recent recruitment is estimated to be the weakest in the time-series.
7 ) **Man. Plan.:** No management plan is in place for this stock.

### General comments

The WG has screened the survey and commercial tuning data independently of the Catch-at-Age data, and report that all tuning-series shows good cohort tracking and consistency between ages. However, the WG report and Stock Annex both note that differing survivor estimates arise from the UK beam trawl survey and UK Beam trawl fleet. Further evaluation of these tuning time-series, independent of their inclusion in the stock assessment, is suggested. This will better ascertain the quality of these tuning data, and their suitability for inclusion in the assessment.

The text in Section 7.13.3 incorrectly defines the recruiting year class as 2007 rather than 2009. The paragraphs in this section are very similar to, but not identical with those in the Stock Annex. These paragraphs should be cross-checked for consistency and accuracy.

The Stock Annex contains large amounts of text that have been copied from the WG report and are specific to a particular year. The Stock Annex appears to be the text from the 2010 WG assessment report. Ideally the stock annex text should be written with generality such that it does not require an annual update.

The method of calculation of the international catch numbers-at-age is inadequately and inconsistently described in the WG report and Stock Annex (the stock annex actually refers to the “Stock Annex” for “further details”!). It is not clear how the age composition of unsampled fleets is derived, or whether age composition and weight-at-age data are available for Ireland.

Neither the Stock Annex, nor the WG Report, provides any information on Ecosystem aspects. Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

### Technical comments

The model formulation proposed for Sole in VIIa at the most recent Benchmark meeting (WKFLAT, February 2011) reduced the age for which catchability is considered as being independent of age from >=7 to ages >=4. The *q*-plateau for Sole in VIIfg however remains at age >=7. The WG should consider whether the life history and fisheries for Sole in these neighbouring stocks are so different that the different model settings are warranted.

Adoption of a combined Age–Length Key to calculate the catch-at-age data for the major fishing nations would be a major improvement to the assessment. The methods recently adopted for VIIa Sole for the calculation of catch numbers, catch weights and stock weights are likely to reduce the interannual variation in derived biomass and catch estimates. Such approaches should be considered for VIIfg, and could be implemented at the next benchmark assessment for VIIfg Sole. In the interim, the WG should in its next report provide a clear description of the current method of calculation of international catch numbers-at-age.

The failure to update the Belgian beam trawl commercial tuning-series places increasing reliance on the UK commercial and survey tuning-series for estimating survivors of all ages. Given the inconsistencies between these UK series and the WG's inability to explain these discrepancies it would be wise to update the Belgian tuning-series as soon as possible. It is noted that a means of resolving these issues was proposed in 2009 but has not been investigated. It is suggested that this work proceed without further delay such that improved tuning-series will be ready in advance of the next benchmark assessment.

### Conclusions

The Stock Annex for Sole VIIfg requires revision. It is not currently an adequate description of the general assessment procedure for this stock.

The assessment has been performed consistent with the approach adopted at assessment WGs since 2006. Notwithstanding the Review Group's suggestions above, the current assessment performs consistently from year to year, and is considered a good basis for management advice. The forecasts are also considered to be a sound foundation for the development of management advice. The estimates contained in these forecasts do not require revision before the advice drafting group, but their basis is incorrectly referenced in the WG report (The source for the 2010 recruitment should read $GM_{71\text{-}08}$, not 5025).

## Sole in Division VIIe (Western Channel) (report Section 8.3)

1 ) **Assessment type:** update according to 2010 assessment. Benchmark procedure in 2009 failed to develop an update procedure due to retrospective bias problem. WGCSE 2010 introduced a modified model setting.
2 ) **Assessment**: analytical
3 ) **Forecast:** short-term forecast provided
4 ) **Assessment model:** XSA, two commercial tuning fleets and one survey (+2 historic commercial tuning fleets)
5 ) **Consistency:** Last years' assessment and forecast was accepted and the current assessment and forecast is accepted. $F_{2009}$ is revised up by 2% and $SSB_{2010}$ is revised up by 15%. These revisions are partly influenced by a 12% upward revision of the 2009 catch.

6 ) **Stock status:** F in 2009 and 2010 is estimated below $F_{MSY}$ and the target F in management plan. SSB in 2011 (2571 t) is below MSY $B_{trigger}$ (2800 t). PA reference points were rejected by WKFLAT 2009. This also questions the basis for the chosen MSY $B_{trigger}$.

7 ) **Man. Plan.:** A management plan for this stock was agreed in May 2007 (Council Regulation (EC) No 509/2007). The long-term management target is F=0.27. The plan specifies a max TAC change of 15% for 2012. The plan has been evaluated by ICES.

### General comments

The RG found no errors in the assessment and forecast, and the results were carried over correctly to the advice.

In 2009 WKFLAT benchmarked this assessment, but failed to develop an update procedure, as it was not possible to address the cause of the substantial retrospective bias in F and SSB. The 2010 WGCSE assessment was based on previous accepted XSA formulations described in the Stock Annex, with a decrease in the F-shrinkage SE from 1.0 to 0.5 (stronger shrinkage) and an increase in the time period for shrinkage from 5 to 10 years. A change in $F_{bar}$ from 3–7 to 3–9 also was made. The same settings were used this year. The new settings still shows retrospective bias in the past, while the pattern for recent years seem satisfactory.

The report Section 8.3.3 contains some unchanged text from last year, giving the impression that several changes are made, while those changes already took place a year ago.

An important mixed fishery issue is the bycatch of plaice in the sole fishery in VIIe. A key finding last year was that F on both sole and plaice declined sharply by about the same amount between 2008 and 2009 (just under 40% reduction), although this is greater than the 23% reduction in beam trawl effort in VIIe between 2008 and 2009. Otter trawl effort has been declining over a longer period. For sole the 2011 assessment shows a 30% F reduction between 2008 and 2009.

The 2010WG decided to use the results of the stochastic simulations carried out by WGSSDS in 2006 to propose an $F_{MSY}$ of 0.27. No further work on MSY reference points were presented this year.

### Technical comments

The RG agrees to the justifications for benchmark raised in report Section 8.3.9.

### Advice sheet

The WG-report Section 8.3.7 describes an ICES evaluation of the management plan, and the advice sheet gives the advice according to management plan on the first page. Further down in the advice sheet it is stated that the management plan has not been evaluated, and that the advice has been based on the MSY framework.

Should the MSY $B_{trigger}$ based on a former $B_{pa}$ still be used? (ADG to decide?)

### Conclusions

The RG accepts the assessment and forecast as basis for advice.

## Sole in Division VIIa (Irish Sea) (report Section 6.8)

1 ) **Assessment type**: Update
2 ) **Assessment**: Analytical
3 ) **Forecast**: Presented
4 ) **Assessment model:** XSA tuned with one survey
5 ) **Consistency**: The assessment data and model formulation used are consistent with the approach adopted at the most recent Benchmark meeting (WKFLAT, February 2011).
6 ) **Stock status:** The stock status is consistent with the previous assessment. SSB remains at the lowest levels estimated for the time-series (at ~1200 t in 2009 and 2010). SSB remains well below both $B_{pa}$ (3100 t) and $B_{lim}$ (2200 t). Fishing mortality ($F_{4–7}$) remains near the lowest levels observed in the time-series, close to $F_{pa}$ (0.3) but greater than $F_{MSY}$ (0.16). Model estimates of recent recruitment are less than half the long-term geometric mean recruitment.
7 ) **Man. Plan.:** There is no management plan in place for Irish this stock.

### General comments

The Benchmark assessment (WKFLAT 2011) recommended several changes to the model formulation. These have all been implemented in the new assessment. As these changes were all implemented together it is not possible to deduce from the WG report the impact of each particular change to the model formulation.

This stock is tuned with just one cpue time-series, the UK(E&W) Q3 beam trawl survey. The WG has properly screened these tuning data independently of the Catch-at-Age data, and report that the survey-series shows good cohort tracking and consistency between ages.

The WG Report does not provide any ecosystem information and the Stock Annex reports that there is "no information" on Ecosystem aspects. This is deficiency in the assessment report and an inaccuracy in the Stock Annex. Information exists for some aspects of the ecosystem interactions of this stock (e.g.: Connolly *et al*. (2009). MEFEPO Northwestern Waters Atlas. Marine Institute). Relevant ecosystem aspects should be drawn from the literature and incorporated into the assessment documentation.

### Technical comments

The use of a combined Age–Length Key to calculate the catch-at-age data for the major fishing nations is a major improvement to the assessment. Application of the age composition of the sampled fleets to the unsampled fleets represents a minor uncertainty in the catch-at-age data as the unsampled fleets account for a very minor proportion of the landings (~2%).

Methods adopted for the calculation of catch weights and stock weights are consistent with the new basis for calculation of the catch numbers-at-age, and are likely to reduce the interannual variation in derived biomass and catch estimates.

The assessment notes that the historic catch-at-age data (pre-2000) is possibly of lower quality (Section 6.8.7) than the most recent data. The change in assessment approach to dispense with time-series weighting seems to be inconsistent with this deficiency in the data. Future assessments should assess this particular change in model formulation independent of any other changes to ascertain the impact on the assessment and its retrospective performance.

The assessment notes that the new model formulation has "resolved the retrospective pattern seen in the previous assessment". However, retrospective plots still indicate a substantial downwards revision in SSB, and upwards revision in fishing mortality, as a percentage of the recent estimates of each value (the text describing the scale of these discrepancies seems at odds with the Figure). An assessment run using the same procedure as used prior to the benchmark assessment would establish whether the retrospective patterns arise due to the addition of the most recent data, or due to the change in model formulation.

### Conclusions

The assessment has been performed consistent with the approach adopted at the most recent Benchmark meeting. The Review Group's considerations are matters that can easily be addressed in the next update assessment as they do not represent changes to the benchmarked model formulation, but matters that will help interpret the quality of the data, and their impact on model performance. The forecasts are considered to be a sound foundation for the development of management advice and do not require revision before the advice drafting group.

## Celtic Sea Review Group 2 Report

- RGCS2
- By correspondence 7 June 2011
- Participants: Mike Armstrong (Chair), Marie Storr-Paulsen and Svein Iversen, Pieter-Jan Schön and Joel Vigneau (WG Chairs), Cristina Morgado and Michala Ovens (Secretariat)
- Working Group: WGCSE

### General

The Review Group considered the following stocks:

| Fish Stock | Stock Name | Advice |
|---|---|---|
| cod VIIe–k | Cod in Division VIIe–k (Celtic Sea) | Update |
| cod-iris | Cod in Division VIIa (Irish Sea) | Update |
| cod-rock | Cod in Division VIb (Rockall) | Catch statistics only |
| cod-scow | Cod in Division VIa (West of Scotland) | Update |
| had-7b–k | Haddock in Divisions VIIb–k | Update |
| had-iris | Haddock in Division VIIa (Irish Sea) | Update |
| had-rock | Haddock in Division VIb (Rockall) | Update |
| had-scow | Haddock in Division VIa (West of Scotland) | Update |
| whg-7e–k | Whiting in Divisions VIIe–k | Update |
| whg-iris | Whiting in Division VIIa (Irish Sea) | Update |
| whg-rock | Whiting in Division VIb (Rockall) | Catch statistics only |
| whg-scow | Whiting in Division VIa (West of Scotland) | Update |
| Pol-celt | Pollock in the Celtic Seas | Collate data |
| nep-11 | *Nephrops* in Division VIa (North Minch) | Update |
| nep-12 | *Nephrops* in Division VIa (South Minch) | Update |
| nep-13 | *Nephrops* in Division VIa (Firth of Clyde) | Update |
| nep-14 | *Nephrops* in Division VIIa (Irish Sea East) | Update |
| nep-15 | *Nephrops* in Division VIIa (Irish Sea West) | Update |
| nep-7bcj | *Nephrops* in Division VIIb,c,j,k (Porcupine Bank) | Update |
| nep-17 | *Nephrops* in Division VIIb (Aran Grounds, FU 17) | Update |
| nep-19 | *Nephrops* in Division VIIa,g,j (Southeast and West of IRL, FU 19) | Update |
| nep-20–22 | *Nephrops* in Divisions VIIfgh (Celtic Sea, FU 20–22 | Update |

### Special requests

No special requests were addressed.

