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Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak - Combined Spring and Autumn (WGNSSK)

6 - 12 May 2009

ICES Headquarters, Copenhagen

By Correspondence - September 2009

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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0 Executive Summary

The ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at ICES Headquarters in Copenhagen, Denmark, during 6-12 May 2009. The Working Group made stock assessments for demersal and industrial stocks in the North Sea, Skagerrak and Eastern Channel. These assessments included estimates of misreporting and discard and provided catch forecasts. Furthermore, stock recovery and management plans were evaluated and the Group commented on the outcome of existing management measures. Descriptions of fisheries were updated the report includes information on national sampling levels and data availability. The group also met by correspondence in September of 2009 to carry out assessments of the sandeel in the North Sea and the second of the biennial assessments of the Norway pout; and by correspondence in October of 2008 to provide update forecasts for stocks with survey information collected after the May meeting.

No update of the executive summary was provided for 2009. For information, please contact the Chair of the meeting.

1 General

1.1 Terms of reference

The **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** [WGNSSK] (Chair: Chris Darby, UK) will meet at ICES HQ, 6–12 May 2009 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below). The Sandeel and Norway pout assessment shall be developed by correspondence;

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.

WGNSSK will report by 18 May and 18 September 2009 (Sandeel/Norway pout) for the attention of ACOM.

Fish Stock	**Stock Name**	**Stock Coordinator**	**Assessment Coord. 1**	**Assessment Coord. 2**	**Advice**
cod-347d	Cod in Subarea IV, Divison VIId & Division IIIa (Skagerrak)	UK(England)	UK(England)	Denmark	Advice
had-34	Haddock in Subarea IV (North Sea) and Division IIIa	UK(Scotland)	UK(Scotland)	UK(England)	Advice
nep-5	*Nephrops* in Division IVbc (Botney Gut - Silver Pit, FU 5)	UK(Scotland)	UK(Scotland)	Denmark	No advice
nep-6	*Nephrops* in Division IVb (Farn Deeps, FU 6)	UK(Scotland)	UK(Scotland)	Denmark	Advice
nep-7	*Nephrops* in Division IVa (Fladen Ground, FU 7)	UK(Scotland)	UK(Scotland)	Denmark	Advice
nep-8	*Nephrops* in Division IVb (Firth of Forth, FU8)	UK(Scotland)	UK(Scotland)	Denmark	Advice
nep-9	*Nephrops* in Division IVa (Moray Firth, FU9)	UK(Scotland)	UK(Scotland)	Denmark	Advice
nep-10	*Nephrops* in Division IVa (Noup, FU 10)	UK(Scotland)	UK(Scotland)	Denmark	No advice
nep-32	*Nephrops* in Division IVa (Norwegian Deeps, FU 32)	UK(Scotland)	UK(Scotland)	Denmark	No advice
nep-33	*Nephrops* in Division IVb (Off Horn Reef, FU 33)	UK(Scotland)	UK(Scotland)	Denmark	No advice
nep-iiia	*Nephrops* in Division IIIa (Skagerak Kattegat, FU 3,4)	Denmark	Sweden	UK(Scotland)	No advice
nop-34	Norway Pout in Subarea IV and Division IIIa	Denmark	Denmark	Norway	Advice
ple-eche	Plaice in Division VIId (Eastern Channel)	France	France	Belgium	Advice

ple-kask	Plaice in Division IIIa (Skagerrak - Kattegat)	Denmark	Denmark	Sweden	Advice
ple-nsea	Plaice Subarea IV (North Sea)	Netherlands	Netherlands	Belgium	Advice
sai-3a46	Saithe in Subarea IV (North Sea) Division IIIa West (Skagerrak) and Subarea VI (West of Scotland and Rockall)	Norway	Norway	Germany	Advice
san-nsea	Sandeel in Subarea IV excluding the Shetland area	Denmark	Denmark	Norway	Advice
san-shet	Sandeel in Division IVa North of 59° N and West of 0 ° E – (Shetland area)	UK/Denmark			No advice
sol-eche	Sole in Division VIId (Eastern Channel)	Belgium	Belgium	France	Advice
sol-nsea	Sole in Subarea IV (North Sea)	Netherlands	Netherlands	Belgium	Advice
whg-47d	Whiting Subarea IV (North Sea) & Division VIId (Eastern Channel)	UK(Scotland)	UK(Scotland)	UK(England)	Advice
whg-kask	Whiting in Division IIIa (Skagerrak - Kattegat)	Sweden	Sweden	Denmark	Same advice as last year

1.2 InterCatch

InterCatch is not used for the data collation of cod, haddock and whiting. The reason is that InterCatch cannot currently be used to generate discard estimates for countries for which no discard sampling data are available. This is a necessary part of the collation process for the three stocks mentioned above. As an interim measure, collation has been carried out for the last three years using a spreadsheet-based approach.

No further update of the 2008 general introduction was provided. For information, please contact the Chair of the meeting.

2 Overview

No update of the 2008 overview was provided, for the most recent overview see Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) 2008 CM 2008 \ACOM:09, section 2.

3 *Nephrops* (Norway lobster) in Division IIIa and Subarea IV

3.1 General comments relating to all *Nephrops* stocks

3.1.1 Introduction

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution and characteristics, and established as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 3.1.1 and illustrated in Figure 3.1.1. The statistical rectangles making up each FU encompass the distribution of mud sediment on which *Nephrops* live. There are two FUs in Division IIIa and eight FUs in Subarea IV. It is important to note that additional catches of *Nephrops* are also taken from smaller, isolated pockets of mud distributed throughout the ICES divisions. In recent years some of these areas have contributed significant landings despite their small size (eg Devils Hole). Management of *Nephrops* currently operates at the ICES Subarea/Division level.

Functional Units were previously aggregated by WGNEPH into a series of nominal Management Areas (MA) intended to provide a pragmatic solution for more localised management. The Working Group agreed that this process had served no useful purpose and should be discontinued.

At the WG this year, advice was requested for FUs for which UWTV surveys are available (Farn Deeps, Fladen, Firth of Forth and Moray Firth) whilst the other FUs were given 'No advice' status. For those FUs requiring no advice, the report therefore consists solely of an update to available data and text describing the fishery, and no assessment or data analyses have been carried out.

The presentation of data and text relating to the Division IIIa FUs can be found as follows: Skagerrak (FU3) in Section 3.2.2; Kattegat (FU4) in Section 3.2.3; Divison IIIa overall in Section 3.2.3. The presentation of data and assessments for the Division IV FUs can be found as follows: Botney Gut – Silver Pit (FU 5) in Section 3.3.1; Farn Deeps (FU 6) in Section 3.3.2; Fladen (FU 7) in Section 3.3.3; Firth of Forth (FU 8) in Section 3.3.4; Moray Firth (FU 9) in Section 3.3.5; Noup (FU 10) in Section 3.3.6; Norwegian Deeps (FU 32) in Section 3.3.7; Off Horn Reef (FU 33) in Section 3.3.8; Other areas of Subarea IV in Section 3.3.9.

Overall landings for Divisions IIIa and IV reported to the WG are summarised by Functional Unit in Table 3.1.2 and Figure 3.1.2.

3.1.2 WKNEPH

General comments relating to *Nephrops* stocks with TV surveys, developments in assessments and the approaches employed are set out in the following section

A benchmark meeting for *Nephrops* stocks with TV surveys was held in March 2009. This meeting was called in order to harmonise the approach taken between the different assessment working groups (WGCSE, WGNSSK). The principle task of the benchmark group was to decide how the TV indices should be used (i.e. as relative trends in abundance or absolute abundance estimates). There are several issues regarding the use of the indices as absolute abundance indices including edge effects, detection rate, confusion with other species and burrow occupancy. In the face of these potential biases it is perhaps desirable to use the indices simply as relative trends in abundance however this approach encounters even more serious problems in providing catch advice. It was not clear how proportional changes in a relative abundance index should be translated into proportional changes in TAC advice (is 1:1 correspondence suitable). Given the short time series of landings data which are considered reliable (2006 onwards) it was also not possible to determine if the relative harvest rates observed in this time period were likely to be sustainable or not. It was therefore decided that the TV indices should be used as absolute measures of abundance and that the potential biases should be estimated.

For each functional unit, bias estimates for edge effects, detection rate and confusion with other species were quantified using a combination of modelling, re-analyses and expert judgement resulting in a bias correction factor to be applied to the raw TV abundance indices. The area which resulted in the largest change to procedure was a re-evaluation of the size selectivity of the TV surveys. Previously there had been an implicit assumption that the TV surveys had the same size selectivity as the fishery, however after extensive debate the Group considered that the TV surveys were detecting burrows of individuals considerably smaller than the fishery can take. The proportion of the total abundance index which is available to the fishery is now considered to be a fraction of what it was and hence the harvest ratios equivalent to fishing at $F_{0.1}$ (or any other proxy for sustainability) also require downward revision. Failure to do this will result in fishing at a rate greater than the target.

New proxies for sustainable fishing ($F_{0.1}$ and F_{max}) were calculated for each FU and are given in the stock annexes. Two modelling approaches were used to derive harvest ratios equating to the candidate reference points under the new assumption of survey selectivity. Both approaches used the same growth, maturity and fishery selectivity data and were cross checked for consistency in the determination of the candidate reference points. The different assumptions in the models governing the length distributions at the time of the survey resulted in different harvest ratios for the given values of $F_{0.1}$ and F_{max}. Both modelling approaches appear to be reasonable simplifications of a complex system and as such there is no *a priori* reason to believe that either model is more correct than the other. The benchmark group therefore decided that, for each candidate F-reference point, the mean harvest ratio between the two approaches should be taken for the point estimate for that FU. There is therefore no direct relationship between the harvest ratio presented and a particular F value (and additionally the fishing mortalities of male and female *Nephrops* are different). Reference fishing mortality values are therefore not given in this report.

3.2 Nephrops in Division IIIa

Official landings supplied to ICES for Division IIIa are shown in Table 3.2.1.1.

Division IIIa includes FU 3 and 4, which are assessed together. This year's assessment is an update of last year's indicator assessment. Total *Nephrops* landings by FU and country are shown in Table 3.2.1.2 and Table 3.2.1.3.

FU 3 and FU 4 have for many years, mainly on basis on historical differences in the local fisheries, been maintained as separate stock units. The minor differences observed between the two areas in for instance size distributions may well have been due to area based differences in selectivity of fishing gear. However, for many years the trends both in fisheries data (LPUE) and size data have been very similar and do not indicate any significant differences between the two areas. Consequently, in the assessments and advice the two FUs have always been merged.

Therefore, the WG suggests and recommends that both assessment data and assessments for these two FUs formally are merged into a single FU, comprising both Skagerrak and Kattegat (ICES Division. IIIa).

3.2.1 General

3.2.1.1 Ecosystem aspects

Nephrops lives in burrows in suitable muddy sediments and is characterised by being omnivorous and emerge out of the burrows to feed. It can, however, also sustain itself as a suspension feeder (in the burrows) (Loo *et al*., 1993). This ability may contribute to maintaining a high production of this species in IIIa, due to increased organic production.

Severe depletion in oxygen content in the water can force the animals out of their burrows, thus temporarily increasing the trawl catchability of this species during such environmental changes (Bagge *et al*. 1979). A specially severe case was observed in the end of the 1980s in the southern part of IIIa in late summer, where initially unusually high catch rates of *Nephrops* were observed. Eventually the increasing amount of dead specimens in the catches lead to the conclusion of severe oxygen deficiency in especially the southern part of IIIa (Kattegat) in late 1988 (Bagge *et al*., 1990).

No information is available on the extent to which larval mixing occurs between *Nephrops* stocks, but the similarity in stock indicator trends between FU 3 and 4 for both Denmark and Sweden indicates that recruitment has been similar in both areas. These observations suggest they may be related to environmental influences.

3.2.1.2 Functional units and their fisheries.

Denmark

The restrictions in the fisheries for especially cod seem to have resulted in some significant changes in the Danish fisheries for *Nephrops*. Traditionally, *Nephrops* have mainly been caught in trawls using 70-89 mm mesh sizes. In the last five years an increasing proportion of total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89mm (which previously have been used in the fishery for cod, plaice and other demersal fish species). In Skagerrak and Kattegat it is since 2005 not allowed to use mesh sizes between 70-89 mm unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation 27/2005). According to Council Regulation 51/2006 there is unlimited days when using this species selective trawl.

Those changes in fishing patterns may be seen in the light of the declines in most important demersal fish stocks in the North Sea, Skagerrak and Kattegat. Economically, *Nephrops* is one of the most important human consumption species in the Danish fishery in IIIa.

A new national management system was introduced in Denmark from the 1st of January 2007. In this new, rather complex, fishing rights system (FKA, 'vessel quota share') each fisher is allocated an annual share of the national quota, which he can dispose of in a much more flexible way than previously. He may now trade his share, exchange it or pool it with other fishers share within the frames of the other regulations, e.g. total effort (fishing days) and national quotas and/or closed seasons.

The sharp increase in LPUE observed for the Danish vessels both in IIIa and in the North Sea, mainly in the Norwegian Deep, may to some extent be explained as a consequence of the regulation system.

- One would expect that the shares targeting *Nephrops* gradually will be concentrated among the more skilled *Nephrops* fishers.
- The fishers targeting *Nephrops* will optimise (minimise) their use of effort in catching their share of the FKA.

One consequence of this system is a more efficient use of the effort by the skilled fishers, which again renders the use of logbook recorded effort data even more problematic when using the data for tuning assessment models or for instance LPUEs directly as indicators of stock fluctuations for *Nephrops* stocks,

Sweden

The specialised Swedish *Nephrops* trawler (catching >3t/yr) shows a decrease in number during 2000 to 2004 (123 to 83 trawler) and an increase the last four years. The increase is mainly due to an increase of trawlers catching >10 t/yr (from 18 in 2004 to 45 in 2008) (see Figure 3.2.1.1). In 2008, mean length was 15m (ranging from 8 to 34m) and GRT of 46 (3 to 263).

Since 2004, new technical regulations were introduced for Swedish national waters in both FU 3 and FU 4. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 NM limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 NM in Kattegat and 4 NM in Skagerrak). The new regulations imply that it is mandatory to use a 35 mm species selective grid and 8 meter of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* on Swedish national waters. The Swedish *Nephrops* landings from MA IIIa by gear during 1989 to 2008 are shown in Figure 3.2.1.2. Twin trawls were introduced in 1990 and the grid and square mesh trawls were legislated in Sweden during 2004 and show an increasing use since then. 65% of the *Nephrops* trawlers operating in IIIa used the grid at some time of the year during 2008.

A new coding of fishing gears in the Swedish log books has taken place since 2007 where the twin trawl code is phased out and the number of trawls of the new trawl codes should be registered. This mean that twin trawls in 2007 likely is included in other trawl categories that earlier was considered as single trawls. Since 2007, it is possible to distinguish between single and twin trawls in the new category with grid and square mesh targeting *Nephrops*. In recent three years, around 40% of the *Nephrops* trawl landings in IIIa was caught with this new trawl. In the first quarter of 2008 a new effort regulation was introduced in the Kattegat, meaning that a "day at sea" without the grid equipped trawl was counted as 2.5 This has further increased the incentives to use the sorting grid to the point were 80 % of all Kattegat *Nephrops* landings in the first quarter of 2008 were caught with sorting grids (compared to around 20% previous years).

The landings from the Swedish creel fishery show an increasing trend in recent years and comprise 26-29% of the Swedish Skagerrak landings in recent four years. The trends in effort and LPUE (g/creel) are shown in Figure 3.2.1.3 and show an increasing trend in effort during the last ten years while LPUE fluctuate without trend.

Norway

In Skagerrak *Nephrops* is fished all year round. The largest part of the catches is taken with trawl (*Nephrops* and shrimp trawls (as bycatch)). In 2001 a creel fishery started developing with landings constituting about 12% of total annual landings.

Nephrops recordings in Norwegian log books from Skagerrak are incomplete. In 2004-2006 logbook recorded catches constituted only 1% of the landings, but increased to 28% in 2008. Furthermore, records on the use of *Nephrops* trawl are lacking in the logbooks for 2006-2008. Norwegian trawlers fish in the whole Skagerrak. Catches from along the Norwegian coast are landed in Norway. Some catches are also landed in Sweden.

The following regulations apply: Fishing with mesh sizes down to 70 mm is legal, but requires square meshes in the cod end, and that the bycatch of other species should not exceed 70% of the total weight. The minimum legal size is 40 mm CL, but landings can none the less contain up to 10% animals (in weight) below the legal size. In Skagerrak in 2000-2005, 97% of *Nephrops* landings were taken by small-meshed trawls (<90 mm).

ICES Advice

In 2008 ICES concluded that:

'Due to uncertainty in the available data ICES is not able to reliably forecast catch. There are no signs of decline in the stocks and therefore current levels of exploitation and effort appear to be sustainable.'

No specific catch levels were recommended, but ICES gave the following comments:

The fishing effort on *Nephrops* has decreased since 2002 and is currently at a low level. In recent years, lpue has shown an increasing trend but this is not necessarily an indication of increase in stock abundance. There are no signs of overexploitation in Division IIIa.

ICES currently advises no catches for cod in Division IIIa, which is a significant bycatch species in the *Nephrops* fisheries. The current effort regulation (limiting days at sea for gears not using selective sorting grids) may increase the incentives to use sorting grids. This may reduce bycatch of cod.'

Management for FU 3 and FU 4

The 2008 and 2009 TAC for *Nephrops* in ICES area IIIa was set to 5170 tonnes, i.e. unchanged from 2006 and 2007. The minimum landings size for *Nephrops* in area IIIa is still 40mm carapace length. This high MLS for IIIa is maintained following advice from the industry. However, this leads to a high discard rate and at present 71% of the catch (N) in IIIa consists of undersized individuals (Figure 3.2.1.4). It is expected that ongoing experimental work on improved selectivity of the gear eventually will reduce the amounts of discards.

Days at sea limits restrict *Nephrops* trawlers to 19 days per month when using 90mm mesh with no square mesh panel, and 22 days with a square mesh panel. New gear regulations imply that it is mandatory to use a 35 mm species selective grid and 8 m of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* in Swedish national waters. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 nm limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 nm in Kattegat and 4 nm in Skagerrak). Since

2006, days at sea is unlimited for this species selective trawl (Council Regulation 51/2006). The changes in the national Danish regulation system from 2007 are described earlier in this section.

3.2.2 The Skagerrak (FU3)

3.2.2.1 Data available

Landings

Denmark, Sweden and Norway exploit this FU. Denmark and Sweden dominate this fishery, with 61 % and 33 % by weight of the landings in 2008. Landings by the Swedish creel fishery represent 13-18 % of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002 and has increased to 29% in 2008 (Table 3.2.2.1)

In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1000 t to just over 2670 t. Since then they have been fluctuating around a mean of 2500 t (Figure 3.2.2.1)).

Length compositions

For the Skagerrak, size distributions of both the landings and discards are available from both Denmark and Sweden for 1991-2008. Of these, the Swedish data series can be considered as being the most complete, since sampling took place regularly throughout the time period and usually covered the whole year. In earlier years the Swedish discard samples were obtained by agreement with selected fishermen, and this might tempt fishermen to bias the samples. However, the reliability of the catch samplings is cross-checked by special discard sampling projects in both the Skagerrak and the Kattegat. In recent years the Swedish *Nephrops* sampling is carried out by on-board observers in both Skagerrak and Kattegat. Geographically, the samples from the Swedish fishery mainly cover the north-eastern part of the Skagerrak.

In 1991, a biological sampling programme of the Danish *Nephrops* fishery was started on board the fishing vessels, in order to also cover the discards in this fishery. Due to its high cost and the lack of manpower, Danish sampling intensity in the early years was in general not satisfactory, and seasonal variations were not often adequately covered. Due to increasing lack of resources the Danish at sea sampling in Skagerrak was at unsatisfactory low level in 2007 and 2008, and for these years the length composition data for Skagerrak are based on Swedish samples only. The Norwegian *Nephrops* fishery is small and has not been sampled. Trends in mean size in catch and landings are shown in Figure 3.2.2.1 and Table 3.2.2.2. Mean sizes in landings, in both sexes are fluctuating without trend while there is a slightly decreasing trend for discards.

Maturity and natural mortality

Data on size at maturity for males and females were presented at the ICES Workshop on *Nephrops* Stocks in January 2006 (ICES WKNEPH, 2006) but since no estimates of SSB has been made, these data were not used in this year's analysis of these stocks.

Catch, effort and research vessel data

Effort data for the Swedish fleet are available from logbooks for 1978-2008 (Figure 3.2.2.1 and Table 3.2.2.3). In recent years the twin trawlers have shifted to target both fish and *Nephrops*, and this shift has resulted in a decreasing trend in LPUE from 1998 to 2005 for this gear (Table 3.2.2.3). In the most recent years LPUEs have increased for both gear types. The long term trend in LPUEs (an increase from 1992 to 1998, a decrease from 1999 to 2001 and a subsequent increase in the last 6 years) is similar in the Swedish and Danish fisheries. Total Swedish trawl effort shows a decreasing trend since 1992. From 2004 onwards total Swedish trawl effort has been estimated from LPUEs from the grid single trawl (targeting only *Nephrops*) and total trawl landings.

Danish effort figures for the Skagerrak (Table 3.2.2.4 and Figure 3.2.2.1) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994-97, effort did increase again in the next five years followed by a decrease in recent six years. Also the trend in LPUE is similar to that in the Swedish single trawl fishery, however with a much more marked increase in the Danish LPUE for 2007 and 2008. This high LPUE level may be partly a consequence of the new national (Danish) management system introduced in 2007 (see Sect. Fisheries) (Figure 3.2.2.2).

It has not been possible to incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. In 2008 the Danish logbook data was analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE (Figure 3.2.2.3):

- Incorporation of kW (HP) in the effort measure
- Vessel size (GLM to standardise LPUE regarding vessel size)
- Degree of targeting *Nephrops* (measured as value of *Nephrops* in landing).

Note, that the trends in the resulting LPUE (relative indices) are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

Norwegian logbook records of *Nephrops* trawl are lacking for the last five years. Additionally, LPUE data for all trawl gears have covered 9% on the average of the Norwegian landings in the last 8 years. Norwegian data are therefore not included in the analysis.

3.2.3 The Kattegat (FU4)

3.2.3.1 Data available

Catch

Both Denmark and Sweden have *Nephrops* directed fisheries in the Kattegat. In 2008, Denmark accounted for about 71 % of total landings, while Sweden took remaining 28 % (Table 3.2.3.1). Minor landings are taken by Germany.

After the low that was observed in 1994, total *Nephrops* landings from the Kattegat increased again until 1998. Since then, they have fluctuated around 1500 t. However, landings increased markedly in 2008 to more than 2000 t, the highest observed landings since 1984 (Figure 3.2.3.1).

Length compositions

For the Kattegat, size distributions of both the landings and discards are available from Sweden for 1990-1992 and 2004-2008, and from Denmark for 1992-2008. The at-sea-sampling intensity has generally increased since 1999, but the Danish sampling decreased in 2007 and 2008. Information on mean size is given in Table 3.2.3.2. Trends in mean size are shown in Figure 3.2.3.1 and after some years of small mean sizes 1993 to 1996 all categories are fluctuating without trend the last 12 years.

Maturity and natural mortality

Data on size at maturity for males and females were presented at the ICES Workshop on *Nephrops* Stocks in January 2006 (ICES WKNEPH, 2006) but since no estimates of SSB has been made, these data were not used in this year's analysis of this stock.

Catch, effort and research vessel data

Swedish total effort, converted to single trawl effort, has been relatively stable over the period 1978-90. An increase is noted in 1993 and 1994, followed by a decrease to 1996, and a stabilisation at intermediate levels in recent years (Figure 3.2.3.1 and Table 3.2.3.3)). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased during 1995 to 2001, but since then it has been showing a decreasing trend until 2007. In 2008 the effort increased slightly (Figure 3.2.3.1 and Table 3.2.3.4).

It has not been possible to incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. In 2008 the Danish logbook data were analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE (Figure 3.2.3.2):

- Incorporation of kW (HP) in the effort measure
- Vessel size (GLM to standardise LPUE regarding vessel size)
- Degree of targeting *Nephrops* (measured as value of *Nephrops* in landing).

Note, that the trends in the resulting LPUE (relative indices) are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

The Swedish single trawl LPUE and Danish annual LPUEs have shown similar trends since 1990. Both series show a marked increase in the last 2 years (Tables 3.2.3.3 & 3.2.3.4; Figure 3.2.3.3).

3.2.4 Combined assessment (FU 3 & 4)

No advice was requested in 2009, so no assessment was carried out this year.

3.2.4.1 Status of the Stock

The 2008 assessment lead to the conclusion for the two FUs in Division IIIa that, given the apparent stability of the stocks, the current levels of exploitation appeared to be sustainable. The most recent assessment data compiled in 2009 do not indicate any changes in the state of the stock

3.3 *Nephrops* IN Subarea IV

Division IV contains eight FUs 5, 6, 7, 8, 9, 10, 32, and 33. Management is applied at the scale of ICES Division through the use of a TAC and an effort regime.

Management at ICES Subarea Level

The 2008 EC TAC for *Nephrops* in ICES Subarea IIa and IV was 26144 tonnes in EC waters (plus 1300 tonnes in Norwegian waters). For 2009, this has been reduced to 24837 tonnes in EC waters and 1210 tonnes in Norwegian waters.

The minimum landings size (MLS) for *Nephrops* in Subarea IV (EC) is 25mm carapace length. Denmark, Sweden and Norway apply a national MLS of 40mm.

Days at sea limits apply to *Nephrops* trawlers when using mesh sizes 70-99 mm and in 2009, under the Scottish Conservation Credits Scheme (CCS), the number of days available to Scottish vessels is the same as 2008 and 2007. EU catch composition regulations apply to *Nephrops* trawlers.

UK legislation (SI 2001/649, SSI 2000/227) requires at least a 90 mm square mesh panel in trawls from 80 to 119mm, where the rear of the panel should be not more than 15 m from the cod-line. The length of the panel must be 3 m if the engine power of the vessel exceeds 112 kW, otherwise a 2 m panel may be used. Under UK legislation, when fishing for *Nephrops,* the cod-end, extension and any square mesh panel must be constructed of single twine, of a thickness not exceeding 4 mm for mesh sizes 70-99 mm, while EU legislation restricts twine thickness to a maximum of 8 mm single or 6 mm double.

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90 mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100 mm in the North Sea south of 57°30'N.

Official catch statistics for Subarea IV are presented in Table 3.3.1. The preliminary officially reported landings in 2008 are just over 22,000 tonnes which is around 2,500 tonnes lower than in 2007. Minor updates have been made to landings in previous years.

Table 3.1.2 shows landings by FU as reported to the WG. It also shows that a small but significant proportion of the landings from Subarea IV come from outside the defined *Nephrops* FUs.

The trends observed in the 2008 North Sea Commission Fisheries Partnership (NSCFP) stock survey for *Nephrops* are discussed in the Quality of Assessment sections.

3.3.1 Botney Gut/Silver Pit (FU 5)

3.3.1.1 Data Available

Landings.

Table 3.3.1.1 shows the landings from this FU. For many years total landings have been at a level of 1000 t. Up to 1995, the Belgian fleet took more than 75% of the international *Nephrops* landings from this FU/stock, but since then, the Belgian landings have declined drastically, and since 2006 there has been no directed Belgian *Nephrops* fishery. Danish landings have been at low levels in recent years. In the most recent years UK, Netherlands and Germany have accounted for most of the landings from this FU.

Discards.

Discard data were available for the Belgian *Nephrops* fleet for the period 2002 - 2005. Since 2006, because of no directed fisheries, there has been no data collection from the Belgian *Nephrops* landings. No discard data are available from the other fisheries.

Length compositions

Danish sampling of landed *Nephrops* has taken place 2005-2007, mainly as a compensation for inadequate at-sea-sampling.

Data on mean sizes of male and female *Nephrops* in the Belgian landings (1991- 2005) are shown in Table 3.3.1.2 and Figure 3.3.1.1. The mean sizes of males show evidence of an overall downward trend, while mean sizes of females seem to be stable. There is little evidence in these of a notable change in sizes and the maximum sizes have remained quite constant during this period.

Natural mortality, maturity at age and other biological parameters

In previous analytical assessments (see e.g. WGNEPH, 2003), natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. Discard survival was assumed to be 0.25 for both males and females (after Gueguen & Charuau, 1975, and Redant & Polet, 1994).

- Growth parameters are as follows:
- Males: L∞ = 62mm CL, k = 0.165.
- Immature females: L∞ = 62mm CL, k = 0.165.
- Mature females: L∞ = 60mm CL, k = 0.080, Size at 50% maturity = 27mm CL.
- Growth parameters have been assumed to be similar to those of Scottish *Nephrops* stocks with similar overall size distributions of the landings (see e.g. WGNEPH, 2003). Female size at 50% maturity was taken from Redant (1994).

Commercial catch-effort data and research vessel surveys

Effort and LPUE figures are available for Belgian *Nephrops* specialist trawlers (1985-2005), the Dutch fleet (all vessels catching *Nephrops* for the period 2000-2005) and the Danish bottom trawlers with mesh size > 70 mm (1996-2008), Table 3.3.1.3 and Figure 3.3.1.1.

The effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all times high in the early 1990s. In 2005, effort was at the lowest level in the time series No data are available for the 2006-2007

The effort of the Dutch (*Nephrops*) fleet was relatively stable, between 7900 and 9800 days at sea annually. Danish *Nephrops* effort in the Botney Gut was always low but has decreased drastically in recent years. The very high LPUE in 2008 may reflect both technological creep and increasing efficiency due to the FKA agreement for fishing industry described in Section 3.2.1.2.

There are no fishery-independent survey data for FU 5.

3.3.1.2 Status of stock

The shortage of information on this stock in the recent 2 years makes an evaluation of stock condition difficult. The high value of the Danish LPUE in 2008 may reflect technological creep, and since the Danish fishery is very small, the LPUE should be viewed with caution. There is no other evidence of significant downward movements trends in LPUE or in mean size, but the lack of more substantial data for the 3 recent years gives rise for concern about the status of this and the stock.

3.3.2 Farn Deeps (FU6)

3.3.2.1 Fishery in 2007 & 2008

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (Table 3.3.2.1). In 2008 total landings were 1,213 tonnes, significantly down from both 2,966 t in 2007 and the historical maximum observed in 2006 of 4,858t (Figure 3.3.2.1). The introduction of the buyers and sellers legislation in 2006 precludes direct comparison with previous years because the resulting improvement in reporting levels has created a discontinuity in the data. Effort also decreased sharply in 2008 and has been generally declining since the early 1990s although again the change in legislation in 2006 complicates the interpretation of any trends. Effort trends in terms of KW hours are further complicated by moves towards multi-rig fishing gears which generally have a higher fishing power. The proportion of landings by multi-rig gears (mainly twin riggers) has risen steadily through time and reached just under 40% in 2008 (Figure 3.3.2.2). Historically the fishery is prosecuted by a combination of local English boats (smaller vessels undertaking day-trips) and larger vessels from Scotland with occasional influxes of effort by Northern Irish vessels. The number of vessels in the fishery from Scotland and Northern Ireland decreased in 2008.

The Farn Deeps fishery is essentially a winter fishery commencing in September and running through to March, hence the 2008 fishery comprises the end of the 2007-2008 fishery and the start of the 2008-2009 fishery. Effort in the first and fourth quarters of 2008 was considerably lower than previous years whilst effort in the second and third quarters remained relatively stable (Figure 3.3.2.3).

3.3.2.2 ICES ADVICE in 2006

The last assessment of *Nephrops* in FU6 was in 2008.

State of the stock. (from ACOM advice sheet)

"The TV survey and lpue data indicate a decline in abundance from the highest estimate in the time-series in 2006 to levels comparable to 1997 and 2002. Mean length in the catches has increased which could indicate that recruitment in 2007 is low, or it could indicate a reduction in fishing mortality. However, there is no apparent trend over the available time-series of relative abundance and mean length and the stock appears to be stable ."

It would appear that there was an error in the final composition of this advice because this is contradictory to both the WGNSSK report for 2008 and the "management considerations" section states of the ACOM advice sheet which states:

"All available indices point to the stock in 2007 having been reduced to a low level following the high abundances in 2005–2006. Latest recruitment signals are low. This is consistent with the industry's perception of the stock."

"ICES recommends that the Nephrops fisheries should not be allowed to increase relative to 2007. This corresponds to landings of no more than 3000 t for the Farn Deeps stock. "

3.3.2.3 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.2.4 Assessment

Review of the 2008 assessment.

May 2008:

"*FU6: the RG agrees with views of EG which are well explained as in terms of assessment as advice. Recent UWTV indices are suggesting a decline in abundance.*

For this FU and with the same concerns mentioned before about the general procedure followed for these stocks, the EG are conscious on delicate of situation and the proposal achieved seems to be more prudent (2,800 t in 2009). It is not recommended to use the average of recent landings, since 2006 landings dropped from 4,858 to 2,966 in 2007. The RG agrees with EG that this stock is in a transition phase and it should be re-assessed in 2009.."

Data available

Catch, effort and research vessel data

Three types of sampling occur on this stock, landings sampling, catch sampling and discard sampling providing information on size distribution and sex ratio. The sampling intensity is considered to be generally good (see section 2.????).

Two different procedures have been used to estimate discards with a change in method in 2002. These are described in detail in the Stock Annex.

LPUE had remained relatively stable between 1993-2000, at a relatively high level around 26 kg.hour^{-1} (Table 3.3.2.2 & Figure 3.3.2.1). Since 2000 annual LPUE has sharply increased to its highest value in the series in 2006 (38 kg.hour^{-1}). Since 2006, effort has decreased by 53%, landings by 75% and LPUE by 49%.. The introduction of the buyers and sellers legislation in 2006 precludes comparison with previous years.

Males generally predominate in the landings, averaging about 70% (range 64%-79%) by biomass in the period 1992-2005. The fishery in 2008 continued this trend and there was no repeat of the anomaly in sex ratio (high proportion of females) observed during the 06/07 winter fishery (Figure 3.3.2.3).

Effort is generally highest in the 1st and 4th quarter of the year in this fishery (Figure 3.3.2.3) with landings correspondingly highest in these quarters. In 2008 effort was down on recent levels with the exception of quarter 2. The reduced number of larger vessels in 2008 may have a disproportional negative impact on CPUE measures in that the larger vessels are likely to have a higher efficiency. Quarterly LPUE values were more variable than the annual trends, but overall the same pattern is apparent. LPUEs of males are typically highest in the 1st and 4th quarters. LPUE for males was slightly reduced from 2007 levels in all quarters. The seasonal pattern of LPUE for females is much more variable ranging from very strong seasonality (1998) to almost none (2002). The extremely high LPUE for Females in quarter 4 in 2006 appears to be genuine and not an artefact of sampling. LPUE on Females was considerably reduced on 2007 levels for the first three quarters but increased for the 4th quarter.

Trends in the mean lengths for the <35mm categories (Figure 3.3.2.1) are used to infer possible changes to recruitment. Changes to the raising procedure in 2000 and 2002 confound comparison with years prior to 2002, but clear upward trends can be seen for both sexes between 2002 and 2007 implying a trend towards lower recruitments. There was a reduction in mean length in 2005 which corresponded with the high abundance index in 2006. The mean length for the <35mm categories in 2008 are the same or lower than 2007 implying improved recruitment for 2008. Length distributions of landed and estimated discarded portions of the catch are shown in Figure 3.3.2.4. Catches of smaller size males are very similar to 2007, however there were considerably more small females.

Analysis of individual vessel records indicates an increase in directed *Nephrops* fishing since around 2000. Restrictions on both quota and effort for directed finfish fishing over the last seven years will have restricted the more casual effort on *Nephrops*. Further research is needed to better define directed fishing effort and thereby improve on this series.

Underwater TV surveys of the Farn Deeps grounds have been conducted at least once in each year from 1996 onwards. The most consistent series, and the one used in the assessment is the autumn survey which coincides with the start of the winter fishery. A time series of indices is given in figure 3.3.2.5 and table 3.3.2.4. Figure 3.3.2.6 shows the distribution of stations and relative density in the most recent 8 TV surveys.

Discard survival is set to zero for this FU in contrast to the 25% used in many other FUs. This is due to the practice of catch sorting and tailing whilst steaming back to port when the vessel passes over ground not suitable for *Nephrops* habitation.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Exploratory analyses of RV data

A comprehensive review of the use of underwater TV surveys for *Nephrops* stock assessment was undertaken by WKNeph (ICES 2009). This covered the range of potential biases resulting from factors including edge effects, species mis-identification, burrow occupancy. Cumulative bias factors were estimated for each FU and for FU6 the bias correction factor is 1.2 meaning that the TV estimate is likely to overestimate absolute abundance of *Nephrops* by 20%. Estimates of mean burrow density and the resulting bias-corrected abundance estimates (with confidence estimates) are given in table 3.3.2.4. The confidence estimates presented are a product of the within-strata variance which only partially takes into account the spatial structure of the data. Analyses which take spatial structuring of the counts into account (such as geostatistical methods) have been carried out for other FUs and indicate that uncertainty in the estimates of abundance from these underwater TV surveys is considerably overestimated.

Final Assessment.

Mean size of *Nephrops* <35mm carapace length (CL) in the catch has been generally increasing for both sexes since 2002, peaking in 2007 with similar or lower values in 2008. Mean size above 35mm has been comparatively static from 2002-2007. The implication of the increase in mean size for the smaller size classes is that there has been either a significant improvement in survivorship of the older classes or a progressive reduction in recruitment. Given the reduced TV abundances and poor fishing in both 2007 and 2008, a reduction in recruitment would seem the more likely scenario. The TV index for 2008 is at a similar low level to that of the absolute minimum observed in 2007 reflecting the low level of the fishery in these years.

3.3.2.5 Historic stock trends.

The time series of TV surveys is short compared to the IBTS (8 consecutive years) but estimates that the stock has fluctuated between 900 and 1700 million individuals with the most recent two estimates being at the bottom of this range.

Estimates of historic harvest ratio (the proportion of the stock which is removed) range from 7.4% to 24.6% (Table 3.3.2.5). The harvest ratio jumped from around 12% in 2004-2005 to 24.6% in 2006 when the new reporting legislation came in.

3.3.2.6 Short term forecasts.

Catch and landing predictions for 2010 are given in the text table below. This assumes that the bias corrected survey index made in October 2008 is relevant to the stock status for 2010. The harvest ratio estimated to be equivalent to fishing at F0.1 was calculated by WKNeph (2009) to be 8.2%. This is significantly lower than the value used in previous advice due to a revision of the assumptions regarding the sizes of *Nephrops* observed by the TV survey.

Discard rate = 29.5%, mean weight in retained portion (2006-2008)=23.4g

	Harvest ratio	Bias corrected survey index	Retained number	Landings
	0%	965	0	0
	2%		14	318
	4%		27	637
	6%		41	955
F2008	7.6%		52	1210
	8%		54	1274
F0.1	8.2%		56	1305
	10%		68	1592
	12%		82	1910
	13%		90	2117
	14%		95	2229
	16%		109	2547
Fmax	18%		122	2866
	20%		136	3184

3.3.2.7 BRPs

No biological reference points have been determined for *Nephrops* in FU6.

3.3.2.8 Quality of assessment

Changes to the legislation regarding the reporting of catches in 2006 means that the levels of reported landings from this point forward are considered to better reflect the true landings and hence effort input into this fishery. This does mean that comparison of LPUE with previous years is inadvisable and the independence of the final assessment from these data is likely to continue for some time.

The length and sex compositions arising from the land-based catch sampling programme are considered to be representative of the fishery. Estimates of discarded and retained length frequencies arising from the discard sampling programme are also considered robust since 2002.

The TV survey in this area has a high density of survey stations compared to other TV surveys and the abundance estimates are considered robust.

The most recent North Sea Stock Survey was carried out in mid 2008. 70 % of the 13 respondents thought that abundance of *Nephrops* in Area 4 (Farn Deeps is the only FU in this area) was less or much less than previously which agrees with the recent decline in TV survey abundance. The time series for Area 4 indicates an increasing trend until 2007 followed by a decline in 2008.

Fishing effort in 2008 declined considerably due to fewer vessels visiting from Scotland and Northern Ireland. This brought the Harvest Rate in 2008 down to below the level considered to be equivalent to fishing at F0.1. Without suitable controls on the movement of effort between Functional Units there is nothing to prevent the effort in 2010 returning to levels observed prior to 2008 all of which have been above the F0.1 level and some of which have been considerably above the level of Fmax. Prior to the introduction of "Buyers and Sellers" legislation in 2006 reporting rates are considered to have been low and hence the estimated Harvest Ratios prior to 2006 are also likely to have been underestimated.

3.3.2.9 Status of stock

The TV survey, fishery data and length frequency data all point to the stock at the start of the 2008 fishing season continuing to be in a depleted state. Recruitment signals for *Nephrops* are inferred rather than estimated but recruitment in 2008 would appear to be low.

3.3.2.10Management 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.

Increases in abundance in other FUs (i.e. Firth of Forth and the Fladen grounds) are likely to translate to increases in TAC, increasing the risk of higher effort being deployed in this FU. The high cost of fuel combined with the relative coastal proximity of this ground may result in it attracting additional fishing effort which would be inadvisable given the current low level of the stock.

3.3.3 Fladen Ground (FU7)

3.3.3.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.3.2 The Fishery in 2007 and 2008

The *Nephrops* fishery at Fladen is the largest in the North Sea and is mainly prosecuted by UK (Scotland) vessels, with Denmark the only other nation taking a significant amount of landings (Table 3.3.3.1).

No major changes have been reported in the Scottish fishery in 2008. Over 100 vessels continue to participate in the fishery which takes a mixed catch consisting of haddock, whiting, cod, anglerfish and megrim as well as *Nephrops*. Changes to more selective gear which are required to qualify for the Scottish Conservation Credits Scheme (CCS; see Section 13.1.4) are likely to reduce bycatch (and therefore) discards of whitefish. The majority of these vessels (80%) fish out of Fraserburgh. Six new *Nephrops* vessels in the 20-25 m size category have joined the fleet in 2008 and a further 5 new vessels are on order. However, a number of vessels have also left the Scottish fleet and are now registered in England to avoid the ban on multiple-rig (>2) trawling. Other developments that may have mitigated effort increases (due to new vessels) to some extent, are the number of larger boats taking up oil guard vessel duties in 2007 and the high oil prices during the latter part of 2007 and into 2008 which curtailed some activity. The seasonal squid fishery (2nd half of the year) was good in 2007 and 2008 and some vessels transferred effort during these periods.

Further general information on the fishery can be found in the Stock Annex.

3.3.3.3 ICES advice in 2008

The ICES conclusions in 2008 in relation to State of the Stock were as follows:

'TV survey estimates of abundance for *Nephrops* on the Fladen Ground indicate that the stock has fluctuated without trend since 1992. Stock abundance rose in 2006 and 2007 to reach the highest estimated in the time-series. Indicators of stock status based on size composition show a stable situation and the size range has not decreased through time. The mean size of *Nephrops* >35 mm carapace length (CL) has fluctuated slightly without trend over the time-series. For *Nephrops* <35 mm CL a slight decline in mean size has been observed over the last couple of years, which is probably associated with increased recruitment leading to increased abundance.'

The ICES advice for 2008 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'The current fishery appears sustainable. Therefore, ICES recommends that *Nephrops* fisheries should not be allowed to increase relative to the past two years (2006–2007). This corresponds to landings of no more than 11 300 tonnes for the Fladen stock.'

3.3.3.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.3.5 Assessment

Review of the 2008 assessment

'*RG agrees with WG on perception of the stock trends but less in terms off advice. It is noticeable that for this FU the EG is more prudent and raises better some concerns. The RG insists in a more conservative, progressive and adaptive management proposals for this FU.*'

Approach in 2009

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 and described in Section 3.1.

Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others, and are presented in Table 3.3.3.1, together with a breakdown by gear type (See also Table 3.3.3.2). Total international landings (as reported to the WG) in 2008 were 12240 tonnes (approximately 300 tonnes greater than the 2007 total), consisting of 12099 tonnes landed by Scotland and 133 tonnes landed by Denmark.

Reported effort by all Scottish *Nephrops* trawlers showed an increasing trend up to 2002, but dropped sharply in 2003 apparently as a result of reduced twin trawl effort (Table 3.3.3.2 and Figure 3.3.3.1). However, these reported effort data (in terms of hours fished) from the Scottish trawl fleets are thought to be rather unreliable 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 the report of the 2000 WGNSSK (ICES, 2001). Together with the likely underreporting of landings prior to 2006, this means that the associated LPUE series are therefore unlikely to be representative of actual trends in LPUE for the Scottish fleets.

Danish LPUE data are presented in Figure 3.3.3.1 and Table 3.3.3.3. These show an increase in the mid-2000s, with values remaining high in 2008.

Males consistently make the largest contribution to the landings, although the sex ratio does seem to vary. 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* (Figure 3.3.3.2).

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 15 % by number in this FU. In 2008, discard rates were estimated to be lower than average at just under 10 % by number. The discard rate estimated at the benchmark workshop was 13.8 % (3 year average) and this value is used in the provision of landings options for 2010.

It is likely 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.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are shown in Section 2.2.4.. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.3.3.3 shows a series of annual length frequency distributions for the period 2000 to 2008. Catch (removals) length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. In both sexes the mean sizes have been fairly stable over time and examination of the tails of the distributions above 35mm 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* (>35mm) in the landings shown in Figure 3.3.3.1 and Table 3.3.3.4. This parameter might be expected to reduce in size if over-exploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35mm) in the catch (and landings) is also quite stable through time although there has been a decrease in recent years which may be associated with increased recruitment (that has led to increased densities observed on the UWTV survey in this area (see below)).

Mean weight in the landings is shown in Figure 3.3.3.4 and Table 3.3.3.5 and this also shows no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 7 since 1992 (missing survey in 1996). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.3.6. On average, about 60 stations have been considered valid each year with over 70 stations in the last two years. Data are raised to a stock area of 28153 km^2 based on the stratification (by sediment type). General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in more detail in the Stock Annex.

Data analyses

Exploratory analyses of survey data

The UWTV survey work-up method employed on the Scottish surveys assumes that the width of the viewed transect is the entire lower edge of the TV screen on which the burrows are counted. This can be calculated from the TV camera parameters and the position of the camera in relation to the seabed. Although the camera has been changed a number of times since the start of the survey, the manufacturer has remained the same and efforts have been made to ensure that the camera parameters (lens properties) remained constant. However, in 2008, it came to light that a number of changes had been made to the housing of the glass front of the camera which meant that the field of view of the camera had actually changed (a number of times) with the actual field of view being less than that calculated from the assumed camera parameters.

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 7 from 2003 onwards are presented here for the first time and are slightly higher than the previous values due to the field of view being smaller than previously calculated. (Due to inconsistent file formats, pre-2003 survey data could not be reworked ahead of this WG).

Table 3.3.3.7 shows the basic analysis for the three most recent TV surveys conducted in FU 7. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate. Most of the variance in the survey is associated with this coarse sediment which surrounds the main centres of abundance.

Figure 3.3.3.5 shows the distribution of stations in recent TV surveys (2003-2008), with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground but in 2007, high densities were also widely recorded in the coarser sediment of the ground. Table 3.3.3.6 and Figure 3.3.3.6 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

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 mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU7 was 1.35 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 35 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Fladen Ground *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. 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 2008 TV survey data presented at this meeting shows that the abundance remains at a high level.

Mean size in the catch of individuals < 35 mm has decreased for both males and females in recent years which may be interpreted as an increase in recruitment which would be in agreement with the increased number of burrows estimated from recent TV surveys.

3.3.3.6 Historic Stock trends

The TV survey estimates of abundance for *Nephrops* in the Fladen suggests that historically the population fluctuated without trend. The recently observed increase has taken the stock to its highest estimated abundance in the time series. The bias adjusted abundance estimates from 2003-2008 (the period over which the survey estimates have been revised) is shown in Table 3.3.3.8. The stock is estimated to be at a high point of over 7000 million individuals.

Table 3.3.3.8 also shows the estimated harvest ratios over this period. These range from 4-10% 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).

3.3.3.7 Recruitment estimates

Recruitment estimates from surveys are not available for this FU. However the drop in mean size of small animals <35mm in the catches may be indicative of good recruitment (Figure 3.3.3.1).

3.3.3.8 Short-term forecasts

A landings prediction for 2010 was made for the Fladen Ground (FU7) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to this chapter (Section 3.1). The table below shows landings predictions at various harvest ratios, including those equivalent to fishing at $F_{0.1}$, F_{max} and the harvest ratio in 2008. The harvest ratios equivalent to $F_{0.1}$ and F_{max} are significantly lower than those previously presented due to a revision of the assumptions regarding the size range of *Nephrops* inhabiting the burrows observed in the TV survey.

The inputs to the landings forecast were as follows:

Mean weight in landings (06-08) = 28.05 g

Discard rate (by number) = 13.8 %

Survey bias = 1.35.

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
	0.0%	7302	0	0
	5.0%	7302	315	8827
F 2008	8.0%	7302	504	14124
F0.1	9.3%	7302	585	16419
	10.0%	7302	629	17655
	15.0%	7302	944	26482
Fmax	15.8%	7302	994	27895
	20.0%	7302	1259	35310

3.3.3.9 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.3.10 Quality of assessment

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 2000, and is considered to represent the fishery adequately.

The quality of landings (and catch) data has improved in the last two years but because of concerns over the accuracy of earlier years, the final assessment adopted is independent of official statistics.

Underwater TV surveys have been conducted for this stock since 1992, with a continual annual series available since 1997. The number of valid stations in the survey have remained relatively stable throughout the time period, with more stations in the last couple of years. Confidence intervals are relatively small.

The landings forecast for 2010 (equivalent to fishing at F0.1) is almost 16,500 tonnes. This is an increase of almost 4,000 tonnes on the reported landings in 2008.

NSCFP stock survey suggests that moderate amounts of recruits are apparent in Areas 1 and 3 (which Fladen FU lies within) compared to 2007. The time series of perceived abundance in Areas 1 and 3 increases to 2007, but in 2008 either declined or remained constant. Status of the stock

TV observations indicate that the stock is fluctuating without obvious trend with estimates for the last 2 years increasing to the highest abundance in the series. Considering the TV result alongside the indications of stable or slightly increasing mean sizes in the length compositions of catches (of individuals >35mm CL) suggests that the stock is being exploited sustainably. The decline in mean length of smaller individuals in the catch may be indicative of recent good recruitment.

3.3.3.11 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.

Nephrops fisheries have a bycatch of cod. In 2005, high abundance of 0 group cod was recorded in Scottish surveys near to this ground. This year class of cod has subsequently contributed to slightly improved cod stock biomass and efforts are being made to avoid the capture of cod so that the stock can build further. The Scottish industry is operating under a voluntary Conservation Credits scheme (uptake > 90%) and has implemented improved selectivity measures in gears which target *Nephrops* and real time closures with a view to reducing unwanted bycatch of cod and other species.

3.3.4 Firth of Forth (FU 8)

3.3.4.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

The *Nephrops* fishery in the Firth of Forth is dominated by UK (Scotland) vessels with low landings reported by other UK nations (Table 3.3.4.1). In recent years the number of Scottish vessels regularly fishing this FU has been around 40 although this varies seasonally as vessels move around the UK with fluctuating catch rates. The fishery continues to be characterised by catches of small *Nephrops* which often leads to high discard rates. The whitefish by-catch is reported to have been particularly low in this fishery in 2008. There is also a small amount of landings by creel vessels in this area, although typically the main target species of these vessels are crabs and lobsters.

Further general information on the fishery can be found in the Stock Annex.

3.3.4.2 Advice in 2008

The ICES conclusions in 2008 in relation to State of the Stock were as follows:

'The UWTV survey indicates that the stock abundance has been at a high level since about 2002. The size composition of the commercial landings are stable and do not show a decrease over time.'

The ICES advice for 2008 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'The current fishery appears sustainable. Therefore, ICES recommends that *Nephrops* fisheries should not be allowed to increase relative to the past two years (2006–2007). This corresponds to landings of no more than 2500 tonnes for the Firth of Forth stock.'

3.3.4.3 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.4.4 Assessment

Review of the 2008 assessment

'The RG agrees with views of EG which are well explained as in terms off assessment as advice. From UWTV abundance trends (and from commercial information with caution) there are indications that the exploitation of stock is being sustainable and now is at a relatively high level. Considering the high discard rates it should recommended exploring an improvement in selection pattern.'

Approach in 2009

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 and described in Section 3.1.

Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.3.4.1, together with a breakdown by gear type (See also Table 3.3.4.2). Total landings (as reported to the WG) in 2008 were 2450 tonnes. Following 5 years of rapidly increasing reported landings (which may have been due to increased reporting as well as increased actual landings), the value for 2008 represents a decline of approximately 200 tonnes on the value for 2007.

Reported effort by Scottish *Nephrops* trawlers dipped in 2003, but has otherwise remained relatively stable since 1995 (Table 3.3.4.2 and Figure 3.3.4.1). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980's and early 1990's, but has apparently fluctuated since then and in the last couple of years has increased markedly. There are concerns over the quality of these fishery data (discussed in Section 3.3.3.2.1) and the apparent sudden increase in LPUE (Figures 3.3.4.1 and 3.3.4.2) may well be an artefact of improved landings reporting combined with reduced effort (hours fished) recording.

Males consistently make the largest contribution to the landings (Figure 3.3.4.2), although the sex ratio does vary. The proportion of females in the landings in 2008 is somewhat higher than in 2007. This may be due to the change in seasonal effort distribution with greatest effort in the 3rd quarter in 2008 when females are likely to be more available to the fishery (compared with a more evenly distributed seasonal effort pattern in 2007).

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU over the last 5 years have varied between 25 and 50 % of the catch by number (31 % in 2008). Discard rates are higher in this stock than the more northerly North Sea FUs for which Scottish discard estimates are also available. This could arise from the fact that the use of larger meshed nets is not so prevalent in this fishery (80mm is more common). The discard rate estimated at the benchmark workshop was 34.6 % (3 year average) and this value is used in the provision of catch options.

It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are shown in Table 2.2.XX. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions may provide an indication of exploitation effects.

Figure 3.3.4.3 shows a series of annual length frequency distributions for the period 2000 to 2008. Catch (removals) are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. There is little evidence of change in the mean size of either sex over time and examination of the tails of the distributions above 35mm 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* (>35mm) in the landings shown in Figure 3.3.4.1 and Table 3.3.4.3. This parameter might be expected to reduce in size if over-exploitation were taking place but over the last 15 years has in fact been quite stable and increased very slightly in more recent years. The mean size in the landings in the < 35 mm category (Figure 3.3.4.1) shows a reduction in recent years although the mean size in the catch has fluctuated without trend. Such signals could be associated with a changing discard or selection pattern.

Mean weight in the landings is shown in Figure 3.3.3.3 and Table 3.3.3.5 and this also shows no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 8 since 1993 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.4.4. On average, about 40 stations have been considered valid each year. In 2008, only 38 stations were considered valid – approximately 5 stations could not be used to provide a density estimate because of poor visibility due to seabed disturbance. Abundance data are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Stock Annex.

Data analyses

Exploratory analyses of survey data

As discussed in Section 3.3.3.2., the most recent 6 years of TV survey data have been revised ahead of this WG.

Table 3.3.4.5 shows the basic analysis for the three most recent TV surveys conducted in FU 8. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand. Depending on the year, high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area.

Figure 3.3.4.4 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher towards the central part of the ground and around the Isle of May. In recent years higher densities have been recorded over quite wide areas. Table 3.3.4.5 and Figure 3.3.4.5 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. The confidence intervals around the 2008 estimate are particularly poor due to the exceptionally high variance associated with the mud/sandy mud stratum. Further stations were carried out in this stratum but could not be used due to extremely poor visibility.

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 mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU 8 was 1.18 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 18 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Firth of Forth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. 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 2008 TV survey data presented at this meeting shows that abundance remains at a similar level to that estimated for 2007.

The mean size of individuals > 35 mm in the landings show slight increases in recent years.

3.3.4.5 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population decreased between 1993 and 1998 and then began a steady increase up to 2003. Abundance is estimated to have fluctuated without trend in the years since then. The bias adjusted abundance estimates form 2003-2008 (the period over which the survey estimates have been revised) is shown in Table 3.3.4.6. The stock is currently estimated to consist of 881 million individuals.

Table 3.3.4.6 also shows the estimated harvest ratios over this period. These range from 15-30 % over this period. (Estimated harvest ratios prior to 2006 may not be representative of actual harvest ratios due to under-reporting of landings before the introduction of 'Buyers and Sellers' legislation).

The harvest rate equivalent to F0.1 is 8.0% and gives landings of 915 tonnes, which is only around 50% of the long term average (1981-2008) from this FU (1881 tonnes) and less than 40 % of landings in 2008. Estimated harvest rates for recent years (based on removed num-bers) have ranged from 15-30 %. Although these persistently high estimated harvest rates do not appear to have adversely affected the stock, they are estimated to be equivalent to fishing at a rate greater than Fmax and therefore it would be unwise to allow effort to increase in this FU.

3.3.4.6 Recruitment estimates

Survey recruitment estimates are not available for this stock.

3.3.4.7 Short-term forecasts

A landings prediction for 2010 was made for the Firth of Forth (FU8) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to this chapter (Section 3.1). The table below shows landings predictions at various harvest ratios, including those equivalent to fishing at $F_{0.1}$, F_{max} and the harvest ratio in 2008. The harvest ratios equivalent to $F_{0.1}$and F_{max} are significantly lower than those previously presented due to a revision of the assumptions regarding the size range of *Nephrops* inhabiting the burrows observed in the TV survey.

The inputs to the landings forecast were as follows:

Mean weight in landings (06-08) = 19.84 g

Discard rate (by number) = 34.6 %

Survey bias = 1.18

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
	0.0%	881	0	0
	5.0%	881	29	572
F0.1	8.0%	881	46	915
	10.0%	881	58	1144
	15.0%	881	86	1715
Fmax	13.7%	881	79	1567
	20.0%	881	115	2287
F2008	24.5%	881	141	2802

3.3.4.8 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.4.9 Quality of assessment

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.

There are concerns over the accuracy of historical landings (pre 2006) and uncertainty in effort data (due to non-mandatory recording of hours fished) and because of this the final assessment adopted is independent of officially reported data.

UWTV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. The confidence intervals around the abundance estimate in 2008 are very wide due to the lack of usable stations in one particular stratum due to poor visibility.

The NSCFP survey does not include specific information for the Firth of Forth. The NSCFP survey area containing the Firth of Forth had only 6 respondents of which 60 % perceived the abundance to be less than previously although it was also suggested moderate recruitment had taken place. The time series of perceived abundance for this area show an increase up to 2007 and then a decline. However, given that there is more than 1 FU within this NSCFP area, it is not clear as to whether the replies were actually related to the Firth of Forth *Nephrops*.

3.3.4.10 Status of the stock

The evidence from the TV survey suggests that the population has been at a relatively high level since 2003. The TV survey information, taken together with information showing stable mean sizes, suggest that the stock does not show signs of overexploitation.

3.3.4.11 Management considerations

The WG, ACFM 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 provide the controls to ensure that catch opportunties and effort were compatible and in line with the scale of the resource.

Nephrops discard rates in this Functional Unit are high and there is a need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. It is important that efforts are made to ensure that other fish are not taken as unwanted bycatch in this fishery which uses 80mm mesh. Larger square mesh panels implemented as part of the Scottish Conservation Credits scheme should help to im-prove the exploitation pattern for some species such as haddock and whiting and small cod.

3.3.5 Moray Firth (FU 9)

3.3.5.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.5.2 The Fishery in 2007 and 2008

The Moray Firth *Nephrops* fishery is essentially a Scottish fishery with only occasional landings made by vessels from elsewhere in the UK (Table 3.3.5.1). The general situation in 2007 and 2008 is similar to previous years with the vessels targeting this fishery typically conducting day trips from the nearby ports along the Moray Firth coast. Occasionally larger vessels fish the outer Moray Firth grounds on their way to/from the Fladen or in times of poor weather. In 2007 and 2008, a good squid fishery appeared in the summer and a number of vessels switched effort to this fishery during the second half of the year, although this was on a sporadic basis in 2007.

Further general information on the fishery can be found in the Stock Annex.

3.3.5.3 Advice in 2008

The ICES conclusions in 2008 in relation to State of the Stock were as follows:

'The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population decreased by around 55% in 2006, but rose again slightly to above the long-term average in 2007. Based on the surveys the stock has been relatively stable since 2002, while length compositions in the catch have been relatively stable for 10 years.'

The ICES advice for 2008 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'The current fishery appears sustainable. Therefore, ICES recommends that *Nephrops* fisheries should not be allowed to increase relative to the past two years (2006–2007). This corresponds to landings of no more than 1800 tonnes for the Moray Firth stock.'

3.3.5.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.5.5 Assessment

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 and is described in Section 3.1.

Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.3.5.1, together with a breakdown by gear type (See also Table 3.3.5.2). Total landings (as reported to the WG) in 2008 were 1514 tonnes. Following a number of years of increasing reported landings (which may have been due to increased reporting as well as increased actual landings), the value for 2008 represents a decline of approximately 300 tonnes (~15 %) on the value for 2007. The long term landings trends are shown in Figure 3.3.5.1.

Reported effort by Scottish *Nephrops* trawlers in terms of hours fished are available since 1981 and are shown in Table 3.3.5.2 and Figure 3.3.5.1. However, given the concerns over the quality of these fishery data (discussed in Section 3.3.3.2) it is unlikely the associated LPUE data are representative of trends in actual LPUE.

Males consistently make the largest contribution to the landings (Figure 3.3.5.2), although the sex ratio does vary. 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.*

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU appear to be highly variable with rates of between 5 and 40 % of the catch by number over the last 5 year (5 % in 2008). The discard rate estimated at the benchmark workshop was 7.4 % (3 year average) and this value is used in the calculation of catch options.

It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are shown in Table 2.2.XX. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions may provide an indication of exploitation effects.

Figure 3.3.5.3 shows a series of annual length frequency distributions for the period 2000 to 2008. Catch (removals) are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. There is little evidence of change in the mean size of either sex over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals. Occasional large year classes can be observed in these length frequency data (2002).

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35mm) in the landings shown in Figure 3.3.5.1 and Table 3.3.5.3. This parameter might be expected to reduce in size if over-exploitation were taking place but over the last 15 years has in fact been quite stable and increased very slightly in more recent years.

Mean weight in the landings is shown in Figure 3.3.3.3 and Table 3.3.3.5 and this also shows no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 9 since 1993 (missing survey in 1995). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.5.5. On average, 38 stations have been considered valid each year. Abundance data are raised to a stock area of 2195 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Stock Annex.

Data analyses

Exploratory analyses of survey data

As discussed in Section 3.3.3.2.2, the most recent 6 years of TV survey data have been revised ahead of this WG.

Table 3.3.5.4 shows the basic analysis for the three most recent TV surveys conducted in FU 9. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand and typically, most off the variance in the survey is associated with a patchy area of this sediment to the west of the FU.

Figure 3.3.5.4 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. The abundance appears to be highest at the western and eastern ends of the FU, with lower densities in the more central area. Table 3.3.5.5 and Figure 3.3.5.5 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

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 mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU 9 was 1.21 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 21 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Moray Firth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. 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 2008 TV survey data presented at this meeting shows that abundance remains at a similar level to that estimated for 2007.

The mean size of individuals > 35 mm (males and females) remains relatively stable.

3.3.5.6 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population increased between 1997 and 2003 but has fallen to a fairly stable lower level since 2006. The bias adjusted abundance estimates from 2003-2008 (the period over which the survey estimates have been revised) are shown in Table 3.3.5.6. The stock is currently estimated to consist of 478 million individuals.

Table 3.3.5.6 also shows the estimated harvest ratios over this period. These range from 7-18 % over this period. (Estimated harvest ratios prior to 2006 may not be representative of actual harvest ratios due to under-reporting of landings before the introduction of 'Buyers and Sellers' legislation).

3.3.5.7 Recruitment estimates

Survey recruitment estimates are not available for this stock.

3.3.5.8 Short-term forecasts

A landings prediction for 2010 was made for the Moray Firth (FU9) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to this chapter (Section 3.1). The table below shows landings predictions at various harvest ratios, including those equivalent to fishing at $F_{0.1}$, F_{max} and the harvest ratio in 2008. The harvest ratios equivalent to $F_{0.1}$ and F_{max} are significantly lower than those previously presented due to a revision of the assumptions regarding the size range of *Nephrops* inhabiting the burrows observed in the TV survey.

The inputs to the landings forecast were as follows:

Mean weight in landings (06-08) = 23.48 g

Discard rate (by number) = 7.4 %

Survey bias = 1.21.

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
	0.0%	478	0	0
	5.0%	478	22	520
F0.1	8.9%	478	39	926
	10.0%	478	44	1040
F 2008	13.2%	478	58	1372
	15.0%	478	66	1560
Fmax	16.6%	478	74	1727
	20.0%	478	89	2080

3.3.5.9 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.5.10 Quality of assessment

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.

There are concerns over the accuracy of landings and effort data and because of this the final assessment adopted is independent of official statistics.

UWTV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. Confidence intervals around the abundance estimates are greater during years when abundance estimates have been slightly higher.

The NSCFP survey does not include specific information for the Moray Firth. The NSCFP survey area containing the Moray Firth had only 6 respondents of which 60 % perceived the abundance to be less than previously although it was also suggested moderate recruitment had taken place. The time series of perceived abundance or this area increased up to 2007 and then declined slightly in 2008. However, given that there is more than 1 FU within this NSCFP area, it is not clear as to whether the replies were actually related to the Moray Firth *Nephrops*.

3.3.5.11 Status of the stock

The evidence from the TV survey suggests that the population is stable, but at a lower level than that evident from 2003-2005. There is no evidence from the mean size information to suggest overexploitation of the FU.

The harvest rate equivalent to $F_{0.1}$ is 8.9 % and gives landings of 926 tonnes, which is below the long term average (1981-2008) from this FU (1549 tonnes) and is around 60 % of landings in 2008. Estimated harvest rates for recent years (based on removed numbers) have ranged from 7-18 %. The estimated harvest ratio in 2008 is equivalent to fishing at a level between F0.1 and Fmax and therefore effort should not be allowed to increase further in this FU.

3.3.5.12 Management considerations

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

There is a bycatch of other species in the Moray Firth area. 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, include the implementation of larger meshed square mesh panels and real time closures to avoid cod.

3.3.6 Noup (FU 10)

3.3.6.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.6.2 The Fishery in 2007 and 2008

The Noup supports a relatively small fishery with only 3-4 boats fishing regularly. The landings data as reported to the WG are shown in Table 3.3.6.1. No new information is available for 2007 and 2008.

Further general information on the fishery can be found in the Stock Annex.

3.3.6.3 Advice in 2008

The ICES conclusions in 2008 in relation to State of the Stock were as follows:

'The lpue indicator is increasing and mean length in the catches is stable. Current levels of exploitation appear to be sustainable.'

The ICES advice for 2008 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'Given the apparent stability of the stock, current levels of exploitation and effort appear to be sustainable. ICES maintains the previous advice (based on the average landings 2003–2005) for the Noup fishery, i.e. less than 240 t. This amount is almost identical to the long-term average for the time-series.'

3.3.6.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.6.5 Assessment

There is no assessment of this FU.

Data available

Commercial catch and effort data

Landings from this fishery are reported only from Scotland and are presented in Table 3.3.6.1 and Figure 3.3.6.1, together with a breakdown by gear type (See also Table 3.3.6.2). Total landings (as reported to the WG) in 2008 were 173 tonnes, a small increase since 2007 (20 tonnes).

Reported effort by Scottish *Nephrops* trawlers in terms of hours fished are available since 1981 and are shown in Table 3.3.6.2 and Figure 3.3.6.1. However, given the concerns over the quality of these fishery data (discussed in Section 3.3.3.2.1) it is unlikely the associated LPUE data are representative of trends in actual LPUE.

Length compositions

Levels of market sampling are low (not available for recent years) and discard sampling is not available. Mean sizes in the landings in previous years are shown in Figure 3.3.6.1.

Natural mortality, maturity at age and other biological parameters

No data available.

Research vessel data

An underwater TV survey of this FU has been conducted sporadically (1994, 1999, 2006 and 2007). A density distribution map of these surveys is shown in Figure 3.3.6.2 and results shown in Table 3.3.6.3.

Data analyses

No assessment has been presented in 2009 and a discussion of management considerations can be found in the report of WGNSSK 2008.

3.3.7 Norwegian Deep (FU 32)

3.3.7.1 Fisheries

Traditionally, Danish and Norwegian fisheries have exploited this stock, while exploitation by UK vessels has been insignificant. Since 2000, Sweden has landed small amounts. Denmark still accounts for the majority of landings from this functional unit, although the contribution from this fishery in 2008 declined to around 75% of total landings, from around 90% in previous years (Table 3.3.7.1).

Denmark

A description of the Danish *Nephrops* fisheries in Subareas IIIa and IV (including the one in the Norwegian Deep) was given in the 1999 WGNEPH report (ICES, WGNEPH 1999a). Due to changes in the management regime (mesh size regulations regarding target species) in the Norwegian zone of the northern North Sea in 2002, there was a switch to increasing Danish effort targeting *Nephrops* in the mixed fisheries in the Norwegian Deep. However, a distinction between the fishing effort directed at *Nephrops*, roundfish or anglerfish is not always clear. The mesh size in the trawls catching *Nephrops* is >100 mm.

Norway

The Norwegian *Nephrops* fishery north of 60 °N (with 15-30% of the Norwegian FU 32 landings (2001-2008)) is mainly a creel fishery, with some landings also from *Nephrops* trawls, while the fishery south of 60 °N is mainly a trawl fishery (*Nephrops* trawls and bycatch from shrimp trawls).

Nephrops recordings in Norwegian log books from the Norwegian Deep are incomplete, with log book catches constituting 9-40% of the landings in 2001-2008. Furthermore, records on the use of *Nephrops* trawls are lacking in the logbooks from 2006-2008. In 2007 the highest effort (hrs trawled) was allocated to the statistical location just west of Egersund on the Norwegian west coast, but it is impossible to know whether this is representative of the total catches. Catches are landed in Norway and Denmark.

The minimum legal size is 40 mm CL. Trawls with mesh sizes down to 70 mm is legal, but requires square meshes in the cod end. There has been a change in the most commonly used mesh size. In 1999, 90% of the vessels used 70-80 mm trawls according to the logbooks. In 2000-2005 small-meshed trawls (70-80 mm) taking 17% of the *Nephrops* landings performed 22% of the trawling hours.

3.3.7.2 Advice in 2008

In 2008 ICES observed for this stock that:

'landings per unit effort (lpue) have been relatively stable over the last 14 years and suggest that current levels of exploitation are sustainable. A slight increase in mean size in the catches in 2007 could indicate a reduced exploitation pressure.'

It was noticed that in previous years TACs based on historical landings had been suggested for this stock. However, in 2008 the advice focused on effort:

'The current fishery appears sustainable. Therefore, ICES recommends that effort should not be allowed to increase.'

3.3.7.3 Management

The EU fisheries in FU 32 take place mainly in the Norwegian zone of the North Sea. The EU fisheries are managed by a separate TAC for this area. For 2009 the agreed TAC for EU vessels was set to1205 t.

3.3.7.4 Assessment

Data available

Catch

Norwegian landings increased from 2007 to 2008 by around 50%. Norway land *Nephrops* from both Divs. IVa and IVb. The negligible IVb landings have always been reported together with the IVa landings, but from 2008 onwards they are reported separately. International landings from the Norwegian Deep increased from less than 20 t in the mid 1980s to 1,190 t in 2001, the highest figure so far (Table 3.3.7.1, Figure 3.3.7.1). Since then landings have declined and total landings in 2008 amounted to 675 t, due to a reduction of Danish landings. In 2008 Danish vessels accounted for 75 % of total landings.

Length composition

Length data for this FU are only available up to 2007. The average size of *Nephrops* as recorded from Danish landings (using a 100 mm *Nephrops* trawl) show a decreasing trend for both males and females in the period 2000-2006, but has increased again in 2007 (Figure 3.3.7.1). Average sizes in catches (for both sexes) also increased in 2007. The size distributions in the Danish catches (100 mm mesh size) from 2002 to 2007 do not show any conspicuous changes (Figure 3.3.7.2). In previous years the Norwegian shrimp survey in this area provided Norwegian data on size distribution of the *Nephrops*. Size data from Norwegian coast guard inspections of Danish and Norwegian trawlers are available for 2006-2007 (Figure 3.3.7.3). The Danish and Norwegian length distributions for 2007 are very similar (Figure 3.3.7.4). Figure 3.3.7.4 shows a time series of length compositions for this stock. There is little evidence of notable change in sizes, and maximum sizes have remained quite constant.

From 2003-2007 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples have not covered all quarters.

Natural mortality, maturity at age and other biological parameters

No data available.

Catch, effort and research vessel data

Effort and LPUE figures for the period 1989-2008 are available from Danish logbooks (Table 3.3.7.2, Figure 3.3.7.1). Catches recorded in Norwegian logbooks constitute only a small proportion of the landings (15-40%) in 2001-2008. Furthermore, logbook data from *Nephrops* trawls are lacking for 2006-2008. Thus, the WG considers the Norwegian data unsuitable for any LPUE analysis. In the beginning of the 1990s vessel size increased in the Danish fleet fishing in the Norwegian Deep. This increase and more directed fisheries for *Nephrops* in areas with hitherto low exploitation levels are probably partly responsible for the observed increase in the Danish LPUEs in those years (Table 3.3.7.2). A similar development has been occurring in the Norwegian fleet. Since 1994 the Danish LPUEs have fluctuated around 200 kg day-1. Some of the fluctuations may be caused by fishing vessels locally switching between roundfish and *Nephrops* due to changes in management regulations in the Norwegian zone. The Danish effort increased from 2004 to 2006, but shows a strong decline in 2007 and a further decline in 2008.

It has not been possible to incorporate 'technological creeping' in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Figure 3.3.7.5 shows the logbook based effort data analysed in various ways to elucidate the effect of some factors likely to influence the effort/LPUE:

- Incorporation of HP (kw) in the effort measure
- Vessel size (GLM to standardise LPUE regarding vessel size)

Note that the trends in the resulting LPUE values (relative indices) are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

Data analysis

Review of last year's assessment

The review group noted:

'It is clear that for this stock there is a lack of basis information. Danish vessels caught recently around 90% of total landings with doubts about its quality, so first it should be necessary to carry out a better segmentation and later a proper standardisation for these fleets. There is a lack of information from Norwegian vessels. From this point of view is quite difficult to know the representation of commercial figures in relation to this stock.

Based on Danish LPUE data the perception of the stock does not indicate any clear decline in abundance but even so the RG is uncomfortable with this EG views. It is evident that under these circumstances (the data) is inadequate to provide any sound advice.'

3.3.7.5 Historic stock trends

The slight increase in mean size in the catches and landings from 2006 to 2007 in females and from 2005 to 2007 in males could indicate a lower exploitation pressure in recent years and coincides well with the decreasing landings in the same time period. The Danish LPUE decreased from 2005 to 2006, and then increased again in 2007. The overall picture is that of a stable LPUE fluctuating around a mean of 200 kg/day. Thus the stock seems to be stable and shows no sign of overexploitation.

3.3.7.6 Biological reference points

No reference points are defined for this stock.

3.3.7.7 Status of stock

There are no changes since the 2008 evaluation/assessment. Perceptions of this stock (FU 32) are based on Danish LPUE data and therefore highly uncertain. However, the effect of technological creep on the effective effort of the fishery is not known. It is noted, that the EU-Norway agreement of 1000 t in 2005 for EU vessels in this area may have had a restrictive effect for the fleets exploiting this stock. For 2009 the agreed catch for EU vessels was 1205 t.

3.3.8 Off Horn Reef

3.3.8.1 Assessment

There is no assessment of this FU.

3.3.8.2 Data Available

Catch

The landings from FU 33 were marginal for many years. However, from 1993 to 2004, Danish landings increased considerably, from 159 to 1,097 t. In this period Denmark dominated this fishery. The other countries reporting landings from the area are Belgium, Netherlands and the UK. In recent years total landings increased to above1400 t. Since 2004 Danish landings have gradually decreased, and in 2008 fell to less than 400 t. During the same period landings from Netherlands increased. In fact in 2008, the Netherlands took 734 t, approximately half of the total landings from this FU. Minor landings are reported from Belgium, Germany and the U.K. (Table 3.3.8.1).

Length compositions

Size distributions of the Danish catches 2001 to 2007 are shown in Figure 3.3.8.2. Note the shift in 2005 and again in 2007 compared to the previous years. Figure 3.3.8.1 gives the development of the mean size of the catches and landings by sex. These data could indicate either a general decrease in the amount of large individuals in the population indicating some overexploiting or increase in smaller individuals (large recruitment). The mean size of landings is fairly constant while the catch declined noticeably (as mentioned above) – the increased numbers around 30mm may indicate increase recruitment.

In the period 2001-2005 the Danish at-sea-sampling programme provided data for discard estimates. However, the samples did not cover all quarters.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

Table 3.3.8.2 and Figure 3.3.8.1 show the development in Danish effort and LPUE. Notice, that the 10-fold increase in fishing effort from 1996 to 2004 seems to correspond to the increase in landings during the same period. It appears from that LPUEs have been rather stable from 1998 to 2004, fluctuating around 200 kg.day^{-1}. However, in 2008 LPUE increased to more than 400 kg*day^{-1}. This increase in LPUE could reflect increase in gear efficiency (technological creep).

Data analysis

No advice was requested this year and therefore no analysis is presented.

3.3.9 Other Rectangles in Subarea IV

3.3.9.1 Landings

A small but increasing proportion of the landings from Subarea IV are taken from statistical rectangles outside the defined *Nephrops* FUs. In 2008, these amounted to 1673 tonnes, a small increase on the 2007 value.

3.3.9.2 Fisheries

The Scottish fishery at the Devil's hole is a mixed fishery which a few boats normally fishing the Fladen grounds prosecute for a few months at the end of the year. Around 10 boats in the 14-24m size are involved landing into Fraserburgh, Peterhead, Aberdeen, and Arbroath. All the boats that fish the Devils hole are twin-rig and they fish with either 80mm or 100mm mesh. The main types of fish caught at the Devil's hole are flat fish with lemon sole being the most important. The area is notorious for gear damage, which is one of the reasons more boats do not fish this area.

3.3.9.3 Data Available

Landings and discard sampling are not carried out for this fishery.

Occasional Scottish TV surveys have been conducted in the Devil's hole area, but a time series is not yet available.

Table 3.1.1 *Nephrops* Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	ICES Rectangles	Division
3	Skagerrak	47G0-G1; 46F9-G1; 45F8-G1; 44F7-G0; 43F8-F9	IIIa
4	Kattegat	44G1-G2; 42-43G0-G2; 41G1-G2	IIIa
5	Botney Gut	36-37 F1-F4; 35F2-F3	IV
6	Farn Deep	38-40 E8-E9; 37E9	IV
7	Fladen	44-49 E9-F1; 45-46E8	IV
8	Firth of Forth	40-41E7; 41E6	IV
9	Moray Firth	44-45 E6-E7; 44E8	IV
10	Noup	47E6	IV
32	Norwegian Deep	44-52 F2-F6; 43F5-F7	IV
33	Off Horn Reef	39-41F4; 39-41F5	IV

Table 3.1.2 Summary of Nephrops landings from the ICES area, by Functional Unit , 1991-2008.

Year	FU 3	FU 4	FU 5	FU 6	FU 7	FU 8	FU 9	FU 10	FU 32	FU 33	Other	Total
1981				1073	373	1006	1416	36			76	3980
1982				2524	422	1195	1120	19			157	5437
1983				2078	693	1724	940	15			101	5551
1984				1479	646	2134	1170	111			88	5628
1985				2027	1148	1969	2081	22			139	7386
1986				2015	1543	2263	2143	68			204	8236
1987				2191	1696	1674	1991	44			195	7791
1988				2495	1573	2528	1959	76			364	8995
1989				3098	2299	1886	2576	84			233	10176
1990				2498	2537	1930	2038	217			222	9442
1991	4228	1304	862	2063	4220	1404	1519	196			560	16356
1992	2905	1012	612	1473	3338	1757	1591	188			401	13277
1993	3212	924	721	3030	3521	2369	1808	376	339	160	434	16895
1994	2874	893	503	3683	4566	1850	1538	495	755	137	703	17997
1995	3427	998	869	2569	6442	1763	1297	280	489	164	844	19142
1996	3980	1285	679	2482	5220	1688	1451	344	952	77	808	18966
1997	4206	1594	1149	2189	6171	2194	1446	316	760	276	662	20963
1998	5056	1808	1111	2177	5138	2145	1032	254	836	350	694	20600
1999	4949	1755	1244	2391	6505	2205	1008	279	1119	724	988	23167
2000	4710	1816	1121	2178	5580	1785	1541	275	1084	597	900	21586
2001	4056	1774	1443	2574	5545	1528	1403	177	1190	791	1268	21749
2002	4448	1471	1231	1953	7234	1340	1118	401	1170	861	1383	22610
2003	3767	1641	1144	2245	6305	1126	1079	337	1089	929	1390	21052
2004	3965	1653	1070	2152	8733	1658	1335	228	922	1268	1224	24208
2005	4034	1488	1058	3094	10685	1990	1605	165	1089	1050	1120	27377
2006	3672	1280	986	4858	10789	2458	1803	133	1028	1288	1249	29543
2007	4512	1741	1311	2966	11910	2652	1842	155	755	1467	1637	30948
2008*	4860	2025	695	1213	12240	2450	1514	173	675	1444	1673	28962

* Provisional

Table 3.2.1.1 Nominal landings (tonnes) of *Nephrops* in Division IIIa, 1986 – 2008, as officially reported to ICES.

	1984	1985	1986	1987	1988	1989
Denmark	3591	2944	2647	2840	2869	3022
Germany	0	0	0	0	0	0
Germany, Fed. Rep.	2	0	10	0	0	0
Netherlands	0	0	0	0	0	0
Norway	97	72	64	80	88	54
Sweden	1159	1115	1237	1240	1062	829
Total	4849	4131	3958	4160	4019	3905

	1990	1991	1992	1993	1994	1995
Denmark	3094	2790	2046	2251	2049	2419
Germany	0	0	0	0	0	1
Germany, Fed. Rep.	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0
Norway	140	185	104	103	62	90
Sweden	1098	1249	772	863	763	913
Total	4332	4224	2922	3217	2874	3423

	1996	1997	1998	1999	2000	2001
Denmark	2843	2959	3538	3487	3329	2868
Germany	1	5	12	6	7	1
Germany, Fed. Rep.	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0
Norway	102	117	184	214	181	138
Sweden	1105	1129	1314	1259	1195	1040
Total	4051	4210	5048	4966	4712	4047

	2002	2003	2004	2005	2006	2007	2008
Denmark	3277	2752	2956	2918	2434	2890	3175
Germany	7	12	13	2	6	13	20
Germany, Fed. Rep.	0	0	0	0	0	0	0
Netherlands	0	0	1	0	0	0	0
Norway	116	99	95	83	91	145	158
Sweden	1033	896	904	1044	1150	1465	1508
Total	4433	3759	3969	4047	3681	4513	4861

Table 3.2.1.2. - Division IIIa: Total Nephrops landings (tonnes) by Functional Unit, 1991-2008.

Year	FU 3	FU 4	Total
1991	2924	1304	4228
1992	1893	1012	2905
1993	2288	924	3212
1994	1981	893	2874
1995	2429	998	3427
1996	2695	1285	3980
1997	2612	1594	4206
1998	3248	1808	5056
1999	3194	1755	4949
2000	2894	1816	4710
2001	2282	1774	4056
2002	2977	1471	4448
2003	2126	1641	3767
2004	2312	1653	3965
2005	2546	1488	4034
2006	2392	1280	3672
2007	2771	1741	4512
2008	2851	2025	4876

Table 3.2.1.3. - Division IIIa: Total Nephrops landings (tonnes) by country, 1991-2008.

Year	Denmark	Norway	Sweden	Germany	Total
1991	2824	185	1219		4228
1992	2052	104	749		2905
1993	2250	103	859		3212
1994	2049	62	763		2874
1995	2419	90	918		3427
1996	2844	102	1034		3980
1997	2959	117	1130		4206
1998	3541	184	1319	12	5056
1999	3486	214	1243	6	4949
2000	3325	181	1197	7	4710
2001	2880	138	1037	1	4056
2002	3293	116	1032	7	4448
2003	2757	99	898	13	3767
2004	2955	95	903	12	3965
2005	2901	83	1048	2	4034
2006	2432	91	1143	6	3672
2007	2887	145	1467	13	4512
2008	3174	158	1509	19	4860

Table 3.2.2.1. Nephrops in Skagerrak (FU 3): Landings (tonnes) by country, 1991-2008.

Year	Denmark	Norway			Sweden			Total
		Trawl	Creel	Sub-total	Trawl	Creel	Sub-total	
1991	1639	185	0	185	949	151	1100	2924
1992	1151	104	0	104	524	114	638	1893
1993	1485	101	2	103	577	123	700	2288
1994	1298	62	0	62	531	90	621	1981
1995	1569	90	0	90	659	111	770	2429
1996	1772	102	0	102	708	113	821	2695
1997	1687	117	0	117	690	118	808	2612
1998	2055	184	0	184	864	145	1009	3248
1999	2070	214	0	214	793	117	910	3194
2000	1877	181	0	181	689	147	836	2894
2001	1416	125	13	138	594	134	728	2282
2002	2053	99	17	116	658	150	808	2977
2003	1421	90	9	99	471	135	606	2126
2004	1595	85	10	95	449	173	622	2312
2005	1727	71	12	83	538	198	736	2546
2006	1516	80	11	91	583	201	784	2391
2007	1664	127	18	145	709	253	962	2771
2008	1745	127	31	158	675	273	948	2851

Table 3.2.2.2. - Skagerrak (FU3): Mean sizes (mm CL) of male and female Nephrops in catches of Danish and Swedish combined, 1991-2008.