### Review process

The Review Group conducted its work by correspondence and through WebEx conference facilities organized by ICES. The reviews were carried out according the Guidelines provided by ICES, particularly focusing on the need to Quality Assure the assessment results supporting the provision of fishery management advice by ICES in the annual ACOM advice sheets. All stocks were reviewed by at least two reviewers. This involved:

- Checking that update assessments have been correctly implemented using the methods described in the Stock Annexes;
- Checking that the assessments have been implemented correctly, which could involve re-running the assessments to ensure the results in the WG report can be replicated exactly;
- Ensuring the assessment results and forecast results are carried over correctly to the advice sheets and advising ICES of any errors detected;
- Evaluating the ability of the stock assessments for providing credible management advice, and suggesting alternative advice where assessments do not appear appropriate;
- Providing recommendations to the Working Group to help with future development of the assessments through benchmarking.

### General comments

The Review Group appreciated the efforts by the Working Group in addressing many of the RG comments and recommendations made last year. A number of general issues common to many stocks and raised by RGCS last year, remain unresolved and are discussed below together with other general issues arising this year:

1 ) Discard estimates

Fleet-raised estimates of discards are included in the assessments of Area VI gadoids, and haddock in VIIb–k, and in the assessments of *Nephrops* stocks. In other cases (e.g. whiting in VIIa and VIIe–k, haddock in VIIa, cod in VIIa and VIIe–k), international raised discards data sufficient for inclusion in assessments are not provided due to inadequate coverage or no agreed methods for raising. EU member States are required through the Data Collection Framework to collect data on discards for fleets where discarding exceeds a specified percentage, and are expected to meet precision targets (albeit very stringent ones). This has been a requirement since the inception of the DCR/DCF. The WGCSE should encourage intersessional work to agree raising procedures and compile international raised discards data for years with sufficient fleet coverage, with associated quality metrics as advised by ICES WKACCU and WKPRECISE including summaries of sampling rates by country.

2 ) Biological sampling on surveys

Considerable archives of biological data collected on surveys exist for many stocks. However, very little of this is used by the WG to provide time-series of biological parameters such as maturity, length/weight-at-age, etc. For example, the practice of using mean weights-at-age in annual commercial catches (or even worse, in landings) as values for weight-at-age in the stock, is prevalent despite the existence of good data from surveys at different times of year, which can be modelled to obtain year and age or year-class effects (see VIIa haddock for example). This is proposed by the WG for some stocks but needs to be followed up actively and included in the ToRs for benchmarks.

3 ) Commercial lpue tuning data

There are a number of roundfish and *Nephrops* stocks where commercial lpue is still presented or used in the assessments. Although the WG mentions the effects of changes in accuracy of catch reporting, and the potential for trends in catchability due to changes in fleet activities, structure and technology, there are no quantitative evaluations other than the modelling of *Nephrops* lpue in FU16. The RG was advised that France has a project to develop improved fishery tuning-series for French fleets, however the WGCSE should ensure that future benchmarks include full statistical evaluation and (where appropriate) modelling of commercial tuning fleet data if these are to be used. VMS data linked to EU logbook data, and observer data, provide an opportunity to examine spatio-temporal patterns in cpue, at least for the larger vessels.

4 ) Benchmarking

Last year's RG noted that few of the stocks covered by WGCSE had been the subject of benchmark assessments, and is glad to see that several roundfish stocks are to be benchmarked in 2012. Suggestions for topics to be addressed during the benchmarking are listed in the WG report for cod and other stocks and in general the RG supports these suggestions. Although it is important to identify major failings to be addressed, the WG should consider that the benchmarking process should cover the compilation and evaluation of all data and aspects of population dynamics that feed into the assessment and advice. The WG is invited to read the proposals in PGCCDBS 2011 for the data compilation process leading up to benchmark assessments, including the formation of data subgroups, setting full terms of reference for benchmark data compilation and evaluation, allocation of responsibilities and timelines, and planning a data workshop prior to the benchmark assessment meetings (ACOM will review the PGCDDBS report later this year). A full set of ToRs suitable for a typical benchmark data compilation process is given by PGCCDBS and could be used or adapted by the WG as a template for forthcoming benchmarks for WGCSE stocks.

5 ) Quality of official landings data

For many stocks in the working group the reported landings are considered more accurate since introduction of Buyers and Sellers legislation in 2006. Supporting evidence of this should be sought prior to benchmarking of stocks.

6 ) Stock Annexes

Stock Annexes should be brought fully up to date and any out-of-date analyses revised if they are still thought to be useful, or removed if no longer of use and aren't necessary for interpreting historical data or assessments.

7 ) *Nephrops* assessments

The assessments and advice for most of the *Nephrops* stocks in Subareas VI and VII have fallen into a common approach based on UWTV surveys, yield-per-recruit $F_{MSY}$ estimates based on results of length-based assessments, and supporting trends indicators. The RG appreciates the efforts by WGCSE to standardize the methods and streamline the reports, and many of the recommendations by last year's RG have been adopted by the WG. However the RG encourages WGCSE to develop approaches to estimate precision of biomass estimates and catch forecasts relative to $F_{MSY}$, taking account the variance (and covariance) in both. For example, there is often considerable variability of mean weights in landings and discard rates used for catch forecasts, which also reflects variability of the inputs to the procedures for estimating $F_{MSY}$ based on recent fishery length compositions and discard rates. It is also not clear if the different discard survival rates adopted for *Nephrops* FUs (ranging from 0% to 25%) represent real differences between stocks.

8 ) Overview sections

The area overview sections are generally among the last to be written by the WG, and are often not available to the RG to check any references to tables or figures in the overviews. For example the Irish Sea overview section was not available for the RG at the time of review.

9 ) Forecasts for trends only stocks

There are some stocks such as VIIb–k haddock where an analytical assessment model is run but the results are used as relative trends only. This procedure loses any quantification of the possible direction of future catches particularly if strong or weak year classes are likely to have a strong impact (as is the case for VIIb–k haddock). The RG considers that ICES should base advice for "trends only" stocks on both the historical trends and the possible short-term changes in catches based on forecasts where these can be carried out with sufficient confidence. Otherwise there is a strong risk of inappropriate management actions being imposed on data-poor stocks for which there is some knowledge of how catches may change in the short term.

## Cod in Division VIIe-k (Celtic Sea) (report Section 7.2)

1 ) **Assessment type**: Update
2 ) **Assessment:** exploratory XSA; survey and fishery trends
3 ) **Forecast:** none provided
4 ) **Assessment model**: XSA
5 ) **Consistency:** failed benchmarked in 2009, no new assessment proposed in 2010; XSA in 2011
6 ) **Stock status:** exploratory analysis suggests that F has decreased, SSB is stable and 2009 year class is relatively strong.
7 ) **Man. Plan.:** No agreed management plan has been developed yet. However, a long-term management plan is under discussion for this stock and an effort based management system in the Celtic Sea (VIIfg) is being discussed by member states and the EC.

### General comments

The specific ToR for VIIe–k cod was to perform an update assessment (as opposed to SALY). Last year the WG continued to follow the WKROUND advice not to perform an analytical assessment due to catch uncertainties. This year, an exploratory XSA has been carried out. The data include age compositions corrected for highgrading and misreporting.

The WG report and Stock Annex do not include any ecosystem information relevant to this stock and its fisheries, or any information on climate changes that could affect the stock. This was also highlighted by the RG last year. Given the location of the stock at the southern limits of the species range, this is a major omission that the WG should address. The Stock Annex comment that "no environmental drivers are known for this stock" is not correct given the history of studies on cod and climate.

There is no agreed Management Plan for this stock.

A French self-sampling programme has been introduced in 2009 and a large part of the data for French fleets is derived from this data source.

The WG has not used mixed fishery data in the stock section or annex other than a statement of which fisheries cod is caught in. Cod in the Celtic Sea are often taken as a minor bycatch in a range of trawl and netting fisheries targeting a diverse range of species. Management measures to conserve cod could impact a wide range of fisheries that do not target cod and the impact of this needs to be evaluated.

Official landings data from France were revised for 2009 and catches had to be derived from landings reported by fishing organizations. Only 68% of the French quota was taken, resulting in an apparent sharp reduction in discarding/highgrading in 2009.

There is no information on the absolute level of misreporting for this stock but there is evidence that misreporting increased from 2002 when quotas became restrictive with a maximum in 2008. In the last two years the problem seems to have decreased.

Discarding (mainly highgrading with some undersized cod) and landings misreporting had been exacerbated since 2003, when quotas became increasingly restrictive. Discard estimates are not used in the assessments as there is no complete time-series covering all the main fleets.

The two main problems in assessing the stock are: 1) perceived problems with accuracy of catch-at-age data in the 2000s due to highgrading (although attempts have been made to adjust for this), and (2) available surveys lack robust trends mainly due to their low catch rates, with all current survey-series taking place in autumn when cod are dispersed and often present in non-trawlable grounds. In 2010 the Marine Institute and the Federation of Irish Fishermen initiated an annual Q1 fishery-independent survey for Celtic Sea cod. The survey uses a commercial vessel and a dedicated survey trawl specification, based on a commercial design and in accordance with the criteria laid down in ICES Study Group on Survey Trawl Standardization. The RG supports the new survey and believes it will improve the assessment in future, but will require several years to indicate stock trends.

The stock will be benchmarked in 2012.

#### Technical comments

1 ) It is stated that French landings have been corrected with highgrading estimates from 2003 to 2005 and there is a reference to a working document in 2006. However, the RG did not have access to this WD and it would be beneficial if all relevant information was placed in the stock annex.
2 ) Long tables of 1 cm interval LFDs by country (Tables 7.2 and 7.2.4a, etc.) take up a lot of report space. It is not necessary to have both tables and graphs showing the same information. Plots are better for LFDs. Some of the tables do not indicate year of sampling.
3 ) There is no information in the stock-annex (or in the WG text) on how stock weights are estimated. However in the table headings it is stated that stock weight equals 1st quarters values; the WG should confirm if this is catch weight or landed weight.
4 ) In Table 7.2.3 the Sums-of-Products for 2010 is only 77%. SOPs gives 4185 t compared to WG landings of 3229 t. WG Chairs were advised, and error was identified (age 6 CN = 9, not 92; age 7 = 0, not 2). All XSA results, tables and figures were re-run.
5 ) The internal consistency regressions for both EVHOE and IBTS 4th Q have negative slopes for age 3–4; could there be immigration of older fish or is it just noisy data?
6 ) The Stock Annex needs to be updated. Only two commercial and two scientific surveys are listed to be used in the assessment. However eleven

tuning fleets are listed in the WG text, and four commercial fleets and three scientific surveys are used in the XSA. There are no XSA settings available in the stock annex and they can therefore not be checked against the settings used in this year's assessment. Table 7.2.9 would be easier to read if the tuning fleets used in the assessment were highlighted in bold.

7 ) The next benchmark should review whether commercial tuning fleets should include lpue down to age 1. Inclusion of landed numbers of partially selected, heavily discarded ages is usually considered bad practice due to apparent changes in catchability associated with changes in discard practices.

8 ) In the XSA results, selectivity appears to change strongly around the mid-2000s with Fs at ages >3 much lower than younger ages. Is this explainable by changes in fishing patterns, e.g. Trevose closure? This makes the F(2–5) decline rather faster than the 2-gp F (apart from the low 2-gp F for 2010).

9 ) The RG appreciates the WGCSE providing comparative XSA runs using all fleets and an additional run using surveys only, and notes that this makes little difference to the results.

10 ) The WG makes a strong statement that the range of the stock has contracted, based on the plots in Figures 7.2.6–7.2.8. It is not clear if this is the case (the yellow areas cover the same area each year) or if what is being seen is a general reduction in the overall catch level across the stock range.

11 ) The RG supports the recommendations for the 2012 benchmark (however see general comments at start of this report). An important question for the WG to address is how the bias/imprecision in catch-at-age values due to discarding, and errors in other variables, can be accounted-for in a suitable analytical model formulation.

### Conclusions

The RG agrees with the use of the comparative XSA runs as indicators of stock trends but not for providing absolute estimates of recent F or catch forecasts.

The RG supports the continued efforts to improve the input data, including the instigation of the new Q1 survey by the Marine Institute and the Federation of Irish Fishermen in 2010.

## Cod in Division VIIa (Irish Sea) (report Section 6.2)

1 ) **Assessment type**: Update

2 ) **Assessment**: analytical

3 ) **Forecast: N**o detailed short-term forecast given. Boot-strap B-adapt used for medium-term forecasts.

**4 ) Assessment model:** B-Adapt-F.exe (13/5/06) with five survey indices and estimation of removals bias from 2000 onwards.