Year	Catches					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30,2	30,9	41,2	42,7	30,9	29,8
1992	33,3	32,3	43,3	44,7	33,3	32,2
1993	33,0	31,5	42,0	43,6	33,0	31,5
1994	31,7	29,6	41,7	43,6	31,7	29,6
1995	30,0	28,5	41,6	41,3	32,9	29,8
1996	33,2	31,9	42,9	44,0	37,6	37,0
1997	35,8	34,5	44,6	44,1	39,8	39,1
1998	34,8	34,4	46,1	43,9	40,7	37,3
1999	34,6	33,9	44,9	43,8	39,3	36,1
2000	30,6	30,5	45,6	45,0	32,5	34,1
2001	33,6	33,6	45,5	43,6	37,3	36,4
2002	33,9	33,7	44,0	42,5	37,2	37,3
2003	33,5	32,6	43,2	43,4	38,0	36,7
2004	34,3	33,4	44,6	45,2	38,7	36,6
2005	33,5	32,4	43,7	43,0	36,4	35,3
2006	33,2	32,9	44,7	42,7	37,1	36,1
2007	32,6	31,9	44,4	42,4	34,9	33,5
2008	33,6	32,3	44,0	42,7	36,5	34,5

Table 3.2.2.3. Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2008. (*Include only Nephrops trawls with grid and square mesh codend).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71,4	9,5	5,6
1992	360	231	73,7	4,9	3,1
1993	614	279	72,6	8,4	3,8
1994	441	246	60,1	7,3	4,1
1995	501	336	60,8	7,8	5,2
1996	754	488	51,1	14,8	9,6
1997	643	437	44,4	14,4	9,8
1998	794	557	49,7	16,0	11,2
1999	605	386	34,5	17,5	9,3
2000	486	329	32,7	14,9	10,9
2001	446	236	26,2	17,0	10,4
2002	503	301	29,4	17,1	8,8
2003	310	254	21,5	13,9	11,4
2004*	474	257	20,1	23,6	13,4
2005*	760	339	29,7	25,6	12,7
2006*	839	401	37,5	22,4	12,2
2007*	894	314	24,1	37,0	13,0
2008*	605	264	20,0	30,3	13,2

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	740	439	39,5	18,7	11,1
1992	370	238	34,1	10,9	7,0
1993	568	258	35,9	15,8	7,2
1994	444	248	34,1	13,1	7,3
1995	403	270	32,9	12,2	8,2
1996	187	121	13,0	14,4	9,3
1997	219	149	17,5	12,5	8,5
1998	254	178	16,7	15,2	10,6
1999	382	244	27,6	13,8	8,8
2000	349	237	31,3	11,1	10,1
2001	470	249	33,7	14,0	7,4
2002	392	244	33,3	11,8	7,1
2003	168	138	22,5	7,5	6,1
2004	217	118	21,7	10,0	5,4
2005	263	117	22,1	11,9	5,3
2006	253	121	19,6	12,9	6,2
2007*	248	87	5,4	45,6	16,0
2008*	139	61	3,4	41,3	18,0

Table 3.2.2.4. Nephrops Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2008.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	17136	73	22158
1992	12183	70	16239
1993	11073	105	14068
1994	10655	110	11958
1995	10494	132	11935
1996	11885	138	12793
1997	11791	140	12075
1998	12501	155	13038
1999	13686	139	14787
2000	14802	120	15663
2001	14244	100	13976
2002	16386	123	16750
2003	10645	121	11802
2004	11987	122	12996
2005	10682	144	12003
2006	9638	141	10737
2007	7598	212	7877
2008	7785	216	8058

Table 3.2.3.1. Nephrops Kattegat (FU4): Landings (tonnes) by country, 1991-2008.

Year	Denmark	Sweden		Sub-total	Germany	Total
		Trawl	Creel			
1991	1185	119	0	119	0	1304
1992	901	111	0	111	0	1012
1993	765	159	0	159	0	924
1994	751	142	0	142	0	893
1995	850	148	0	148	0	998
1996	1072	213	0	213	0	1285
1997	1272	319	3	322	0	1594
1998	1486	306	4	310	12	1808
1999	1416	329	4	333	6	1755
2000	1448	357	4	361	7	1816
2001	1464	304	6	309	1	1774
2002	1240	219	5	224	7	1471
2003	1336	287	5	292	13	1641
2004	1360	270	11	281	12	1653
2005	1175	303	8	311	2	1488
2006	916	347	11	358	6	1280
2007	1223	491	15	505	13	1741
2008	1429	561	16	577	19	2025

Table 3.2.3.2. Nephrops Kattegat (FU 4): Mean sizes (mm CL) of male and female Nephrops in discards, landings and catches, 1991-2008. Since 2005 based on combined Danish and Swedish data.

Year	Catches					
	Discards		**Landings**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30,7	31,1	42,4	42,5	32,5	32,9
1992	33,0	30,3	44,4	43,2	36,7	34,9
1993	30,5	29,3	42,3	43,1	31,3	30,1
1994	29,7	28,3	40,8	40,2	31,2	28,9
1995	30,8	30,5	42,4	42,0	33,7	33,2
1996	32,7	31,3	42,0	44,0	36,7	37,3
1997	33,6	33,2	45,0	44,5	37,1	35,0
1998	34,2	33,2	45,6	44,1	41,3	36,8
1999	32,9	33,8	45,3	40,9	37,8	34,9
2000	35,1	35,2	45,7	42,1	40,4	36,9
2001	32,2	33,0	44,1	41,9	35,9	36,5
2002	34,4	33,3	44,4	43,8	37,2	36,2
2003	33,0	33,2	43,5	42,2	37,1	36,0
2004	34,7	34,2	45,1	43,2	39,9	37,5
2005	33,5	33,9	45,8	43,1	38,7	38,7
2006	33,2	33,6	45,1	42,8	37,9	37,4
2007	33,9	33,2	44,8	43,5	37,2	35,5
2008	32,6	32,4	44,0	43,9	37,5	35,9

Table 3.2.3.3. Nephrops, Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2008 (*Include only Nephrops trawls with grid and square mesh codend).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	66	39	10,3	6,4	3,7
1992	44	28	11,6	3,8	2,4
1993	128	58	14,9	8,6	3,9
1994	95	53	16,2	5,7	3,2
1995	79	53	9,6	7,8	5,5
1996	207	134	13,7	15,1	9,8
1997	269	183	18,0	15,0	10,2
1998	181	127	13,1	13,8	9,7
1999	146	93	8,1	17,9	11,4
2000	114	77	8,5	13,4	9,1
2001	117	62	7,6	15,4	8,2
2002	42	25	3,7	11,2	6,7
2003	49	40	4,6	10,7	8,7
2004	70	44	4,3	16,2	10,1
2005	147	100	12,3	11,9	8,1
2006	234	154	15,1	15,5	10,2
2007*	107	51	4,1	25,7	12,3
2008*	121	57	4,4	27,6	13,0

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	93	55	8,8	10,6	6,2
1992	101	65	14,2	7,1	4,6
1993	187	85	17,8	10,6	4,8
1994	138	77	14,2	9,7	5,4
1995	125	84	11,0	12,2	7,7
1996	97	63	7,5	13,0	8,4
1997	183	124	12,7	14,3	9,7
1998	215	151	15,0	14,4	10,1
1999	306	195	20,1	15,2	9,7
2000	330	224	24,5	13,5	9,1
2001	353	187	25,1	14,1	7,4
2002	256	153	23,2	11,0	6,6
2003	222	181	24,8	9	7,3
2004	253	158	16,5	15,4	9,6
2005	198	135	15,3	12,9	8,8
2006	183	121	12,7	14,4	9,5
2007*	112	54	3,6	30,9	14,8
2008*	164	78	4,8	34,1	16,1

Table 3.2.3.4. Nephrops Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2008.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	13494	69	17175
1992	12126	65	13627
1993	8815	75	10195
1994	9403	77	9802
1995	9039	91	9357
1996	9872	96	11209
1997	10028	112	11348
1998	10388	122	12144
1999	11434	109	13019
2000	12845	100	14448
2001	13017	93	15870
2002	11571	88	13772
2003	11768	103	13015
2004	11122	115	11669
2005	9286	127	9286
2006	8080	113	7998
2007	7165	162	7588
2008	7911	170	8428

Table 3.3.1. Nominal landings (tonnes) of *Nephrops* in Sub-area IV, 1987 – 2008, as officially reported to ICES.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	638	679	344	437	500	574	610	427	384	418	304	410	185
Denmark	7	50	323	479	409	508	743	880	581	691	1128	1182	1315
Faeroe Islands	-	-	-	0	0	0	0	0	0	1	3	12	0
France	-	-	-	7	0	0	0	0	0	0	0	0	0
Germany	.	.	.	0	0	0	0	2	2	16	24	16	69
Germany (Fed. Rep.)	5	4	5	1	2	1	2	0	0	0	0	0	0
Ireland	-	-	-	0	0	0	0	0	0	0	0	0	0
Netherlands	-	-	-	0	0	0	9	3	134	131	159	254	423
Norway	1	1	1	2	17	17	46	117	125	107	171	74	83
Sweden	-	1	-	0	0	0	0	4	0	1	1	1	0
UK (Eng + Wales + NI)	.	.	.	0	0	2938	2332	1955	1451	2983	3613	2530	2462
UK (Eng + Wales)	1477	2052	2002	2173	2397	0	0	0	0	0	0	0	-
UK (Scotland)	4158	5369	6190	5304	6527	7065	6871	7501	6898	8250	8850	10018	8981
UK	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	6286	8156	8865	8403	9852	11103	10613	10889	9575	12598	14253	14497	13518

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008*
Belgium	311	238	350	252	283	284	229	213	180	214	205	200
Denmark	1309	1440	1963	1747	1935	2154	2128	2244	2339	2024	1408	1104
Faeroe Islands	1	1	1	0	-	-	-	-	-	-	-	-
France	0	0	0	0	-	-	-	-	-	-	-	+
Germany	64	58	104	79	140	125	50	50	109	288	602	265
Germany (Fed. Rep.)	0	0	0	0	-	-	-	-	-	-	-	-
Ireland	0	0	0	0	-	-	1	2	-	-	-	-
Netherlands	627	695	662	572	851	966	940	918	1019	982	1147	737
Norway	64	93	144	147	115	130	100	93	132	96	99	144
Sweden	1	3	4	37	26	14	1	1	3	1	5	26
UK (Eng + Wales + NI)	2206	2094	2431	2210	2691	1964	2295	2241	3236	4924	3295	…
UK (Eng + Wales)	-	-	-	-	-	-	-	-	-	-	-	…
UK (Scotland)	10466	8980	10715	9834	9681	11045	10094	12912	10565	16165	17930	…
UK	-	-	-	-	-	-	-	-		-	-	19614
Total	15049	13602	16374	14878	15722	16682	15838	18674	17583	24694	24691	22091

* Landings data for 2008 are preliminary.

Table 3.3.1.1. ***Nephrops*, Botney Gut (FU 5) Landings (tonnes) by country, 1981-2008.**

	Belgium	Denmark	Netherl.	Germany	UK	Total **
1991	682	176	na		4	862
1992	571	22	na		19	612
1993	694	20	na		7	721
1994	494	0	na		9	503
1995	641	77	148		3	869
1996	266	41	317		55	679
1997	486	67	540		56	1149
1998	372	88	584	39	28	1111
1999	436	53	538	59	158	1244
2000	366	83	402	52	218	1121
2001	353	145	553	114	278	1443
2002	281	94	617	88	151	1231
2003	265	36	661	24	158	1144
2004	171	39	646	16	198	1070
2005	109	87	654	51	157	1058
2006	77	24	444	99	342	986
2007	75	3	464	201	568	1311
2008*	49	29	268	108	509	962

* provisional na = not available

** Totals for 1991-94 exclusive of landings by the Netherlands

Table 3.3.1.2. Nephrops, Botney Gut (FU 5) Mean sizes (CL mm) of males and females (> 35 mm) in Belgian landings.

	Landings	
	Males	Females
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998	41.0	39.2
1999	40.9	39.5
2000	40.8	39.9
2001	40.3	39.7
2002	39.7	39.3
2003	40.5	39.3
2004	40.1	39.9
2005	40.2	39.5
2006	no directed fishery	
2007	no directed fishery	
2008	no directed fishery	
* provisional na = not available		

Table 3.3.1.3. ***Nephrops*****, Botney Gut (FU 5) Landings, effort and LPUEs of Belgian Nephrops trawlers and Dutch and Danish trawlers, 1991-2008.**

	Belgium (1)			Netherlands (2)			Denmark (3)		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
	tons	'000 hrs	kg/hour	tons	days at sea	kg/day	tons	days at sea	kg/day
1991	566	74.0	7.7						
1992	525	74.5	7.0						
1993	672	58.3	11.5						
1994	453	35.5	12.7						
1995	559	32.5	17.2						
1996	245	30.1	8.1				34	132	261.0
1997	399	31.8	12.5				24	59	412.0
1998	309	28.6	10.8				78	174	447.0
1999	322	31.8	10.1				44	107	408.0
2000	174	21.8	8.0	402	7936	50.7	76	247	306.0
2001	195	21.5	9.1	553	9797	56.5	78	283	275.0
2002	144	15.8	9.1	617	8999	68.6	47	200	237.0
2003	118	6.2	19.3	661	9043	73.1	33	132	247.3
2004	106	5.7	18.8	646	8676	74.5	36	149	241.9
2005	69	2.9	23.9	654	7912	82.7	87	297	290.9
2006	no data	no data	no data	no data	no data	no data	24	66	365.6
2007	no data	no data	no data	no data	no data	no data	3	13	253.6
2008*	no data	no data	no data	no data	no data	no data	29	41	777.0

* provisional na = not available

(1) Vessels directed towards Nephrops at least 10 months per year

(2) All vessels operating in FU 5, regardless of directedness towards Nephrops

(3) Logbook records from vessels operating in FU 5, with mesh size >=70 mm with Nephrops in catches

Table 3.3.2.1. *Nephrops*, Farn Deeps (FU 6) Landings (tonnes) by country, 1981-2008.

Year	UK England	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2482
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1953	0	1953
2003	2031	214	2245	0	2245
2004	1952	201	2152	0	2152
2005	2936	158	3093	0	3094
2006	4385	434	4819	39	4858
2007	2525	437	2962	4	2966
2008*	969	244	1213	0	1213

* provisional na = not available

** Other countries includes Ne, Be and Dk

Table 3.3.2.2. *Nephrops*, Farn Deeps (FU 6). Catches and landings (tonnes), effort ('000 hrs fished), CPUE & LPUE from UK (England) trawlers.

Year	Catches	Landings	Effort	CPUE	LPUE
1985	2546	1906	70.8	35.9	26.9
1986	2541	1902	72.1	35.2	26.4
1987	2773	2075	80.1	34.6	25.9
1988	3187	2385	98.8	32.2	24.1
1989	3754	2809	122.4	30.7	23.0
1990	2980	2230	103.5	28.8	21.5
1991	2384	1784	107.2	22.2	16.7
1992	1729	1294	58.2	29.7	22.2
1993	3756	2811	106.7	35.2	26.3
1994	4612	3451	152.5	30.2	22.6
1995	3192	2388	96.8	33.0	24.7
1996	3031	2268	87.3	34.7	26.0
1997	2508	1877	75.7	33.2	24.8
1998	2531	1894	62.7	40.4	30.2
1999	2888	2161	86.2	33.5	25.1
2000	3409	1863	74.2	46.0	25.1
2001	4024	2096	88.8	45.3	23.6
2002	2222	1605	65.8	33.7	24.4
2003	2576	1975	79.6	32.4	24.8
2004	2239	1824	65.5	34.2	27.8
2005	3059	2498	78.7	38.9	31.8
2006	4307	3547	93.7	46.0	37.9
2007	2205	1914	78.3	28.2	24.5
2008*	979	838	44.9	21.8	18.6

* provisional na = not available

Table 3.3.2.3. *Nephrops*, Farn Deeps (FU 6). Mean sizes (CL mm) of males and females in the catch and landings.

Year	Catches		Landings	
	Males	Females	Males	Females
1985	30.1	28.5	35.4	33.8
1986	31.7	30.2	35.3	33.7
1987	28.6	27.0	35.3	33.3
1988	28.7	27.3	35.0	33.9
1989	29.0	28.2	32.4	31.9
1990	27.1	27.4	31.8	31.3
1991	28.9	27.1	33.5	33.1
1992	30.8	29.0	33.0	31.9
1993	32.1	28.7	33.4	30.1
1994	30.5	27.7	33.8	30.5
1995	28.4	27.4	33.8	31.6
1996	29.8	28.2	34.5	32.1
1997	29.9	29.6	33.5	32.1
1998	30.0	28.9	34.9	33.7
1999	29.6	27.5	35.1	33.6
2000	27.3	26.8	31.1	31.3
2001	26.3	26.4	30.6	31.3
2002	28.4	26.8	31.2	29.8
2003	29.2	27.2	31.9	30.6
2004	30.4	28.0	32.5	30.9
2005	29.9	29.4	32.2	32.2
2006	29.0	30.3	31.4	32.4
2007	31.2	30.5	33.3	32.5
2008	30.8	30.2	32.8	32.7
* provisional na = not available				

Table 3.3.2.4. ***Nephrops*, Farn Deeps (FU6). Results from the TV surveys (1996-2008) giving estimates of abundance (bias-corrected).**

Year	Stations	Season	Mean density	Bias-corrected Abundance	95% confidence interval
			burrows/m²	millions	millions
1996	71	Spring	0.53	1459	100
	-	Autumn	No survey		
1997	105	Spring	0.53	1494	139
	87	Autumn	0.55	1500	125
1998	78	Spring	0.25	662	48
	91	Autumn	0.39	1090	89
1999	95	Spring	0.29	829	78
	-	Autumn	No survey		
2000	98	Spring	0.33	927	67
	-	Autumn	No survey		
2001	-	Spring	No survey		
	180	Autumn	0.67	1685	67
2002	180	Spring	0.54	1390	93
	37	Autumn	0.39	1048	112
2003	-	Spring	No survey		
	958	Autumn	0.39	1085	90
2004	-	Spring	No survey		
	76	Autumn	0.51	1377	101
2005	-	Spring	No survey		
	105	Autumn	0.59	1657	148
2006	-	Spring	No survey		
	105	Autumn*	0.44	1244	114
2007	-	Spring	No survey		
	105	Autumn*	0.34	958	114
2008	-	Spring	No survey		
	95	Autumn*	0.34	965	112

Table 3.3.2.5. *Nephrops*, Farn Deeps (FU 6). Estimated harvest rates over 2001-2008.

Year	Bias corrected TV abundance index	Landings (t)	Discard rate	Mean Weight (g)	N removed	Observed Harvest Rate
2001	1685	2574	66.4%	20.9	366	21.7%
2002	1048	1953	45.0%	20.8	171	16.3%
2003	1085	2245	41.3%	21.1	181	16.7%
2004	1377	2152	33.9%	22.1	147	10.7%
2005	1657	3094	33.9%	23.2	202	12.2%
2006	1244	4858	31.4%	23.1	306	24.6%
2007	968	2966	26.1%	23.5	171	17.6%
2008	965	1213	28.0%	23.6	71	7.4%

Table 3.3.3.1 *Nephrops*, Fladen (FU 7), Nominal Landings of *Nephrops*, 1981-2008, as reported to the WG.

Year	Denmark	UK Scotland			Other countries	Total
		Nephrops trawl	Other trawl	Sub-total		
1981	0	304	69	373	0	373
1982	0	382	40	422	0	422
1983	0	548	145	693	0	693
1984	0	549	97	646	0	646
1985	7	1016	125	1141	0	1148
1986	50	1398	95	1493	0	1543
1987	323	1024	349	1373	0	1696
1988	81	1306	186	1492	0	1573
1989	165	1719	415	2134	0	2299
1990	236	1703	598	2301	0	2537
1991	424	3024	769	3793	3	4220
1992	359	1794	1179	2973	6	3338
1993	224	2033	1233	3266	31	3521
1994	390	1817	2356	4173	3	4566
1995	439	3569	2428	5997	6	6442
1996	286	2338	2592	4930	4	5220
1997	235	2713	3221	5934	2	6171
1998	173	2291	2672	4963	2	5138
1999	96	2860	3549	6409	0	6505
2000	103	2915	2546	5461	16	5580
2001	64	3539	1936	5475	6	5545
2002	173	4513	2546	7059	2	7234
2003	82	4175	2033	6208	15	6305
2004	136	7274	1319	8593	4	8733
2005	321	8849	1514	10363	1	10685
2006	283	9396	1101	10497	9	10789
2007	119	11055	733	11788	3	11910
2008	133	11432	667	12099	8	12240

Table 3.3.3.2 *Nephrops*, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2008 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.7	6177	47.5	130.2	1097	8.6	127.6
2005	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7
2006	9396	65.7	143.0	7149	50.2	142.4	2320	15.5	149.7
2007	11055	69.6	158.8	8232	52.2	157.7	2822	17.4	162.2
2008	11432	80.3	142.4	8247	58.8	140.3	3185	21.5	148.1

Table 3.3.3.3 *Nephrops*, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2008.

Year	Logbook data	
	Effort	LPUE
1991	3115	116
1992	2289	130
1993	820	130
1994	1209	251
1995	841	343
1996	568	254
1997	395	349
1998	268	165
1999	197	251
2000	292	170
2001	213	181
2002	335	368
2003	194	308
2004	290	461
2005	607	482
2006	576	450
2007	274	426
2008*	241	512

* provisional na = not available

Table 3.3.3.4 *Nephrops*, Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1993-2008.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1993	na	na	30.4	29.6	38.7	38.2
1994	na	na	30.0	28.9	39.2	37.8
1995	na	na	30.6	29.8	39.9	38.1
1996	na	na	30.4	29.1	40.6	38.8
1997	na	na	30.2	29.1	40.9	38.8
1998	na	na	30.8	29.4	40.7	38.4
1999	na	na	30.9	29.6	40.5	38.5
2000	30.8	30.1	31.2	30.5	41.3	38.7
2001	30.1	29.4	30.7	29.7	39.6	38.0
2002	30.6	30.1	31.3	30.7	39.5	38.3
2003	30.9	29.8	31.3	30.1	40.0	38.1
2004	30.8	29.6	31.1	29.8	39.9	38.8
2005	30.9	30.0	31.2	30.1	40.1	38.2
2006	30.1	29.5	30.8	30.0	40.7	38.3
2007	29.6	29.0	30.4	29.5	40.8	38.8
2008	29.6	28.5	29.8	28.7	41.8	39.1
* provisional, na = not available						

Table 3.3.3.5. Nephrops, FUs 7-9. Mean weight (g) in the landings.

Year	Fladen	Firth of Forth	Moray Firth
1990	31.66	20.24	19.96
1991	26.57	19.98	18.41
1992	29.69	20.90	23.40
1993	25.45	24.26	23.35
1994	23.76	19.47	22.19
1995	27.58	19.51	20.53
1996	29.88	20.76	21.31
1997	32.12	18.82	20.35
1998	31.43	18.18	20.38
1999	30.59	20.01	21.72
2000	36.42	21.78	25.37
2001	25.14	21.17	24.11
2002	28.00	19.58	27.65
2003	30.22	22.24	23.25
2004	31.06	22.41	27.52
2005	29.10	22.30	23.76
2006	29.29	21.41	22.26
2007	26.65	20.94	22.97
2008	28.20	17.20	25.22
Mean (06-08)	28.05	19.85	23.48

Table 3.3.3.6. ***Nephrops*****, Fladen (FU 7): Results of the 1992-2008 TV surveys.**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1992	69	0.17	4942	508
1993	74	0.21	6007	768
1994	59	0.30	8329	1099
1995	61	0.24	6733	1209
1996	No survey			
1997	56	0.13	3736	689
1998	60	0.18	5181	968
1999	62	0.20	5597	876
2000	68	0.17	4898	663
2001	50	0.23	6725	1310
2002	54	0.29	8217	1022
2003	55	0.27	7488	1452
2004	52	0.27	7729	1391
2005	72	0.21	5839	894
2006	69	0.23	6564	836
2007	82	0.34	9473	986
2008	74	0.35	9857	1377

Table 3.3.3.7. *Nephrops*, Fladen Ground (FU 7):Summary of TV results for most recent 3 years (2006-2008) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum (ranges of % silt clay)	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2006 TV survey							
>80	3248	11	0.34	0.00	1095	3397	0.019
55<80	4967	17	0.33	0.02	1633	26025	0.149
40<55	4304	13	0.25	0.02	1066	25457	0.146
<40	15634	28	0.18	0.01	2769	119745	0.686
Total	28153	69			6564	174624	1
2007 TV survey							
>80	3248	12	0.52	0.00	1686	2517	0.010
55<80	4967	17	0.43	0.02	2136	21856	0.090
40<55	4304	17	0.36	0.02	1534	24566	0.101
<40	15634	36	0.26	0.03	4117	194102	0.799
Total	28153	82			9473	243040	1
2008 TV survey							
>80	3248	12	0.68	0.00	2209	4028	0.008
55<80	4967	18	0.32	0.04	1589	50866	0.107
40<55	4304	17	0.60	0.04	2562	38458	0.081
<40	15634	27	0.22	0.04	3497	380988	0.803
Total	28153	74			9857	474340	1

Table 3.3.3.8 *Nephrops*, Fladen (FU 7): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest ratio 2003-2008.

	Adjusted survey (millions)	Landings (tonnes)	Discard rate	Harvest ratio
2003	5547	6305	0.10	0.04
2004	5725	8733	0.11	0.06
2005	4325	10685	0.11	0.10
2006	4862	10789	0.22	0.09
2007	7017	11910	0.19	0.08
2008	7302	12240	0.09	0.08

Table 3.3.4.1 *Nephrops*, Firth of Forth (FU 8), Nominal Landings of *Nephrops*, 1981-2008, as reported to the WG.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	945	61	0	1006	0	1006
1982	1138	57	0	1195	0	1195
1983	1681	43	0	1724	0	1724
1984	2078	56	0	2134	0	2134
1985	1908	61	0	1969	0	1969
1986	2204	59	0	2263	0	2263
1987	1582	92	0	1674	0	1674
1988	2455	73	0	2528	0	2528
1989	1833	52	0	1885	1	1886
1990	1901	28	0	1929	1	1930
1991	1359	45	0	1404	0	1404
1992	1714	43	0	1757	0	1757
1993	2349	18	0	2367	2	2369
1994	1827	17	0	1844	6	1850
1995	1708	53	0	1761	2	1763
1996	1621	66	1	1688	0	1688
1997	2137	55	0	2192	2	2194
1998	2105	38	0	2143	2	2145
1999	2192	9	1	2202	3	2205
2000	1775	9	0	1784	1	1785
2001	1484	35	0	1519	9	1528
2002	1302	31	1	1334	6	1340
2003	1115	8	0	1123	3	1126
2004	1651	4	0	1655	3	1658
2005	1973	0	6	1979	11	1990
2006	2437	4	12	2453	5	2458
2007	2628	9	8	2645	7	2652
2008*	2435	3	7	2445	5	2450

* provisional na = not available

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

Table 3.3.4.2 *Nephrops*, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2008 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8
2006	2437	61.4	39.7	2432	61.0	39.9	5	0.4	14.2
2007	2628	57.6	45.6	2607	57.1	45.7	21	0.5	43.2
2008	2435	52.2	46.6	2405	51.7	46.5	30	0.5	60.0

Table 3.3.4.3 *Nephrops*, Firth of Forth (FU 8): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991-2008.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	31.5	31.0	39.7	38.7
1982	na	na	30.4	30.1	40.0	39.1
1983	na	na	31.1	30.8	40.2	38.7
1984	na	na	30.3	29.7	39.4	38.4
1985	na	na	30.6	29.9	39.5	38.2
1986	na	na	29.7	29.2	39.1	38.5
1987	na	na	29.9	29.6	39.1	38.2
1988	na	na	28.5	28.5	39.2	39.0
1989	na	na	29.2	28.9	38.7	38.9
1990	28.5	27.5	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	28.0	30.2	28.7	38.1	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.3	27.0	29.2	28.7	38.8	38.2
1998	27.7	26.4	29.0	27.9	38.6	38.4
1999	27.2	26.5	29.6	28.8	38.0	37.9
2000	28.5	27.2	30.7	29.8	38.2	38.3
2001	28.1	26.7	30.6	29.2	38.0	37.9
2002	27.1	26.3	29.8	29.3	38.3	37.9
2003	27.2	25.5	30.2	29.1	38.1	38.0
2004	28.7	27.8	30.7	29.9	38.4	37.7
2005	27.6	26.9	30.3	30.0	38.8	38.2
2006	27.4	27.1	29.8	29.9	38.7	37.8
2007	29.1	28.2	29.8	28.6	39.1	38.6
2008*	27.6	27.0	28.1	26.9	39.4	37.9
	* provisional na = not available					

Table 3.3.4.4. ***Nephrops*****, Firth of Forth (FU 8): Results of the 1993-2008 TV surveys.**

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	37	0.72	655	167
1994	30	0.58	529	92
1995	no survey			
1996	27	0.48	443	104
1997	no survey			
1998	32	0.38	345	95
1999	49	0.60	546	92
2000	53	0.57	523	83
2001	46	0.54	494	93
2002	41	0.66	600	140
2003	36	0.99	905	163
2004	37	0.81	743	166
2005	54	0.92	838	169
2006	43	1.07	976	148
2007	49	0.90	816	156
2008	38	1.14	1040	350

Table 3.3.4.5. ***Nephrops*****, Firth of Forth (FU 8):Summary of TV results for most recent 3 years (2006-2008) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.**

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2006 TV survey							
M & SM	171	8	0.54	0.39	92	1410	0.257
MS(west)	139	9	0.76	0.53	105	1134	0.207
MS(mid)	211	9	1.87	0.15	394	743	0.135
MS(east)	395	17	0.97	0.24	385	2200	0.401
Total	915	43			976	5486	1
2007 TV survey							
M & SM	171	10	0.99	0.69	168	1998	0.329
MS(west)	139	8	0.58	0.24	81	577	0.095
MS(mid)	211	12	1.18	0.45	248	1676	0.276
MS(east)	395	19	0.81	0.22	319	1817	0.299
Total	915	49			816	6069	1
2008 TV survey							
M & SM	171	3	0.92	1.67	156	24333	0.793
MS(west)	139	9	1.04	0.82	144	1757	0.057
MS(mid)	211	11	1.69	0.47	355	1898	0.062
MS(east)	395	15	0.97	0.26	384	2685	0.088
Total	915	38			1040	30673	1

Table 3.3.4.6 *Nephrops*, Firth of Forth (FU 8): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest ratio 2003-2008.

	Adjusted survey (millions)	Landings (tonnes)	Discard rate	Harvest ratio
2003	767	1126	0.54	0.15
2004	630	1658	0.35	0.19
2005	710	1990	0.42	0.23
2006	827	2458	0.53	0.30
2007	692	2652	0.25	0.25
2008	881	2450	0.31	0.25

Table 3.3.5.1 *Nephrops*, Moray Firth (FU 9), Nominal Landings of *Nephrops*, 1981-2008, as reported to the WG.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	1298	118	0	1416	0	1416
1982	1034	86	0	1120	0	1120
1983	850	90	0	940	0	940
1984	960	210	0	1170	0	1170
1985	1908	173	0	2081	0	2081
1986	1933	210	0	2143	0	2143
1987	1723	268	0	1991	0	1991
1988	1638	321	0	1959	0	1959
1989	2101	475	0	2576	0	2576
1990	1698	340	0	2038	0	2038
1991	1285	234	0	1519	0	1519
1992	1285	306	0	1591	0	1591
1993	1505	303	0	1808	0	1808
1994	1178	360	0	1538	0	1538
1995	967	330	0	1297	0	1297
1996	1084	364	1	1449	2	1451
1997	1102	343	0	1445	1	1446
1998	739	289	4	1032	0	1032
1999	813	193	2	1008	0	1008
2000	1344	194	3	1541	0	1541
2001	1188	213	2	1403	0	1403
2002	884	232	2	1118	0	1118
2003	874	194	11	1079	0	1079
2004	1223	103	9	1335	0	1335
2005	1526	64	12	1602	3	1605
2006	1718	73	11	1802	1	1803
2007	1816	17	7	1840	2	1842
2008	1443	67	4	1514	0	1514

* provisional na = not available

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

Table 3.3.5.2 *Nephrops*, Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2008 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**			**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	36.7	35.4	1298	36.7	35.4	na	na	na
1982	1034	28.2	36.7	1034	28.2	36.7	na	na	na
1983	850	21.4	39.7	850	21.4	39.7	na	na	na
1984	960	23.2	41.4	960	23.2	41.4	na	na	na
1985	1908	49.2	38.8	1908	49.2	38.8	na	na	na
1986	1933	51.6	37.5	1933	51.6	37.5	na	na	na
1987	1723	70.6	24.4	1723	70.6	24.4	na	na	na
1988	1638	60.9	26.9	1638	60.9	26.9	na	na	na
1989	2102	69.6	30.2	2102	69.6	30.2	na	na	na
1990	1700	58.4	29.1	1700	58.4	29.1	na	na	na
1991	1284	47.1	27.3	571	25.1	22.7	713	22.0	32.4
1992	1282	40.9	31.3	624	24.8	25.2	658	16.1	40.9
1993	1505	48.6	31.0	783	28.1	27.9	722	20.6	35.0
1994	1178	47.5	24.8	1023	42.0	24.4	155	5.5	28.2
1995	967	30.6	31.6	857	27.0	31.7	110	3.6	30.6
1996	1084	38.2	28.4	1057	37.4	28.3	27	0.8	33.8
1997	1102	47.7	23.1	960	42.5	22.6	142	5.1	27.8
1998	739	34.4	21.5	576	28.1	20.5	163	6.3	25.9
1999	813	35.5	22.9	699	31.5	22.2	114	4.0	28.5
2000	1343	49.5	27.1	1068	39.8	26.8	275	9.7	28.4
2001	1188	47.6	25.0	913	37.0	24.7	275	10.6	25.9
2002	1526	35.5	43.0	649	27.2	23.9	234	7.9	29.6
2003	1718	41.1	41.8	737	25.3	29.1	135	3.6	37.5
2004	1818	36.9	49.3	1100	29.2	37.7	123	2.5	49.2
2005	1526	37.6	40.6	1309	34.0	38.5	217	3.6	60.3
2006	1718	41.1	41.8	1477	37.4	39.5	241	3.7	65.1
2007	1816	36.9	49.2	1502	32.4	46.4	314	4.5	69.8
2008	1443	30.1	47.9	1125	25.3	44.5	318	4.8	66.3

Table 3.3.5.3 *Nephrops*, Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991-2008.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		=> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	30.5	28.2	39.1	37.7
1982	na	na	30.2	29.0	40.0	37.9
1983	na	na	29.9	29.1	40.6	38.3
1984	na	na	29.7	29.3	39.4	38.1
1985	na	na	28.9	28.7	38.7	37.8
1986	na	na	28.7	27.8	39.1	38.4
1987	na	na	29.0	28.3	39.5	38.6
1988	na	na	29.1	28.7	38.9	38.4
1989	na	na	29.8	28.8	40.1	39.4
1990	28.8	28.1	30.4	29.1	38.4	38.7
1991	28.4	27.4	30.1	28.7	38.2	38.2
1992	29.4	28.6	31.0	30.5	38.3	38.0
1993	29.8	29.9	31.3	30.9	38.6	37.7
1994	28.9	30.1	30.8	31.0	39.5	37.5
1995	25.8	25.0	29.9	29.3	39.1	38.0
1996	29.3	28.4	30.6	29.7	38.5	38.0
1997	28.5	27.9	29.5	28.9	38.8	38.2
1998	28.7	28.2	30.1	29.3	38.8	38.2
1999	29.5	28.8	30.4	29.7	38.9	37.6
2000	29.8	29.1	31.5	30.6	39.2	38.3
2001	30.0	29.2	30.9	30.2	39.6	37.9
2002	27.2	27.0	31.2	30.9	41.0	38.7
2003	29.3	29.2	30.3	30.1	39.8	38.0
2004	29.3	28.3	31.1	30.3	39.0	39.1
2005	30.0	28.6	31.0	29.6	39.2	38.5
2006	30.2	29.3	30.6	29.6	39.3	38.6
2007	30.0	28.8	30.3	29.0	39.4	38.6
2008*	29.9	27.9	30.3	28.2	39.8	40.2

* provisional na = not available

Table 3.3.5.4 ***Nephrops*****, Moray Firth (FU 8):Summary of TV results for most recent 3 years (2006-2008) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.**

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2006 TV survey							
M & SM	169	6	0.46	0.03	77	127	0.022
MS(west)	682	18	0.19	0.06	129	1634	0.290
MS(mid)	698	13	0.19	0.04	133	1646	0.292
MS(east)	646	13	0.31	0.07	201	2231	0.396
Total	2195	50			539	5638	1
2007 TV survey							
M & SM	169	3	0.45	0.11	76	1006	0.112
MS(west)	682	13	0.29	0.12	195	4263	0.475
MS(mid)	698	11	0.24	0.01	166	460	0.051
MS(east)	646	13	0.32	0.10	205	3248	0.362
Total	2195	40			642	8977	1
2008 TV survey							
M & SM	169	2	0.35	0.08	58	1200	0.144
MS(west)	682	16	0.35	0.17	239	5023	0.603
MS(mid)	698	13	0.20	0.01	141	413	0.050
MS(east)	646	14	0.22	0.06	141	1699	0.204
Total	2195	45			579	8335	1

Table 3.3.5.5 *Nephrops*, Moray Firth (FU 9): Results of the 1993-2008 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	31	0.19	418	94
1994	29	0.39	850	213
1995	no survey			
1996	27	0.26	563	109
1997	34	0.14	317	66
1998	31	0.18	391	115
1999	52	0.22	484	105
2000	44	0.21	467	118
2001	45	0.19	417	135
2002	31	0.29	630	146
2003	32	0.40	883	380
2004	42	0.35	757	225
2005	42	0.48	1052	239
2006	50	0.25	539	150
2007	40	0.29	642	189
2008	45	0.26	579	183

Table 3.3.5.6 *Nephrops*, Moray Firth (FU 8): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest ratio 2003-2008.

	Adjusted survey (millions)	Landings (tonnes)	Discard rate	Harvest ratio
2003	729	1079	0.14	0.07
2004	626	1335	0.33	0.11
2005	869	1605	0.15	0.09
2006	446	1803	0.05	0.18
2007	530	1842	0.08	0.16
2008	478	1514	0.05	0.13

Table 3.3.6.1 *Nephrops*, Noup (FU 10), Nominal Landings of *Nephrops*, 1981-2008, as reported to the WG.

Year	UK Scotland				Total **
	Nephrops trawl	Other trawl	Creel	Sub-total	
1981	13	23	0	36	36
1982	12	7	0	19	19
1983	9	6	0	15	15
1984	75	36	0	111	111
1985	2	20	0	22	22
1986	46	22	0	68	68
1987	12	32	0	44	44
1988	23	53	0	76	76
1989	24	61	0	84	84
1990	101	116	0	217	217
1991	110	86	0	196	196
1992	56	130	0	188	188
1993	200	176	0	376	376
1994	308	187	0	495	495
1995	162	118	0	280	280
1996	180	164	0	344	344
1997	185	130	1	316	316
1998	183	71	0	254	254
1999	211	68	0	279	279
2000	196	79	0	275	275
2001	89	88	0	177	177
2002	244	157	0	401	401
2003	258	79	0	337	337
2004	175	53	0	228	228
2005	81	84	0	165	165
2006	44	89	0	133	133
2007	47	108	0	155	155
2008*	75	98	0	173	173

* provisional na = not available

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

Table 3.3.6.2 *Nephrops*, Noup (FU 10): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2008 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	13	0.4	34.3	13	0.4	34.3	na	na	na
1982	12	0.5	24.7	12	0.5	24.7	na	na	na
1983	9	0.3	30.7	9	0.3	30.7	na	na	na
1984	75	2.0	36.9	75	2.0	36.9	na	na	na
1985	2	0.1	25.0	2	0.1	25.0	na	na	na
1986	46	0.7	62.6	46	0.7	62.6	na	na	na
1987	12	0.7	18.1	12	0.7	18.1	na	na	na
1988	23	1.0	34.3	23	1.0	34.3	na	na	na
1989	24	0.9	25.8	24	0.9	25.8	na	na	na
1990	101	2.9	34.6	101	2.9	34.6	na	na	na
1991	110	4.8	22.9	23	0.9	25.6	87	3.9	22.3
1992	56	1.8	31.1	33	1.4	23.6	23	0.4	57.5
1993	200	4.8	41.7	152	3.6	42.0	48	1.2	39.0
1994	308	8.4	36.7	273	7.6	36.0	35	0.8	42.1
1995	162	3.9	41.5	139	3.5	39.9	23	0.4	63.2
1996	180	4.4	40.9	174	4.2	41.4	6	0.2	30.0
1997	185	5.3	34.9	172	4.9	35.1	13	0.4	32.5
1998	183	3.2	57.2	171	3.0	57.0	12	0.2	60.0
1999	211	4.1	51.8	196	3.8	53.0	15	0.3	54.9
2000	196	2.0	98.0	161	1.8	89.4	35	0.2	175.0
2001	89	1.7	52.4	82	1.4	58.6	7	0.3	23.3
2002	244	3.3	73.9	185	2.1	88.1	59	1.2	49.2
2003	258	2.7	95.6	217	2.3	94.3	41	0.4	102.5
2004	175	2.2	79.5	144	2.2	65.2	31	0.0	-
2005	81	0.6	135.0	58	0.6	98.3	23	0.0	-
2006	44	0.3	146.7	42	0.4	94.6	2	0.0	-
2007	47	0.3	78.3	43	0.3	71.3	4	0.0	-
2008	75	0.8	93.4	55	0.6	91.2	20	0.2	100.0

Table 3.3.6.3 *Nephrops*, Noup (FU 10): Results of the 1994, 1999, 2006 & 2007 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1994	10	0.63	250	90
1995	no survey			
1996	no survey			
1997	no survey			
1998	no survey			
1999	10	0.30	120	42
2000	no survey			
2001	no survey			
2002	no survey			
2003	no survey			
2004	no survey			
2005	2	poor visibility, limited survey - see text		
2006	7	0.18	73.7	47.1
2007	9	0.15	60	25

Table 3.3.7.1. ***Nephrops*****, Norwegian Deep (FU 32) Landings (tonnes) by country, 1981-2008.**

Year	Denmark	Norway			Sweden	UK	Total
		Trawl	Creel	Sub-total			
1993	220	102	1	103		16	339
1994	584	161	0	161		10	755
1995	418	68	1	69		2	489
1996	868	73	1	74		10	952
1997	689	56	8	64		7	760
1998	743	88	1	89		4	836
1999	972	119	15	134		13	1119
2000	871	143	0	143	37	33	1084
2001	1026	72	13	85	26	53	1190
2002	1043	42	21	63	13	52	1170
2003	996	68	11	79	1	14	1089
2004	835	72	8	80	1	6	922
2005	979	89	13	102	2	6	1089
2006	939	62	19	81	1	6	1028
2007	652	77	20	97	5	1	755
2008*	505	116	26	142	24	4	675

* provisional na = not available

Table 3.3.7.2. *Nephrops*, Norwegian Deep (FU 32) Danish effort (days) and LPUE, 1993-2008.

Year	Effort	LPUE
1993	1317	121
1994	2126	208
1995	1792	198
1996	3139	235
1997	3189	218
1998	2707	214
1999	3710	226
2000	3986	192
2001	5372	166
2002	4968	188
2003	5273	177
2004	3488	216
2005	3919	234
2006	4796	196
2007	2878	226
2008	2301	220

Table 3.3.8.1. ***Nephrops*****, Off Horn Reef (FU 33) Landings (tonnes) by country, 1993-2008.**

	Belgium	Denmark	Germany	Netherl.	UK	Total **
1993	0	159		na	1	160
1994	0	137		na	0	137
1995	3	158		3	1	164
1996	1	74		2	0	77
1997	0	274		2	0	276
1998	4	333	8	12	1	350
1999	22	683	14	12	6	724
2000	13	537	12	39	9	597
2001	52	667	11	61	+	791
2002	21	772	13	51	4	861
2003	15	842	4	67	1	929
2004	37	1097	24	109	1	1268
2005	16	803	31	191	9	1050
2006	97	710	151	314	15	1288
2007	118	610	201	496	42	1467
2008*	130	362	160	386	58	1096

* provisional na = not available

** Totals for 1993-94 exclusive of landings by the Netherlands

Table 3.3.8.2. - Off Horns Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1993-2008.

	Logbook data		Estimated total effort
	Effort	LPUE	
1993	975	170	971
1994	739	165	830
1995	724	194	816
1996	370	157	471
1997	925	161	1702
1998	1442	208	1601
1999	2323	252	2710
2000	2286	209	2569
2001	2818	191	3489
2002	3214	207	3734
2003	3640	212	3973
2004	4306	234	4694
2005	2524	285	2776
2006	2062	308	2288
2007	1609	337	1818
2008	755	448	805

* provisional na = not available

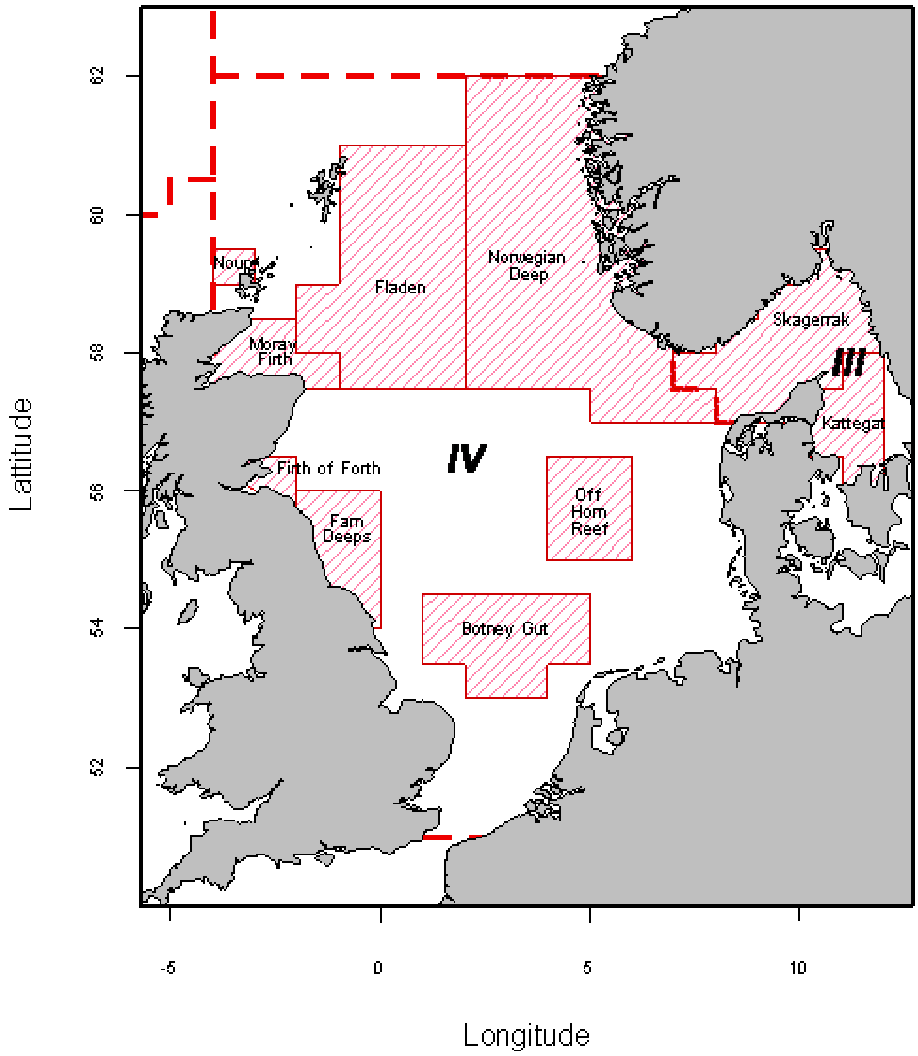


Figure 3.1.1 ***Nephrops*** **Functional Units in the North Sea and Skagerrak/Kattegat region.**

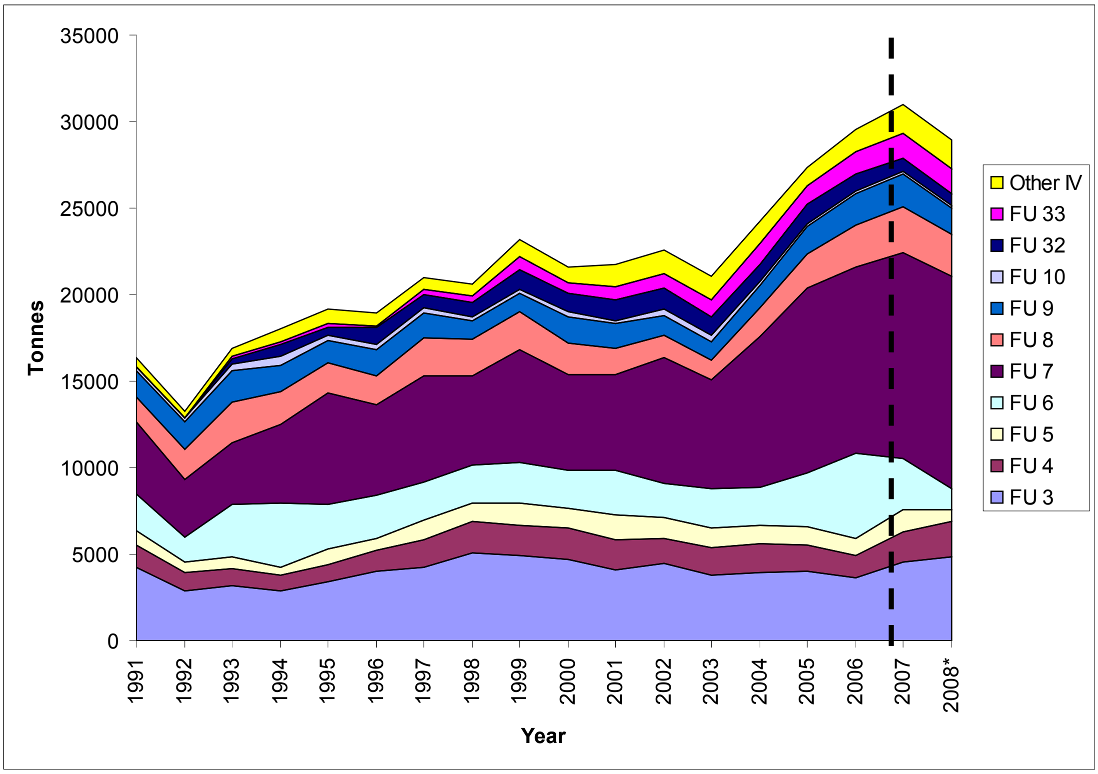


Figure 3.1.2. Nephrops, international landings by Functional Unit, 1991-2008. Vertical lines shows introduction of buyers and sellers legislation.

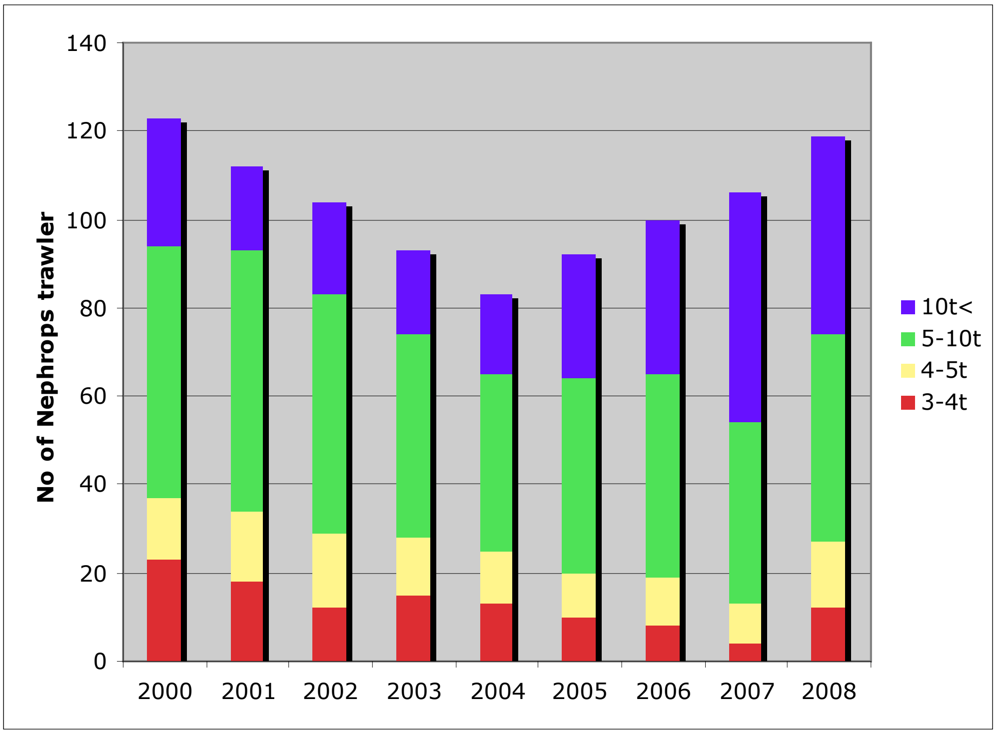


Figure 3.2.1.1. ***Nephrops*** **Division IIIa (Skagerrak, FU 3 & Kattegat, FU 4). Number of Swedish** ***Nephrops*** **trawlers with respect to yearly landings, 2000 - 2008.**

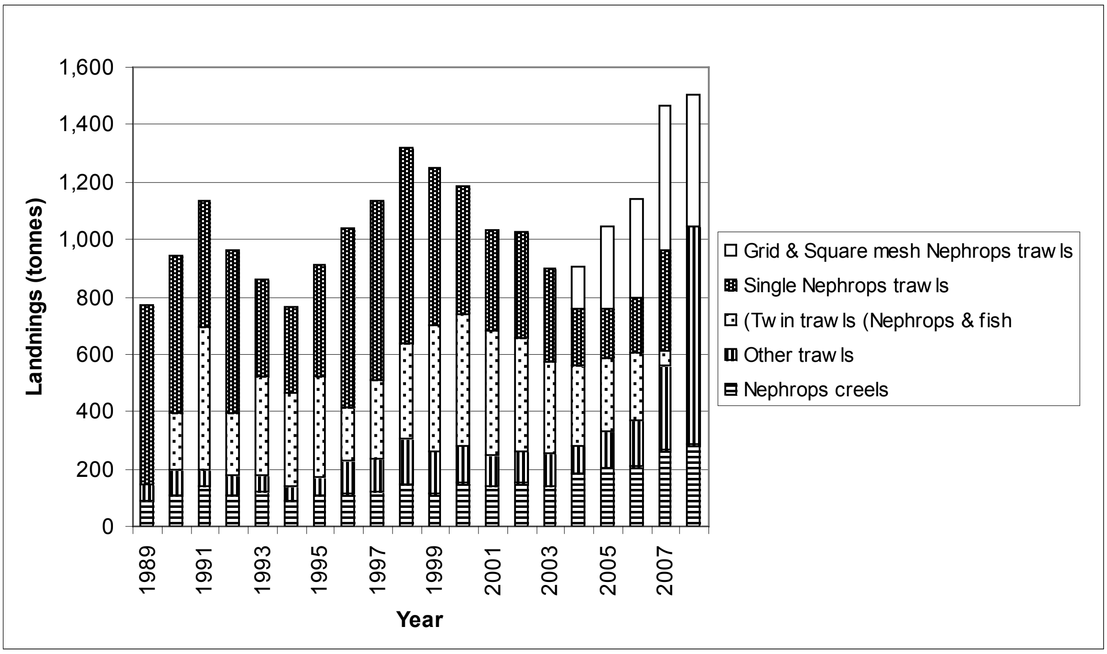


Figure 3.2.1.2 *Nephrops* Division IIIa (Skagerrak, FU3 & Kattegat, FU4). Swedish *Nephrops* landings from IIIa by gear 1989-2008. Other trawls are mainly finfish and *Pandalus* trawls.

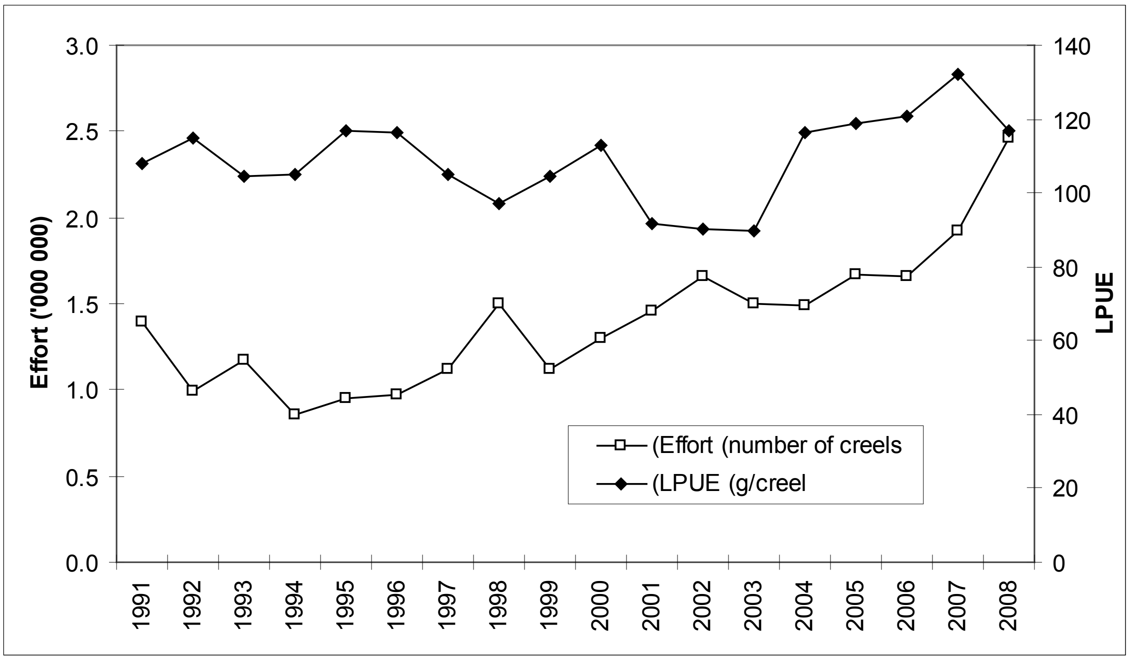


Figure 3.2.1.3. ***Nephrops*** **Division IIIa (Skagerrak, FU 3 & Kattegat, FU 4). Long term trend in effort and LPUE from the Swedish creel fishery.**

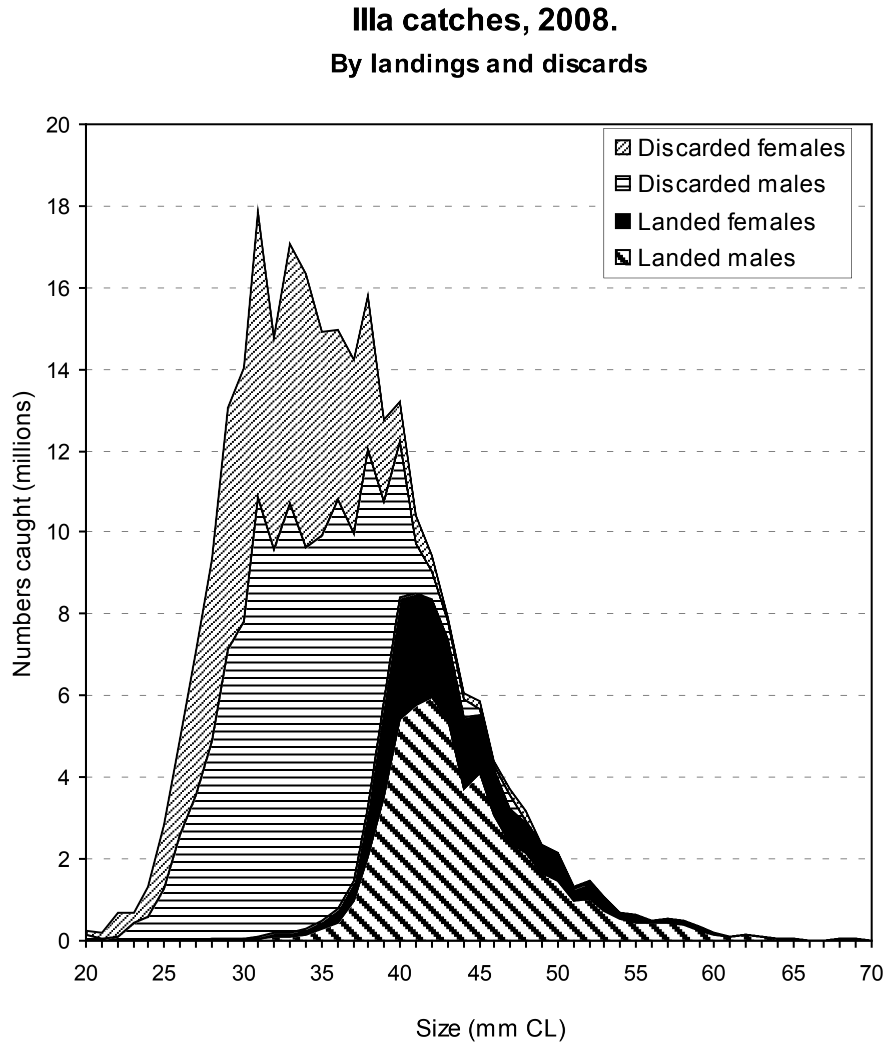


Figure 3.2.1.4 ***Nephrops*** **Division IIIa (Skagerrak (FU 3) and Kattegat (FU 4)). Length frequency distributions of** ***Nephrops*** **catches, split by catch fraction (landings and discards) and sex. Data for Denmark and Sweden combined, 2008 catches.**

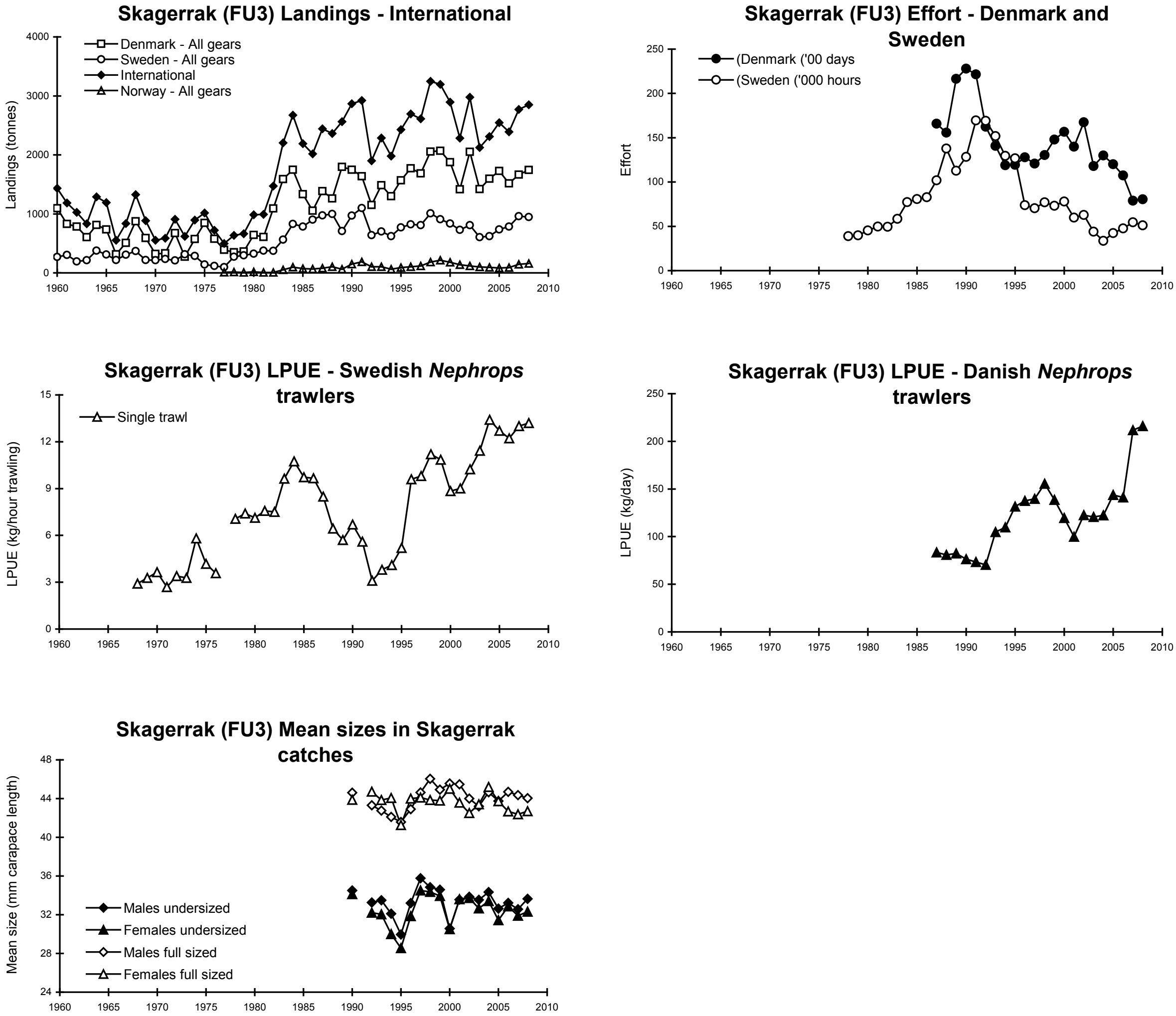


Figure 3.2.2.1 ***Nephrops*** **Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of** ***Nephrops*****.**

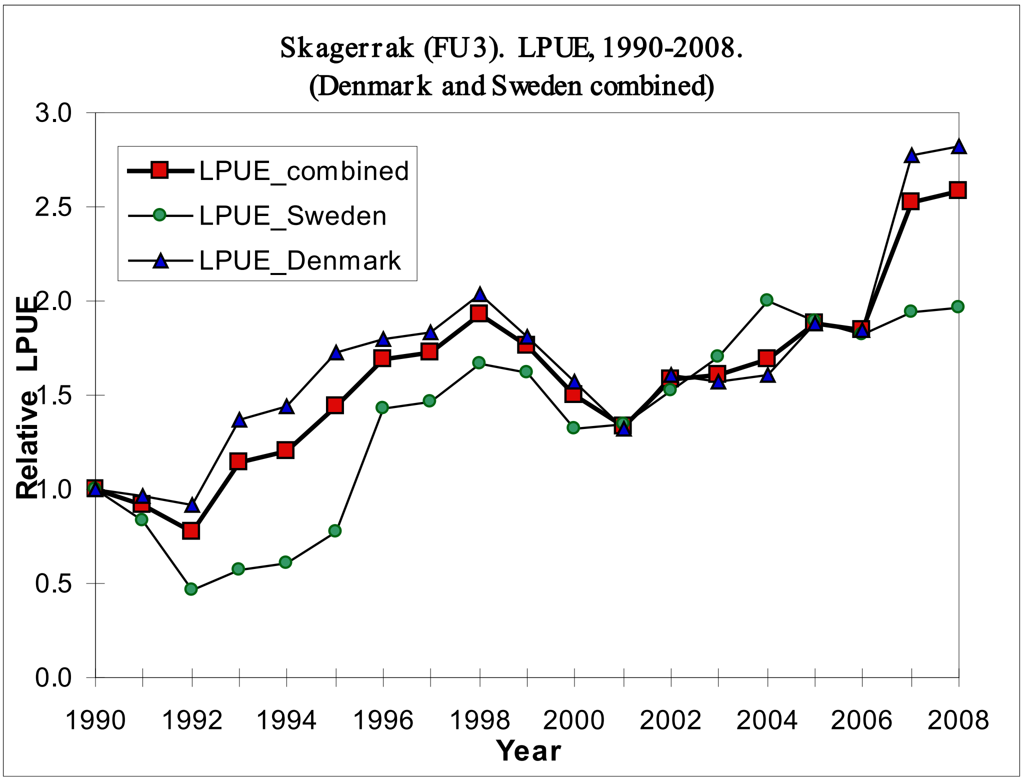


Figure 3.2.2.2. ***Nephrops*** **Skagerrak (FU 3): Trends in Danish and Swedish LPUE.**

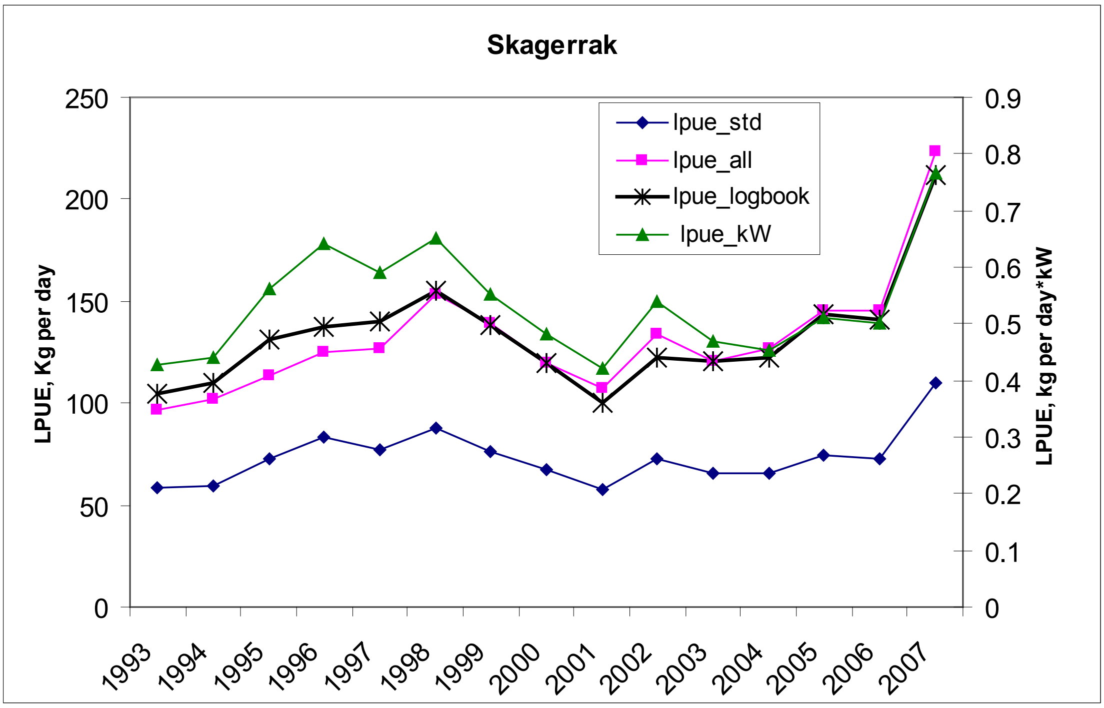


Figure 3.2.2.3. ***Nephrops*** **Skagerrak (FU 3): Danish LPUEs**

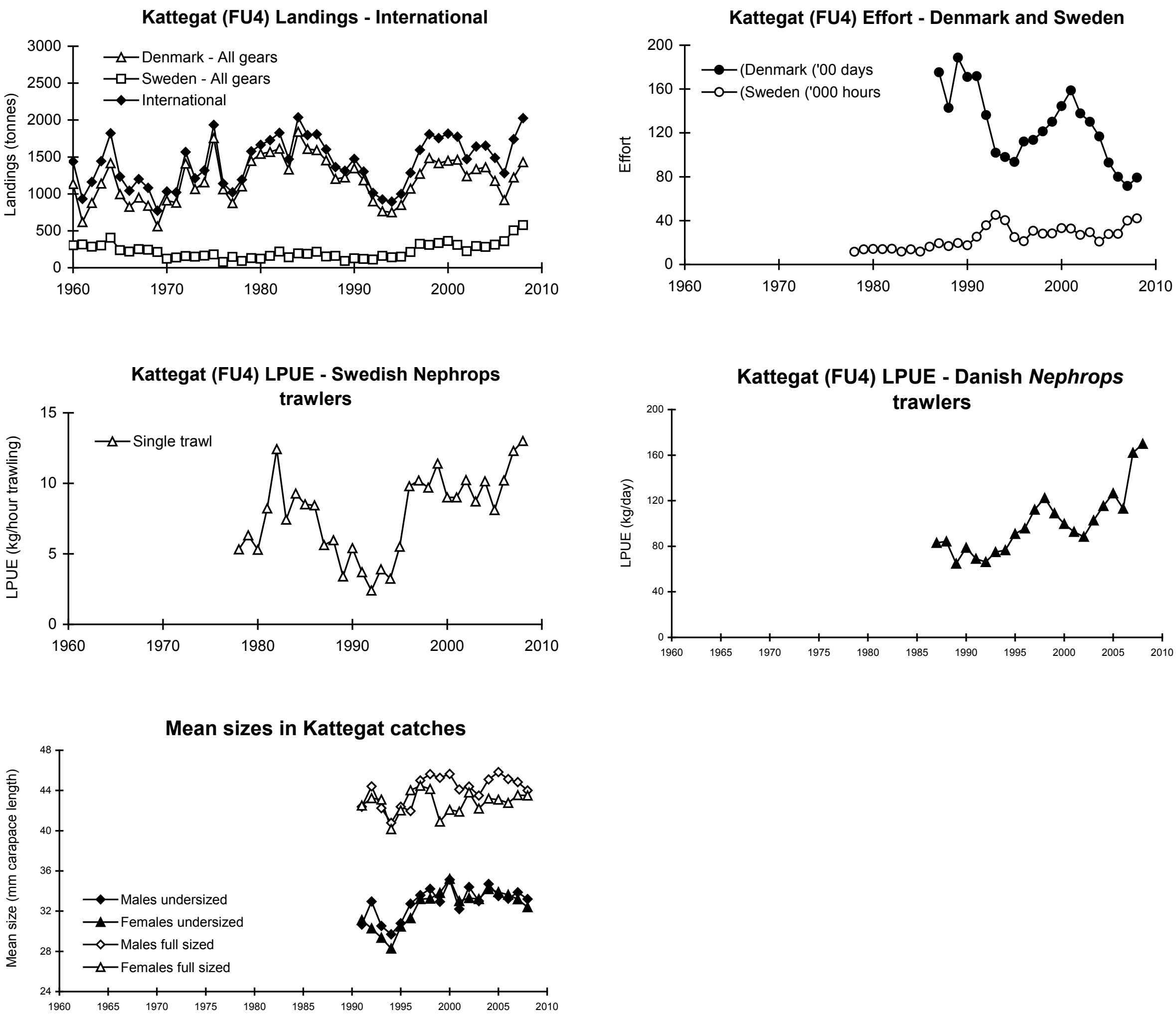


Figure 3.2.3.1. ***Nephrops*** **Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of** ***Nephrops*****.**

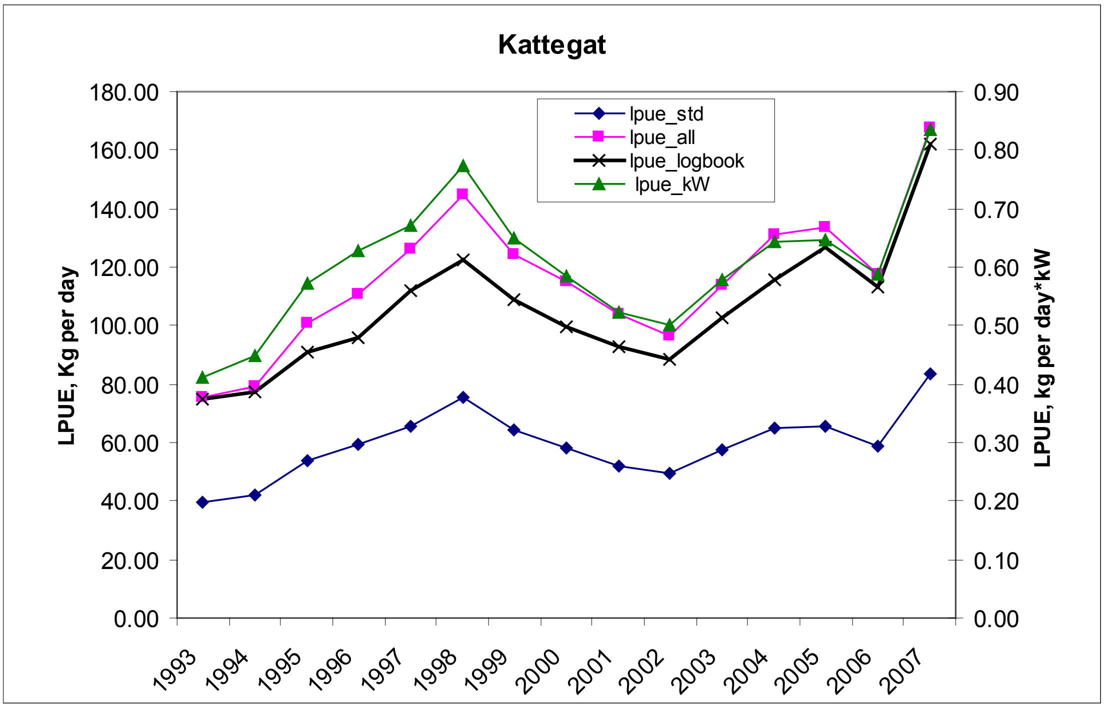


Figure 3.2.3.2. ***Nephrops*** **Kattegat (FU 4): Danish LPUEs**

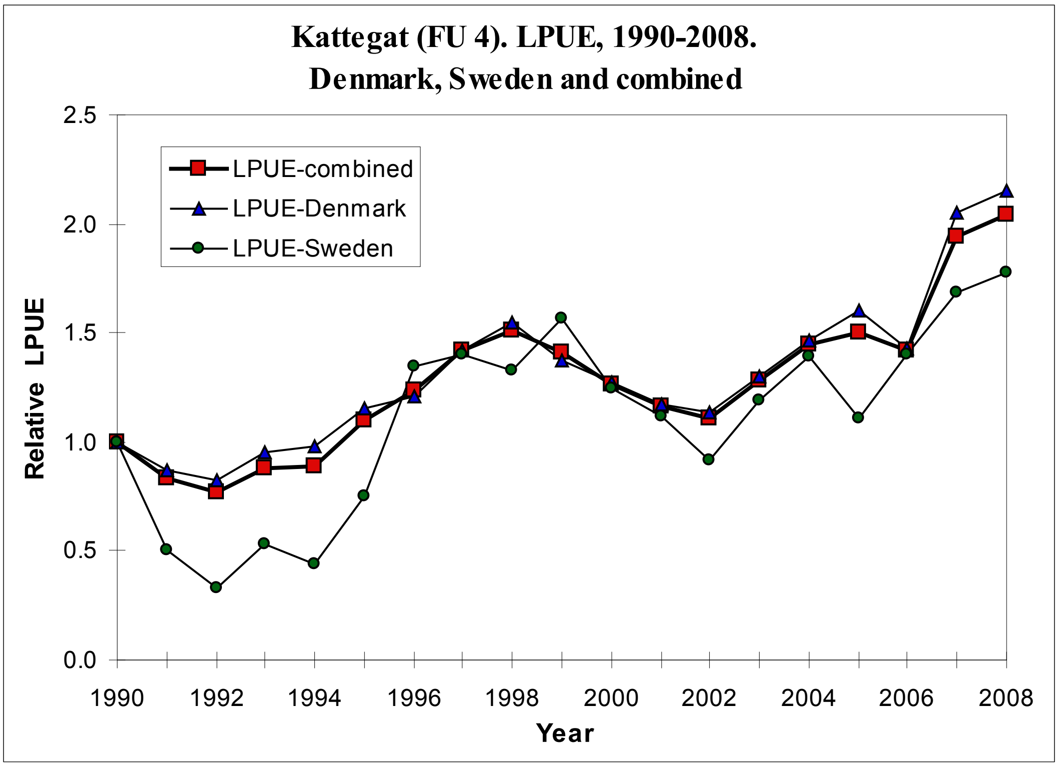


Figure 3.2.3.3. ***Nephrops*** **Kattegat (FU 4): Trends of Danish and Swedish LPUE.**

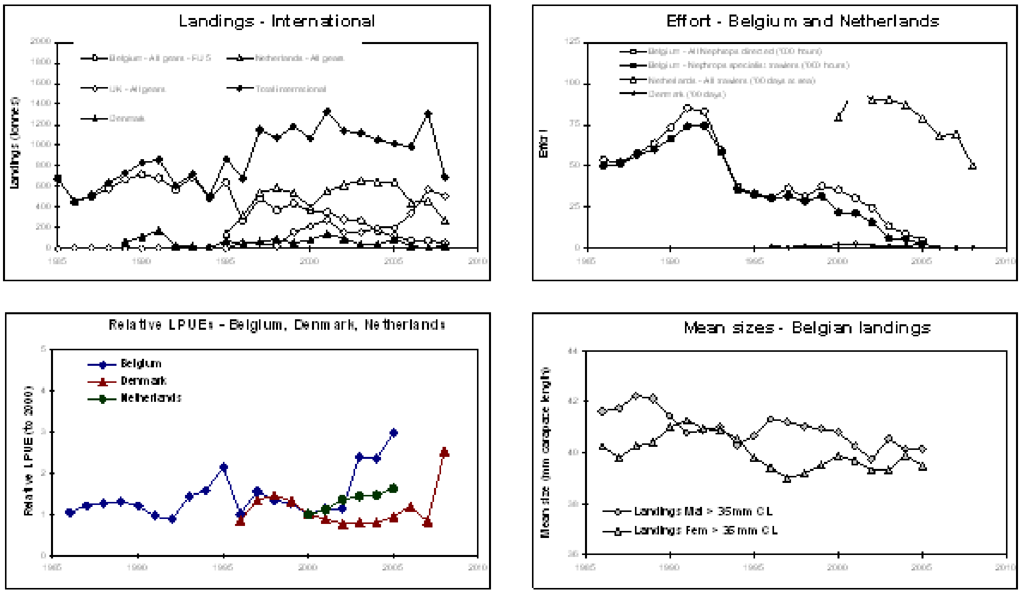


Figure 3.3.1.1 Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

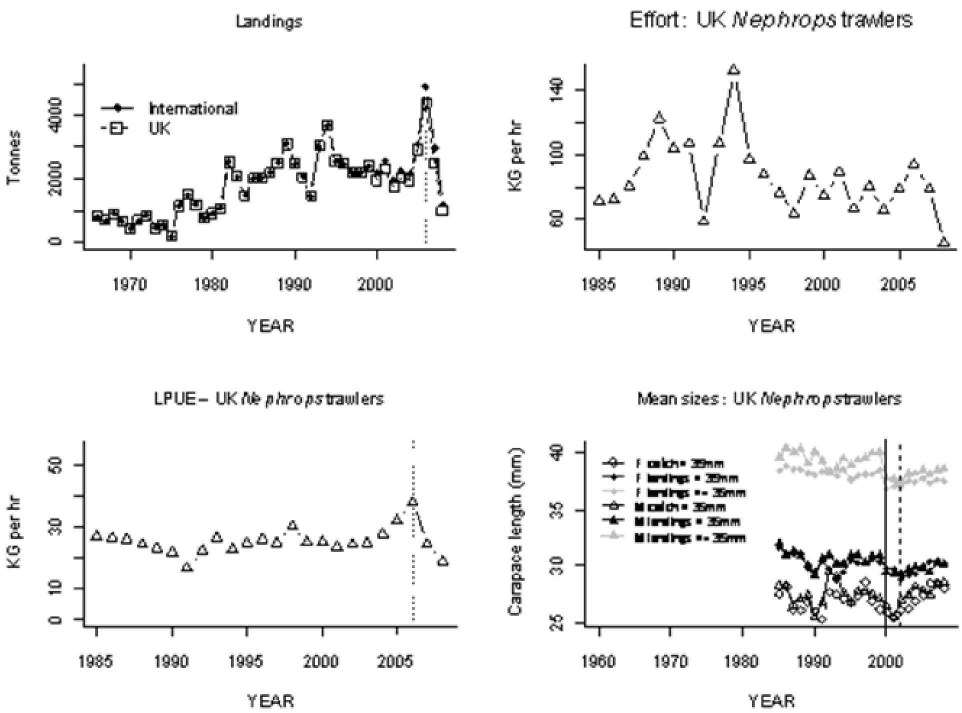


Figure 3.3.2.1 *Nephrops*, Farn Deeps (FU 6), Long term landings, effort, LPUE and mean sizes.

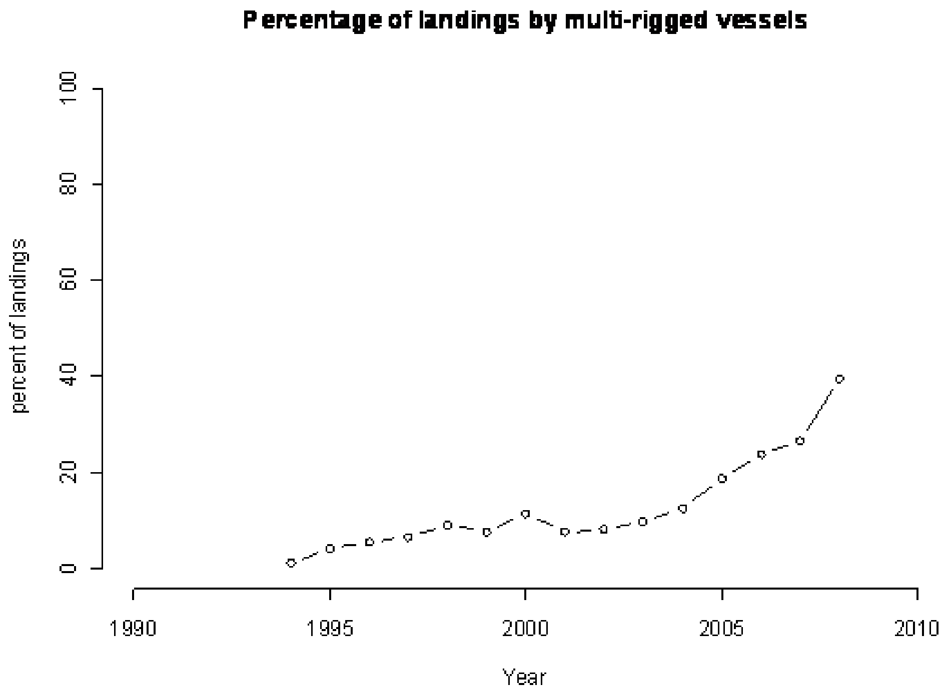


Figure 3.3.2.2. Nephrops, Farn Deeps (FU 6). Percentage of landings by multi-rigged vessels.