**5 ) Consistency:** very consistent with last year

6 ) **Stock status:** The spawning–stock biomass has declined tenfold since the late 1980s and is suffering reduced reproductive capacity, with SSB in 2010 (947 t) reaching a record low, well below the $B_{lim}$ of 6000 t. The low SSB is confirmed by annual egg production surveys. The fishing mortality estimates since 1988 have remained above the $F_{lim}$ value of F=1.0 and the stock

has therefore been harvested unsustainably over this period. SSB in 2010 is expected to increase due to an improvement in recruitment in 2009.

7) **Man. Plan.:** In 2008 the EU adopted a long-term plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008) that repeals Regulation (EC) No 423/2004, and has the objective of ensuring the sustainable exploitation of the cod stocks on the basis of maximum sustainable yield while maintaining a target fishing mortality of 0.4 on specified age groups.

### General comments

The report is well written and has a good structure. The WG addressed the ToRs by providing an update with associated management advice.

The assessment was carried out according to the stock annex description. The RG found no errors in the implementation of the assessment, and the results were carried over correctly to the advice sheets.

The WG report and Stock Annex do not include any ecosystem information. Previous WGs (2006) documented a relationship between temperature in spring and cod recruitment anomalies and this is mentioned in the Annex. However the assessment and advice do not take climate effects into account. The WG report includes information on stock structure and migrations based on tagging studies, indicating mixing of cod stocks between the Irish Sea, west of Scotland and the Celtic Sea.

The stock is subject to an EU multi-annual management plan. ICES (2009 Advice) evaluated the management plan, and considers the implementation to Irish Sea cod is not in accordance with the precautionary approach if a constraint on interannual TAC adjustments is applied, given the poor state of the stock.

The WG has not used mixed fishery data in providing management advice.

Discards data are not included in the assessment. Data presented up to 2010 show discarding on the observer trips to have been predominantly undersized cod at ages 0 and 1, rather than the highgrading or over-quota discards observed in some other cod stocks. However, over-quota discards of fish >MLS is observed in some fleets in 2010. The RG noted that discards data for UK(E&W) are presented by gear up to 2006 but for combined gears thereafter.

The RG acknowledged the effort to apply an alternative method (the state space SAM model) which gave a very similar result as the B-adapt. The RG was not able to evaluate the application of this model from the information provided.

The major issue with this assessment is the apparently large "removals bias" estimated by B-Adapt over the 2000–2010 period. The bias multiplier remains between 2 and 3. This represents the multiplier that has to be applied to the landings-at-age to remove any catchability trends in the surveys. The WG still has no knowledge of the cause of such removals, or the extent to which the bias may reflect catchability trends in the surveys. The TAC has not been fully utilized for a number of years, and reported landings are considered more accurate since introduction of Buyers and Sellers legislation in 2006.

The WG Irish Sea overview section was as last year not available to the RG to evaluate effort trends. Last year's WG showed large declines in the whitefish trawl effort (100 mm+ mesh) during the 2000s, and more stable *Nephrops* trawl effort. It is difficult to reconcile this with the lack of any recovery in age composition as shown by the continued very high Z. All available trawl data indicate a truncated age distribution in the Irish Sea. The declining SSB is supported by the Fishery Science Partnership surveys not included in the assessment, and the low SSB < $B_{lim}$ is supported by the results of surveys using the Annual Egg Production Method since 1995.

In the whiting VIIa section there is a description of the *Nephrops* fishery where the Swedish sorting grid has been implemented since 2009 in a large part of the fleet. However, the effect of the grids on cod is not mentioned in the VIIa cod section.

### Technical comments

1 ) The Stock Annex should be updated
2 ) The state space SAM model also has a multiplier function (as B-adapt) however there is no description in the text if this function has been added.
3 ) As last year's RG pointed out, the survey NIGFS_Oct (0 gr) has slope < 1 with very high t-value of 3.66 indicating a density-dependent catchability for this age. Future benchmarks should consider how 0-gp trawl indices are handled in the assessment, as the preferred habitat for 0-gp cod would be inshore rough ground poorly covered by the surveys.
4 ) No new $F_{MSY}$ evaluation has been conducted since last year's assessment.
5 ) Fleet-raised discards estimates are needed for all countries with significant discarding of cod, to produce a matrix of discards-at-age. It is important to have adequate estimates of discards-at-age to evaluate changes in selectivity due to technical measures.
6 ) Very good internal consistency is apparent in the UK(NI) March GFS, which is important as this is the main survey driving the assessment.
7 ) Figure 6.2.15 uses term "catch bias" -need consistent use of one term for this. "Removals bias" or "bias factor" could be used; see North Sea cod assessment report and use same terminology to avoid confusion.

### Advice sheet

Landings trends figure is wrong; reported landings line includes misreporting from 1991–1999.

### Benchmark

The RG supports the extensive list of benchmark recommendations for VIIa cod. However see general comments at start of this report concerning a structured approach to setting ToRs for benchmark data compilation and evaluation. The RG supports the WG group recommendation that the assessment of this stock should be benchmarked in the context of a benchmarking of all three western waters cod stocks, given the availability of new data not included in the assessments (FSP surveys; egg production survey estimates; discards data collected in the 2000s through the DCF) and improving knowledge of metapopulation structure and movements of cod in the overall ecoregion. The WG has suggested an initial Data Workshop to collate and interpret existing and new data on cod stock; the RG highly support this initiative, which is in line with PGCCDBS 2011 recommendations for benchmark assessments.

The RG suggests the following issues need to be included in the benchmark assessment:

1 ) Mean weight-at-age in landings is used both for stock and catch weight, which gives biased estimates for age group 1 in particular, and is affected by changes in selectivity. This could be improved by using modelled 1st quarter survey weights as stock weights (as done for 7a haddock). Maturity data from the surveys should also be modelled to provide smoothed trends in the maturity ogive.
2 ) It is known that the UK(NI) March GFS survey often has catches dominated by male cod, due to spawning behaviour patterns. Year effects in the survey could be generated by changes in sex ratio caused by behaviour. There may be merit in computing indices separately for males and females before combining using a more robust figure for sex ratio at age (~0.5 according to previous publications on Irish Sea cod maturity).
3 ) The mortality rate is still very high on this stock although there is a very limited fishing on the stock and the quota has not been fished in recent years. It will be beneficial to use discard data to evaluate F due to discarding although this is unlikely to explain the continued high mortality at the older ages.
4 ) A modelling framework is needed that is not constrained to estimate equal removals-biases for all ages and fleets and that can avoid the need to truncate the oldest true age to 4 for the entire time-series.

### Conclusions

The RG accepts the updated assessment as a basis for providing advice on the state of the stock relative to biological reference points.

## Cod in Division VIb (Rockall) (report Section 4.2)

1 ) **Assessment type:** No advice; catch statistics only
2 ) **Assessment:** not presented
3 ) **Forecast:** not presented
4 ) **Assessment model:** none
5 ) **Consistency:**
6 ) **Stock status:** unknown
7 ) **Man. Plan.:** none

### General comments

Official landings have been below 100 t since 2004. The maximum landings close to 2000 t, were in 1985 and 1988.

### Conclusions

There are no data allowing an assessment of stock trends. However both the Scottish and Irish time-series of lpue show a fall in 2010 relative to previous years.

## Cod in Division VIa (West of Scotland) (report Section 3.2)

1 ) **Assessment type**: update
2 ) **Assessment**: analytical
3 ) **Forecast**: Short-term deterministic forecast using WGFRANSW software.
4 ) **Assessment model**: TSA

5) **Consistency**: This year's assessment is very similar to the results from last year
6) **Stock status**: SSB 6580 t in 2010 is below $B_{lim}$ (14 000 t) and Z-0.2 (0.82) is estimated to be above $F_{lim}$ (0.8). However the Z-0.2 estimate has very large confidence intervals and is not considered to represent a fishing mortality F at age but rather estimates of total mortality above M=0.2.
7) **Man. Plan**.: Cod in Division VIa is included in the EU long-term management plan for cod stocks and the fisheries exploiting those stocks (Council Regulation (EC) 1342/2008). ICES WGCSE (2009) reviewed the plan in relation to west of Scotland cod and could not conclude that it was precautionary.

### General comments

The WG addressed the ToRs by providing an update with associated management advice.

The assessment was carried out according to the stock annex description. The RG could not run the TSA model and could only check the documented inputs which are in accordance with the annex. The results were carried over correctly to the advice sheets.

The WG report and Stock Annex only include ecosystem information in respect to the possible role of seal predation as a source of the unaccounted mortality. Climate effects on cod production are not considered.

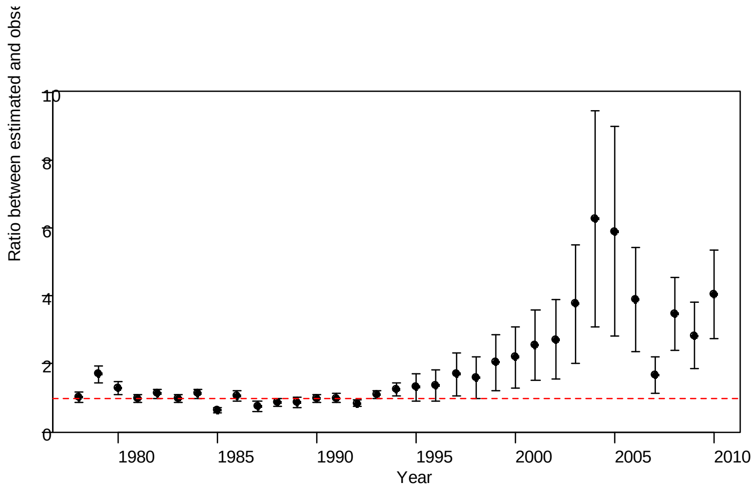
The stock is subject to an EU multi-annual management plan.

The WG has not used mixed fishery data in providing management advice.

Discarding/highgrading appears to be a major problem with discard rates in 2009 as high as 82% at age 4 but fell to 42% in 2010. The 2005 year class has been very heavily discarded.

The increase in discards-at-ages one and two and additional ages of cod discarded since 2006 are not able to influence the assessment due to the exclusion of all fishery data from 1995 onwards. A new version of the model is now capable of fitting discard proportions across more ages and can be considered at the planned benchmark in 2012. To consider discards from 2006 requires commercial data (landings and discards) to be reintroduced from 2006, as done for VIa haddock and whiting.

The main issue with this assessment is the exclusion of all fishery (landings and discards) data other than weights-at-age, from 1995 onwards. Effectively the assessment is a survey-based model calibrated against fishery catch-based population estimates pre-1995. The model gives a clear picture of a major decline in abundance at all ages, with a slight upturn in recent years due to improved recruitment of the 2005 and 2008 year classes. The removals predicted from the survey based Z (minus 0.2 for M) drift progressively away from the WG figures for fishery catches until 2004–2005, then the difference starts to reduce between 2004–2009 but increased again in 2010(see WG Figure 3.2.13 below).




Last year's WG ran an additional TSA run reintroducing the landings and discards-at-age data for 2006 onwards, as has been done for VIa haddock and whiting, as the WG indicated more accurate catch reporting since 2006 under the Buyers and Sellers legislation. This gave qualitatively the same picture of stock trends as given by the baseline model, and gave "true" F estimates for recent years close to $F_{lim}$ (0.8); i.e. very similar to the Z-0.2 estimates for the most recent years from the baseline model. The arguments put forward by the WG last year for not adopting this as the final model are firstly that the model estimates of removals are scaled downwards to an extent that they are the same as the WG catch data in the mid-1990s, whereas the WG states there is evidence of inaccurate catch reporting at that time. Secondly, the TSA model as currently configured can only handle discards up to age 2 whereas discarding across a wider age range is currently occurring. The first of these arguments may be spurious, as the confidence intervals around the model-predicted removals in the 1990s are wide and could encompass the likelihood of misreporting. The second problem (discard age range) would have required reconfiguring the TSA. Nonetheless, the exercise was useful in indicating that recent F could be of the same magnitude as the Z-0.2 from the baseline model. The effects of including recent catch data in the model was not discussed by this year's WG.

## Technical comments

1 ) Stock weight and catch weight are the same data. No description can be found in the stock annex. More robust and realistic (for younger ages) stock weights could be obtained from Q1 survey data, for example by modelling age and year effects. Q1 fishery data could be included for fully selected ages, although since 2006 the discard rate has increased for older age groups which may affect mean weights estimates.