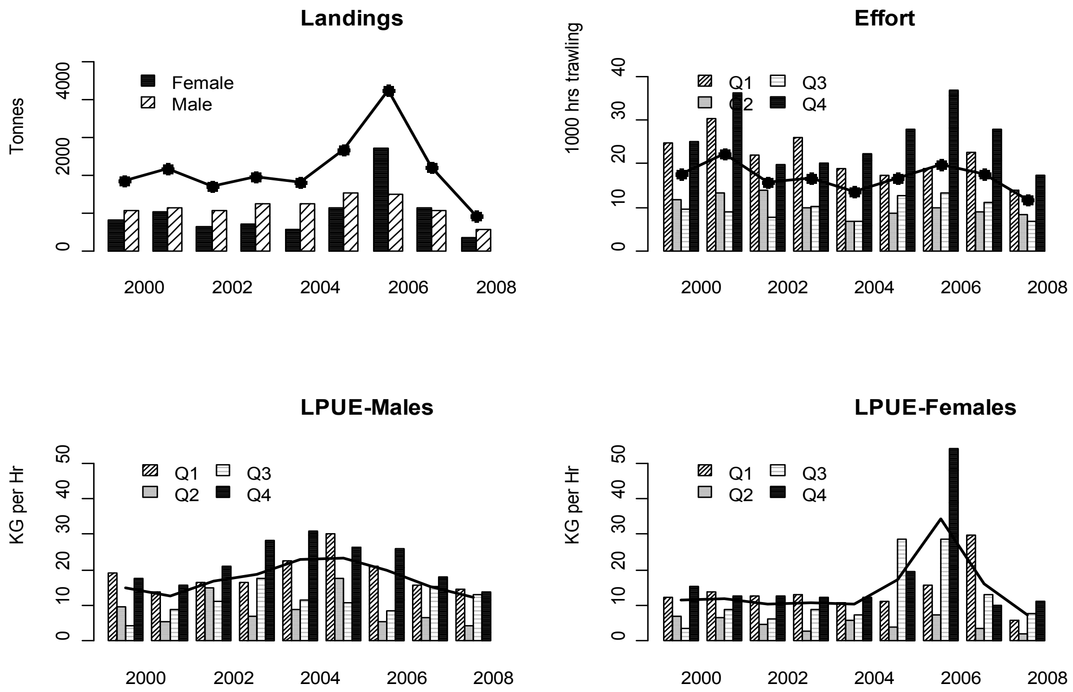


Figure 3.3.2.3 ***Nephrops*****, Farn Deeps (FU 6), Landings, effort and LPUEs by quarter and sex.**

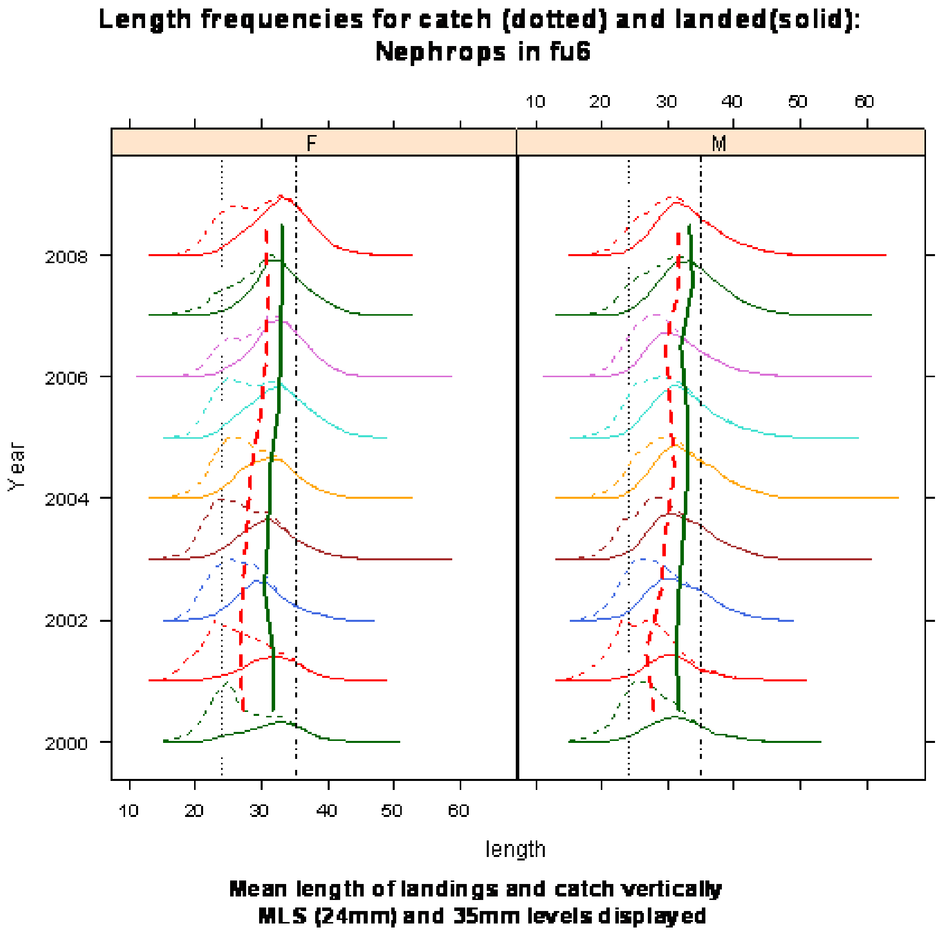


Figure 3.3.2.4 ***Nephrops*** **Farn Deeps (FU 6). Length composition of catch of males (right) and females left from 2000 (bottom) to 2008 (top). Mean sizes of catch and landings are displayed vertically.**

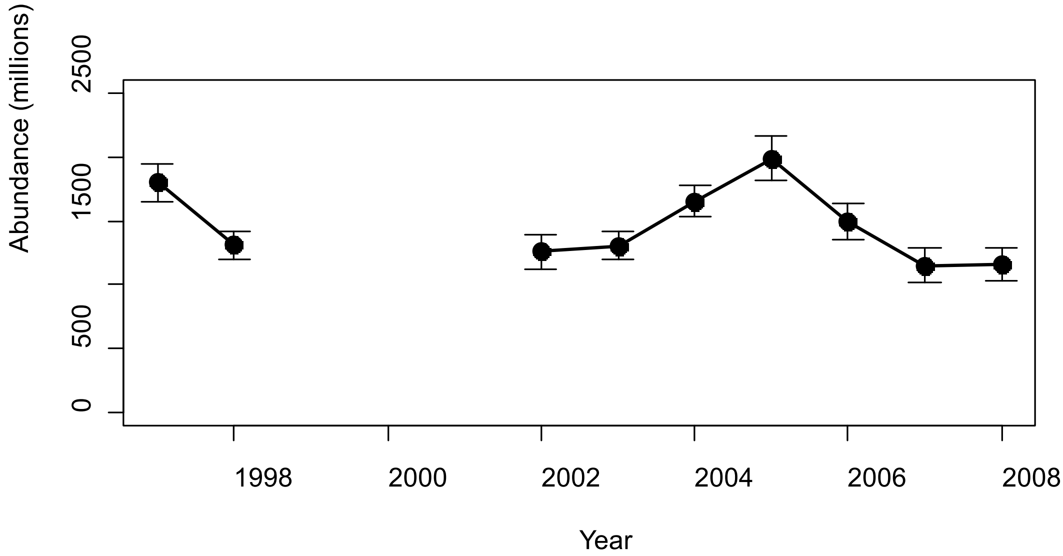


Figure 3.3.2.5 ***Nephrops*****, Farn Deeps (FU 6), Time series of TV survey abundance estimates (not bias adjusted), with 95% confidence intervals, 1997 – 2008.**

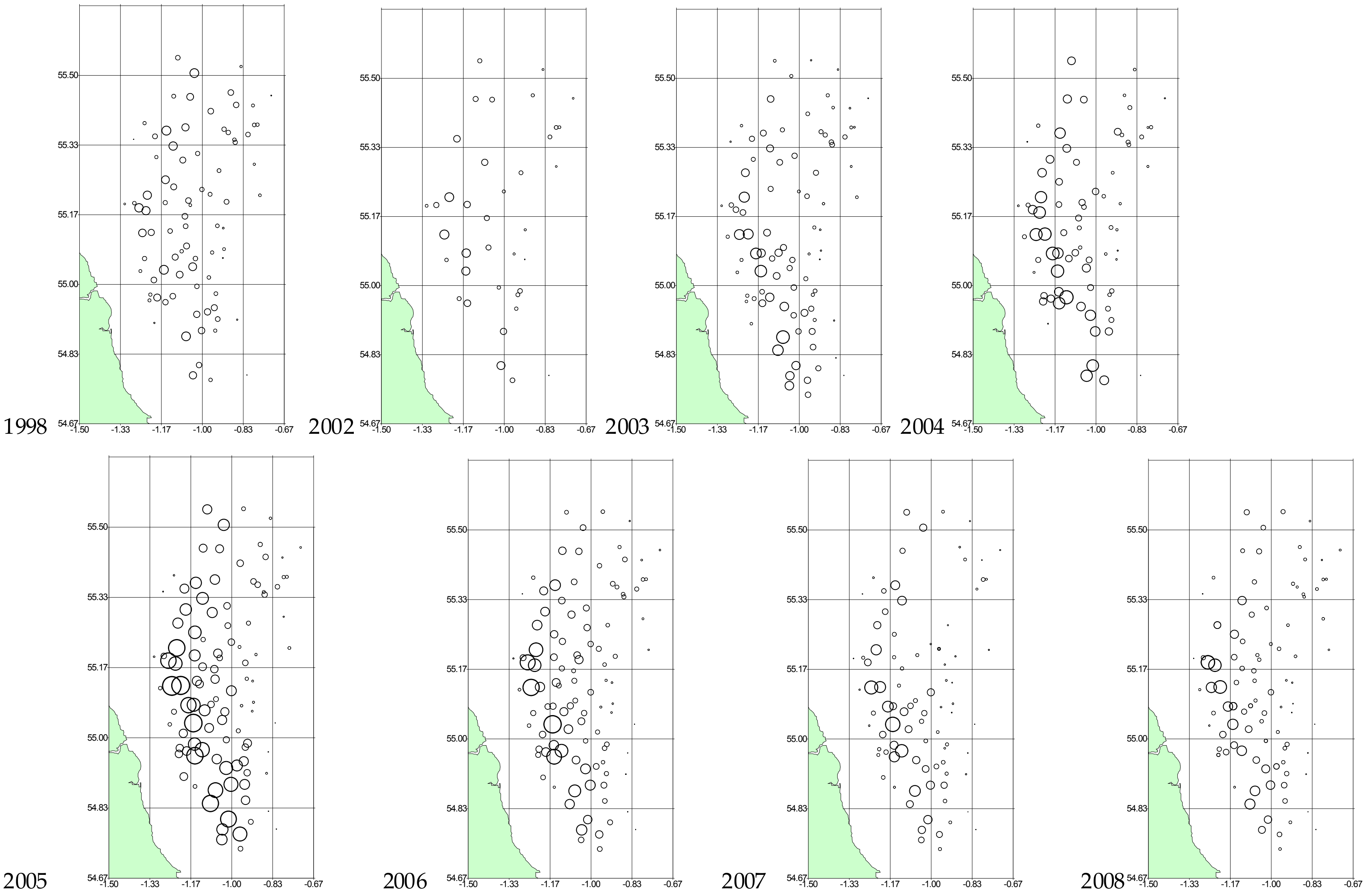


Figure 3.3.2.6. Nephrops Farn Deeps (FU6) - Station distribution and relative burrow density, from Autumn surveys 1998 – 2008.

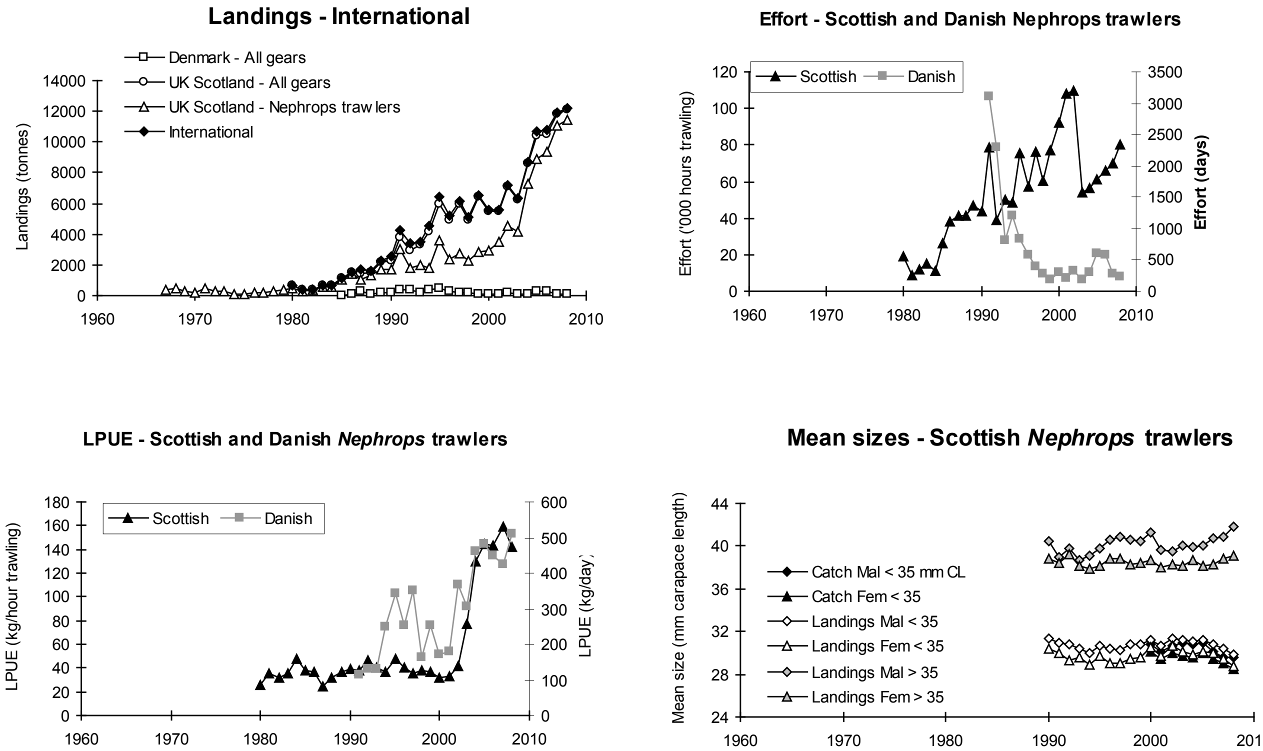


Figure 3.3.3.1 ***Nephrops*****, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.**

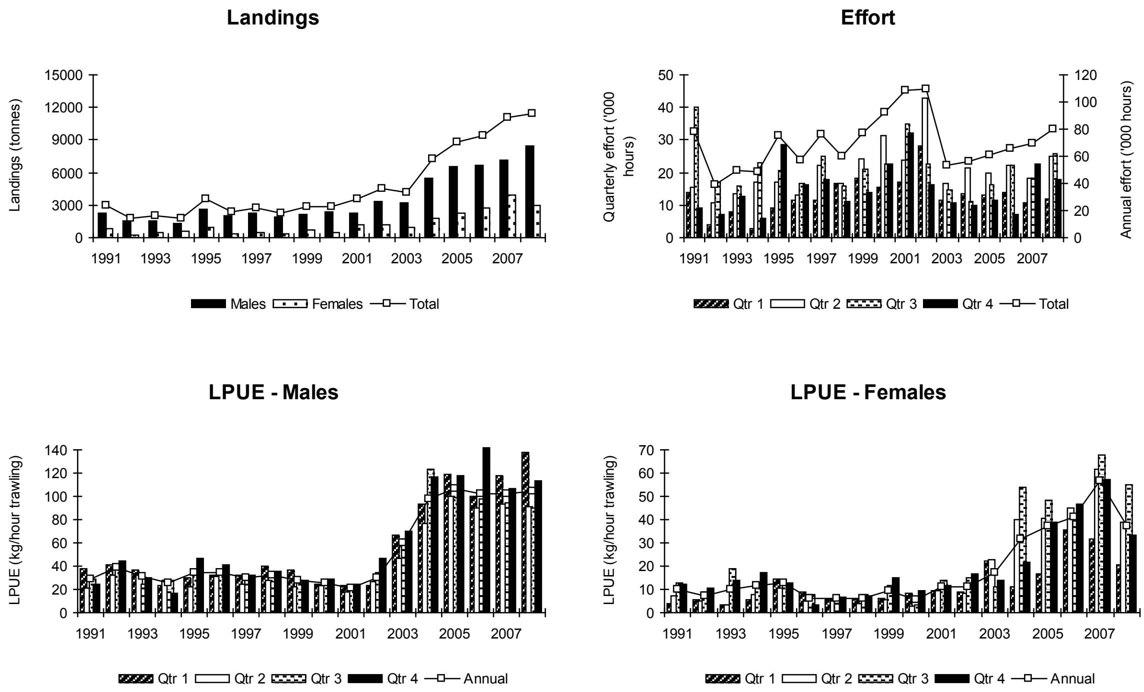


Figure 3.3.3.2 *Nephrops*, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

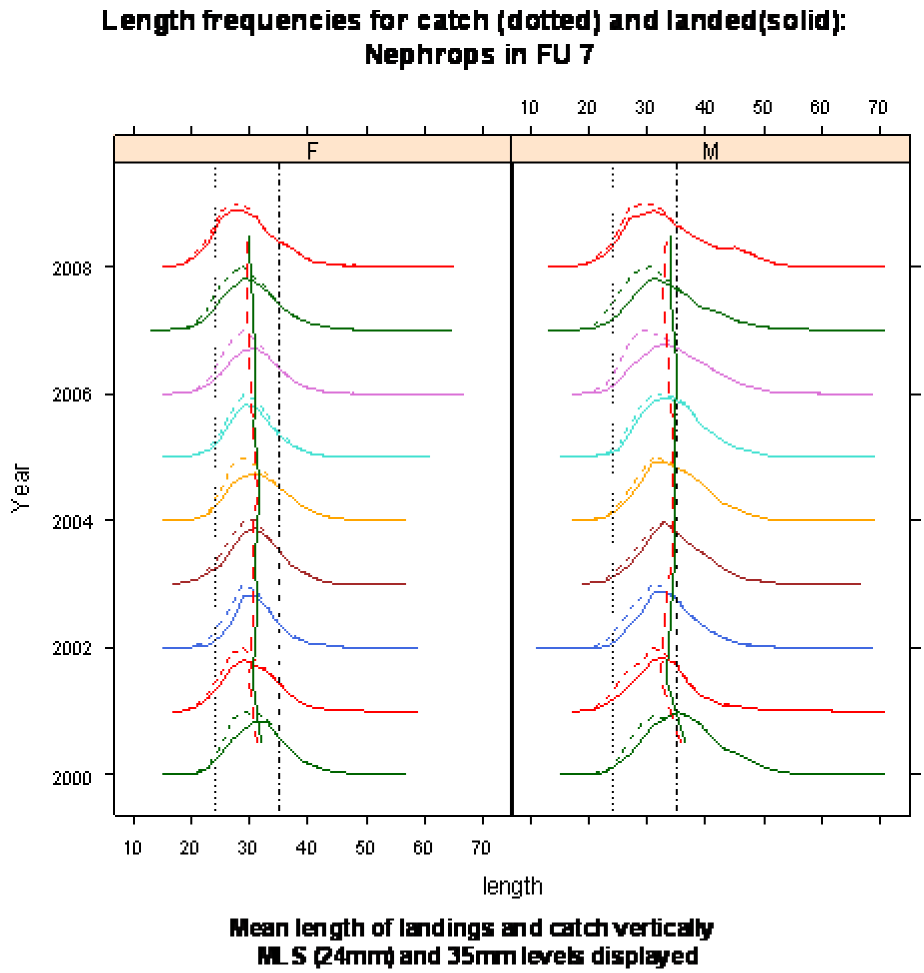


Figure 3.3.3.3. *Nephrops* Fladen Ground (FU 7)Length composition of catch of males (right) and females left from 2000 (bottom) to 2008 (top). Mean sizes of catch and landings are displayed vertically.

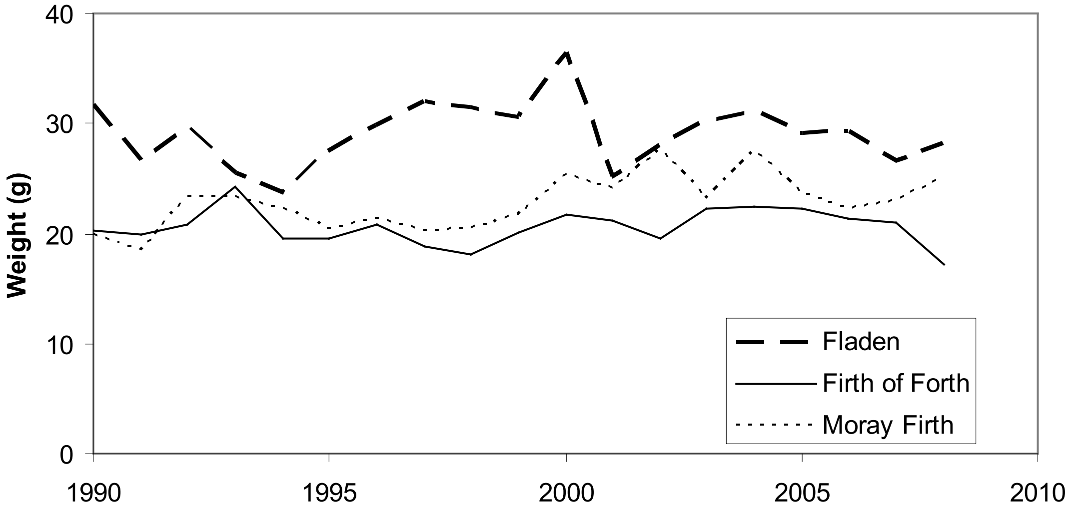


Figure 3.3.3.4 ***Nephrops*****, (FUs 7-9), individual mean weight in the landings from 1990-2008 (from Scottish market sampling data).**

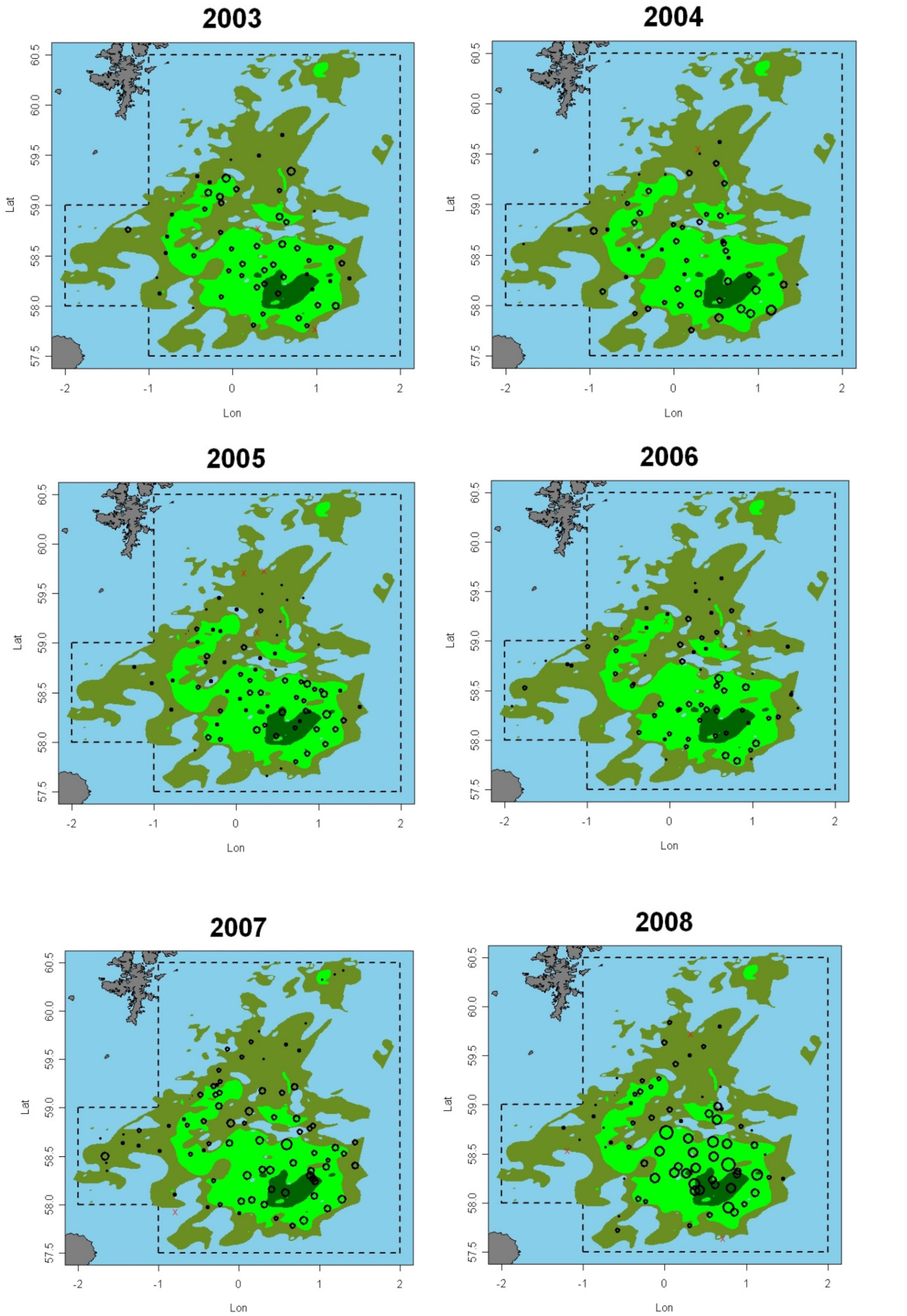


Figure 3.3.3.5 Nephrops, Fladen (FU 7). TV survey distribution and relative density (2003-2008). Green and brown areas represent areas of suitable sediment for Nephrops. Density proportional to circle radius. Red crosses represent zero observations.

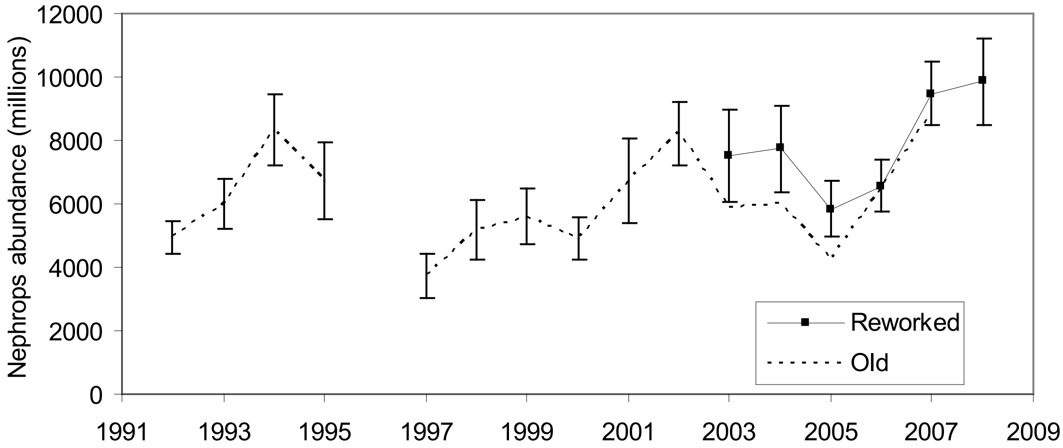
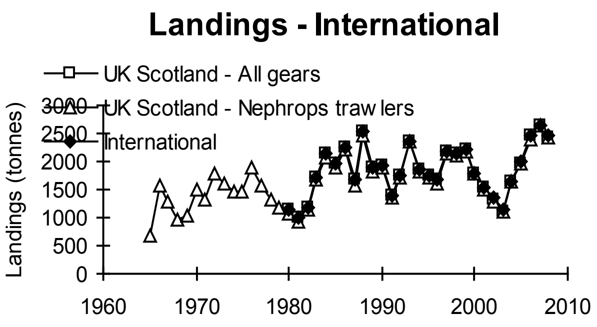
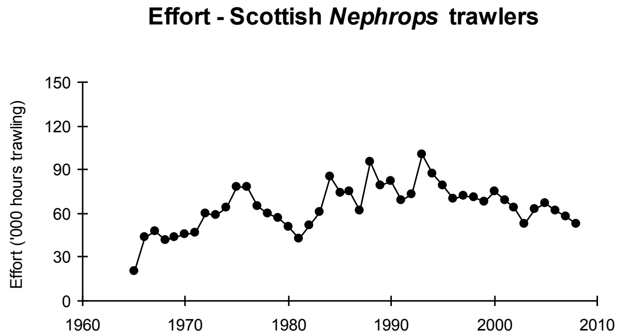
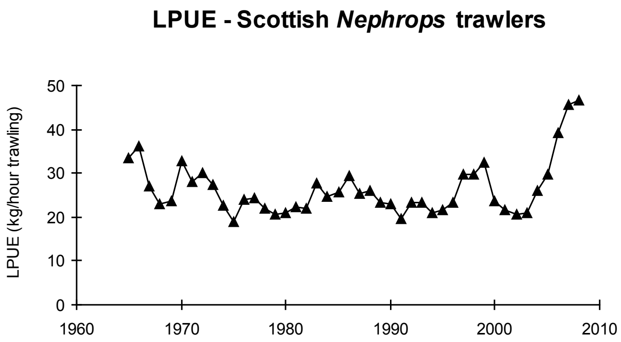


Figure 3.3.3.6 Nephrops, Fladen (FU 7), Time series of TV survey abundance estimates (not bias adjusted), with 95% confidence intervals, 1992 – 2008.







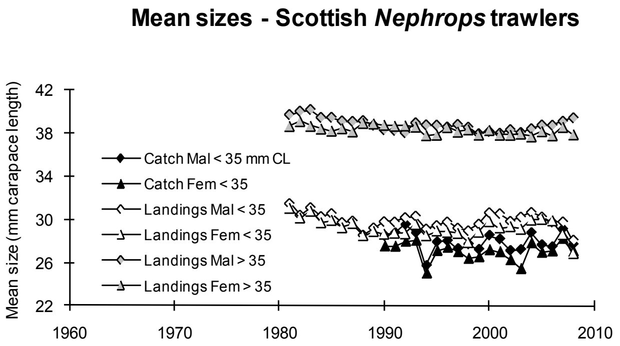


Figure 3.3.4.1 ***Nephrops*****, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.**

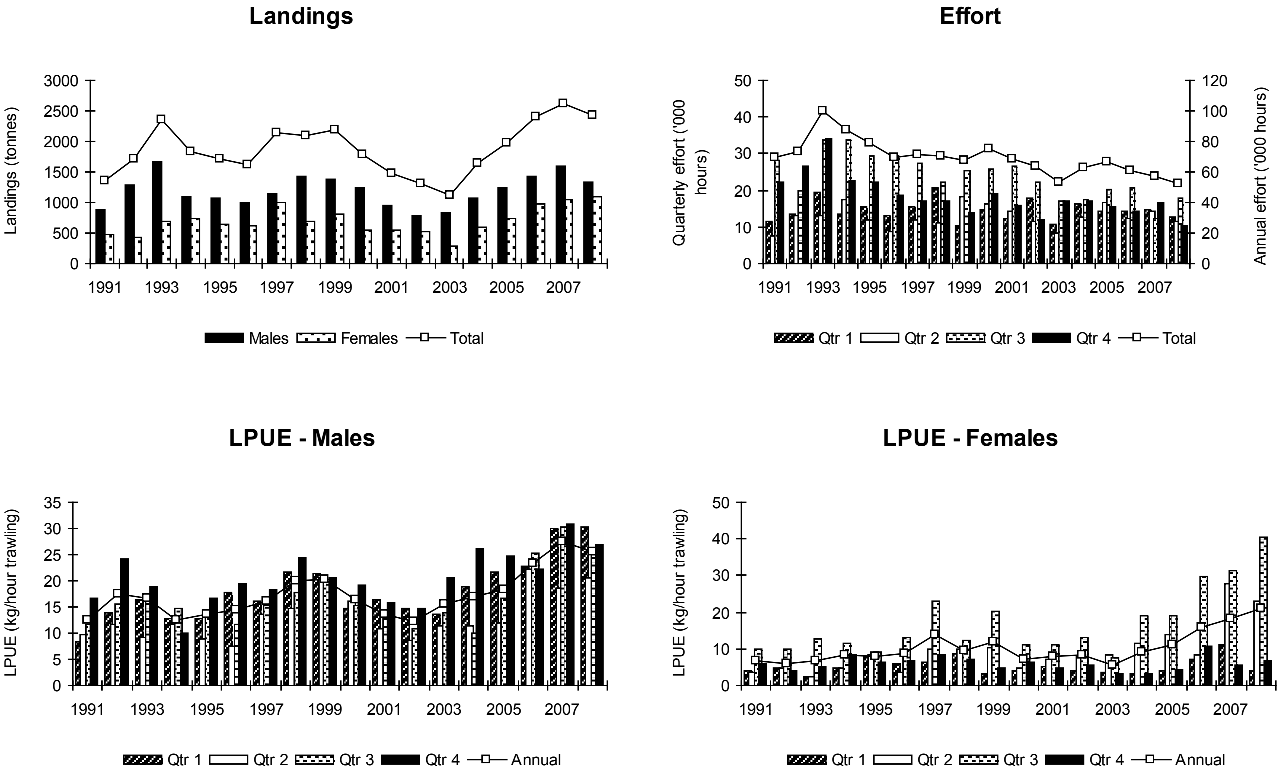


Figure 3.3.4.2 *Nephrops*, Firth of Forth (FU8), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

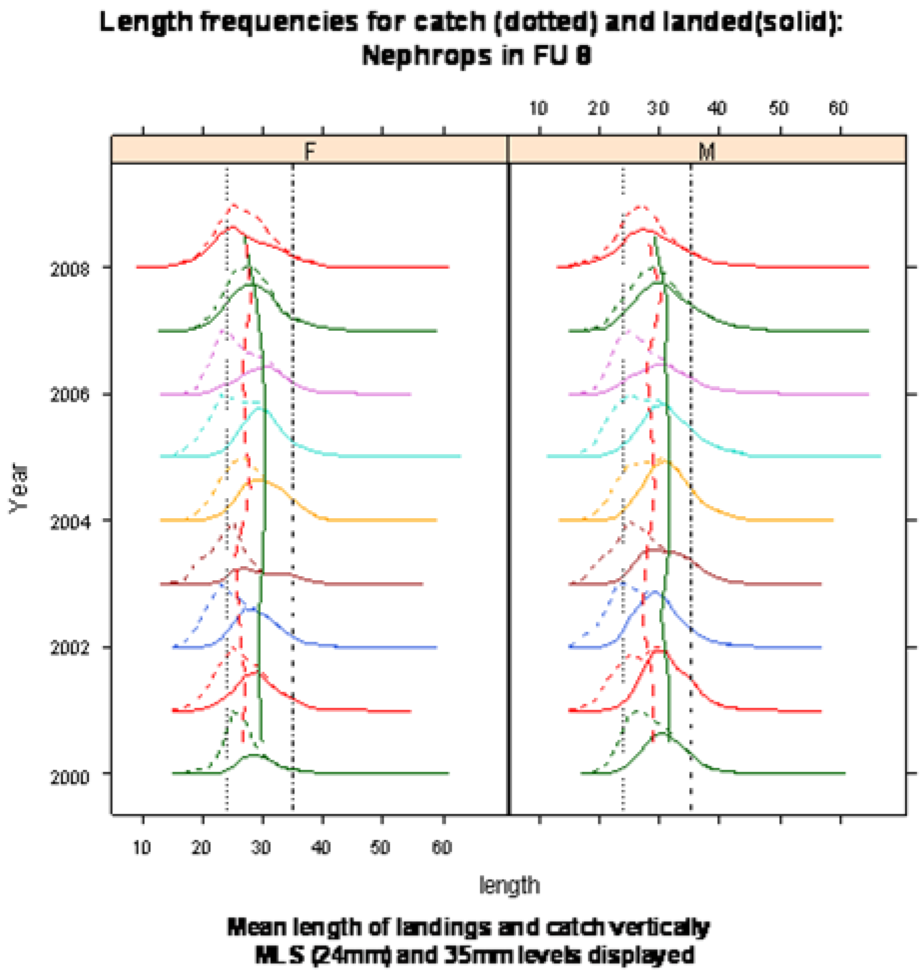


Figure 3.3.4.3 *Nephrops* Firth of Forth (FU 8)Length composition of catch of males (right) and females left from 2000 (bottom) to 2008 (top). Mean sizes of catch and landings are displayed vertically.

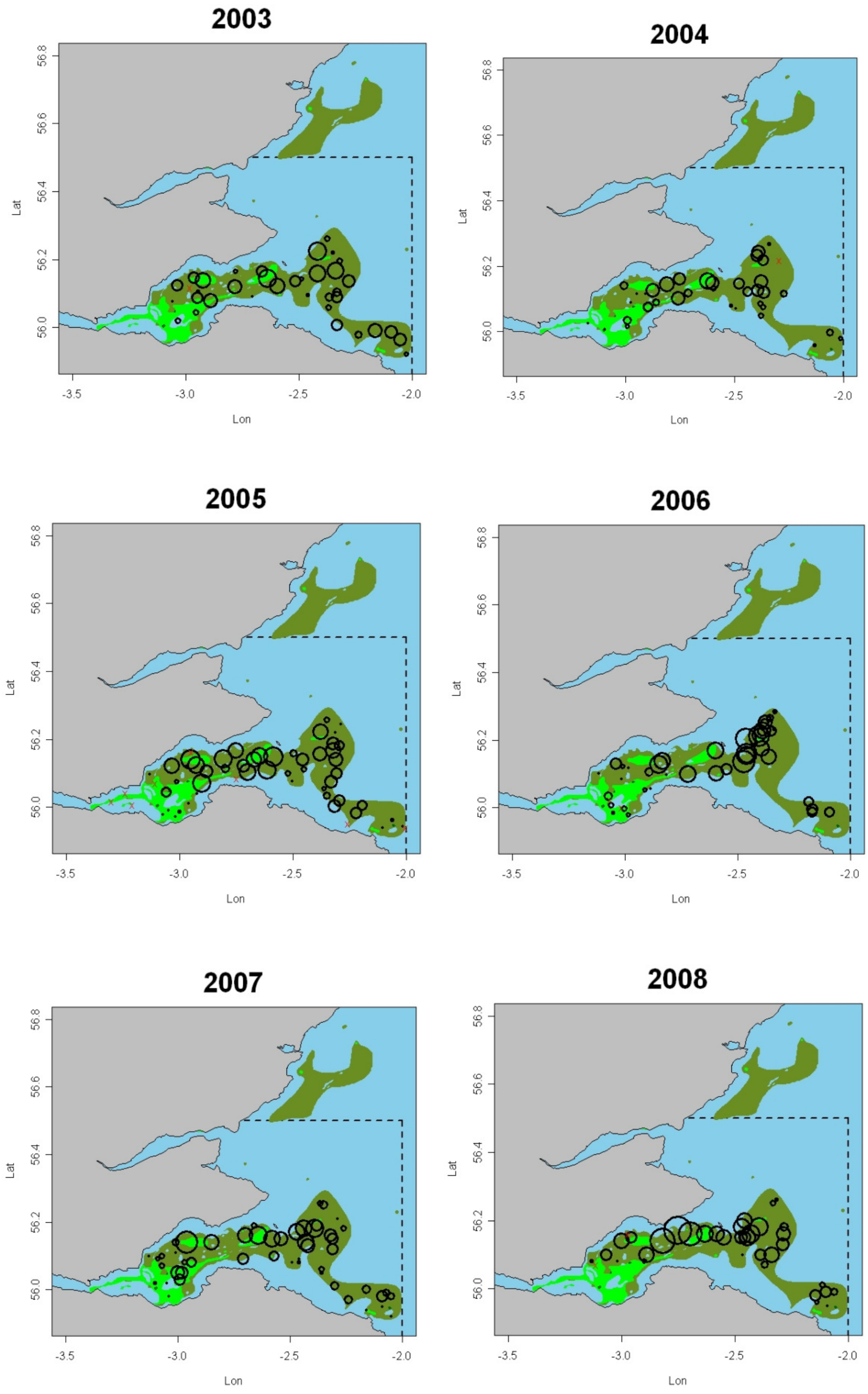


Figure 3.3.4.4 ***Nephrops*****, Firth of Forth (FU 8). TV survey distribution and relative density (2003-2008). Green and brown areas represent areas of suitable sediment for** ***Nephrops*****. Density proportional to circle radius. Red crosses represent zero observations.**

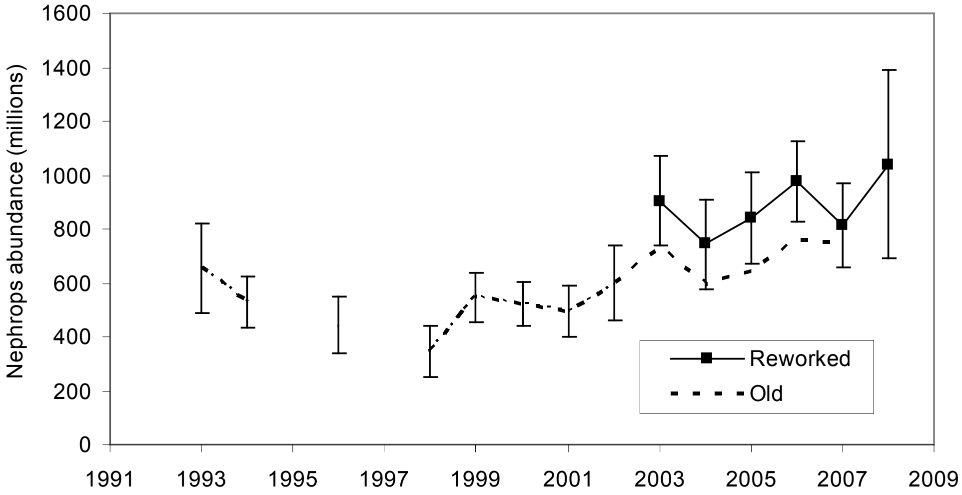


Figure 3.3.4.5 *Nephrops*, Firth of Forth (FU 8), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2008.

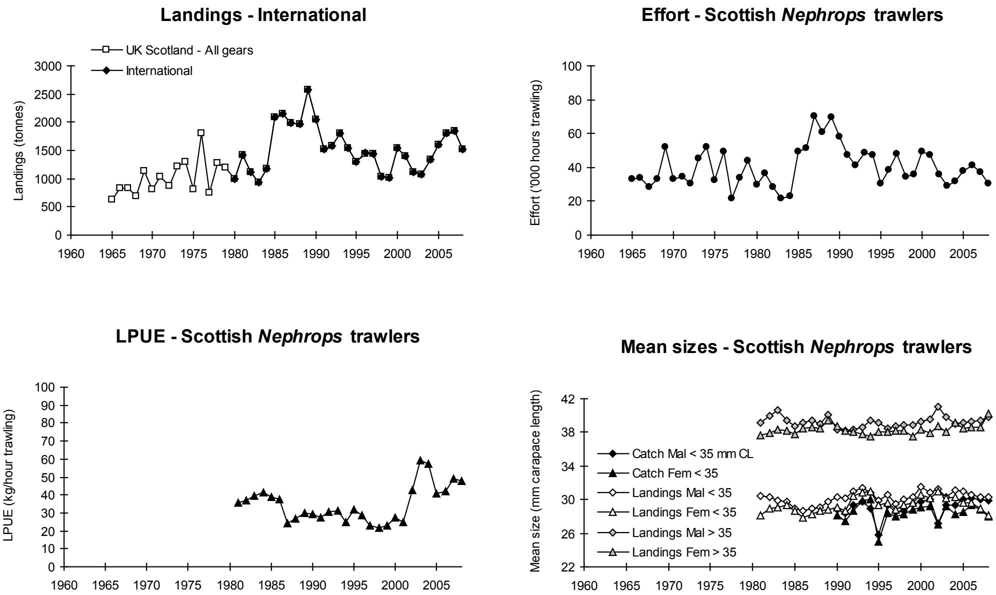


Figure 3.3.5.1 *Nephrops*, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.

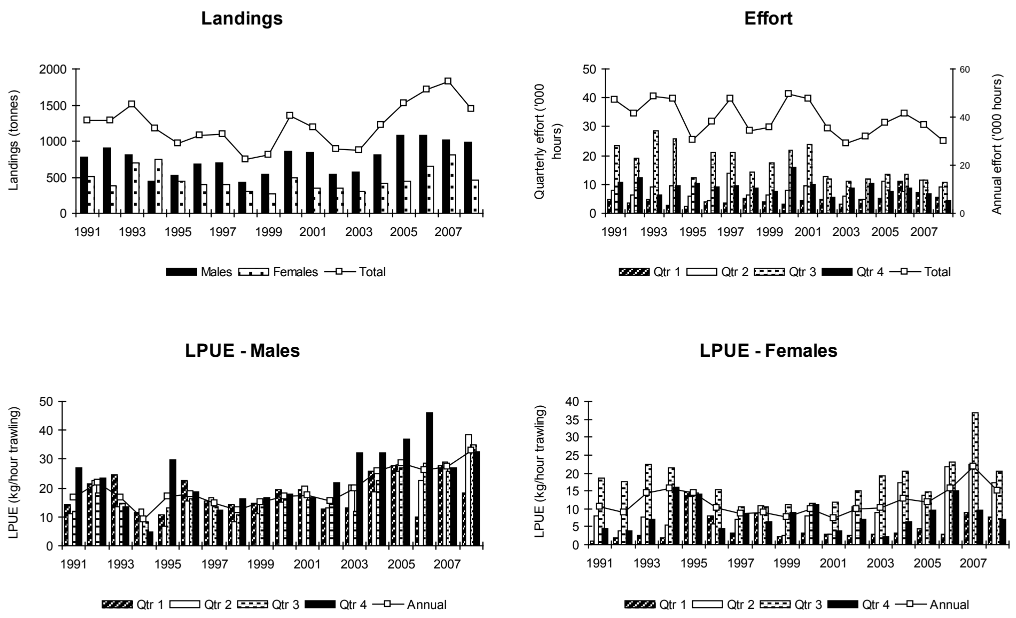


Figure 3.3.5.2 *Nephrops*, Moray Firth (FU 9), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

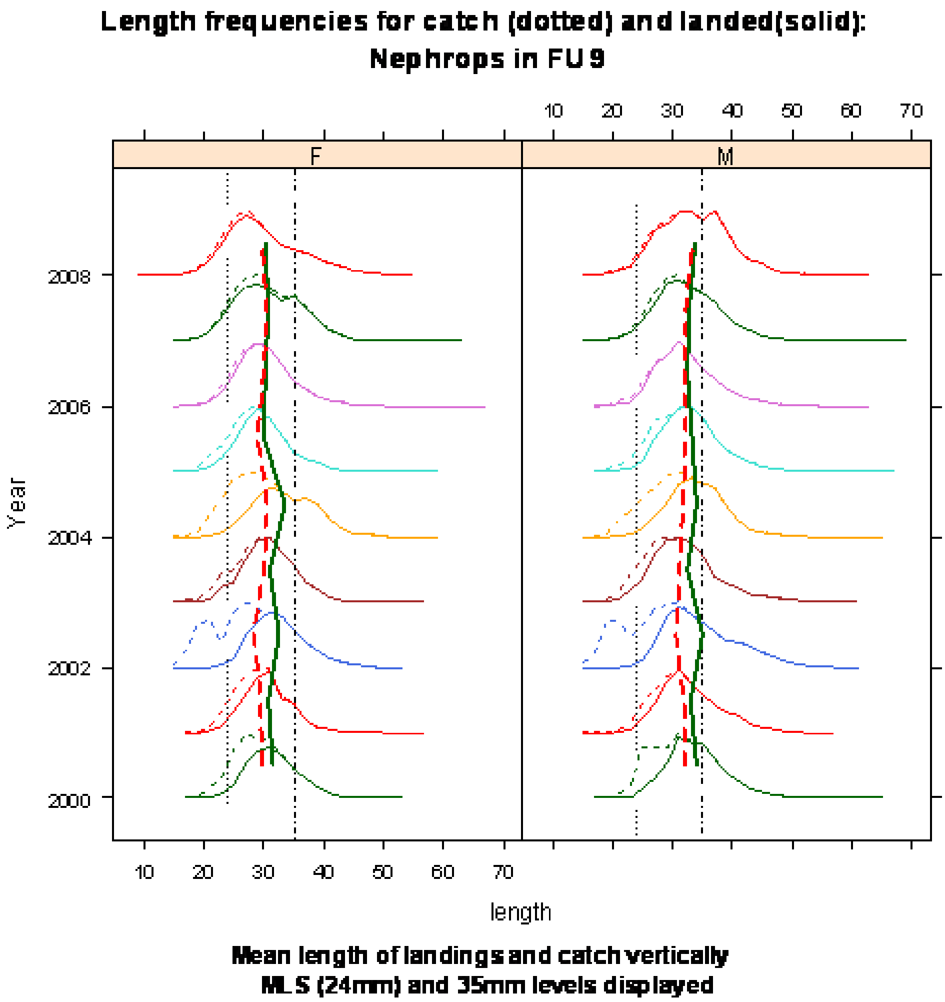


Figure 3.3.5.3 Nephrops Moray Firth (FU 9) Length composition of catch of males (right) and females left from 2000 (bottom) to 2008 (top). Mean sizes of catch and landings are displayed vertically.

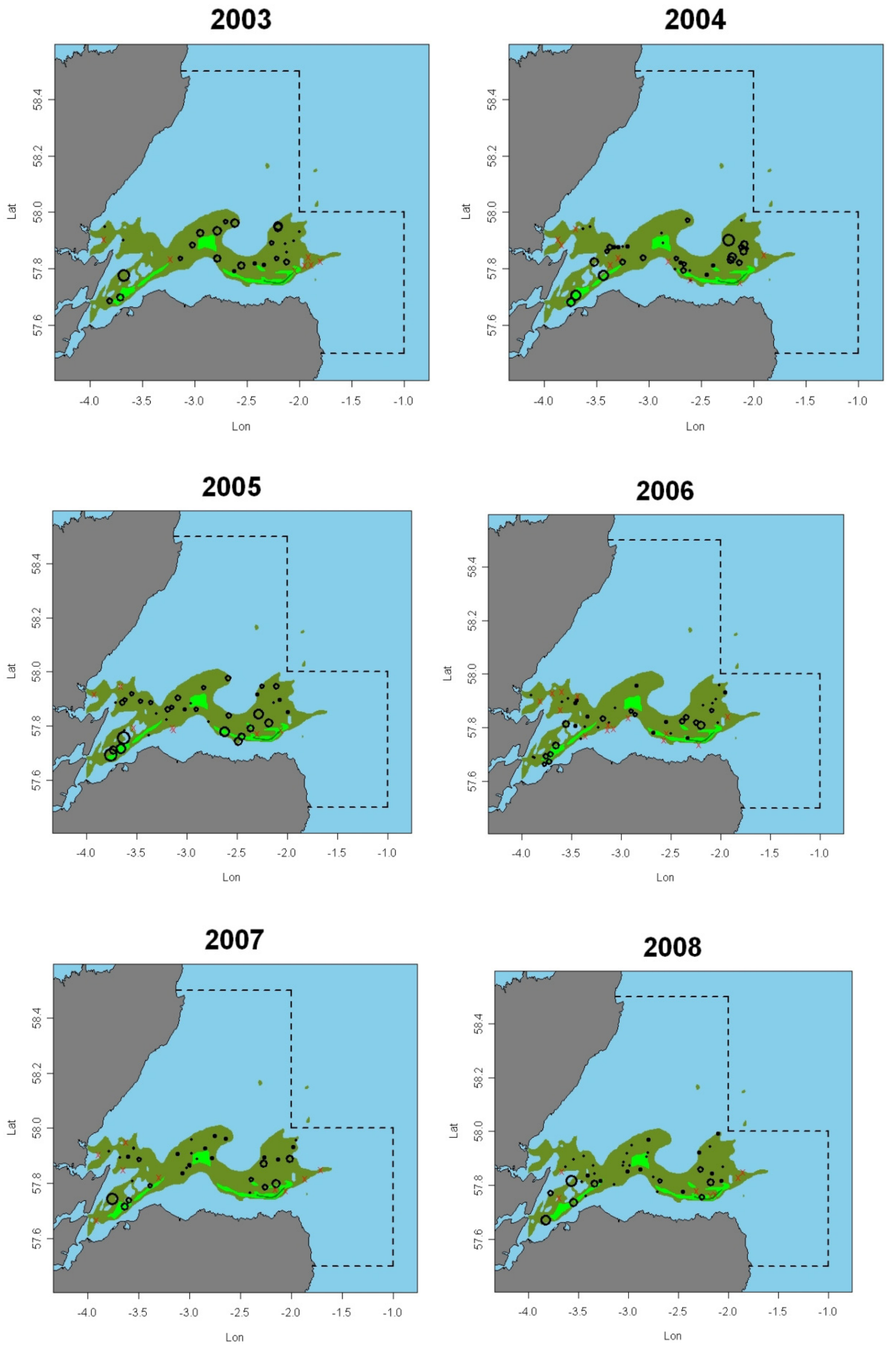


Figure 3.3.5.4 ***Nephrops*, Moray Firth (FU 9). TV survey distribution and relative density (2003-2008). Green and brown areas represent areas of suitable sediment for *Nephrops*. Density proportional to circle radius. Red crosses represent zero observations.**

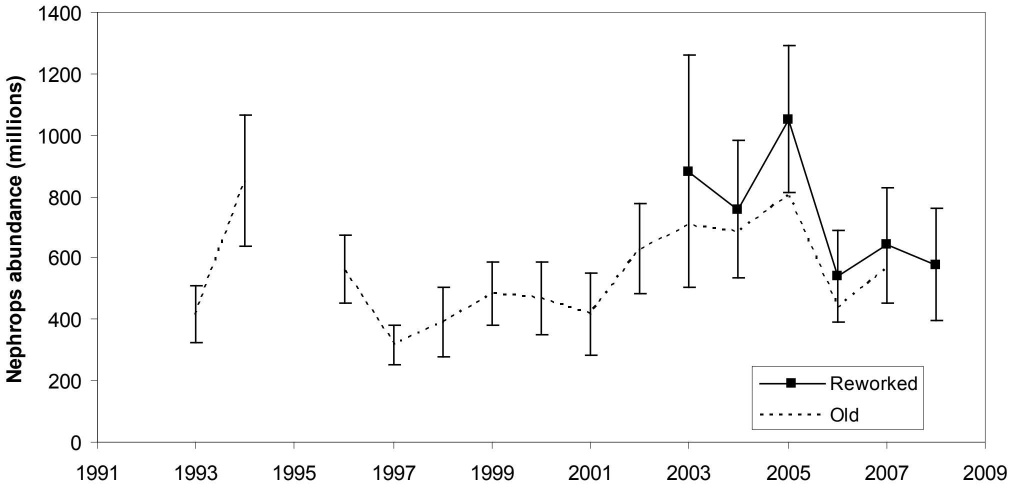


Figure 3.3.5.5 ***Nephrops*, Moray Firth (FU 9), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 –2008.**

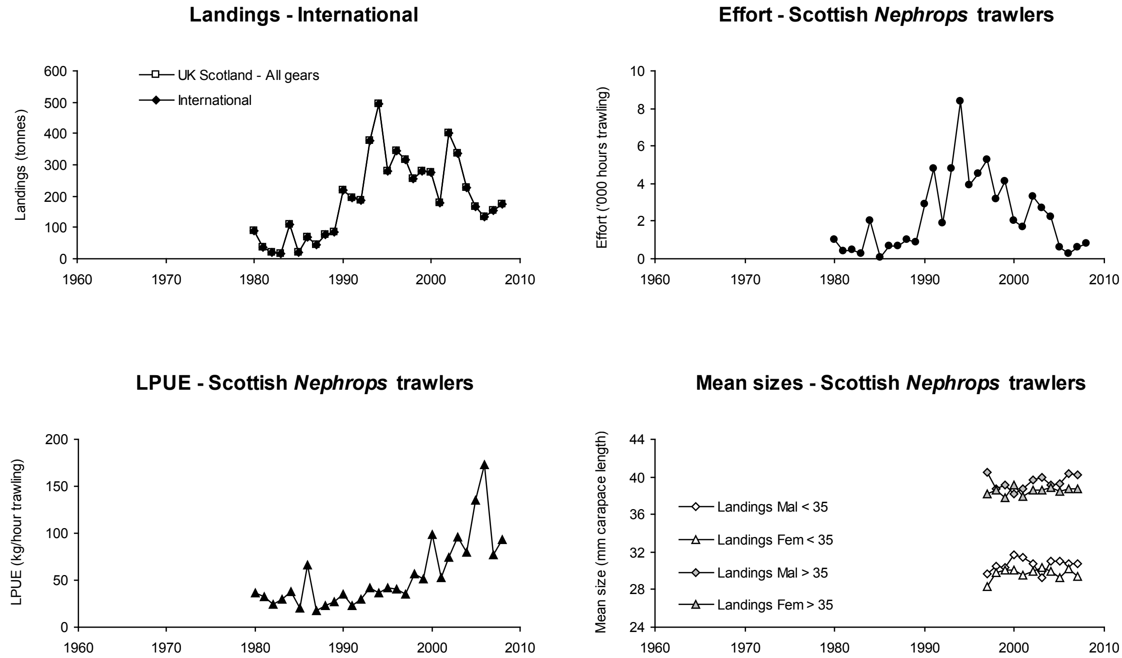


Figure 3.3.6.1 ***Nephrops*****, Noup (FU 10), Long term landings, effort, LPUE and mean sizes.**

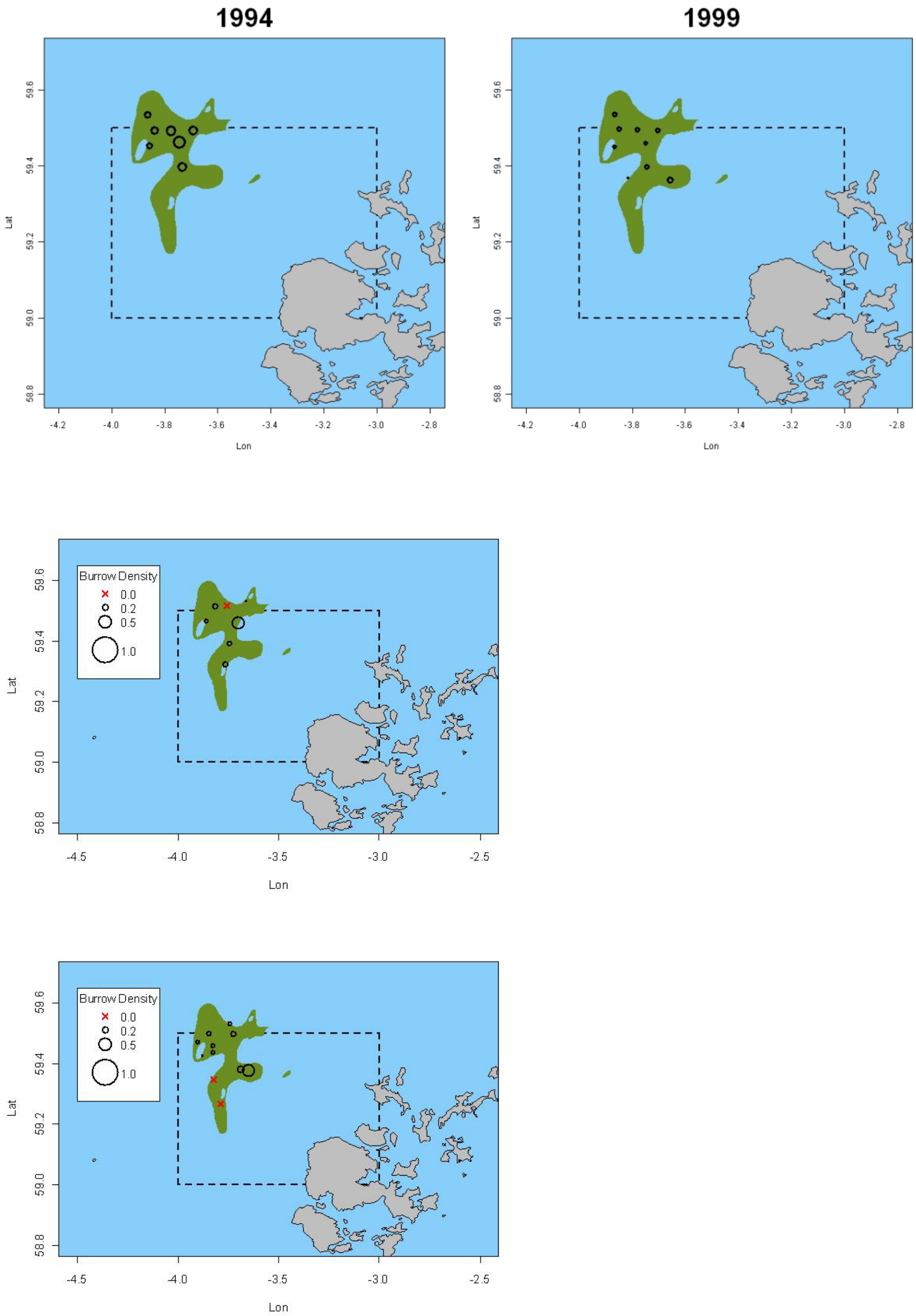


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Figure 3.3.6.2 ***Nephrops*****, Noup (FU 10). TV survey distribution and relative density (1994, 1999, 2006, 2007). Green and brown areas represent areas of suitable sediment for** ***Nephrops*****. Density proportional to circle radius. Red crosses represent zero observations.**

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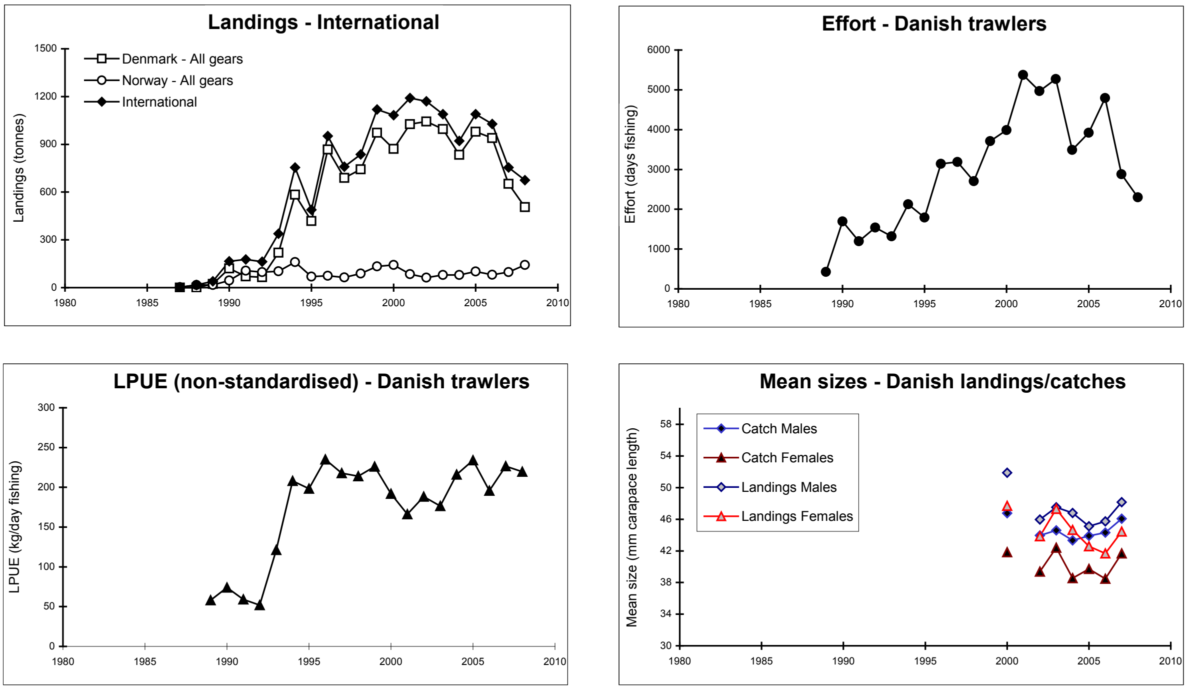

Figure 3.3.7.1 ***Nephrops*** **Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of** ***Nephrops*****.**

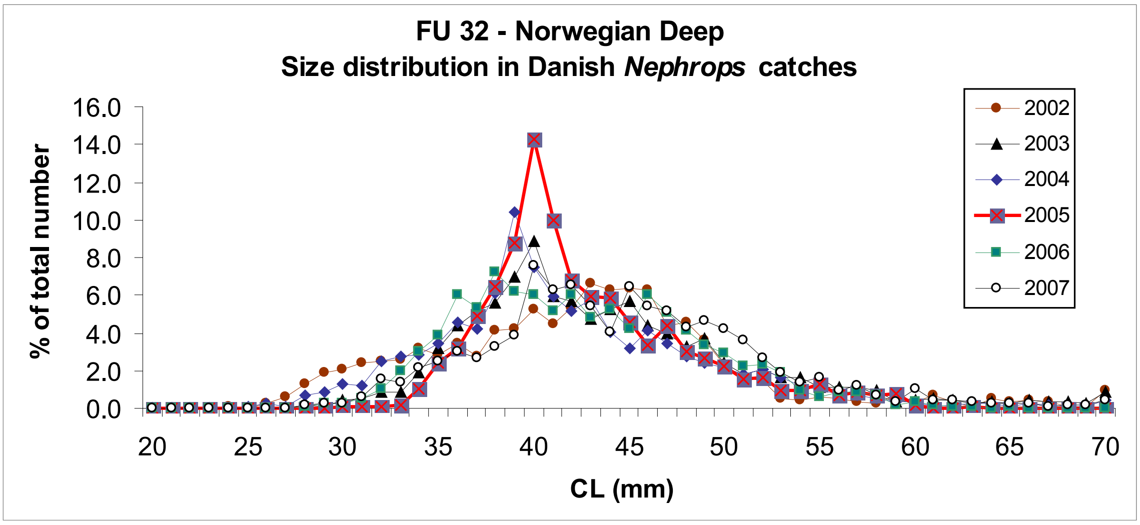

Figure 3.3.7.2. ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Danish Nephrops/finfish trawlers in FU 32.**

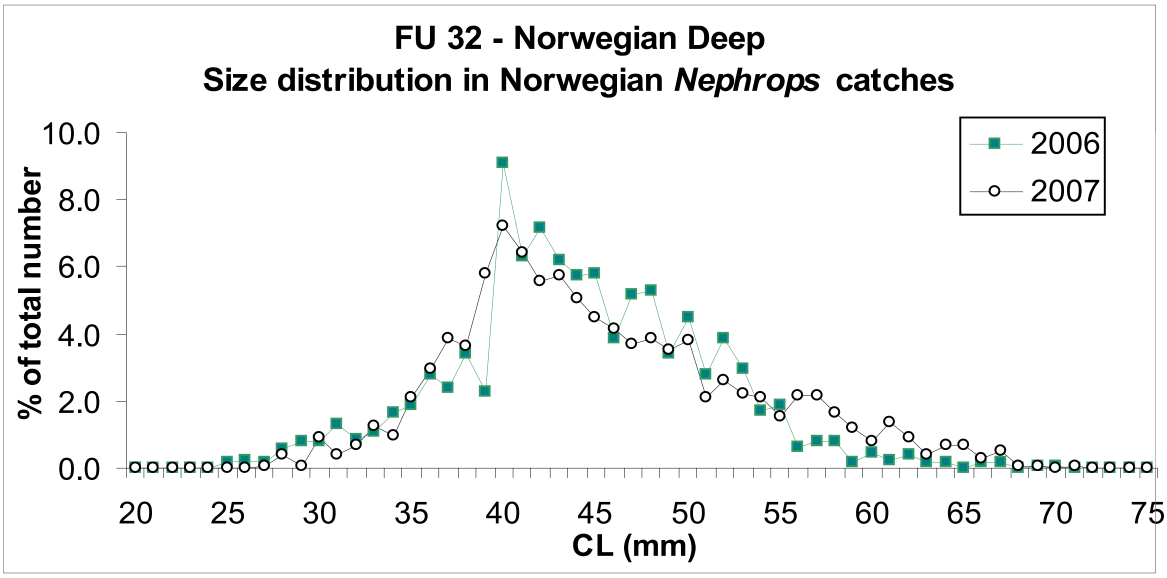

Figure 3.3.7.3. *Nephrops* **Norwegian Deep (FU 32): LFDs from Norwegian Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).**

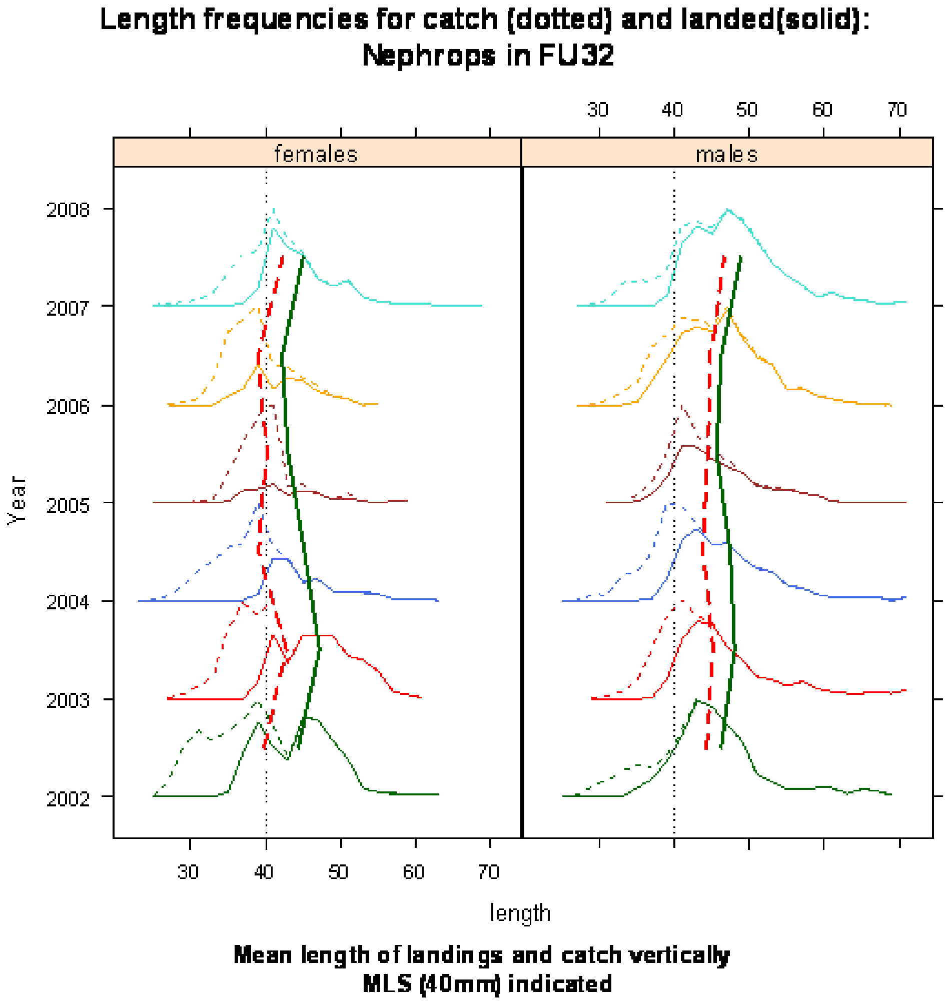

Figure 3.3.7.4 *Nephrops* Norwegian Deep (FU 32) Length composition of catch (dotted) and landed (solid) of males (right) and females left from 2002 (bottom) to 2007 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS.

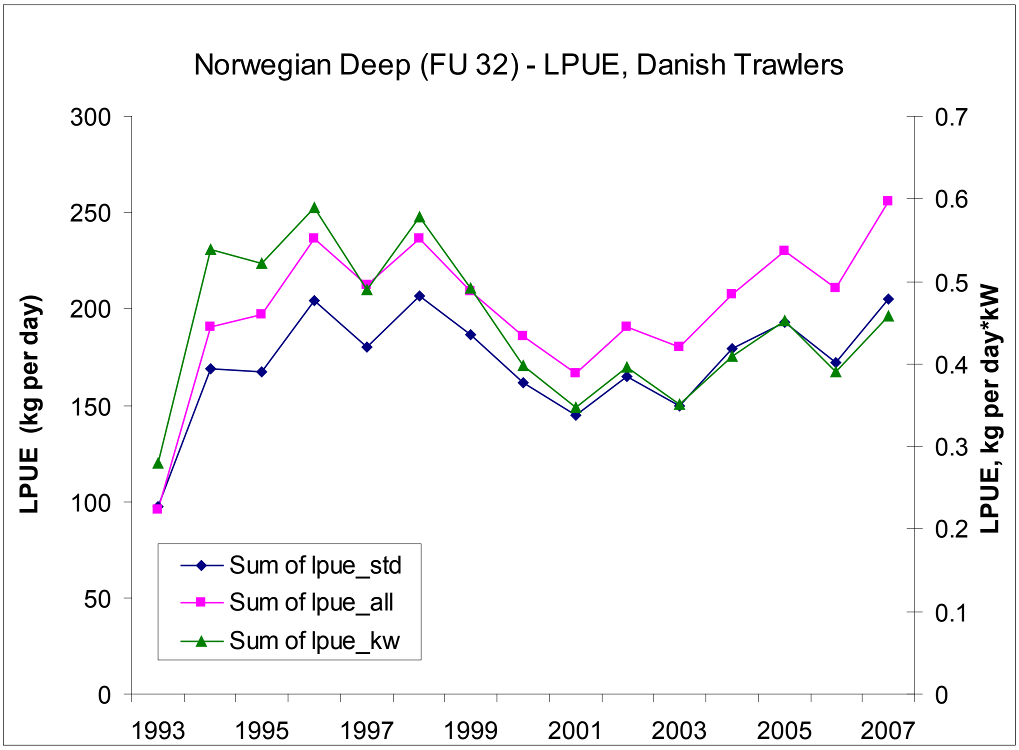

Figure 3.3.7.5. ***Nephrops*** **Norwegian Deep (FU 32) Relative LPUE of Danish trawlers calculated in various ways**

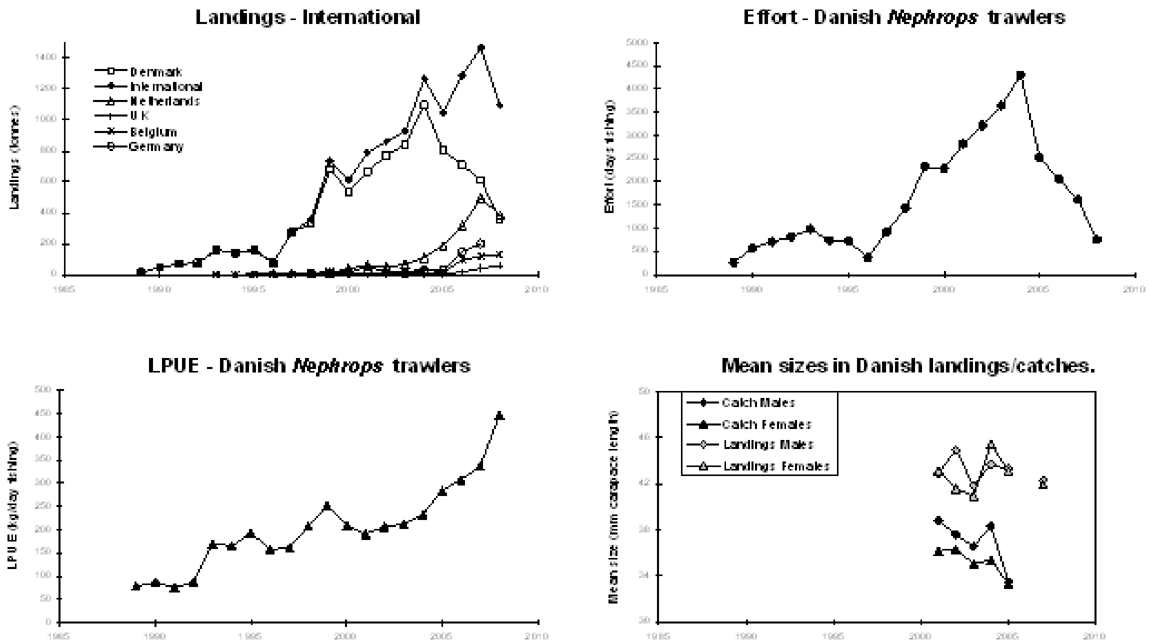

Figure 3.3.8.1 *Nephrops* Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*.

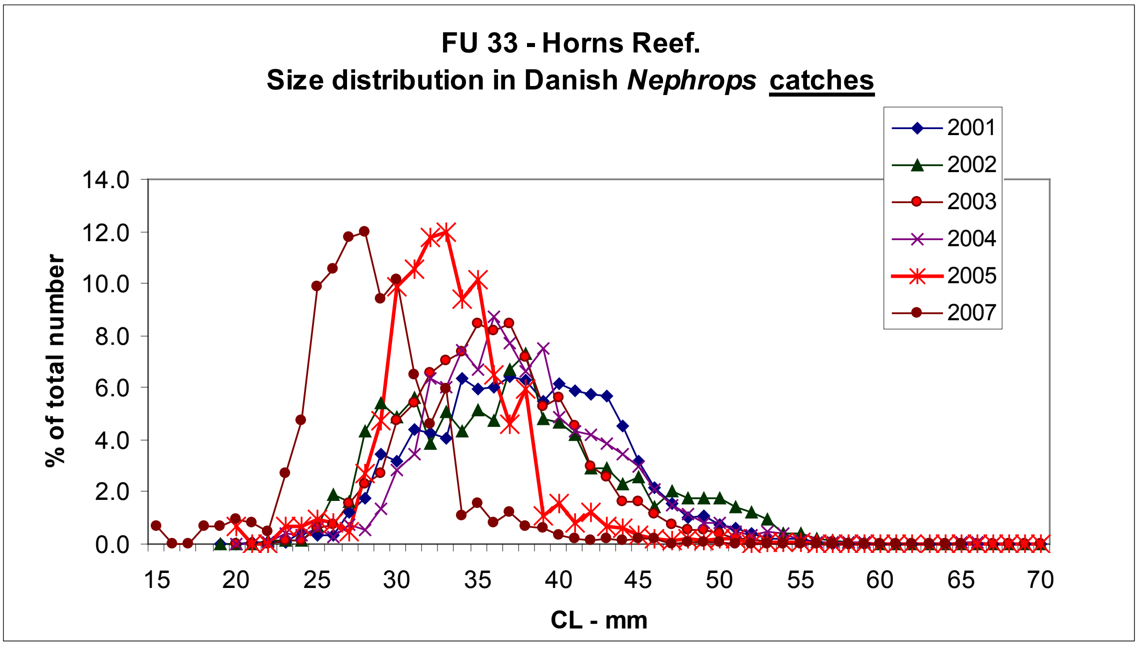

Figure 3.3.8.2. ***Nephrops*** **Off Horn Reef Size distributions of Danish catches, 2001-2007 (no data for 2006).**

4 Sandeel in IV (WGNSSK Sep. 2009)

For assessment purposes, the European continental shelf has since 1995 been divided into four regions: Division IIIa (Skagerrak), Division IV (the North Sea excl Shetland Islands), Division Vb2 (Shetland Islands), and Division VIa (west of Scotland). Only the stock in Division IV is assessed in this report. This assessment is classified as an update assessment.

4.1 General

4.1.1 Ecosystem aspects

Sandeels in the North Sea can be divided into a number of reproductively isolated sub-populations (see the Stock Quality Handbook). A decline in the sandeel population in recent years, with SSB being below B_{lim} from 2001 to 2007 concurrent with a marked change in distribution has increased the concern about local depletion, of which there has been some evidence (ICES WGNSSK 2006b, ICES AGSAN 2008b).

Local depletion of sandeel aggregations at a distance less than 100 km from seabird colonies may affect some species of birds, especially black-legged kittiwake and sandwich tern, whereas the more mobile marine mammals and fish may be less vulnerable to local sandeel depletion. In the light of studies linking low sandeel availability to poor breeding success of kittiwake, all commercial fishing in the Firth of Forth area has been prohibited since 2000, except for a short-term fishery in May and June of each year for stock monitoring purposes

The stock annex contains a broader description of ecosystem aspects.

4.1.2 Fisheries

General information about the sandeel fishery can be found in the Stock Quality Handbook.

There has been a substantial decrease in the Danish fishing fleet due to decommissioning in recent years. The Norwegian fleet also declined in the number of vessels fishing sandeels around 2005, but has increased again in recent years (section 4.2.5). How changes in the fleet structure have affected the catching efficiency and thereby the CPUE trends is unknown.

The sandeel fishery in 2009 was opened 1st of April.. As in the most recent years then main fishery took place in the in the Dogger Bank area and grounds north east of Dogger Bank.

Except in 2007 when the fishery was closed in May, the TAC has never been restrictive on the sandeel fishery. Therefore TAC regulation of the fishery does not explain the reduced level of landings observed from 2003 to 2006 (section 4.2.1), except in the Norwegian EEZ where there was only a limited monitoring fishery permitted in 2006.

4.1.3 ICES Advice

ICES recommended that the catches in 2009 should not exceed 400 000t. The recommendation was based on the harvest control rule agreed by EU and Norway (section 4.6.10) taking into account catch rates and average weight of 1 year old sandeel obtained from the real time monitoring.

Results from the harvest control rule indicated that catches in 2009 should not exceed 435 000 t. However the recommendation was set at 400.000 tons as this is the maximum catches giving a 95% probability that the stock will rebuild to $\mathbf{B}_{pa}$ by 2010.

ICES noted that the management of sandeel fisheries should try to prevent depletion of local aggregations, particularly in areas where predators congregate.

ICES also advised that, the fishery in 2009 should be allowed only if analysis of monitoring indicated that the stock could be rebuilt to $\mathbf{B}_{pa}$ by 2010.

ICES recommended that future management should take into account the spatial structure of sandeels.

4.1.4 Management

TAC

The TAC and quotas regarding sandeels in 2009 was given by the Commission regulation No. 571/2009 of 17 June 2009. The total TAC in the EU share of the North Sea was set at 360 000 tons.

Closed periods

Since 2004 the fishery in the Norwegian EEZ has been opened April 1 and closed again June 23. Since 2005 Danish vessels have not been allowed to fish sandeels before 31st of March. In 2009 sandeel fishery in the EU zone was opened on the 1st of April and closed from the 1t of August.

Closed areas

The Norwegian EEZ was closed to fishery in 2009.

4.2 Data available

4.2.1 Catch

Landing and trends in landings

Landings statistics of sandeels are given in Tables 4.2.1.1 to 4.2.1.5. Official landings were only available up to and including 2006. Figure 4.1.2.1 shows the areas for which catches are tabulated in Tables 4.2.1.1 to 4.2.1.5. The catch history is shown in Figure 4.2.1.1.

The sandeel fishery developed during the 1970s, and landings peaked in 1097 and 1998 at more than 1 million tons. There was a steep drop in total landings from 2002 to 2003, after which they have remained been low (Figure 4.2.1.1 and Table 4.2.1.2). The average landings in the last 20 years are on 632 000 t and total landings in 2009 were 348 000 t.

The distribution of landings

There are large differences in the regional patterns of the landings (Figure 4.2.1.2). In the north-eastern North Sea landings have declined since 2006 due to national regulation of the fishery in the Norwegian EEZ (see section 4.1.4). In the same period there was a marked increase in landings in the southern North Sea

Figure 4.2.1.3 shows the distribution of catches for 2009 by quarter and ICES statistical rectangle. Yearly landings for the period 1995–2009 distributed by ICES rectangle are shown in Figure 4.2.1.4.

The distribution of landings in the southern North Sea in 2003 to 2005 (i.e. from the first year when landings were at a low level in both the northern and southern North Sea) seemed more dispersed than the typical long-term pattern in the same area. Hence, grounds usually less exploited became more important for the total fishery during this period.

In 2006 there was only a limited monitoring fishery in the Norwegian EEZ and in the southern North Sea the fishery was concentrated at the fishing grounds in the Dogger Bank area in both 2006 and 2007.

In 2008 and 2009 the Dogger Bank area remained the main fishing area. However, the number of fishing grounds fished in the Dogger Bank area has increased and the fishery has expanded into the central North Sea north east of the Dogger Bank area.

4.2.2 Age compositions

Catch numbers at age by half-year is given in Table 4.2.2.1.

In 2009 the proportion of 1-group in the catch was 93% in the northern and 53% in the southern North Sea.

4.2.3 Weight at age

The methods applied to compile age-length-weight keys and mean weights at age in the catches and in the stock are described in the Stock Quality Handbook no. Q4.

The mean weights-at-age in the catch for the northern and southern North Sea in the time period 2001 to 2008 are given by country in Tables 4.2.3.1 and 4.2.3.2.

The weighted average mean weights in the catch used in the assessment are given in Table 4.2.3.3 by half year.

Mean weight in the stock from 1983 to 2009 is given in Table 4.2.3.4 by half year.

The time series of mean weight in the catch and in the stock is shown in Figure 4.2.3.1 and 4.2.3.2. From 2004 there is an increasing trend in mean weights in first half year in both the northern and southern North Sea.

Additional information about the variation in catch weight at age can be found in the Stock Quality Handbook (Q4).

4.2.4 Maturity and natural mortality

The maturity and natural mortality used in this year's sandeel assessment are assumed to be constant at age as described in the Stock Quality Handbook no. Q4. Natural mortality values are presented below. The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1.

Text table: Values for natural mortality by age and half year used in the assessments.

Age	First half year	Second half year
0	-	0.8
1	1.0	0.2
2	0.4	0.2
3	0.4	0.2
4+	0.4	0.2

4.2.5 Catch, effort and research vessel data

Catch data

Catch data used in the assessment is given in Table 4.2.2.1.

Recent changes in the fleet composition

The size distribution of the Danish fleet has changed through time, with a clear tendency towards fewer and larger vessels (ICES WGNSSK 2006b). In 2009 only 84 Danish vessels participated in the North Sea sandeel fishery, compared to more than 200 vessels in 2004 (Table 4.2.5.1).

The same tendency was seen for the Norwegian vessels fishing sandeels until 2005 (Table 4.2.5.1). In 2006 only 6 Norwegian vessels were allowed to participate in an experimental sandeel fishery in the Norwegian EEZ compared to 53 in 2002. However, the number of Norwegian fishing vessels participating in the sandeel fishery has increased to 42 in 2008. From 2002 to 2008 also the average GRT per trip in the Norwegian fleet increased from 269 to 507 t.

The rapid changes of the structure of the fleet that have occurred in recent years may introduce more uncertainty in the assessment, as the fishing pattern and efficiency of the "new" fleet may differ from the previous fleet.

Trends in overall effort and CPUE

Tables 4.2.5.2 and 4.2.5.3 and Figure 4.2.5.1 show the trends in the international effort over years measured as number of fishing days standardised to a 200 GRT vessel. Total international standardized effort peaked in 1989 (26000 days), and was at a relative stable level from 1989 to 2001 (in average 18.000 days). Total international effort decreased again from 2001 and has remained at a historical low level around 6.000 days since 2005

As indicated in Figure 4.2.5.1 the CPUE had an by increasing trend from 1989 to 2002 followed by a steep decrease from 63 tons/day in 2002 to 21 tons/day in 2003. Since 2004 the CPUE have been increasing and was in 2009 almost at the same level as in 2002.

A discussion about the possible problems of using commercial CPUE as an index of sandeel population size was included in ICES WGNSSK (2006a) and ICES AGSAN (2007a).

The tuning series used in the assessments

The following commercial tuning series were made available for the assessment (Table 4.2.5.4):

Fleet 1: Northern North Sea 1983–1998 first half year

Fleet 2: Northern North Sea 1999–2009 first half year

Fleet 3: Southern North Sea 1982–1998 first half year

Fleet 4: Southern North Sea 1999–2009 first half year

Fleet 5: Northern North Sea 1983–2009 second half year

Fleet 6: Southern North Sea 1983–2009 second half year

Standardisation of effort data

Due to the change in size distribution of the vessels fishing sandeels in the North Sea (see e.g. ICES WGNSSK 2006b or STECF 2004 and 2005a and b) and the relationship between vessel size and fishing power, effort standardisation is required when establishing the commercial tuning series used in the sandeel assessment. The standardisation procedure is described in the Stock Quality Handbook.

Fisheries independent tuning

A time series of fishery independent surveys are being conducted for this stock (see ICES AGSAN 2008b). Currently, the time series are too short or do not cover the entire distribution area of sandeels in IV, preventing evaluation as tuning time series for stock assessment.

4.3 Data analyses

The Seasonal XSA (SXSA) developed by Skagen (1993) was used to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2009.

In addition to the analysis using the same settings and input data as last year (the SPALY run) three exploratory analyses were made to investigate the sensitivity of the results to different assumptions regarding weighting of the tuning fleets.

4.3.1 Exploratory catch-at-age-based analyses

All the exploratory assessments used the same SXSA settings as the SPALY assessment (listed in Table 4.3.2.7) except assessment 4 that applied log weightings of S-hat (estimate of survivors) from the inverse variance of catchabilities from the individual tuning fleets, instead of the default manual weighting (listed in Table 4.3.2.1).

Exploratory assessment 1: The SPALY run used the same settings and tuning fleets as the 2008 final assessment. The residuals of log stock number for the SPALY analysis are given in Figure 4.3.2.1. They appear to be noisy but without strong trends.

The retrospective analysis (Figure 4.3.2.2) shows that the assessment has a strong tendency to underestimate F and overestimate stock size. The retrospective bias is about the same level as that of last year's assessment.

For comparison with the suggested Final assessment the output from the SPALY assessment analysis is presented in Tables 4.3.2.8 (fishing mortality at age by half year), 4.3.2.9 (fishing mortality at age by year), 4.3.2.10 (stock numbers at age), 4.3.2.11 (catchabilities for the tuning fleets). The stock summary is presented in Table 4.3.2.12.

Exploratory assessment 2: If all tuning data from the Northern North Sea in recent years (i.e. after 1998) was excluded from the calibration a less biased retrospective pattern was obtained as shown in Figure 4.3.2.3.

Exploratory assessment 3: Excluding only the most recent tuning data from the northern North Sea, i.e. the 2009 data from Fleet 2 , also improved the retrospective pattern significantly as shown in Figure 4.3.2.4.

Exploratory assessment 4: The default setting of SXSA that is used in SPALY assessment, gives equal and fixed weight to the CPUE indices from the northern and southern areas. In exploratory assessment 4 this setting was changed allowing the SXSA to weight the tuning indices individually (Option 2 with log weighting of Shat). As indicated in Figure 4.3.2.5 this exploratory assessment also provided a less biased retrospective pattern than obtained by the SPALY run. The residuals of log stock number for this assessment are given in Figure 4.3.2.6.

4.3.2 Final assessment

The exploratory analyses indicated that the perception of the stock and the retrospective bias were sensitive to the tuning fleets from the northern North Sea in particular.

The settings of SXAS as used in the SPALY run gives equal and fixed weighting to the CPUE indices from the northern and southern areas. This seems unreasonable as the overall effort and catch proportions in the two areas have changed over the years. In recent years the fishing effort in the northern North Sea have declined both in absolute terms and relative to the effort applied in southern North Sea (Table 4.2.5.2 and 4.2.5.3). For example the average total standardised effort in the period 1983 – 2002 estimated at 5620 days declined to an average at 1620 days in the period 2003 – 2009. In 2009 the effort in this area was estimated at 840 days only. Furthermore in 2006 and 2009 the Norwegian EEZ was closed to fishery. In these years the fishery from the northern North Sea was restricted to very few squares in sampling area 3 as indicated in Figure 4.2.1.3 and 4.2.1.4.

All the exploratory assessments that down weighted the influence of the northern CPUE indices provided significantly less biased retrospective patterns than the SPALY assessment. In addition the residuals are decreased when the northern tuning fleets are down weighted in the assessment. In particular residuals from Fleet 6 (which contribute most to the catches) in the exploratory run 4 (Figure 4.3.2.6) were smaller than in the SPALY assessment.

As it was not possible to find an objective way to exclude parts of the northern CPUE indices from the assessment it was decided to adopt exploratory assessment 4 as the final run. In this run model and data determine the weighting of the individual tuning fleets. The same approach is also used in the Norway Pout assessment also using the SXSA model.

The output from the Final assessment analysis is presented in Tables 4.3.2.2 (fishing mortality at age by half year), 4.3.2.3 (fishing mortality at age by year), 4.3.2.4 (stock numbers at age), 4.3.2.5 (catchabilities for the tuning fleets). The stock summary is presented in Table 4.3.2.6.

4.4 Historic Stock Trends

The stock summary is given in Figure 4.3.2.7. The final assessment estimates SSB to have been below B_{lim} from 2004 to 2006 and above B_{pa} in 2008 and 2009. $F_{(1-2)}$ is estimated to have been below the long time average since 2006.

4.5 Recruitment estimates

DTU AQUA has measured sandeel larvae abundance in the North Sea from 2004 to 2009. In addition to the larvae survey, DTU AQUA has been implementing a dredge survey from 2003 to 2008. Both surveys are exploratory with limited coverage of the sandeel distribution area and do not provide sufficient information to be included in the assessment yet. The Institute of Marine research (IMR) is also implementing surveys to measure the abundance 1-group and older sandeels. However, no information was available from the Norwegian survey for the present assessment.

As no recruitment estimates from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. This year the recruitment is estimated at 3000 billions (number at age 0 in 2009) which is a factor 10 higher than in most recent years. However the tuning diagnostics (Figure 4.3.2.6) indicate that the 0-group CPUE within the assessment year is a poor predictor of recruitment and therefore, this estimate is not used in the forecast.

Recruitment estimates used for short term forecasting

For the short term forecast (section 4.6) the 25th percentile, of the long-term recruitment estimated in the Final SXSA assessment (329×10^9 age 0 sandeels) was used as the recruitment in 2009 and 2010. This long term estimate is close to the average recruitment over the last 3 years estimated at 325×10^9.

For comparison the 25th percentile, of the long-term recruitment estimated in the SPALY assessment was 292×10^9 age 0 sandeels (Table 4.6.2).

4.6 Short-term forecasts

The high natural mortality of sandeel and the few year classes contributing to the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Commercial CPUE is a poor predictor of 0-group recruitment and reliable indices from surveys are not yet available, therefore prediction of 1 group abundance in the year following an assessment has a high degree of uncertainty

Prognosis for 2009 and 2010

The prediction was made using half year time steps as in the assessment. Stock numbers at 1st of January 2009 were calculated from the final SXSA assessment. Values for natural mortalities and proportion mature are the same as those used in the assessment.

F-at-age in the assessment year (2009) was used as a estimates of F in the forecast year.

Stock and catch weights of 2009 were those used in the SXSA assessment (Table 4.2.3.4). Average weights of the time period 1995 to 2009 were used in 2010 and 2011. Stock and catch weight prior to 1995 were not used, due to a change in the procedure used for age determination from 1995 (see Stock Annex).

The input data used in the forecast based on the suggested Final assessment is given in Table 4.6.1.

The input data used in the forecast based on the SPALY assessment is given in Table 4.6.2.

Text Table: Forecast based on suggested Final assessment

SSB(2010) = 1030 000 t; landings (2009) = 331 000 t. Input data in Table 4.6.1.

F multiplier	F(2010)	Landings(2010) `000 t	SSB(2011) `000t
0	0	0	1196
0.1	0.033	41	1160
0.2	0.066	81	1124
0.3	0.1	119	1090
0.4	0.133	156	1058
0.5	0.166	191	1027
0.6	0.2	226	996
0.7	0.233	259	968
0.8	0.266	291	940
0.9	0.299	321	913
1	0.332	351	887
1.1	0.366	380	863
1.2	0.399	408	839
1.3	0.432	434	816
1.4	0.466	460	794
1.5	0.499	485	772
1.6	0.532	510	752
1.7	0.565	533	732
1.8	0.598	556	713
1.9	0.632	578	695
2	0.665	599	677
2.1	0.698	620	660
2.2	0.732	640	643
2.3	0.765	659	627
2.4	0.798	678	612
2.5	0.831	696	597
2.6	0.864	714	583
2.7	0.898	731	569
2.8	0.931	748	556
2.9	0.964	764	543
3	0.998	780	530
3.1	1.031	795	518
3.2	1.064	810	506
3.3	1.097	824	495
3.4	1.131	838	484

Shaded scenarios are not considered consistent with the precautionary approach.

Text Table: Forecast based on SPALY assessment.

SSB(2010) = 456 000t; Landings (2009) = 327 000t. Input data in Table 4.6.2

F multiplier	F(2010)	Landings (2010) '000t	SSB(2010) '000t
0	0	0	734
0.1	0.064	42	696
0.2	0.128	81	661
0.3	0.192	118	629
0.4	0.256	153	599
0.5	0.32	186	570
0.6	0.384	217	544
0.7	0.448	246	519
0.8	0.512	274	495
0.9	0.576	300	473
1	0.641	325	452
1.1	0.705	348	433
1.2	0.769	370	414
1.3	0.833	391	397
1.4	0.897	412	381
1.5	0.961	431	365
1.6	1.025	449	350
1.7	1.089	467	337
1.8	1.153	483	323
1.9	1.217	499	311
2	1.281	515	299
2.1	1.345	530	288
2.2	1.409	544	277
2.3	1.473	557	267
2.4	1.537	570	257
2.5	1.601	583	248
2.6	1.665	595	239
2.7	1.729	606	230
2.8	1.793	617	222
2.9	1.857	628	215
3	1.922	639	207
3.1	1.986	649	200
3.2	2.05	658	193
3.3	2.114	668	187
3.4	2.178	677	181

Shaded scenarios are not considered consistent with the precautionary approach.

4.6.1 Harvest control rule

In its advice on harvest control rules and long term management strategies for sandeels (ICES Advice, 2007, 2008a) ICES suggest a management strategy for setting a TAC for sandeel in the North Sea based on real time monitoring of the fishery in the beginning of the season.

The harvest control rule is based on results from a high number of short term forecasts estimating the relationship between recruitment in a given year (the assessment year) and the maximum catch level of the subsequent year (forecast year) that will lead to a SSB at Bpa (600 000t) at the beginning of the year after.

Short term forecasts indicate that the relationship between the recruitment in 2009 and the TAC in 2010 (i.e. the maximum catch in 2010 that will meet the objective of SSB to be above Bpa in 2011) can be approximated by the relationship:

$$TAC_{2010} = 142 + R_{0,2009} * 1.693 \qquad (1)$$

where $R_{0,2009}$ is recruitment at age-0 in 2009 and TAC_{2010} is the catch in 2010 that will result in SSB=Bpa in 2011. The relationship is indicated in Figure 4.6.1a.

The relationship (1) can be translated into a relationship between the stock size of 1-group sandeels in 2010 and the TAC in 2010, that will lead to SSB being 600 000 t in 2011, by projecting age-0 sandeels in second half year of 2009 to age-1 sandeels 1st of January 2010 applying natural mortality of age-0 sandeels for second half year of 2009. This relationship is indicated in Figure 4.6.1b and can be expressed by:

$$TAC_{2010} = 142 + R_{1,2010} * 3.768 \qquad (2)$$

where $R_{1,2010}$ is the stock size of age-1 sandeels in 2010.

In order to compensate for the changes in mean weights at age between the years in 2007 and 2008 the relationship (2) was adjusted by a factor expressing the ratio between the observed mean weight of age 1 sandeels during the real time monitoring period and the mean weight for age-1 sandeels during the RTM in former years. Applying this weighting procedure to estimate the TAC in 2010 (2) can be expressed by:

$$TAC_{2010} = 142 + \left(R_{1,2010} \cdot 3.768 \cdot \frac{W_{obs}}{W_m} \right) \qquad (3)$$

where W_{obs} is mean weight of age-1 sandeels observed during 2010 RTM and W_m is the mean weight of age-1 sandeels observed in RTM in 2004 to 2009 (see text table below).

Text table: Mean weight of age-1 sandeels in week 17, as measured in RTM from 2004 to 2009.

Year	Mean weight age-1 g
2004	3.7
2005	3.5
2006	3.5
2007	4.6
2008	3.7
2009	5.9
Average	4.2

4.6.2 Stochastic short-term forecast.

Stochastic short term forecast not made for sandeels.

4.7 Medium-term forecasts

Medium term prognoses can not be made for sandeels.

4.8 Biological reference points

B_{lim} is set at 430,000 t, the lowest observed SSB in the period 1976-1998. The Bpa is estimated to 600,000 t. Further information about biological reference points for sandeels in IV can be found in the Stock Quality Handbook no. Q4.

4.9 Quality of the assessment

Although the present assessment gave better statistics and improved the retrospective pattern it is still considered uncertain.

The assessment does not take into consideration the spatial stock structure of sandeels, fishery independent data is not available yet, and the potential changes in catchabilities of the larger vessels are not taken into account

The exploratory assessments indicated that the retrospective bias is related to changes in the distribution of fishing effort (section 4.3). Therefore the exploratory assessment 4 was selected as the final run. In this run the model and data determine the weighting of the individual tuning fleets which improved the retrospective pattern as well as the statistics.

The forecast assumption is based on the relationship between effort and F. However this relationship is poor. The relationship between the effort and landings indicated in the forecast table is therefore uncertain.

Suggestions for modifications of the assessment

The assessment should take account of the spatial stock structure of sandeels. It is accordingly important to define the population units to be assessed. A framework for implementing area based population analysed was presented in ICES (ICES AGSAN 2007a and ICES 2008a).

Preliminary results of the area based analysis can be found at http://www.nielsensweb.org/sandeel/

It is a prerequisite for the improvement of the assessment that a fisheries independent time series of sandeel abundance is established. Development of such time series should preferably be the result of coordinated effort between European institutes.

4.10 Status of the Stock

Recruitment has been below average from 2002 to 2007. In 2008 the recruitment estimate was above the long term average. SSB is estimated to have been below Bpa from 2000 to 2007, and above Bpa in 2008 and 2009. SSB is forecast to be above B_{pa} in 2010. $F_{(1-2)}$ is estimated to have been below the long term average since 2006.

4.11 Management Considerations

No fishing mortality (F) reference points are given for sandeels in the North Sea because there is no clear relationship between the size of the spawning stock biomass and the recruitment. The recruitment of sandeels seems more linked to environmental factors than to the size of the spawning stock biomass (see the Stock Quality Handbook no. Q4).

The present knowledge on defining subpopulations is too limited to recommend specific management measures for 2010, which can fully take the population structure into account, but work is proceeding on defining local sub-populations so that the scale of "local depletion" can be quantified and be made operational for a North Sea-wide implementation.

Suggestion for management of the sandeel fishery in 2010

The aim of management in 2010 should be to maintain SSB above B_{lim} with a high probability, and to prevent local depletion.

The short-term forecast (section 4.6) indicates that a TAC less than 612 000 tons would maintain the SSB above B_{pa}. However, as the assessment is considered uncertain it is suggested that the TAC in 2010 should not exceed 400 000t in order to maintain 95% probability that SSB remains above B_{lim} . Simulations (WGNSSK 2006) showed that upper catch limit 400 000t makes the HCR robust, defined as a 95% probability of SSB>Blim, to assessment bias.

If a fixed TAC at 400 000t is maintained, the Real Time Monitoring of the fishery is considered redundant given the improved stock conditions. As indicated in Figure 4.6.1a only a very low recruitment (less than 75 billion) would give a TAC less than 400.000t. The lowest estimate of recruitment was 80 billion in 2002 and the preliminary (and uncertain) estimate of the 2009 recruitment does not indicate such a recruitment failure.

The fishery shall be closed 1 August 2010 or earlier to prevent fishery of the 0 group.

Due to the different and likely smaller stock in the Northern North Sea special management should be considered for this area in 2010 to prevent depletion at grounds with known local low stock size.

Changes in the fleet composition

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005, and a 53% reduction in total kilowatt days. In 2006 and 2007 the Danish fleet increased to 124 and 116 vessels participating in the sandeel fishery. The introduction of ITQ accelerated the change towards fewer and larger vessels, and only 83 and 84 Danish vessels were fishing sandeels in 2008 and 2009 respectively.

Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has was observed from 2002 to 2006. However the number increased again in 2007 and 2008 when the vessels were given individual quotas.

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Table 4.2.1.1. SANDEEL in IV.

Official landings reported to ICES

SANDEELS IVa

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	4,742	1,058	111	399	147	-	-	1,873	958
Faroe Islands	-	-	-	-	15	-	-		
Norway	11,522	4,121	185	280	64	-	-		20,332
Sweden	55	-	-	73	-	-	-	21	
UK (E/W/NI)	-	-	-	-	-	-	-		
UK (Scotland)	4,781	970	543	186	-	-	-		
Total	21,100	6,149	839	938	226	0	0	1,894	21,290

*Preliminary.

SANDEELS IVb

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	533,905	638,657	627,097	245,096	273492	129776	241,257	142,309	240,689
Faroe Islands			16,167	5,168	3461	-	-	2,391	2,385
Germany	-	-	-	534	2658	-	3,304	1,989	
Ireland	-	-	-	-	-	-	-		
Norway	107,493	183,329	175,799	29,336	48464	17341	5,814	51,134	61,221
Sweden	27,867	47,080	36,842	21,444	34477	8327	32,709	6,721	12,405
UK (E/W/NI)	-	-	-	-	-	-	-		
UK (Scotland)	5,978	-	2,442	115	29	-	688	1,657	6,259
France								2	
Total	675,243	869,066	858,347	301,693	362,552	155,444	283,772	206,203	324,967

*Preliminary.

SANDEELS IVc

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	11,993	7,177	4,996	28,646	14,104	22,985	10,595	804	1,439
Germany	-	-	-	-	-	-	301		
France	1	-	-	-	+	-	2		1
Netherlands	-	-	+	-	-	-	-		
Norway	-	-	-	-	139	-	-		
Sweden	-	-	-	160	-	-	-		
UK (E/W/NI)	+	-	-	+	-	-	-		
Total	11,994	7,177	4,996	28,806	14,243	22,985	10,898	804	1,440

*Preliminary.

Summary table official landings

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total IV tonnes	708,337	882,392	864,182	331,437	377,021	178,429	294,670	208,901	347,697
TAC	1,020,000	1,020,000	1,020,000	918,000	826,200	660,960	300,000	173,000	400,000

By-catch and other landings

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Area IV tonnes: official-WG	9,188	20,781	53,482	5,817	15,521	6,329	6,770	2,601	12,497

Summary table - landing data provided by Working Group members

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total IV - tonnes	699,149	861,611	810,700	325,620	361,500	172,100	287,900	206,300	335,200

Table 4.2.1.2. SANDEEL in IV. Landings ('000 t), 1952-2009 (Data provided by Working Group members)

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Lithuania	Total
1952	1.6	-	-	-	-	-	-	-		1.6
1953	4.5	+	-	-	-	-	-	-		4.5
1954	10.8	+	-	-	-	-	-	-		10.8
1955	37.6	+	-	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	-	113.3
1970	187.8	+	-	-	-	+	-	3.6	-	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	-	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	-	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	-	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	-	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	-	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	-	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	-	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	-	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	-	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	-	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	-	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	-	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	-	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	-	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	-	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	-	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	-	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	-	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	-	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	-	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	-	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	-	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	-	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	-	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	-	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	-	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	-	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	-	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	-	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	-	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	-	861.6
2002	629.7	-	-	-	-	176.0	0.1	4.9	-	810.7
2003	274.0	-	-	-	-	29.6	21.5	0.5	-	325.6
2004	277.1	2.7	-	-	-	48.5	33.2	+	-	361.5
2005	154.8	-	-	-	-	17.3	-	-	-	172.1
2006	250.6	3.2	-	-	-	5.6	27.8	-	-	287.9
2007	144.6	1.0	2.0	-	-	51.1	6.6	1.0	-	206.3
2008	234.4	4.4	2.4	-	-	81.6	12.4	-	-	335.2
2009	285.7	12.2	2.5	-	1.8	27.4	12.4	3.6	2.0	347.7

* Preliminary

\+ = less than half unit.

\- = no information or no catch.

Table 4.2.1.3. SANDEEL in IV. Monthly landings (ton) by area as indicated in Fig 4.1.2.1.

	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Total
2002												
Mar	3077	0	0	3911	2715	0	928	322	0	0	0	10953
Apr	104033	1745	0	66992	51007	0	15466	904	59	475	109	240790
May	176437	3341	0	78497	37385	0	37058	915	151	3272	12	337068
Jun	118879	125	0	27386	19380	10	10561	8673	2531	12498	0	200043
Jul	1128	0	0	90	48	0	193	2744	204	9869	0	14276
Aug	0	0	0	109	261	0	397	0	0	5146	422	6335
Sept	0	0	0	0	74	0	290	0	0	0	0	364
Oct	0	0	0	1	0	0	0	0	0	2	0	3
Dec	0	0	0	0	0	0	0	0	2	0	0	2
Total	403554	5211	0	176986	110870	10	64893	13558	2947	31262	543	809834
2003												
Mar	1947	52	0	97	380	7	225	325	0	0		3033
Apr	28806	5026	0	8341	6072	0	1900	81	0	662	49	50937
May	59890	1812	24	8884	9357	0	4532	10995	1020	9991	16	106521
Jun	11737	49	0	11906	398	10	2140	20891	13318	21639		82088
Jul	3604	0	0	9857	2013	0	3272	2738	1697	5790		28971
Aug	960	6	0	4381	4687	0	11293	16	175	687	121	22326
Sept	0	255	73	35	1551	0	2955	0	0	1094		5963
Oct	0	0	0	114	0	0	1589	0	0	127		1830
Nov	0	0	0	0	0	0	2070	0	0	0		2070
Dec	0	0	0	0	0	0	45	0	0	0		45
Total	106944	7200	97	43615	24458	17	30021	35046	16210	39990	186	303784
2004												
Feb	0	0	0	0	0	0	0	0	0	7		7
Mar	326	0	0	1001		0	37		260	2		1626
Apr	15893	627	0	15824	4847	0	10732	471	322	834		49550
May	46631	1044	0	21607	5495	0	22629	20484	233	8578		126701
Jun	21841	146	0	5077	1800	0	13821	13680	4789	35909		97063
Jul	1146	116		813	2272		6019	7430	1184	12923		31903
Aug	325			3963	5449		2589			3357		15683
Sept					3006		116			2		3124
Oct												
Total	86162	1933	0	48285	22869	0	55943	42065	6788	61612	0	325657
2005												
Apr	4017			71	1476		462	144		88		6258
May	34506	57		9536	7512		6507	13333	32	2410		73893
Jun	19216	21		8952	2545		8107	8224	19370	21959		88394
Jul				1668			987	922				3577
Aug				3			2					5
Sep												0
Okt										1		1
Total	57739	78	0	20230	11533	0	16065	22623	19402	24457	0	172128
2006												
Apr	10141			8733	1387		188	111		82		20642
May	96349			25020	3096		3830	201		6455		134951
Jun	59827	34		3184	47		4815	12035	5236	9506		94684
Jul	1122			94			3309	2600	1171	11745		20041
Aug				2			94			283		379
Sep				5			2			2		9
Oct					5		257					262
Nov		30										30
Total	167439	64	0	37038	4530	0	12495	14947	6407	28073	0	270998
2007												
Apr	23545			6378	19966		7098	646		406		58039
May	65238	308	4	4990	31062		22979	3024	244	1470		129319
Jun	501	69		50	4512		4032	25	559	2966		12714
Total	89284	377	4	11418	55540	0	34109	3695	803	4842	0	200072
2008												
April	20072	41		8148	10313		3884			460		42917
May	114280	9972		26263	29615		15986	1291		4700		204518
June	62816			3452	1599		10738	5152	384	3574		87715
July	1926			465			613	368	577	2823		6771
August				0			2			1		4
September				16			2			2		19
Total	199094	10013	0	38344	41527	0	31225	6810	961	11560	0	341945
2009												
April	42072			12774			1528			168		56542
May	126157	51		26225	976		5077	1364		3694		163544
June	17273			50825	1083		23876	4377	187	4126		101747
July	680			15492	0		9398			267		25836
Total	186182	51	0	105316	2059	0	39880	5742	187	8254	0	347670
%	54%	0%	0%	30%	1%	0%	11%	2%	0%	2%	0%	100%
Avera 02-09	162050	3116	13	60154	34173	3	35579	18061	6713	26256	91	346209

Table 4.2.1.4. SANDEEL in IV. Total annual landings ('000 t) by area (data provided by Working Group members)

	Area										Sampling area		
Year	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98.8	28.1	3.9	24.5	85.1	0.0	13.5	58.3	6.7	28.0	0	130.6	216.3
1973	59.3	37.1	1.2	16.4	60.6	0.0	8.7	37.4	9.6	59.7	0	107.6	182.4
1974	50.4	178.0	1.7	2.2	177.9	0.0	29.0	27.4	11.7	25.4	7.4	386.6	117.1
1975	70.0	38.2	17.8	12.2	154.7	4.8	38.2	42.8	12.3	19.2	12.9	253.7	156.5
1976	154.0	3.5	39.7	71.8	38.5	3.1	50.2	59.2	8.9	36.7	20.2	135.0	330.6
1977	171.9	34.0	62.0	154.1	179.7	1.3	71.4	28.0	13.0	25.3	21.5	348.4	392.3
1978	159.7	--50.2--		346.5	--70.3--		42.5	37.4	6.4	27.2	28.1	163.0	577.2
1979	194.5	0.9	61.0	32.3	27.0	72.3	34.1	79.4	5.4	44.3	13.4	195.3	355.9
1980	215.1	3.3	119.3	89.5	52.4	27.0	90.0	30.8	8.7	57.1	25.4	292	401.2
1981	105.2	0.1	42.8	151.9	11.7	23.9	59.6	63.4	13.3	45.1	46.7	138.1	378.9
1982	189.8	5.4	4.4	132.1	24.9	2.3	37.4	75.7	6.9	74.7	52.0	74.4	479.2
1983	197.4	-	2.8	59.4	17.7	-	57.7	87.6	8.0	66.0	37.0	78.2	419.0
1984	337.8	4.1	5.9	74.9	30.4	0.1	51.3	56.0	3.9	60.2	32.6	91.8	532.8
1985	281.4	46.9	2.8	82.3	7.1	0.1	29.9	46.6	18.7	84.5	17.2	79.7	513.5
1986	295.2	35.7	8.5	55.3	244.1	2.0	84.8	22.5	4.0	80.3	14.0	375.1	457.4
1987	275.1	63.6	1.1	53.5	325.2	0.4	5.6	21.4	7.7	45.1	7.2	395.9	402.8
1988	291.1	58.4	2.0	47.0	256.5	0.3	37.6	35.3	12.0	102.2	4.7	384.8	487.6
1989	228.3	31.0	0.5	167.9	334.1	1.5	125.3	30.5	4.5	95.1	3.5	492.4	526.3
1990	141.4	1.4	0.1	80.4	156.4	0.6	61.0	45.5	13.8	85.5	2.3	219.5	366.7
1991	228.2	7.1	0.7	114.0	252.8	1.8	110.5	22.6	1.0	93.1	+	372.9	458.9
1992	422.4	3.9	4.2	168.9	67.1	0.3	101.2	20.1	2.8	54.4	0	176.7	668.6
1993	196.5	21.9	0.1	26.2	164.9	0.3	88.0	26.6	3.9	48.7	0	276.0	301.9
1994	157.0	108.6	-	61.7	203.4	2.7	175.0	16.0	2.8	42.0	0	489.7	279.5
1995	322.4	43.9	147.4	86.7	169.5	1.0	59.4	26.6	5.3	55.8	1.3	421.2	496.8
1996	310.5	18.6	31.2	40.8	153.0	4.5	134.1	12.7	3.0	52.5	1	341.2	419.5
1997	352.0	53.3	8.9	92.8	390.5	1.2	112.9	18.1	4.7	88.6	2.4	566.8	535.8
1998	282.2	58.3	2.0	90.3	395.3	1.0	40.6	34.5	4.2	63.4	5.2	497.2	480.7
1999	266.7	32.6	0.1	132.8	167.9	0.0	48.0	16.9	2.7	27.2	4.2	248.7	446.4
2000	226.1	29.2	0.0	87.2	139.9	0.3	111.7	20.4	8.3	43.3	4.3	281.0	385.4
2001	239.9	13.0	1.6	263.0	177.9	0.1	49.6	12.4	7.3	49.0	1.3	242.2	571.6
2002	403.6	5.2	0.0	177.0	110.9	0.0	64.9	13.6	3.0	31.3	0.5	181.0	628.4
2003	106.9	7.2	0.1	43.6	24.5	0.0	30.0	35.0	16.2	40.0	0.5	61.8	241.7
2004	86.2	1.9	0.0	48.3	22.9	0.0	55.9	42.1	6.8	61.6	0.0	80.7	245.0
2005	57.7	0.1	0.0	20.2	11.5	0.0	16.1	22.6	19.4	24.5	0.0	27.7	144.4
2006	184.4	0.1	0.0	37.0	4.5	0.0	12.5	14.9	6.4	28.1	0.0	17.1	270.8
2007	93.6	0.4	0.0	11.4	55.5	0.0	34.1	3.7	0.8	4.8	0.0	92.0	114.3
2008	201.5	10.0	0.0	38.3	41.5	0.0	31.2	6.8	1.0	11.6	0.0	82.8	259.2
2009	186.2	0.1	0.0	105.3	2.1	0.0	39.9	5.7	0.2	8.3	0.0	42.0	305.7

Sampling areas: Northern - Areas 1B, 1C, 2B, 2C, 3.

Southern - Areas 1A, 2A, 4, 5, 6.

Table 4.2.1.5. SANDEEL in IV. Monthly landings (t) by country. (Data provided by Working Group Members).

Year	Month	Denmark	Norway	Faroe	Germany	Others	Scotland	Sweden	Total
2002	March	10.236	0.717				0.000		10.953
	April	177.597	63.083				0.109	0.037	240.826
	May	247.494	86.942				2.632		337.069
	June	174.467	24.568				1.008		200.043
	July	14.228	0.048				0.000		14.276
	August	5.652	0.261				0.422		6.335
	September	0.000	0.364				0.000		0.364
	October	0.003	0.000				0.000		0.003
	December	0.002	0.000				0.000		0.002
Total		629.679	175.982	0.000	0.000	0.000	4.171	0.037	809.869
2003	March	2.802	0.231						3.033
	April	42.885	8.003				0.366		51.254
	May	96.105	10.401					21.517	128.023
	June	80.271	1.817						82.088
	July	27.784	1.186						28.970
	August	15.782	6.422				0.121		22.326
	September	4.407	1.555						5.963
	October	1.831	0.000						1.831
	November	2.070	0.000						2.070
	December	0.045	0.000						0.045
Total		273.981	29.615	0.000	0.000	0.000	0.487	21.517	325.600
2004	February	0.007	0.000						0.007
	March	1.444	0.183						1.627
	April	42.664	6.886						49.550
	May	100.715	25.986		2.658	0.000	0.029	33.246	162.634
	June	89.369	7.695						97.064
	July	30.485	1.419						31.904
	August	12.191	3.492						15.683
	September	0.254	2.869						3.123
	October	0.000	0.000						0.000
Total		277.129	48.530	0.000	2.658	0.000	0.029	33.246	361.592
2005	April	4.397	1.876						6.273
	May	63.063	12.556						75.619
	June	87.336	2.900						90.236
Total		154.796	17.332	0.000	0.000	0.000	0.000	0.000	172.128
2006	April	19.258	1.385						20.643
	May	115.949	4.200		1.246			13.556	134.951
	June	94.683	0.000		1.981		0.678	14.271	111.613
	July	20.042	0.000						20.042
	August	0.379	0.000						0.379
	September	0.009	0.000						0.009
	October	0.266	0.000						0.266
	November	0.030	0.000						0.030
Total		250.616	5.585	0.000	3.227	0.000	0.678	27.827	287.933
2007	April	46.817	11.222						58.039
	May	89.057	35.976	2.000	1.000		1.000	3.286	132.319
	June	8.775	3.938					3.286	15.999
	October	0.006	0.000						0.006
Total		144.654	51.136	2.000	1.000	0.000	1.000	6.572	206.362
2008	April	33.541	9.377						42.917
	May	120.635	68.744	2.410	4.383			8.345	204.518
	June	80.224	3.432					4.060	87.715
	July	6.771	0.000						6.771
	August	0.004	0.000						0.004
	September	0.019	0.000						0.019
Total		241.194	81.553	2.410	4.383	0.000	0.000	12.405	341.945
2009	April	53.185	3.357						56.542
	May	119.000	22.409		12.234	9.900			163.544
	June	87.691	1.651					12.405	101.747
	July	25.836	0.000						25.836
Total		285.713	27.418	0.000	12.234	9.900	0.000	12.405	347.670

OTH: Others: sum of preliminary data for Lithuania, Faroes, UK, Netherlands

Table 4.2.2.1. SANDEEL in IV.Catch numbers at age (millions) by half year.

Fishery in the NORTHERN North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		7911 *		0 *		349 *		7105 *		455 *		13196
1	5684	303	11692	1207	2688	109	23934	7077	26236	5768	9855	1283
2	1215	316	1647	121	3292	239	2600	473	10855	198	25922	340
3	89	19	153	43	1002	89	200	0	350	0	1319	119
4+	12	0	5	0	480	11	0	0	155	0	26	17
SOP	50871	37464	91792	20871	106279	12946	174378	128325	305979	83202	430970	71479

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		3380 *		12107 *		13616 *		6797 *		26960 *		457
1	56661	4038	13101	1670	41855	866	9871	48	15768	1004	28490	829
2	2219	274	3907	342	2342	28	4056	3	2635	112	7225	1211
3	3385	0	578	51	908	8	486	0	1023	34	5954	396
4+	0	0	175	15	318	3	305	0	646	22	2155	25
SOP	437540	57222	148411	70806	374465	55536	115957	38189	188264	86785	413536	83222

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		4046 *		31817 *		2431 *		35220 *		33653 *		0
1	36140	3374	11524	1706	67038	11346	6667	10005	2118	694	22887	467
2	3360	338	5385	1772	3640	633	33216	1837	3491	551	8810	84
3	1091	26	761	136	5254	25	2039	79	5086	58	1420	24
4+	145	2	301	55	1206	2	410	1	1023	0	1470	46
SOP	348280	71351	201546	141902	451606	103226	360999	148508	135432	115849	270507	9974

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		46385 *		0 *		7510 *		2961 *		0 *		0
1	6434	771	21719	157	2315	118	6819	656	2550	0	1408	230
2	2408	73	2649	6	1305	164	542	9	412	0	122	37
3	472	134	402	0	456	0	375	11	97	0	17	9
4+	1035	0	219	0	635	0	213	0	49	0	2	2
SOP	88280	153698	179581	1263	51447	29772	59588	19555	27623	0	13400	3703

Year	2007		2008		2009	
Season	1	2	1	2	1	2
AGE						
0 *		0 *		0 *		0
1	8310	0	3092	0	2619	675
2	761	0	2077	0	171	31
3	131	0	378	0	44	15
4+	40	0	70	0	2	1
SOP	89270	0	70308	0	32128	9167

Fishery in the SOUTHERN North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		9298 *		0 *		11940 *		112 *		298 *		0
1	2232	240	62517	9423	7790	1896	43629	5350	4351	3095	2349	0
2	35029	2806	2257	92	39301	3229	7333	293	22771	6664	10074	234
3	934	513	13272	577	2490	2234	1604	241	1158	196	17914	2084
4+	387	2	442	44	265	298	30	18	165	51	2769	68
SOP	380561	61745	556796	80581	472949	114931	335960	47286	296758	105111	464851	40003

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		1 *		597 *		12115 *		134 *		838 *		0
1	44444	1619	20179	1438	20058	11411	60337	3903	3581	1037	24697	4093
2	4525	165	16670	477	9224	344	10021	382	14659	953	2594	322
3	957	35	2467	71	1320	111	1002	157	3707	266	2654	198
4+	3368	123	745	21	454	0	621	34	1012	87	715	137
SOP	309830	22244	341693	24002	345866	123092	618474	47520	267430	34453	226318	47670

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0 *		2088 *		198 *		1142 *		1322 *		6659
1	39683	3166	10194	2031	52359	15238	9546	738	31951	203	35613	3601
2	6607	2789	16015	4080	3648	536	39553	2673	6499	58	5973	496
3	1555	307	6403	536	2405	406	3188	209	13150	1392	1825	339
4+	1226	157	1169	1023	683	136	2260	65	947	166	3528	330
SOP	427820	67591	293882	138796	420729	138483	448116	42753	431487	35899	358998	53020

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		73443 *		0 *		5320 *		2383 *		0 *		0
1	64084	819	84858	1370	4982	922	33909	1637	15842	0	33256	1827
2	13531	15	8667	472	15588	452	1113	473	5204	0	2801	38
3	1158	0	1060	0	3593	163	4302	405	312	0	1035	20
4+	2389	0	250	0	1204	28	270	68	439	0	240	0
SOP	432330	184311	608649	17428	197210	31295	249398	30821	144167	0	252624	17024

Year	2007		2008		2009	
Season	1	2	1	2	1	2
AGE						
0 *		0 *		0 *		906
1	9301	0	27073	0	16339	2280
2	4871	0	4375	0	13303	284
3	365	0	1302	0	1478	21
4+	129	0	170	0	418	0
SOP	114122	0	252430	0	279127	16475

Table 4.2.3.1. SANDEEL in IV. Northern North Sea. Mean weight (g) in the catch by country and combined. Age group 4++ is the 4-plus group used in assessment

		Denmark		Norway		Combined	
		Half-year		Half-year		Half-year	
Year	Age	1	2	1	2	1	2
2004	0		3.76	1.73	3.46	1.73	3.56
	1	4.16	13.13	7.36		6.27	13.13
	2	11.10		10.07	21.42	10.64	21.42
	3	11.23	18.50	15.78		13.40	18.50
	4	25.01				25.01	
	5	33.17				33.17	
	6						
	4++	30.69		27.53		28.39	
2005	0	1.00				1.00	
	1	7.36		7.56		7.43	
	2	15.44		14.28		14.42	
	3	17.16		15.99		16.06	
	4	22.56				22.56	
	5	33.00				33.00	
	6						
	4++	23.41		23.94		23.90	
2006	0						
	1	8.35	11.55	6.99		7.92	11.99
	2	13.79	17.45	15.28		14.42	17.62
	3	26.02	26.83	24.23		25.47	27.45
	4	16.30	16.30			16.30	16.30
	5	31.00	31.00			31.00	
	6						
	4++	30.95	30.94	23.00		30.61	30.94
2007	0	1.00		1.74		1.74	
	1	7.50		10.72		8.60	
	2	15.97		16.81		16.68	
	3	21.10		26.95		26.48	
	4	30.93				30.93	
	5						
	6						
	4++	30.93		41.93		41.62	
2008	0	1.36		1.19		1.28	
	1	7.31		8.74		7.77	
	2	16.57		16.85		16.81	
	3	25.89		23.84		24.01	
	4	24.41				24.41	
	5	32.34				32.34	
	6	38.00					
	4++	26.41		32.74		32.56	
2009	0	2.70		no data	no data	2.70	
	1	10.29	11.30			10.29	11.30
	2	20.50	28.30			20.50	28.30
	3	36.51	42.30			36.51	42.30
	4	8.70				8.70	
	5	42.30	42.30			42.30	42.30
	6						
	4++	37.82	42.30			37.82	42.30

Table 4.2.3.2. SANDEEL in IV. Southern North Sea. Mean weight (g) in the catch by (Denmark). Age group 4++ is the 4-plus group used in assessment

		Half-year	
Year	Age	1	2
2004	0		2.60
	1	3.86	7.35
	2	10.87	13.31
	3	12.28	13.37
	4	10.27	12.97
	5		
	6		
	7		
	4++	10.27	12.97
2005	0	2.46	-
	1	5.54	-
	2	9.17	-
	3	10.73	-
	4	11.93	-
	5	13.63	-
	6	14.35	-
	7	12.67	-
	4++	12.18	-
2006	0	1.81	-
	1	6.19	8.97
	2	10.66	9.69
	3	12.83	13.30
	4	14.09	16.30
	5	15.35	-
	6	16.06	-
	7		-
	4++	15.15	16.30
2007	0	1.40	-
	1	5.91	-
	2	10.60	-
	3	14.90	-
	4	16.08	-
	5	16.73	-
	6	16.37	-
	7		-
	4++	16.18	-
2008	0	1.31	-
	1	6.62	-
	2	12.07	-
	3	13.60	-
	4	15.28	-
	5	17.35	-
	6	19.13	-
	7		-
	4++	15.89	-
2009	0	2.30	2.40
	1	5.55	4.33
	2	11.52	14.19
	3	15.61	18.61
	4	17.81	15.00
	5	17.74	16.00
	6		
	7		
	4++	19.28	15.50

Table 4.2.3.3. SANDEEL in IV. Mean weight (g) in the catch by half year.

Northern North Sea, first half-year

year	age-1	age-2	age-3	age-4+
1983	5.64	13.05	27.30	43.97
1984	5.64	13.05	27.30	42.20
1985	5.64	13.05	27.30	43.34
1986	5.64	13.05	27.30	
1987	5.64	13.05	27.30	43.84
1988	5.64	13.05	27.30	42.20
1989	6.20	14.00	16.30	
1990	5.64	13.05	27.30	44.32
1991	7.43	14.23	22.40	30.87
1992	5.45	10.86	18.49	29.92
1993	5.97	20.62	24.92	22.14
1994	6.43	13.70	15.08	19.29
1995	6.95	19.75	24.90	24.70
1996	7.80	14.98	25.93	37.49
1997	4.94	7.95	11.76	24.64
1998	4.24	8.73	14.21	33.61
1999	6.53	8.08	13.20	25.68
2000	6.78	7.90	11.86	19.66
2001	6.29	11.78	15.82	11.58
2002	6.17	11.77	18.40	31.98
2003	5.30	14.70	17.81	18.69
2004	6.27	10.64	13.40	28.39
2005	7.43	14.42	16.06	23.90
2006	7.92	14.44	25.47	30.61
2007	8.60	16.68	26.48	41.62
2008	7.77	16.81	24.01	32.56
2009	10.29	20.50	36.51	37.82

Northern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	3.03	13.23	27.84	36.20	
1984	3.03	13.23	27.84	36.20	
1985	3.03	13.23	27.84	36.20	51.91
1986	3.03	13.23	27.84	36.20	
1987	3.03	13.23	27.84	36.20	
1988	3.03	13.23	27.84	36.20	44.00
1989	5.00	8.90	16.00		
1990	3.03	13.23	27.84	36.20	44.00
1991	3.42	9.57	14.99	16.20	44.00
1992	5.48	18.03	25.40	21.56	
1993	2.71	10.37	19.22	20.28	21.37
1994	6.58	22.75	30.20	58.07	72.15
1995	5.08	13.46	14.20	21.00	19.00
1996	2.94	10.85	14.92	15.59	23.58
1997	1.71	8.11	10.15	23.96	17.19
1998	2.48	3.91	11.13	20.15	13.39
1999	3.07	7.78	10.43	24.15	
2000		14.92	17.95	19.18	22.67
2001	3.10	9.61	17.50	9.07	
2002		7.33	17.52		
2003	3.37	13.00	17.90		
2004	3.56	13.13	21.42	18.50	
2005					
2006		11.99	17.62	27.45	30.94
2007					
2008					
2009		11.30	28.30	42.30	42.30

Southern North Sea, first half-year

year	age-1	age-2	age-3	age-4+
1983	5.51	9.96	13.74	16.90
1984	5.51	9.96	13.74	16.95
1985	5.51	9.96	13.74	16.51
1986	5.51	9.96	13.74	16.30
1987	5.80	11.00	15.60	18.04
1988	4.00	12.50	15.50	18.73
1989	4.00	12.50	15.50	18.01
1990	4.00	12.50	15.50	19.28
1991	8.20	16.40	16.90	17.20
1992	7.43	13.83	17.51	22.60
1993	6.08	11.54	15.09	20.31
1994	6.07	11.01	13.46	16.94
1995	7.30	13.20	16.60	20.48
1996	5.57	8.31	13.16	16.89
1997	6.52	10.92	11.81	16.27
1998	5.54	8.38	10.64	13.21
1999	5.52	9.27	13.50	18.33
2000	6.16	9.56	14.42	15.93
2001	4.22	7.93	12.57	16.76
2002	6.14	8.10	12.49	16.73
2003	5.25	7.86	9.33	12.47
2004	5.49	10.49	11.34	10.27
2005	5.54	9.17	10.73	12.18
2006	6.19	10.66	12.83	15.15
2007	5.91	10.60	14.90	16.18
2008	6.62	12.07	13.6	15.89
2009	5.71	11.59	15.95	19.28

Southern North Sea, second half-year

year	age-0	age-1	age-2	age-3	age-4+
1983	2.42	7.50	10.75	14.12	17.71
1984	2.42	7.50	10.75	14.12	17.71
1985	2.42	7.50	10.75	14.12	18.66
1986	2.42	7.50	10.75	14.12	18.76
1987	1.30	8.90	10.80	21.40	19.85
1988	1.00	10.50	14.00	17.00	19.11
1989	1.00	10.50	14.00	17.00	19.01
1990	1.00	10.50	14.00	17.00	20.05
1991	2.60	7.50	13.60	12.00	
1992	3.40	9.43	16.61	20.04	22.58
1993	3.08	10.13	15.66	17.04	21.96
1994		8.56	17.16	19.50	23.74
1995		6.60	13.60	17.70	21.22
1996	2.34	9.90	16.66	21.77	33.39
1997	4.72	7.99	13.54	14.73	18.88
1998	2.79	3.01	12.65	11.57	17.14
1999	5.42	10.02	11.05	16.85	15.68
2000	1.66	6.61	13.68	15.74	18.34
2001	2.40	9.51	17.00		
2002		8.40	12.53		
2003	2.65	7.47	15.72	17.30	13.80
2004	2.60	7.35	13.31	13.37	12.97
2005					
2006		8.97	9.69	13.30	16.30
2007					
2008					
2009	2.40	4.33	14.19	18.61	15.50

Table 4.2.3.4. SANDEEL in IV. Mean weight (g) in the stock by half year.

First half-year

Year	age-1	age-2	age-3	age-4+
1983	5.03	12.89	16.92	24.76
1984	4.10	13.81	16.28	21.01
1985	4.19	12.79	18.75	22.08
1986	4.18	13.10	16.32	27.79
1987	4.70	12.82	16.00	21.23
1988	4.40	14.84	15.81	19.17
1989	4.40	13.49	19.58	18.28
1990	4.26	13.31	17.59	19.26
1991	4.29	13.22	16.95	20.65
1992	4.08	13.07	17.18	21.15
1993	4.50	12.70	16.38	21.34
1994	6.26	12.99	14.58	18.71
1995	7.13	15.41	20.02	20.93
1996	6.75	9.99	14.52	21.10
1997	5.63	9.44	11.77	21.61
1998	5.01	8.54	12.03	16.34
1999	5.59	8.85	13.42	22.15
2000	6.40	8.57	13.30	17.03
2001	4.41	8.51	13.51	15.19
2002	6.14	8.96	14.11	23.85
2003	5.26	8.39	10.29	14.62
2004	5.62	10.54	11.51	18.25
2005	5.81	9.55	12.00	13.37
2006	6.26	10.82	13.03	15.30
2007	7.19	11.44	18.01	22.25
2008	6.74	13.59	15.95	20.78
2009	6.34	11.70	16.54	19.36

Second half-year

Year	age-0	age-1	age-2	age-3	age-4+
1983	1.11	11.83	14.73	19.14	24.35
1984	1.19	10.58	16.58	19.54	21.90
1985	1.19	10.69	14.65	22.49	24.95
1986	1.72	10.64	14.75	17.96	30.44
1987	1.43	11.18	14.29	17.26	20.91
1988	1.44	10.81	18.07	17.19	20.61
1989	1.28	10.76	15.80	17.05	19.39
1990	1.36	10.72	15.51	19.37	19.95
1991	1.10	10.67	15.49	18.02	19.39
1992	1.54	10.57	14.85	18.67	20.44
1993	1.44	10.91	14.25	17.61	20.49
1994	6.58	10.95	27.46	45.24	31.15
1995	5.08	10.14	13.66	17.96	21.19
1996	2.90	10.33	16.13	20.52	32.88
1997	1.94	8.04	11.70	15.27	18.86
1998	2.49	3.84	12.03	13.92	17.11
1999	3.15	8.29	10.49	17.14	15.68
2000	1.66	7.56	14.29	15.96	18.87
2001	2.67	9.56	17.42	9.07	17.22
2002	2.49	8.29	12.60	14.06	17.22
2003	3.07	8.10	16.30	17.30	13.80
2004	3.13	9.00	13.46	13.51	12.97
2005	no data				
2006	3.11	9.31	13.61	17.59	28.91
2007	no data				
2008	no data				
2009	2.40	5.93	15.59	28.34	36.51

Table 4.2.5.1. SANDEEL in IV. Effort of Danish vessels and number of Danish and Norwegian vessels participating in the sandeel fishery by year. In 2006 only experimental fishing was allowed for 6 Norwegian vessels. In 2007 the fishery was stopped in May due to RTM.

	Denmark		Norway
Year	Kilo watt days (thousands)	Number of vessels	Number of vessels
2002	7,867	207	53
2003	7,306	171	35
2004	7,334	200	40
2005	3,390	98	22
2006	3,946	122	6
2007	2,316	112	41
2008	3,728	83	42
2009	4,126	84	

Table 4.2.5.2. SANDEEL in IV. Fishing effort in the Northern North Sea (days fishing times scaling factors for each vessel category to represent days fishing for a vessel of 200 GT), based on Danish and Norwegian data.

	Norweigian			Danish				
Year	Standardized Fishing days	Catch sampled for fishing effort ('000t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)	Mean CPUE (t/day)	Total internat. catch ('000t)	Derived internat. effort ('000 days)
				First half-year				
1976	593	11.1	18.7	-	-	18.7	110.3	5.90
1977	2061	50.4	24.4	-	-	24.5	276.0	11.27
1978	1761	44.9	25.5	-	-	25.5	109.7	4.30
1979	1451	29.6	20.4	-	-	20.4	47.7	2.34
1980	2733	112.8	41.3	-	-	41.3	220.9	5.35
1981	1804	42.8	23.7	-	-	23.7	93.3	3.94
1982	1231	26.9	21.9	13.5	34.9	26.2	62.3	2.38
1983	338	8.7	25.7	17.4	28.9	27.8	54.5	1.96
1984	139	3.5	25.2	54.1	41.2	40.2	74.1	1.84
1985	382	8.7	22.8	47.4	46.7	43.0	69.9	1.63
1986	1565	60.4	38.6	154.1	54.7	50.2	221.3	4.41
1987	2219	122.9	55.4	214.4	51.8	53.1	360.9	6.80
1988	3600	143.8	39.9	158.6	39.0	39.5	332.0	8.41
1989	4211	146.9	34.9	247.0	35.1	35.0	435.2	12.43
1990	2299	58.6	25.5	89.7	24.7	25.0	148.7	5.94
1991	1748	67.7	38.7	198.4	39.0	39.0	282.2	7.24
1992	1214	53.7	44.2	106.7	33.6	37.1	151.2	4.07
1993	1565	70.7	45.2	138.2	33.6	37.5	189.0	5.04
1994	2707	130.1	48.1	289.0	56.4	53.8	413.4	7.68
1995	3429	208.6	60.8	146.4	44.7	54.2	348.5	6.43
1996	2036	100.9	49.6	101.8	30.8	40.1	203.1	5.06
1997	3489	254.9	73.1	190.0	50.9	63.6	456.5	7.18
1998	2622	220.8	84.2	125.8	37.1	67.1	364.8	5.44
1999	2217	77.4	34.9	47.5	32.9	34.2	137.2	4.02
2000	2328	104.5	44.9	154.7	40.6	42.3	271.1	6.40
2001	672	44.6	66.4	45.9	34.3	50.1	88.5	1.77
2002	1003	119.5	119.2	58.5	44.8	94.8	179.7	1.90
2003	914	17.1	18.7	15.3	16.0	17.41	53.8	3.09
2004	692	19.3	27.9	41.6	24.5	25.59	61.2	2.39
2005	469	13.8	29.4	13.9	28.2	28.78	27.7	0.96
2006	112	5.6	50.0	8.5	27.8	36.68	13.4	0.37
2007	704	49.0	69.6	39.7	49.2	60.47	92.0	1.52
2008	1202	60.2	50.1	21.8	40.0	47.41	82.1	1.73
2009	0	0.0	0.0	26.7	38.8	38.8	32.6	0.84
				Second half-year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.43
1977	445	11.8	26.5	-	-	26.5	110.0	4.15
1978	811	22.5	27.6	-	-	27.8	53.3	1.92
1979	1688	52.2	30.9	-	-	30.9	147.7	4.78
1980	1117	33.1	29.6	-	-	29.5	71.1	2.41
1981	398	7.9	19.6	-	-	19.9	44.9	2.26
1982	-	-	-	1.8	32.3	33.0	12.0	0.36
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.64
1984	-	-	-	10.7	29.6	30.2	17.7	0.59
1985	-	-	-	16.4	38.0	38.8	16.8	0.43
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.68
1987	1586	68.1	42.9	3.1	24.7	42.1	76.9	1.83
1988	922	26.9	29.2	64.3	29.4	29.3	71.4	2.43
1989	590	11.5	19.5	44.9	25.6	24.4	57.2	2.35
1990	721	22.8	31.6	61.0	31.1	31.3	70.8	2.26
1991	943	30.3	32.1	72.0	38.7	36.8	90.7	2.47
1992	24	1.5	63.8	43.0	34.8	35.8	25.5	0.71
1993	972	30.7	31.6	59.1	28.4	29.5	87.0	2.95
1994	777	35.7	45.9	82.8	43.6	44.3	76.4	1.73
1995	1009	53.3	52.8	59.4	44.8	48.6	72.6	1.49
1996	749	42.9	57.3	93.9	36.5	43.0	140.7	3.27
1997	1542	95.7	62.1	22.9	27.5	55.4	121.5	2.19
1998	2257	114.4	50.7	35.5	24.6	44.5	148.5	3.34
1999	1665	77.8	46.7	37.8	29.3	41.0	125.2	3.05
2000	0	0.0	0.0	7.6	33.3	33.3	10.0	0.30
2001	1508	122.2	81.0	28.0	36.9	72.8	153.8	2.11
2002	0	0.7	0.0	0.5	10.6	4.5	1.3	0.29
2003	295	7.5	25.4	19.5	21.0	22.23	29.8	1.34
2004	419	7.8	18.6	9.6	19.0	18.76	19.6	1.04
2005	0	0	-	0.0 -	-	*		-
2006	0	0	-	2.3	30.2	30.2	3.7	0.12
2007	0	0	-	0.0 -	-		0 -	
2008	0	0	-	0.1	19.0	19	0.617	0.03
2009	0	0	-	11.1	57.3	57.3	9.398	0.16

- No data   * Added to first half year

Table 4.2.5.3. SANDEEL in IV. Fishing effort in the southern North Sea (days fishing times scaling factors for each vessel category to represent days fishing for a vessel of 200 GT), based on Danish and Norwegian data.

	First half year			Second half year		
Year	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)	CPUE (t/day)	Total Int'l catch ('000 t)	Total int'l effort ('000 days)
1982	48.2	427	8.85	35.7	53	1.47
1983	42.8	360	8.41	33.9	59	1.75
1984	50.5	461	9.13	32.9	71	2.16
1985	41.9	417	9.95	33.6	111	3.29
1986	53.7	386	7.20	44.1	76	1.71
1987	57.4	298	5.19	37.1	105	2.83
1988	46.7	462	9.89	30.2	33	1.11
1989	43.8	506	11.54	29.5	19	0.63
1990	31.0	342	11.03	35.6	24	0.67
1991	47.0	327	6.95	46.6	132	2.84
1992	54.9	621	11.31	36.2	73	2.02
1993	38.6	268	6.94	32.0	34	1.07
1994	53.4	226	4.24	48.9	48	0.97
1995	56.8	429	7.56	52.0	68	1.30
1996	41.6	294	7.05	50.1	139	2.77
1997	64.2	421	6.55	41.1	138	3.36
1998	46.6	448	9.61	26.2	43	1.64
1999	40.9	432	10.56	31.9	36	1.13
2000	43.1	360	8.36	33.4	53	1.59
2001	38.7	433	11.20	46.4	185	3.98
2002	62.2	609	9.79	22.4	19	0.86
2003	22.6	211	9.33	20.5	31	1.53
2004	25.2	250	9.91	23.5	31	1.32
2005	27.9	145	5.18	*	*	*
2006	39.0	254	6.50	30.3	17	0.56
2007	45.1	114	2.53	-	-	-
2008	51.1	253	4.95	28.7	6.8	0.24
2009	52.3	289	5.53	65.6	16.4	0.25

- No data (due to no fishery) * Added to first half year

Table 4.2.5.4. SANDEEL in IV. Tuning fleets used in the SXSA assessment. Total international standardised effort and catch at age in numbers (millions)

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1976	1	1	5.90	237	5697	1130	445	155
1977	1	1	11.30	3686	24307	2351	516	144
1978	1	1	4.30	0	6127	2338	573	144
1979	1	1	2.30	0	2335	1328	242	12
1980	1	1	5.40	17	13394	8865	1050	827
1981	1	1	3.90	17	5505	4109	904	174
1982	1	1	2.40	2	3518	2132	556	85
1983	1	1	2.00	0	5684	1215	89	12
1984	1	1	1.80	0	11692	1647	153	5
1985	1	1	1.60	1	2688	3292	1002	480
1986	1	1	4.40	7	23934	2600	200	0
1987	1	1	6.80	0	26236	10855	350	155
1988	1	1	8.43	2453	9855	25922	1319	26
1989	1	1	12.43	6124	56661	2219	3385	0
1990	1	1	5.95	0	13101	3907	578	175
1991	1	1	7.26	0	41855	2342	908	318
1992	1	1	4.07	137	9871	4056	486	305
1993	1	1	5.04	1112	15768	2635	1023	646
1994	1	1	7.69	398	28490	7225	5954	2156
1995	1	1	6.43	0	36140	3360	1091	145
1996	1	1	5.06	0	11524	5385	761	301
1997	1	1	7.18	2434	67038	3640	5254	1206
1998	1	1	5.44	2278	6667	33216	2039	410
1999	1	2	4.02	265	2118	3491	5086	1023
2000	1	2	6.40	0	22887	8810	1420	1470
2001	1	2	1.77	87	6434	2408	472	1035
2002	1	2	1.90	12	21719	2649	402	219
2003	1	2	3.09	599	2315	1305	456	635
2004	1	2	2.39	179	6819	542	375	213
2005	1	2	0.96	5	2550	412	97	49
2006	1	2	0.37	0	1408	122	17	2
2007	1	2	1.52	459.5	8309.8	761.1	130.9	39.5
2008	1	2	1.73	237.4	3091.5	2077.4	377.9	70.4
2009	1	2	0.84	171.1	2618.8	170.5	44.2	1.9
1982	1	3	8.90	242	56545	6224	3277	1939
1983	1	3	8.40	955	2232	35029	934	387
1984	1	3	9.10	20	62517	2257	13272	442
1985	1	3	10.00	6573	7790	39301	2490	265
1986	1	3	7.20	0	43629	7333	1604	30
1987	1	3	5.19	0	4351	22771	1158	165
1988	1	3	9.89	1420	2349	10074	17914	2769
1989	1	3	11.54	29	44444	4525	957	3368
1990	1	3	11.03	0	20179	16670	2467	745
1991	1	3	6.95	0	20058	9224	1320	454
1992	1	3	11.31	2	60337	10021	1002	621
1993	1	3	6.96	0	3581	14659	3707	1012
1994	1	3	4.25	0	24697	2594	2654	715
1995	1	3	7.56	0	39060	6503	1531	1226
1996	1	3	7.05	0	10194	16015	6403	1169
1997	1	3	6.56	0	52359	3648	2405	683
1998	1	3	9.62	57	9546	39553	3188	2260
1999	1	4	10.57	0	31951	6499	13150	947
2000	1	4	8.36	1126	35613	5973	1825	3528
2001	1	4	11.20	579	64084	13531	1158	2389
2002	1	4	9.79	420	84858	8667	1060	250
2003	1	4	9.33	6148	4982	15588	3593	1204
2004	1	4	9.91	0	33909	1113	4302	270
2005	1	4	5.18	74	15842	5204	312	439
2006	1	4	6.50	869	33256	2801	1035	240
2007	1	4	2.53	145	9301	4871	365	129
2008	1	4	4.95	351.5	27073.1	4375	1301.8	169.6
2009	1	4	5.53	4077.1	15158.9	12342.2	1371.3	388.2

Table 4.2.5.4. Continued.

Year	Season	Fleet	Effort	a-0	a-1	a-2	a-3	a-4+
1976	2	5	2.40	6126	648	84	368	37
1977	2	5	4.20	3067	2856	913	142	141
1978	2	5	1.90	7820	1001	307	39	2
1979	2	5	4.80	44203	1310	433	66	10
1980	2	5	2.40	8349	1173	214	19	8
1981	2	5	2.30	9128	346	94	14	6
1982	2	5	0.40	6530	65	0	0	0
1983	2	5	0.60	7911	303	316	19	0
1984	2	5	0.60	0	1207	121	43	0
1985	2	5	0.40	349	109	239	89	11
1986	2	5	2.70	7105	7077	473	0	0
1987	2	5	1.83	455	5768	198	0	0
1988	2	5	2.43	13196	1283	340	119	17
1989	2	5	2.35	3380	4038	274	0	0
1990	2	5	2.26	12107	1670	342	51	15
1991	2	5	2.47	13616	866	28	8	3
1992	2	5	0.71	6797	48	3	0	0
1993	2	5	2.95	26960	1004	112	34	22
1994	2	5	1.73	457	829	1211	396	25
1995	2	5	1.49	4046	3374	338	26	2
1996	2	5	3.27	31817	1706	1772	136	55
1997	2	5	2.19	2431	11346	633	25	2
1998	2	5	3.34	35220	10005	1837	79	1
1999	2	5	3.05	33653	694	551	58	0
2000	2	5	0.30	0	467	84	24	46
2001	2	5	2.11	46385	771	73	134	0
2002	2	5	0.29	0	157	6	0	0
2003	2	5	1.34	7510	118	164	0	0
2004	2	5	1.04	2961	656	9	11	0
2005	2	5	0.00	0	0	0	0	0
2006	2	5	0.12	0	230	37	9	2
2007	2	5	0.00	0	0	0	0	0
2008	2	5	0	0	0	0	0	0
2009	2	5	0.16	0	675.3	31.4	14.5	0.8
1982	2	6	1.50	5039	4718	490	344	40
1983	2	6	1.80	9298	240	2806	513	2
1984	2	6	2.20	0	9423	92	577	44
1985	2	6	3.30	11940	1896	3229	2234	298
1986	2	6	1.70	112	5350	293	241	18
1987	2	6	2.83	298	3095	6664	196	51
1988	2	6	1.11	0	0	234	2084	68
1989	2	6	0.63	1	1619	165	35	123
1990	2	6	0.67	597	1438	477	71	21
1991	2	6	2.84	12115	11411	344	111	0
1992	2	6	2.02	134	3903	382	157	34
1993	2	6	1.07	838	1037	953	266	87
1994	2	6	0.97	0	4093	322	198	137
1995	2	6	1.30	0	3166	2789	307	157
1996	2	6	2.77	2088	2031	4080	536	1023
1997	2	6	3.36	198	15238	536	406	136
1998	2	6	1.64	1142	738	2673	209	65
1999	2	6	1.13	1322	203	58	1392	166
2000	2	6	1.59	6659	3601	496	339	330
2001	2	6	3.98	73443	819	15	0	0
2002	2	6	0.86	0	1370	472	0	0
2003	2	6	1.53	5320	922	452	163	28
2004	2	6	1.32	2383	1637	473	405	68
2005	2	6	0.00	0	0	0	0	0
2006	2	6	0.56	0	1827	38	20	0
2007	2	6	0.00	0	0	0	0	0
2008	2	6	0	0	0	0	0	0
2009	2	6	0.25	906.1	2280.4	284.4	20.8	0.2

Table 4.3.2.1. SANDEEL in IV. Options for SXSA applied in 'suggested Final assessment'

Dankert Skagens SXSA program
last updated 5/9 - 1995
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Name of the stock:
Sandeel in the North Sea

The following values were used:

1:	First VPA year	1983
2:	Last VPA year	2009
3:	Youngest age	0
4:	Oldest true age	3
5:	Number of seasons	2
6:	Recruiting season	2
7:	Last season in last year	2
8:	Spawning season	1
9:	Number of fleets	6

The following input files were used:

1:	Catch in numbers:	CANUM4.hyr
2:	Weight in catch:	WECA4.hyr
3:	Weight in stock:	WEST4.hyr
4:	Natural mortalities:	natmor.hyr
5:	Maturity ogive:	matprop.hyr
6:	Tuning data (CPUE):	Tuning4.hyr
7:	*Weighting for rhats:	tweq.new
8:	*Weighting for shats:	twred.xsa

The following fleets were used:
Fleet: 1: Northern First Half 76-98
Fleet: 2: Northern First Half 99-09
Fleet: 3: Southern First Half 82-98
Fleet: 4: Southern First Half 99-09
Fleet: 5: Northern Secon Half 76-09
Fleet: 6: Southern Secon Half 82-09

The following options were used:

1: Inv. Catchability (1: Linear; 2: Log; 3: Cos. filter):	2
2: Indiv. shats: (1: Direct; 2: Using z)	2
3: Comb. shats (1: Linear; 2: Log.)	2
4: *Fit catches: (0: No fit; 1: No SOP corr; 2: SOP corr.)	0
5: *Est. unknown catches (0: No; 1: No SOP corr; 2: SOP corr.; 3: Sep. F)	0
6: *Weighting of r (0: Manual; (1: not available at present).)	0
7: *Weighting of shats (0: Manual; 1: Linear; 2: Log.)	2
8: Handling of the plus group (1: Dynamic; 2: Extra age group)	1

You need a factor for weighting the inverse catchabilities at the oldest age vs. the second oldest age
It must be between 0.0 and 1.0. Factor 1.0 means that the catchabilities for the oldest are used as they are
Present value 0.0000000E+00

You have to specify a minimum value for the survivor number.
This is used instead of the estimate if the estimate becomes very low
Present value: 1.000000

Weighting factors for computing catchability (weighting for rhat)

Year:	1983-2008		2009	
Season	1	2	1	2
Age				
0	1	1	0.5	0.1
1	1	1	0.5	0.1
2	1	1	0.5	0.1
3	1	1	0.5	0.1

Table 4.3.2.2 SANDEEL in IV. SXSA fishing mortality at age, Suggested Final Assessment

Partial fishing mortality Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.012 *		0 *		0 *		0.017 *		0.003 *		0.027
1	0.078	0.009	0.049	0.013	0.041	0.004	0.068	0.045	0.162	0.081	0.173	0.051
2	0.017	0.009	0.067	0.007	0.069	0.015	0.154	0.059	0.113	0.004	0.786	0.036
3	0.019	0.007	0.008	0.005	0.096	0.017	0.02	0	0.07	0	0.046	0.01
4+	0.05	0	0.003	0	0.073	0.002	0	0	0.02	0	0.005	0.007
F(1-2)	0.048	0.009	0.058	0.01	0.055	0.009	0.111	0.052	0.138	0.043	0.48	0.044

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.015 *		0.029 *		0.025 *		0.029 *		0.059 *		0.001
1	0.364	0.09	0.17	0.06	0.287	0.017	0.053	0.001	0.179	0.026	0.178	0.013
2	0.146	0.033	0.179	0.047	0.164	0.005	0.156	0	0.059	0.004	0.306	0.096
3	0.709	0	0.126	0.025	0.221	0.004	0.144	0	0.136	0.01	0.408	0.057
4+	0	0	0.04	0.005	0.098	0.001	0.117	0	0.388	0.044	1.593 *	
F(1-2)	0.255	0.062	0.174	0.053	0.225	0.011	0.104	0	0.119	0.015	0.242	0.054

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.017 *		0.024 *		0.01 *		0.132 *		0.105 *		0
1	0.179	0.044	0.126	0.044	0.135	0.054	0.071	0.257	0.024	0.02	0.229	0.015
2	0.082	0.014	0.118	0.08	0.15	0.044	0.296	0.036	0.173	0.052	0.484	0.012
3	0.143	0.006	0.055	0.019	0.495	0.006	0.258	0.022	0.183	0.005	0.231	0.008
4+	0.033	0.001	0.07	0.027	0.231	0.001	0.098	0	0.334	0	0.2	0.014
F(1-2)	0.13	0.029	0.122	0.062	0.142	0.049	0.184	0.147	0.098	0.036	0.356	0.013

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.082 *		0 *		0.036 *		0.025 *		0 *		0
1	0.056	0.022	0.134	0.003	0.116	0.016	0.102	0.033	0.063	0	0.016	0.007
2	0.171	0.019	0.127	0.001	0.047	0.012	0.122	0.004	0.036	0	0.012	0.006
3	0.109	0.054	0.187	0	0.079	0	0.05	0.003	0.07	0	0.004	0.003
4+	0.372	0	0.106	0	1.001 *		0.133	0	0.017	0	0.001	0.001
F(1-2)	0.114	0.02	0.131	0.002	0.082	0.014	0.112	0.018	0.049	0	0.014	0.006

Year	2007		2008		2009	
Season	1	2	1	2	1	2
AGE						
0 *		0 *		0 *		0
1	0.139	0	0.029	0	0.017	0.009
2	0.034	0	0.129	0	0.006	0.002
3	0.031	0	0.038	0	0.007	0.004
4+	0.014	0	0.02	0	0	0
F(1-2)	0.086	0	0.079	0	0.011	0.006

Partial fishing mortality Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.014 *		0 *		0.013 *		0 *		0.002 *		0
1	0.031	0.007	0.262	0.099	0.12	0.064	0.125	0.034	0.027	0.044	0.041	0
2	0.495	0.078	0.092	0.006	0.825	0.201	0.434	0.036	0.238	0.124	0.305	0.025
3	0.194	0.178	0.682	0.067	0.238	0.431	0.164	0.038	0.231	0.066	0.629	0.172
4+	1.599	0.197	0.255	0.041	0.04	0.068	0.005	0.004	0.021	0.009	0.55	0.027
F(1-2)	0.263	0.042	0.177	0.052	0.472	0.132	0.279	0.035	0.132	0.084	0.173	0.013

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0 *		0.001 *		0.023 *		0.001 *		0.002 *		0
1	0.286	0.036	0.261	0.052	0.138	0.229	0.323	0.054	0.041	0.027	0.154	0.064
2	0.298	0.02	0.764	0.065	0.645	0.061	0.386	0.029	0.328	0.037	0.11	0.025
3	0.201	0.02	0.539	0.034	0.321	0.054	0.296	0.087	0.491	0.076	0.182	0.028
4+	0.397	0.026	0.169	0.007	0.14	0	0.237	0.022	0.607	0.174	0.529 *	
F(1-2)	0.292	0.028	0.512	0.058	0.391	0.145	0.354	0.041	0.184	0.032	0.132	0.045

Year	1995		1996		1997		1998		1999		2000	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0 *		0.002 *		0.001 *		0.004 *		0.004 *		0.019
1	0.196	0.041	0.111	0.052	0.105	0.073	0.102	0.019	0.366	0.006	0.357	0.117
2	0.161	0.113	0.352	0.185	0.15	0.037	0.353	0.053	0.321	0.006	0.328	0.07
3	0.204	0.07	0.46	0.076	0.226	0.09	0.404	0.059	0.473	0.113	0.297	0.112
4+	0.283	0.061	0.271	0.494	0.131	0.045	0.543	0.033	0.309	0.121	0.481	0.103
F(1-2)	0.179	0.077	0.232	0.119	0.128	0.055	0.227	0.036	0.344	0.006	0.342	0.093

Year	2001		2002		2003		2004		2005		2006	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0 *		0.129 *		0 *		0.026 *		0.02 *		0 *		0
1	0.558	0.023	0.523	0.028	0.25	0.122	0.508	0.081	0.394	0	0.367	0.052
2	0.962	0.004	0.417	0.045	0.561	0.034	0.25	0.199	0.449	0	0.287	0.006
3	0.267	0	0.493	0	0.621	0.064	0.571	0.118	0.223	0	0.248	0.008
4+	0.858	0	0.121	0	1.896 *		0.169	0.071	0.153	0	0.123	0
F(1-2)	0.76	0.013	0.47	0.037	0.406	0.078	0.379	0.14	0.422	0	0.327	0.029

Year	2007		2008		2009	
Season	1	2	1	2	1	2
AGE						
0 *		0 *		0 *		0
1	0.155	0	0.256	0	0.103	0.03
2	0.215	0	0.272	0	0.479	0.019
3	0.087	0	0.131	0	0.239	0.005
4+	0.045	0	0.048	0	0.063	0
F(1-2)	0.185	0	0.264	0	0.291	0.025

Table 4.3.2.3. SANDEEL in IV. SXSA annual fishing mortality at age. Suggested Final assessment.

Year	Age 0	Age 1	Age 2	Age 3	Age 4+	F(1-2)
1983	0.026	0.127	0.638	0.384	3.311	0.383
1984	0.000	0.405	0.186	0.830	0.317	0.295
1985	0.013	0.214	1.184	0.734	0.181	0.699
1986	0.017	0.257	0.731	0.233	0.009	0.494
1987	0.005	0.278	0.492	0.385	0.052	0.385
1988	0.027	0.264	1.296	0.902	0.654	0.780
1989	0.015	0.792	0.535	1.045	0.462	0.663
1990	0.030	0.538	1.158	0.790	0.241	0.848
1991	0.048	0.609	0.963	0.649	0.263	0.786
1992	0.029	0.443	0.625	0.557	0.410	0.534
1993	0.061	0.270	0.461	0.768	1.389	0.366
1994	0.001	0.409	0.558	0.725	0.000	0.483
1995	0.017	0.460	0.370	0.443	0.400	0.415
1996	0.025	0.314	0.738	0.649	0.811	0.526
1997	0.011	0.336	0.396	0.885	0.438	0.366
1998	0.137	0.347	0.796	0.805	0.758	0.571
1999	0.110	0.443	0.595	0.827	0.832	0.519
2000	0.019	0.723	0.978	0.685	0.878	0.851
2001	0.212	0.704	1.317	0.459	1.602	1.011
2002	0.000	0.745	0.641	0.759	0.251	0.693
2003	0.062	0.481	0.715	0.835	0.000	0.598
2004	0.045	0.740	0.575	0.791	0.391	0.658
2005	0.000	0.502	0.537	0.322	0.187	0.519
2006	0.000	0.454	0.339	0.286	0.137	0.397
2007	0.000	0.321	0.274	0.130	0.064	0.297
2008	0.000	0.311	0.443	0.185	0.074	0.377
2009	0.000	0.153	0.554	0.278	0.070	0.354

Table 4.3.2.4. SANDEEL in IV. SXSA stock numbers at age (millions) at start of season. Suggested Final assessment.

Year		1983		1984		1985		1986		1987		1988	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		969057 *		243741 *		1344375 *		624205 *		218018 *		707768
	1	120110	39385	423890	110930	109520	33935	595829	178214	275636	82849	97457	28450
	2	105870	41293	31754	18089	81204	19560	25969	9275	134665	62738	59811	10622
	3	6399	3452	30983	9778	14618	6940	12877	7155	6901	3391	45157	14523
	4+	508	12	2353	1212	8396	5018	7409	4942	9669	6219	7645	2836
SSN		112778		65090		104218		46255		151235		112613	
SSB		1485526		992366		1498079		756237		2042089		1748073	
TSN		232888	1053199	488980	383750	213738	1409828	642084	823791	426871	373215	210070	764199
TSB		2089681	2216192	2730314	1981203	1956967	2530413	3246801	3385563	3337577	2323117	2176884	1826763

Year		1989		1990		1991		1992		1993		1994	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		323167 *		618275 *		793767 *		346699 *		678052 *		817314
	1	309175	52416	142942	32400	269293	61515	339415	82280	151136	43864	286035	72967
	2	22132	9314	37796	8488	23715	6427	39256	14789	63790	28601	34066	14796
	3	8177	1926	7229	2352	6209	2338	4925	2083	11760	4010	22453	8003
	4+	12141	5381	5840	3161	4371	2298	3685	1712	2934	609	3412	0
SSN		42450		50864		34294		47866		78484		59931	
SSB		680609		742684		509007		675623		1065377		833716	
TSN		351626	392205	193806	664677	303587	866345	387280	447563	229620	755136	345965	913079
TSB		2040980	1261993	1351617	1428468	1664274	1715747	2060434	1697116	1745489	1945619	2624293	6945252

Year		1995		1996		1997		1998		1999		2000	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		358402 *		1967229 *		357070 *		408642 *		484912 *		511718
	1	366936	88999	158328	45073	861205	244402	158680	48541	159241	37918	194441	36049
	2	55287	28900	66949	27356	33522	16504	176045	58429	30022	11946	30234	8163
	3	10726	5024	20832	8098	17103	5194	12454	4069	43757	14401	9229	3530
	4+	6015	2909	6050	2852	7381	3401	6522	2185	4800	1605	11642	3712
SSN		72028		93830		58006		195022		78579		51105	
SSB		1192598		1098940		677254		1759824		959240		580110	
TSN		438964	484234	252158	2050609	919211	626570	353701	521867	237820	550782	245545	563171
TSB		3808855	3269776	2167655	6871774	5525840	2994252	2554809	2000851	1849395	2239125	1824530	1365007

Year		2001		2002		2003		2004		2005		2006	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		897614 *		80355 *		310530 *		174979 *		366644 *		235036
	1	225466	40173	323001	54183	36106	8857	130930	23464	75041	16451	164744	39582
	2	25833	4267	31452	11818	42979	14979	6310	2876	17135	6888	13469	6635
	3	6159	2794	3414	1092	9243	2881	11707	4018	1919	951	5640	2920
	4+	5261	723	2758	1464	2093	0	2211	1086	3740	2108	2505	1481
SSN		37253		37624		54315		20228		22794		21613	
SSB		382957		395758		486309		241605		236671		257540	
TSN		262719	945571	360625	148913	90421	337247	151158	206423	97835	393043	186357	285654
TSB		1377261	2880361	2378983	598089	676226	1319066	977433	865934	672661	1428565	1288837	552972

Year		2007		2008		2009	
Season		1	2	1	2	1	2
AGE							
	0 *		414551 *		582543 *		2901534
	1	105609	28170	186270	50229	261753	84795
	2	30546	15865	23064	10177	41124	16535
	3	5365	3190	12989	7331	8332	4339
	4+	3574	2258	4461	2793	8289	5212
SSN		39485		40513		57746	
SSB		525598		613297		779450	
TSN		145094	464034	226783	653074	319499	3012415
TSB		1284924		1868756		2438967	8037563

Table 4.3.2.5. SANDEEL in IV. SXSA catchability, Suggested Final Assessment

Log inverse q

	age			
Fleet	0	1	2	3
Fleet 1: Northern North Sea 83-98	*	3.728	3.661	3.661
Fleet 2: Northern North Sea 99-08	*	3.362	3.189	3.189
Fleet 3: Southern North Sea 83-98	*	4.266	3.252	3.252
Fleet 4: Southern North Sea 99-08	*	3.069	2.951	2.951
Fleet 5: Northern North Sea 83-07	4.611	4.146	4.68	4.68
Fleet 6: Southern North Sea 83-07	6.312	3.562	3.696	3.696

q

	age			
Fleet	0	1	2	3
Fleet 1: Northern North Sea 83-98	*	0.0240	0.0257	0.0257
Fleet 2: Northern North Sea 99-08	*	0.0347	0.0412	0.0412
Fleet 3: Southern North Sea 83-98	*	0.0140	0.0387	0.0387
Fleet 4: Southern North Sea 99-08	*	0.0465	0.0523	0.0523
Fleet 5: Northern North Sea 83-07	0.0099	0.0158	0.0093	0.0093
Fleet 6: Southern North Sea 83-07	0.0018	0.0284	0.0248	0.0248

Table 4.3.2.6. SANDEEL in IV. Assessment summary for SXSA. Suggested Final Assessment

Year	Recruitment Age 0 millions	TSB tons	SSB tons	Landings tons	Yield/SSB	Mean F age 1-2
1983	969057	2089681	1485526	530641	0.357	0.383
1984	243741	2730314	992366	750040	0.756	0.295
1985	1344375	1956967	1498079	707105	0.472	0.699
1986	624205	3246801	756237	685949	0.907	0.494
1987	218018	3337577	2042089	791050	0.387	0.385
1988	707768	2176884	1748073	1007303	0.576	0.780
1989	323167	2040980	680609	826836	1.215	0.663
1990	618275	1351617	742684	584912	0.788	0.848
1991	793767	1664274	509007	898959	1.766	0.786
1992	346699	2060434	675623	820140	1.214	0.534
1993	678052	1745489	1065377	576932	0.542	0.366
1994	817314	2624293	833716	770746	0.924	0.483
1995	358402	3808855	1192598	915042	0.767	0.415
1996	1967229	2167655	1098940	776126	0.706	0.526
1997	357070	5525840	677254	1114044	1.645	0.366
1998	408642	2554809	1759824	1000376	0.568	0.571
1999	484912	1849395	959240	718667	0.749	0.519
2000	511718	1824530	580110	692499	1.194	0.851
2001	897614	1377261	382957	858619	2.242	1.011
2002	80355	2378983	395758	806921	2.039	0.693
2003	310530	676226	486309	309724	0.637	0.598
2004	174979	977433	241605	359362	1.487	0.658
2005	366644	672661	236671	171790	0.726	0.519
2006	235036	1288837	257540	286751	1.113	0.397
2007	414551	1284924	525598	203392	0.387	0.297
2008	582543	1868756	613297	322738	0.526	0.377
2009		2438967	779450	336897	0.432	0.354
2010			1030000			
Average	570564		865948	660132	0.931	0.551

Forecast

Table 4.3.2.7. SANDEEL in IV. Options for SXSA applied in 'SPALY assessment'

Dankert Skagens SXSA program
last updated 5/9 - 1995
===========================

Name of the stock:
Sandeel in the North Sea

The following values were used:

1: First VPA year	1983
2: Last VPA year	2009
3: Youngest age	0
4: Oldest true age	3
5: Number of seasons	2
6: Recruiting season	2
7: Last season in last year	2
8: Spawning season	1
9: Number of fleets	6

The following input files were used:

1: Catch in numbers:	CANUM4.hyr
2: Weight in catch:	WECA4.hyr
3: Weight in stock:	WEST4.hyr
4: Natural mortalities:	natmor.hyr
5: Maturity ogive:	matprop.hyr
6: Tuning data (CPUE):	Tuning4.hyr
7: *Weighting for rhats:	tweq.new
8: *Weighting for shats:	twred.xsa

The following fleets were used:
Fleet: 1: Northern First Half 76-98
Fleet: 2: Northern First Half 99-09
Fleet: 3: Southern First Half 82-98
Fleet: 4: Southern First Half 99-09
Fleet: 5: Northern Secon Half 76-09
Fleet: 6: Southern Secon Half 82-09

The following options were used:

1: Inv. Catchability (1: Linear; 2: Log; 3: Cos. filter):	2
2: Indiv. shats: (1: Direct; 2: Using z)	2
3: Comb. shats (1: Linear; 2: Log.)	2
4: *Fit catches: (0: No fit; 1: No SOP corr; 2: SOP corr.)	0
5: *Est. unknown catches (0: No; 1: No SOP corr; 2: SOP corr.; 3: Sep. F)	0
6: *Weighting of r (0: Manual; (1: not available at present).)	0
7: *Weighting of shats (0: Manual; 1: Linear; 2: Log.)	0
8: Handling of the plus group (1: Dynamic; 2: Extra age group)	1

You need a factor for weighting the inverse catchabilities at the oldest age vs. the second oldest age
It must be between 0.0 and 1.0. Factor 1.0 means that the catchabilities for the oldest are used as they are
Present value 0.0000000E+00

You have to specify a minimum value for the survivor number.
This is used instead of the estimate if the estimate becomes very low
Present value: 1.000000

Weighting factors for computing catchability (weighting for rhat)

Year:	1983-2008		2009	
Season	1	2	1	2
Age				
0	1	1	0.5	0.1
1	1	1	0.5	0.1
2	1	1	0.5	0.1
3	1	1	0.5	0.1

Weighting factors for computing survivors in all years (weighting for shats)

Season	1	2
Age		
1	*	0.02
2	1	0.1
3	1	0.1
4	1	0.1

Table 4.3.2.8 SANDEEL in IV. SXSA fishing mortality at age, 'SPALYAssessment'

Partial fishing mortality Northern North Sea

Year		1983		1984		1985		1986		1987		1988	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.013 *		0 *		0 *		0.017 *		0.003 *		0.027
	1	0.091	0.01	0.055	0.015	0.045	0.004	0.077	0.053	0.162	0.082	0.192	0.058
	2	0.021	0.012	0.081	0.009	0.088	0.028	0.175	0.072	0.136	0.005	0.791	0.037
	3	0.035	0.015	0.012	0.013	0.121	0.025	0.047	0	0.09	0	0.067	0.021
	4+	0.051	0	0.009	0	0.24	0.011	0	0	0.056	0	0.016 *	
F		0.056	0.011	0.068	0.012	0.066	0.016	0.126	0.063	0.149	0.043	0.492	0.047

Year		1989		1990		1991		1992		1993		1994	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.015 *		0.028 *		0.025 *		0.032 *		0.065 *		0.001
	1	0.359	0.088	0.169	0.06	0.279	0.017	0.052	0.001	0.199	0.029	0.199	0.015
	2	0.171	0.041	0.172	0.043	0.163	0.005	0.147	0	0.058	0.004	0.357	0.119
	3	0.726	0	0.171	0.043	0.197	0.003	0.141	0	0.122	0.008	0.398	0.055
	4+	0 *		0.22	0.077	0.512	0.021	0.21	0	0.61	0.745	1.307 *	
F		0.265	0.065	0.17	0.051	0.221	0.011	0.1	0	0.128	0.017	0.278	0.067

Year		1995		1996		1997		1998		1999		2000	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.017 *		0.025 *		0.011 *		0.142 *		0.105 *		0
	1	0.168	0.04	0.127	0.044	0.141	0.057	0.08	0.298	0.026	0.023	0.227	0.015
	2	0.098	0.017	0.106	0.068	0.152	0.045	0.32	0.041	0.215	0.072	0.574	0.017
	3	0.189	0.009	0.074	0.032	0.388	0.004	0.265	0.023	0.219	0.006	0.359	0.017
	4+	0.032	0.001	0.088	0.04	0.445	0.002	0.093	0	0.332	0	0.303	0.034
F		0.133	0.028	0.117	0.056	0.146	0.051	0.2	0.17	0.121	0.048	0.4	0.016

Year		2001		2002		2003		2004		2005		2006	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.086 *		0 *		0.041 *		0.03 *		0 *		0
	1	0.06	0.024	0.146	0.004	0.127	0.018	0.12	0.044	0.08	0	0.021	0.01
	2	0.166	0.018	0.149	0.001	0.058	0.017	0.143	0.005	0.054	0	0.019	0.01
	3	0.171	0.102	0.168	0	0.11	0	0.08	0.008	0.095	0	0.008	0.009
	4+ *	*		0.308	0 *	*		0.306	0	0.061	0	0.004	0.005
F		0.113	0.021	0.147	0.002	0.092	0.018	0.132	0.024	0.067	0	0.02	0.01

Year		2007		2008		2009	
Season		1	2	1	2	1	2
AGE							
	0 *		0 *		0 *		0
	1	0.175	0	0.042	0	0.032	0.019
	2	0.054	0	0.186	0	0.011	0.006
	3	0.055	0	0.073	0	0.013	0.007
	4+	0.042	0	0.046	0	0.001	0
F		0.115	0	0.114	0	0.022	0.013

Partial fishing mortality Southern North Sea

Year		1983		1984		1985		1986		1987		1988	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.016 *		0 *		0.015 *		0 *		0.002 *		0
	1	0.036	0.008	0.293	0.115	0.13	0.07	0.141	0.04	0.027	0.044	0.046	0
	2	0.605	0.106	0.11	0.007	1.046	0.373	0.493	0.045	0.286	0.16	0.307	0.025
	3	0.362	0.417	1.076	0.174	0.3	0.623	0.375	0.105	0.297	0.091	0.913	0.374
	4+	1.654	0.473	0.872	0.257	0.132	0.29	0.013	0.01	0.06	0.027	1.682 *	
F		0.32	0.057	0.202	0.061	0.588	0.221	0.317	0.042	0.157	0.102	0.177	0.013

Year		1989		1990		1991		1992		1993		1994	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0 *		0.001 *		0.022 *		0.001 *		0.002 *		0
	1	0.281	0.035	0.26	0.051	0.134	0.219	0.32	0.053	0.045	0.03	0.173	0.075
	2	0.348	0.025	0.732	0.06	0.64	0.06	0.364	0.027	0.323	0.037	0.128	0.032
	3	0.205	0.021	0.73	0.06	0.286	0.045	0.291	0.085	0.441	0.065	0.178	0.027
	4+	2.193 *		0.936	0.108	0.732	0	0.427	0.05	0.956	2.947	0.434 *	
F		0.315	0.03	0.496	0.056	0.387	0.14	0.342	0.04	0.184	0.034	0.151	0.053

Year		1995		1996		1997		1998		1999		2000	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0 *		0.002 *		0.001 *		0.005 *		0.004 *		0.02
	1	0.184	0.037	0.112	0.053	0.11	0.077	0.114	0.022	0.4	0.007	0.353	0.115
	2	0.192	0.141	0.315	0.157	0.152	0.038	0.381	0.06	0.4	0.008	0.389	0.099
	3	0.269	0.101	0.625	0.124	0.177	0.061	0.414	0.061	0.565	0.154	0.461	0.239
	4+	0.271	0.058	0.343	0.732	0.252	0.117	0.515	0.031	0.307	0.12	0.727	0.243
F		0.188	0.089	0.214	0.105	0.131	0.057	0.247	0.041	0.4	0.007	0.371	0.107

Year		2001		2002		2003		2004		2005		2006	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		0.137 *		0 *		0.029 *		0.024 *		0 *		0
	1	0.598	0.026	0.569	0.033	0.273	0.139	0.599	0.11	0.498	0	0.486	0.078
	2	0.934	0.004	0.487	0.057	0.69	0.048	0.294	0.251	0.684	0	0.433	0.011
	3	0.419	0	0.445	0	0.87	0.124	0.917	0.3	0.303	0	0.519	0.02
	4+ *	*		0.352	0 *	*		0.389	0.24	0.544	0	0.384	0.001
F		0.766	0.015	0.528	0.045	0.481	0.093	0.446	0.181	0.591	0	0.459	0.045

Year		2007		2008		2009	
Season		1	2	1	2	1	2
AGE							
	0 *		0 *		0 *		0
	1	0.196	0	0.37	0	0.202	0.066
	2	0.348	0	0.391	0	0.892	0.053
	3	0.153	0	0.25	0	0.423	0.011
	4+	0.136	0	0.112	0	0.144	0
F		0.272	0	0.381	0	0.547	0.059

Table 4.3.2.9. SANDEEL in IV. SXSA annual fishing mortality at age. SPALY assessment

Year	Age 0	Age 1	Age 2	Age 3	Age 4+	F(1-2)
1983	0.029	0.148	0.794	0.792	4.175	0.471
1984	0.000	0.457	0.222	1.391	1.257	0.340
1985	0.015	0.233	1.616	0.998	0.661	0.925
1986	0.017	0.292	0.840	0.552	0.022	0.566
1987	0.006	0.279	0.601	0.501	0.149	0.440
1988	0.027	0.293	1.305	1.430	0.000	0.799
1989	0.015	0.779	0.629	1.072	0.000	0.704
1990	0.030	0.536	1.105	1.100	1.623	0.820
1991	0.048	0.591	0.955	0.574	1.648	0.773
1992	0.032	0.439	0.589	0.547	0.766	0.514
1993	0.067	0.301	0.454	0.685	0.000	0.377
1994	0.001	0.460	0.660	0.707	0.000	0.560
1995	0.017	0.430	0.448	0.596	0.383	0.439
1996	0.026	0.317	0.649	0.908	1.147	0.483
1997	0.012	0.352	0.402	0.681	0.899	0.377
1998	0.147	0.395	0.866	0.826	0.716	0.630
1999	0.109	0.484	0.750	1.011	0.826	0.617
2000	0.020	0.715	1.185	1.128	1.494	0.950
2001	0.225	0.758	1.275	0.739	0.000	1.016
2002	0.000	0.814	0.757	0.683	0.753	0.785
2003	0.070	0.530	0.891	1.213	0.000	0.710
2004	0.055	0.888	0.692	1.380	0.997	0.790
2005	0.000	0.638	0.826	0.439	0.686	0.732
2006	0.000	0.608	0.517	0.608	0.436	0.563
2007	0.000	0.407	0.445	0.228	0.196	0.426
2008	0.000	0.452	0.641	0.356	0.174	0.547
2009	0.000	0.306	1.069	0.497	0.159	0.687

Table 4.3.2.10. SANDEEL in IV. SXSA stock numbers at age (millions) at start of season. SPALY assessment.