2 ) Several aspects of the design of the ScoGFS-WIBTS-Q1 were changed at the same time in 2011. A new groundgear was introduced to allow fishing on rougher seabed types, the strata were altered, stations within strata were selected at random rather than the previous fixed-station design, and mean catch rates in strata were weighted by stratum area rather than number of tows. Although these changes seem to be an improvement in survey design and compatibility with the Irish survey, the RG considers the changes are sufficient to invalidate the use of the 2011 data as part of the existing series pending an evaluation of changes in catchability. The RG therefore

requested an additional TSA run excluding the Q1 2011 survey indices to be available for the Advice Drafting Group.

3 ) Cohort tracking in Q1 survey has become very poor.

4 ) The WG should explain the differences between the official landings figures and the WG estimates.

5 ) The WG report is still not giving any indication of the sampling effort for estimating discards by fleet/country. The methods used to raise discards data are only briefly described in the "uncertainties and bias" section of the WG report.

6 ) Table 3.2.3 shows survey data; with data in bold used in the final assessment age 1–6. The table provided in the stock annex gives the available input data but not the used input data. The WG should revise the annex to clearly state the "update" assessment inputs (e.g. age ranges in surveys).

7 ) Figure 3.2.15 shows the fitted S–R curve in the TSA is heavily driven by the 1986 y.c. and bulk of other yc lie below it. The stock–recruit relationships fitted by srmsymc package for last year's MSY calculations fitted the data better.

### Benchmark recommendations

The RG supports the extensive list of benchmark recommendations for VIa cod. However see general comments at start of this report concerning a structured approach to setting ToRs for benchmark data compilation and evaluation. The RG recommends that the VIa cod benchmark addresses metapopulation structure in western waters, and consider the implications of mixing of populations between neighbouring stock areas in VIIa, west of Ireland and in the North Sea (see VIIa cod benchmark proposals).

### Conclusions

The RG considers the updated TSA assessment to be appropriate to providing management advice for the stock, confirming that SSB is well below $B_{lim}$ and fishing mortality is likely to be well above any $F_{MSY}$ candidates.

## Haddock in Divisions VIIb-k (report Section 7.4)

1 ) **Assessment type**: Update

2 ) **Assessment**: Indicator of trends only.

3 ) **Forecast**: Short-term forecast presented, not used in advice sheets due to uncertainties in the data and the estimate of the large 2009 year class.

4 ) **Assessment model**: XSA, tuned with two surveys and two commercial fleets.

5 ) **Consistency**: XSA has been performed with the same settings as before with the exception of missing data for French commercial tuning fleets in 2009 and 2010. Updated results up to 2009 are similar to last year's run.

6 ) **Stock status**: The state of the stock is not precisely known due to uncertainties in the discards data and there are no accepted biological reference points. SSB is perceived to be increasing. The stock is highly dependent on the incoming recruits. Between 2002–2008 no strong year classes have been

observed, whereas the 2009 year class seems to be the highest on record as age 0 and 1. The 2010 yc is below average.

7 ) **Man. Plan**.: None

### General comments

The WG addressed the ToRs relevant to providing advice through an update assessment.

The assessment was carried out according to the stock annex description. The RG found no errors in the implementation of the assessment and forecast, and the assessment results were carried over correctly to the advice sheets. No forecast is given in the advice sheets.

The Stock Annex contains some limited information on ecosystem aspects or environmental drivers and was updated in 2011.

There is no EU management plan for this stock.

The WG has not used mixed fishery data in providing management advice. The proposed increase in square mesh panels to 120 mm will impact other species such as whiting and all such measures should be viewed in the context of mixed species catches.

The WG has done a good job with the available data. The time-series available for the assessment is short although a longer series of landings data are available.

In 2009 and 2010 the total landings were below TAC but the national quota appeared to become restrictive again for Ireland and Belgium (but not for France and the UK).

The major source of uncertainty in the assessment is the estimates of discards which are based on very small numbers of Irish observer trips, extrapolated to all fleets. There are also some uncertainties concerning landings data. Discarding appears to be an important feature in the fishery, comprising a large fraction of the catches up to age 3 and including fish above MLS. Sampling intensity of demersal fleets in the Celtic Sea needs to increase to improve the quality of discards estimates for haddock and other demersal stocks.

The WG estimates that the average discard rate over the last ten years was 70% by number and 45% by weight. However in 2010 discarding increased to 82% by number and 56% by weight. The short-term forecast predicts a further substantial increase in both landings and discards in 2011 due to the very strong 2009 year class. Landings are expected to remain high in 2012 at *status quo* F but discards of undersized haddock will reduce as the 2009 year-class fish grow past the MLS (assuming same discard ogive as recent years).

The French tuning fleet data for 2009 and 2010 were not available due to problems with the French logbooks database.

Survey data for VIIb–k haddock have variable area coverage but appear to be consistent in tracking year classes, and provide a consistent index showing a potentially very large 2009 year class. The potential of the new Irish Q1 joint science–industry survey to provide additional data on haddock is not mentioned.

### Technical comments

1) RG appreciates the inclusion of a longer term series of landings data as requested last year. Clearly shows that the fishery has been very variable in response (presumably) to sporadic recruitments as suggested.
2) It is stated correctly in the report the average of the discard in the last ten years and also illustrated by some very nice Figures 7.4.3b; however there could have been more discussion on the discard level in 2010 that increased by 17% in number and nearly 25% in weight.
3) Despite the poor quality of the discards data, the assessment appears to perform quite well, with good consistency of survivors' estimates, good retrospective performance for recent years, very consistent with last year's assessment. Some indices generate slopes differing from 1 with high t-value, probably reflecting the variability of the data (e.g. IRL-OTB (7bj) for age 6 and the FR-GAD for age 4).
4) The RG agrees with the advice from last year's RG that the data for VIIb–k haddock are more suitable for inclusion in a statistical modelling framework in which the nature and magnitude of the errors in the different datasets are accounted for, and the bias and variance in the population estimates can be properly evaluated. This should be explored before any future benchmark.
5) The WG has declined to put forward any candidate $F_{MSY}$ values due to concerns that the stock–recruit relationship is not well captured. It is clear that the Ricker model would not be a robust choice. However, last year's analyses showed that the range of B&H and hockey-stick $F_{MSY}$ and yield-per-recruit $F_{0.1}$, $F_{35\%}$ and $F_{MAX}$ values for landings are within the range 0.18–0.26.
6) In Summary Table 7.4.9, it would be useful to give the F(2–5) separated by landings and discards.

### Advice sheet

Given that the assessment is quite consistent, and provides selectivity estimates, weights-at-age, etc., a YPR could be updated.

### Conclusions

The WG has taken note of earlier recommendations from RG and made a good compilation of the steps needed before making a benchmark assessment. Particular progress is needed on obtaining and making best use of available discards data, and evaluating the quality of available datasets using ICES Quality Assurance Framework.

The RG agrees that the WG assessment is suitable for indicating general trends. However, the forecast also has a useful exploratory role, given the possibility of a very large 2009 year class entering the fishery, and could be used to guide management decisions given the potential for a very large increase in catches in 2012. The short-term forecast indicates that the catch weight could increase from 22 kt in 2010 (10 kt landed) to 65 kt in 2011 (30 kt landed) and reduce to 44 kt in 2012 (37 kt landed) at *status quo* F, although precision is not indicated and is likely to be relatively poor.

## Haddock in Division VIIa (Irish Sea) (report Section 6.3)

1) **Assessment type**: update

2 ) **Assessment**: survey trends
3 ) **Forecast**: Short-term forecast of abundance from SURBA model
4 ) **Assessment model**: Single fleet SURBA analysis, using only the NIGFS-Mar survey
5 ) **Consistency**: Updated survey trends are very consistent with last year's assessment.
6 ) **Stock status**: SSB decreased sharply in 2010 due to poor recruitment but is expected to increase following stronger recruitment in 2009 and 2010. Total mortality (Z=2–3) appears relatively stable. There are no MSY reference points.
7 ) **Man. Plan**.: There is no specific management plan for haddock in the Irish Sea. Due to the bycatch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the cod management plan (Council Regulation (EC) 1342/2008).

## General comment

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The RG found no errors in the assessment.

Mixed fishery data are not used when formulating management advice by the WG. Potential impacts of Swedish grids being used in some *Nephrops* trawlers should be considered.

The WGCSE was unable to provide absolute values for $F_{MSY}$ proxies (not updated in 2011), as there are insufficient data to derive estimates of $F_{MSY}$ with any degree of precision.

The method used by the WG to estimate stock weights based on survey data could be further developed and applied to other stocks (cod and whiting) with good survey data but noisy stock weights from fishery sampling at older ages. The weight-at-age in the stock shows a very clear decreasing trend over time, stabilizing in more recent years.

The SSB indices appear to respond dynamically to the very variable recruitment, as would be expected given the steep age profile in the surveys. Stock trends indicate an increase in SSB over the time-series followed by a decrease since 2008 due to some below average year classes. The rapid decline in Surba SSB index from 2009 to 2010 is also reflected in the AEPM egg survey biomass estimates, indicating that year classes are depleted very rapidly. However the catches in 2006 and 2008 were quite small relative to the AEPM SSB estimates, suggesting low mortality. This conundrum (continuing apparent very steep age profile despite large reductions in whitefish fishing effort) is the same as with cod and whiting.

The 2009 and 2010 year classes appear to be above average which is expected to cause an increase in SSB from the very low value observed in 2010. The index of total mortality appears relatively stable.

The survey data show very coherent year-class signals and appear to give a very clear picture of the development of the stock.

## Technical comments

1 ) The stock annex needs updating. The most recent version found by the RG was on the WG SharePoint for 2009.

2 ) The Irish Sea overview was not available for the RG at present time and therefore reference to this section cannot be checked.

3 ) It is stated in the report that: The NIGFS-WIBTS-Q4 survey has good internal consistency (see Stock Annex); however in the stock annex found by the RG (maybe an old version) this plot was not present.

4 ) The main problem with the historical yield-per-recruit analysis is the absence of discard fishing mortality. The Advice sheets no longer show YPR reference points.

### Advice sheet

1 ) In the advice sheets $F_{pa}$ at 0.5 is included however in the WG report it is stated that the Working Group no longer considers an $F_{pa}$ value determined in association with other haddock stocks as appropriate.

### Conclusions

The RG considers the updated survey-based analysis to provide an appropriate basis for formulating management advice based on relative abundance trends. The different surveys provide a consistent picture of the stock development.

The RG also agrees that the state of the stock with regard to reference points is uncertain as there are no biological reference points calculated, and the fishing mortality cannot be estimated directly from the surveys without independent knowledge of the survey selectivity characteristics across the age classes. The apparently very high Z from the survey age data is at odds with the low ratio of fishery landings to egg production estimates of SSB in 2006 and 2008.

The absence of reliable discard estimates is a serious deficiency that must be addressed if management is to be based on catch-at-age analysis, and if the fishery selectivity is to be defined and monitored in relation to technical measures to reduce discard fishing mortality. Levels of discard sampling have increased substantially in the last three years and reliable discards-at-age matrix could be formulated over the next few years.

Given the availability of data other than those used in the survey assessment (other survey data; egg production estimates; discards data) there is an urgent need for a data compilation workshop and benchmark assessment for this stock to establish a more comprehensive evidence base and a robust quantitative procedure for developing management advice. Benchmarking alongside the VIIb–k stock would be beneficial.

## Haddock in Division VIb (Rockall) (report Section 4.3)

1 ) **Assessment type**: Update

2 ) **Assessment**: analytical

3 ) **Forecast**: Short-term forecast provided

4 ) **Assessment model**: XSA tuned with 1 survey and including discards.

5 ) **Consistency**: Updated assessment results in 60% upward revision of 2008 F and a small downward revision of SSB. Assessment does not exhibit retrospective bias but appears to be unstable due to weak shrinkage used with noisy data. The survey-series has been revised since last year.

6 ) **Stock status**: F is below $F_{pa}$ =0.4 and close to F giving long-term equilibrium yield. SSB has been above $B_{pa}$ =9000 t since 2003. Recruitments since 2007 are estimated to be extremely weak and there is a high probability that SSB will decrease to levels below $B_{pa}$ in 2013.

7 ) **Man. Plan**.: None

### General comments

The WGCSE addressed the ToRs in providing an updated assessment with associated management advice.

The assessment was carried out according to the stock annex description. However the RG has some concerns as the only survey used for tuning was not conducted in 2010.