Year		1983		1984		1985		1986		1987		1988	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		878848 *		225599 *		1199288 *		622401 *		198475 *		716146
	1	104184	33526	383356	96019	101368	30936	530637	154232	274825	82550	88676	25220
	2	90146	30752	26957	14874	68995	11377	23514	7629	115030	49576	59567	10458
	3	3690	1636	22353	3993	11986	5175	6176	2663	5553	2488	34380	7299
	4+	498	6	861	211	2841	1295	2915	1930	3526	2101	3534	80
SSN		94334		50171		83822		32606		124109		97481	
SSB		1236745		754271		1169916		489853		1638389		1495275	
TSN		198518	944767	433527	340695	185190	1248071	563243	788854	398934	335191	186157	759203
TSB		1760792	1856561	2326031	1613593	1594648	2073218	2707916	2930658	2930066	2002058	1885447	1619985

Year		1989		1990		1991		1992		1993		1994	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		324068 *		632191 *		799404 *		316352 *		618012 *		865131
	1	312940	53801	143347	32549	275546	63816	341948	83212	137500	38848	259057	63042
	2	19487	7541	38930	9248	23837	6509	41139	16051	64553	29112	29959	12043
	3	8043	1836	5777	1379	6831	2755	4992	2128	12793	4703	22871	8284
	4+	3982	0	1472	233	1177	157	2274	766	2197	115	3579	49
SSN		31513		46178		31845		48405		79543		56409	
SSB		493162		648117		455214		671540		1076253		789593	
TSN		344452	387246	189525	675601	307391	872641	390352	418509	217043	690789	315466	948548
TSB		1870096	1144164	1258773	1383519	1637307	1713764	2066686	1660480	1695003	1813788	2411290	7089828

Year		1995		1996		1997		1998		1999		2000	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		355327 *		1893077 *		321517 *		382990 *		488704 *		484686
	1	388422	96904	156946	44565	827887	232145	142705	42664	147714	33677	196144	36675
	2	47161	23453	73420	31694	33106	16225	166010	51702	25210	8720	26762	5836
	3	8472	3513	16372	5109	20654	7574	12226	3916	38250	10709	6589	1760
	4+	6245	3063	4939	2107	4324	1352	6793	2367	4824	1621	8633	1695
SSN		61878		94731		58084		185030		68284		41983	
SSB		1027068		1075400		649068		1675811		843271		463992	
TSN		450300	482259	251678	1976552	885971	578813	327734	483640	215998	543432	238128	530652
TSB		3796517	3236029	2134789	6635630	5310070	2821175	2390761	1834467	1668994	2119055	1719316	1225306

Year		2001		2002		2003		2004		2005		2006	
Season		1	2	1	2	1	2	1	2	1	2	1	2
AGE													
	0 *		851253 *		74343 *		274977 *		145349 *		289127 *		191141
	1	213320	35705	302170	46520	33405	7863	114956	17587	61728	11553	129913	26768
	2	26347	4611	27793	9366	36705	10774	5497	2330	12324	3663	9459	3947
	3	4253	1517	3696	1281	7235	1535	8263	1709	1472	652	2999	1150
	4+	2160	0	1120	367	1349	0	1109	348	1246	436	891	399
SSN		32760		32610		45289		14869		15042		13349	
SSB		314486		327895		402129		173288		152014		155050	
TSN		246080	893086	334779	131877	78694	295149	129825	167323	76769	305431	143262	223404
TSB		1255226	2708269	2183216	503661	577837	1110034	819338	672195	510651	1072714	968308	334683

Year		2007		2008		2009	
Season		1	2	1	2	1	2
AGE							
	0 *		299138 *		310412 *		2720185
	1	85885	20914	134412	31151	139477	39812
	2	20055	8832	17123	6195	25505	6065
	3	3164	1715	7231	3472	5072	2154
	4+	1239	693	1971	1125	3764	2179
SSN		24459		26326		34341	
SSB		313998		389009		455164	
TSN		110344	331293	160737	352356	173818	2770394
TSB		931511		1294943		1339450	6999661

Table 4.3.2.11. SANDEEL in IV. SXSA catchability, SPALY Assessment

Log inverse q

Fleet	age 0	1	2	3
Fleet 1: Northern North Sea 83-98	*	3.675	3.581	3.581
Fleet 2: Northern North Sea 99-08	*	3.178	2.916	2.916
Fleet 3: Southern North Sea 83-98	*	4.214	3.172	3.172
Fleet 4: Southern North Sea 99-08	*	2.885	2.678	2.678
Fleet 5: Northern North Sea 83-07	6.247	3.464	4.512	4.512
Fleet 6: Southern North Sea 83-07	6.247	3.464	3.52	3.52

q

Fleet	age 0	1	2	3
Fleet 1: Northern North Sea 83-98	*	0.0253	0.0278	0.0278
Fleet 2: Northern North Sea 99-08	*	0.0417	0.0541	0.0541
Fleet 3: Southern North Sea 83-98	*	0.0148	0.0419	0.0419
Fleet 4: Southern North Sea 99-08	*	0.0559	0.0687	0.0687
Fleet 5: Northern North Sea 83-07	0.0019	0.0313	0.0110	0.0110
Fleet 6: Southern North Sea 83-07	0.0019	0.0313	0.0296	0.0296

Table 4.3.2.12. SANDEEL in IV. Assessment summary for SXSA. SPALY assessment

Year	Recruitment Age 0 millions	TSB tons	SSB tons	Landings tons	Yield/SSB	Mean F age 1-2
1983	878848	1760792	1236745	530641	0.429	0.471
1984	225599	2326031	754271	750040	0.994	0.340
1985	1199288	1594648	1169916	707105	0.604	0.925
1986	622401	2707916	489853	685949	1.400	0.566
1987	198475	2930066	1638389	791050	0.483	0.440
1988	716146	1885447	1495275	1007303	0.674	0.799
1989	324068	1870096	493162	826836	1.677	0.704
1990	632191	1258773	648117	584912	0.902	0.820
1991	799404	1637307	455214	898959	1.975	0.773
1992	316352	2066686	671540	820140	1.221	0.514
1993	618012	1695003	1076253	576932	0.536	0.377
1994	865131	2411290	789593	770746	0.976	0.560
1995	355327	3796517	1027068	915042	0.891	0.439
1996	1893077	2134789	1075400	776126	0.722	0.483
1997	321517	5310070	649068	1114044	1.716	0.377
1998	382990	2390761	1675811	1000376	0.597	0.630
1999	488704	1668994	843271	718667	0.852	0.617
2000	484686	1719316	463992	692499	1.492	0.950
2001	851253	1255226	314486	858619	2.730	1.016
2002	74343	2183216	327895	806921	2.461	0.785
2003	274977	577837	402129	309724	0.770	0.710
2004	145349	819338	173288	359362	2.074	0.790
2005	289127	510651	152014	171790	1.130	0.732
2006	191141	968308	155050	286751	1.849	0.563
2007	299138	931511	313998	203392	0.648	0.426
2008	310412	1294943	389009	322738	0.830	0.547
2009		1339450	455164	336897	0.740	0.687
2010			456000			
Average	529152		706856	660132	1.162	0.631

Forecast

Table 4.6.1. SANDEEL in IV. Data used for short term forecast, Suggested Final Assessment

Input in the assessment year (2009)

Season	age	N	F	WEST	WECA	M	Propmat
1	0	0	0	0	0	0	0
1	1	261753	0.12	0.00634	0.00634	1	0
1	2	41124	0.485	0.0117	0.0117	0.4	1
1	3	8332	0.246	0.01654	0.01654	0.4	1
1	4	8289	0.063	0.01936	0.01936	0.4	1
2	0	329050	0	0.0024	0.0024	0.8	0
2	1	0	0.039	0.00593	0.00593	0.2	0
2	2	0	0.021	0.01559	0.01559	0.2	1
2	3	0	0.009	0.02834	0.02834	0.2	1
2	4	0	0	0.03651	0.03651	0.2	1

Input in the forcast year (2010) and forward

Season	age	N	F	WEST	WECA	M	ProbMat
1	0	0	0	0	0	0	0
1	1	147851.7	0.12	0.006	0.006	1	0
1	2	67248.944	0.485	0.0103	0.0103	0.4	1
1	3	13607.102	0.246	0.014	0.014	0.4	1
1	4	7814.807	0.063	0.0188	0.0188	0.4	1
2	0	329050	0	0.0029	0.0029	0.8	0
2	1	0	0.039	0.0084	0.0084	0.2	0
2	2	0	0.021	0.0139	0.0139	0.2	1
2	3	0	0.009	0.0166	0.0166	0.2	1
2	4	0	0	0.0215	0.0215	0.2	1

Table 4.6.2. SANDEEL in IV. Data used for short term forecast, SPALY Assessment

Input in the assessment year (2009)

Season	age	N	F	WEST	WECA	M	Propmat
1	0	0	0	0	0	0	0
1	1	139477	0.234	0.00634	0.00634	1	0
1	2	25505	0.903	0.0117	0.0117	0.4	1
1	3	5072	0.436	0.01654	0.01654	0.4	1
1	4	3764	0.145	0.01936	0.01936	0.4	1
2	0	292000	0	0.0024	0.0024	0.8	0
2	1	0	0.085	0.00593	0.00593	0.2	0
2	2	0	0.059	0.01559	0.01559	0.2	1
2	3	0	0.018	0.02834	0.02834	0.2	1
2	4	0	0	0.03651	0.03651	0.2	1

Input in the forcast year (2010) and forward

Season	age	N	F	WEST	WECA	M	ProbMat
1	0	0	0	0	0	0	0
1	1	131204	0.234	0.006	0.006	1	0
1	2	30536	0.903	0.0103	0.0103	0.4	1
1	3	5349	0.436	0.014	0.014	0.4	1
1	4	3555	0.145	0.0188	0.0188	0.4	1
2	0	292000	0	0.0029	0.0029	0.8	0
2	1	0	0.085	0.0084	0.0084	0.2	0
2	2	0	0.059	0.0139	0.0139	0.2	1
2	3	0	0.018	0.0166	0.0166	0.2	1
2	4	0	0	0.0215	0.0215	0.2	1

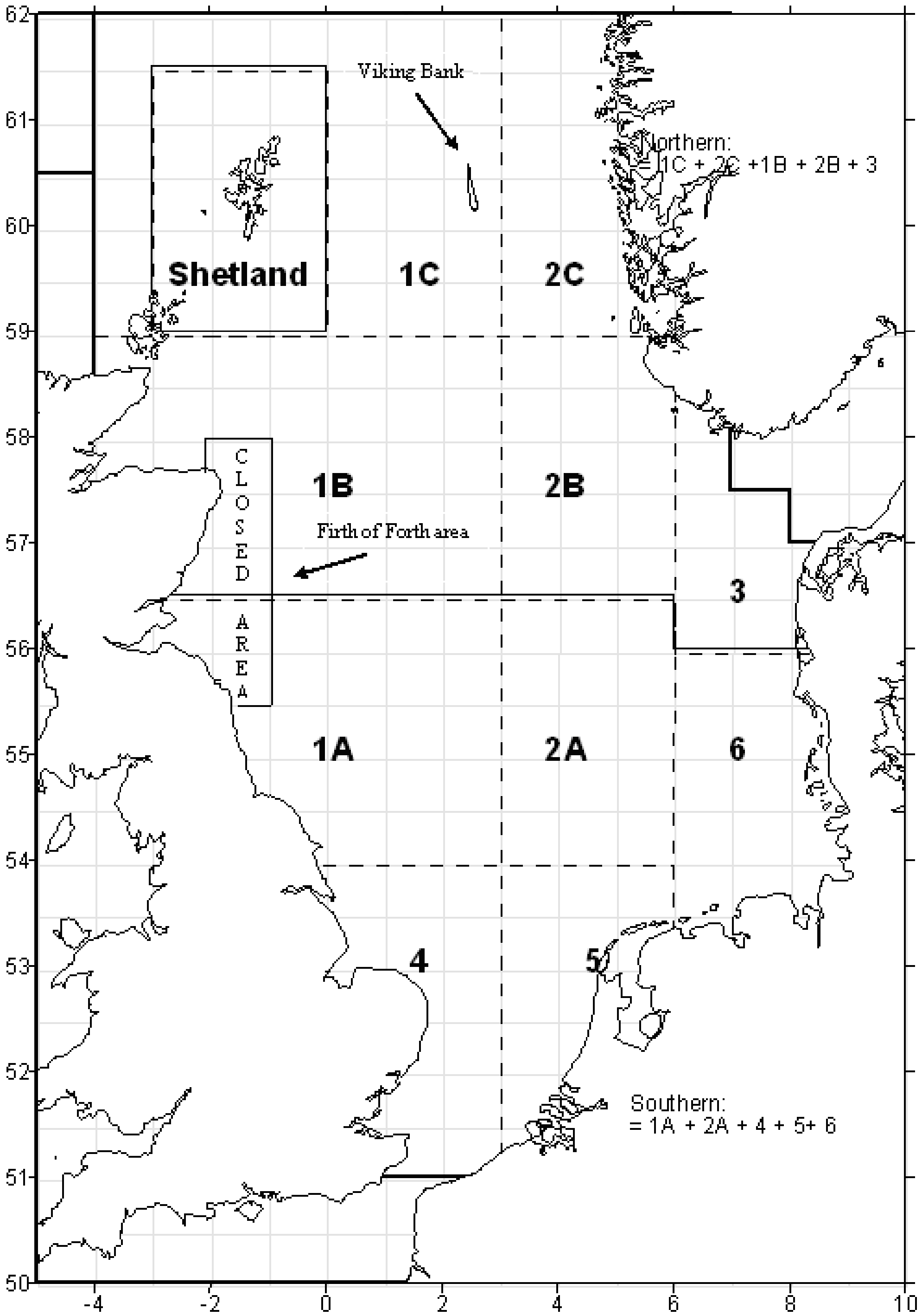


Figure 4.1.2.1. SANDEEL in IV.

Sandeel in IV. Danish sandeel sampling areas.

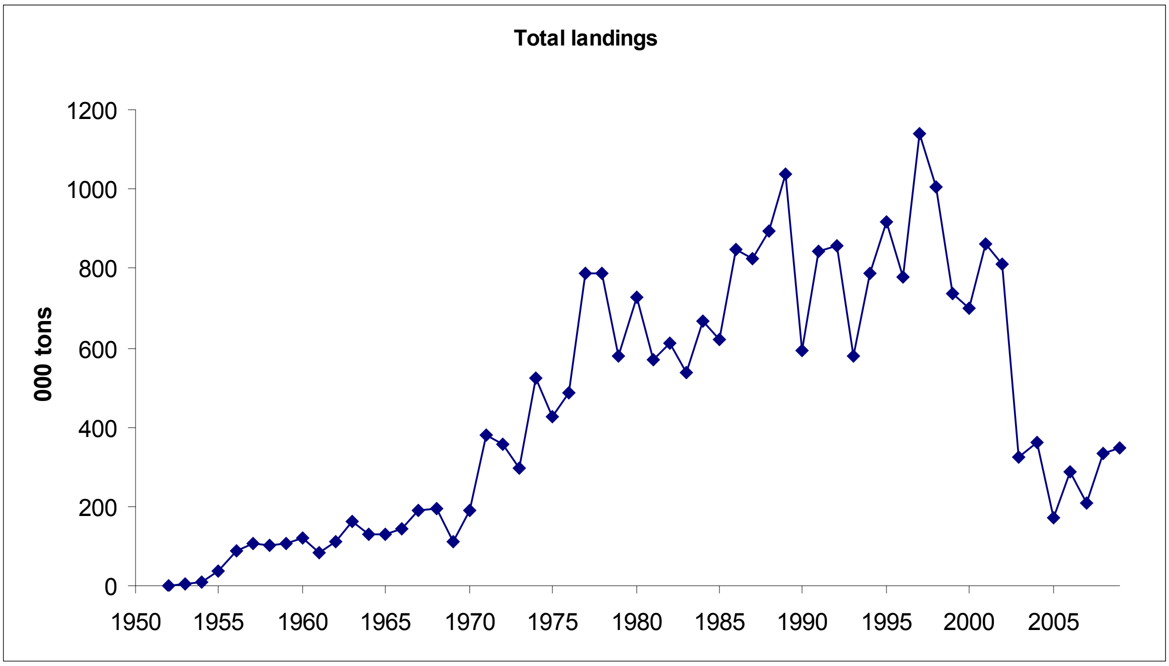


Figure 4.2.1.1 SANDEEL in IV. Total international landings

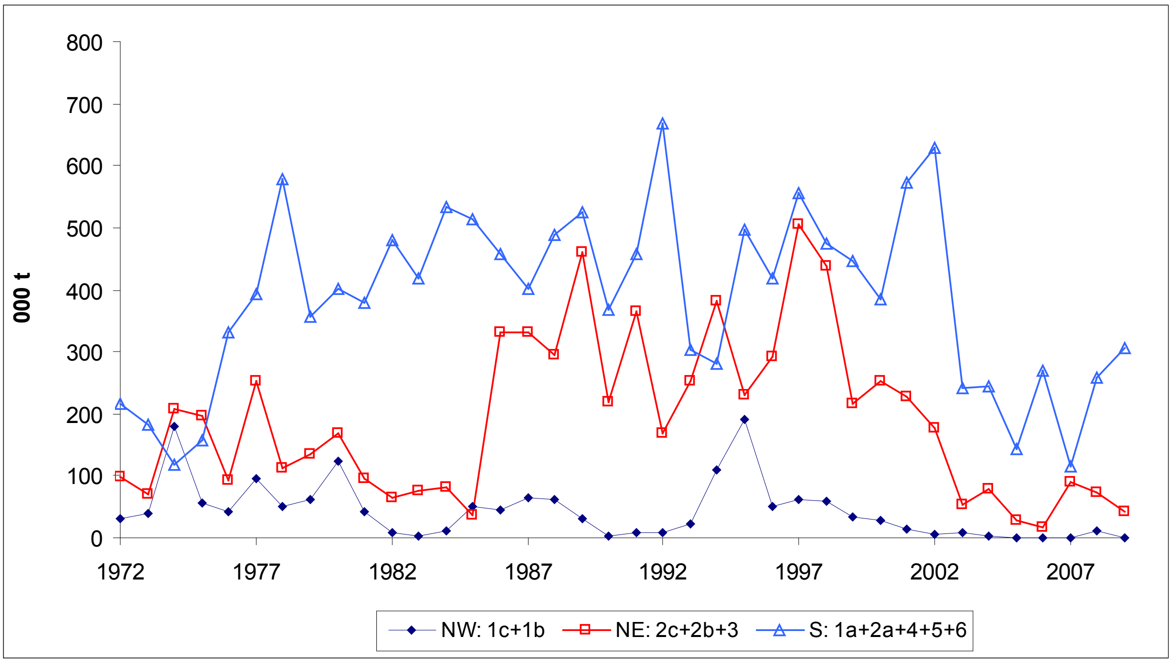


Figure 4.2.1.2 SANDEEL in IV. Total international landings in three areas (see Figure 4.1.2.1)

North Sea sandeel landings in 2009 quarter 2

Total landings: 287294 ton

Max landings per rectangle: 42092 ton

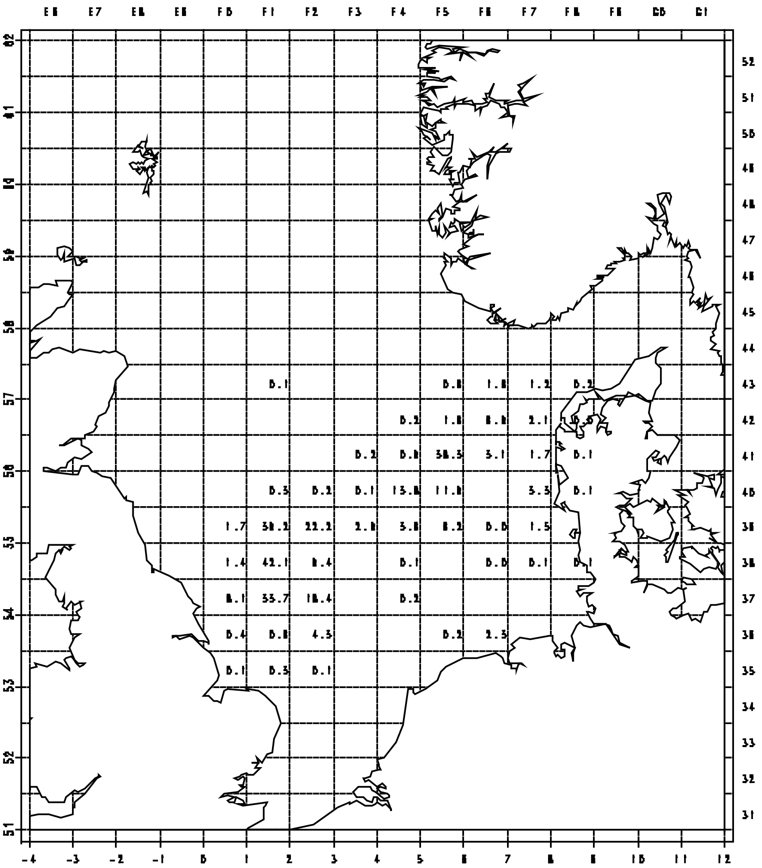


Figure 4.2.1.3 SANDEEL in IV. Quarterly Catches of sandeels in 2009 by ICES rectangle

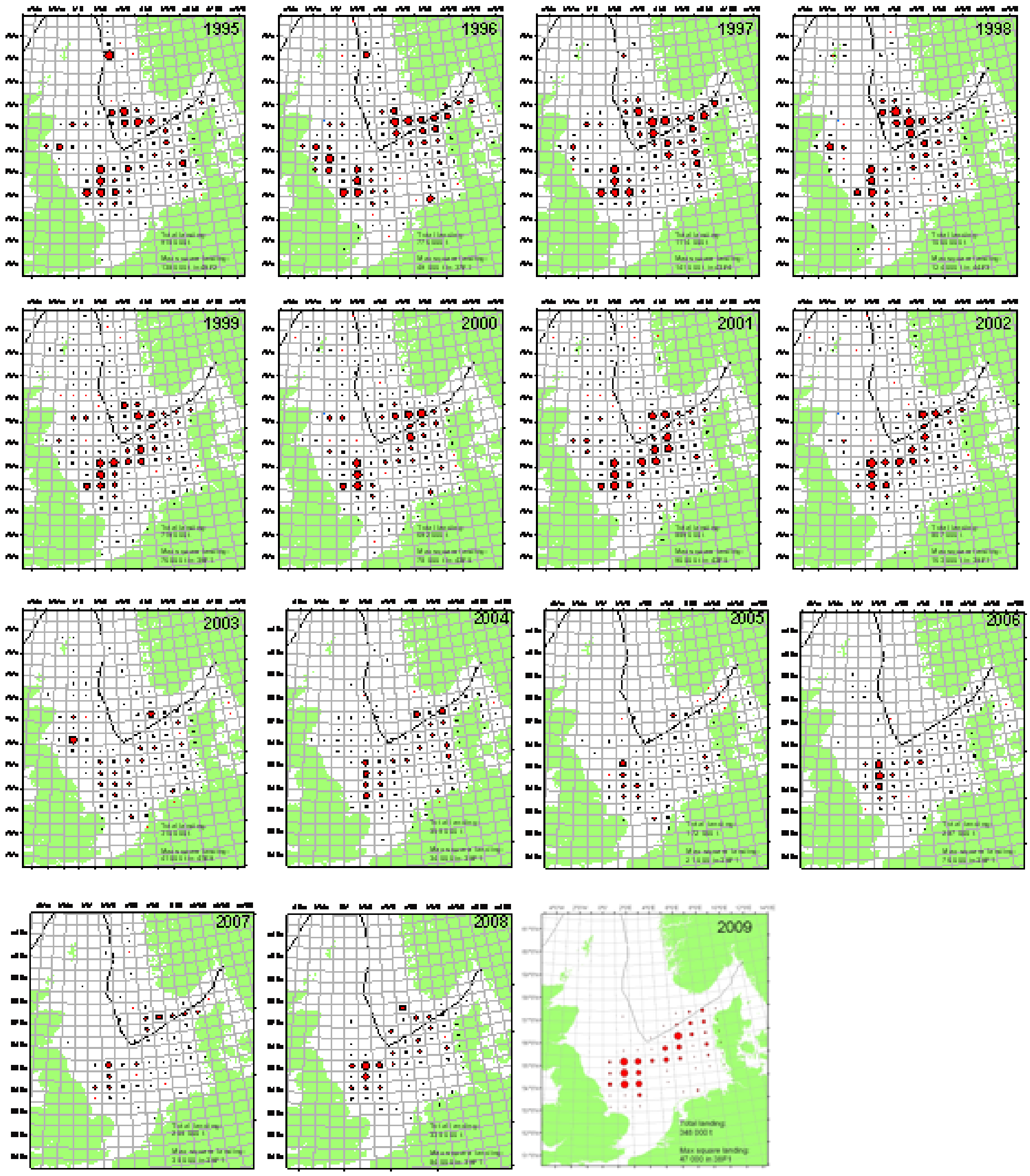


Figure 4.2.1.4 SANDEEL in IV. Landings by ICES rectangles 1995-2009

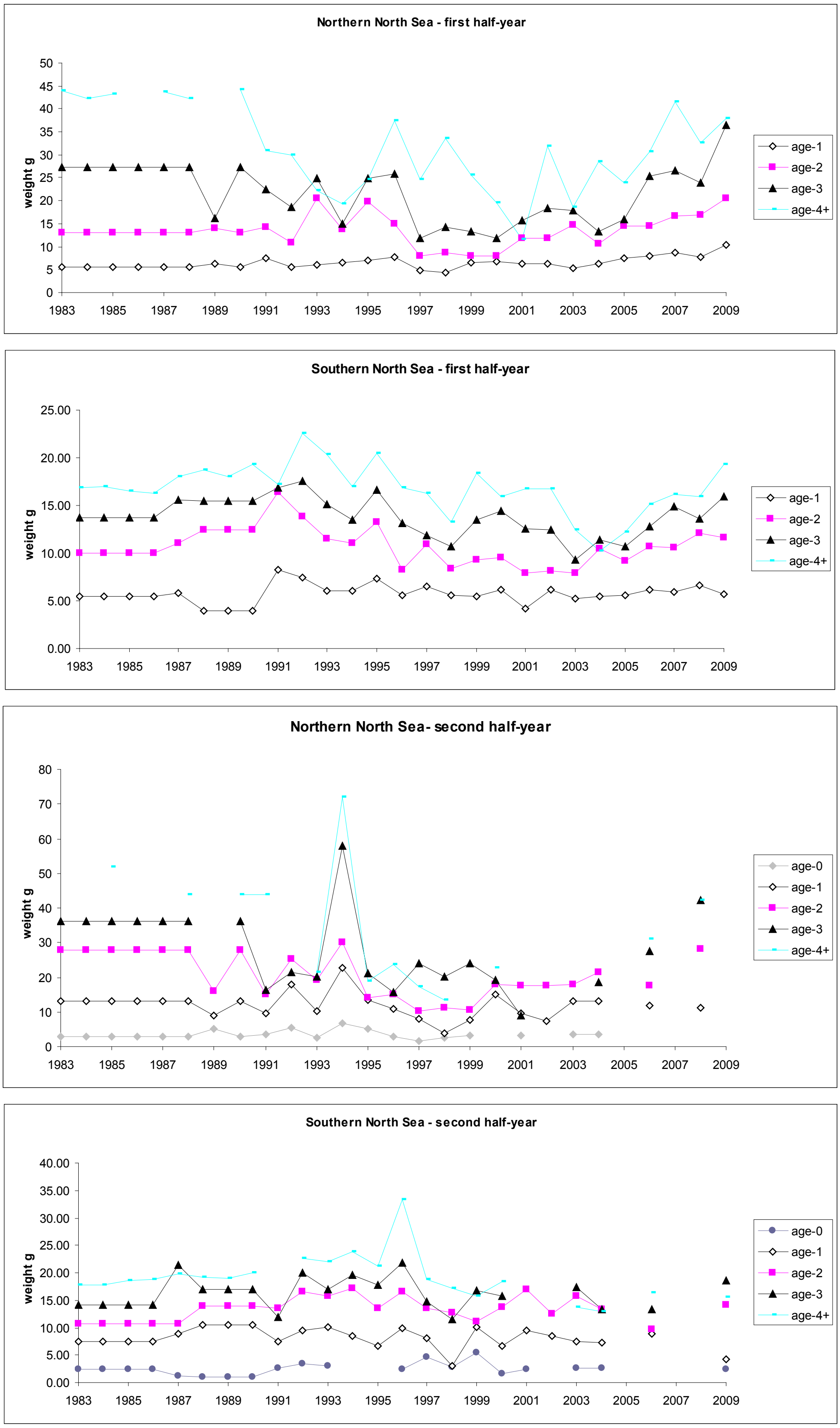
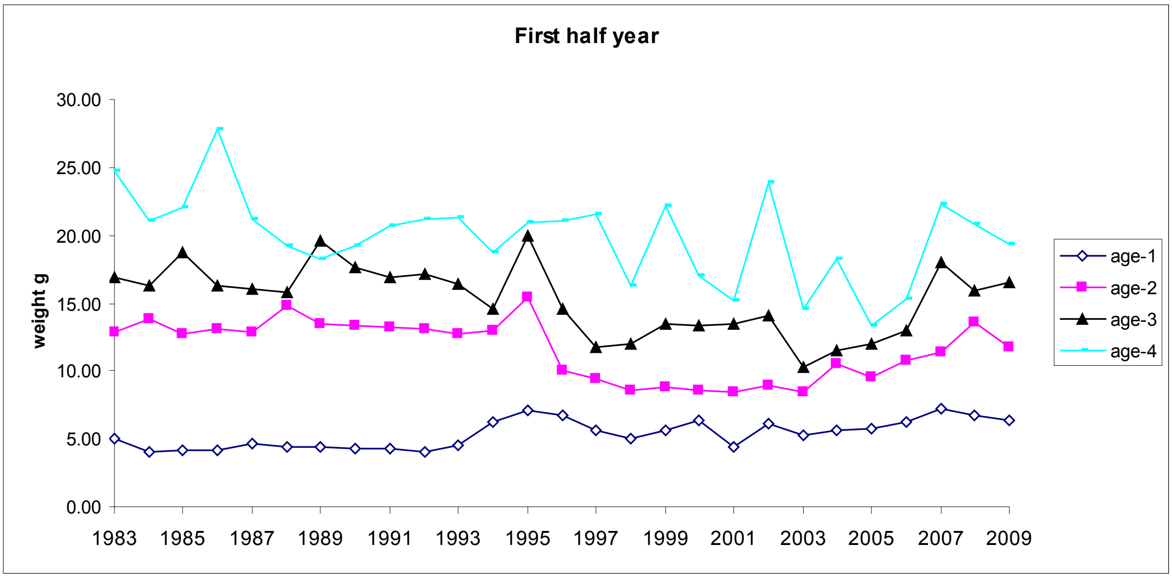


Figure 4.2.3.1 SANDEEL in IV. Mean weight at age in the catch by area and half year.



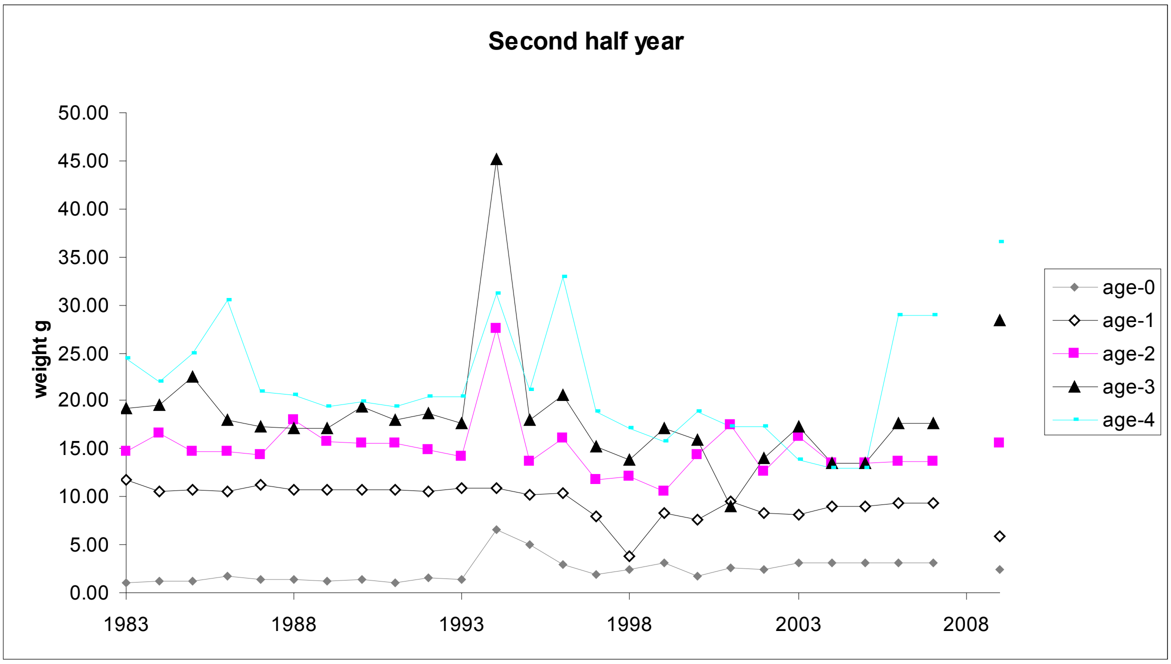


Figure 4.2.3.2. SANDEEL in IV. Mean weight at age in the stock by half year.

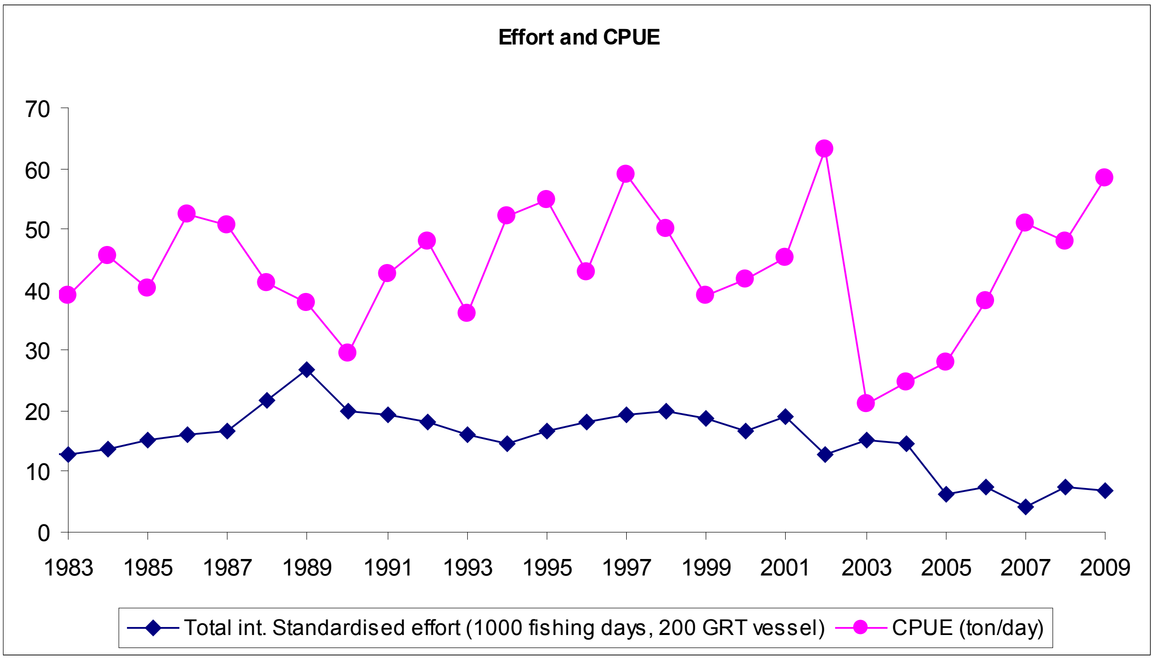
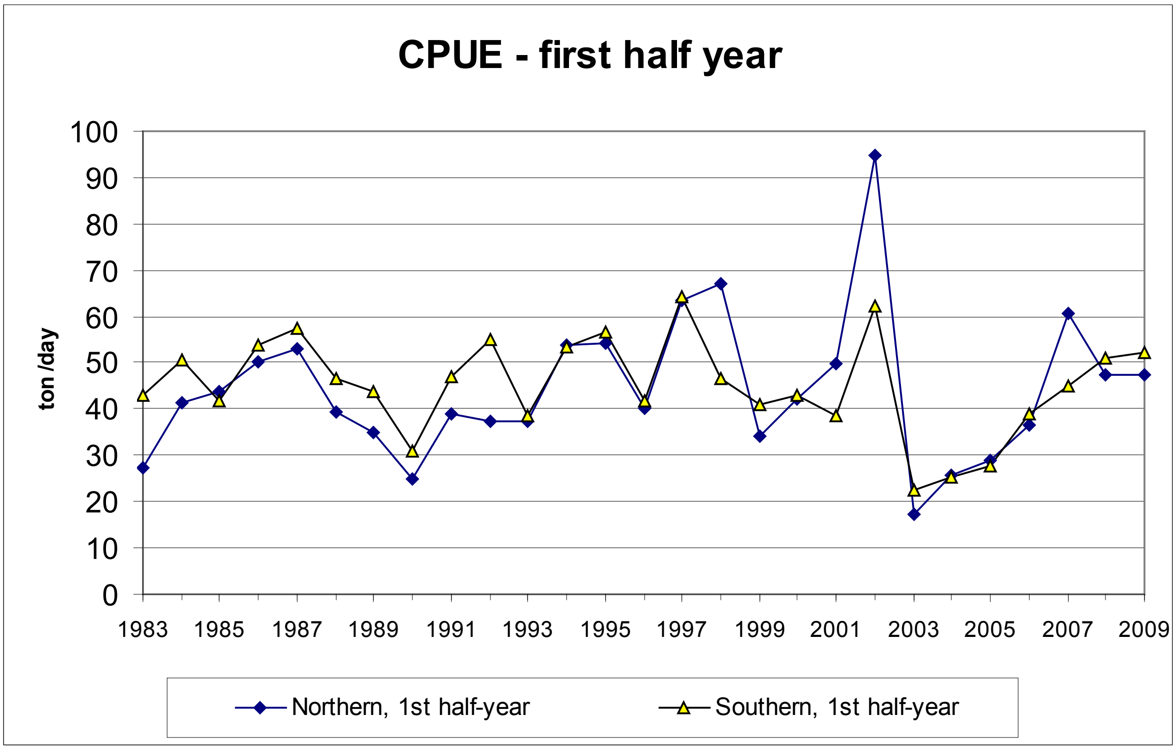


Figure 4.2.5.1. SANDEEL in IV. Total international effort and CPUE



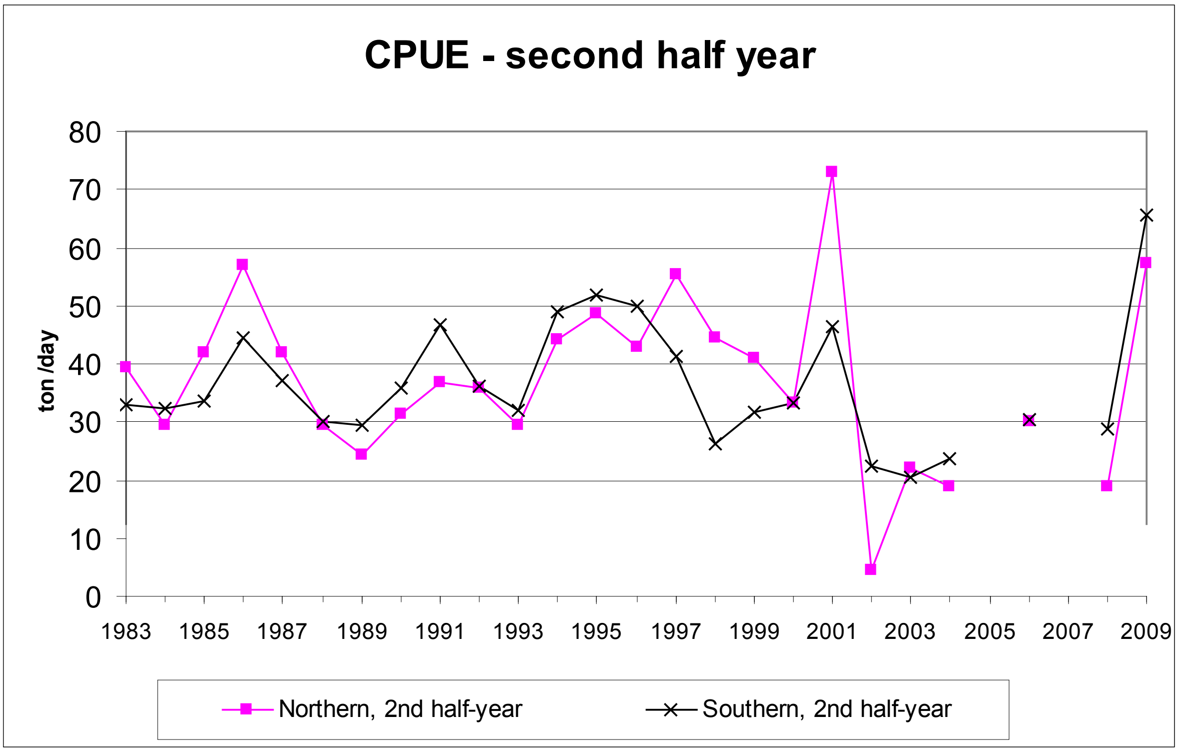


Figure 4.2.5.2. SANDEEL in IV. CPUE (ton/day) by area, half year and year.

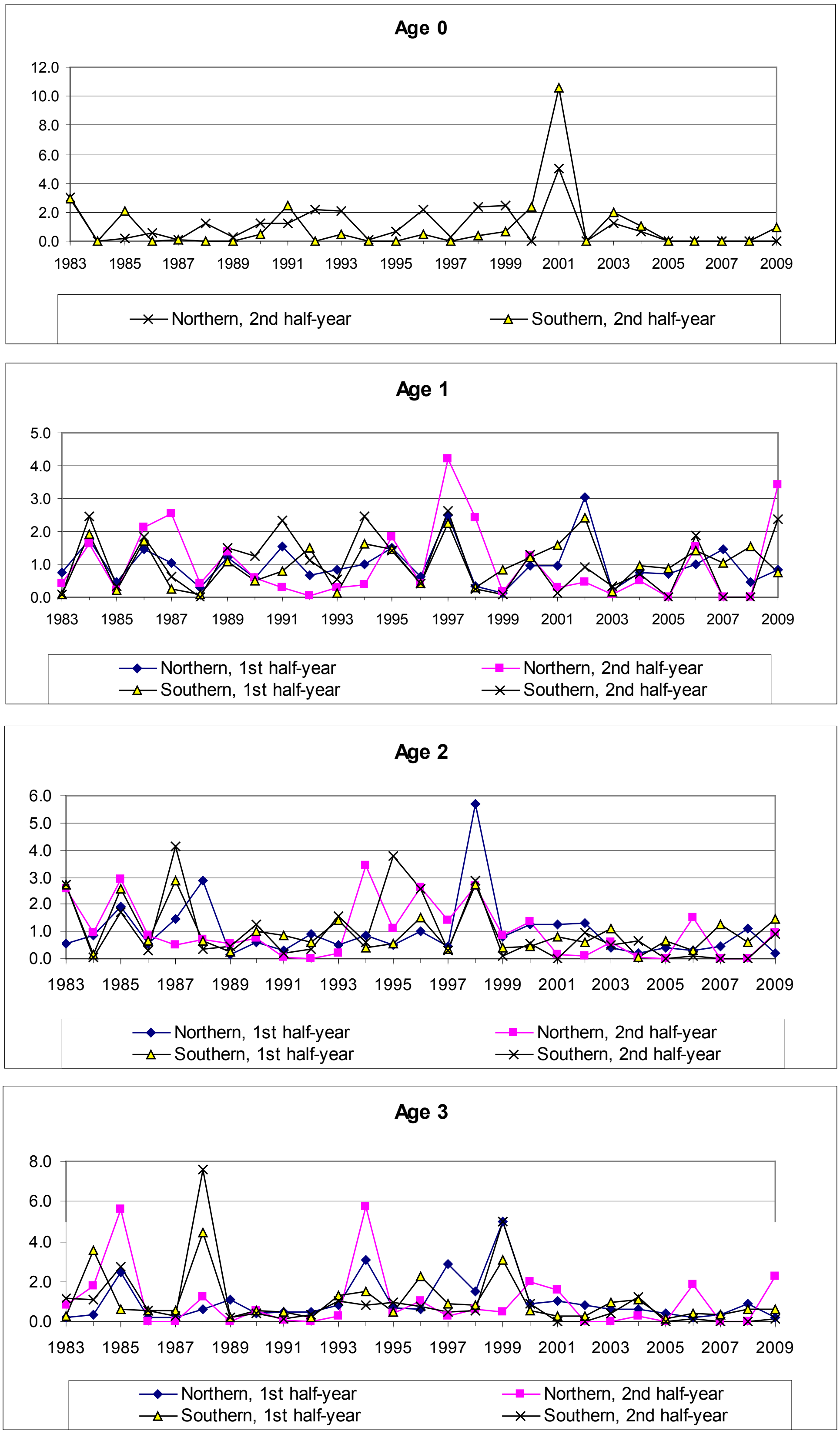


Figure 4.2.5.3 SANDEEL in IV. CPUE (million/day) by area, age group and year

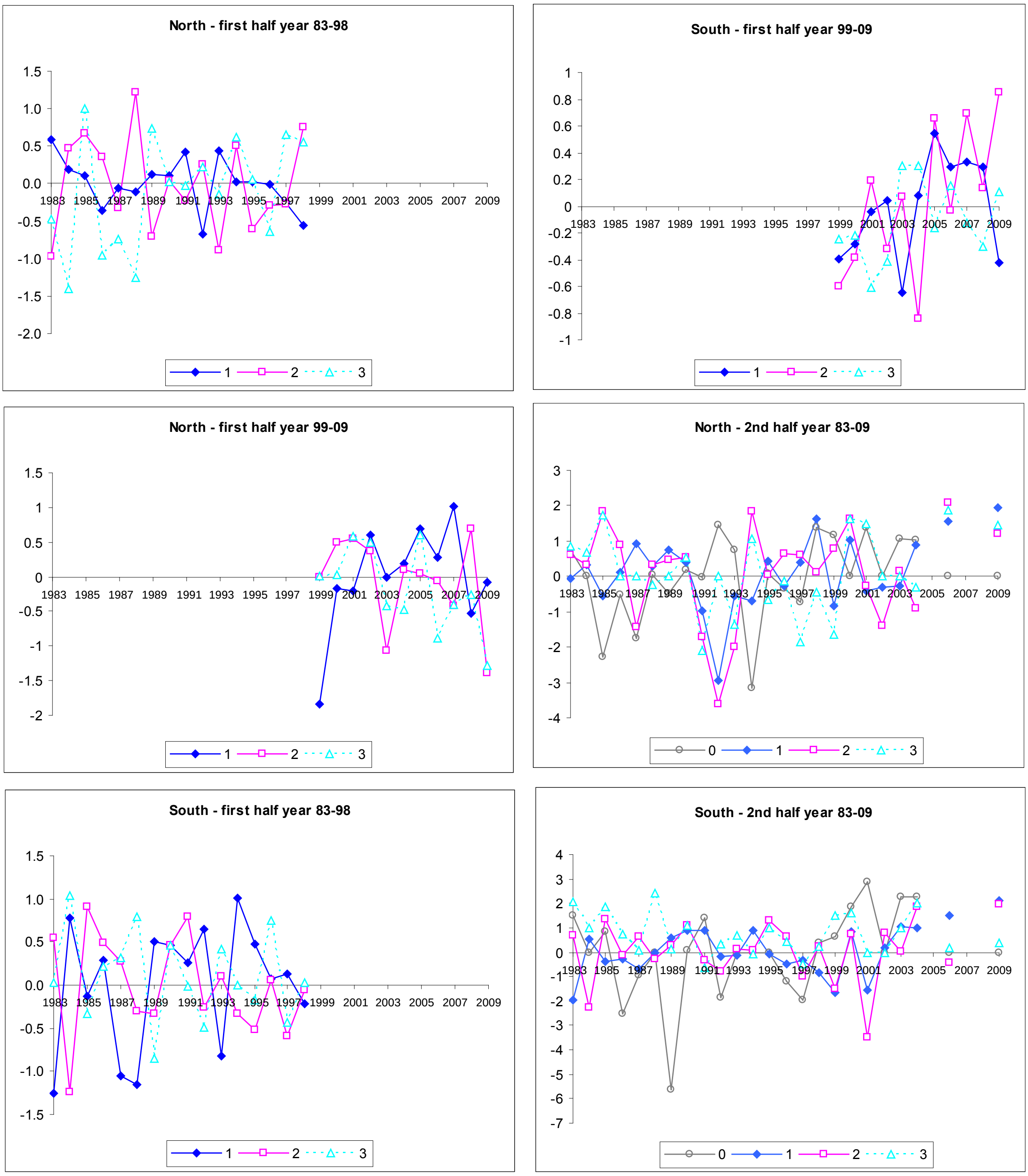


Figure 4.3.2.1. SANDEEL in IV. Log residuals by fleet. Exploratory assessment 1: SPALY run

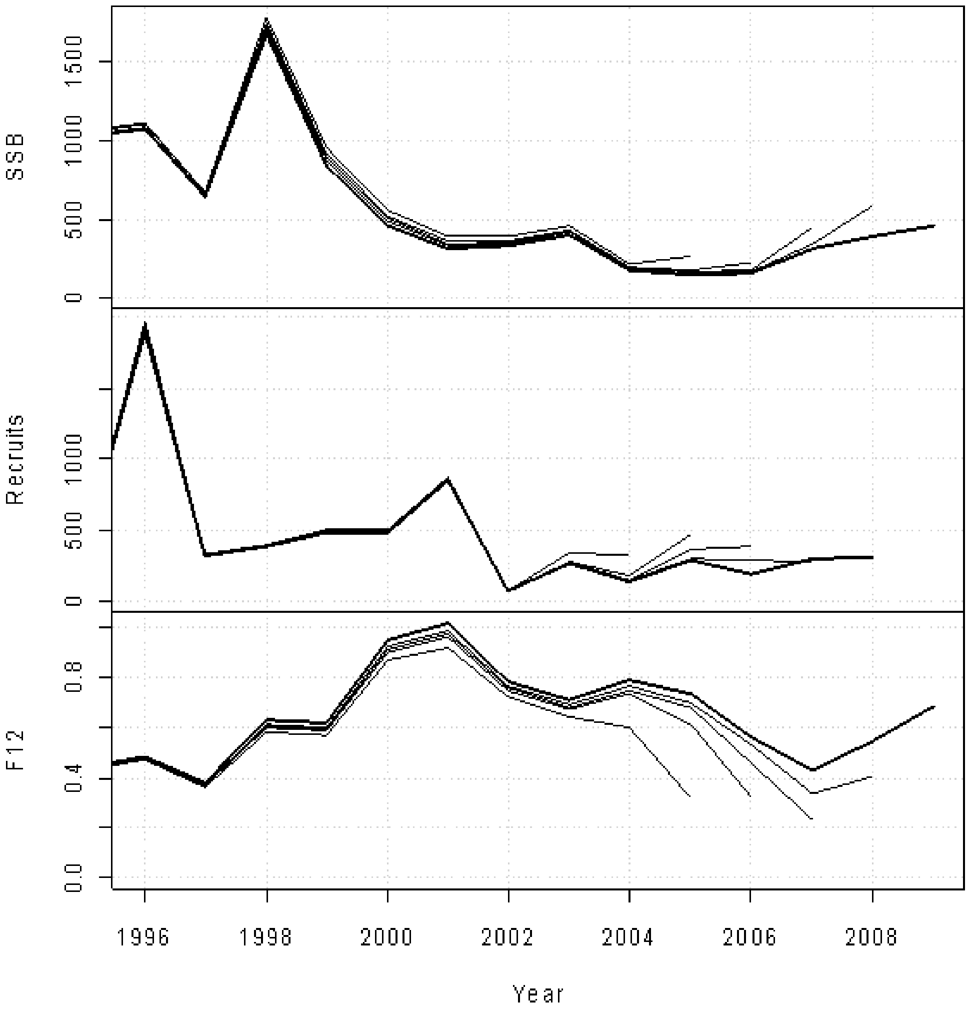


Figure 4.3.2.2 SANDEEL in IV. Retrospective analysis of SSB, recruitment, and Fbar from the Exploratory Assessment 1: SPALY run

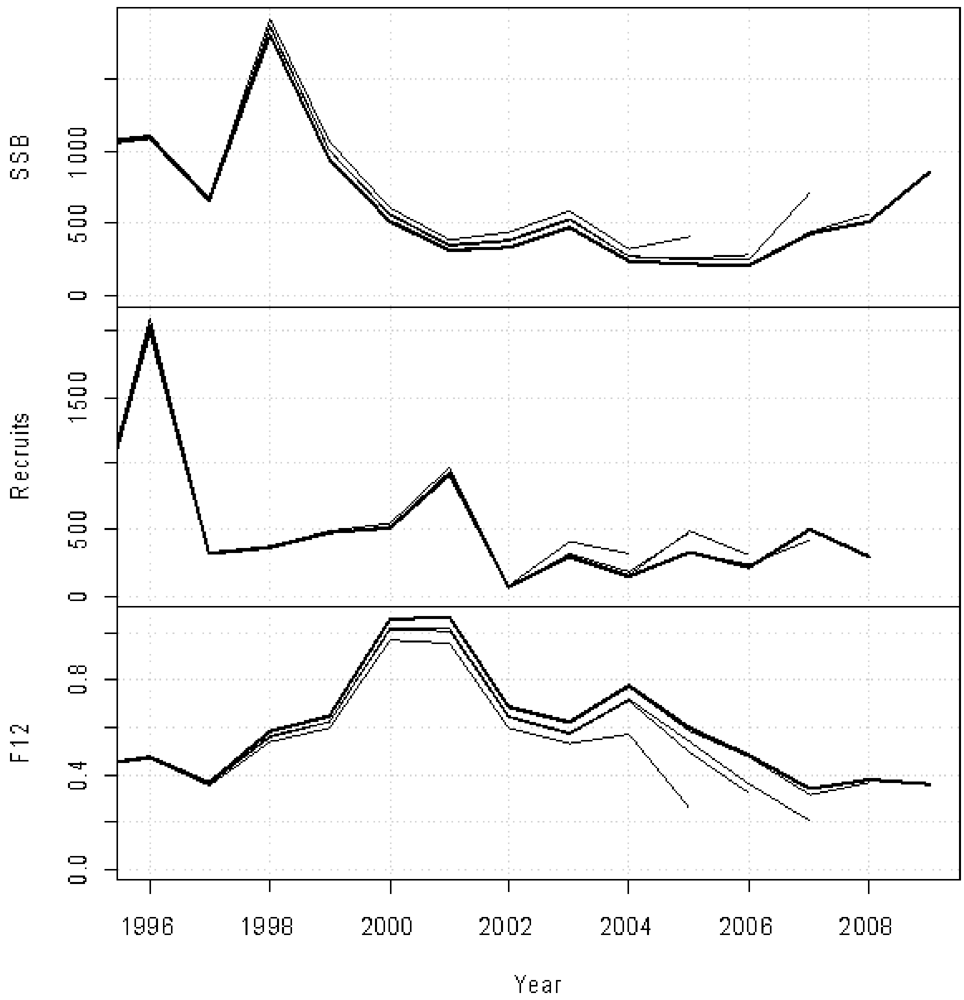


Figure 4.3.2.3 SANDEEL in IV. Retrospective analysis of SSB, recruitment, and Fbar from the Exploratory Assessment 2 excluding all tuning data from northern North Sea after 1999.

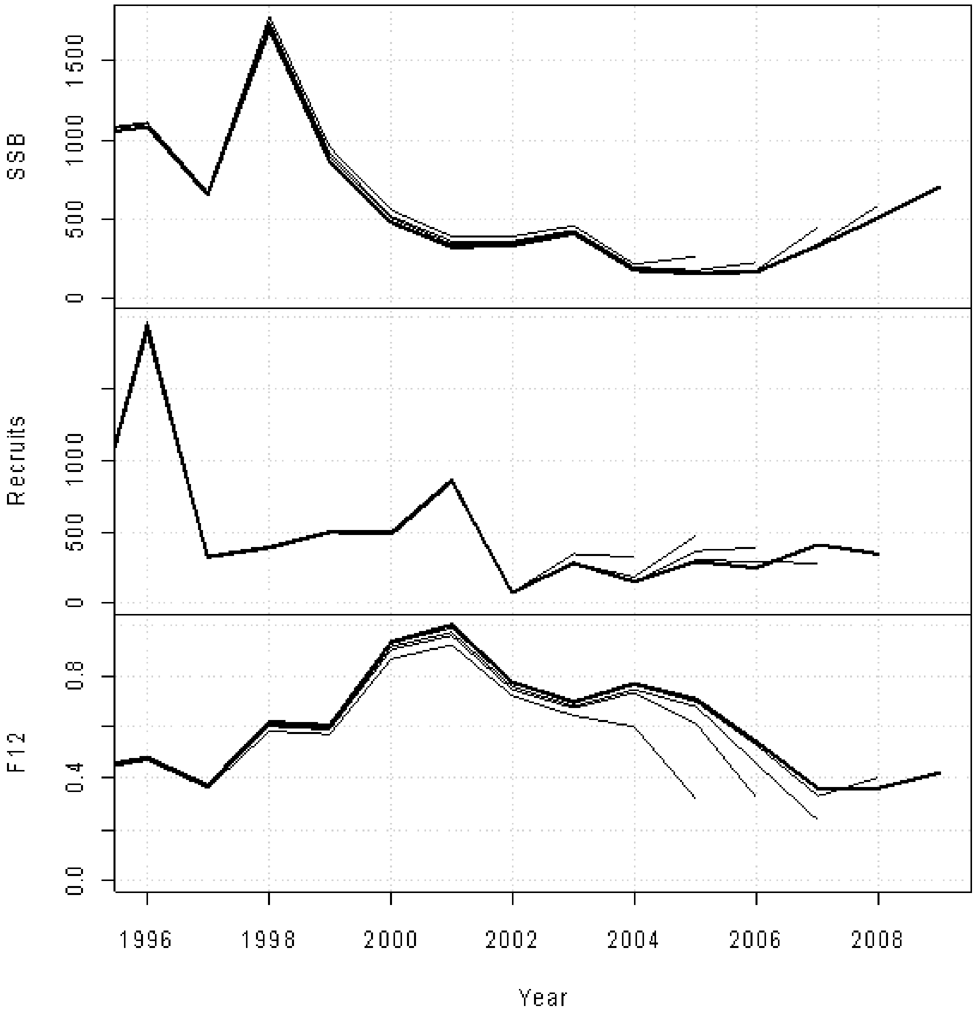


Figure 4.3.2.4 SANDEEL in IV. Retrospective analysis of SSB, recruitment, and Fbar from the Exploratory Assessment 3 excluding Fleet 2 (i.e. first half year, northern North Sea) in 2009.

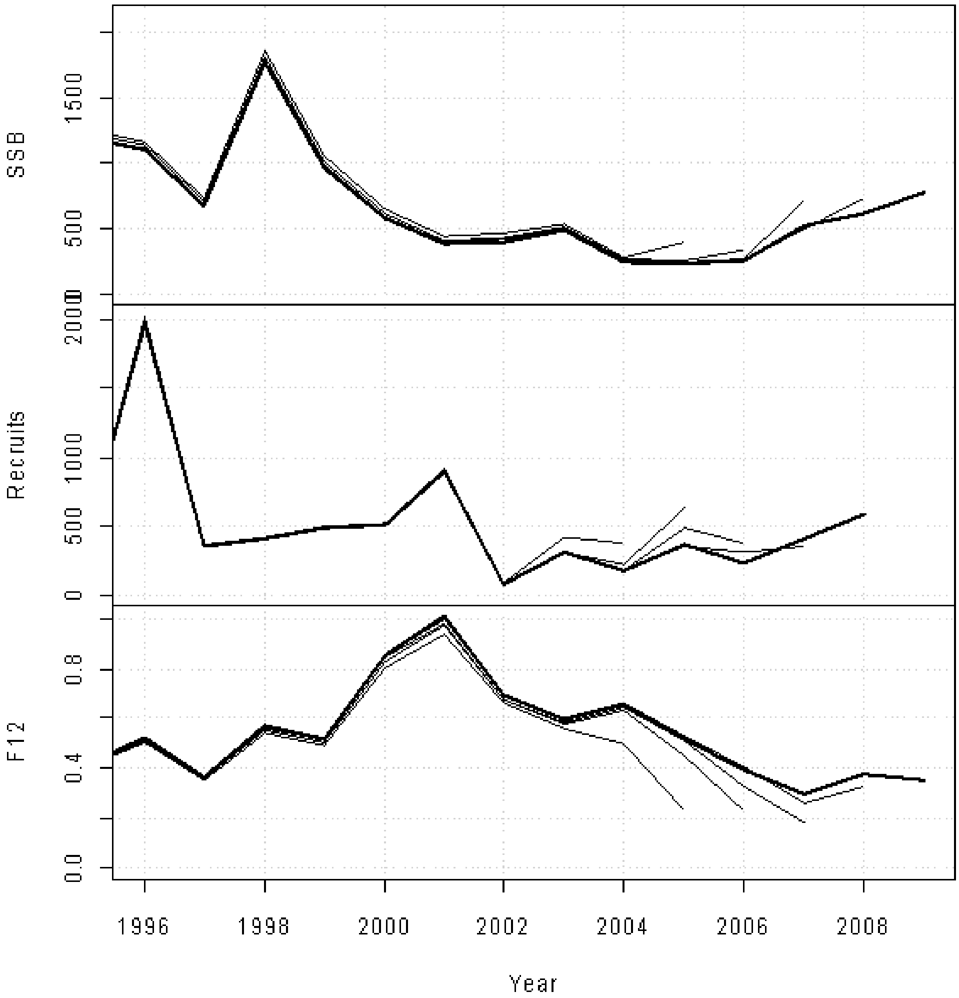


Figure 4.3.2.5 SANDEEL in IV. Retrospective analysis of SSB, recruitment, and Fbar from the Exploratory Assessment 4 (Suggested Final run) applying log weighting of Shat.

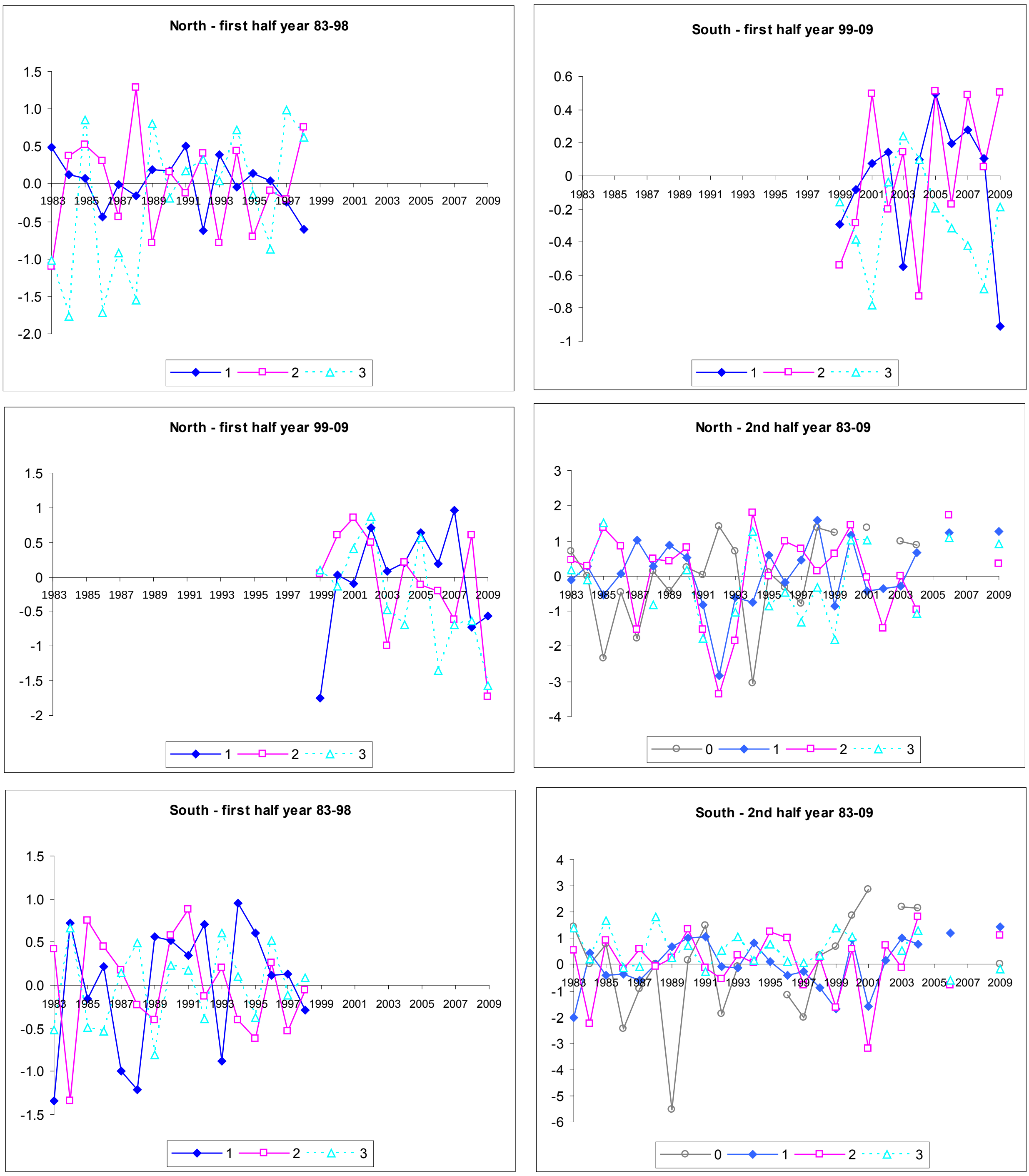


Figure 4.3.2.6. SANDEEL in IV. Log residuals by fleet. Exploratory assessment 4: Suggested Final run

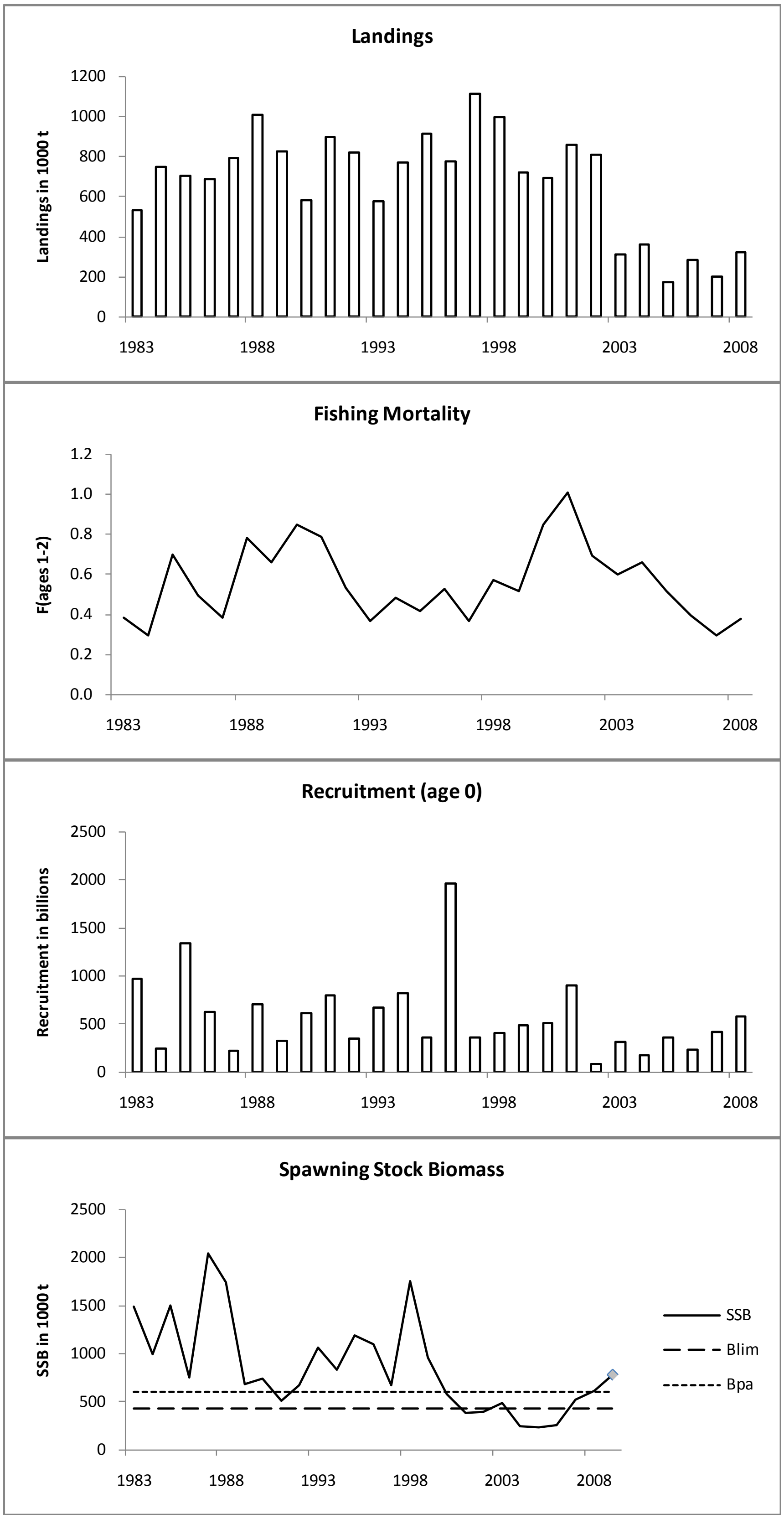
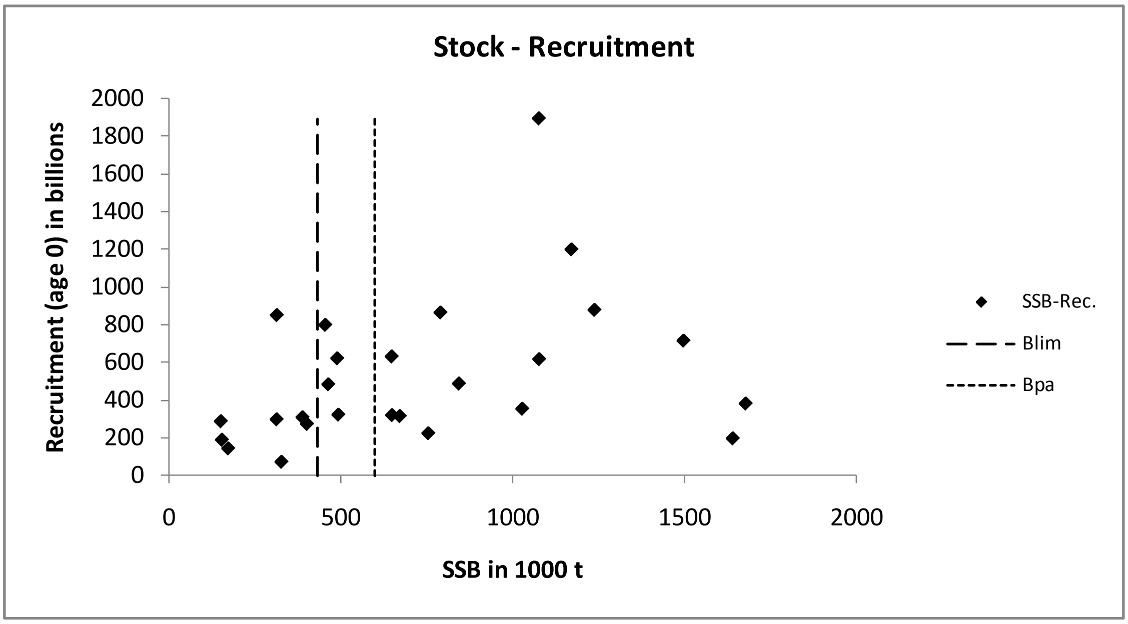


Figure 4.3.2.7 Stock Summary, Suggested Final Assessment



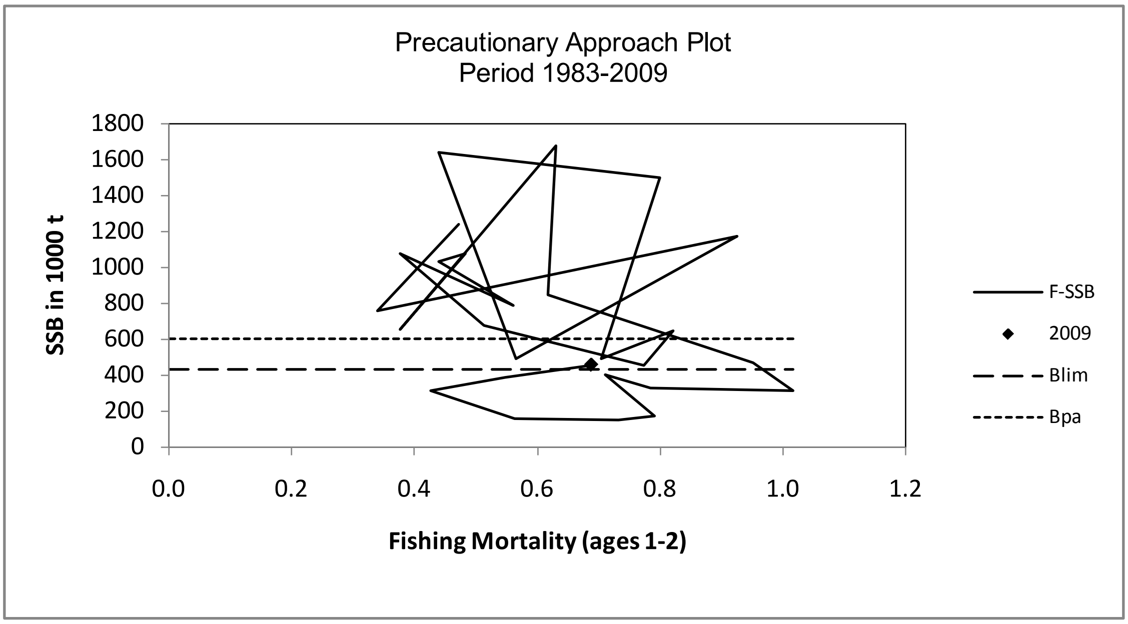


Figure 4.3.2.8 Stock Summary, SPALY assessment

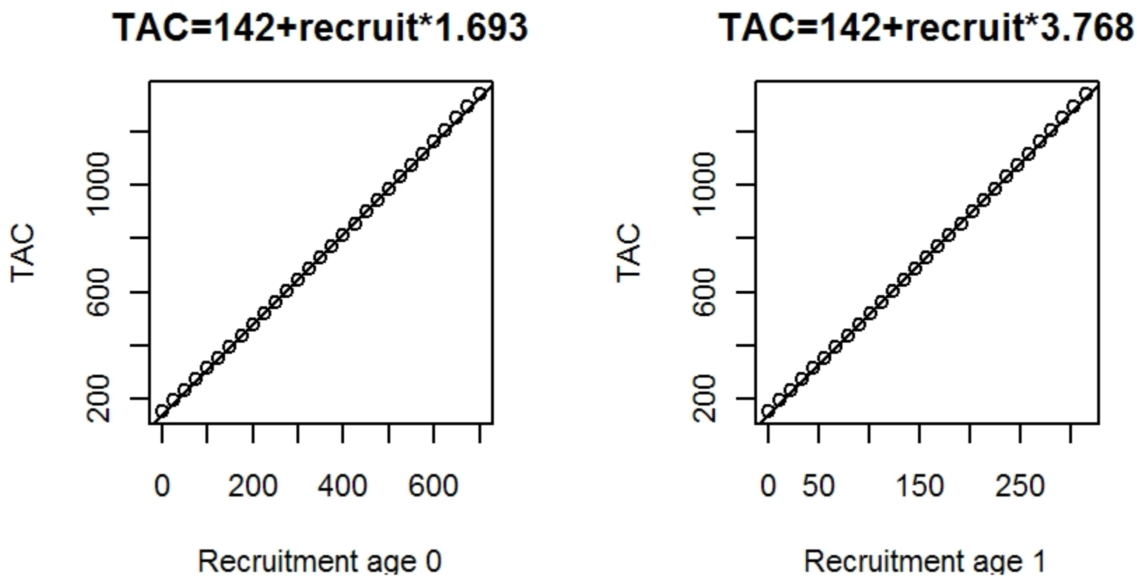


Figure 4.6.1. Suggested Final Assessment: Regression of recruitment against the TAC that will lead to SSB at Bpa.

(left figure) Recruitment at age 0 in 2009 against TAC in 2010.

(right figure) Recruitment at age 1 in 2010 against TAC in 2010

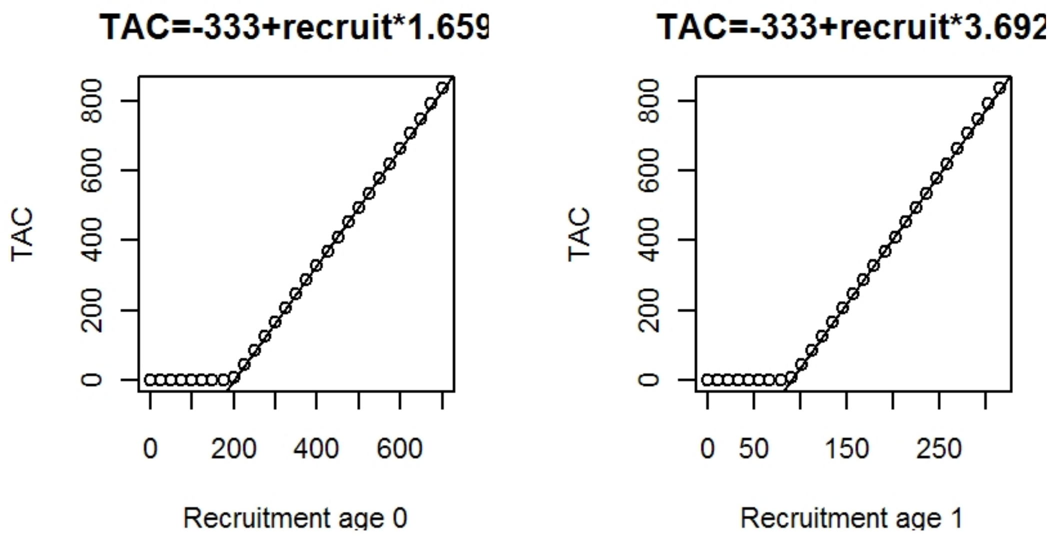


Figure 4.6.2. SPALY Assessment: Regression of recruitment against the TAC that will lead to SSB at Bpa.

(left figure) Recruitment at age 0 in 2009 against TAC in 2010.

(right figure) Recruitment at age 1 in 2010 against TAC in 2010

5 Norway Pout in ICES Subarea IV and Division IIIa

Introduction: Update assessment

The May 2009 assessment of Norway pout in the North Sea and Skagerrak is an up-date assessment from the May and September 2008 assessments all of which are essentially up-date assessments of the 2004 benchmark assessment using the same tuning fleets and parameter settings. The assessment is a "real time" monitoring (and management) run up to 1st April 2009 and includes information from 1st quarter 2009.

A short term prognosis (Forecast) up to 1st January 2010 is given for the stock based on the up-date assessment.

5.1 General

5.1.1 Ecosystem aspects

Stock definition: Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Lambert, Nielsen, Larsen and Sparholt, 2009). It is distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea. The distribution for this stock is in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b). Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway (Lambert, Nielsen, Larsen and Sparholt, 2009).

So far it has been evaluated that around 10 % of the Norway pout reach maturity already at age 1, and that most individuals reach maturity at age 2 on which the maturity ogive in the assessment has been based. Results in a recent paper (Lambert, Nielsen, Larsen and Sparholt (2009) indicate that the maturity rate for the 1-group is close to 20% in average (varying between years and sex) with an increasing tendency over the last 20 years. Furthermore, the average maturity rate for the 2 and 3 groups in 1st quarter of the year was observed to be only around 90% and 95%, respectively, as compared to 100% used in the assessment. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Sparholt and Nielsen (2001), gave no evidence for a stock separation in the whole northern area, and this conclusion is supported by the results in Lambert, Nielsen, Larsen and Sparholt (2009).

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by high recruitment variation and variation in predation mortality (or other natural mortality causes) due to the short life span of the species (Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt 2009). With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery, and in general the fishing mortality on 0-group Norway pout is low (ICES WGNSSK Reports). However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is important as a food source for other species (e.g. saithe, haddock, cod and mackerel) (ICES-SGMSNS 2006). Natural mortality levels by age and season used in the stock assessment do include the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

Natural mortality varies between age groups, and natural mortality at age varies over different time periods. Even though different sources of information (surveys, MSVPA) give slightly different perception of natural mortality at age (see below), the natural mortalities obtained from the most recent run with the North Sea MSVPA model (presented and used in the ICES SGMSNS (2006)) indicate high predation mortality on Norway pout. Especially the more recent high abundance of saithe predators and the more constant high stock level of western mackerel as likely predators on smaller Norway pout are likely to significantly affect the Norway pout population dynamics. However, inter-specific density dependent patterns in Norway pout growth and maturity were not found in relation to stock abundance of those predators but rather in relation to North Sea cod and whiting stock abundance (Lambert, Nielsen, Larsen and Sparholt, 2009).

In order to protect other species (cod, haddock, saithe and herring as well as mackerel, squids, flatfish, gurnards, *Nephrops*) there is a row of technical management measures in force for the small meshed fishery in the North Sea such as the closed Norway pout box, by-catch regulations, minimum mesh size, and minimum landing size (Annex 3**)**.

5.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian vessels using small mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. The main fishing seasons are the 3rd and 4th quarters of the year; with high catches in 1st quarter of the year especially prior to 1999. The average quarterly spatial distribution of the Norway pout catches during a ten year period from 1994-2003 is shown in figures in the Stock Annex A5. The Norway pout fishery is a mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species together with Blue Whiting.

Landings have been low since 2001, and the 2003-2004 landings were the lowest on record. Effort in 2003 and 2004 has been historically low and well below the average of the 5 previous years (Table 5.2.9). The effort in the Norway pout fishery was in 2002 at the same level as in the previous eight years before 2001. The targeted Norway pout fishery was closed for 2005, in the first half year of 2006, as well as in all of 2007, but Norway pout were in the periods of closure taken as a by-catch in the Norwegian mixed blue whiting and Norway pout fishery, as well as in a small experimental fishery in 2007. The fishery was open for the second half year of 2006 and in all of 2008 based on the 2005 and 2007 year classes, respectively, both being on the long term average level. However, the Norwegian part of the Norway pout fishery was only open from May to August in 2008. Despite opening of the fishery by 1st January 2008 (with an preliminary EU quota of 36 500 t and a Norwegian quota of 4 750 t as well as a final EU quota of 110 000 t set late in 2008) only 30.4 kt was taken by Denmark, and the Norwegian catches were 5.7 kt, i.e. 36.1 kt in total. According to information from the fishery associations this is due mainly to high fuel prices and only to a minor extent late setting of the final quota affecting the trade of individual Danish vessel quotas, and less due to the by-catch percentages of other species in the fishery. Trends in yield are shown in Table 5.2.2 and Figures 5.3.2-3.

By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degel *et al*., 2006, ICES CM 2007/ACFM:35, (WD 22 and section 16.5.2.2)), and recent by-catch numbers are given in section 2 of this report. In general, the by-catch levels of these gadoids have decreased in the Norway pout fishery over the years. Review of scientific documentation reveals that by-catch reduction gear selective devices can be used in the Norway pout fishery, significantly reducing by-catches of juvenile gadoids, larger gadoids, and other non-target species (Nielsen and Madsen, 2006, WD 23 and section 16.5.2.2 of ICES CM 2007/ACFM:35). By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. A detailed description of the regulations and their background can be found in the Stock Annex.

5.1.3 ICES advice

In September 2008 the advice on North Sea Norway pout was updated with the addition of the 3rd quarter 2008 English and Scottish groundfish surveys. This up-date changed the estimate of the size of the 2007 year class slightly resulting in a slight downward revision of SSB at the beginning of 2008. Based on the estimates of SSB in September 2008, ICES classified the stock at increased risk of suffering reduced reproductive capacity with SSB just below B_{pa} at the start of 2008.

The targeted fishery for Norway pout was closed in 2005, the first half year 2006, and all of 2007. For these periods ICES advised a closure of the fishery (i.e. a TAC=0 t) in the EC zone a TAC of 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery.

Recruitment reached historical minima in 2003-2004 and was low in 2006 (39 billions), but was about the long term average (at 80 billions, arithmetic mean) in 2005 (75 billions), 2007 (69 billions), and 2008 (81 billions). Based on the real time management and confirmation of recruitment estimates through consecutive surveys, the fishery was opened for second half of 2006 with a TAC of 95 000 t and on 1st January 2008 with a preliminary TAC of 41 000 t and a final TAC of 115 000 t. On the basis of the average 2008 recruitment ICES advised in October 2008 that catches in 2009 up to 35 000 t corresponding to a fishing mortality of 0.15 could maintain the stock above B_{pa} in 2010. This advice and the real time management has led to an initial EU TAC of 26 000 t and a Norwegian quota of 1 000 t for 2009 following the escapement strategy management plan (see below).

ICES provides advice according to 3 management strategies for the stock (see below). The final 2008 ICES advice for 2009 has, under the escapement strategy (real time management), been a TAC of 35 000 t, under the long term fixed TAC strategy a TAC of 50 000 t (corresponding to long term F=0.17), and under the long-term fixed fishing mortality or fishing effort strategy (TAE) a TAC on 76 000t corresponding to a fixed F=0.35.

ICES advise is that there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. It is advised that by-catches of other species should also be taken into account in management of the fishery. Also it is advised that existing measures to protect other species should be maintained.

Biological reference points for the stock have been set by ICES at B_{lim} = 90 000 t as the lowest historical observed biomass (SSB) before 2000 (1986, 1989) and B_{pa} = 150 000 t. However, in 2005 the SSB was as low as 55 000 t from which the stock has recovered. No F-based reference points are advised for this stock.

5.1.4 Management up to 2009

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

ICES advised in 2005 real time management of this stock. In previous years the advice was produced in relation to a precautionary TAC, which was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the advice for 2005 from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006, and in all of 2007. In 2005 and 2007, the TAC was 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. On basis of the real time management advice provided by ICES in spring 2006 EU set a quota on 95.000 t for 2006 (intended for the whole year in the EC zone), while the advice in autumn 2006 taking the low recruitment in 2006 into consideration led to a closure of the fishery again by 1st of January 2007. This advice was reiterated by ICES in May 2007, and resulted in a management where the directed Norway pout fishery continued to be closed for all of 2007. Following the September 2007 real time management advice the fishery was opened again 1st of January 2008 with a preliminary TAC of 41 250 t and a final TAC of 115 kt. On basis of the average 2008 recruitment ICES advised in October 2008 a TAC up to 35 000 t in 2009 which has led to setting an initial TAC on 26 000 t in the EC zone and a Norwegian quota on 1 000 t.

In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

Long term management strategies have been evaluated for this stock. (See section 5.11). An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock Annex.

5.2 Data available

5.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in Table 5.2.1. Historical data for annual landings as provided by Working Group members are presented in Table 5.2.2, and data for national landings by quarter of year and by geographical area are given in Table 5.2.3.

Both the Danish and Norwegian landings of Norway pout were low in 2008 and the TAC was not reached. The most recent catches have been included in the up-date assessment. However, only limited biological sampling has been performed from this small fishery (see below).

5.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark (except for Norway 2008). Catch at age by quarter of year is shown in **Table** 5.2.4. Very few biological samples were taken from the low Norway pout catches in 2005, first half year 2006 and in 2007.

Landings for the 1st quarter 2009 are very low (below 500 t). At present there is no biological information for this catch, and consequently catches of 0.1 million individuals per age (for age group 1-3) have been assumed for the first quarter in 2009 in the SXSA. Weight at age in the catch for 1st quarter 2009 have been assumed equal to those used for the 1st quarter of 2008.

5.2.3 Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Mean weight at age in the catch is shown in Table 5.2.5 and the historical levels, trends and seasonal variation in this is shown in Figure 5.2.1. In general, the mean weights at age in the catches are variable between seasons of the year. Mean weight at age in the stock is given in Table 5.2.6. The same mean weight at age in the stock is used for all years. The reason that mean weight at age in catch is not used as an estimate of weight in the stock is mainly because of the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year because of likely strong effects of selectivity in the fishery. The estimation of mean weights at age in the catches and the used mean weights in the stock in the assessment is described in the Stock Annex.

Mean landings weight at age from Danish and Norwegian fishery from 2005-2007 are uncertain because of the few observations. Missing values have been filled in using a combination of sources (values from 2004, from adjacent quarters and areas, and from other countries within the same year). The assumptions of no changes in weight at age in catch in these recent years do not affect assessment output significantly because the catches in the same period were low. Also, mean weights at age values for 2008 are uncertain given low landings and few observations. Among other, Danish data have been applied for the Norwegian catch as there has been no individual sampling in Norway for 2008.

5.2.4 Maturity and natural mortality

Maturity and natural mortality used in the assessment is described in the Stock Annex. Proportion mature and natural mortality by age and quarter used in the assessment is given in Table 5.2.6.

5.2.4.1

The same proportion mature and natural mortality are used for all years in the assessment. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Nielsen and Sparholt (2001), indicated variation in maturity at age between years and sexes, especially for the 1-group.

The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups.

In response to the wish from ACFM RG 2006 on a separate description of natural mortality aspects for Norway pout in the North Sea a summary of the September 2006 benchmark assessment on this issue is given here (ICES CM 2006/ACFM:35). Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing, and extensive description of that is given in the Stock Annex. Studies presented to the working group in 2001 and published in 2002 indicate that natural mortality may be significantly different between age groups compared to constant as currently assumed in the assessment model Sparholt, Larsen and Nielsen (2002a,b).

Exploratory runs of the SXSA model were presented in the 2001 and 2002 assessment reports as well as in the 2004 and 2006 Norway pout benchmark assessments with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (later published in *Sparholt, Larsen and Nielsen, 2002a,b*) as well as natural mortality estimates from the North Sea MSVPA model in the 2006 assessment. The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F were compared to those for the accepted run with standard settings. It appeared that the implications of these revised input data are very significant. The results of the exploratory runs have been consistent throughout all years in which comparisons were repeated.

The working group recommended in 2005 that there was a limited benchmark assessment for Norway pout in the 2006 assessment with specific reference to evaluation of effects of using revised natural mortalities, and that the WG on this basis should decide on which natural mortalities to use in the assessment. The benchmarking evaluated three independent sources and data time series for natural mortality and made exploratory SMS assessment model runs for those:

1. Constant natural mortalities by age, quarter and year as used in previous years standard assessment
2. Revised natural mortalities obtained from and based on the results from Sparholt et al (2002a,b)
3. Revised natural mortalities obtained from most recent run with the North Sea MSVPA model (presented and used in the ICES-SGMSNS 2006).

The survey based mortality estimates all indicate age specific differences in Z and M. These mortality estimates show high within-survey variability and, periodically, contradictory patterns between the surveys. Sparholt, Larsen and Nielsen (2002a,b) discussed their results in context of changed catchability in the surveys, migration out of the area, or age specific distribution patterns of Norway pout and concluded that the mortality patterns were not caused by this.

In contrast, the MSVPA estimates indicate rather constant M between age groups and years, and do not provide the most recent estimates of M.

In conclusion, the exploratory runs gave very much similar results and showed no differences in the perception of the stock status and dynamics. However, with respect to the exploratory runs using different natural mortalities no conclusions could be reached as the mortality between age groups was contradictive and inconclusive between periods (variable) from the different sources showing different trends with no obvious biological explanation. On that basis it was in the 2006 benchmark assessment decided that the final assessment continues using the baseline assessment constant values for natural mortality at age and quarter by year as in previous year's assessment. This has been adopted in this year's up-date assessment.

Evaluation of total mortality Z in recent years, where fishing mortality has been very low and where total mortality accordingly approximately equals natural mortality, has been performed and is shown in the September 2007 report (ICES CM

2007/ACFM:18 and 30, Table 5.2.12). The evaluation has been based on catch curve analysis on the most recent survey estimates for Norway pout. The results indicate somewhat different levels of Z between different survey time series mirroring the results from the 2006 benchmark assessment. The overall Z estimates for the period 2003-2007 indicates present levels of Z at age between 1.2 - 1.9. Also the results confirm the results from the 2006 benchmark assessment on different natural mortality at age. The assessment uses constant values of M at age of 0.4 per quarter (totally 1.6 per year).

5.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment are given in the Stock Annex. Data used in the present assessment are given in Tables 5.2.7-5.2.11 as described below. No commercial fishery tuning fleets are included for 2005-2009 except for second half year 2006. Recent catch information for 2008-09 is included in this assessment. Catches in all of 2005 as well as in 1st quarter 2009 were nearly 0 and only very limited information exists about this catch. Consequently, there has been assumed and used low catches of 0.1 million individuals per age (for age groups 1-3) per quarter in the SXSA for 2005 and 1st quarter 2009.

Effort standardization:

The method for effort standardization of the commercial Norway pout fishery tuning fleet is described in the **Stock Annex**, which has also been used with up-dated data in the May 2009 assessment. Information from 2nd half year 2006 has been included. The results of the standardization are also presented in the **Stock Annex**.

Up-dated effort data from the commercial fishery is given in **Tables** 5.2.7-5.2.9, and the CPUE trends in the commercial fishery are shown in **Table** 5.2.10 and **Figure** 5.2.2.

5.2.5.1 Danish effort data

Table 5.2.7 shows CPUE data by vessel size category and year for the Danish commercial fishery in ICES area IVa. The basis for these data is described in the Stock Annex. However, no Danish effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007 due to closure of the fishery. Data for 2008 has been included.

5.2.5.1.1 Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in Table 5.2.8, however, no Norwegian effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007. Norwegian effort data for the directed Norway pout fishery in 2008 has not been prepared because the fishery has been on low level.

5.2.5.1.2 Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in Table 5.2.9. However, no standardized effort data for the commercial fishery tuning fleet is included for 2005-2008 except for 2nd half year 2006. Standardized effort data for 2008 for the Danish part of the fleet is presented in the table.

5.2.5.1.3 Commercial fishery standardized CPUE data

Combined CPUE indices by age and quarter for the commercial fishery tuning fleet are shown in Table 5.2.10. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet for each age group and all age groups together are shown in Figure 5.2.2. However, no combined CPUE indices by age and quarter for the commercial fishery tuning fleet are used for 2005, first half year 2006 and for 2007 and 2008.

5.2.5.1.4 Research vessel data

Survey indices series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (International Bottom Trawl Survey 1st and 3rd quarter) and the EGFS (English Ground Fish Survey, 3rd quarter) and SGFS (Scottish Ground Fish Survey, 3rd quarter), Table 5.2.11. The new survey data from the 1st quarter 2009 IBTS and the 3rd quarter 2008 IBTS research surveys have been included in this assessment (as well as the 3rd quarter 2008 EGFS and SGFS research survey information which also were included in the September 2008 assessment). The survey data time series including the new information is presented in Table 5.2.11, as well as trends in survey indices in Figure 5.2.2. Surveys covering the Norway pout stock are described in the Stock Annex. Survey data time series used in tuning of the Norway pout stock assessment are described below.

Revision of assessment tuning fleets

The revision of the tuning fleets used in the benchmark 2004 assessment as used also in the 2005-2006-2007 and May 2008 up-date assessments is summarised in Table 5.3.1. Details of the revision are described in the Stock Annex.

Apart from the up-dated catch data and research survey indices, all other data and data standardization methods used in this assessment are identical to those used and described in the May and September 2008 assessments (see also Table 5.3.1).

5.3 Catch at Age Data Analyses

5.3.1 Review of last year's assessment

The short term forecast table should highlight the three accepted management strategies and their associated effects on landings, SSB and recruitment.

As noted by the WG, further work is needed on the commercial tuning fleet data. The WG is encouraged to collaborate with SGGEM (Study Group on Gear and Effort Metrics) to investigate possible metrics that could provide more precise estimators of effort. This could also help address the concerns of technological creep associated with the effort control strategy.

The RG recommends an exploration of an alternative stock assessment model that removes commercial lpue data, because there seem to be problems with lpue when the fishery has been closed. The WG should explore the use of survey data only in the assessment.

The WG note that there is an apparent link between effort and F, this relationship should be presented and explored as part of any future benchmark assessments. This could be part of a wider work item on issues relating to commercial tuning fleets.

5.3.2 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in May 2009. A general description of and reference to documentation for the SXSA model is given in the Stock Annex. Stock indices and assessment settings used in the assessment is presented in Tables 5.3.1-2. The SXSA uses the geometric mean for the stock-recruitment relationship (see Table 5.3.6).

In contrast to the September 2008 assessment, no back-shifting of the third quarter survey indices was undertaken, and the recruitment season to the fishery in the assessment is accordingly set to quarter 3. All other aspects and settings in the assessment are an up-date of the May 2008 and September 2008 assessments.

Results of the SXSA analysis are presented in Table 5.3.1-2 (assessment model parameters, settings, and options), Table 5.3.3 (population numbers at age (recruitment), SSB and TSB), Table 5.3.4 (fishing mortalities by year), Table 5.3.5 (diagnostics), and Table 5.3.6 (stock summary). The summary of the results of the assessment are shown in Table 5.3.6 and Figures 5.3.1-5.

Fishing mortality has generally been lower than natural mortality and has decreased in the recent decade below the long term average (0.6). Fishing mortality for the 1st and 2nd quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 4th quarter, that historically constitutes the main part of the annual F, had not decreased prior to 2006. Fishing mortality in 2005, the first part of 2006, and in 2007 was close to zero due to the closure of the Norway pout fishery in these periods. Fishing mortality has been low in 2008, and the TAC has not been fished up.

Spawning stock biomass (SSB) decreased continuously from 2001 until 2005 but has in recent years increased again due to the average 2005, 2007 and 2008 year classes and the lowered fishing mortality. The stock biomass fell to a level well below B_{lim} in 2005 which is the lowest level ever recorded. By 1st January 2007 the stock was just above B_{pa}, and just below by 1st January 2008 (i.e. at increased risk of suffering reduced reproductive capacity), while the stock by 1st January 2009 is well above B_{pa} (i.e. show full reproductive capacity).

5.3.3 Comparison with 2008 assessment

The final, accepted May 2009 SXSA assessment run was compared to the September 2008 SXSA assessment. The results of the comparative run between the May 2009 and the September 2008 assessments are shown in Figure 5.3.5. The resulting outputs of these assessments are almost identical giving similar perceptions of stock status and dynamics. The difference in recruitment is because of use of different recruitment seasons in the two assessments (as described above).

5.4 Historical stock trends

The assessment and historical stock performance is consistent with previous years assessments.

5.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 80 millions (arithmetic mean) and 67 millions (geometric mean) for the period 1983-2009 (Table 5.3.6). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. The recruitment in 2005, 2007 and 2008 (age 0, 3rd quarter) has been around the long term average of 81 billions, while the 2006 year class was weak (38 billions).

5.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2010 using full assessment information for 2008 and 1st quarter 2009, i.e. it is based on the SXSA assessment estimate of stock numbers at age at the start of 2009.

The purpose of the forecast is to calculate the catch of Norway pout in 2009 which would result in SSB at or above Bpa 1st of January 2010 (B_{pa} = 150 000 t). The forecast is based on an escapement management strategy but also provides output for the long term fixed E or F management strategy and a long term fixed TAC strategy for Norway pout (see ICES WGNSSK Report ICES CM 2007/ACFM:30 section 5.3, and ICES AGNOP Report ICES CM 2007/ACFM:39, and the ICES AGSANNOP Report ICES CM 2007/ACFM:40 as well as section 5.11 below).

Input to the forecast is given in Table 5.6.1. Observed fishing mortalities for all quarters of 2008 have been used (assessment year). The forecast assumes a 2009 (the forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1) which has been used in the 2007 and 2008 ICES WGNSSK Reports (ICES CM 2007/ACFM:30; ICES CM 2008/ACOM:09) and in the ICES AGNOP Report as well (ICES CM 2007/ACFM:39). Recruitment in the forecast year is assumed to be the 25th percentile = 47878 millions of the SXSA recruitment estimates (GM = 66865 millions) in the 3rd quarter of the year.

A sensitivity analysis of the forecast was run using a fishing pattern scaled to the seasonal exploitation pattern in 2008 (standardized with the 2008 Fbar to F(1,2)=1). The input to this alternative forecast is given in Table 5.6.1b. The background for this sensitivity analysis forecast is that 2004 was the last year where the directed Norway pout fishery was open in all seasons of the year, except for 2008 where the fishery was open all of the year in the EU Zone (but only May-August in the Norwegian zone). The catches in 2008 have been relatively low and the exploitation pattern between seasons (and ages) is very different from the average previous long term (1991-2004) exploitation pattern. The targeting in the small meshed trawl fishery has changed recently where targeting of Norway pout has decreased mainly due to high fuel prices.

The weight at age in the catch per quarter is based on estimated mean weight at age in catches during 2003-2006 and 2008. The constant weight at age in stock by year and quarter of year used in the SXSA assessment has also been used in the forecast for 2009.

The results of the forecasts are presented in Table 5.6.2. It can be seen that if the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2010 then a catch around 157 000 t can be taken in 2009 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 100 000 t can be taken in 2009. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2009 (corresponding to an F around 0.16) according to the long term management strategies.

The results of the sensitivity analysis forecast are presented in Table 5.6.2b; under this alternative scenario a catch around 220 000 t can be taken in 2009 according to the escapement strategy.

5.7 Medium-term projections

No medium-term projections are performed for this stock. The stock contains only a few age groups and is highly influenced by recruitment.

5.8 Biological reference points

ICES considers that:	ICES proposes that:
B_{lim} is 90 000 t	B_{pa} be established at 150 000 t. Below this value the probability of below average recruitment increases.
Note:	

Technical basis:

$B_{lim} = B_{loss} = 90\ 000$ t.	$B_{pa} = B_{pa} = B_{lim}\ e^{0.3\text{-}0.4*1.65}$ (SD): 150 000 t.
F_{lim} None advised.	F_{pa} None advised.

Biomass based reference points have been unchanged since 1997.

B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 90 000 t. B_{pa} has been calculated from

$B_{pa} = B_{lim}\ e^{0.3\text{-}0.4*1.65}$ (SD).

A SD estimate around 0.3-0.4 is considered to reflect the real uncertainty in the assessment. This SD-level also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software (CEFAS, 1999). The relationship between the Blim and Bpa (90 000 and 150 000 t) is 0.6.

5.9 Quality of the assessment

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. This appears from the results of the assessment as well as from Figures 5.3.4 and 5.3.5 with among other the comparisons of the 2008 assessment.

The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery, use seasonal based fishery independent information, and using most recent information about recruitment. The assessment provides stock status and year class strengths of all year classes in the stock up to the first quarter of the assessment year. The real time assessment method with up-date every half year also gives a good indication of the stock status the 1st January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year.

5.10 Status of the stock

Based on the estimates of SSB in September 2008, ICES classified the stock at increased risk of suffering reduced reproductive capacity with SSB just below B_{pa} at the start of 2008. The most recent estimates of SSB (Q1 2009, 189 000t) indicate full reproductive capacity of the stock again with SSB higher than B_{pa}.

The targeted fishery for Norway pout was closed in 2005, first half year 2006, and in all of 2007 and fishing mortality and effort accordingly reached historical minima in these periods (Table 5.3.6). The fishery was reopened on the 1st of January 2008 but did not catch the TAC set for 2008. Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years. The estimate for 2008 is 0.12 well below the long term average F (0.6).

Recruitment reached historical minima in 2003-2004 and was low in 2006 (39 billions), but was near to the long term average (at 80 billions, arithmetic mean) in 2005 (75 billions) and 2007 (69 billions) and just above in 2008 (81 billions) (Tables 5.3.3 and Table 5.3.6).

5.11 Management considerations

There are no management objectives for this stock.

From the results of the forecast presented here it can be seen that if the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2010 then a catch around 157 000 t can be taken in 2009 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 100 000 t can be taken in 2009. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2009 (corresponding to a F around 0.16) according to the long term management strategies (see section 5.11.1 below).

On basis of the average 2008 recruitment ICES advised in October 2008 a TAC up to 35 000 t in 2009 which has resulted in management with an initial TAC set for 2009 on 26 000 t in the EC zone and a TAC of 1 000 t in the Norwegian zone. Up to May 2009 only a very small catch has been taken in the Danish and Norwegian commercial fisheries.

There is consistent bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management options for 2010 will be provided for the stock in autumn 2009.

Norway pout is a short lived species. The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment reflect the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock Annex.

Historically, the fishery includes bycatches especially of haddock, whiting, saithe, and herring. Existing technical measures to protect these bycatch species should be maintained or improved. Bycatches of these species have been low in the recent decade. Sorting grids in combination with square mesh panels have been shown to reduce bycatches of whiting and haddock by 57% and 37%, respectively (Eigaard and Holst, 2004; ICES CM 2006/ACFM:35); ICES suggests that these devices (or modified forms of those) should be brought into use in the fishery. The introduction of these technical measures should be followed up by adequate control measures of landings or catches at sea to ensure effective implementation of the existing bycatch measures. An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock Annex.

5.11.1 Long term management strategies

ICES has evaluated and commented on three management strategies, following requests from managers – fixed fishing mortality (F=0.35), Fixed TAC (50 000 t), and a variable TAC escapement strategy. The evaluation shows that all three management strategies are capable of generating stock trends that stay away from B_{lim} with a high probability in the long term and are, therefore, considered to be in accordance with the precautionary approach. ICES does not recommend any particular one of the strategies.

The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. The escapement strategy has higher long term yield compared to the fixed fishing mortality strategy, but at the cost of a substantially higher probability of having closures in the fishery. If the continuity of the fishery is an important property, the fixed F (equivalent to fixed effort) strategy will perform better.

A detailed description of the long term management strategies and management plan evaluations can be found in the **Stock Annex** and in the ICES AGNOP 2007 (ICES CM 2007/ACFM:39), ICES WGNSSK 2007 (ICES CM 2007/ACFM:30) and the ICES AGSANNOP (ICES CM 2007/ACFM:40) reports.

5.12 Other issues

Recommendations for future assessments:

Coming benchmark assessment should consider new biological information (new estimates of spawning maturity, estimates of growth and growth parameters as well as of natural mortality published recently in ICES J. Mar. Sci. should be evaluated in context of the assessment). This includes recent developments in research survey based natural mortality estimates and new research results on natural mortality for the stock as well as up-dated natural mortality from the MSVPA model. Also variation in maturity at age as well as growth variation in the stock should be considered in relation to the assessment based on new research results. It is suggested that variable M be examined to determine the amount of biomass removed via predation.

Furthermore, consideration of revision of the tuning fleets with special focus on the commercial tuning fleets should be done in a coming benchmark assessment (see also the May 2007 assessment ICES CM 2007/ACFM:18 and 30, as well as the Stock Annex**)**. This includes evaluation of the quality of the assessment with respect to inclusion of historical time series for fisheries data. The fluctuations in the fisheries effort over times and between seasons should be evaluated.

Evaluation of survey based assessment and/or more simple assessment methods: Assessment of stock status based exclusively on survey indices should be considered and robustness of survey indices should be considered.

Recent developments in relation to implementation of seasonal stochastic assessment models not dependent on constant exploitation patterns (F-patterns between years and ages) should be considered for the assessment of the stock.

New research findings on developments in by-catch reducing gear devices should be reported and evaluated under ecosystem aspects and fisheries aspects in relation to future benchmark assessment.

Trends and dynamics in landings and other available relevant information of Norway pout in VIa should be evaluated and brought forward to ACOM.

Table 5.2.1 NORWAY POUT IV and IIIa. Nominal landings (tonnes) from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1998-2008, as officially reported to ICES and EU.

By-catches of Norway pout in other (small meshed) fishery included.

Norway pout ICES area IIIa

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	7,194	14,545	13,619	3,780	4,235	110	-	18	24	156
Faroe Islands	-	-	-	-	50	-	-	-	-	-
Norway	-	-	-	96	30	41	-	2	34	34
Sweden	-	133	780	-	-	-	-	-	-	-
Germany	-	-	-	-	-	54	-	-	-	-
Total	7,194	14,678	14,399	3,876	4,315	205	0	20	58	190

*Preliminary.

Norway pout ICES area IVa

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	39,319	133,149	44,818	68,858	12,223	10,762	941***	38,676	2,032 *****	32,158
Faroe Islands	2,534		49	3,367	2,199	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	27	-	15	-	-
Norway	44,841	48,061	17,158	23,657	11,357	4,958	311	13,618	4,712	6,650
Sweden	-	-	-	-	-	-	-	-	-	10
Total	86,694	181,210	62,025	95,882	25,779	15,747	1,092	52,309	6,744	38,818

*Preliminary.

Norway pout ICES area IVb

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	5,299	158	632	556	191	473	-	1248	0	244
Germany	-	2	-	-	-	26	-	19	-	3
Netherlands	-	3	-	-	-	-	-	-	-	-
Norway	-	34	-	-	-	-	-	2	0	0
Sweden	-	-	-	-	-	2	-	-	-	-
UK (E/W/NI)	-	+	-	+	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	-
Total	5,299	197	632	556	191	501	0	1,269	0	247

*Preliminary.

Norway pout ICES area IVc

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	514	182	304	-	-	-	-	-	-	-
Netherlands	+	-	-	-	-	-	-	-	-	-
UK (E/W/NI)	-	-	+	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0

*Preliminary.

Norway pout Sub-area IV and IIIa (Skagerrak) combined

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	51,812	147,852	59,069	73,194	16,649	11,345	941***	39,942	2,056	32,558
Faroe Islands	2,534	0	49	3,367	2,249	0	0	0	0	0
Norway	44,841	48,095	17,158	23,753	11,387	4,999	311	13,622	4,746	6,684
Sweden	0	133	780	0	0	2	0	0	0	10
Netherlands	0	3	0	0	0	0	0	0	0	0
Germany	0	2	0	0	0	107	0	34	0	3
UK	0	0	0	0	0	0	0	0	0	0
Total nominal landings	99,187	196,085	77,056	100,314	30,285	16,453	1,252	53,598	6,802	39,255
By-catch of other species and other	-7,187	-11,685	-11,456	-23,614	-5,385	-2,953	-	-6,972	-	-3,117
WG estimate of total landings (IV+IIIaN)	92000	184400	65600	76700	24900	13500	-	46626	-	36138
Agreed TAC	220000	220000	211200	198000	198000	198000	0****	95000	0****	114616

* provisional

** provisional

*** 781 ton from trial fishery (directed fishery); 160 ton from by-catches in other fisheries

**** A by-catch qouta of 5000 t has been set.

***** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.

+ Landings less than 1

n/a not available

Table 5.2.2 NORWAY POUT IV and IIIa. Annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2008 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species). Includes by-catch of Norway pout in other (small meshed) fisheries).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51	-	-	-	61.4
1965	8.2	-	-	35	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.5
1968	410.8	-	-	40.9	-	-	+	451.7
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63	2.9	13	0.6	345.9
1974	464.5	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	48.8	98.3	2.9	4.6	1	387.8
1978	163.4	-	18.5	80.8	0.7	5.5	-	268.9
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.4	51.6	-	+	-	238.3
1982	256.3	35.6	12.3	88	-	-	-	392.2
1983	301.1	28.5	30.7	97.3	-	+	-	457.6
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.01
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	2.5	21.5	-	-	-	174.3
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.3	21.1	-	-	-	109.3
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	57.7
1999	41	6.8	2.5	44.2	+	-	-	94.5
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	3.4	23.6	-	-	-	80.0
2003	9.9	3.4	2.4	11.4	-	-	-	27.1
2004	8.1	0.3	-	5	-	-	0.1	13.5
2005	0.9*	-	-	1	-	-	-	1.9
2006	35.1	0.1	-	11.4	-	-	-	46.6
2007	2.0**	-	-	3.7	-	-	-	5.7
2008	30.4	-	-	5.7	+	-	+	36.1

* 781 t taken in a trial fishery; 160 t in by-catches in other (small meshed) fisheries.

** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.

Table 5.2.3 NORWAY POUT IV and IIIa. National landings (t) by quarter of year 1993-2008. (Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species). (By-catch of Norway pout in other (small meshed) fisheries included).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1994	1	568	75	643	18,660	3,588	533	-	22,781	23,350			
	2	4	0	4	511	170	-	-	681	685			
	3	2,137	74	2,211	5,674	12,604	493	-	18,772	20,908			
	4	3,623	116	3,739	5,597	49,935	91	-	55,622	59,246			
	Total	6,332	265	6,598	30,442	66,298	1,117	-	97,857	104,189			
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	316	-	316	87	650	-	-	737	1,053	989	989	2,042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1,195	9	-	1,493	1,507	2484	2484	3,991
	4	13	-	13	93	5,683	107	-	5,883	5,896	865	865	6,761
	Total	343	-	343	469	7,528	123	-	8,120	8,463	4,998	4,998	13,461
2005	1	-	-	-	9	-	-	-	9	9	12	12	21
	2	-	-	-	151	-	-	-	151	151	352	352	503
	3	-	-	-	781	-	-	-	781	781	387	387	1,168
	4	-	-	-	-	-	-	-	-	-	211	211	211
	Total	-	-	-	941	-	-	-	941	941	962	962	1,903
2006	1	-	-	-	75	83	-	-	158	158	2,205	2205	2,363
	2	-	-	-	-	-	15	-	15	15	2,846	2846	2,861
	3	114	-	114	-	649	20	-	669	783	5,749	5749	6,532
	4	3	-	3	-	34,262	-	-	34,262	34,265	605	605	34,870
	Total	117	-	117	75	34,994	35	-	35,104	35,221		11,405	46,626
2007	1	-	-	-	561	789	-	-	1,350	1,350	74	74	1,424
	2	-	-	-	4	-	-	-	4	4	1,097	1097	1,101
	3	1	2	3	-	-	-	-	-	1	2,429	2429	2,430
	4	-	-	-	-	682	-	-	682	682	155	155	837
	Total	1	2	3	565	1,471	-	-	2,036	2,037		3,755	5,792
2008	1	125	-	125	19	86	123	-	228	353	7	7	360
	2	-	-	-	-	-	30	-	30	30	1,803	1803	1,833
	3	-	-	-	-	6,102	-	-	6,102	6,102	3,582	3582	9,684
	4	-	-	-	-	22,686	1,239	-	23,925	23,925	336	336	24,261
	Total	125	-	125	19	28,874	1,392	-	30,285	30,410		5,728	36,138

Table 5.2.4 NORWAY POUT in IV and IIIaN (Skagerrak). Catch in numbers at age by quarter (millions). SOP is given in tonnes. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.

Age	Year	1983				1984				1985			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	446	2671	0	0	1	2231	0	0	6	678
1		4,207	1826	5825	4296	2,759	2252	5290	3492	2,264	857	1400	2991
2		1,297	1234	1574	379	1,375	1165	1683	734	1,364	145	793	174
3		15	10	17	7	143	269	8	0	192	13	19	0
4+		0	2	0	0	0	0	0	0	1	0	0	0
SOP		58587	69964	216106	131207	56790	56532	152291	110942	57464	15509	62489	92017
Age	Year	1986				1987				1988			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	0	5572	0	0	8	227	0	0	741	3146
1		396	260	1186	1791	2687	1075	1627	2151	249	95	183	632
2		1069	87	245	39	401	60	171	233	700	74	250	405
3		72	3	6	0	12	0	0	5	20	0	0	0
4+		3	0	0	0	1	0	0	0	0	0	0	0
SOP		37889	7657	45085	89993	33894	15435	38729	60847	22181	3559	21793	61762
Age	Year	1989				1990				1991			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	159	4854	0	0	20	993	0	0	734	3486
1		1736	678	1672	1741	1840	1780	971	1181	1501	636	1519	1048
2		48	133	266	93	584	572	185	116	1336	404	215	187
3		6	6	5	13	20	19	6	4	93	19	22	18
4+		0	0	0	0	10	0	0	0	6	0	0	0
SOP		15379	13234	55066	82880	28287	39713	26156	45242	42776	20786	62518	64380
Age	Year	1992				1993				1994			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	879	954	0	0	96	1175	0	0	647	4238
1		3556	1522	3457	2784	1942	813	1147	1050	1975	372	1029	1148
2		1086	293	389	267	699	473	912	445	591	285	421	134
3		118	20	1	2	15	58	19	2	56	29	71	0
4+		3	0	0	0	0	0	0	0	0	0	0	0
SOP		64224	27973	114122	96177	36206	29291	62290	53470	34575	15373	53799	79838
Age	Year	1995				1996				1997			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	700	1692	0	0	724	2517	0	0	109	343
1		3992	1905	2545	3348	535	560	1043	650	672	99	3090	1922
2		240	256	47	59	772	201	1002	333	325	131	372	207
3		6	32	3	3	14	38	37	0	79	119	105	35
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		36942	28019	69763	97048	21888	13366	74631	46194	15320	8708	78809	54100
Age	Year	1998				1999				2000			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	94	339	0	0	41	1127	0	0	73	302
1		261	210	411	531	202	318	1298	576	653	280	1368	4616
2		690	310	332	215	128	220	338	160	185	207	266	245
3		47	18	2	13	73	93	35	23	3	48	20	6
4+		8	24	0	0	1	0	0	0	0	0	0	0
SOP		19562	12026	20866	22830	7833	12535	41445	30497	10207	11589	44173	119001
Age	Year	2001				2002				2003			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	32	368	0	0	340	290	0	0	7	1
1		220	133	122	267	485	351	621	473	59	64	191	54
2		845	246	27	439	148	24	284	347	76	49	121	161
3		35	100	1	1	17	5	24	26	22	25	16	32
4+		0	0	0	0	0	0	0	0	0	0	0	1
SOP		21400	11778	4630	26565	8553	6686	32922	28947	3190	3106	10842	7549
Age	Year	2004				2005				2006			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	14	57	*	*	*	*			10	368
1		13	4	51	100	*	*	*	*	30	56	130	1086
2		55	16	51	78	*	*	*	*	52	45	65	50
3		9	6	7	2	*	*	*	*	9	24	7	1
4+		0	0	0	0	*	*	*	*	0	0	0	0
SOP		2040	667	4018	6762	8	8	13	13	2205	2848	6551	34949
Age	Year	2007				2008							
	Quarter	1	2	3	4	1	2	3	4				
0		0	0	0	0	0	0	0	1179				
1		20	41	32	10	5	54	166	438				
2		43	26	16	6	7	41	115	31				
3		0	0	2	1	0	0	0	0				
4+		0	0	0	0	0	0	0	0				
SOP		1428	1100	2430	838	271	1840	8532	24111				

In 2007-08: Catch numbers from Norwegian fishery calculated from Norwegian total catch weight divided by mean weight at age from Danish Fishery.

Table 5.2.5 NORWAY POUT in IV and IIIaN (Skagerrak). Mean weights (grams) at age in catch, by quarter 1983-2007, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983. See footnote concerning data from 2005-2008.

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00
Year	2004				2005				2006			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			9.80	7.89			9.8	7.89			8.90	8.90
1	11.54	14.63	31.02	31.75	11.97	14.65	31.02	31.75	14.80	14.70	27.42	26.92
2	27.41	26.22	38.44	39.31	27.90	26.24	38.44	39.31	27.20	26.24	39.16	47.80
3	41.52	34.80	49.50	49.80	41.36	34.80	49.50	49.80	40.60	34.80	49.80	48.50
4												
Year	2007				2008							
Quarter of year	1	2	3	4	1	2	3	4				
Age 0			8.9	8.9				9.9				
1	7.8	7.8	45.00	45.00	11.0	11.0	26.8	24.40				
2	29.86	29.86	57.07	57.07	29.8	29.8	35.6	56.0				
3	41.52	34.80	56.22	56.22	56.0	56.0						
4												

Mean weights at age from Danish and Norwegian landings from 2005-2008 uncertain because of few observations and use of values from 2004 and from adjacent quarters in the same year where observations have been missing.

Table 5.2.6 NORWAY POUT IV and IIIaN (Skagerrak). Mean weight at age in the stock, proportion mature and natural mortality used in the assessment (as well as revised natural mortality used in previous exploratory assessment runs).

Age	Weight (g)				Proportion mature	M (quarterly)	Revised M vers.1 (quarterly)
	Q1	Q2	Q3	Q4			(Exploratory run)
0	-	-	4	6	0	0.4	0.25
1	7	15	25	23	0.1	0.4	0.25
2	22	34	43	42	1	0.4	0.55
3	40	50	60	58	1	0.4	0.75

Table 5.2.7 NORWAY POUT IV and IIIaN (Skagerrak). Danish CPUE data (tonnes / fishing day) and fishing activities by vessel category for 1988-2008. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
51-100	20.27	14.58	10.03	12.56	31.75	31	24.8	29.53	-	20
101-150	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73	22.05	27.45
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34	24.96	30.59
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84	31.43	32.55
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9	39.14	43.01

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
16.85	12.43	29.13	-	20.45	-	-	-	-	-	-
19.68	26.69	48.55	25.35	17.09	12.94	8.88	n/a*	-	n/a*	-
17.48	23.98	45.92	20.02	21.73	10.8	5.50	n/a*	41.11	n/a*	-
32.32	31	64.33	52.95	46.36	30.86	37.14	n/a*	60.39	n/a*	79.13

* Non-available data from 2005 and 2007 is due to closure of the Norway pout fishery the whole year

Data for 2006 and 2008 does only cover 2nd half year as the directed fishery was closed 1st half year 2006 and very low 1st half year 2008.

Data for 2008 only covers Danish directed fishery for Norway pout

Table 5.2.8 NORWAY POUT IV and IIIaN (Skagerrak). Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2008.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Year	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT
1983	293	167.6	1168	168.4	2039	159.9	552	171.7
1984	509	178.5	1442	141.6	1576	161.2	315	212.4
1985	363	166.9	417	169.1	230	202.8	250	221.4
1986	429	184.3	598	148.2	195	197.4	222	226.0
1987	412	199.3	555	170.5	208	158.4	334	196.3
1988	296	216.4	152	146.5	73	191.1	590	202.9
1989	132	228.5	586	113.5	1054	192.1	1687	178.7
1990	369	211.0	2022	171.7	1102	193.9	1143	187.6
1991	774	196.1	820	180.0	1013	179.4	836	187.7
1992	847	206.3	352	181.3	1030	202.2	1133	199.8
1993	475	227.5	1045	206.6	1129	217.8	501	219.8
1994	436	226.5	450	223.5	1302	212.0	686	211.4
1995	545	223.6	237	233.8	155	221.7	297	218.1
1996	456	213.6	136	219.9	547	208.3	132	207.2
1997	132	202.4	193	218.9	601	194.8	218	182.3
1998	497	192.6	272	213.6	263	176.8	203	193.8
1999	267	173.0	735	180.1	1165	187.4	229	166.9
2000	294	197.1	348	180.7	929	205.3	196	219.3
2001	252	203.4	297	192.9	130	165.0	65	219.4
2002	90	208.6	246	189.1	1022	211.7	205	182.2
2003	162	219.1	320	215.3	550	252.8	75	208.4
2004	94	214.6	85	196.7	210	220.9	99	197.9
2005*	0	0.0	0	0.0	0	0.0	0	0.0
2006*	0	0.0	0	0.0	169	267.1	132	279.0
2007*	0	0.0	0	0.0	0	0.0	0	0.0
2008**	**	**	**	**	**	**	**	**

* 0-values in all of 2005 and 2007 as well as in first half year 2006 are due to closure of the fishery (no directed fishery for Norway pout)

** No effort data provided from Norway due to small directed Norway pout fishery.

Table 5.2.9 NORWAY POUT IV and IIIaN (Skagerak). Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1125	1566	547	31	578	197	1192	1388	355	1634	1989	1540	3981	5522
1988	315	881	1196	144	13	156	75	416	491	617	1891	2507	1150	3201	4351
1989	146	776	922	485	195	680	1093	1746	2839	1701	2280	3981	3424	4999	8423
1990	406	990	1395	2002	87	2089	1162	462	1624	1185	1650	2835	4754	3189	7943
1991	824	1316	2140	833	33	866	1027	484	1511	869	1721	2590	3553	3554	7107
1992	866	2089	2955	354	17	371	1051	1527	2578	1154	1240	2393	3424	4873	8298
1993	483	1232	1715	1056	37	1094	1145	1557	2702	508	1668	2176	3193	4494	7687
1994	463	1263	1726	477	74	551	1363	616	1978	717	1224	1942	3020	3177	6197
1995	577	808	1385	254	99	352	164	851	1015	313	1483	1796	1308	3241	4548
1996	478	577	1055	144	184	328	570	758	1328	137	1237	1374	1329	2756	4085
1997	137	393	530	203	17	220	617	1241	1857	220	1118	1338	1177	2768	3945
1998	509	445	954	285	34	319	264	560	824	208	455	663	1265	1494	2760
1999	266	304	571	740	56	796	1184	386	1570	226	731	957	2417	1477	3894
2000	303	302	605	351	75	425	965	220	1185	207	1898	2104	1825	2494	4319
2001	261	440	701	304	15	319	128	48	176	69	540	608	762	1042	1804
2002	94	387	480	251	21	271	1069	674	1744	207	550	757	1621	1632	3252
2003	171	211	382	336	15	351	599	79	678	78	101	179	1184	406	1590
2004	99	151	246	87	35	122	222	65	287	102	95	197	510	346	856
2005*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006*	0	0	0	0	0	0	186	32		147	641	787	333	673	1005
2007*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008**	n/a	6	6	n/a	0	0	n/a	161	161	n/a	244	244	n/a	411	411

* 0-values in all of 2005 and 2007 as well as in first half year 2006 are due to closure of the fishery (no directed fishery for Norway pout). The 0-values not used in assessment.

** Data for 2008 does only include information from the Danish small meshed fishery as no data was provided from Norway on this. Data not used in assessment.

Table 5.2.10 NORWAY POUT IV and IIIaN (Skagerrak). CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144.5	169.0	87.9	.	1320.2	86.5	12.4	368.4	1050.5	16.0	0.0
1983	.	1524.2	470.0	5.4	.	969.6	262.0	2.8	604.9	972.9	85.9	1.7
1984	.	1137.9	566.8	59.1	.	990.2	314.9	1.5	462.0	723.1	152.1	0.0
1985	.	877.1	528.2	74.3	.	599.0	339.0	8.3	183.6	809.5	47.2	0.0
1986	.	108.5	292.9	19.8	.	531.1	109.7	2.7	892.9	277.1	5.9	0.0
1987	.	1701.8	254.2	7.7	.	1141.9	118.9	0.0	111.1	1074.9	115.6	2.5
1988	.	205.5	584.0	16.4	.	373.1	510.0	0.0	1175.5	252.0	161.5	0.0
1989	.	1862.8	52.1	7.6	.	386.3	69.7	0.0	1185.8	488.6	22.7	3.2
1990	.	1065.1	451.5	25.7	.	571.3	126.7	7.2	444.6	394.9	39.7	2.3
1991	.	693.9	623.8	43.4	.	668.6	44.0	1.0	1006.5	397.7	71.6	6.6
1992	.	1130.2	361.0	39.7	.	1011.6	144.2	0.4	190.5	1104.5	106.1	1.0
1993	.	1122.3	403.7	7.9	.	384.9	328.9	6.9	427.1	474.8	203.2	0.8
1994	.	1102.1	341.3	32.6	.	520.1	203.4	35.7	1953.6	591.0	69.0	0.0
1995	.	2850.1	171.3	4.0	.	1864.2	38.6	3.0	198.7	1705.6	33.0	1.7
1996	.	365.7	732.0	13.2	.	346.7	715.5	27.5	1066.5	473.4	242.5	0.2
1997	.	990.6	480.2	146.8	.	1256.7	154.4	56.5	75.2	1347.0	152.9	25.9
1998	.	150.0	723.5	49.3	.	319.5	350.1	1.1	233.1	775.7	322.9	20.0
1999	.	351.0	224.6	128.0	.	726.4	213.8	22.0	1086.8	516.2	166.9	24.1
2000	.	1079.3	305.3	4.5	.	895.6	207.0	17.2	122.2	2180.3	114.9	2.8
2001	.	300.7	1198.6	50.1	.	369.2	142.7	6.3	559.2	322.6	720.8	1.5
2002	.	1010.9	308.4	34.8	.	321.3	157.9	13.5	383.2	602.0	454.9	34.9
2003	.	153.6	200.1	57.2	.	174.7	156.1	23.3	3.9	276.4	893.3	178.2
2004	.	26.9	189.7	35.1	.	176.1	177.6	24.0	289.1	505.5	394.6	8.6
2005	.	.	.	.	.	.	.	.	.	.	.	.
2006	.	.	.	.	.	588.6	294.2	32.6	467.1	1379.8	64.0	0.9
2007	.	.	.	.	.	.	.	.	.	.	.	.
2008	.	.	.	.	.	.	.	.	.	.	.	.

Table 5.2.11 NORWAY POUT IV and IIIA (Skagerrak). Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February (1st Q)			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1970	35	6	-	-	-		-	-	-	-	-	-	-		-
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	2,578	872	3	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,557	391	24	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,573	1,880	4	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,411	371	2	-	-	-	-	-	-	-	-	-	-	-	-
1977	6,093	273	42	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,479	575	47	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,738	316	75	-	-	-	-	-	-	-	-	-	-	-	-
1980	3,277	550	29	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,092	377	15	-	-	-	-	-	185	127	9	-	-	-	-
1982	4,537	262	59	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	7	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	4,994	982	75	457	3,605	359	14	2	615	69	8	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,171	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	20	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,531	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	7,301	1,039	189	2
1992	5,071	885	32	2,885	6,193	1,069	157	12	1,715	221	24	2,559	4,318	633	48
1993	2,682	2,644	258	5,698	3,278	1,715	0	2	580	329	20	4,104	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	2,860	4,440	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	4,554	762	362	12
1997	9,752	1,474	670	1,045	6,262	376	30	1	2,154	130	32	490	3,447	236	46
1998	1,010	5,336	265	2,573	404	260	0	2,628	938	127	5	2,931	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	179	37	7,844	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	759	727	710	26	2,088	1,274	862	27
2002	1,795	809	880	9,678	1,784	61	21	2,559	1,192	151	123	1,974	766	64	48
2003	1,239	575	94	379	681	85	5	1,767	779	126	1	1,812	1,063	146	7
2004	895	376	34	564	542	90	7	731	719	175	19	773	647	153	12
2005	691	131	37	6,912	803	67	11	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	1,680	2,147	151	18	1,127	1,285	69	9	1,349	1,869	150	15
2007	1,286	778	23	3,329		332	1	5,003	1,023	395	8	4,143	1,191	447	11
2008	2,345	506	186	1,435	1,084	253	35	3,455	1,263	263	57	3,034	1,646	262	66
2009	5,496	1,566	120	-	1,371-	-	-	-	-	-	-	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area. [2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3. [3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5. Minor GOV sweep changes in 2006 EGFS. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment. In 2007 numbers for 1997 and 1998 as well as 2002 has been adjusted based on new automatic calculation and processing process has been introduced.

Table 5.3.1 Norway pout IV and IIIaN (Skagerak). Stock indices and tuning fleets used in final 2004 benchmark assessment as well as in the 2005-2009 assessments compared to the 2003 assessment.

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT	2007-09 ASSESSMENTS
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	3rd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	1st quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)	4+ (SXSA)
FLT01: comm Q1					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED	NOT USED
	Year range	1982-2003			
	Quarter	2			
	Ages	1-3			
FLT01: comm Q3					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	3	3	3	3
	Ages	0-3	1-3	1-3	1-3
FLT01: comm Q4					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	4	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)	0-3 (SXSA)
FLT02: ibtsq1					
	Year range	1982-2003	1982-2006	1982-2006	1982-2009
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT03: egfs					
	Year range	1982-2003	1992-2005	1992-2005	1992-2008
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT04: sgfs					
	Year range	1982-2003	1998-2006	1998-2006	1998-2008
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT05: ibtsq3		NOT USED			
	Year range		1991-2005	1991-2005	1991-2008
	Quarter		3	3	Q3
	Ages		2-3	2-3	2-3

Table 5.3.2 Norway pout IV and IIIaN (Skagerrak). Baseline run with SXSA

seasonal extended survivor analysis): Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

```
SURVIVORS ANALYSIS OF: Norway pout stock in May 2009
Run: Baseline May 2009 (Summary from NP509_1)
The following parameters were used:
Year range:                                    1983 - 2009
Seasons per year:                              4
The last season in the last year is season:           1
Youngest age:                           0
Oldest age:                                    3
Plus age:                                      4
Recruitment in season:                                3
Spawning in season:                            1

The following fleets were included:
Fleet  1:    commercial q134 (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4:
0-3)
Fleet  2:           ibtsq1       (Age 1-3)
Fleet  3:           egfsq3       (Age 0-1)
Fleet  4:           sgfsq3       (Age 0-1)
Fleet  5:           ibtsq3       (Age 2-3)

The following options were used:
1: Inv. catchability:                                 2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:                                      2
  (1: Direct; 2: Using z)
3: Comb. shats:                                       2
  (1: Linear; 2: Log.)
4: Fit catches:                                       0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:                              0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:                                0
  (0: Manual)
7: Weighting of shats:                                2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:                        1
  (1: Dynamic; 2: Extra age group)

Data were input from the following files:
Catch in numbers:                                     canum.qrt
Weight in catch:                               weca.qrt
Weight in stock:                                      west.qrt
Natural mortalities:                                  natmor.qrt
Maturity ogive:                                       matprop.qrt
Tuning data (CPUE):                                   tun2009.xsa
Weighting for rhats:                                  rweigh.xsa
```

Table 5.3.3 Norway pout IV and IIIaN (Skagerrak). Seasonal extended survivor analysis (SXSA). Stock numbers, SSB and TSB at start of season.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	148005.	98845.	*	*	79964.	53601.	*	*	57240.	38364.
1	108896.	69551.	45126.	25480.	64071.	40689.	25431.	12715.	34103.	21006.	13379.	7822.
2	13108.	7724.	4167.	1505.	13562.	7966.	4386.	1562.	5665.	2681.	1678.	476.
3	115.	65.	36.	10.	698.	350.	15.	3.	446.	142.	84.	41.
4+	6.	3.	0.	0.	1.	0.	0.	0.	2.	1.	1.	0.
SSN	24119.				20668.				9523.			
SSB	369559.				371168.				166474.			
TSN	122125.	77342.	197334.	125840.	78332.	49005.	109796.	67882.	40216.	23830.	72383.	46703.
TSB	1055603.	1309273.	1901489.	1242880.	774816.	898707.	1145117.	679873.	381322.	413389.	640668.	432441.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	106163.	71163.	*	*	31029.	20793.	*	*	85564.	56749.
1	25161.	16541.	10875.	6319.	43140.	26718.	17029.	10083.	13752.	9015.	5965.	3849.
2	2795.	998.	598.	200.	2770.	1528.	975.	514.	4998.	2777.	1801.	1003.
3	176.	59.	37.	20.	102.	59.	39.	26.	154.	87.	58.	39.
4+	28.	16.	11.	7.	18.	11.	8.	5.	17.	11.	8.	5.
SSN	5515.				7204.				6544.			
SSB	87691.				96240.				126673.			
TSN	28159.	17614.	117683.	77709.	46030.	28316.	49080.	31421.	18921.	11890.	93396.	61644.
TSB	246204.	285891.	724457.	581871.	368024.	456284.	594120.	379763.	213313.	234610.	572316.	473381.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	91146.	60967.	*	*	85606.	57367.	*	*	162888.	108586.
1	35464.	22351.	14427.	8302.	36894.	23224.	14110.	8663.	37641.	24003.	15569.	9192.
2	2062.	1343.	791.	312.	4140.	2297.	1071.	567.	4840.	2151.	1111.	569.
3	341.	223.	145.	93.	133.	73.	33.	17.	285.	115.	61.	23.
4+	29.	20.	13.	9.	58.	31.	20.	14.	18.	7.	5.	3.
SSN	5979.				8020.				8907.			
SSB	85470.				125472.				145219.			
TSN	37897.	23937.	106523.	69684.	41225.	25625.	100842.	66629.	42784.	26276.	179634.	118373.
TSB	308896.	393206.	767979.	575277.	357903.	431817.	743251.	568274.	382360.	439310.	1092257.	888148.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	69526.	45885.	*	*	48705.	32569.	*	*	206710.	138032.
1	69934.	43966.	28225.	16090.	29977.	18504.	11738.	6929.	20870.	12372.	7989.	4512.
2	5304.	2666.	1547.	719.	8506.	5130.	3051.	1298.	3785.	2053.	1143.	422.
3	228.	57.	22.	14.	263.	164.	63.	26.	506.	294.	173.	58.
4+	3.	0.	0.	0.	8.	5.	3.	2.	18.	12.	8.	5.
SSN	12528.				11774.				6396.			
SSB	174919.				219056.				119107.			
TSN	75468.	46689.	99320.	62707.	38753.	23803.	63559.	40825.	25178.	14731.	216022.	143030.
TSB	615500.	752965.	1051550.	676338.	407909.	460458.	623228.	410846.	250585.	270727.	1086075.	953043.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	65215.	43142.	*	*	158260.	105492.	*	*	45059.	30115.
1	89056.	56428.	36265.	22226.	27534.	18019.	11620.	6935.	68652.	45469.	30397.	17846.
2	2085.	1201.	595.	361.	12157.	7517.	4874.	2447.	4116.	2493.	1564.	744.
3	173.	111.	49.	30.	193.	118.	48.	2.	1368.	852.	474.	232.
4+	42.	28.	19.	13.	26.	18.	12.	8.	7.	4.	3.	2.
SSN	11206.				15130.				12355.			
SSB	117492.				295932.				193685.			
TSN	91356.	57769.	102143.	65771.	39910.	25671.	174813.	114884.	74142.	48818.	77497.	48939.
TSB	678544.	894410.	1195995.	786942.	469395.	532748.	1136004.	895366.	626194.	809631.	1035843.	635840.

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	62988.	42145.	*	*	154278.	103382.	*	*	53603.	35872.
1	19906.	13130.	8629.	5447.	27974.	18586.	12198.	7114.	68377.	45299.	30136.	19081.
2	10389.	6399.	4036.	2433.	3217.	2051.	1195.	524.	4296.	2729.	1659.	895.
3	329.	182.	107.	70.	1455.	915.	537.	332.	221.	146.	58.	22.
4+	128.	79.	33.	22.	51.	34.	23.	15.	214.	143.	96.	64.
SSN	12837.				7520.				11569.			
SSB	262835.				151420.				163187.			
TSN	30753.	19790.	75793.	50119.	32697.	21586.	168231.	111367.	73108.	48317.	85553.	55934.
TSB	388245.	428056.	647633.	484440.	327655.	396203.	1005703.	825188.	593961.	787573.	1042645.	692954.

Table 5.3.3 (Cont´d.). Norway pout IV and IIIaN (Skagerrak).

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	47602.	31883.	*	*	32874.	21758.	*	*	14504.	9717.
1	23799.	15773.	10464.	6915.	21070.	13726.	8914.	5466.	14347.	9569.	6362.	4108.
2	9010.	5348.	3384.	2246.	4417.	2839.	1883.	1030.	3277.	2134.	1391.	833.
3	399.	239.	78.	52.	1146.	754.	502.	317.	407.	255.	150.	88.
4+	53.	36.	24.	16.	45.	30.	20.	13.	200.	134.	90.	60.
SSN	11843.				7714.				5318.			
SSB	233846.				160244.				109596.			
TSN	33262.	21396.	61552.	41111.	26677.	17350.	44193.	28585.	18231.	12092.	22497.	14805.
TSB	383778.	432373.	602217.	447650.	292985.	341825.	465427.	317918.	199985.	236336.	285889.	192870.

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	18941.	12685.	*	*	74807.	50144.	*	*	38574.	25849.
1	6512.	4355.	2916.	1913.	8456.	5668.	3800.	2547.	33613.	22507.	15041.	9976.
2	2709.	1771.	1174.	745.	1201.	805.	539.	361.	1707.	1102.	701.	417.
3	427.	279.	182.	117.	436.	292.	196.	131.	242.	155.	85.	51.
4+	72.	48.	32.	22.	91.	61.	41.	27.	106.	71.	48.	32.
SSN	3859.				2573.				5417.			
SSB	85262.				54872.				76720.			
TSN	9720.	6452.	23245.	15481.	10184.	6826.	79382.	53211.	35668.	23835.	54448.	36324.
TSB	126290.	142163.	210077.	158162.	108147.	130411.	429145.	382225.	288480.	386814.	565547.	404993.

Year	2007				2008				2009
Season	1	2	3	4	1	2	3	4	1
AGE									
0	*	*	69004.	46255.	*	*	80956.	54267.	*
1	17026.	11397.	7605.	5072.	31005.	20779.	13885.	9172.	35411.
2	5798.	3852.	2561.	1704.	3391.	2267.	1486.	902.	5789.
3	238.	159.	107.	70.	1137.	762.	511.	342.	579.
4+	55.	37.	25.	17.	58.	39.	26.	17.	241.
SSN	7794.				7687.				10150.
SSB	152075.				145030.				188815.
TSN	23117.	15445.	79302.	53117.	35591.	23848.	96864.	64700.	42020.
TSB	259338.	311945.	582670.	469811.	340364.	429059.	765486.	594287.	411903.

Table 5.3.4 Norway pout IV and IIIaN (Skagerrak).
Seasonal extended survivor analysis (SXSA).
Fishing mortalities by quarter of year.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.004	0.033	*	*	0.000	0.052	*	*	0.000	0.022
1	0.048	0.032	0.169	0.225	0.054	0.069	0.285	0.392	0.084	0.051	0.135	0.587
2	0.127	0.213	0.578	0.355	0.130	0.193	0.590	0.769	0.337	0.068	0.774	0.557
3	0.169	0.195	0.784	1.529	0.281	1.609	0.938	0.000	0.683	0.119	0.319	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.436	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.374	0.290	0.092	0.131	0.437	0.581	0.210	0.059	0.454	0.572
Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.099	*	*	0.000	0.013	*	*	0.011	0.069
1	0.019	0.019	0.141	0.407	0.078	0.050	0.122	0.293	0.022	0.013	0.038	0.219
2	0.588	0.111	0.642	0.264	0.191	0.049	0.235	0.733	0.184	0.033	0.182	0.630
3	0.641	0.061	0.215	0.000	0.154	0.000	0.010	0.260	0.171	0.000	0.000	0.000
4+	0.141	0.000	0.000	0.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.304	0.065	0.391	0.336	0.135	0.049	0.179	0.513	0.103	0.023	0.110	0.424
Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.101	*	*	0.000	0.021	*	*	0.005	0.040
1	0.061	0.037	0.150	0.288	0.062	0.097	0.087	0.179	0.049	0.033	0.125	0.148
2	0.029	0.127	0.501	0.432	0.186	0.350	0.231	0.280	0.395	0.254	0.263	0.486
3	0.022	0.033	0.039	0.183	0.198	0.369	0.242	0.318	0.483	0.221	0.553	1.672
4+	0.000	0.000	0.000	0.000	0.232	0.000	0.000	0.000	0.508	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.326	0.360	0.124	0.224	0.159	0.229	0.222	0.143	0.194	0.317
Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.015	0.026	*	*	0.002	0.045	*	*	0.004	0.038
1	0.063	0.043	0.159	0.232	0.082	0.055	0.125	0.201	0.121	0.037	0.168	0.359
2	0.280	0.142	0.354	0.567	0.104	0.118	0.434	0.512	0.207	0.182	0.560	0.467
3	0.873	0.532	0.058	0.193	0.070	0.531	0.442	0.096	0.143	0.127	0.643	0.000
4+	*	*	*	*	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.172	0.092	0.257	0.399	0.093	0.086	0.280	0.356	0.164	0.110	0.364	0.413
Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.013	0.049	*	*	0.006	0.029	*	*	0.003	0.014
1	0.056	0.042	0.089	0.199	0.024	0.038	0.115	0.120	0.012	0.003	0.131	0.139
2	0.149	0.293	0.099	0.219	0.080	0.033	0.281	0.179	0.100	0.066	0.332	0.400
3	0.039	0.411	0.077	0.128	0.091	0.473	1.574	0.161	0.072	0.183	0.306	0.198
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.102	0.168	0.094	0.209	0.052	0.036	0.198	0.149	0.056	0.034	0.231	0.269
Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.010	*	*	0.000	0.013	*	*	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.137	0.103	0.012	0.008	0.056	0.339
2	0.084	0.060	0.105	0.113	0.049	0.138	0.406	0.444	0.054	0.096	0.213	0.391
3	0.189	0.129	0.018	0.256	0.063	0.131	0.081	0.088	0.015	0.493	0.526	0.379
4+	0.078	0.446	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.050	0.040	0.082	0.119	0.029	0.080	0.272	0.273	0.033	0.052	0.135	0.365
Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.014	*	*	0.013	0.016	*	*	0.001	0.000
1	0.011	0.010	0.014	0.048	0.028	0.031	0.088	0.110	0.005	0.008	0.037	0.016
2	0.120	0.057	0.010	0.266	0.041	0.010	0.199	0.501	0.029	0.028	0.111	0.262
3	0.112	0.658	0.017	0.021	0.018	0.008	0.059	0.106	0.067	0.125	0.135	0.550
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.026
F (1- 2)	0.066	0.034	0.012	0.157	0.035	0.021	0.144	0.306	0.017	0.018	0.074	0.139

Table 5.3.4 (Cont´d.). Norway pout IV and IIIaN (Skagerrak).

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.005	*	*	0.000	0.000	*	*	0.000	0.017
1	0.002	0.001	0.021	0.065	0.000	0.000	0.000	0.000	0.001	0.003	0.011	0.140
2	0.025	0.011	0.054	0.135	0.000	0.000	0.000	0.000	0.038	0.051	0.119	0.157
3	0.026	0.025	0.047	0.018	0.000	0.000	0.001	0.001	0.043	0.204	0.107	0.017
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.014	0.006	0.038	0.100	0.000	0.000	0.000	0.000	0.019	0.027	0.065	0.149

Year	2007				2008				2009
Season	1	2	3	4	1	2	3	4	1
AGE									
0	*	*	0.000	0.000	*	*	0.000	0.027	*
1	0.001	0.004	0.005	0.002	0.000	0.003	0.015	0.060	0.000
2	0.009	0.008	0.007	0.004	0.003	0.022	0.098	0.043	0.000
3	0.001	0.001	0.018	0.010	0.000	0.001	0.000	0.000	0.000
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.005	0.006	0.006	0.003	0.001	0.013	0.056	0.051	0.000

Table 5.3.5 Norway pout IV and IIIaN (Skagerrak).
SXSA (Seasonal extended survivor analysis).
Diagnostics of the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.541
1	10.720	*	9.874	9.180
2	9.252	*	8.757	8.429
3	9.252	*	8.757	8.429

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.466	*	*	*
2	1.496	*	*	*
3	1.496	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq3)

Year 1992-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3
AGE			
0	*	*	2.833
1	*	*	1.670
2	*	*	*
3	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq3)

Year 1998-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3
AGE			
0	*	*	2.963
1	*	*	1.889
2	*	*	*
3	*	*	*

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3
AGE			
0	*	*	*
1	*	*	*
2	*	*	1.496
3	*	*	1.496

Table 5.3.5 (Cont´d.). Norway pout IV and IIIaN (Skagerrak).

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.076
1	1.340	*	3.170	2.068
2	2.153	*	1.696	1.245
3	1.258	*	0.831	0.766

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.629	*	*	*
2	1.781	*	*	*
3	1.040	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq3)

Year 1992-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	1.329	*
1	*	*	2.226	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq3)

Year 1998-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	1.681	*
1	*	*	2.404	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2008 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.418	*
3	*	*	0.856	*

Table 5.3.6 Norway pout IV and IIIaN (Skagerrak). Stock summary table. (SXSA Baseline May 2009).

(Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits (age 0 3rd qrt)	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2)
1983	148005	369559	1901489	457.6	0.873
1984	79964	371168	1145117	393.01	1.241
1985	57240	166474	640668	205.1	1.295
1986	106163	87691	724457	174.3	1.096
1987	31029	96240	594120	149.3	0.876
1988	85564	126673	572316	109.3	0.660
1989	91146	85470	767979	166.4	0.813
1990	85606	125472	743251	163.3	0.736
1991	162888	145219	1092257	186.6	0.876
1992	69526	174919	1051550	296.8	0.920
1993	48705	219056	623228	183.1	0.815
1994	206710	119107	1086075	182.0	1.051
1995	65215	117492	1195995	236.8	0.573
1996	158260	295932	1136004	163.8	0.435
1997	45059	193685	1035843	169.7	0.590
1998	62988	262835	647633	57.7	0.291
1999	154278	151420	1005703	94.5	0.654
2000	53603	163187	1042645	184.4	0.585
2001	47602	233846	602217	65.6	0.269
2002	32874	160244	465427	80.0	0.506
2003	14504	109596	285889	27.1	0.248
2004	18941	85262	210077	13.5	0.158
2005	74807	54872	429145	1.9	0.000
2006	38574	76720	565547	46.6	0.260
2007	69004	152075	582670	5.7	0.020
2008	80956	145030	765486	36.1	0.121
2009		188815			
Arit mean	**80,354**	**165,854**	**804,338**		**0.614**
Geomean	**66,865**				

Table 5.6.1 NORWAY POUT IV and IIIaN (Skagerrak). Input data to forecast May 2009.

Basis: HCR with 2008 observed exploitation pattern and 2009 (forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 878 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 865 millions).

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2008	1	0	0	0.000	0.000	0.000	0.4	0
2008	1	1	31005	0.000	0.007	0.011	0.4	0.1
2008	1	2	3391	0.003	0.022	0.030	0.4	1
2008	1	3	1195	0.000	0.040	0.056	0.4	1
2008	2	0	0	0.000	0.000	0.000	0.4	0
2008	2	1	20779	0.003	0.015	0.011	0.4	0
2008	2	2	2267	0.022	0.034	0.030	0.4	0
2008	2	3	801	0.001	0.050	0.056	0.4	0
2008	3	0	80956	0.000	0.004	0.000	0.4	0
2008	3	1	13885	0.015	0.025	0.027	0.4	0
2008	3	2	1486	0.098	0.043	0.036	0.4	0
2008	3	3	537	0.000	0.060	0.000	0.4	0
2008	4	0	54267	0.027	0.006	0.010	0.4	0
2008	4	1	9172	0.060	0.023	0.024	0.4	0
2008	4	2	902	0.043	0.042	0.056	0.4	0
2008	4	3	359	0.000	0.058	0.000	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2009	1	0	0	0.000	0.000	0.000	0.4	0
2009	1	1	35411	0.052	0.007	0.012	0.4	0.1
2009	1	2	5789	0.211	0.022	0.028	0.4	1
2009	1	3	820	0.269	0.040	0.045	0.4	1
2009	2	0	0	0.000	0.000	0.000	0.4	0
2009	2	1	0	0.043	0.015	0.014	0.4	0
2009	2	2	0	0.176	0.034	0.027	0.4	0
2009	2	3	0	0.615	0.050	0.040	0.4	0
2009	3	0	47878	0.009	0.004	0.010	0.4	0
2009	3	1	0	0.163	0.025	0.029	0.4	0
2009	3	2	0	0.407	0.043	0.038	0.4	0
2009	3	3	0	0.597	0.060	0.049	0.4	0
2009	4	0	0	0.038	0.006	0.009	0.4	0
2009	4	1	0	0.277	0.023	0.029	0.4	0
2009	4	2	0	0.668	0.042	0.046	0.4	0
2009	4	3	0	0.507	0.058	0.048	0.4	0

Table 5.6.1b NORWAY POUT IV and IIIaN (Skagerrak). Input data to forecast May 2009.

Basis: HCR with 2008 observed exploitation pattern and 2009 (forecast year) fishing pattern scaled to 2008 seasonal exploitation pattern (standardized with 2008 Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 878 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 865 millions).

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2008	1	0	0	0.000	0.000	0.000	0.4	0
2008	1	1	31005	0.000	0.007	0.011	0.4	0.1
2008	1	2	3391	0.003	0.022	0.030	0.4	1
2008	1	3	1195	0.000	0.040	0.056	0.4	1
2008	2	0	0	0.000	0.000	0.000	0.4	0
2008	2	1	20779	0.003	0.015	0.011	0.4	0
2008	2	2	2267	0.022	0.034	0.030	0.4	0
2008	2	3	801	0.001	0.050	0.056	0.4	0
2008	3	0	80956	0.000	0.004	0.000	0.4	0
2008	3	1	13885	0.015	0.025	0.027	0.4	0
2008	3	2	1486	0.098	0.043	0.036	0.4	0
2008	3	3	537	0.000	0.060	0.000	0.4	0
2008	4	0	54267	0.027	0.006	0.010	0.4	0
2008	4	1	9172	0.060	0.023	0.024	0.4	0
2008	4	2	902	0.043	0.042	0.056	0.4	0
2008	4	3	359	0.000	0.058	0.000	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2009	1	0	0	0.000	0.000	0.000	0.4	0
2009	1	1	35411	0.025	0.007	0.012	0.4	0.1
2009	1	2	5789	0.000	0.022	0.028	0.4	1
2009	1	3	820	0.000	0.040	0.045	0.4	1
2009	2	0	0	0.025	0.000	0.000	0.4	0
2009	2	1	0	0.182	0.015	0.014	0.4	0
2009	2	2	0	0.008	0.034	0.027	0.4	0
2009	2	3	0	0.000	0.050	0.040	0.4	0
2009	3	0	47878	0.124	0.004	0.010	0.4	0
2009	3	1	0	0.810	0.025	0.029	0.4	0
2009	3	2	0	0.000	0.043	0.038	0.4	0
2009	3	3	0	0.000	0.060	0.049	0.4	0
2009	4	0	0	0.496	0.006	0.009	0.4	0
2009	4	1	0	0.355	0.023	0.029	0.4	0
2009	4	2	0	0.000	0.042	0.046	0.4	0
2009	4	3	0	0.000	0.058	0.048	0.4	0

Table 5.6.2 NORWAY POUT IV and IIIaN (Skagerrak). Results of the short term forecast (May 2009) with different levels of fishing mortality. Shaded scenarios are not considered consistent with the precautionary approach.

Basis: HCR with 2008 observed exploitation pattern and 2009 (forecast year) fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 878 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 865 millions).

SSB in the start of the Forecast year (1st Jan. 2009): 185 000 t		
F(2009)	Landings(2009) `000 t	SSB(2010) ´000t
0.00	0	226
0.05	16	218
0.10	32	210
0.15	46	203
0.16	49	201
0.17	52	200
0.20	61	196
0.25	74	189
0.30	87	183
0.35	100	177
0.40	112	171
0.45	124	165
0.50	135	160
0.55	146	155
0.60	157	150
0.65	167	146
0.70	177	141
0.75	186	137
0.80	196	133
0.85	204	129
0.90	213	125
0.95	221	122
1.00	230	118
1.05	237	115
1.10	245	112
1.15	252	109
1.20	260	106
1.45	293	92
1.50	299	90
1.55	305	88

Table 5.6.2b NORWAY POUT IV and IIIaN (Skagerrak). Results of the short term forecast (May 2009) with different levels of fishing mortality. Shaded scenarios are not considered consistent with the precautionary approach.

Basis: HCR with 2008 observed exploitation pattern and 2009 (forecast year) fishing pattern scaled to 2008 seasonal exploitation pattern (standardized with 2008 Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47 878 millions of recruitment during the period 1983-2008 in the 3rd quarter of the year (long term geometric mean is 66 865 millions).

SSB in the start of the Forecast year (1st Jan. 2009): 185 000 t

F(2009)	Landings(2009) `000 t	SSB(2010) ´000t
0.00	0	226
0.04	30	215
0.06	48	209
0.06	54	207
0.10	81	197
0.20	156	172
0.30	216	152
0.30	220	151
0.31	223	149
0.35	242	143
0.35	246	142
0.36	250	141
0.40	271	135
0.50	315	121
0.60	357	110
0.70	390	100
0.80	422	92
0.83	429	90
0.84	431	90
0.84	433	89

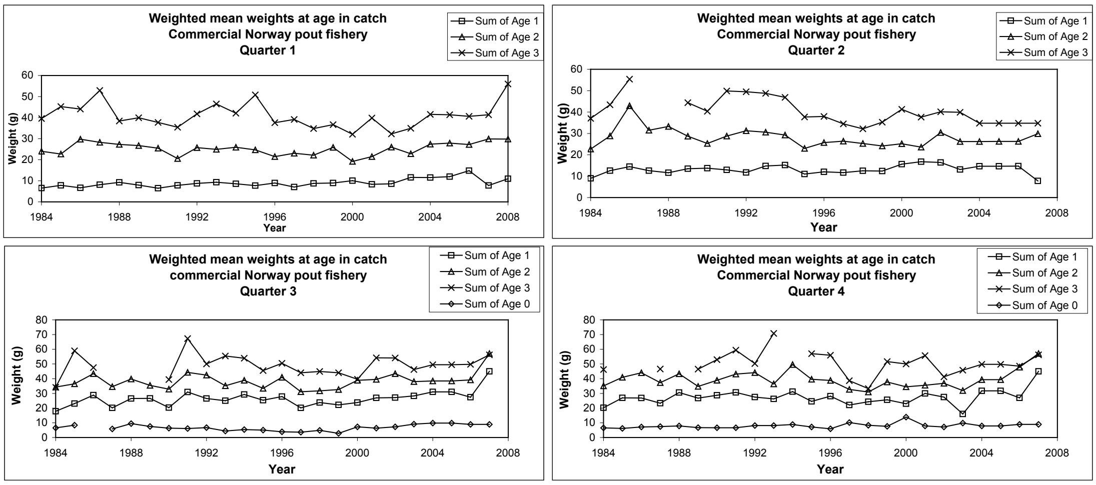


Figure 5.2.1. NORWAY POUT IV and IIIaN (Skagerrak). Weighted mean weights at age in catch of the Danish and Norwegian commercial fishery for Norway pout by quarter of year during the period 1982-2008.

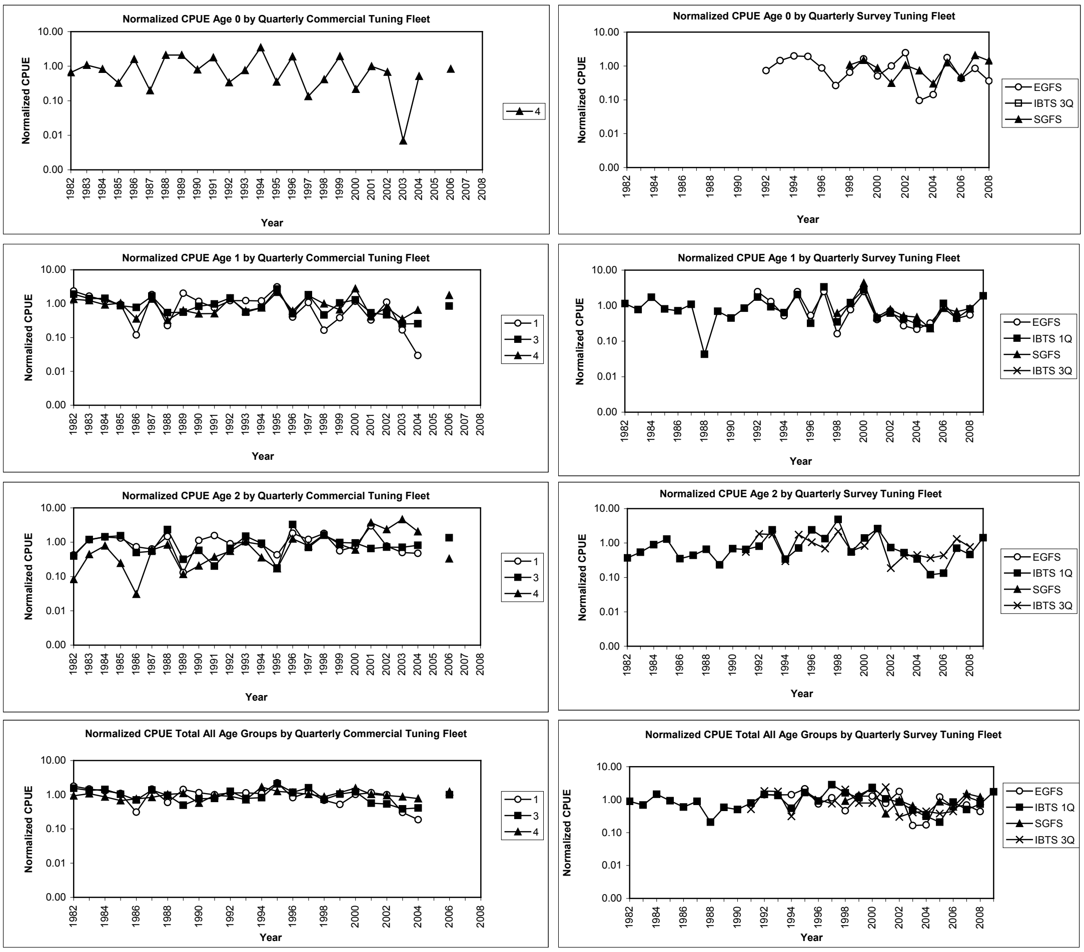


Figure 5.2.2 NORWAY POUT IV and IIIaN (Skagerrak). Trends in CPUE (normalized to unit mean) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway pout SXSA assessment for each age group and all age groups together.

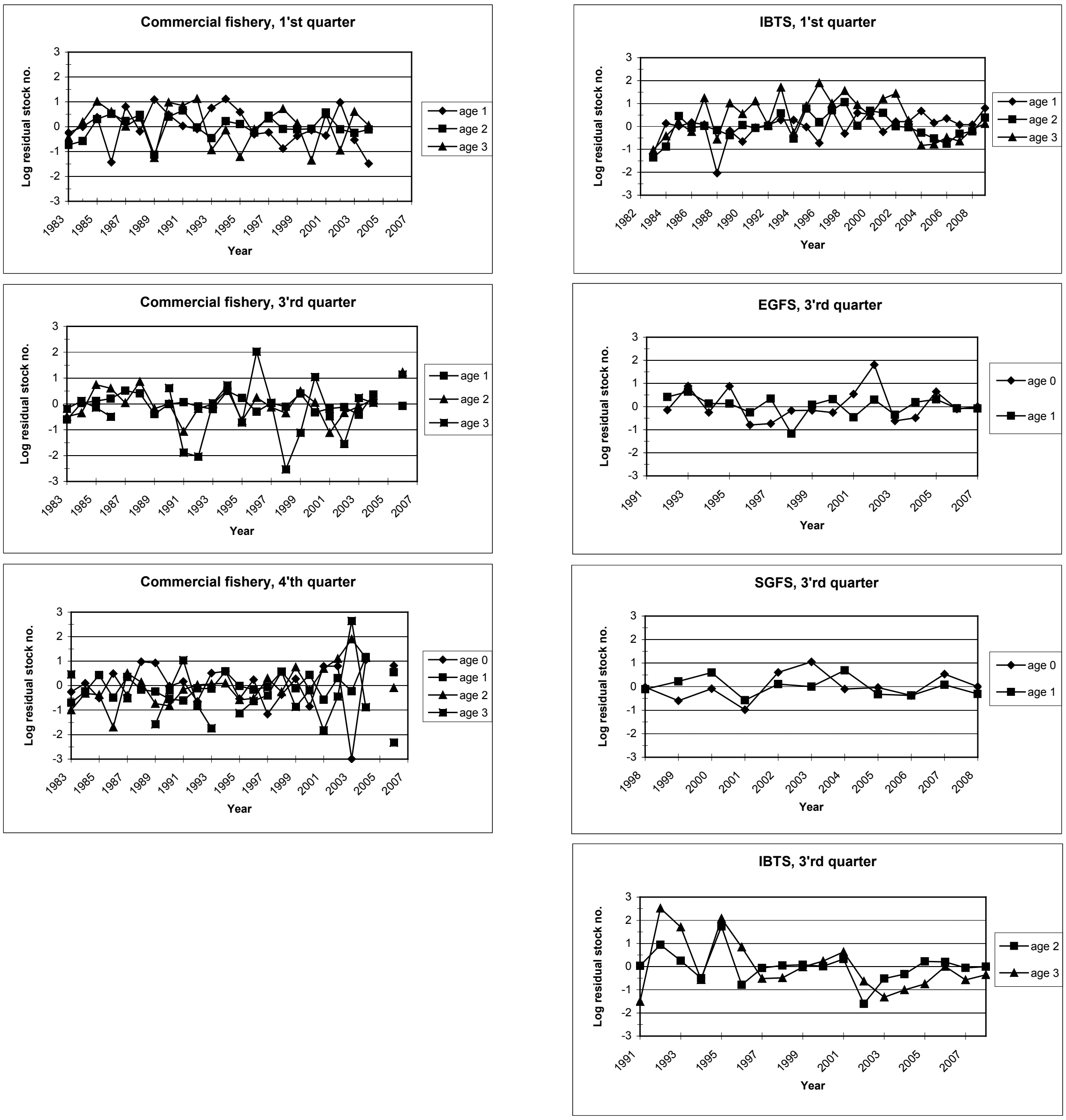


Figure 5.3.1 Norway pout IV and IIIaN (Skagerrak). Log residual stock numbers (log (Nhat/N)) per age group. SXSA divided by fleet and season.