Substantial discarding occurs in the EU fisheries but has only been directly estimated in a few years. For other years, the WG conducts a convoluted process to infer discards from the Scottish survey length frequencies together with theoretical selection parameters and a discarding ogive, tuned using data from the few historical years with observer data. It remains unclear if these estimates are robust over the full time-series since there appears to have been no observer data since 2001 other than a few trips sampled by Ireland in 2007–2009 and none in 2010 to validate the figures inferred from survey and fishery length compositions. As no survey has been conducted and no discard trip has been conducted in 2010 the discard estimate from 2010 was calculated using an average proportion of discards/landings-at-age in 1999–2009.

Improved sampling of discards is needed. The RG supports the WG recommendation for the need for technical measures to reduce discarding.

Ecosystem aspects: The Stock Annex describes closures on Rockall to protect vulnerable habitats. In order to protect cold-water corals, three areas (Northwest Rockall, Logachev Mounds and West Rockall Mounds) are closed since January 2007. A new area to protect cold-water corals (Empress of British Banks) was established by the NEAFC in 2007. These are in addition to the Rockall Haddock Box to protect prerecruits that has been in place since 2002.

There is no EU management plan in place for this stock.

The WG has not used mixed fishery data in providing management advice. The stock annex and WG report do not provide information to evaluate bycatches in the directed haddock fishery.

A major signal in the fishery data is the very sharp reduction in Russian landings of haddock from around 5000 t in 2004–2005 to only 198 t in 2010. UK landings declined in the mid-2000s but have subsequently increased again.

### Technical comments

1 ) Table 4.3.14 highlights 1995, 1997, 1999 and 2001 as years with discards estimates calculated directly from observer trips. The Stock Annex also mentions 1998 and 2000 as years with Irish discards estimates (both are years with no survey). Why were these data not used for estimating discards?

2 ) The method of calculating discards in 2010 is not clearly explained. Although an average discard rate was applied to 2010 landings, the WG report says that the discard rate in 2010 was the lowest in the series (do you mean the quantities discarded?)

3 ) Although the biological parameters do not change between years the report should state how they were derived.

4 ) Mean weights-at-age 6 and 7+ in total catch were higher in 2010 compared to 2006–2009 and was therefore recalculated using a linear regression; however there is no explanation why the data are not to be trusted (actually the same pattern is seen in both fleets). The RG would like some documentation before real data are excluded.

5 ) Data screening; report states that SURBA gives steep decline in Z after 2000. However the Zs since mid-2000s are closer to earlier values.

6 ) Tuning did not converge after 180 iteration. This could be an indication of data or model problems. Following comment from RG to the WG Chairs, the XSA was re-run to 50 iterations, as per last year's run. This made very little difference to the results. The report tables were updated.

7 ) Figure 4.3.34 shows correlation between 0 group in the survey and age 1 in VPA. The regression has a positive intercept indicating that a zero 0-group index would predict 10 000 cod age 1.

8 ) The WG omitted to over-write the XSA estimate of 1-year-olds in 2010 with an RCT3 prediction for use in forecasts. The RG advised the WG chairs, who arranged for the RCT3 input and output files to be included and the forecasts updated.

9 ) The forecast value for the 2010 year class at age 1 uses the 5th percentile for recruitment. The arguments for this are rather weak given that SSB similar to 2010 have generated quite large recruitments in the past, and haddock are well known for very variable recruitment.

10 ) As pointed out last year by the RG the $F_{MSY}$ output table for the different stock–recruit options is not given in the WG report.

11 ) The RG could not evaluate the significance of the results of the StatCam model, or interpret the differences with the XSA, as the method is not explained anywhere.

### Advice sheets

In the summary figure on first page, the 2010 recruitment estimate should be identified as the 25th percentile for the entire time-series.

### Conclusions

The RG accepts the updated XSA run as a basis for providing advice and forecasts as the assessment is consistent with last year's run.

## Haddock in Division VIa (West of Scotland) (report Section 3.3)

1 ) **Assessment type**: Update

2 ) **Assessment**: Analytical

3 ) **Forecast**: Short-term

4 ) **Assessment model**: TSA, tuned with two surveys

5 ) **Consistency**: The current assessment method has been in use since 2006 and is considered consistent. A new survey design has been applied in the ScoGFS-WIBTS Q1. The assessment is therefore no longer a simple update.

The retrospective downward adjustment of F in 2009 was relatively large with the new assessment.

6 ) **Stock status**: ICES classifies the stock as being at risk of reduced reproductive capacity. The stock is below $B_{pa}$ since 2005. F has decreased in the same time period without any positive response on SSB and is now estimated to be below $F_{pa}$. The 2009 year class appears stronger than in recent years. There is no indication of an effect of SSB on recruitment over the range of SSB observed.

7 ) **Man. Plan**.: There is a proposed management plan and it is evaluated by ICES as precautionary

### General comments

The WG addressed the ToRs in providing an update assessment with associated management advice.

The TSA modelling approach was carried out according to the stock annex description, although the input data for the 2010 and 2011 WG assessments have included fishery data from 2006 onwards. The RG could not run the TSA and was only able to check the model settings.

Ecosystem consideration is not discussed in the report or stock annex (which only includes some basic haddock biology under the heading "Ecosystem aspects".)

The proposed management plan has been evaluated by ICES and "*ICES advises that a harvest rule with a target fishing mortality of 0.3 and a TAC constraint of ±15% is consistent with the precautionary approach*."

The WG provides some indication that haddock is taken in mixed fisheries but does not use mixed fishery data in providing advice in support of management.

Catch data are only considered reliable in the periods 1978–1994 and 2006–2010. This is a change compared to assessments prior to 2010 where catch data after 1994 were not used.

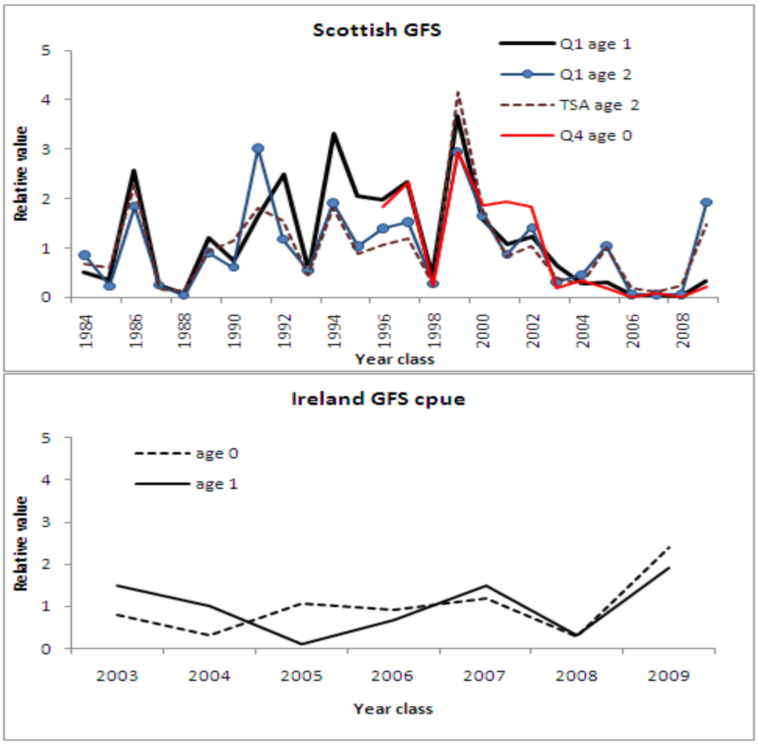
In recent years the uptake of quota has generally been low; however in 2010 the TAC uptake was 109% reflecting the recruitment of the 2009 year class.

### Technical comments

1 ) No stock annex was available.

2 ) The main technical issue for this assessment is the inclusion of abundance indices from the ScoGFS-WIBTS-Q1 survey in 2011, as this survey has been radically changed. The move from a systematic to a stratified random survey in Q1 with new strata and sampling intensities, plus a new groundgear and stratum raising procedures, effectively means a new survey-series with potentially different overall catchability-at-age and a different selectivity pattern than before. The impact of the new survey design is not mentioned by WGCSE until the quality section of the report. As the survey revises the strength of the 2009 year class upwards substantially, with a big impact on forecasts, the accuracy of the indices is critical. Crucially there are no maps or data presented to evaluate the data on the strong year class; e.g. what is the precision (now that the survey is random stratified!). The plots below show that the TSA estimate for 2009 year class at age 2 is heavily driven by the Q1 survey indices at age 2. The Scottish Q4 survey at age

0 and Q1 survey at age 1 both indicated improved recruitment in this year class, but still below the long-term average. The IreGFS Q4 at ages 0 and 1 indicate similar improvement in 2009 yc, but relatively not as large an increase as shown by the ScoGFS Q1 at age 2. Hence the derivation of the large index at age 2 in Q1 2011 Scottish survey needs to be investigated. The RG notes that the WG down weighted an outlying large index at age 6 in the same survey in TSA, but did not consider down weighting the large age 2 index. Pending investigation of the 2011 Q1 results, given the new design and gear, RGCS2 advised the WG chairs that the assessment and forecasts should be redone without the 2011 Q1 survey data, and supporting evidence from the 2011 survey (e.g. distribution maps) should be provided. The results with and without the 2011 survey indices would be available to the Advice Drafting Group to evaluate the impact on stock status and forecasts.




3 ) The very large downward revision in terminal F in the updated assessment including the 2011 Q1 survey may well be due to the large 2011 survey index.

4 ) Section 3.3.3 should clearly give the arguments (from last year) for re-including fishery data from 2006 onwards and why this is different from VIa cod where the data are still not included.

5 ) Figure 3.3.9: stock–recruit relationship. The estimates do not support a Ricker model, which may give poor indication of stock dynamics and MSY. Last year's MSY section stated that there is no ability to distinguish between Ricker, B&H and hockey-stick.

6 ) Section 3.3.7 argues that the fishery data are more accurate (precise) than the survey data. However this ignores the often poor precision of discards estimates based on relatively small sampling coverage, not to mention ad-

ditional biases due to the vessel selection procedure and incomplete sampling frames.

7 ) RG recommends that stock weights should be derived from the Q1 survey using suitable modelling approaches (see VIIa haddock), rather than using weights-at-age in fishery catches which may alter following changes in gear selectivity.
8 ) As requested by the RG last year, the WG should clarify if down weighting of individual data points in TSA described in the WG report were the same as in previous assessments.

### Benchmarking

RGCS2 agrees with the proposed analyses for the benchmarks but suggests additional work:

- Evaluation of precision of the survey catches-at-age, and review of survey estimation procedures (including collection and use of age data allowing for spatial variations in age compositions at length);
- There appear to be linkages with the North Sea stock. Any benchmark assessment of North Sea haddock and VIa haddock should be done in the same meeting to allow these connections and their effect on the assessments to be explored.

### Advice sheet

Relevant estimates were carried over correctly to the advice sheet.

### Conclusions

The RG considers the updated assessment with 2006–2010 catch data, and excluding the Scottish Q1 survey data for 2011 would provide an appropriate basis for providing management advice. However, the assessment requires benchmarking to validate the data and assessment approach and explore other assessment approaches and other information not included at present.

## Whiting in Divisions VIIe-k (report Section 7.15)

1 ) **Assessment type**: Update
2 ) **Assessment**: Indicator of trends only.
3 ) **Forecast**: Short-term forecast provided but not used in advice sheets.
4 ) **Assessment model**: FLXSA tuned with two commercial and three survey indices.
5 ) **Consistency**: The assessment is consistent with last year's update but shows periods of retrospective bias. The bias in SSB has decreased lately.
6 ) **Stock status**: The SSB estimate for 2010 (42 kt) is well above $B_{pa}$ (21 kt); however SSB is normally overestimated. There is no $F_{lim}$ or $F_{pa}$ defined.
7 ) **Man. Plan.**: None

### General comments

The WG addressed the ToR requiring an update assessment and associated management advice. The assessment was carried out according to the stock annex description, with the exception of missing French commercial lpue for 2009 and 2010 in the tuning file which was not updated. The RG found no errors in the implementation of the assessment and forecast. However, both the $F_{MSY}$ and the short-term predictions are considered very unreliable and are not carried forward to the advice sheets.

The WG report and the Stock Annex do not contain any information on ecosystem aspects or environmental drivers.

There is no EU management plan for this stock.

The WG has not used mixed fishery data in developing advice for this stock. A brief description is given in the WG report of fisheries taking whiting.