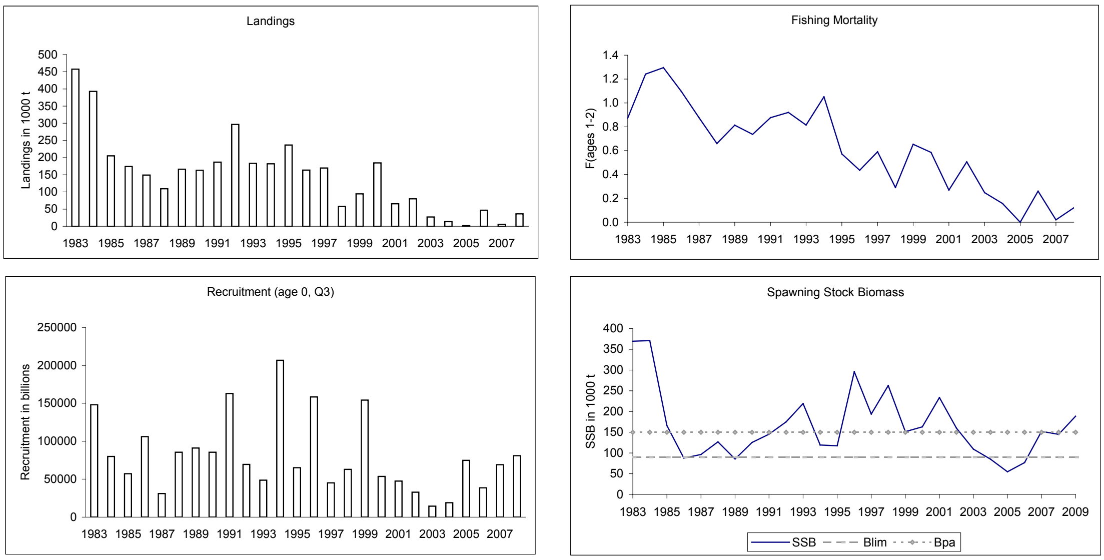


Figure 5.3.2 Norway Pout IV and IIIaN (Skagerrak). Stock Summary Plots. SXSA baseline run May 2009.

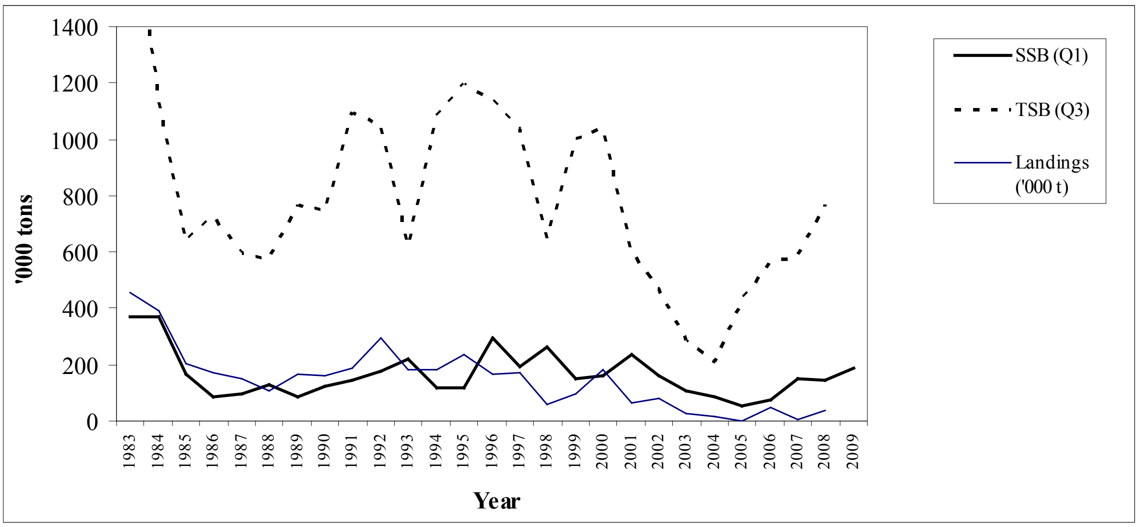


Figure 5.3.3 Norway pout IV and IIIaN (Skagerrak). Trends in yield, SSB and TSB during the period 1983-2009.

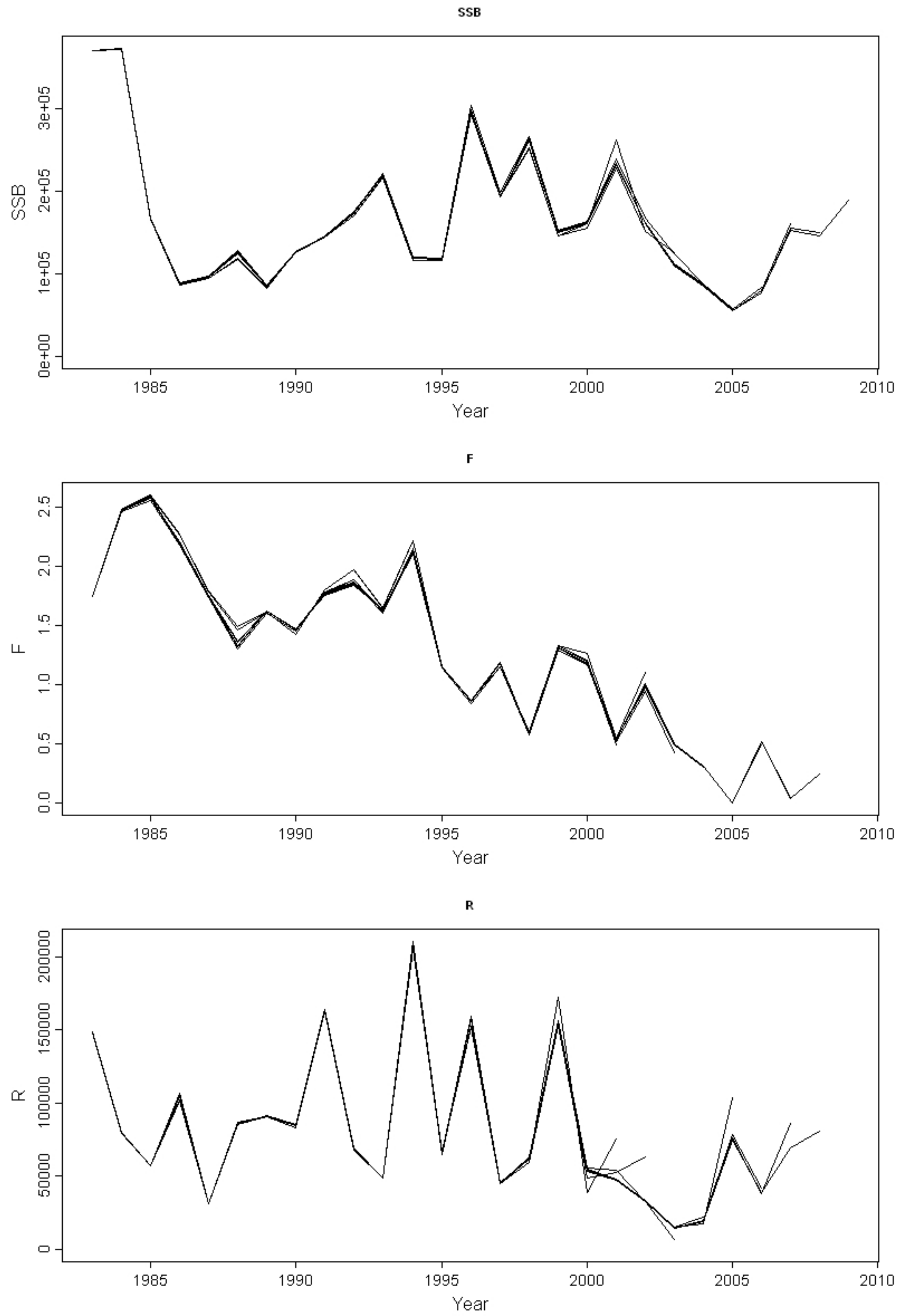


Figure 5.3.4 Norway pout IV and IIIaN (Skagerrak). Retrospective plots of final SXSA assessment May 2009, with terminal assessment year ranging from 2002-2009.

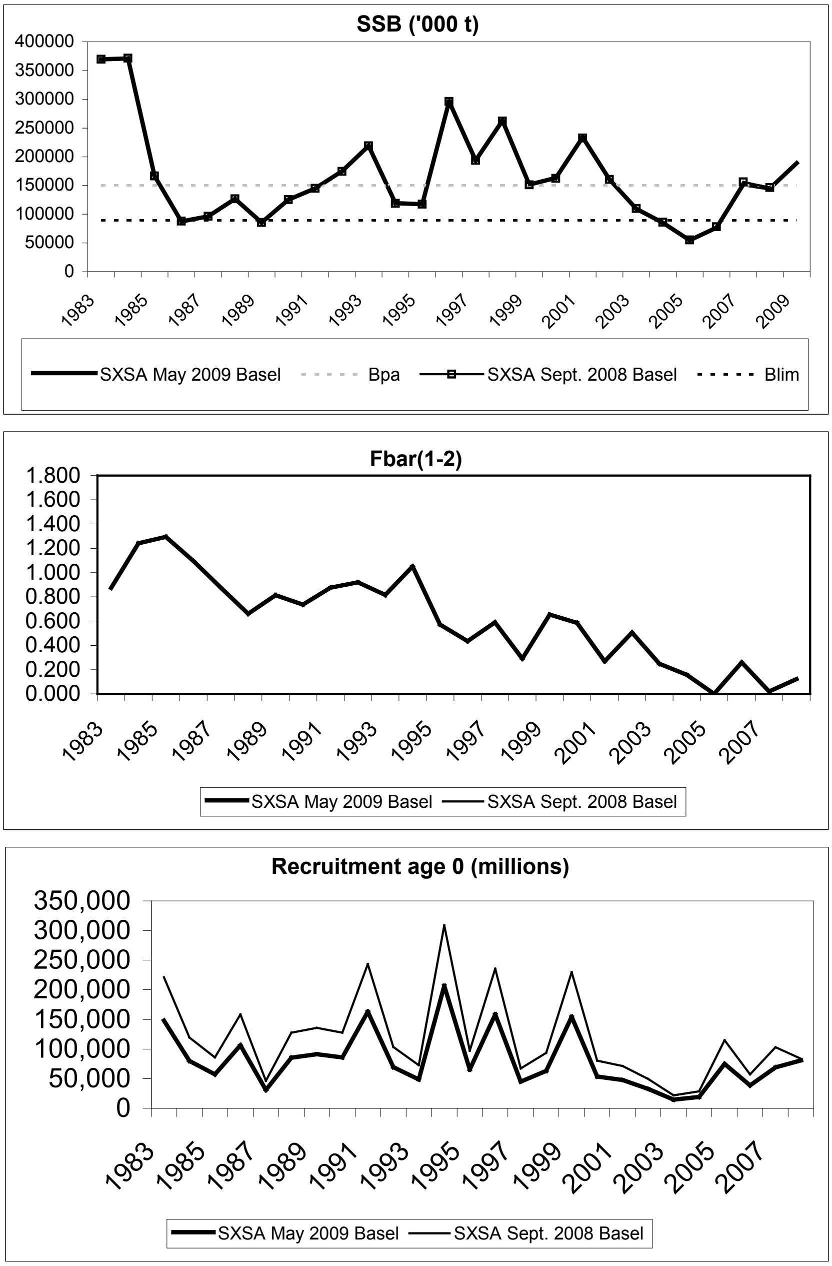


Figure 5.3.5 Norway pout IV and IIIaN (Skagerrak). Comparison of May 2009 SXSA baseline assessment with SXSA September 2008 baseline assessment.(OBS: In Sept 2008 recruitment were calculated for 2nd quarter and in May 2009 for 3rd quarter)

6 Plaice in Division VIId

This assessment of plaice in Division VIId is an update. All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. This stock is scheduled for benchmark in March 2010.

6.1 General

6.1.1 Ecosystem aspects

See section 9.1.1.

6.1.2 Fisheries

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts, where the main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st (targeting spawning concentrations in the central Eastern Channel) and 4th quarter and their area of activity covers almost the whole of VIId south of the 6 miles contour off the English coast. There is only light activity by this fleet between April and September. The second offshore fleet consists mainly of French large otter trawlers from Boulogne, Dieppe. The target species of these vessels are cod, whiting, plaice, mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 12 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish. The latter two groups are active when plaice is spread over the whole area and IVc.

Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of undersized plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice (27 cm). Management measures directed at sole fisheries will also impact the plaice fisheries.

The first quarter is usually the most important for the fisheries but the share of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 38% of the total recently. In 2008, the beginning of the year catches are predominant with the first semester corresponding to 52% of the total landings (see text table below).

Quarter	Landings	Cum. Landings	Cum. %
I	1116.8	1116.8	33
II	668.8	1785.6	52
III	687.5	2473.1	72
IV	955.8	3428.9	100

The age distribution in the exploitation pattern may be quite different between quarters, as shown for 2008 in Figure 6.1.2.1, with older fish being caught in quarter 1 and recruits at age 1 starting to be caught after summer. This is in line with what is known of the biology of this species, which operates spawning migration in the centre of the Eastern channel during winter.

Belgium beam trawlers are increasingly being equipped with 3D mapping sonar which opens up new areas to fishing (close to wrecks) and a few French vessels have shifted from otter trawl to Danish seine recently (WGFTFB, 2007). These changes are not likely to have modified the fisheries behaviour or affected the data entering into the assessment model.

6.1.3 ICES advice

2007 advice: State of the stock: In the absence of a reliable assessment, the state of the stock cannot be evaluated in relation to the precautionary approach. An exploratory assessment suggests that the spawning-stock biomass has declined through the last 15 years. The current level of SSB is low.

Exploitation boundaries in relation to precautionary limits: In the absence of short-term forecasts, ICES recommends that landings in 2008 do not increase above the average of landings from the last three years (2004–2006), corresponding to 3500 t.

2008 advice: The new landings, cpue, and survey data available for this stock do not change the perception of the stock and do not give reason to change the advice from 2007. The advice for the fishery in 2009 is therefore the same as the advice given in 2007 for the 2008 fishery: "In the absence of short-term forecasts, ICES recommends that landings [...] do not increase above the average of landings from the last three years (2004–2006), corresponding to 3500 t."

6.1.4 Management

There are no explicit management objectives for this stock.

The TACs have been set to 5050t for 2008 and 4646t for 2009 for the combined ICES Divisions VIId & VIIe.

The minimum landing size for plaice is 27 cm, which is not in accordance with the minimum mesh size of 80 mm, permitted for catching plaice by beam and otter trawling. Fixed nets are required to use 100-mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

For 2008, Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in Subarea VIId could be summarised as follows: Trawls or Danish seines can fish between 86 and an unlimited number of days. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 117 and 140 days per year. Trammel nets are allowed a maximum of 205 days for member states whose quotas are less than 5% of the Community share of the TACs of both place and sole; otherwise the limit is 180 days.

For 2009, Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different groups of vessels depending on gear and mesh size (see section 1.2.1 for complete list). 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 (≤100mm) – TR2 (≤70 and ≤100mm) – TR3 (≤16 and ≤32mm); Beam trawl of mesh size: BT1 (≤120mm) – BT2 (≤80 and ≤120mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

6.2 Data available

6.2.1 Catch

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 6.2.1.1. From 1992 to 2002, the landings have remained relatively stable between 5100 t and 6300 t. The 2008 landings in VIId of 3491t are close to those observed since 2005. As usual, France contributed the largest share (47%) of the total VIId landings in 2008 followed by Belgium (40%) and UK (13%) which is nearly unchanged from 2007.

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2008 are available from France and UK (Tables 6.2.1.2 and Figure 6.2.1.1a-c) though sampling levels are not high. Discards from the Belgian beam trawler fleet could not be processed in time for the working group due to logistic problems.

The percentage discarded per period, metier and country (Table 6.2.1.3a-b) and figures 6.2.1.1a-c) is highly variable per metier and from year to year. In every case, this percentage is substantial. Gillnetters had no discards in 2006 which was considered doubtful. In 2007, 26% of the catch were discarded by this metier but again the sampling level is very low (4 trips) to consider this rate to be representative. In 2008, 15% of the catch were discarded by gillnetters but again, only 3 trips were sampled. French trawlers had a discard rate of 33% this year (74% in 2007). The discard rate for beam trawlers is 63% (45% in 2007).

The time series of discards is currently not long enough to be used in analytical assessment. Discards at young ages influence the recruitment level, forecast and predictions, but do not influence estimates of F and SSB.

An average total fish mortality Z of 0.85 is estimated from catch curves slopes (figure 6.2.1.2a-b).Z which was at 0.92 in 1980 dropped to 0.52 in 1989-90 before increasing to 1.2 in 1994. Z has then slowly decreased to 0.70 in 2003. In 2005, Z was estimated at 1.03.

UK has provided data this year under the ICES InterCatch format. France and Belgium are working to provide data using this format for the next working group.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.1.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3.1 and weight at age in the stock in Table 6.2.3.2, both are presented Figure 6.2.3.1. The procedure for calculating mean weights is described in the Stock Annex.

6.2.4 Maturity and natural mortality

Information about maturity per age class is given with the table included in this section. At an age of three years more than 50 percent and at age four years 96percent of the plaice are mature. The natural mortality is assumed at a fixed value of 0.1 through all ages.

Age	1	2	3	4	5	6	7	8	9	10
Proportion of mature	0	0.15	0.53	0.96	1	1	1	1	1	1

6.2.5 Catch, effort and research vessel data

Effort and CPUE data are available from four commercial fleets (Figure 6.2.5.1). These are:

UK Inshore Trawlers

Belgian Beam Trawlers

French otter trawlers

UK Beam Trawlers

The survey series consist of:

UK Beam Trawlers

French Ground Fish Survey

International Young fish survey.

All survey and commercial data available for calibration of the assessment are presented in Tables 6.2.5.1, Figures 6.2.5.1 and 6.2.5.2 and fully described in the Stock Annex. Effort from the French trawlers has been relatively stable since 2002. Effort of the UK inshore fleet dropped sharply in 1998 and has remained relatively stable in recent years. The Belgian beam trawler fleet has been increasing since 1998 due to the absence of restrictions on fishing effort. However, LPUE has been decreasing for Belgium to one with its lowest level in 2006. LPUE tends to increase for the UK fleet. Those opposite trends for Belgium and UK may be linked to regional difference. LPUE for the French fleet is at some of its lowest values of the time series.

6.3 Data analyses

An update assessment has been carried out this year. As in 2008, a series of exploratory analysis have been carried out to examine the effect of different F shrinking and the respective performance of individual tuning fleets. In the following sections, the catch at age matrix and the tuning fleets are examined, plus an analysis of a survey-based assessment with SURBA which avoids the use of commercial CPUE.

6.3.1 Reviews of last years assessment

In 2008, RGNSSK stated that :

- There is a stock definition problems, which is tricky to solve. Mixing stocks during feeding period (North Sea and Channel stocks). Rate of mixing is not known for assessment.

- New discarding information available, however time series considered too short to be taken into account in assessment. Discarding figures in the report are good, showing where Achilles heel is.
- Survey data somewhat noisy, but reduction of noise in revised French data observed. The UK inshore trawlers excluded from the assessment. Does not reflect stock development.
- Last year it was RGs wish to have a catch curve analyses just for consistency.
- The sampling seems to be adequate, but it seems that discarding estimates and stock identity are major problems for assessment. Discarding in 1-3 quarters high and dependent on gear in use. By omitting young fish discards, is influencing short term predictions, by boosting SSB somewhat upwards, but perhaps not Fs.
- The assessment has a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge.
- There are no new elements in the assessment. A conclusion is that the assessment is indicative for trends only

The working group is aware of the comments of the review group. The different points will be addressed during the next benchmark analysis of this stock. Catch curves have been added to the 2009 report.

For this meeting, discards were not included in the assessment as the group considered the time series not long enough. The French survey indices are currently revised each year.

6.3.2 Exploratory catch-at-age-based analyses

The investigation on the level of shrinking has confirmed the result found the last two years, i.e. visible but no drastic effect on retrospective performance (Figure 6.3.2.1). The tendency to underestimate F and overestimate SSB and recruitment from year to year is slightly constrained by a strong shrinkage but never disappears The similarities between results obtained with F shrinkage values of 1.0, 1.5 and 2.0 may be explained by the large reduction of influence on the estimates of survivors at age when shifting from 0.5 to 1.0, as shown in the text table below. Higher F shrinkage values (1.5–2.0) have almost no influence on the estimates.

Table : F shrinkage influence (scaled weights) on the final estimates of survivors at age.

Age / F shrinkage	0.5	1	1.5	2
1	0.55	0.24	0.14	0.10
2	0.19	0.05	0.03	0.02
3	0.15	0.04	0.02	0.01
4	0.17	0.05	0.02	0.01
5	0.16	0.04	0.02	0.01
6	0.17	0.05	0.02	0.01
7	0.19	0.05	0.02	0.01
8	0.27	0.07	0.03	0.02
9	0.24	0.05	0.02	0.01

The log catch ratio residuals of the separable VPA (Figure 6.3.2.2) show no special pattern nor large values for the recent years of data, which suggests a relative consistency of the catch-at-age matrix.

The log catchability residuals from single fleet runs (with settings as in XSA and F shrinkage = 1.0) are shown in Figure 6.3.2.3 for all the fleets including the new UK Beam trawler fleet. Together with the two surveys covering the entire geographical area of the stock (UK BTS and French GFS), the UK Inshore Trawl residuals are increasing from the mid 1990s, indicating a progressive divergence with the landings at age. There is a jump in the residuals of the UK BTS in 2000, correlated to the decrease of the SSB that same year and the discrepancy between the surveys and the commercial fleets originates from that period. A similar pattern occurs also in the log catchability residuals of this survey for sole VIId. The French Otter trawlers series show a step shift in 1997, although no known reason was found for this. The group recommended to separate this series into two parts, one ending in 1996 and the other beginning in 1997. The log catchability residuals from a XSA run combining all fleets are shown in Figure 6.3.2.4.

In 2007 the rationale to include a new commercial tuning series was set out. The UK Inshore Trawl effort had strongly decreased in recent years and were therefore considered not representative of the dynamic of the stock due to sample noise. The UK Beam Trawl was thought to be more consistent in terms of its effort series and LPUE and was included in the assessment and the UK Inshore Trawl removed.

6.3.3 Exploratory survey-based analyses

The survey-based analysis was carried out with SURBA software, the results being shown in Figures 6.3.3.1. The parameters used for this exercise are a smoothing coefficient lambda set to 1.0 and a reference age set to 4, the age range being 0–10+, the range of F values for calculating the mean being 3 to 6 like the XSA analysis. The SURBA analysis has been proven to be insensitive to the choice of the initial parameters in the neighbourhood of those chosen here (ICES WGNSSK 2005). Figures 6.3.3.1 shows a good performance of the UK beam trawl survey for tracking year classes through time. This is different from the French GFS, which exhibits rather erratic patterns and has a low internal consistency. The French GFS indices have been revised since the 2007 report and standardized index per survey shows year class strength estimated by the FR GFS are now similar to those estimated by UK BTS. Considering the relative consistency of FR GFS at younger ages, the group recommended in 2007 to truncate the age range of this survey to ages 1 to 3 in the assessment.

The retrospective analysis (Figure 6.3.3.2) does not show tendencies to under or over estimate SSB as does the XSA but the estimates of mean Z are given with confidence bounds that question on the quality of this information. Some extreme values prevent from drawing a contrasted picture of the recruitment estimates by SURBA.

6.3.4 Conclusions drawn from exploratory analyses

In 2007, the group agreed that the new parametrisation of the model should exclude UK inshore trawl, include the new UK Beam trawl fleet, split the FR otter trawlers fleet in two, truncate FR GFS to ages 1 to 3 and use a level of F shrinkage of 1.0. A summary table of these settings can be found section 6.3.5.

There is a decreasing trend in the contribution of the first quarter to the whole landings, where a fishery on the spawners takes place, yielding an age distribution which differs from the rest of the year. It is unknown whether there is major inter-annual variability in the immigration from the North Sea to these spawning grounds, which could distort any catch-based analysis. Any migration events taking place in the first quarter cannot be represented in the surveys in the second semester.

Discarding is shown to take place and is substantial, but is constrained to younger ages. The year range of the data series is too short to make use of it in the analysis.

Both landings-at-age and tuning fleets information are highly dependent on the accuracy of the spatial declaration of the fishing activity as an important component of the fisheries operates on the borderline to ICES subdivision IVc.

Comparison of historical dynamics perceived through XSA and SURBA models and from current and previous year's analysis is shown Figure 6.3.4.1 on SSB, F and Recruitment estimates. The values shown in this figure are all respectful of the settings used since 2007. The F signals coming from SURBA and XSA are hardly comparable, but the discrepancies are not considered problematic given the uncertainty surrounding F estimates from SURBA. The recruitment estimates are much more volatile in SURBA than in XSA but the high and low values are found concurrently. The mean standardized values of SSB obtained from XSA and SURBA diverged in 2000 and 2001, and followed a strict parallel behaviour since then. Looking solely on the recent years trends, the two models agree that the SSB followed a stepped decline (taking into account the overestimation tendency of the two last years) since the end of the 1990s. This tendency was confirmed by a survey carried out in 2006 to assess French fisher's perception of the Eastern Channel ecosystem (Prigent *et al*., 2007). 76% of the interviewees expressed their worry and found the fisheries resources depleted, especially flatfish and gadoids.

Figure 6.3.4.2 compares the single fleet performances to the final assessment. The two main surveys keep diverging from the commercial fleets. A map of UK BTS indices per tow locations from 1996 to 2006 (Figure 6.3.4.3) shows that the catches of plaice by the survey occur mainly inshore, whereas the commercial fisheries spread all over the Channel as plaice is mainly taken as a by-catch. It is important to notice that the three surveys occur in the second half of the year, whereas the period when the most plaice is landed is the first semester. A part of the annual dynamic of the stock seems to be missing in the survey indices.

6.3.5 Final assessment

The settings in the XSA assessment for last year are (parameters were unchanged in 2009):

Year of assessment:		2008	2009
Assessment model:		XSA	XSA
Assessment software		FLR library	FLR library
Fleets:			
UK Inshore Trawlers	Age range	**Excluded**	**Excluded**
UK Beam Trawl	Age range	**2–10**	**2–10**
BE Beam Trawlers	Age range	2–10	2–10
FR Otter Trawlers	Age range	**2–10**	**2–10**
	Year range	**2–10**	**2–10**
UK Beam Trawl Survey	Age range	1–6	1–6
FR Ground Fish Survey	Age range	**1–3**	**1–3**
Intern'l Young Fish Survey	Age range	1	1
Catch/Landings			
Age range:		1–10+	1–10+
Landings data:		1980–2007	1980–2008
Discards data		None	None
Model settings			
Fbar:		3–6	3–6
Time series weights:		None	None
Power model for ages:		No	No
Catchability plateau:		Age 7	Age 7
Survivor est. shrunk towards the mean F:		5 years / 3 ages	5 years / 3 ages
S.e. of mean (F-shrinkage):		**1.0**	**1.0**
Min. s.e. of population estimates:		0.3	0.3
Prior weighting:		No	no

The final XSA output is given in Table 6.3.5.1 (diagnostics), table 6.3.5.2 (fishing mortalities) and Table 6.3.5.3 (stock numbers). A summary of the XSA results is given in Table 6.5.3.4 and trends in yield, fishing mortality, recruitment and spawning stock and Total Stock biomass are shown in Figure 6.3.5.4.

6.4 Historic Stock Trends

Fishing mortality has remained stable over the last 4 years.

The 1985 year class dominates the history of this stock. A second peak occurred with the 1996 year class, although estimated to be at 65% of the 1985 year class. The ephemeral peek of SSB in 1999 has been followed by years of stepped decline. SSB is stable at its lowest level, a situation confirmed by the fishermen's perception as assessed by a survey in France in 2006.

Recruitment in 2008 (24 millions) is close to the level of 2007, higher than the value of GM (15 millions) for the period 2000 – 2006. This strong recruitment has been confirmed by two surveys used for the assessment. GM 1980 – 1999 is around 23 millions fish at age 1.

6.5 Recruitment estimates

Recruitment estimation was carried out according to the specifications in the stock annex. The model used was RCT3. Input to the RCT3 model is presented in Table 6.5.1. Results are presented in Table 6.5.2 and 6.5.3. For the estimation of year classes 2007 and 2008, the new information brought in by the RCT3 analysis was not considered to be reliable enough to be taken into the forecast. For the 2008 year class (age 1 in 2009), the contribution from survey information was close to 0 as a result of high standard errors. For the 2007 year class (age 2 in 2009), the RCT3 estimate was close to the XSA estimates and well below the survey estimates.

The 2007 year class was estimated to be around 27 millions fish at age 1 in 2007 (24 millions fish at age 2 in 2008) from the XSA estimate.

The 2008 and 2009 year classes were estimated using the average recruitment calculated over the period 2000–2006. The truncation was meant to take into account the relative stability of the recruitment in the recent years at a lower level than at the beginning of the series. The geometric mean was about 16 millions 1-year-old-fish. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year Class	Age in 2008	XSA (Thousands)	RCT3 (Thousands)	GM (1998–2005) (Thousands)	Survey estimates (Thousands)
2007	2	**20935**	19584	-	YFS0: 42192 GFS1: 16814
2008	1	-	19346	**15503**	-
2009	0	-	-	**15503**	-

6.6 Short-term forecasts

The short term prognosis was carried out with FLR package. The average F for the last three years was used for the forecast. Although the 2006 exploitation pattern shows a noisy signal (Figure 6.6.1), it expresses a trend of F decreasing in the younger ages and increasing in the older ages in the recent years (Figure 6.6.2). The exploitation pattern used was the mean F-at-age over the period 2006–2008 scaled to the last year. The weights used for prediction were the average over the last three years.

Input to the short term predictions are presented in Table 6.6.1 and results in Table 6.6.2.

Assuming status quo F implies a landing in 2009 in VIId of 5310t (the agreed TAC is 4646t for both VIId and VIIe) and a landing of 5370t in 2010. Assuming status quo F will result in a SSB in 2010 and 2011 of 6890t and 6660t, respectively.

6.7 Medium-term forecasts

No medium-term forecast is available for this stock.

6.8 Biological reference points

ICES considers that:	ICES proposes that:
B_{lim} = 5 600 t	B_{pa} = 8 000 t
F_{lim} = 0.54	F_{pa} = 0.45.
Technical basis	
B_{lim} ~ B_{loss} (= 5 584 t)	B_{pa} = 1.4 B_{lim}
F_{lim} = F_{loss}	F_{pa} = 5th percentile of F_{loss}; long-term SSB > B_{pa} and P (SSB_{MT} < B_{pa}) < 10 %

6.9 Quality of the assessment

- The sampling for plaice in VIId are considered to be at a reasonable level
- Discarding of plaice is significant and variable depending on the gear used. The omission of young fish discards has influence on the forecast and the predictions, but is not considered to severely affect the estimates of F and SSB.
- The assessment has a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge.
- Trends from surveys and commercial fleets are similar before and after 2000. The rescaling of surveys estimates operated in 2000 is consistent with the shift in log q residuals seen for FR GFS and UK BTS, both for plaice and sole in VIId.

6.10 Status of the stock

Fishing mortality is estimated in 2008 at 0.63. F has been stable for the last four years and is above Flim.

The spawning stock biomass has followed a stepped decline in the last 10 years, following a peak generated by the strong 1996 year class. The current level of SSB is stable at a low level below Blim, and this confirms the fisher's impression assessed by a survey in France in 2006. Year classes 2006 and 2007 suggest a substantially stronger recruitment than in recent years. Based on a status quo fishing value in 2009 and 2010, the short-term projections suggest a stock between Blim and Bpa by 2011.

6.11 Management considerations

SSB in 2008 was close to its lowest level and below B_{lim}. Projections based on the recruitment for year class 2007 and F value in 2008 indicate a stock between Blim and Bpa by 2011.

The stock identity of plaice in the Channel is unclear and may raise some issues :

- The TAC is combined for Divisions VIId and VIIe. Plaice in VIIe is considered at risk of being harvested unsustainably and estimated from trends in the assessment to be at a very low level.
- The plaice stock in VIId is mostly harvested in a mixed fishery with sole in VIId. There exists a directed fishery on plaice occurring in a limited period at

the beginning of the year on the spawning grounds. Plaice is mainly taken as by-catch by the demersal fisheries, especially targeting sole.

Due to the minimum mesh size (80 mm) in the mixed beam and otter trawl fisheries, a large number of undersized plaice are discarded. The 80 mm mesh size is not matched to the minimum landing size of plaice (27 cm). Measures taken specifically to control sole fisheries will impact the plaice fisheries.

Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different groups of vessels depending on gear and mesh size. The new regime has not reduced effort for beam trawls in this area.

Table 6.2.1.1 - Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES , 1976-2008.

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Total as used by WG	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-	1963	
1977	149	81(2)	1714	302	-	2246	-	2246	
1978	161	156(2)	1810	349	-	2476	-	2476	
1979	217	28(2)	2094	278	-	2617	-	2617	
1980	435	112(2)	2905	304	-	3756	-1106	2650	
1981	815	-	3431	489	-	4735	34	4769	
1982	738	-	3504	541	22	4805	60	4865	
1983	1013	-	3119	548	-	4680	363	5043	
1984	947	-	2844	640	-	4431	730	5161	
1985	1148	-	3943	866	-	5957	65	6022	
1986	1158	-	3288	828	488 (2)	5762	1072	6834	
1987	1807	-	4768	1292	-	7867	499	8366	8300
1988	2165	-	5688 (2)	1250	-	9103	1317	10420	9960
1989	2019	+	3265 (1)	1383	-	6667	2091	8758	11700
1990	2149	-	4170 (1)	1479	-	7798	1249	9047	10700
1991	2265	-	3606 (1)	1566	-	7437	376	7813	10700
1992	1560	1	3099	1553	19	6232	105	6337	9600
1993	877	+(2)	2792	1075	27	4771	560	5331	8500
1994	1418	+	3199	993	23	5633	488	6121	9100
1995	1157	-	2598 (2)	796	18	4569	561	5130	8000
1996	1112	-	2630 (2)	856	+	4598	795	5393	7530
1997	1161	-	3077	1078	+	5316	991	6307	7090
1998	854	-	3276 (23)	700	+	4830	932	5762	5700
1999	1306	-	3388 (23)	743	+	5437	889	6326	7400
2000	1298	-	3183	752	+	5233	781	6014	6500
2001	1346	-	2962	655	+	4963	303	5266	6000
2002	1204		3454	841		5499	278	5777	6700
2003	995	-	2783 (3)	756		4536	-	4536	6000
2004	987		2439 (4)	580		4007	-	4007	6060
2005	830		1756	411	20	3018	428	3446	5150
2006	1031		1713	545	16	3305	-	3305	5080
2007	1356		1858	460		3674	-	3674	5050
2008	1388		1642	461		3491	-	3491	5050

1 Estimated by the working group from combined Division VIId+e
2 Includes Division VIIe
3 Provisional
4 Data provided to the WG but not officially provided to ICES
5 TAC´s for Divisions VII d, e.

Table 6.2.1.2. Plaice in VIId. Discards

	FR - Gillnet		FR - Trawl						UK - Trawl			
	Q4		Q2		Q3		Q4		Q2		Q4	
Trips	1		4		1		5		2		6	
Hauls	3		27		3		16		2		43	
Length	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN
10												
11												
12												
13												
14			12									
15			24									
16												
17			63								7	
18			104									
19			730						2		24	
20			960						1		43	
21			662								33	
22			785								100	
23			893								201	
24			702					5	5		301	
25	6		261	340					3		370	
26	12		187	1242				5	1	1	376	1
27	6	4	626	2949				126	2	6	390	5
28	6	2	7	2922		3		88		8	296	34
29		8		1970		11		340		2	159	93
30		16		2316		8	78	136		7	51	163
31		2		2068		3		500		3	21	104
32		4		2408		5		541		4		120
33				1749				392		5	8	75
34		6		1427				614		3		94
35				1109				324		4		89
36				272		3		25		4		81
37		2		335				22				84
38				314				15		2		56
39		2		357				8		1	1	67
40		4		313				73		1	5	57
41				321				8				43
42				103				25				33
43				25								34
44		6		3				33				24
45								126				16
46												14
47												22
48												16
49				84								11
50				3								11
51				3								2
52												7
53										1		6
54				19								8
55												3
56												4
57												
58												
59												
60												
61												
62												1
63												
total	30	56	6014	22652	0	32	78	3403	14	52	2382	1378

Table 6.2.1.3a. Plaice in VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in 2008.

Period	Métier	Country	Numbers				%D
			Trips sampled	Hauls sampled	Landed	Discarded	
Quarter 2	Trawl	France	4	27	628	357	36%
Quarter 2	Beam Trawl	UK	2	2	52	14	21%
Quarter 3	Trawl	France	1	3	12	0	0%
Quarter 4	Trawl	France	5	16	98	1	1%
Quarter 4	Gillnet	France	1	3	28	5	15%
Quarter 4	Beam Trawl	UK	6	43	1378	2382	63%
2008	Gillnet	France	1	3	28	5	15%
2008	Trawl	France	10	46	738	358	33%
2008	Beam Trawl	UK	8	45	1430	2396	63%

Table 6.2.1.3b. Plaice in VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in 2007.

Period	Métier	Country	Numbers				%D
			Trips sampled	Hauls sampled	Landed	Discarded	
Quarter 1	Gillnet	France	2	6	13	15	54%
Quarter 1	Beam Trawl	UK	4	12	59	45	43%
Quarter 2	Trawl	France	5	14	115	424	79%
Quarter 2	Beam Trawl	UK	10	37	1087	1025	49%
Quarter 3	Trawl	France	14	23	65	121	65%
Quarter 3	Beam Trawl	UK	5	27	65	75	54%
Quarter 4	Trawl	France	8	47	17	4	19%
Quarter 4	Gillnet	France	2	14	30	0	0%
Quarter 4	Beam Trawl	UK	1	16	164	0	0%
2007	Gillnet	France	4	20	43	15	26%
2007	Trawl	France	27	84	197	549	74%
2007	Beam Trawl	UK	20	92	1375	1145	45%

Table 6.2.2.1. Plaice in VIId. Landings in numbers (thousands)

	1	2	3	4	5	6	7	8	9	10+
1980	53	2644	1451	540	490	75	45	44	4	103
1981	16	2446	6795	2398	290	159	51	42	56	200
1982	265	1393	6909	3302	762	206	96	62	21	88
1983	92	3030	3199	5908	931	226	92	122	4	101
1984	350	1871	7310	2814	1874	533	236	101	34	100
1985	142	5714	6195	4883	413	612	164	99	139	50
1986	679	4884	7034	3663	1458	562	254	69	19	34
1987	25	8499	7508	3472	1257	430	442	154	105	77
1988	16	5011	18813	4900	1118	541	439	127	105	174
1989	826	3638	7227	9453	2672	588	288	179	81	197
1990	1632	2627	8746	5983	3603	801	243	203	178	231
1991	1542	5860	5445	4524	2437	1681	286	120	113	125
1992	1665	6193	4450	1725	1187	1044	698	200	116	118
1993	740	7606	3817	1259	542	468	334	287	102	152
1994	1242	3633	6968	3111	850	419	312	267	275	312
1995	2592	4340	2933	2928	922	228	277	225	122	258
1996	1119	4847	3606	1547	1436	488	179	176	165	347
1997	550	4246	7189	3434	1080	752	464	199	114	306
1998	464	4400	8629	3419	537	143	136	81	52	188
1999	741	1758	12104	6460	1043	171	86	81	38	111
2000	1383	6214	4284	7241	1652	307	82	27	42	98
2001	2682	4159	4380	2141	1985	310	87	22	13	78
2002	902	7204	5191	1907	1565	888	234	62	25	92
2003	646	4874	5668	1864	424	373	333	75	50	62
2004	967	4964	5471	894	389	152	133	133	38	48
2005	324	3080	3876	2282	461	195	107	88	68	48
2006	509	3027	3128	1610	878	204	84	92	61	72
2007	790	2910	2811	1763	866	555	148	44	17	66
2008	357	3867	2542	1521	626	284	264	28	16	30

Table 6.2.3.1. Plaice in VIId. Weights in the landings

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.207	0.245	0.261	0.283	0.375	0.576	0.687	0.875	0.926	1.067
2001	0.215	0.252	0.303	0.37	0.447	0.642	0.876	1.008	1.144	1.223
2002	0.254	0.256	0.309	0.376	0.438	0.562	0.627	0.88	0.909	1.33
2003	0.254	0.268	0.271	0.363	0.556	0.643	0.624	0.85	0.583	1.205
2004	0.217	0.243	0.295	0.421	0.493	0.61	0.636	0.933	1.093	1.348
2005	0.21	0.263	0.293	0.36	0.527	0.536	0.753	0.778	0.82	1.014
2006	0.209	0.263	0.318	0.374	0.463	0.611	0.711	0.732	0.858	1.071
2007	0.246	0.293	0.322	0.382	0.473	0.541	0.685	0.793	0.983	1.193
2008	0.244	0.286	0.334	0.404	0.509	0.596	0.727	1.316	0.921	1.254

Table 6.2.3.2. Plaice in VIId. Weights in the stock.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.171	0.332	0.482	0.622	0.751	0.87	0.977	1.074	1.161	1.339
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.23	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.143	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.124	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.53	0.67	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.76	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.89	1.131
2001	0.093	0.206	0.274	0.338	0.404	0.624	0.844	0.989	1.153	1.405
2002	0.102	0.206	0.281	0.379	0.467	0.558	0.61	0.759	1.053	1.25
2003	0.103	0.191	0.249	0.33	0.496	0.492	0.548	0.748	0.522	0.982
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287
2005	0.096	0.201	0.269	0.308	0.47	0.492	0.707	0.629	0.814	0.89
2006	0.106	0.209	0.275	0.336	0.397	0.525	0.636	0.704	0.842	1.09
2007	0.125	0.224	0.265	0.323	0.431	0.463	0.62	0.831	1.04	1.222
2008	0.155	0.253	0.285	0.343	0.41	0.447	0.615	0.755	0.912	1.266

Table 6.2.5.1. Plaice in VIId. Tuning fleets

Plaice in Division VIId (run name: XSAEDB01 - NOT USED In THE ASSESSMENT)

108									
FLT01:	UK INSHORE TRAWL METIER<40 trawl lands all trawl age comps(Catch: Unknown)								
1985	2008								
1 1	0	1							
2 10									
2520	618.3	419.7	221.1	18.8	0	0	0	19	0
1804	237.9	300.2	132.9	51.6	6.5	4.7	2.9	0	0
2556	456	430.2	153.2	48	25.1	5	6.3	4.3	0
2500	382.4	856.1	141.7	57.8	30.1	14.1	2.8	4	5.2
2131	47.4	221.7	465.4	97.1	41.3	19	5.5	1.2	6.2
1094	34.3	92.1	52.6	56.9	18	7.5	5.5	3.6	3.1
2349	240.2	229.7	166.6	76.6	64.9	10.7	4.3	2.1	1.3
2527	298	225.5	140.4	77.8	55.3	44.2	14.6	2.9	2.4
2503	309.3	181.4	66.6	40.5	30.1	21.5	25.1	8.5	3.8
2635	176	240.2	99.7	37.8	21	17	8.9	17.9	3.5
1531	124.1	70.7	54.6	23.5	8.5	5	5.5	3.9	6.8
1659	274.4	63.8	16.9	19.1	10	2.5	3.1	2.5	2.5
2024	317.1	223.8	20.4	7.7	10.2	8	4.9	2.8	4
813	104.3	77.7	27.6	3.7	1.7	3.9	1.4	1.2	0.3
861	53.4	222.2	27	8.7	1.2	0.4	1.4	0.5	0.4
652	75	46	81.3	13.8	4.5	1.1	0.5	1	0.4
491	29.4	21.3	13.8	17.5	3.3	0.9	0.6	0.2	0.2
607	120.2	77.2	17.2	8.5	14.7	2.2	1.5	0.3	0.2
653	216.9	46.4	24.9	5.1	4.1	6.9	5.1	0.3	0.3
661	84.6	127.5	13.5	5.4	2.3	1.9	3.8	1.7	0.5
235	52.2	23	19.3	2.4	1.8	0.5	0.4	1.1	0.2
629	189	123.4	39.4	27.9	4	3.4	1.9	1.1	2.4
500	84.3	65.3	33.3	9.9	7.7	1.6	1.2	0.4	0.5
633	155.4	38.6	13.1	7.6	2	2.5	0.2	0.2	0.2
FLT02:	BELGIAN BEAM TRAWL(HP corr) all gears age comp [rev: 03/09/03-WD] (Catch: Unknown) (Effort: Unknown)								
1981	2008								
1 1	0	1							
2 10									
24.4	285.9	1126.5	593.3	67.3	21.6	8.3	7.1	13.3	14.1
29.8	147.8	1065.4	688.2	187.2	55.1	21.1	6.5	4.6	4
26.4	476.7	654.3	1384.5	165	52.2	23	31.6	1.3	1.4
35.4	92	1570.4	712.1	467.5	134.3	61	28.2	5.4	6.8
33.4	557.2	1125.3	1115.1	93.9	197.2	52.9	31.9	5.3	6.1
30.8	700.6	1141.8	667.8	269.9	145.9	60.3	11.3	5.6	6.4
49.3	1944.8	1639.7	889	343.1	92.7	154.5	41.1	28	14.1
48.9	773	4264.6	1301.8	237.1	109.9	113.2	35.8	25.4	24
43.8	73.6	1733.7	2950.5	973.4	212.8	113.1	61.1	21.7	0.1
38.5	372.1	2687.5	1942.8	1007	184.8	43.9	50.5	13.1	14
32.8	595.4	1689.2	1149.4	1089.5	698.4	86.9	36	58.9	1.7
30.9	889.8	1031.7	403.8	277.6	282.1	159.7	58.2	60.7	6.7
28.2	488.8	684.2	274.3	197.6	121.6	74.7	62.8	10.6	19.3
32.8	424.6	1259.2	1426.5	268	132.6	109.5	75.5	90	37.6
31.7	39.8	591.9	925.2	396.5	82	140.1	82.6	26.1	0.7
32.6	259.3	689.3	541.5	503.7	137.6	46.4	49.9	38.4	44.4
39.7	0	287.3	931.8	570.2	295.7	143.7	37.3	27.7	11.2
23.6	164.6	900.7	616.6	122	39	40	18.2	18.4	13.7
27.6	40.7	1687.7	1366.6	370.5	67.5	25.4	13.5	14	12.7
37	60.4	369.7	529	235.4	43.4	12.1	5.9	10.4	1.5
40.2	422.6	1759.9	1085	705.3	119.4	26.5	9.3	7.6	26.9
41.1	412.7	1361.3	641	578	138.7	62.7	9.6	5	26.4
40	407.2	1194.7	581.6	144	176.8	130.8	25	18.2	24.9
39.1	317.8	1329.4	313.9	154.7	48.8	68.3	51.5	13.3	23.4
44	299.6	737.6	708.8	239.5	73.6	39.8	35.3	21.3	1.1
56.9	475.7	882.2	758.5	440.6	78.1	34.5	41.6	40.7	25
65.1	826.7	911.5	725.5	493.7	374.6	104.7	21.7	6.2	39.3
54.5	745.2	966.6	843.6	307.2	129.5	178.7	11.9	2	8.7

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

FLT03: FRENCH TRAWLERS (EFFORT H*KW*10-4) 1989-90 DERAISED 1991-98 TRUE (Catch: Unknown) (Effort: Unknown)

1989	2008								
1	1	0	1						
2	10								
6983	1190.1	1635.9	1643.2	466.2	73.5	34.3	34.1	19.3	16.1
8395	698.2	1876.1	1289.5	728.3	153.7	42.6	33.1	46.5	14.4
10689	1938.7	1474.1	1430	399.5	255.2	41	17.6	11.9	9.9
10519	1802.9	1396.1	370.2	269.4	230.7	143.5	21.2	12.1	11.6
10217	2124.4	1118.2	268.4	56	73.4	48.7	32.3	14.3	4.6
10609	1034.2	2271.2	476.4	177.6	69.5	48.2	48.3	32	25
12384	1354.7	686.5	578.5	95.4	21.4	19.5	27.5	21.8	28.2
14476	1133.3	1283.9	352.7	317.5	98.8	43.6	33.3	34.6	36.9
10921	1396.2	3536	1155.4	139	170.7	88.3	50.8	22.4	28.2
11707	1446	3541.9	1534.4	205.4	29.8	20.2	17.8	6.9	8.2
10625	1139.1	5654.6	2456	254.4	36.1	24.8	23.5	4.4	16.6
13779	2757.4	1634	3110.4	781.5	130.9	21.2	6.1	12.9	19.9
11376	2113.6	1726.3	663.1	642.5	81.3	21.6	1.4	1.2	16.4
13489	3130.4	1134.9	336.6	230.9	186.2	36.7	9.5	2.9	13.1
12647	1984.9	2715.5	701.5	129.6	82.8	75.1	17.8	16.3	11.2
11582	3107.1	2308.6	284.8	110.4	50.1	22.3	24.4	5.9	6.7
12157	1131.3	1428.8	652.9	63.1	37.1	22.4	15.1	10.6	8.9
11779	1009	922	333.6	140.1	43.5	14.5	14.7	5	10.6
12250	731.5	730.3	356.8	120.9	45.8	11.3	5.7	2.7	7.2
10133	1167	619.3	223.1	95.4	50.8	13.9	4.4	4.2	5.2

FLT04: UK BEAM TRAWL SURVEY true age 6 [rev: 05/09/03-RM] (Catch: Unknown) (Effort: Unknown)

1988	2008					
1	1	0.5	0.75			
1	6					
1	26.5	31.3	43.8	7	4.6	1.5
1	2.3	12.1	16.6	19.9	3.3	1.5
1	5.2	4.9	5.8	6.7	7.5	1.8
1	11.8	9.1	7	5.3	5.4	3.2
1	16.5	12.5	4.2	4.2	5.6	4.9
1	3.2	13.4	5	1.7	1.9	1.6
1	8.3	7.5	9.2	5.6	1.9	0.8
1	11.3	4.1	3	3.7	1.5	0.6
1	13.2	11.9	1.3	0.7	1.3	0.9
1	33.1	13.5	4.2	0.6	0.3	0.3
1	11.4	27.3	7	3.1	0.3	0.2
1	11.3	14.1	15.9	2.9	1	0.2
1	13.2	21	14.4	13.8	3.5	0.9
1	17.9	13	10	7.1	10.9	1.9
1	20.7	15.9	7.7	3.5	1.8	3.5
1	6.2	22.8	6	2.9	1.6	0.8
1	36.2	15	13.2	3.4	0.9	0.2
1	10.8	31.2	13.8	10.3	2.9	1.2
1	17.2	16.1	9.2	3.3	2.6	0.8
1	42.6	18.8	8.7	3.9	1.7	2
1	30.3	26.5	7.2	3	2.3	1.1

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

```
FLT05: French GFS [option 2] true age 5 [rev:     01/09/03-JV]     (Catch:
Unknown) (Effort: Unknown)
1988   2008
1      1      0.75   1
0      5
1      1.9    8      17.6   9.9    1.7    0.6
1      1.6    3.5    7.4    2.7    1.1    0.1
1      0.1    3.9    1.2    2.7    1.9    1.6
1      0.1    2.5    2.1    0.8    0.6    0.4
1      0.9    34.4   3.6    1.9    0.3    0.2
1      4.4    18.7   8.8    4.2    1.2    0.5
1      3.8    5      2.2    0.8    0.2    0.1
1      1.4    4.9    3      1.1    0.7    0.2
1      21.3   4.5    2.6    0.3    0.1    0.1
1      8.5    34.5   8.3    4.3    0.3    0.1
1      7.8    12.4   14     3.1    0.5    0
1      0.9    7.1    4.2    7.7    1.3    0.2
1      16.6   9.8    13.7   3.4    2.4    0.5
1      4.6    7.4    3.5    1.2    0.8    0.3
1      0.2    12.8   6.5    3.4    1      0.5
1      9.7    5.8    9.4    1.3    0.3    0.2
1      2.1    9.8    9.3    4.5    0.9    0.1
1      1.2    5.7    12.4   6.8    2.1    0.6
1      128    12.9   9.9    3.8    1.3    0.5
1      1      11.3   8.6    3.6    1.4    0.4
1      1.6    8.1    19.2   2.5    0.6    0.2
FLT06: Intl YFS     [rev: 01/09/03-JV] (Catch: Unknown) (Effort: Unknown)
1987   2006
1      1      0.5    0.75
0      1
1      11.68  1.44
1      5.56   1.3
1      3.97   0.6
1      3.42   0.7
1      4.36   0.6
1      4.04   1.8
1      3.7    0.8
1      8.69   0.8
1      6.87   1.7
1      4.07   0.7
1      2.23   0.8
1      5.3    0.8
1      3.81   0.8
1      5.14   0.48
1      3.74   0.83
1      0.67   0.92
1      4.86   0.2
1      4.83   0.78
1      2.19   0.17
1      7.62   0.3
```

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

FLT07: UK BEAM TRAWL FLEET >=10 METRES WHERE PLAICE CATCH IS >=20%

1991	2008								
1	1	0	1						
2	10								
9794	518.2	495.5	359.4	165.2	140	23.1	9.2	4.5	2.8
10270	524	396.5	246.9	136.8	97.2	77.7	25.7	5.1	4.2
8993	476.8	279.8	102.7	62.5	46.4	33.2	38.6	13.1	5.8
7398	238.6	325.6	135.1	51.2	28.4	23.1	12	24.3	4.7
6293	346	197.2	152.2	65.5	23.7	13.9	15.2	10.7	18.9
8124	785.2	182.5	48.4	54.8	28.5	7.2	8.8	7.1	7.2
9258	781.9	552	50.4	19	25	19.8	12.1	7	9.9
5954	342	254.8	90.6	12.1	5.7	12.9	4.5	3.9	0.9
5181	151.8	632.1	76.8	24.7	3.3	1.2	4	1.4	1.1
4640	258.7	158.9	280.7	47.6	15.4	3.8	1.6	3.5	1.4
5762	211.3	153.2	99	126	23.4	6.6	4	1.4	1.6
7634	430.3	276.2	61.7	30.5	52.6	7.9	5.2	1.1	0.7
6441	684.2	146.5	78.6	16	13	21.8	16.1	1	1.1
3726	206.2	310.8	33	13.1	5.6	4.6	9.3	4.1	1.2
2944	188.5	83	69.9	8.8	6.4	1.8	1.6	4	0.8
2789	198.5	129.6	41.4	29.3	4.2	3.6	2	1.2	2.5
2664	124.5	96.4	49.2	14.7	11.3	2.3	1.7	0.6	0.8
3492	283.4	70.3	23.9	13.8	3.6	4.6	0.3	0.4	0.3

FLT08: French YFS (NOT USED IN THE ASSESSMENT)

1987	2008		
1	1	0.5	0.75
0	1		
1	9.8	1.8	
1	2.5	1.7	
1	5.4	0.5	
1	2.3	0.9	
1	6.8	0.8	
1	5	2.4	
1	2	1	
1	5.5	1	
1	6.4	1	
1	6.4	0.6	
1	3.1	1.3	
1	5.4	1.2	
1	3	1.3	
1	9.1	0.3	
1	4.7	1.5	
1	0.9	0.4	
1	2.1	0.2	
1	1.1	0.2	
1	1.5	0.1	
1	11.7	0.3	
1	1.3	0.2	
1	5.4	0.3	

Table 6.3.5.1. Plaice in VIId. XSA diagnostics

FLR XSA Diagnostics 2009-05-07 17:42:20

CPUE data from My.Fleet

Catch data for 29 years. 1980 to 2008. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	UK B TRAWL	2	9	1991	2008	0	1
2	BE BEAM TRAWL	2	9	1981	2008	0	1
3	FR TRAWL-1	2	9	1989	1996	0	1
4	FR TRAWL-2	2	9	1997	2008	0	1
5	UK BTS	1	6	1988	2008	0.5	0.75
6	FR GFS	1	3	1988	2008	0.75	1
7	Intl YFS	1	1	1987	2006	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 1

Catchability independent of age for ages > 7

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

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.045	0.090	0.142	0.048	0.043	0.079	0.030	0.046	0.031	0.016
2	0.153	0.553	0.375	0.606	0.347	0.471	0.343	0.370	0.357	0.189
3	0.663	0.588	0.856	0.990	1.289	0.722	0.731	0.613	0.615	0.535
4	1.164	0.974	0.583	1.053	1.111	0.613	0.670	0.682	0.750	0.710
5	0.952	0.974	0.692	1.021	0.613	0.635	0.659	0.520	0.870	0.576
6	0.669	0.728	0.419	0.680	0.630	0.409	0.677	0.609	0.648	0.699
7	0.685	0.703	0.409	0.569	0.517	0.425	0.499	0.617	1.116	0.652
8	0.402	0.418	0.360	0.507	0.316	0.356	0.489	0.954	0.682	0.560
9	0.476	0.334	0.323	0.786	0.888	0.234	0.276	0.661	0.395	0.499
10	0.476	0.334	0.323	0.786	0.888	0.234	0.276	0.661	0.395	0.499

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8	9	10
1999	17779	13047	26239	9874	1786	368	182	257	105	307
2000	16894	15382	10133	12228	2790	624	171	83	156	362
2001	21234	13971	8007	5093	4177	953	273	76	50	296
2002	20269	16662	8685	3079	2572	1891	567	164	48	176
2003	16045	17482	8224	2921	972	839	867	291	89	110
2004	13355	13903	11182	2050	870	476	404	467	192	242
2005	11713	11164	7858	4914	1004	417	286	239	296	209
2006	11797	10290	7172	3424	2276	470	192	157	133	156
2007	26934	10190	6432	3514	1566	1224	231	94	55	212
2008	23513	23619	6452	3146	1503	594	579	69	43	80

Estimated population abundance at 1st Jan 2009

year \ age	1	2	3	4	5	6	7	8	9	10
2009	0	20936	17694	3420	1400	764	267	274	35	24

Fleet: UK B TRAWL

Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	0.036	-0.187	-0.432	-0.181	0.087	0.274	-0.182	-0.821	-0.545	0.119	-0.285	0.073	0.542	0.175	0.482	0.682	0.265	-0.103
3	0.293	0.195	-0.384	-0.231	0.132	-0.513	0.148	-0.646	0.155	-0.197	-0.099	0.184	-0.106	0.654	-0.075	0.465	0.325	-0.300
4	0.350	0.507	-0.128	-0.066	0.100	-0.658	-0.772	-0.088	-0.636	0.480	-0.070	-0.121	0.367	0.191	0.327	0.224	0.446	-0.453
5	0.034	0.271	-0.048	0.129	0.257	-0.270	-0.558	-0.317	-0.039	0.291	0.525	-0.552	-0.227	0.242	-0.054	0.323	0.205	-0.214
6	0.118	0.234	-0.094	-0.136	0.135	-0.187	-0.213	-0.155	-0.559	0.590	0.231	0.191	-0.246	-0.074	0.548	0.031	0.127	-0.542
7	-0.246	0.157	-0.057	-0.068	-0.090	-0.822	0.258	0.459	-0.802	0.534	0.271	-0.492	0.247	-0.041	-0.365	0.836	0.455	-0.234
8	-0.264	0.334	0.064	-0.378	0.196	-0.197	0.213	0.219	-0.068	0.262	1.019	0.304	0.944	0.486	-0.307	0.590	0.878	-0.871
9	-0.376	-0.242	0.324	0.259	0.182	-0.170	0.175	0.238	-0.194	0.379	0.386	0.096	-0.402	0.501	0.297	0.125	0.242	-0.139

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-12.3377	-12.0766	-12.2073	-12.3151	-12.3487	-12.4071	-12.4071	-12.4071
S.E_Logq	0.3868	0.3436	0.4083	0.3083	0.3112	0.4508	0.4941	0.2763

Fleet: BE BEAM TRAWL

Log catchability residuals.

age \ year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-0.022	-0.198	0.449	-1.279	0.454	0.533	0.364	0.105	-1.979	0.327	0.986	1.261	0.471	0.927	-1.672	-0.203	NA	-0.909	-1.514	-1.392
3	0.354	-0.312	-0.007	-0.004	-0.078	0.038	-0.435	-0.143	-0.359	0.462	0.790	0.529	-0.153	0.112	0.094	-0.095	-1.482	-0.281	-0.056	-0.949
4	0.380	0.031	0.329	-0.042	-0.019	-0.278	-0.378	-0.511	-0.145	0.022	0.114	-0.293	-0.479	0.612	0.098	0.178	0.499	0.263	0.380	-1.152
5	-0.566	0.015	-0.310	0.041	-1.263	-0.399	-0.523	-0.793	0.254	-0.212	0.509	-0.326	-0.242	0.093	0.238	0.356	1.185	0.414	0.794	-0.389
6	-0.704	-0.265	-0.238	0.210	0.319	-0.037	-1.100	-0.756	0.152	-0.179	0.535	0.217	-0.255	-0.066	-0.222	0.017	0.820	0.410	0.804	-0.432
7	-0.295	-0.456	-0.611	0.282	0.056	-0.132	0.270	-0.358	-0.049	-0.654	-0.171	-0.266	-0.431	-0.043	0.561	-0.390	0.742	0.171	0.536	-0.425
8	0.038	0.345	0.804	-0.278	0.577	-0.903	-0.372	-0.426	-0.261	-0.108	-0.150	0.008	-0.634	-0.070	0.230	0.106	-0.158	0.197	-0.567	-0.551
9	0.059	0.167	0.154	-0.287	-0.936	-0.411	0.274	-0.091	-0.189	-0.956	0.946	1.091	-1.073	0.037	-0.585	0.087	0.053	0.371	0.394	-0.650

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

age \ year	2001	2002	2003	2004	2005	2006	2007	2008
2	0.486	0.368	0.217	0.277	0.261	0.561	0.982	0.137
3	0.879	0.575	0.646	0.236	-0.115	-0.153	-0.145	0.052
4	0.192	0.346	0.352	-0.097	-0.251	-0.073	-0.249	0.173
5	0.102	0.504	-0.058	0.157	0.343	-0.184	0.320	-0.062
6	-0.063	-0.504	0.557	-0.241	0.305	-0.043	0.450	0.312
7	-0.324	-0.145	0.171	0.265	-0.015	0.039	1.036	0.636
8	-0.122	-0.808	-0.484	-0.195	0.040	0.567	0.186	0.020
9	0.094	-0.115	0.631	-0.715	-0.777	0.591	-0.661	-1.319

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-7.4502	-5.6483	-5.1096	-5.2047	-5.4594	-5.4575	-5.4575	-5.4575
S.E_Logq	0.8756	0.4927	0.3724	0.4984	0.4616	0.4262	0.4109	0.6104

Fleet: FR TRAWL-1

Log catchability residuals.

age \ year	1989	1990	1991	1992	1993	1994	1995	1996
2	-0.139	-0.300	0.509	0.266	0.176	0.167	0.016	-0.696
3	-0.136	0.071	0.221	0.355	-0.201	0.276	-0.372	-0.215
4	0.270	0.300	0.618	-0.137	-0.320	-0.191	-0.267	-0.274
5	0.795	0.428	0.068	0.163	-1.047	0.251	-0.805	0.147
6	0.379	0.614	0.103	0.546	-0.291	-0.130	-1.172	-0.049
7	0.264	0.508	-0.132	0.374	-0.175	-0.065	-0.802	0.028
8	0.661	0.662	-0.075	-0.255	-0.615	0.281	-0.260	0.183
9	1.199	1.503	0.137	0.225	-0.089	-0.199	-0.156	0.463

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-11.5790	-11.0019	-11.1823	-11.5535	-11.8206	-12.0344	-12.0344	-12.0344
S.E_Logq	0.3745	0.2671	0.3483	0.6182	0.5739	0.4076	0.4569	0.6396

Fleet: FR TRAWL-2

Log catchability residuals.

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	-0.627	-0.915	-0.108	0.537	0.478	0.629	0.072	0.894	-0.004	0.007	-0.350	-0.612
3	0.496	-0.034	0.284	-0.299	0.299	-0.317	0.794	0.180	0.009	-0.358	-0.520	-0.534
4	0.774	0.645	0.690	0.376	-0.269	-0.415	0.460	-0.209	-0.277	-0.550	-0.519	-0.706
5	0.111	0.683	0.419	0.845	0.318	-0.253	0.034	0.083	-0.659	-0.709	-0.370	-0.503
6	0.578	-0.141	0.150	0.677	-0.168	-0.079	-0.033	0.019	-0.077	-0.037	-0.964	0.076
7	0.853	-0.503	0.774	0.431	0.042	-0.259	0.075	-0.330	0.004	0.055	-0.213	-0.928
8	0.749	0.184	0.250	-0.222	-1.446	-0.397	-0.364	-0.418	-0.215	0.410	-0.173	0.015
9	0.439	-0.601	-0.501	-0.139	-1.182	-0.238	0.980	-1.003	-0.881	-0.623	-0.514	0.413

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-11.4778	-10.7322	-10.7865	-11.1588	-11.3841	-11.6729	-11.6729	-11.6729
S.E_Logq	0.5605	0.4215	0.5461	0.5105	0.4060	0.5099	0.5464	0.6473

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

Fleet: UK BTS

Log catchability residuals.

year

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.336	-1.470	-0.816	-0.190	-0.130	-0.950	-0.301	-0.350	-0.438	0.209	0.116	-0.056	0.166	0.262	0.389	-0.523	1.339	0.297	0.739	0.783	0.585
2	0.175	-0.623	-0.964	-0.270	-0.149	-0.368	-0.200	-1.076	-0.401	-0.612	-0.167	0.122	0.605	0.112	0.280	0.431	0.319	1.191	0.628	0.785	0.182
3	0.401	-0.032	-0.785	0.059	-0.284	-0.532	-0.073	-0.510	-1.670	-0.766	-0.754	-0.169	0.636	0.673	0.414	0.404	0.534	0.937	0.550	0.604	0.361
4	-0.202	0.293	-0.340	-0.090	0.204	-0.611	0.232	-0.322	-1.343	-1.351	-0.151	-0.712	0.516	0.485	0.572	0.473	0.678	0.947	0.178	0.361	0.184
5	0.492	-0.263	-0.117	0.047	0.530	-0.250	-0.019	-0.555	-0.753	-1.182	-1.039	-0.393	0.428	0.985	-0.127	0.475	0.025	1.066	0.052	0.218	0.379
6	-0.053	0.105	-0.032	-0.237	0.723	-0.160	-0.590	-0.605	-0.418	-1.190	-0.582	-0.559	0.455	0.586	0.675	-0.019	-0.977	1.114	0.546	0.530	0.688

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3	4	5	6
Mean_Logq	-6.7948	-6.7639	-6.635	-6.4401	-6.4806
S.E_Logq	0.5727	0.6533	0.616	0.5876	0.6257

Regression statistics

Ages with q dependent on year class strength

	slope	intercept
Age 1	0.9708769	7.285884

Fleet: FR GFS

Log catchability residuals.

year

age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	-1.480	-5.900	-5.234	-8.993	9.481	7.014	-3.282	-4.205	-5.844	8.381	3.500	-0.997	1.797	-0.548	2.995	-2.214	2.365	-1.577	4.509	1.203	-0.971
2	0.401	-0.321	-1.566	-0.859	-0.533	0.064	-0.572	-0.543	-1.099	-0.302	-0.047	-0.300	1.067	-0.356	0.288	0.382	0.709	1.104	0.984	0.842	0.658
3	0.054	-0.762	-0.399	-0.930	0.097	0.387	-1.361	-0.387	-2.026	0.432	-0.443	0.245	0.313	-0.259	0.818	0.171	0.612	1.385	0.793	0.849	0.411

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	2	3
Mean_Logq	-7.5202	-7.7126
S.E_Logq	0.7444	0.8059

Regression statistics

Ages with q dependent on year class strength

	slope	intercept
Age 1	2.709575	3.763583

Fleet: Intl YFS

Log catchability residuals.

year

age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.094	0.166	0.025	0.036	-0.211	0.392	0.429	0.205	0.469	-0.409	-0.504	0.313	0.165	-0.156	0.085	0.158	-0.796	0.411	-0.652	-0.22

Regression statistics

Ages with q dependent on year class strength

	slope	intercept
Age 1	0.8701796	10.09091

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

Terminal year survivor and F summaries:

Age 1 Year class = 2007

source

	survivors	N	scaledWts
UK BTS	38254	1	0.602
FR GFS	14628	1	0.085
fshk	7219	1	0.312

Age 2 Year class = 2006

source

	survivors	N	scaledWts
UK B TRAWL	15969	1	0.343
BE BEAM TRAWL	20288	1	0.068
FR TRAWL-2	9590	1	0.159
UK BTS	26961	2	0.256
FR GFS	33190	2	0.108
fshk	7995	1	0.066

Age 3 Year class = 2005

source

	survivors	N	scaledWts
UK B TRAWL	3097	2	0.329
BE BEAM TRAWL	4265	2	0.128
FR TRAWL-2	2112	2	0.192
UK BTS	6303	3	0.149
FR GFS	6703	3	0.075
Intl YFS	2656	1	0.081
fshk	1980	1	0.045

Age 4 Year class = 2004

source

	survivors	N	scaledWts
UK B TRAWL	1451	3	0.313
BE BEAM TRAWL	1579	3	0.242
FR TRAWL-2	833	3	0.177
UK BTS	2044	4	0.141
FR GFS	3157	3	0.039
Intl YFS	662	1	0.037
fshk	1250	1	0.051

Age 5 Year class = 2003

source

	survivors	N	scaledWts
UK B TRAWL	792	4	0.398
BE BEAM TRAWL	666	4	0.211
FR TRAWL-2	492	4	0.172
UK BTS	1302	5	0.135
FR GFS	1937	3	0.018
Intl YFS	1226	1	0.021
fshk	634	1	0.045

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

Age 6 Year class = 2002

source	survivors	N	scaledWts
UK B TRAWL	207	5	0.408
BE BEAM TRAWL	333	5	0.202
FR TRAWL-2	257	5	0.211
UK BTS	431	6	0.116
FR GFS	714	3	0.007
Intl YFS	107	1	0.006
fshk	331	1	0.050

Age 7 Year class = 2001

source	survivors	N	scaledWts
UK B TRAWL	301	6	0.377
BE BEAM TRAWL	403	6	0.265
FR TRAWL-2	122	6	0.221
UK BTS	423	6	0.076
FR GFS	472	3	0.006
Intl YFS	328	1	0.007
fshk	282	1	0.049

Age 8 Year class = 2000

source	survivors	N	scaledWts
UK B TRAWL	27	7	0.320
BE BEAM TRAWL	45	7	0.347
FR TRAWL-2	33	7	0.225
UK BTS	71	6	0.035
FR GFS	43	3	0.001
Intl YFS	39	1	0.001
fshk	35	1	0.070

Age 9 Year class = 1999

source	survivors	N	scaledWts
UK B TRAWL	27	8	0.515
BE BEAM TRAWL	17	8	0.243
FR TRAWL-2	26	8	0.168
UK BTS	45	6	0.020
FR GFS	32	3	0.001
Intl YFS	20	1	0.001
fshk	17	1	0.052

Table 6.3.5.2. Plaice in VIId. Fishing mortality (F) at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.002	0.001	0.011	0.005	0.015	0.005	0.012	0.001	0.001	0.055
2	0.169	0.119	0.134	0.153	0.117	0.315	0.213	0.181	0.205	0.174
3	0.278	0.743	0.501	0.453	0.581	0.603	0.699	0.517	0.662	0.451
4	0.387	0.878	0.898	0.953	0.816	0.873	0.778	0.802	0.671	0.738
5	0.631	0.329	0.680	0.603	0.818	0.229	0.616	0.591	0.576	0.858
6	0.409	0.379	0.365	0.385	0.742	0.610	0.489	0.325	0.483	0.603
7	0.378	0.478	0.368	0.245	0.780	0.469	0.487	0.793	0.568	0.455
8	0.235	0.643	1.736	0.980	0.411	0.793	0.326	0.546	0.485	0.423
9	0.342	0.467	0.690	0.406	0.718	1.483	0.296	1.046	0.792	0.580
10	0.342	0.467	0.690	0.406	0.718	1.483	0.296	1.046	0.792	0.580

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.095	0.078	0.064	0.061	0.078	0.115	0.039	0.015	0.033	0.045
2	0.220	0.505	0.443	0.410	0.414	0.379	0.290	0.184	0.148	0.153
3	0.705	0.827	0.803	0.478	0.720	0.611	0.549	0.801	0.605	0.663
4	0.737	0.880	0.598	0.486	0.802	0.672	0.676	1.473	1.037	1.164
5	0.615	0.674	0.526	0.334	0.630	0.516	0.733	1.366	0.870	0.952
6	0.597	0.577	0.608	0.359	0.415	0.301	0.503	0.984	0.558	0.669
7	0.475	0.389	0.443	0.350	0.383	0.471	0.364	1.159	0.408	0.685
8	0.596	0.403	0.458	0.292	0.463	0.466	0.548	0.776	0.548	0.402
9	0.864	0.695	0.755	0.397	0.445	0.353	0.655	0.739	0.414	0.476
10	0.864	0.695	0.755	0.397	0.445	0.353	0.655	0.739	0.414	0.476

age	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.090	0.142	0.048	0.043	0.079	0.030	0.046	0.031	0.016
2	0.553	0.375	0.606	0.347	0.471	0.343	0.370	0.357	0.189
3	0.588	0.856	0.990	1.289	0.722	0.731	0.613	0.615	0.535
4	0.974	0.583	1.053	1.111	0.613	0.670	0.682	0.750	0.710
5	0.974	0.692	1.021	0.613	0.635	0.659	0.520	0.870	0.576
6	0.728	0.419	0.680	0.630	0.409	0.677	0.609	0.648	0.699
7	0.703	0.409	0.569	0.517	0.425	0.499	0.617	1.116	0.652
8	0.418	0.360	0.507	0.316	0.356	0.489	0.954	0.682	0.560
9	0.334	0.323	0.786	0.888	0.234	0.276	0.661	0.395	0.499
10	0.334	0.323	0.786	0.888	0.234	0.276	0.661	0.395	0.499

Table 6.3.5.3. Plaice in VIId. Stock number at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	25414	12904	25086	19841	24970	29696	60458	31414	26443	16350
2	17830	22945	11661	22447	17866	22261	26735	54058	28401	23912
3	6294	13618	18435	9226	17428	14386	14707	19545	40830	20931
4	1770	4315	5859	10109	5305	8816	7124	6616	10543	19049
5	1100	1088	1623	2160	3527	2124	3333	2962	2684	4879
6	235	530	708	744	1069	1409	1529	1628	1484	1365
7	150	141	328	445	458	460	692	849	1064	828
8	221	93	79	205	315	190	261	385	347	546
9	15	158	44	13	70	189	78	170	202	193
10	373	561	185	317	204	67	139	124	332	468

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	18876	21719	28023	13234	17301	25104	30518	37739	14906	17779
2	14008	15527	18185	23773	11271	14473	20249	26550	33624	13047
3	18176	10176	8476	10564	14275	6742	8967	13711	19984	26239
4	12065	8127	4028	3436	5928	6289	3311	4684	5568	9874
5	8244	5226	3050	2004	1911	2404	2905	1524	972	1786
6	1873	4032	2410	1631	1298	921	1299	1263	352	368
7	676	933	2049	1188	1030	776	617	711	427	182
8	476	380	572	1190	757	635	439	388	202	257
9	323	237	230	327	804	431	361	229	161	105
10	417	261	233	486	909	908	755	612	581	307

age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	16894	21234	20269	16045	13355	11713	11797	26934	23513	15503**
2	15382	13971	16662	17482	13903	11164	10290	10190	23619	20935
3	10133	8007	8685	8224	11182	7858	7172	6432	6452	17693
4	12228	5093	3079	2921	2050	4914	3424	3514	3146	3420
5	2790	4177	2572	972	870	1004	2276	1566	1503	1400
6	624	953	1891	839	476	417	470	1224	594	764
7	171	273	567	867	404	286	192	231	579	267
8	83	76	164	291	467	239	157	94	69	273
9	156	50	48	89	192	296	133	55	43	35
10	362	296	176	110	242	209	156	212	80	67

** GM: 2000-2006

Table 6.3.5.4. Plaice in VIId. Summary table

	recruitment	ssb	catch	landings	fbar3-6	Y/ssb
1980	25414	5483	2650	2650	0.43	0.48
1981	12904	6493	4769	4769	0.58	0.73
1982	25086	7425	4865	4865	0.61	0.66
1983	19841	7975	5043	5043	0.6	0.63
1984	24970	7214	5161	5161	0.74	0.72
1985	29696	7840	6022	6022	0.58	0.77
1986	60458	9898	6834	6834	0.65	0.69
1987	31414	13072	8366	8366	0.56	0.64
1988	26443	12919	10420	10420	0.6	0.81
1989	16350	14176	8758	8758	0.66	0.62
1990	18876	14439	9047	9047	0.66	0.63
1991	21719	10096	7813	7813	0.74	0.77
1992	28023	8669	6337	6337	0.63	0.73
1993	13234	7977	5331	5331	0.41	0.67
1994	17301	8656	6121	6121	0.64	0.71
1995	25104	7845	5130	5130	0.53	0.65
1996	30518	6616	5393	5393	0.62	0.82
1997	37739	6961	6307	6307	1.16	0.91
1998	14906	7788	5762	5762	0.77	0.74
1999	17779	8389	6326	6326	0.86	0.75
2000	16894	6478	6015	6015	0.82	0.93
2001	21234	6308	5266	5266	0.64	0.83
2002	20269	5927	5777	5777	0.94	0.97
2003	16045	4253	4536	4536	0.91	1.07
2004	13355	4618	4007	4007	0.59	0.87
2005	11713	4367	3446	3446	0.68	0.79
2006	11797	4136	3305	3305	0.61	0.8
2007	26934	4114	3674	3674	0.72	0.89
2008	23513	4336	3491	3491	0.63	0.81

Table 6.5.1. Plaice in VIId. RCT3 input

7D PLAICE (1 YEAR OLD)						
5	23	2				
1986	31414	-11	144	-11	-11	-11
1987	26443	1168	132	2647	-11	80
1988	16350	556	58	231	19	35
1989	18876	397	71	516	16	39
1990	21719	342	62	1175	1	25
1991	28023	436	178	1653	1	344
1992	13234	404	84	322	9	187
1993	17301	370	79	833	44	50
1994	25104	869	168	1132	38	49
1995	30518	687	66	1320	14	45
1996	37739	407	82	3310	213	345
1997	14906	223	80	1140	85	124
1998	17779	530	76	1130	78	71
1999	16894	381	48	1319	9	98
2000	21234	514	83	1791	166	74
2001	20269	374	92	2066	46	128
2002	16045	67	20	618	2	58
2003	13355	486	78	3618	97	98
2004	11713	483	17	1084	21	57
2005	11797	219	30	1721	12	129
2006	-11	762	-11	4261	1280	113
2007	-11	-11	-11	3028	10	81
2008	-11	-11	-11	-11	16	-11
yfs0						
yfs1						
bts1						
gfs0						
gfs1						

7D PLAICE (2 YEARS OLD)						
5	23	2				
1986	28401	-11	144	-11	-11	-11
1987	23912	1168	132	2647	-11	80
1988	14008	556	58	231	19	35
1989	15527	397	71	516	16	39
1990	18185	342	62	1175	1	25
1991	23773	436	178	1653	1	344
1992	11271	404	84	322	9	187
1993	14473	370	79	833	44	50
1994	20249	869	168	1132	38	49
1995	26550	687	66	1320	14	45
1996	33624	407	82	3310	213	345
1997	13047	223	80	1140	85	124
1998	15382	530	76	1130	78	71
1999	13971	381	48	1319	9	98
2000	16662	514	83	1791	166	74
2001	17482	374	92	2066	46	128
2002	13903	67	20	618	2	58
2003	11164	486	78	3618	97	98
2004	10290	483	17	1084	21	57
2005	-11	219	30	1721	12	129
2006	-11	762	-11	4261	1280	113
2007	-11	-11	-11	3028	10	81
2008	-11	-11	-11	-11	16	-11
yfs0						
yfs1						
bts1						
gfs0						
gfs1						

Table 6.5.2. Plaice in VIId. RCT3 results (Age 1)

Analysis by RCT3 ver3.1 of data from file :

pl7drec1.txt
7D Plaice (1 year old)
Data for 5 surveys over 23 years : 1986 - 2008
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 = 2006

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0	1.39	1.50	.77	.160	19	6.64	10.71	.861	.119
yfs1									
bts1	1.24	1.11	.85	.135	19	8.36	11.44	.997	.088
gfs0	3.27	-.44	4.73	.005	18	7.16	22.97	6.216	.002
gfs1	2.78	-2.44	2.00	.027	19	4.74	10.73	2.181	.018
					VPA Mean =		9.87	.337	.772

Yearclass = 2007

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
yfs0									
yfs1									
bts1	1.24	1.11	.85	.135	19	8.02	11.02	.964	.107
gfs0	3.27	-.44	4.73	.005	18	2.40	7.41	5.193	.004
gfs1	2.78	-2.44	2.00	.027	19	4.41	9.81	2.170	.021
					VPA Mean =		9.87	.337	.869

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**
yfs0									
yfs1									
bts1									
gfs0	**3.27**	**-.44**	**4.73**	**.005**	**18**	**2.83**	**8.83**	**5.160**	**.004**
gfs1									
					VPA Mean =		**9.87**	**.337**	**.996**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	25797	10.16	.30	.39	1.77		
2007	21725	9.99	.31	.22	.50		
2008	**19346**	**9.87**	**.34**	**.07**	**.04**		

Table 6.5.3. Plaice in VIId. RCT3 results (Age 2)

Analysis by RCT3 ver3.1 of data from file :
pl7drec2.txt
7D Plaice (2 years old)
Data for 5 surveys over 23 years : 1986 - 2008
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 = 2006

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0	1.66	-.30	.94	.109	18	6.64	10.68	1.056	.074
yfs1									
bts1	.97	2.89	.65	.203	18	8.36	10.98	.773	.139
gfs0	6.34	-10.43	9.44	.001	17	7.16	34.96	12.452	.001
gfs1	1.69	2.29	1.21	.069	18	4.74	10.29	1.329	.047
					VPA Mean =		9.74	.335	.739

Yearclass = 2007

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression----------I					**I-----------Prediction---------I**			
yfs0									
yfs1									
bts1	**.97**	**2.89**	**.65**	**.203**	**18**	**8.02**	**10.65**	**.746**	**.159**
gfs0	**6.34**	**-10.43**	**9.44**	**.001**	**17**	**2.40**	**4.78**	**10.426**	**.001**
gfs1	**1.69**	**2.29**	**1.21**	**.069**	**18**	**4.41**	**9.73**	**1.321**	**.051**
					VPA Mean =		**9.74**	**.335**	**.789**

Yearclass = 2008

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
yfs0									
yfs1									
bts1									
gfs0	6.34	-10.43	9.44	.001	17	2.83	7.54	10.355	.001
gfs1									
					VPA Mean =		9.74	.335	.999

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	22556	10.02	.29	.37	1.67		
2007	**19584**	**9.88**	**.30**	**.21**	**.50**		
2008	**16986**	**9.74**	**.33**	**.07**	**.05**		

Table 6.6.1. Plaice in VIId. Input to catch forecast

Age	Stock	Mat	M	F
1	15503	0	0.1	0.03
2	20935	0.15	0.1	0.29
3	17693	0.53	0.1	0.57
4	3420	0.96	0.1	0.69
5	1400	1	0.1	0.63
6	764	1	0.1	0.63
7	267	1	0.1	0.77
8	273	1	0.1	0.71
9	35	1	0.1	0.5
10	67	1	0.1	0.5

Table 6.6.2. Plaice in VIId. Management option table

2009

fmult	f3-6	landings	catch	ssb
1	0.630	5309	5309	5825

2010

fmult	f3-6	landings	catch	ssb 2010	ssb 2011
0	0.000	0	0	6891	11350
0.1	0.063	679	679	6891	10746
0.2	0.126	1322	1322	6891	10177
0.3	0.189	1929	1929	6891	9641
0.4	0.252	2504	2504	6891	9136
0.5	0.315	3048	3048	6891	8661
0.6	0.378	3563	3563	6891	8213
0.7	0.441	4051	4051	6891	7791
0.8	0.504	4513	4513	6891	7393
0.9	0.567	4951	4951	6891	7018
1	0.630	5366	5366	6891	6664
1.1	0.693	5759	5759	6891	6331
1.2	0.756	6132	6132	6891	6016
1.3	0.819	6486	6486	6891	5720
1.4	0.882	6821	6821	6891	5440
1.5	0.945	7140	7140	6891	5176
1.6	1.008	7443	7443	6891	4927
1.7	1.071	7730	7730	6891	4692
1.8	1.134	8003	8003	6891	4470
1.9	1.197	8263	8263	6891	4260
2	1.260	8509	8509	6891	4062

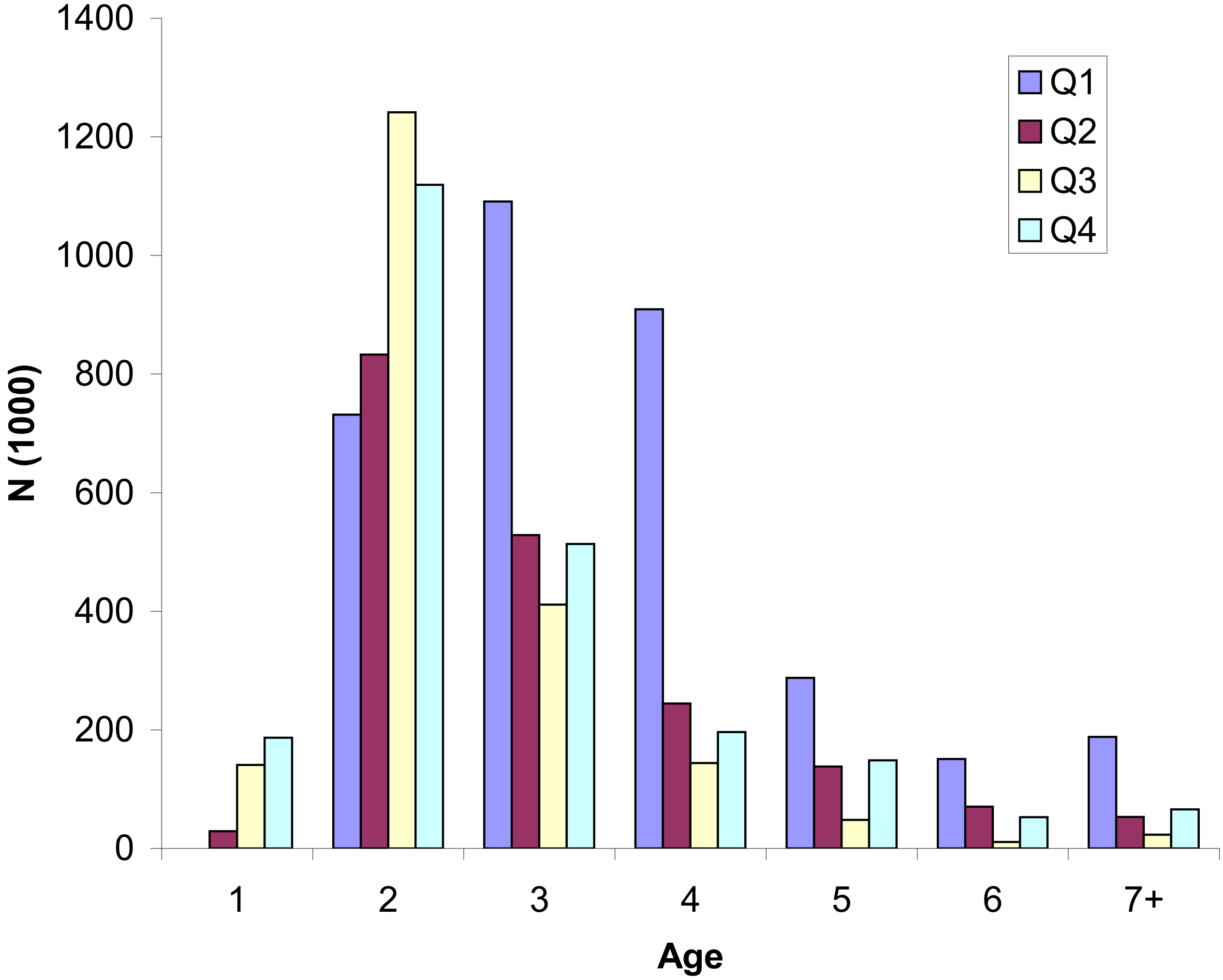


Figure 6.1.2.1. Plaice in VIId. Age distribution in the landings per quarter.