The problem of missing French landings data for 2009 in last year's assessment is now rectified, and French landings (but not effort) are available for 2009 and 2010. Due to absence of the French effort data, the French commercial tuning lpue fleets have no data for 2009 and 2010.

A minor error was identified and corrected in this year's assessment whereby age 7 mean weights have historically been used as in the calculation of SSB rather than a weighted average mean weight for 7+.

As with VIIb–k haddock, the discard issue for the whiting stock is considerable (>50% by fleet/quarter) and is discussed at length by the WG, which excluded discards data from the assessment. Discards data of variable coverage are provided to the WG but are not used for the following reasons given by the WG: 1) don't have discards data for the full period of landings-at-age data; 2) sampled fleets are not representative of the main fleets in the fishery and 3) need to examine and agree the best raising procedures for the various fleets. In the "recommendation for the next benchmark" section, the WG at least makes a clear proposal for work that needs to be done to make use of the discards data. The same proposal should apply to Area VII haddock and other stocks with significant discarding not included in the assessment. The WG should ensure that these proposals are followed up and a commitment is made to resolving the discards data issues.

The TAC has not been utilized in many years and in 2010 only 60% of the TAC was landed. However the TAC area does not fully correspond to the assessment area.

### Technical comments

1 ) An explanation is missing for the difference in WG landings estimate and the official landings.
2 ) The internal consistency of the surveys is generally quite poor. There is also poor coherence between survey trends by age class; does this reflect spatial differences? Some of the year-class time-series for IR-GFS-7G shows a negative correlation in the internal consistency plot for age groups 3–4 and 4–5. This survey has relatively high weighting in the assessment up to ages 4–5.
3 ) The estimation errors in the catch data make XSA a questionable model for this assessment. As with VIIb–k haddock, the RG suggests exploring a more statistical model that can deal with a variety of different datasets of differing quality and more accurately deal with the types and magnitude of errors.
4 ) There are strongly patterned non-random q residuals across all age groups, possibly related to absence of discards estimates ($F_{bar}$ estimates also show patterning). Recent retrospective performance is ok for SSB but there is a

tendency for strong year classes to get revised downwards. RG agrees with the WG that this is probably due to exclusion of discards from the assessment.

5 ) The WG should provide a comparative plot of this year's and last year's assessment results.

### Benchmark recommendations

RGCS2 agrees with proposed benchmark recommendations; however see general comments at start of this report about the overall data compilation and review process. A major problem to be addressed is the treatment of discards and the difficulties in estimating recent year-class strength based on the surveys.

### Advice sheet

Information from the WG report has been carried over correctly to the advice sheets.

### Conclusions

The RG supports the use of the updated XSA assessment as providing an indication of longer term trends but not for providing a forecast. The assessment shows difficulties in estimating recruitment. The estimate of the 2008 year class is shifted down by 29% and the 2009 year class upwards by 44%. The indication is nevertheless that the last three year classes are improved compared to the preceding ones in the 2000s and would be expected to build the spawning stock and lead to improved catches.

Estimates of SSB for recent years have increased well above the $B_{pa}$ of 21 000 t due to the improvement in recruitment.

## Whiting in Division VIIa (Irish Sea) (report Section 6.6)

1 ) **Assessment type**: Update

2 ) **Assessment**: survey trends; no assessment since 2007

3 ) **Forecast**: not presented

4 ) **Assessment model**: SURBA

5 ) **Consistency**: Retrospective SURBA runs show consistent trends compared to previous assessments.

6 ) **Stock status**: The state of the stock is unknown, however the stock is perceived to be subject to high fishing mortality and is at an extremely low level. Existing biological reference points are from XSA assessments no longer considered valid.

7 ) **Man. Plan.**: No management plan has been agreed or proposed

### General comments

The WG has addressed the ToR in providing an updated assessment using a survey based model, able to provide information on relative trends. The SURBA model has been implemented using the approach outlined in previous assessments. The Stock Annex does not tabulate SURBA model settings.

The whiting fishery for human consumption in VIIa has effectively disappeared and most of the catch is now discarded in the small mesh fisheries. A range of discards data is presented by the WG but the data are patchy and there is no unified set of discards-at-age for the full period up to 2010. Some fleets do not appear to have discards data after 2002 despite the DCF requirement to collect discards data for stocks with significant discard rates. It is therefore not possible to evaluate the full extent of discarding at age. The RG emphasizes the importance that steps are taken to obtain robust and reliable estimates of discards, otherwise the effectiveness of technical measures to reduce discarding will be difficult to quantify.

The TAC in 2010 was set at a very small value of 157 t, but even this was not fully utilized. In 2011 TAC was further reduced to 118 t. The reported landings are claimed to be more accurate since introduction of Buyers and Sellers legislation in 2006.

The Irish Sea whiting stock is primarily caught by otter trawlers which utilize two main mesh size ranges, 70–89 mm and 100–119 mm. Effort of trawlers utilizing the larger mesh range, traditionally targeting whitefish (cod, haddock, whiting) has seen a large decline since 2003. Effort in the 70–89 mm *Nephrops* fisheries has remained relatively stable. The RG notes that despite the reduction in whitefish trawl effort, apparent mortality estimates of whiting from the surveys have been increasing. Other sources of loss of adult fish from the Irish Sea other than fishing in VIIa should be investigated in any future benchmark assessment.

In late 2009, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. The WG reports that this is expected to reduce the whiting catches of these vessels by 60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel which is expected to reduce whiting catch by 76% in weight. Preliminary Irish discard data shows a reduction in 45% by number of whiting on boats using these selectivity devices. The RG recommends that the uptake of such devices is reported in future WGCSE reports, together with any observer or self-sampling data that demonstrates changes in catch size composition compared to vessels without the devices.

Catch-at-age data has not been updated since 2003 due to very low landings and lack of discards estimates for all the main métiers.

### Technical comments

1 ) The Stock Annex is still several years out of date (this was pointed out by last year's RG) and should be updated before next year's WG.

2 ) Figure 6.6.1 should present the catch series broken down into landings and discards.

3 ) As pointed out by last year's RG, and not commented on in this year's report: The decline in survey catch rates >MLS appears particularly sharp between 2003 and 2004 in the eastern Irish Sea. The tuning file for the March-East survey suggests this occurs over the age range, indicating a shift in whiting distribution or a change in catchability. The WG should evaluate causes for this.

4 ) In the text Section 6.6.3; final update assessment it is stated that "Recruitment appears to have been good in 2006 and 2008" and this is evident in both surveys (Figures 6.6.10 and 6.6.13, actually 6.6.11 and 6.6.14). However in the plots in the report and in the advice sheet Figure 5.4.25.1, this is not readily apparent.

### Advice sheet

1 ) Landings plot contains discards, and has the wrong scale (maximum ~200 kt; should be ~20 kt). See Tables 6.6.1 and 6.6.10 in WG report.
2 ) In the text it is stated that "No precautionary reference points have been defined for this stock." However in the advice sheet and stock annex biological reference points are stated; they should be removed from the advice sheet if they are no longer relevant.

### Conclusions

The RG considers that the SURBA model indices of abundance provide credible information showing a severe decline in biomass of whiting in the Irish Sea since the mid 1990s, and may be used as the basis for providing advice. Available discards data show that most of the whiting catch is discarded but there is no single coherent set of fleet-raised discards data for tracking changes in discarding over time.

## Whiting in Division VIb (Rockall) (report Section 3.5)

The WG provided an update of the landings table. International landings have declined from almost 500 t in the early 1990s to less than 20 t in recent years.

## Whiting in Division VIa (West of Scotland) (report Section 3.4)

1 ) **Assessment type**: Update
2 ) **Assessment**: Assessment of trends only.
3 ) **Forecast**: None
4 ) **Assessment model**: SURBA and TSA exploratory analytical assessment.
5 ) **Consistency**: The stock has not been assessed since 2007.
6 ) **Stock status**: It is not possible to evaluate stock status relative to reference points. SSB and recruitment appear to have declined to a very low level. There are indications of F declining below $F_{pa}$=0.6, but a sequence of low recruitments led to a fall in SSB in recent years.
7 ) **Man. Plan**.: None

### General comments

There are no outlined procedures in the Stock Annex.

There are no ecosystems considerations described.

The WG describes mixed fisheries as a problem as whiting is mainly linked with fisheries for cod and haddock in VIa that are affected by the cod management plan. Shifts in effort to small mesh *Nephrops* fisheries would worsen the exploitation pattern for whiting. There has been mandatory use of larger square mesh panels for the TR2 (*Nephrops*) fleet since 2008 and a mandatory increase in mesh size to 120 mm in the TR1 fleet since 2009. The RG recommends that the WG should use future assessments to try to evaluate if the partial selectivities by fleet have been altered by these measures.

There is no management plan for VIa whiting.

The WG has responded to an ACOM request to carry out an update of the TSA model, which was not applied in the previous two years. Commercial fishery data from 2006 were reintroduced in view of reports of improved accuracy of catch statistics. Experimental runs using both in SURBA and TSA were performed to evaluate different possibilities for the assessment. The only survey used in the final TSA run, the ScoGFSQ1, had a major change in design and gear in 2011 (see Technical comments below). The other survey (ScoGFSQ4) normally used for comparison was not conducted in 2010 due to technical problems. The comparisons show that the VIa whiting assessment suffers a similar problem to the North Sea whiting assessment in that trends in abundance from surveys and model fits to commercial fishery data diverge considerably in earlier years. The trends are more similar since the mid 1990s, suggesting the problem lies in a change in data or stock dynamics around the mid-1990s. The North Sea WG considers this could be due to bias in catch estimates, changes in survey catchability, or changes in natural mortality due to predation or regime shift. The VIa whiting TSA was fitted allowing a trend in survey catchability, which resulted in a marked trend of increasing catchability being fitted. The WG can provide no explanation for this. The RG supports the WG recommendation that this is explored in some depth in future benchmark assessments.

Substantial discarding occurs in this stock. This year the WG has estimates of discards from the Irish and Scottish discard programmes and states that Scottish discards are being reworked. It is important that discards data are fully worked up by country and fleet prior to any benchmark assessment.

### Technical comments

1 ) Reasons for differences between official and WG landings figures should be given.

2 ) In the stock annex the stock weight-at-age is calculated with the formula : (CW i,j + CW i+1,j+1)/2 = SW at start of year; however the WG report states that the catch mean weights-at-age were also used as stock mean weights-at-age. It is not clear if the formula has been applied as there is no table with stock weights. The RG recommends using survey data to estimate stock weights-at-age to avoid changes in stock weights associated with changes in fishery gear selectivity.

3 ) For reasons given in the VIa haddock review, the RG considers the changes to the Scottish Q1 goundfish survey gear, design and analysis procedures in 2011 are sufficient to invalidate the use of the 2011 data as part of the existing series, pending an evaluation of changes in catchability. Unlike the haddock results, the addition of the Q1 survey does not seem to have revised the perception of the strength of the 2009 year class which appears stronger than other recent year classes though still below-average. However, the survey indicates a sharp increase in SSB in 2011. The RG has requested a TSA run excluding the 2011 indices, for comparison [AWAITING RESULTS].

4 ) Survey internal consistency correlation is poor for ScoGFS-WIBTS-Q4 but good for the younger adjacent age classes in ScoGFS-WIBTS-Q1. The correlations become negative between young and old ages; possible evidence of density-dependent mortality in year classes? Or ageing errors?

5 ) There are no assessment model settings in the stock annex, and it is therefore not possible to check the settings used in this year's assessment.

6 ) The TSA run fits the fishery catch data for 2006–2010 very closely. This is also observed in the 6a haddock assessment. Is this a true reflection of

more accurate catch data or does the lengthy period with no catch data included allow the model flexibility to fit accurately to the recent catch data?

### Benchmark recommendations

The stock is due to be benchmarked in 2012. The WG provides few recommendations to guide the preparation for this. The RG recommends that benchmarking of North Sea and west of Scotland whiting should ideally take place at the same time as there appear to be similar problems with the long-term data for both stocks, and linkages between whiting in the two areas could be evaluated.

### Advice sheet

1 ) The correct figures have been carried into the Advice sheets.
2 ) Advice is given on the basis of the MSY approach, however there are no MSY reference points provided.

### Conclusions

The RG considers that the updated TSA and SURBA analysis, excluding the 2011 Q1 survey data, are suitable for providing advice on recent stock trends since the mid-1990s, but there are some difficulties in interpreting stock trends for earlier years. Even given the uncertainties in the performance of the assessment the stock is likely to have declined to the lowest observed biomass by the late 2000s.

## Pollock in the Celtic Seas (ICES Subareas VI and VII)

1 ) **Assessment type:** No advice; catch statistics only
2 ) **Assessment**: not presented
**3 ) Forecast:** not presented
4 ) **Assessment model**: none
5 ) **Consistency**:
6 ) **Stock status**: unknown
7 ) **Man. Plan**.: none

### General comments

This is not a "stock" but it relates to a species in a wider region where data are available. The nominal landings are given for each of the two Subareas VI and VII. Subarea VII provided 98% of the landings in 2010.

The RG considers that WGCSE has inadequately addressed the Terms of Reference for this stock ("Collate data"). The fisheries for pollock are significant (4000–8000 t in Area VII in last 30 years). Pollock is on the DCF list as a species for sampling in western waters, and recent data should also be available from the DCF fleet-based national sampling programmes.

WG states that "The overall gear contribution is unknown due to the lack of complete statistics." Surely Member States have landings by gear type as this is mandatory on EU logbooks?

The RG would have liked to see the following data in order to advise on future directions for supporting ICES advice on pollock in western waters:

- Full description of the fisheries taking pollock, directed and as bycatch, including historical reported landings by gear type/mesh band; spatial distribution (landings by rectangle);
- Mixed fishery information; i.e. associations with other species such as ling, conger eel and saithe;
- Available fishery length compositions by gear/area;
- Discard rates and discard size compositions where available;
- Documented (referenced) information on size and maturity-at-age.

Although the ToR was only to collate data, an evaluation of potential sources of information on relative abundance over time would have been useful;– for example, how could useful cpue data be obtained from line or gillnet fisheries?

#### Advice sheet

Figure 3 is not very useful and possibly misleading as we do not expect the Evhoe survey to be a useful index of abundance for pollock which are associated with rocky areas and wrecks where the survey does not fish. The figure should be removed.

#### Conclusions

There are no data allowing an assessment of stock trends, and very little useful information other than long-term landings trends which may reflect development of the fisheries rather than stock trends.

### General comments on WGCSE *Nephrops* stocks 2011

WGCSE has responded positively to most of the corrections, comments, and suggestions given in last year's RGCS report.

The WG states that the UWTV bias factors include expert judgment, but there is no knowledge of the precision of this, or of the constancy of the bias factors (e.g. edge effects) when burrow density is changing. This needs further investigation.

The introduction of the buyers and sellers legislation in UK in 2006 has improved the reliability in the reported landings, but complicates the interpretation of longer term trends in landings and lpue.

The geostatistical approach in Division VIIa (FU14) and Aran seems promising and should be considered also in other areas.

There is a general lack of comparisons with the present assessment with previous ones (except for FU15).

There are no management plans for the different stocks.

Since observed harvest ratios are now being compared to $F_{MSY}$ (rather than Pa ref points which include buffer for estimation error), ICES should be providing precision estimates and evaluating contribution to precision due to the survey, mean weights, discard ratios, etc. i.e. what is the probability that the observed harvest ratio each year was at or below the $F_{MSY}$ harvest ratio?

### *Nephrops* in Division VIa (FU11 North Minch) (report Section 3.5)

1) **Assessment type**: Update

2) **Assessment**: Fishery trends and absolute abundance estimates from UWTV survey. Stock underestimated due to UWTV not covering sea loch areas.
3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark WG (WK*NEPH* 2009).
4) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG.
5) **Consistency**: The UWTV series have been adjusted using VMS areas, which are larger than previously estimated from sediment charts.
6) **Stock status**: Abundance estimates from UWTV have declined from the high estimates in 2003–2006. The current harvest ratio is just below the $F_{MSY}$ proxy ($F_{35\%SpR}$). The length frequency distribution, mean size and mean weight of *Nephrops* have all been stable for the time-series. There is no MSY transition stage since the current harvest rate is below $F_{msy}$ proxy.
7) **Man. Plan**: There is no management plan for this stock.

## General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The 2011 assessment calculated the area covered by the *Nephrops* population using filtered VMS data from vessels targeting *Nephrops*, rather than the British Geological Survey sediment maps as for the other stocks. This approach was supported by last year's RG. The VMS area is larger than the BGS areas.

Based on the criteria adopted previously by the WG for choosing $F_{MSY}$ proxies according to *Nephrops* productivity, RG supports the WG proposal for a combined-sex $F_{35\%SpR}$ as the $F_{MSY}$ reference point for this stock. As last year, the $F_{MSY}$ was computed using combined length compositions from trawl and (new) creels. The creel fishery accounts for 24% of the landings. The $F_{35\%SpR}$ harvest ratio is adjusted this year to 12.5% compared to 13.3% last year, based on the analysis of updated length compositions from the trawl and creel fisheries.

Length compositions and mean weights have been relatively stable over time.

Discards are included in the assessment and forecast. The observed discard rate shows a marked decline in 2010.

## Technical comments

1) The RG appreciates the inclusion of Table 3.5.10 with all the variables for the catch forecasts.
2) The discard rate was very low in 2010, as observed in other *Nephrops* stocks in this area. The WG did not provide a clear reason for this. In 2010, discard trips in quarters one and two have not been completed and as such, fill-ins from quarters four and two were applied respectively. The WG does not indicate what bias this procedure could introduce.

## Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice.

The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level.

The RG agrees with the WG that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by the WGCSE for choosing $F_{MSY}$ proxies for *Nephrops*.

## Nephrops in Division VIa (FU12 South Minch) (report Section 3.6)

1) **Assessment type**: Update
2) **Assessment**: Absolute abundance UWTV survey estimates; considered as underestimates due to survey not covering sea lochs.
3) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark
4) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WK*NEPH*, 2009).
5) **Consistency**: Methods are the same as last year.
6) **Stock status**: The UWTV series indicate that abundance has declined from the high estimates in the early 2000s to around the same values in the late 1990s, but increased in 2010 to near the 2001 biomass. The harvest ratio in 2010 was considerable lower than the $F_{35\%spr}$ $F_{MSY}$ proxy. The length frequency distribution and mean size of *Nephrops* have all been stable for the time-series.
7) **Man. Plan.**: None

### General comments

The assessment and provision of advice in 2011 followed the process defined by the benchmark WG and the WG fulfilled the ToRs.

The 2011 assessment did not apply VMS data to estimate the area of *Nephrops* habitat, as done for the assessment in FU11. The RG endorses the proposals by the WG to explore the use of VMS data for this purpose.

This year's assessment is performed using combined length compositions from trawl and (new) creels. The WG considers the incorporation of creel length compositions has improved the estimates of harvest ratios. Length compositions and mean weights have been relatively stable over time.

Estimates of discard rates are included in the assessment. The technical aspects and general fishery information is well described in the Stock annex, and the WG gives a good overview of the MSY work done and clear view of the preferred $F_{MSY}$.

### Technical comments

1) No table of mean weights in landings is given so the RG could not check 2008–2010 mean figure used in forecasts.
2) A better explanation is needed as to why the discard rate in 2009 and 2010 is so low compared to earlier years.

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, and that $F_{35\%spr}$ (combined between sexes) is consistent with the approach adopted by WGCSE for choosing $F_{MSY}$ proxies for *Nephrops*.

The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level.

## *Nephrops* in Division VIa ( FU13 firth of Clyde) (report Section 3.7.)

1 ) **Assessment type**: update
2 ) **Assessment**: Fishery lpue trends and UWTV survey estimates
3 ) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark
4 ) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WK*NEPH*, 2009).
5 ) **Consistency**: Methods are the same as last year.
6 ) **Stock status**: The UWTV series indicate that abundance increased until mid-2000s followed by a declining trend with population levels fluctuating around the values prior to the maximum abundance in 2004. Recent harvest ratios are above the $F_{35\%spr}$ $F_{MSY}$ proxy. The length frequency distribution and mean size of *Nephrops* have all been stable for the time-series. The Sound of Jura subarea appears to have very low harvest ratios.
7 ) **Man. Plan**: none

### General comments

The assessment and provision of advice in 2011 followed the process defined by the benchmark WG and the WG fulfilled the ToRs.

For the second time an attempt was made to use the UWTV data available for the Sound of Jura. Although the dataseries is incomplete it indicates a lower burrow density and lower harvest ratios than in the Clyde.

The length composition indicators (>35 mm) are relatively stable over time. Estimates of discard rates are included in the assessment.

### Technical comments

1 ) Are the sharp dips in burrow count in 1999 and 2007 explainable by any factors such as weather affecting survey efficiency?
2 ) The WG should provide an explanation for the very low estimate of discard rate in 2010, which results in a lower average discard rate in the landings forecast. Low discard rates in 2010 are estimated for all three Area VI FUs. Last year's RG noted that recent discard rates were much higher than had been used in the $F_{MSY}$ calculations. The $F_{MSY}$ has been recalculated this year using trawl and creel LFDs and discard ogives for 2008–2009.

3 ) The WG should encourage the collection of the necessary biological and fishery data to allow $F_{MSY}$ reference points to be estimated separately for the Sound of Jura population, which has a relatively low burrow density. The RG agrees with the use of the Clyde discard rates and $F_{MSY}$ calculations as an interim approach (combined sex $F_{35\%SpR}$ HR of 14.5%, based on low burrow density).

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG considers the Underwater Television Survey (UWTV) and associated catch options to be an appropriate basis for management advice, but notes that the catch forecast depends on the recent low discard rates continuing.

The RG agrees with the WG that management of this stock should be applied at a local FU level rather than at the ICES division level.

The RG agrees with the approach adopted by WGCSE for choosing $F_{MSY}$ proxies for *Nephrops*. The $F_{MSY}$ proxy is considered by WGCSE to be the combined-sex $F_{35\%SpR.}$

## *Nephrops* in Division VIIa (FU14 Irish Sea East) (report Section 6.4)

1 ) **Assessment type**: Update
2 ) **Assessment**: Fishery lpue trends and UWTV survey estimates
3 ) **Forecast**: Short-term prediction of landings for 2012 at various harvest ratios using catch option table developed during the benchmark
4 ) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG (WK*NEPH*, 2009).
5 ) **Consistency**: As last year, advice is based on UWTV survey, but applying a geostatistical method for the first time together with other modifications to the estimation methods for the UWTV surveys, which together result in substantial increases to biomass estimates for 2008 and 2009.
6 ) **Stock status**: The WG proposes $F_{0.1}$ as the $F_{MSY}$ proxy (harvest ratio = 9.8%). The HR in 2010 was 7.4%. Compared to other fisheries in VII the absolute population density of this stock is relatively low.
7 ) **Man. Plan**: None

### General comments

The assessment and provision of advice for 2012 generally followed the process defined by the benchmark WG and the WG fulfilled the ToRs. However the UWTV survey methods adopted by the 2011 WG differed from the previous assessment in using geostatistics to estimate burrow numbers in the UWTV survey and in changing the algorithm used to calculate the distance towed on each station. The combination of these changes has resulted in a 36% increase in the burrow density estimates for 2008 and a 60% increase for 2009, the two previous years with UWTV survey estimates.

The time-series of abundance estimates is too short to be compared with lpue trends. The RG notes the biases in lpue trends introduced by improvements in accuracy of landings reporting since 2006.

The assessment determines the health of the stock by looking at trends in total landings, lpue, size composition, and biological data from the commercial fisheries.

There are no stock-specific growth rates for FU14 and figures for FU15 are adopted.

The combination of the increased burrow count in 2010 compared to 2009, and the revised UWTV analysis methods has resulted in a landings forecast at $F_{35\%Comb}$ that is 87% larger than ICES advice for 2011 given last year.

### Technical comments

1 ) As last year, Table 6.4.1 giving official landings is missing.

2 ) Due to lack of data none of the length derived metrics have been updated for 2011.

3 ) As with other *Nephrops* stocks, more accurate catch reporting since the introduction of Buyers and Sellers legislation has resulted in an apparent increase in landings and lpue which causes misleading trends plots (Figures 6.4.1–6.4.3) This should be clearly indicated on the figure legends.

4 ) No table of discards and landings estimates is provided to show trends in estimated discard rates. It is therefore not possible to validate the mean discard rate for 2006–2008 used in the catch forecast. (Discard rates in 2010; only five trips sampled so data not used; in 2009–2010 observed trips: discard rate much lower than 2008 but WG had concerns over the estimates and has used 2006–2008 rates and mean landings weights in the catch forecast).

5 ) The final table in the stock annex indicates discard survival is zero, and no reference is made in the text of incorporation of a non-zero discard survival in the $F_{MSY}$ calculations or catch forecasts. In this respect the assessment is inconsistent with other stocks which assume some survival.

6 ) The text table in the Section 6.4.4 states that the discard rate is 27.9% based on sampling in 2006–2008. At the bottom of the table it says that the “Prop of removals retained by the fishery” is 0.79. Which is correct, given that discards survival is taken as being zero? Or has a discard survival rate been included?

7 ) The survey bias factor used this year is 1.14; “as per WK*NEPH* 2009”. Last year a figure of 1.2 was used, with the same reference to WK*NEPH*. This is also the figure in the Stock Annex. Which is correct?

8 ) In the spreadsheet with the tables for this section, the bias-corrected abundance estimates are calculated as a figure multiplied by 1.019. This figure is not documented anywhere.

9 ) The WG should provide a clear table showing all the time-series data (landings, discards, discard rates, mean weights, etc). See Table 6.5.8 in FU15 report and similar table in other *Nephrops* sections. It has proven impossible to track the variables and calculations for this stock and the RG cannot therefore validate the catch forecasts.

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG agrees that the UWTV survey and associated $F_{MSY}$ values represent an appropriate means of providing quantitative management advice, but has difficulty validating some of the inputs used in the catch forecasts.

The WG is concerned about how well the UWTV survey covers the distribution area, but on the other hand the WG is not conclusive when stating rather vaguely *: there may be a need to increase the survey area further south to ensure that the edge of the ground has been sampled*.

## *Nephrops* in Division VIIa (FU15 Irish Sea West) (report Section 6.5)

1 ) **Assessment type**: Update
2 ) **Assessment**: Fishery lpue trends and UWTV survey estimates
3 ) **Forecast**: Landing predictions for 2012 presented
4 ) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WK (WK*NEPH*, 2009).
5 ) **Consistency**: Methods are the same as last year. No new MSY explorations were carried out.
6 ) **Stock status**: The WG argues use of $F_{max}$ as $F_{MSY}$ proxy (Harvest ratio = 17.1%). The UWTV survey indicates a constant high abundance over the time-series of the surveys and the 2010 survey estimate is around average. The harvest ratio in 2010 was estimated to be 15%. Reported landings have been stable around 9000 tonnes without a negative impact on the stock.
7 ) **Man. Plan**.: None

### General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs. The RG found no errors in the assessment.

The fishery is well described in WG and stock annex. Mixed fisheries data are not used in providing management advice. Discards estimates are included in the assessment. There is no management plan for this stock but the fishery is affected by measures implemented for cod. The cod closure affects the distribution of fishing to some extent. The effort control regime has also influenced the switching of effort into the *Nephrops* fishery.

### Technical comments

1 ) The introduction of Buyers and Sellers legislation has resulted in an apparent increase in landings and lpue which causes misleading trends plots (Figure 6.5.1). This should be clearly indicated on the figure legends.
2 ) Table 6.5.7: multiplying the burrow density (n/m$^2$) by the area gives values different from the ones in the table; more than can be explained by rounding errors. The WG should explain this.
3 ) The calculation of $B_{trigger}$ using trawl survey indices scaled to the UWTV estimates no longer appears valid due to the very different trends now apparent in the two time-series (Figure 6.5.5). If the UWTV trends are correct, then some other factors are affecting the trends in the trawl survey in a non-random fashion. The high values in 2003 and 2004 are not apparent in

the April survey (Figure 6.5.4). The RG recommends that the $B_{trigger}$ value based on the rescaled trawl survey indices is not used or presented.

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG agrees that the UWTV survey and associated $F_{MSY}$ values represent an appropriate means of providing quantitative management advice, but the proposed $B_{trigger}$ value is suspect.

The RG agrees with the WG that management on a FU level would be beneficial.

The RG agrees that $F_{max}$ (harvest ratio 17.1% combined between sexes) is consistent with the approach adopted by WGCSE for choosing $F_{MSY}$ proxies for *Nephrops*.

## *Nephrops* in Division VIIb,c,j,k (FU16 Porcupine Bank) (report Section 7.6)

1 ) **Assessment type**: update
2 ) **Assessment**: trends
3 ) **Forecast**: not presented
4 ) **Assessment model**: No Analytical Assessment
5 ) **Consistency**: Consistent with last assessment
6 ) **Stock status**: Status of the stock cannot be evaluated because reference points have not been determined for this stock. A decline in abundance in the 2000s has been reversed by improved recruitment and the sex ratio has returned to a more usual value.
7 ) **Man. Plan**.: There is no management plan for this stock, but there are Area Closures, MLS and mesh size regulations. The closure displaced effort to other parts of the *Nephrops* grounds.

### General comments

The assessment was carried out according to the stock annex description and the WG addressed the ToRs in providing updated series of indicators.

General ecosystem information has not been provided, and mixed fishery data are not used in support of management advice.

### Technical comments

1 ) The RG appreciates the involvement of industry in discussing lpue trends, and the responsive action of WGCSE. WD12 provides a valuable analysis of the Irish lpue data exploring effects of rectangle, month, vessel, etc. on lpue. The lpue series from all countries would benefit from being standardized in the same way. Figure 10 in WD12 shows lpue trends by rectangle. For the main rectangles with *Nephrops* landings, the trends don't show the large decline over time given by the model fits or the aggregated data. Why is this?

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG agrees with the WG that the stock indicators suggest the state of the stock has improved from last year when the stock was considered to be severely depleted with an unnatural sex ratio that could impair productivity. Nonetheless, despite the small proportion male, the stock appears to have produced a better recruitment in 2009, which will need to be protected to promote rebuilding of the biomass. Unfortunately the discard practices are poorly known and sampled and unless this is rectified it will not be known if the 2009 recruitment is being heavily fished and discarded.

## *Nephrops* in Division VIIb (Aran Grounds, FU17) (report Section 7.5)

1 ) **Assessment type**: Update
2 ) **Assessment**: Fishery lpue trends and UWTV survey estimates
3 ) **Forecast**: Short-term
4 ) **Assessment model**: Assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WK (WK*NEPH*, 2009).
5 ) **Consistency**: Methods are the same as last year plus attempts to incorporate decisions taken at WKFRAME for the provision of MSY advice by ICES.
6 ) **Stock status**: The 2010 UWTV estimate is close to average of the series. Recent harvest rates have fluctuated around 8% compared with $F_{35\%spr}$ $F_{MSY}$ proxy harvest rate of 10.5%.
7 ) **Man. Plan**: none

### General comments

The assessment was carried out in accordance with the description in the stock annex. The assessment approach used by WGCSE 2010 was said to be consistent with that set out in the stock annex and WK*NEPH* (2009). The stock annex was very clear and contained good information on ecosystem consideration.

Discard estimates are included in the assessment since 2001 with the exception of 2006–2007 when there was no sampling of landings and discards.

### Technical comments

1 ) The RG appreciates the WG's efforts to address last year's RG recommendation to explore the analyses leading to an apparent very low $F_{MSY}$ harvest ratio for males. However, the WG was not able to conclude on an alternative SCA analysis for this stock. The RG supports the WGs recommendation to explore this at the next benchmark process.
2 ) Table 7.5.5; why does the product of the mean density and the domain area or area surveyed not give the total abundance? For geostats, is the mean density the simple mean over tows? Unless these things are explained, people may deduce that there are errors in the table.

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG agrees that the UWTV survey and associated $F_{MSY}$ values represent an appropriate means of providing quantitative management advice.

The RG agrees that $F_{35\%spr}$ is consistent with the approach adopted by WGCSE for choosing $F_{MSY}$ proxies for *Nephrops*.

## *Nephrops* in Division VIIa,g,j (southeast and west of Ireland, FU19) (report Section 7.8)

1 ) **Assessment type**: None
2 ) **Assessment**: None
3 ) **Forecast**: None
4 ) **Assessment model**: none
5 ) **Consistency**: Cannot be evaluated
6 ) **Stock status**: The status of the stock cannot be evaluated. Sampling indicates a decline in mean size of indviduals.
7 ) **Man. Plan.**: None

### General comments

This FU was not assessed and no data analysis was carried out in 2009–2010. The only available information for the FU19 is from the UK March groundfish survey during 1984–2004 that indicated some decline in mean size. In 2006 there was some UWTV stations covered in the FU19 but there does not seem to be an annual coverage of the area. The WG states that the area is heterogeneous and UWTV surveys would be very hard to carry out on an accurate and regular basis.

No ecosystem considerations are presented in report.

As last year, no information on discarding is provided.

The fishery description contains information about mixed fisheries and indicates that it is of importance, but there are no indications how it can be used in future advice.

### Technical comments

1 ) As last year, Table 7.8.1 presents landings from FU18 and 19 but it is not referred to in text how the fisheries in FU18 and 19 are connected.

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

RG agrees that analytical assessment is not possible to perform on this FU.

It is recommended that the WG gives some suggestion how the sampling and survey data can be improved.

## *Nephrops* in Divisions VIIfgh (Celtic Sea, FU20-22 (report Section 7.7)

1 ) **Assessment type**: update
2 ) **Assessment**: Fishery lpue trends plus UWTV survey for FU22

3 ) **Forecast**: Only for FU22 (UWTV)
4 ) **Assessment model**: no
5 ) **Consistency**: consistent with last year's methods and stock annex
6 ) **Stock status**: Considered to be stable at a high level based on long-term indicators, lpue, mean size, recent UWTV surveys. Harvest ratios since 2006 have fluctuated around the proposed $F_{MSY}$ of 10.9%.
7 ) **Man. Plan.**: no

### General comments

The assessment was carried out in accordance with the description in the Stock annex. The WG report and the Stock Annex for this FU are comprehensive but difficult to follow in places due to the amount of detail.

MSY explorations were carried out for the FU22 component (which represents 50% of the landings) using the Bell/Dobby model to determine harvest rates associated with various potential $F_{MSY}$ proxies. As with most other stocks the WG concluded that $F_{35\%Spr}$ is appropriate as an $F_{MSY}$ proxy for FU22. This corresponds to a harvest rate of 10.9%.

No French lpue and effort indices for 2009 were available.

### Technical comments

1 ) Data from the EVHOE survey were cited but time-series plots of number caught by year, etc, were not found. The utility of the survey for supporting the *Nephrops* assessment could be explored but the results would need to be validated. The experiences in FU15 (Irish Sea west) where there are dedicated trawl surveys as well as a UWTV survey should be reviewed before the Evhoe survey is used for *Nephrops*.
2 ) Table 7.7.18, showing landings by rectangle and year, might be better presented as a series of maps?
3 ) Some values of sex ratio are given in the text, but no data on trends in sex ratio are provided.
4 ) Tables 7.7.3–7.7.14: There is no need for all this detailed LFD tabulation in the assessment report. It could go in the Stock Annex. If any comparisons are needed to make a point, this is best done graphically.
5 ) Tables 7.7.16 and 7.7.17: again a lot of LFD detail that could be better shown graphically. Interpretation of variation is also difficult because the number of trips providing the data is not tabulated.
6 ) Table 7.7.19; why is lpue of French twin trawl vessels less than that of single-trawl vessels?

### Advice sheets

Information has been carried over correctly from the WG report to the advice sheets.

### Conclusions

The RG considers that the fishery lpue indicators provide relatively little information for evaluating stock trends. Irish and French fleets show different lpue trends but it is not clear if this reflects shifts in activities between different grounds.

The UWTV results for the Smalls (FU22) grounds indicate a stable abundance over the last four years. The RG recommends that VMS and other data be used to map out the *Nephrops* grounds more accurately (see VIa stocks) to allow the possibility of extending the UWTV coverage to include other significant mud patches (Labadie/Nymphe/Seven Heads ground) on an annual basis if funding is available for this. The Annex indicates that UWTV was tried on very small areas of these three grounds in 2006 but that poor weather precluded surveys in 2007 and 2008. The different allocation of French and Irish Effort between the four main grounds would argue for UWTV coverage of all areas given the different trends in effort of these fleets. The WG proposal to develop fishery data (length compositions, discard rates, etc.) specifically for the Smalls is a necessity for developing the UWTV survey for providing quantitative management advice for this ground. However the other mud patches should not be ignored.

The back calculation of discard rates when fishing procedures such as tailing rates are changing is rather difficult and should be replaced by direct observations whenever possible. However, the method should be further evaluated for the next benchmark.