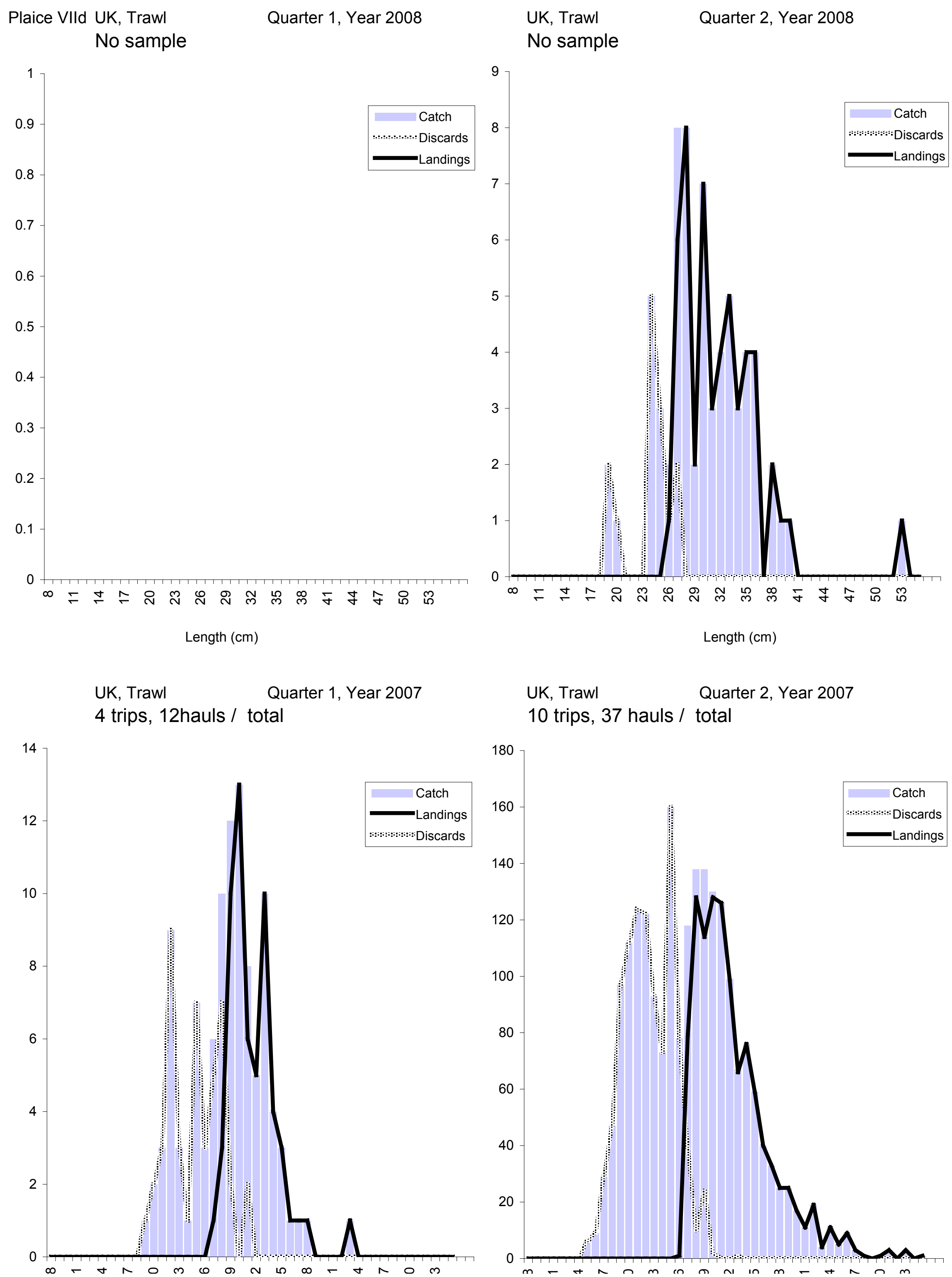


Figure 6.2.1.1a - Plaice VIId - Length structure of discards and landings collected by observations on board

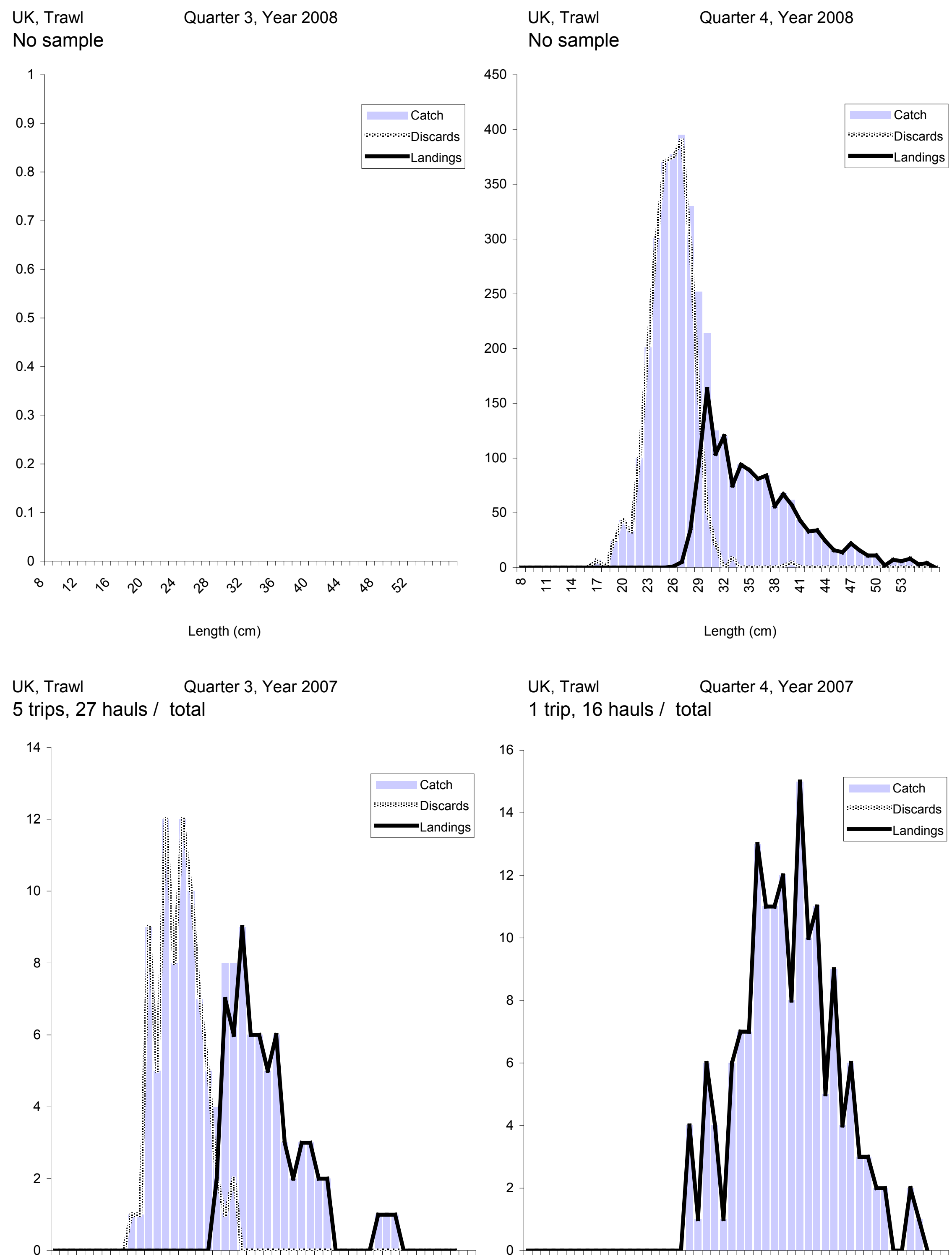


Figure 6.2.1.1a (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

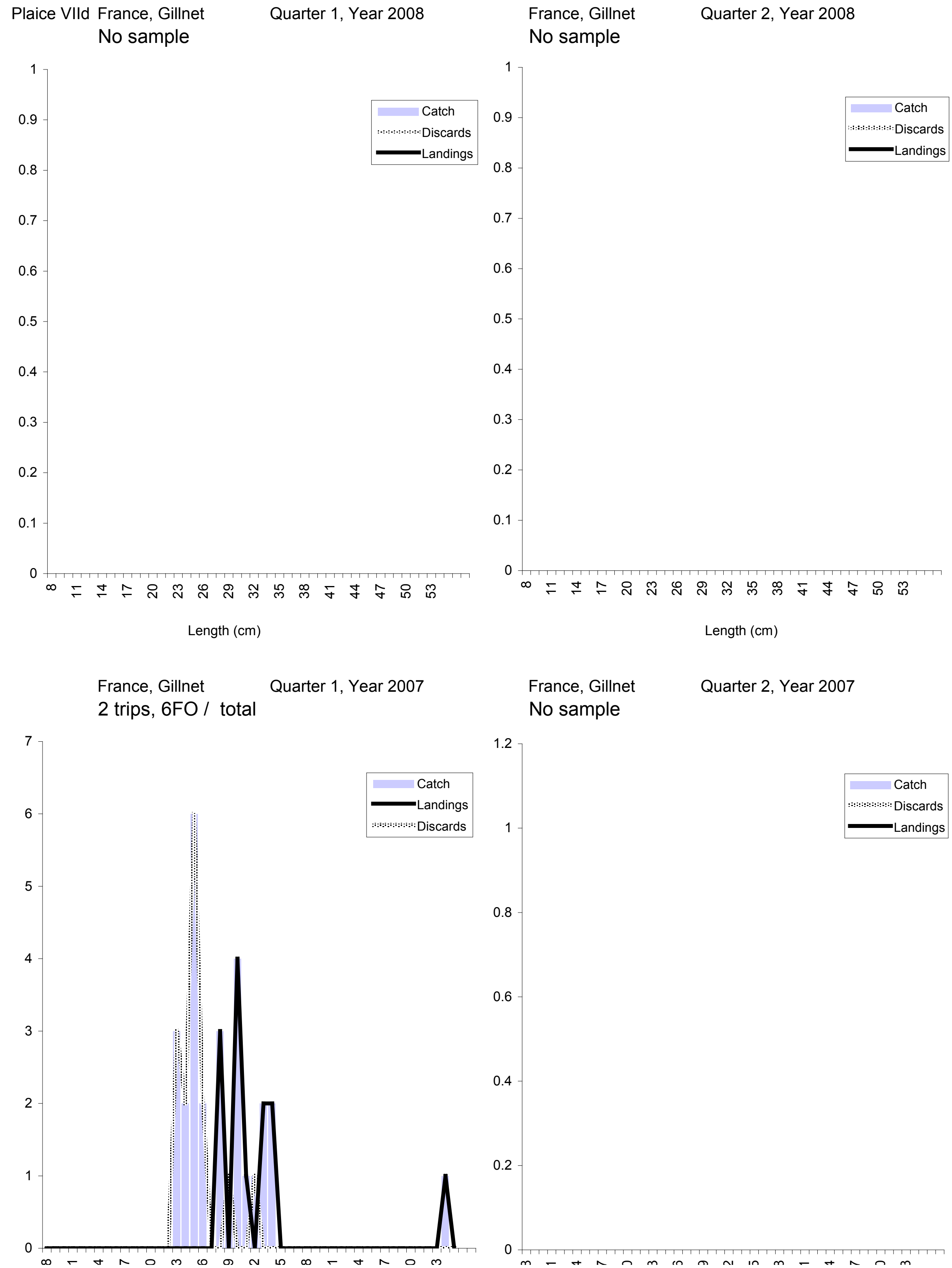


Figure 6.2.1.1b - Plaice VIId - Length structure of discards and landings collected by observations on board

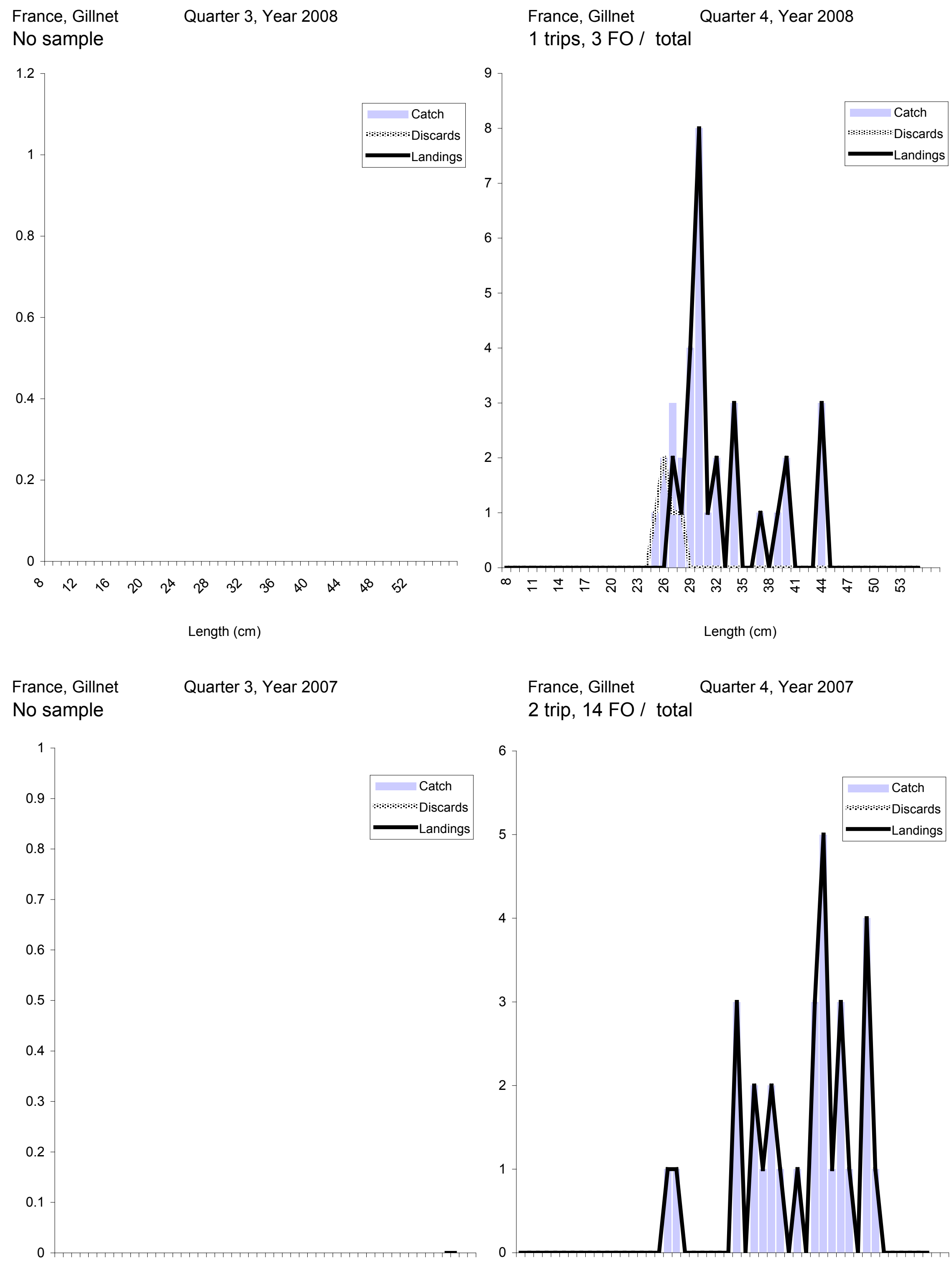


Figure 6.2.1.1b (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

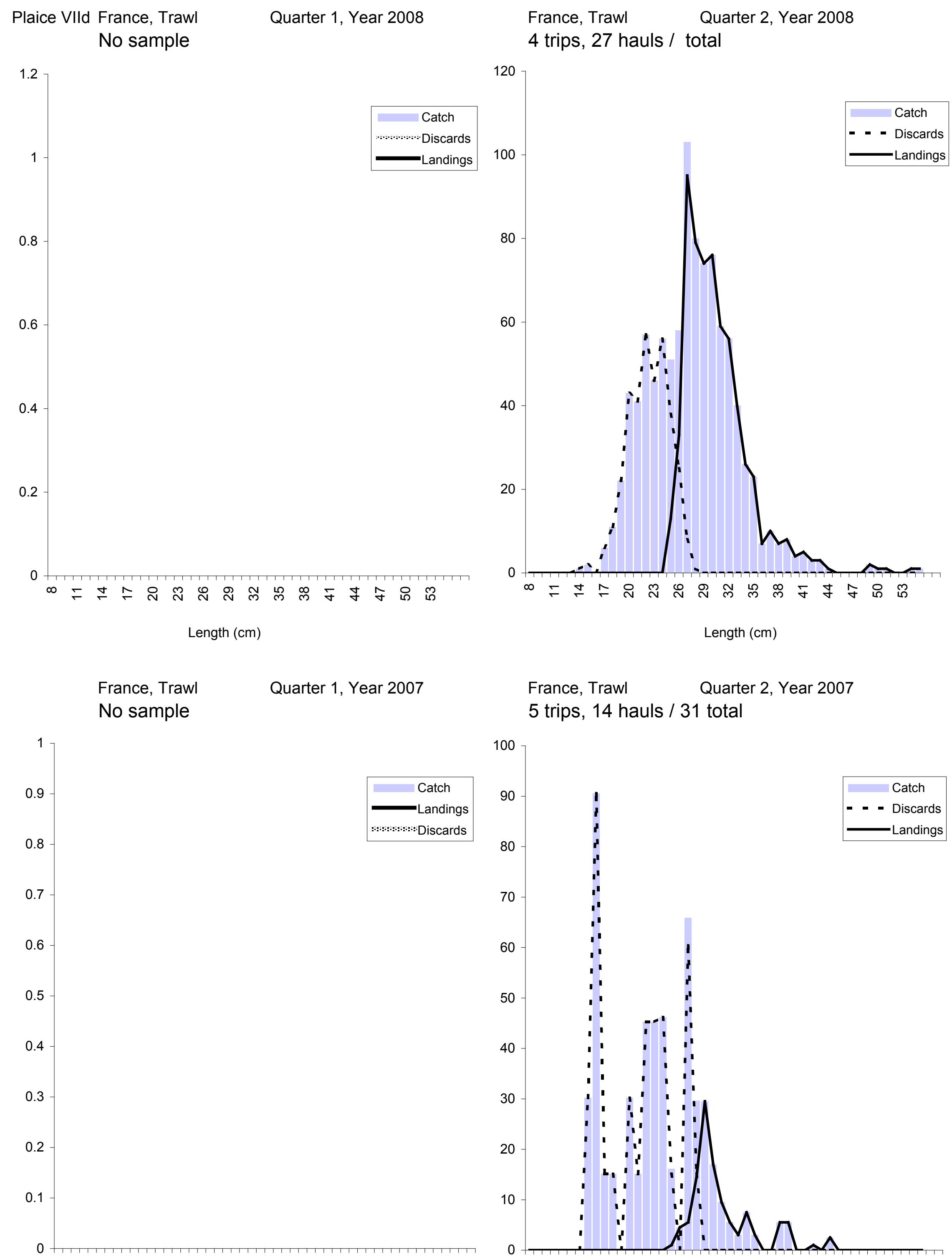


Figure 6.2.1.1c - Plaice VIId - Length structure of discards and landings collected by observations on board

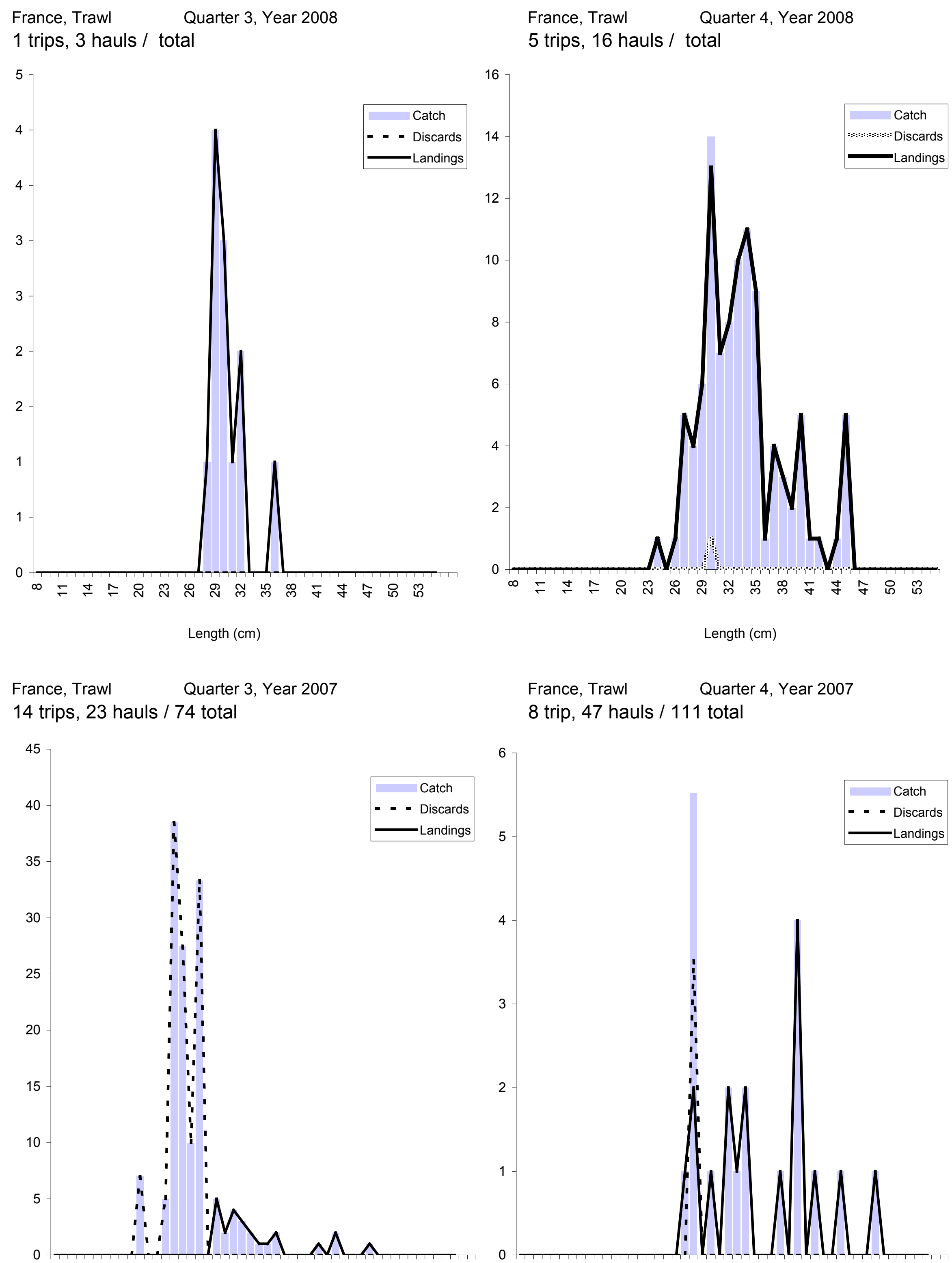


Figure 6.2.1.1c (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

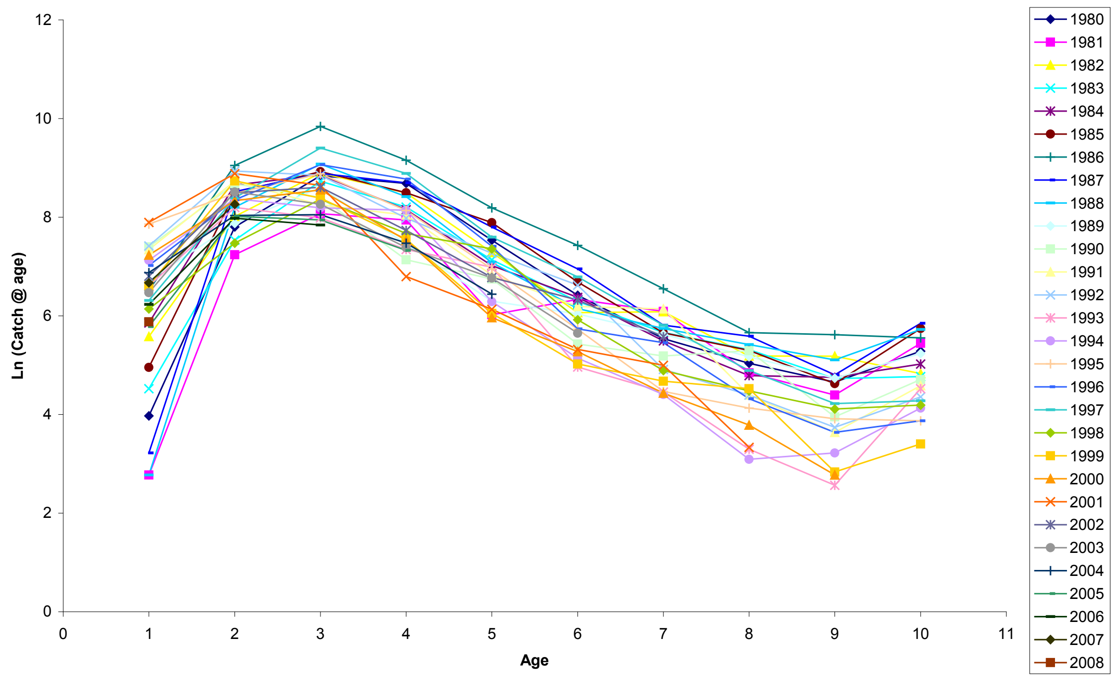


Figure 6.2.1.2a. Plaice in VIId. Catch curves by year class.

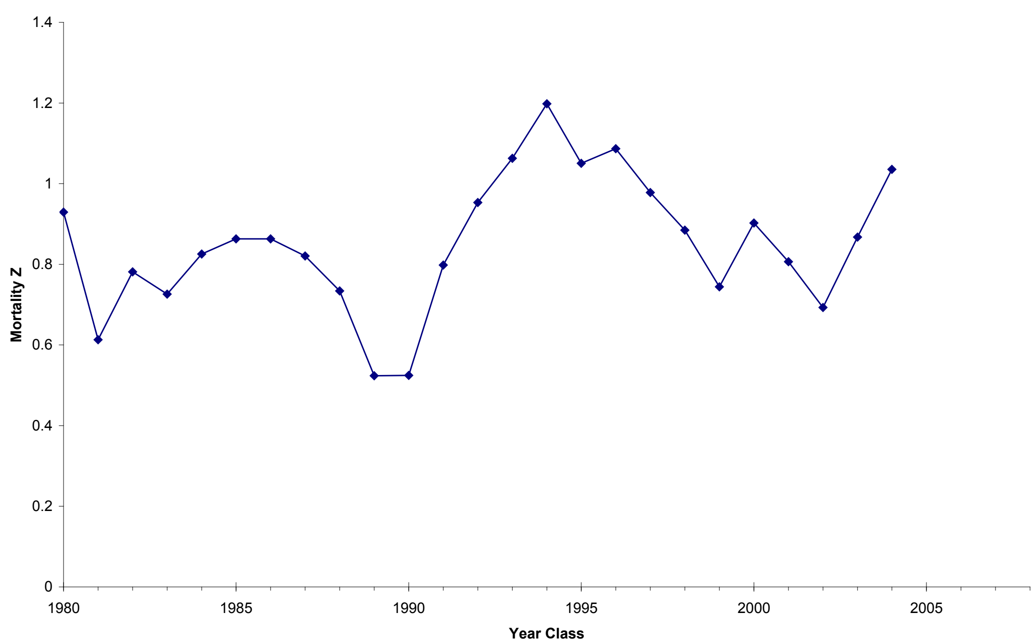


Figure 6.2.1.2b. Plaice in VIId. Evolution of fish mortality.

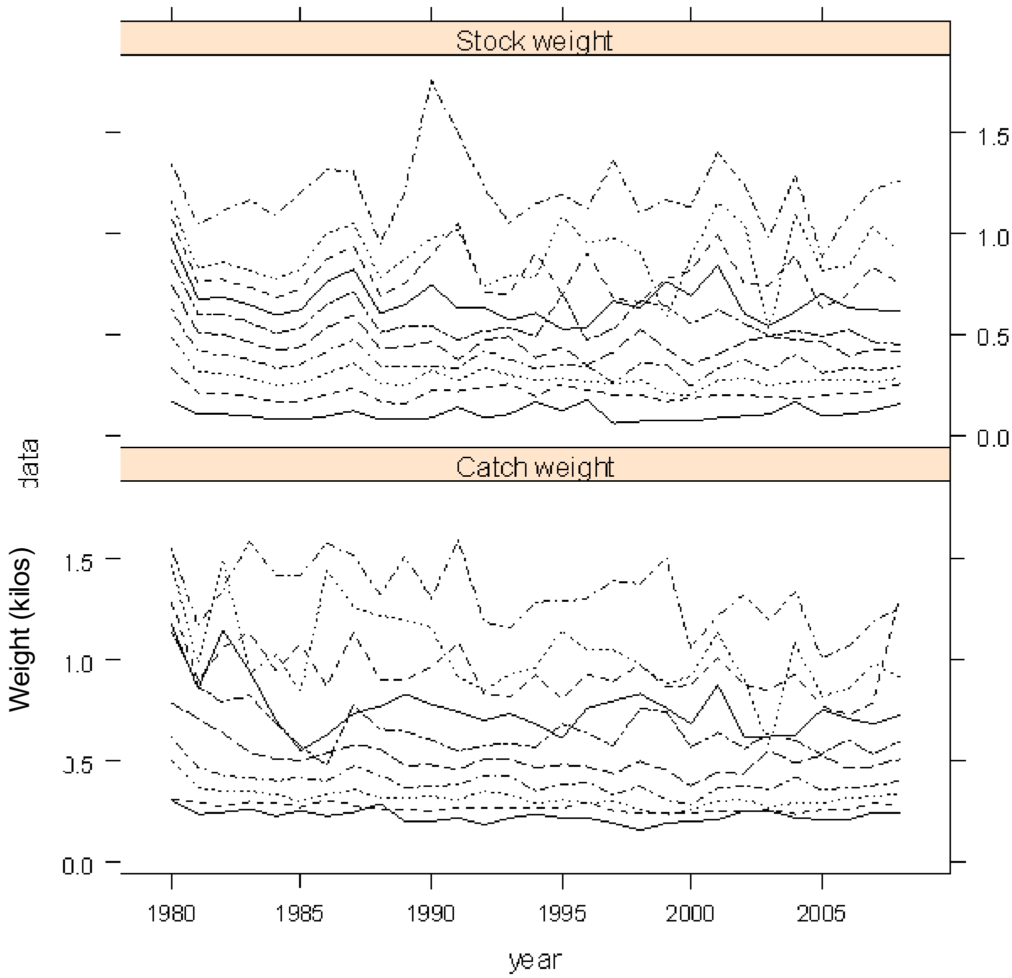


Figure 6.2.3.1. Plaice in VIId. Stock and Catch weight

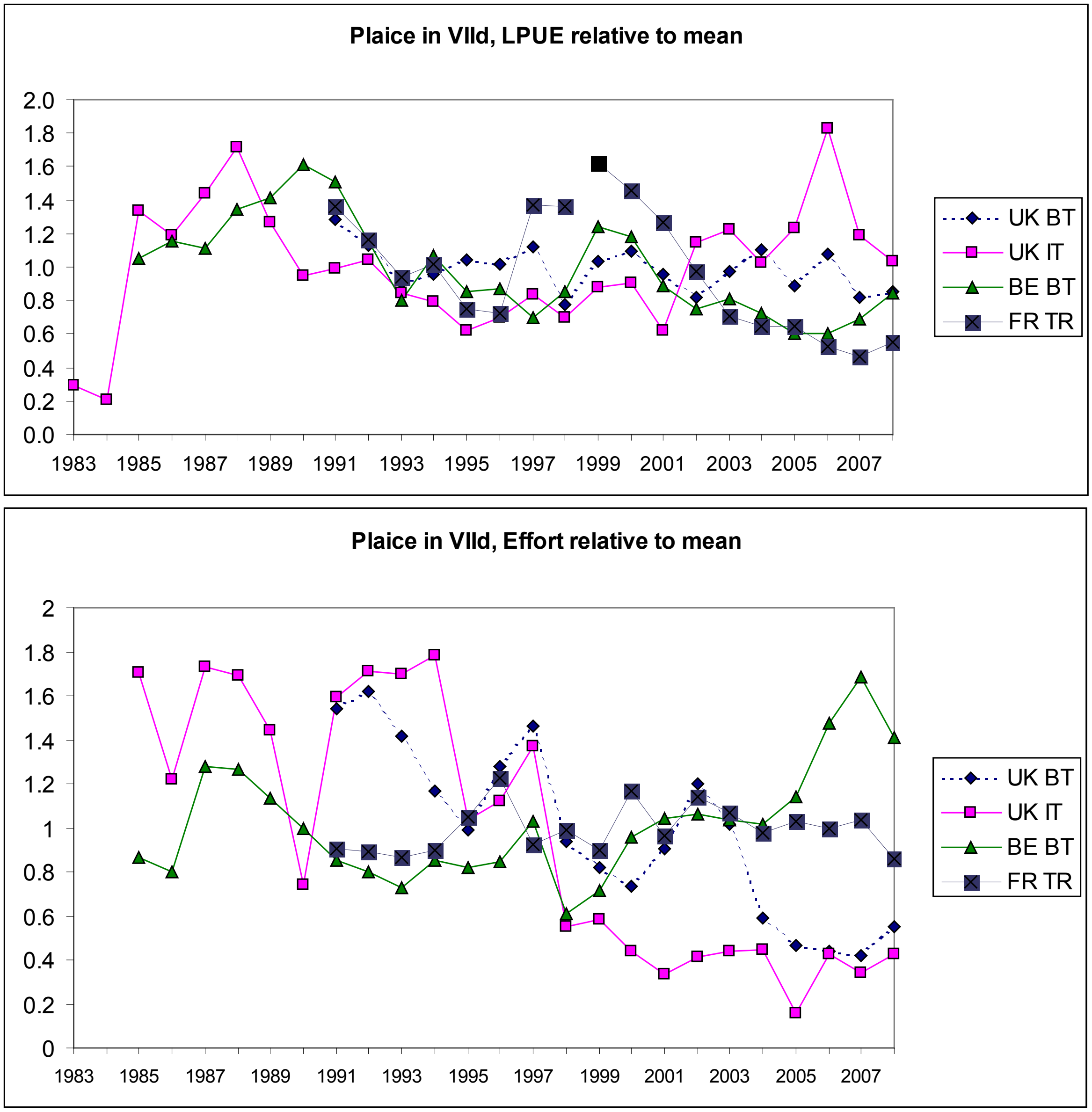
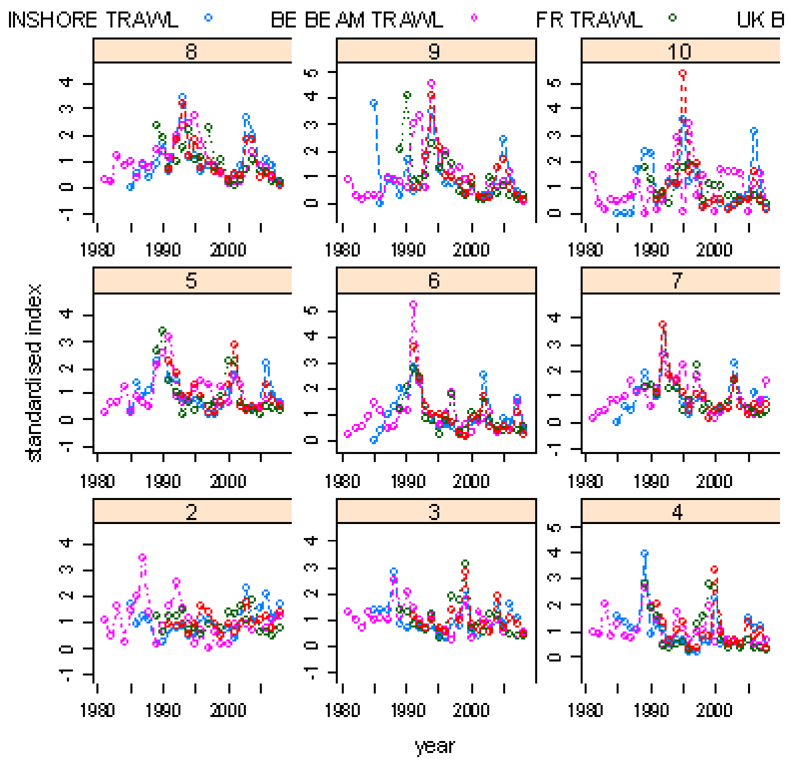
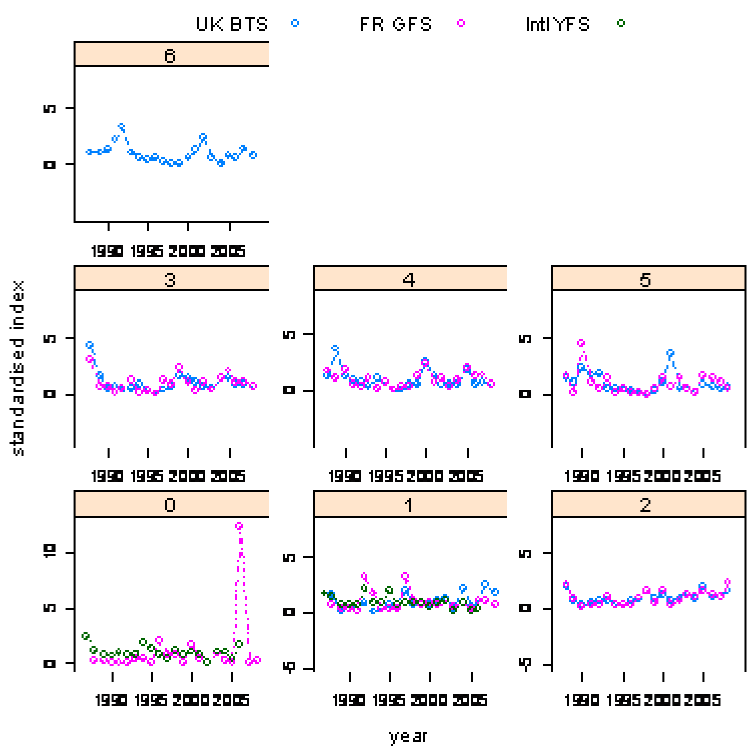


Figure 6.2.5.1 - Plaice in VIId. LPUE and effort





1)

Figure 6.2.5.2. Plaice in VIId. Between survey consistency. Mean standardised indices by surveys for each age

2)

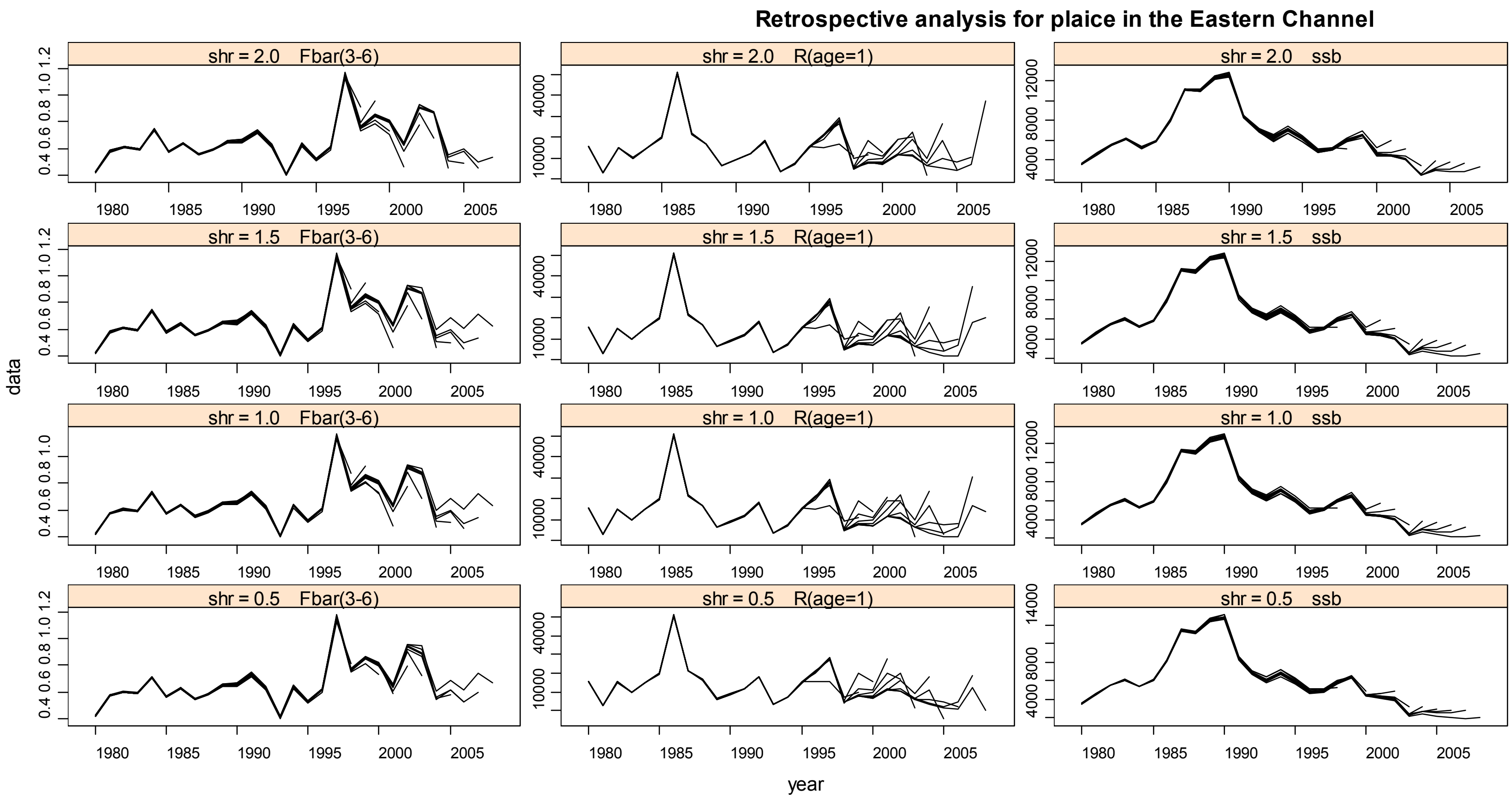
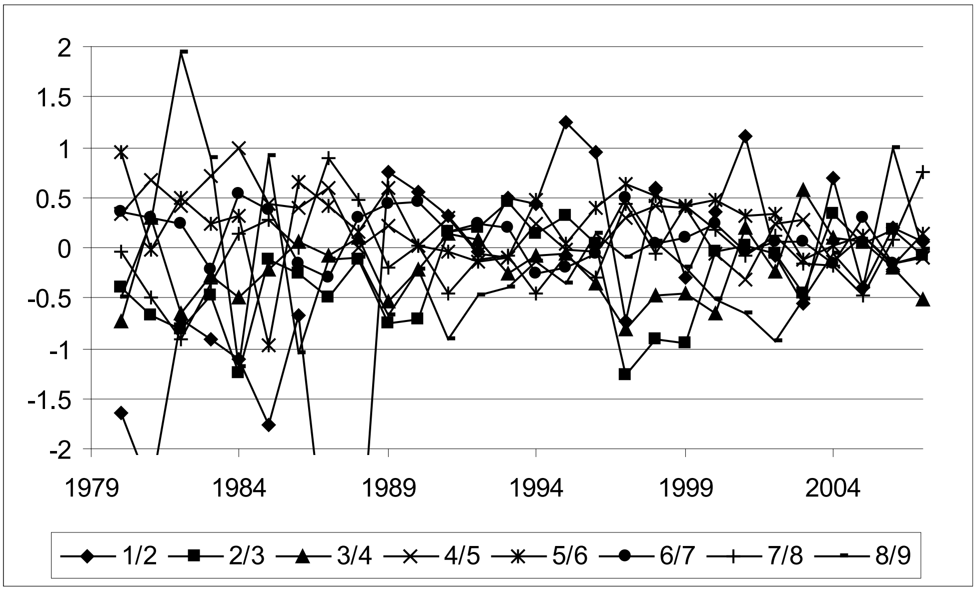


Figure 6.3.2.1. Plaice in VIId. Retrospective analysis for different values of F shrinkage



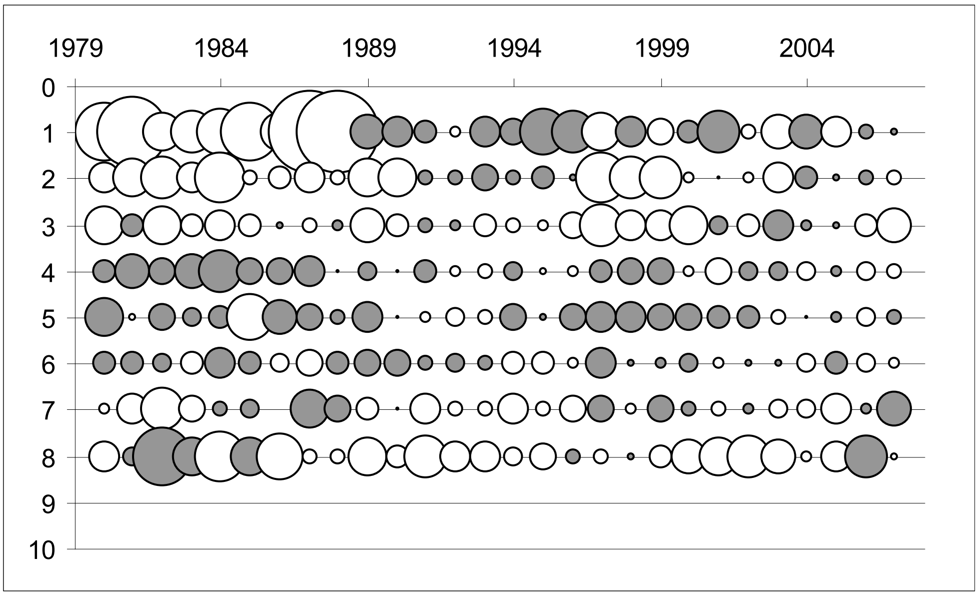


Figure 6.3.2.2 - Plaice in VIId. Separable VPA

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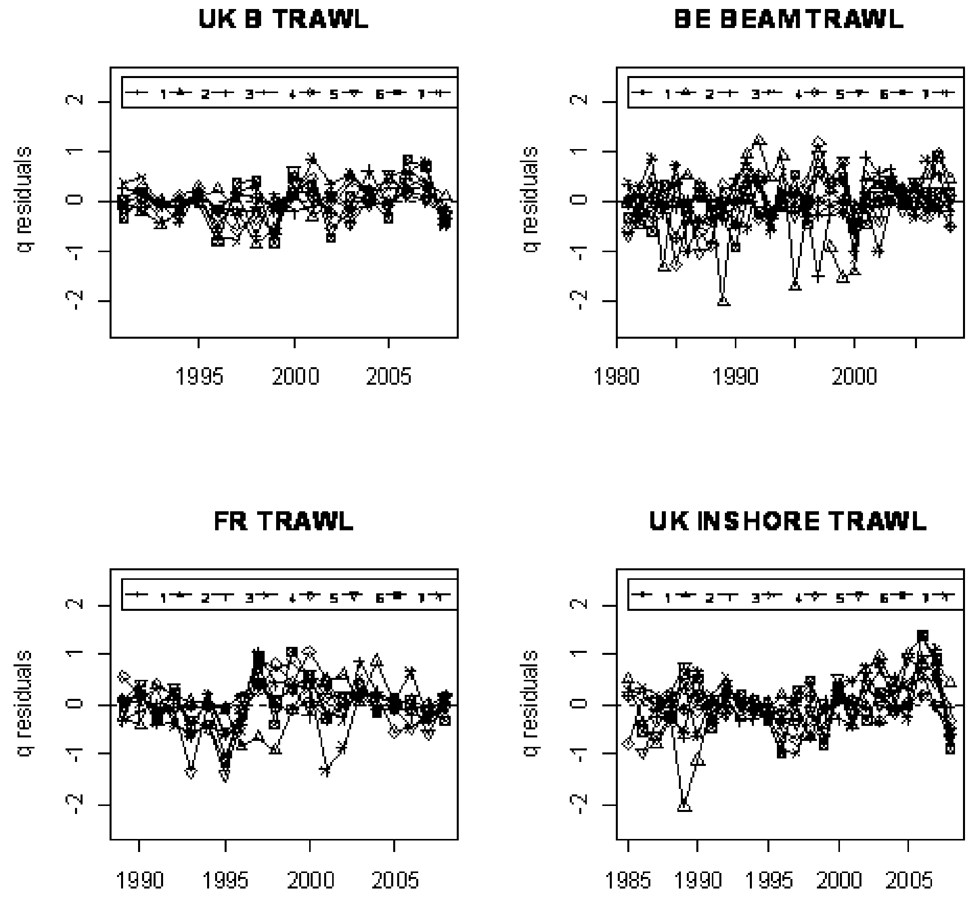

Figure 6.3.2.3. Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

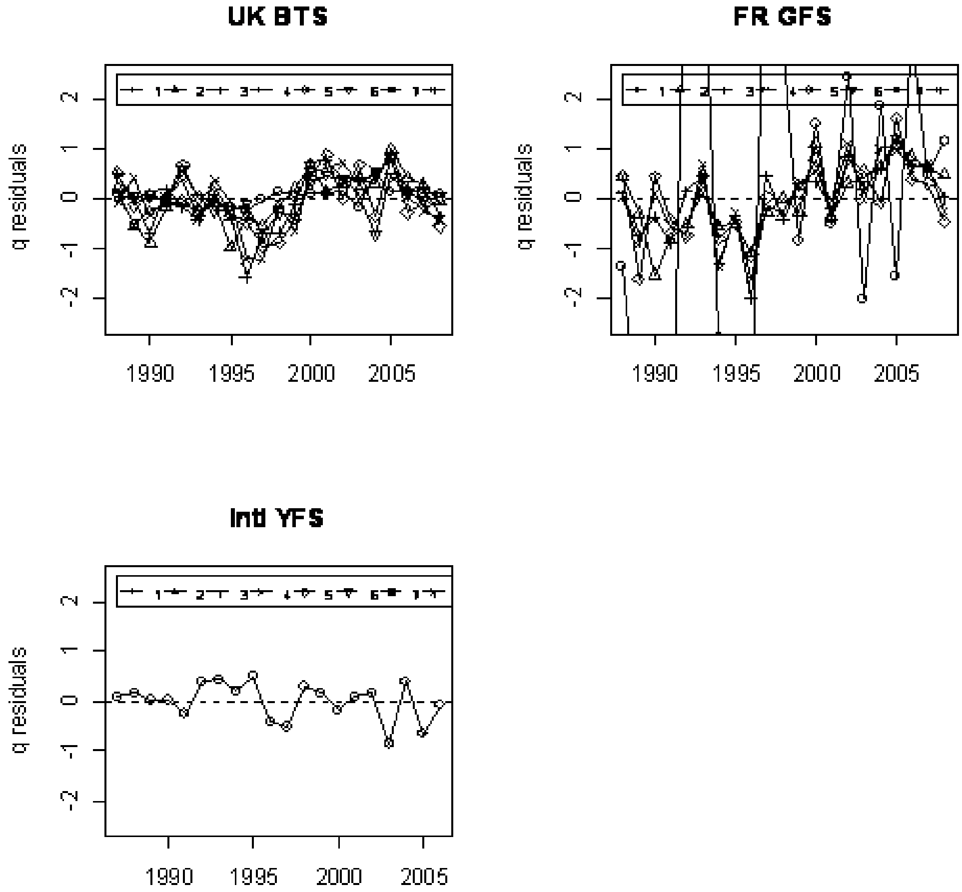

Figure 6.3.2.3 (cont.). Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

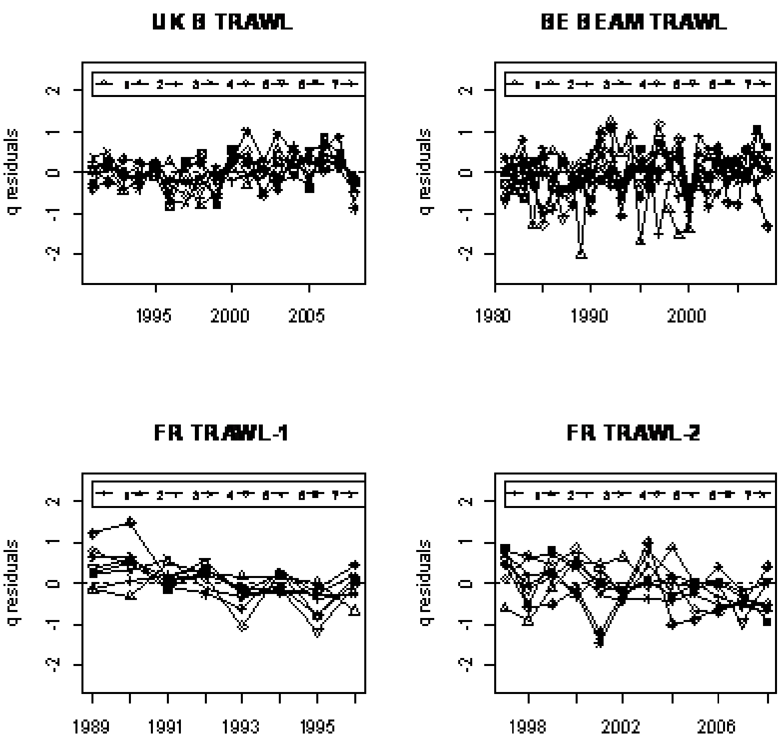

Figure 6.3.2.4. Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5.

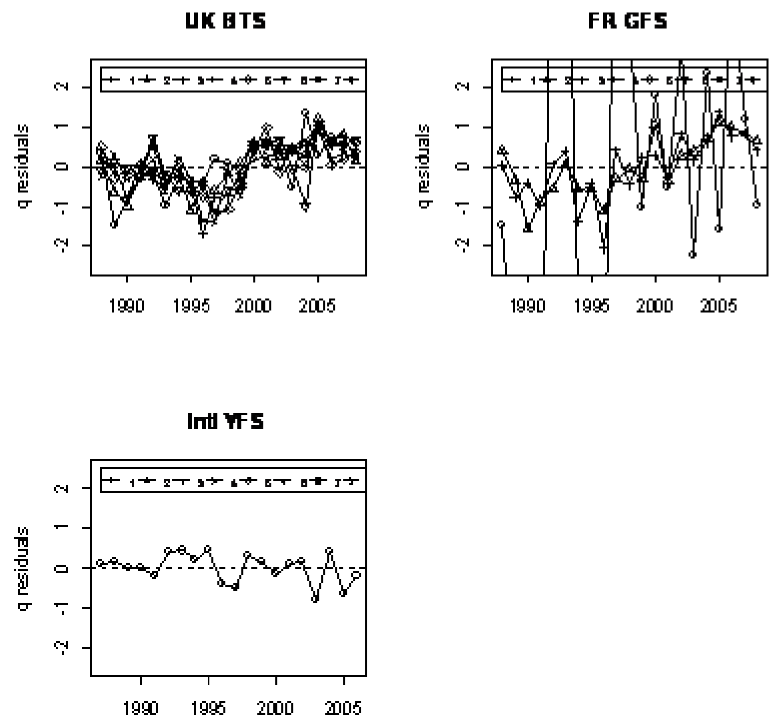

Figure 6.3.2.4 (cont.). Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5.

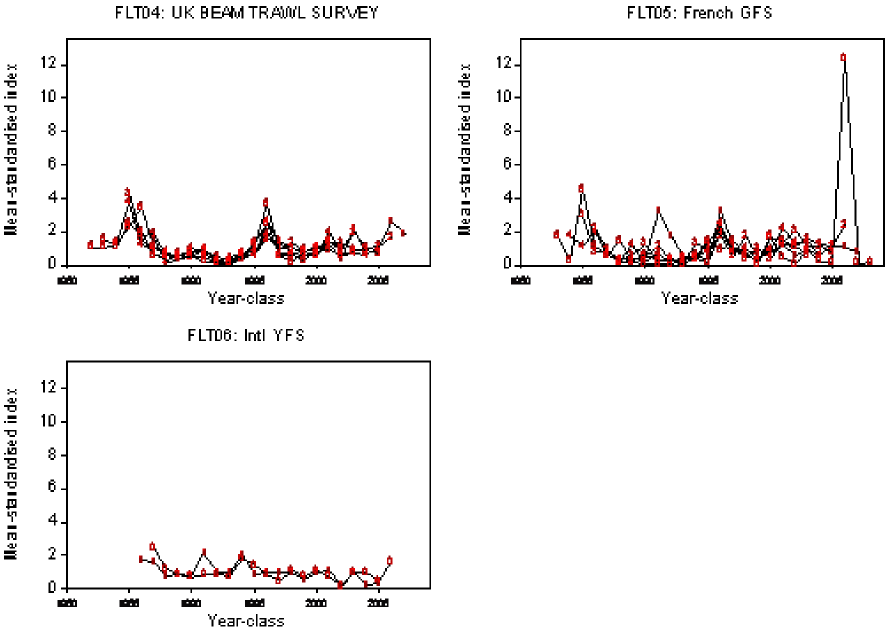

Figure 6.3.3.1. Plaice in VIId. Within survey consistency. Mean standardised indices by year class for each of the surveys.

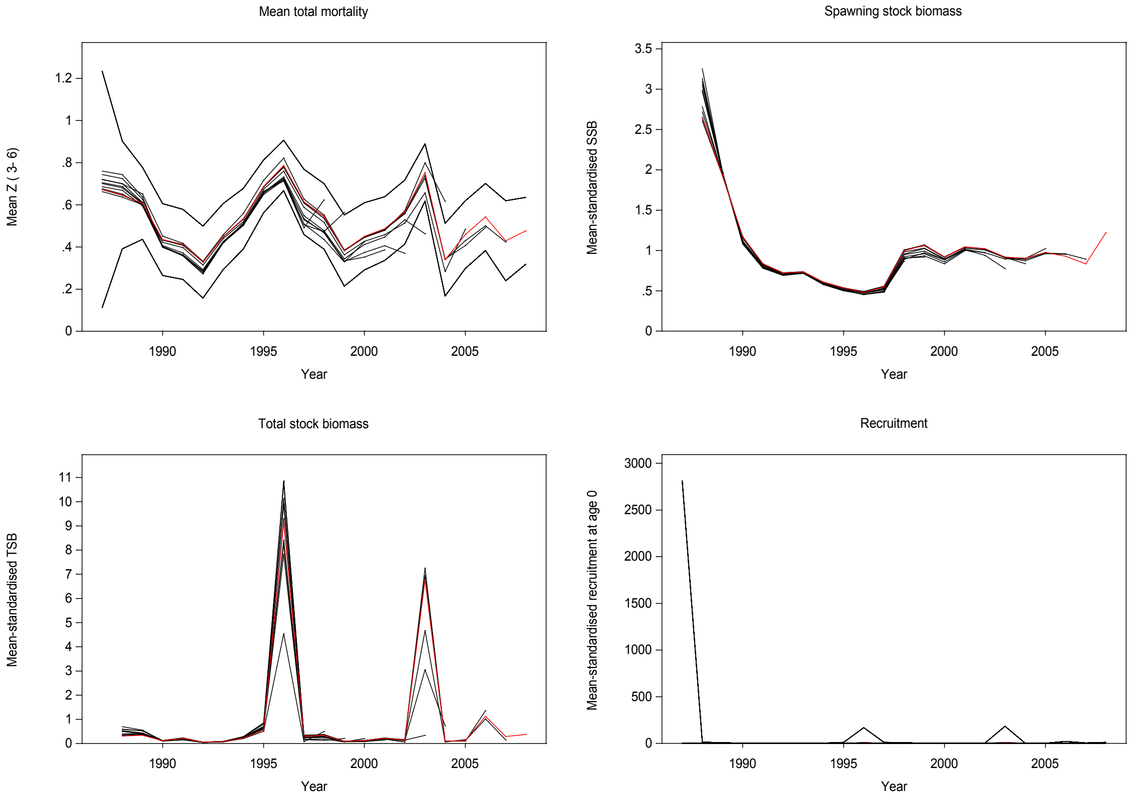

Figure 6.3.3.2. Plaice in VIId. Summary plots of the retrospective analysis from SURBA

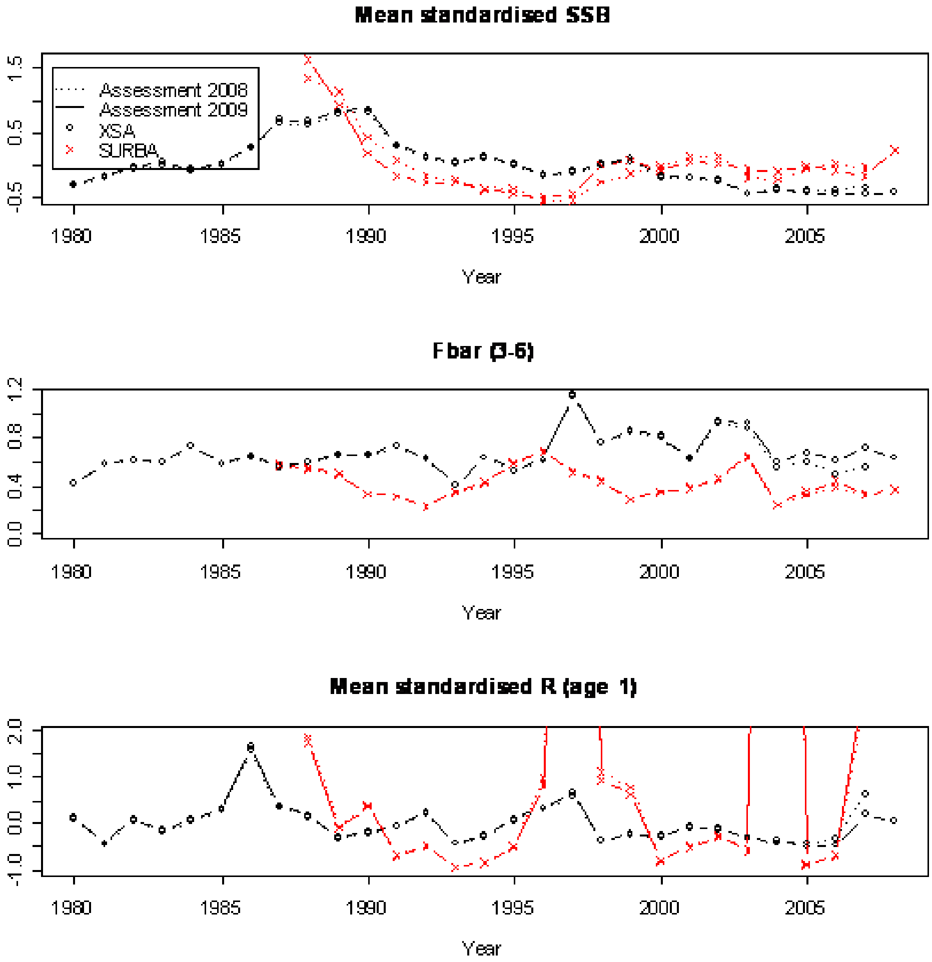

Figure 6.3.4.1. Plaice in VIId. Comparison between 2006 and 2007 assessment and between SURBA and XSA results.

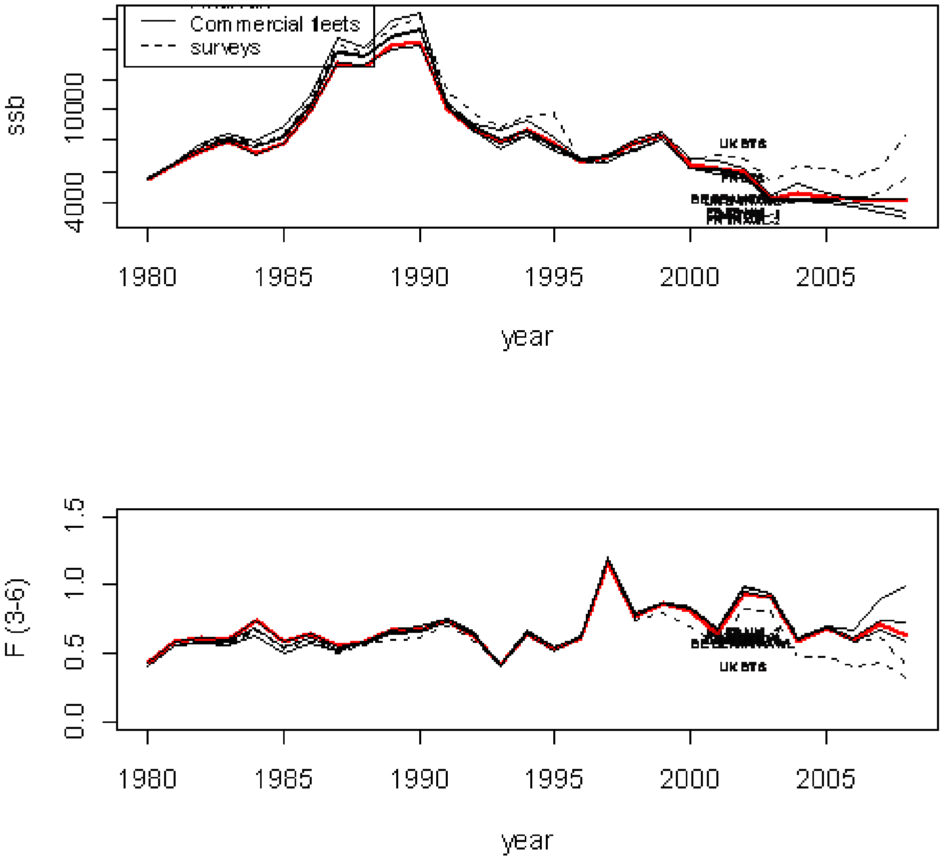

Figure 6.3.4.2. Plaice in VIId. Individual fleet historical performance.

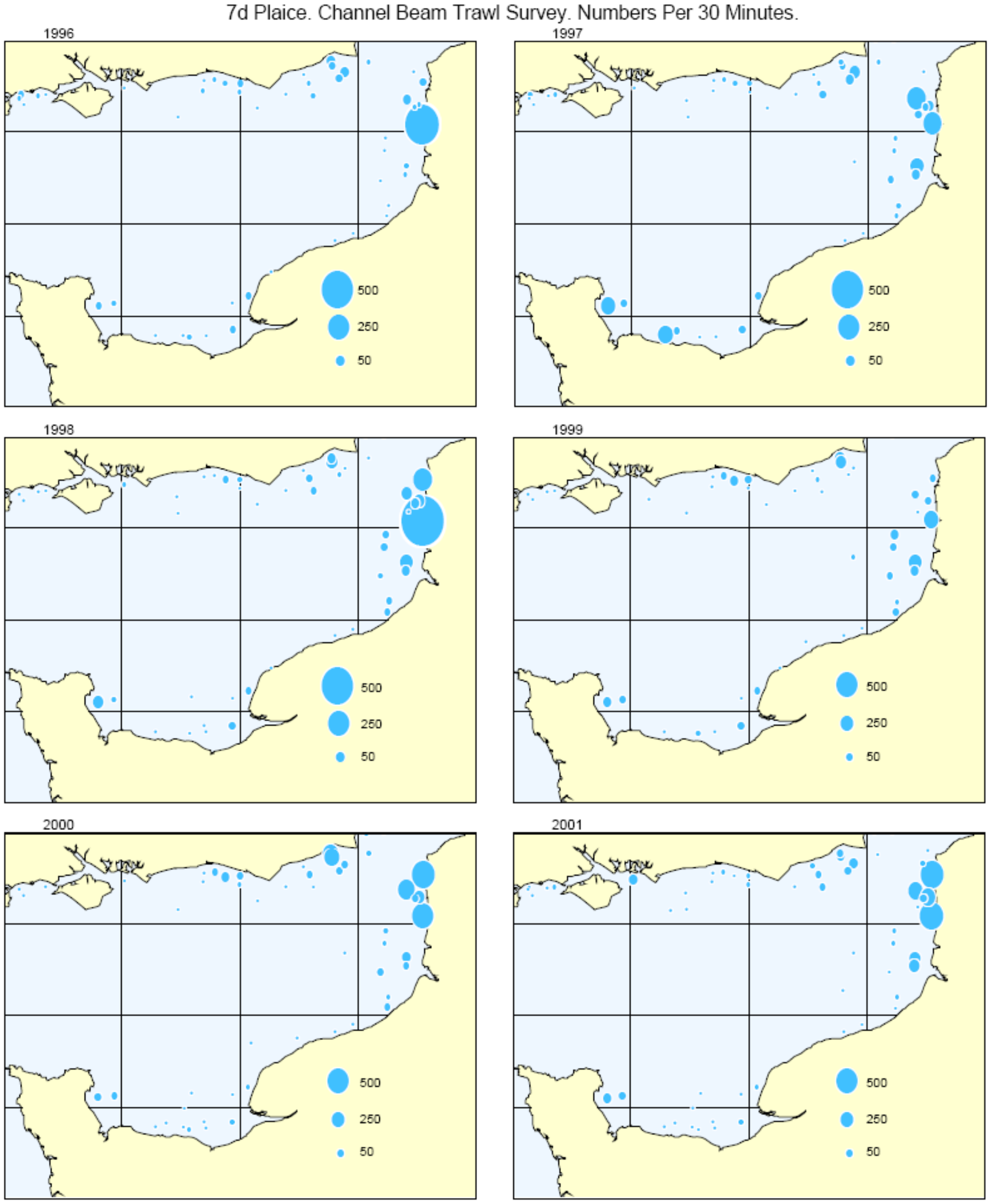

Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

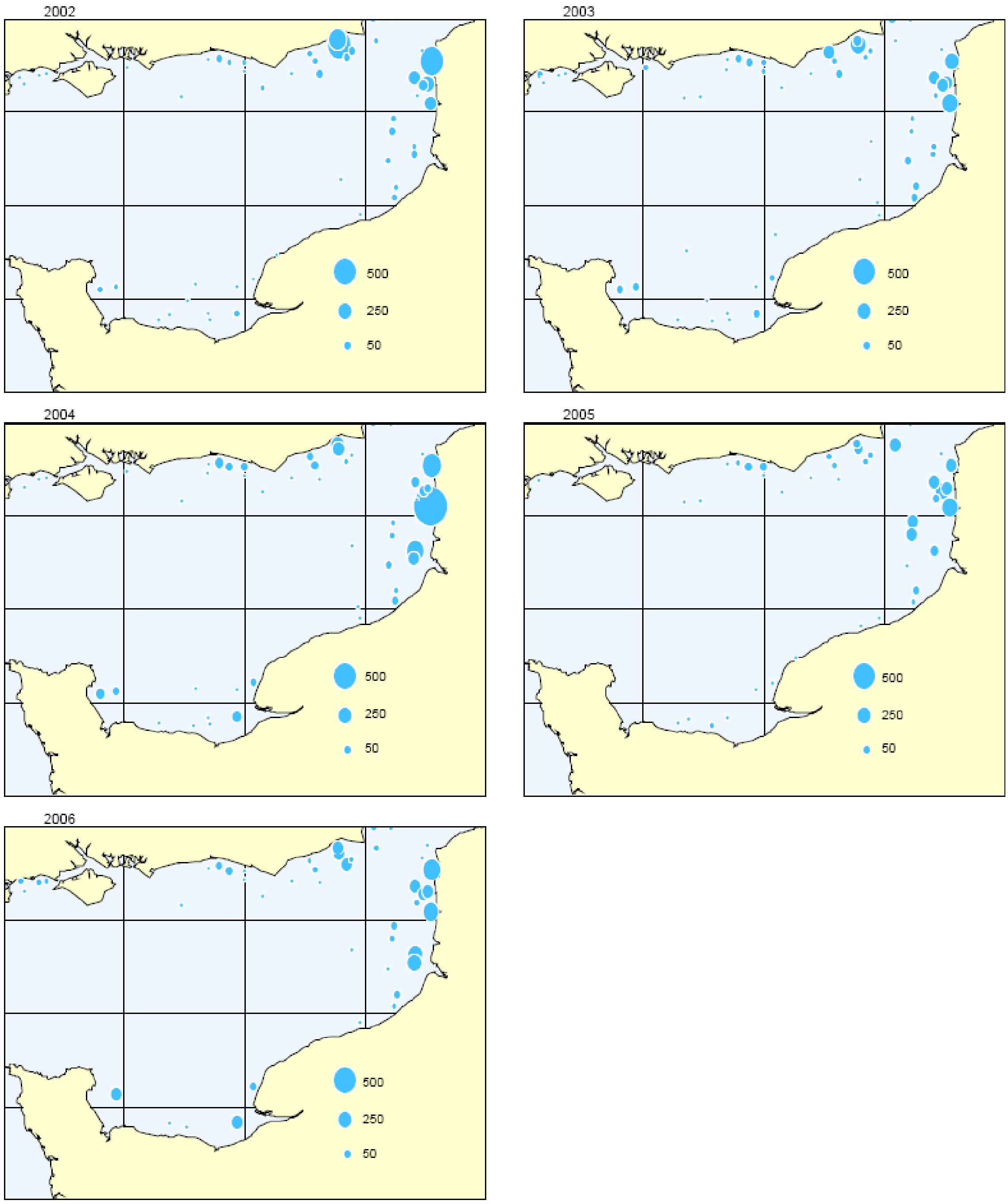

Figure 6.3.4.3. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

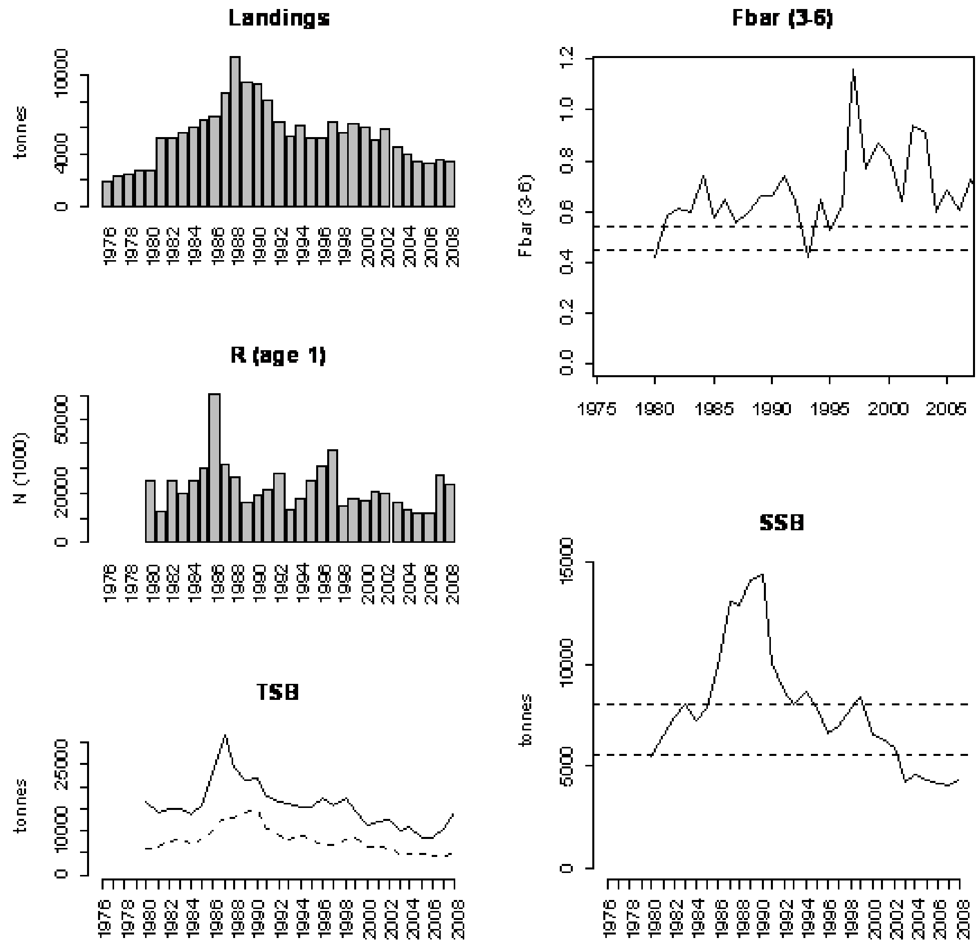

Figure 6.3.5.4. Plaice in VIId. Summary of assessment results

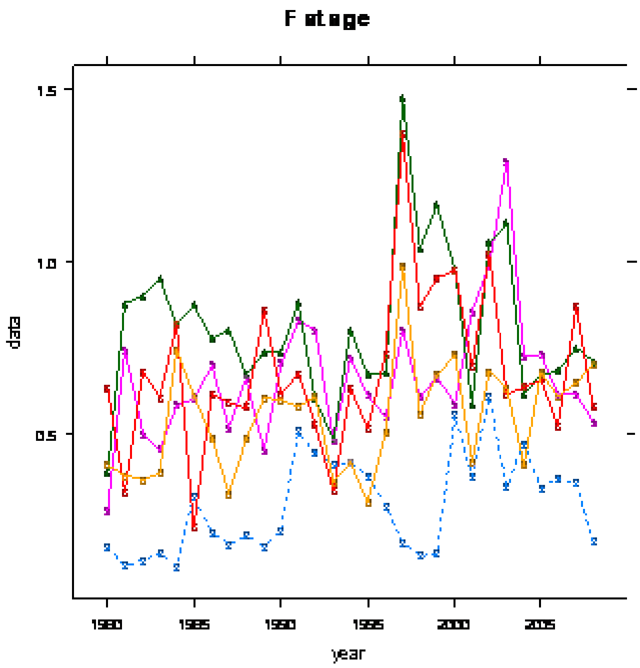

Figure 6.6.1 Plaice in VIId. Trends in F (Age 2 to 6)

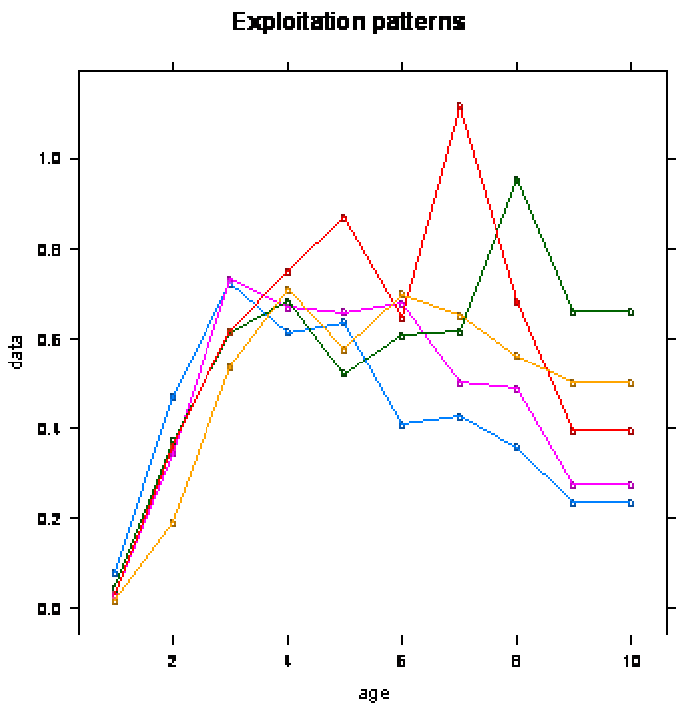

Figure 6.6.2 Plaice in VIId. Exploitation patterns over the last 6 years

7 Plaice in IIIa

This year, exploratory analyses were conducted for plaice in IIIa, but no final assessment was produced. The last analytical assessment accepted by the WG was in 2004. A large number of issues were investigated during WG sessions in 2006 and 2007, but no analysis were performed in 2008.

The assessment of this stock suffers from a number of issues, mainly dealing with (i) catch at age information and (ii) survey spatial coverage. Catch at age issues relate both to the fisheries mainly taking place in the South-Western entrance of Skagerrak where some mixing may occur with North Sea plaice, and to large intrinsic variability in growth within the distributional area, which may not be sufficiently covered by the sampling. Survey issues arise from the survey stations sampling exclusively the Eastern side of the stock distribution where only limited fishing occurs.

These issues cannot be easily addressed through a standard benchmarking procedure and would require large-scale improvement in both commercial and survey sampling design. The WG considers that analytical assessment is not appropriate until these issues are solved.

Standard trial runs performed by this year's WG showed the same issues as during previous years. There seemed, though, to be stabilisation of the large fluctuations in F and SSB observed in previous years assessments, as well as a decrease of the large retrospective patterns in F.

In addition, focus was thus given to recent improvements in knowledge about this stock, in particular updated information from older tagging studies and recent improvements in age-reading.

A stock annex was made available to the WG this year (Annex 3)

7.1 Ecosystem aspects

A general description of the ecosystem is given in the Stock Annex.

7.1.1 Fisheries

A general description of the fishery is given in the Stock Annex.

Technical Conservation Measures

Minimum Landing Size is 27 cm.

Closed areas were implemented by Denmark and Sweden in the SouthEast Kattegat and North of Øresund from the fourth quarter of 2008, with the aim of protecting spawning cod. Two smaller areas are to be closed on a permanent basis while one large area is to be closed during the first quarter only.

Changes in fleet dynamics

The implementation of a number of changes in the regulatory systems in the Kattegat and Skagerrak between 2007 and 2008 (see also 7.1.4 and 7.2.4) may have significantly changed the fishing patterns of the Danish and Swedish fleets, thereby affecting their consistency as tuning fleets. Two of these fleets were still used as tuning indices in the exploratory assessment runs, but this should be further investigated in future assessment.

Fisheries Science Partnerships

No Fisheries Science Partnerships are applicable for this stock

Additional information provided by the fishing industry

7.1.2 ICES Advice

ICES ACFM advice for 2007

In 2007, ICES noted that there were indications that the biomass and recruitment had increased in the recent years. There were no indications that the current catch level was detrimental to the stock and therefore the advice for 2008 was not to increase the catches above the most recent catch of 9400 t (2006).

ICES ACFM advice for 2008

The analysis available for this stock in 2008 did not give a reason to change the advice from 2007. The advice on this stock for the fishery in 2009 was therefore the same as the advice given in 2007 for the 2008 fishery: "Landings should not exceed the level recorded in 2006 of 9400 t."

7.1.3 Management

There are no explicit management objectives for this stock.

TAC in 2008 was 11 688 t, a 10% increase compared to the TAC of 10 625 t in 2007. The TAC was split between Skagerrak and Kattegat, with 9 350 t and 2 338 t, respectively. In 2008, the TAC was taken at 80% in Skagerrak, and only at 43% in the Kattegat (Table 7.1.4). In most years the combined TAC for the area has been largely higher than the actual landings estimates. (Figure 7.1.1)

TAC in 2009 is kept unchanged at 11 688 t.

Effort in plaice IIIa fisheries has been regulated through the implementation of a days-at-sea regulation for the cod recovery plan and fishing effort limitation of the long term management plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 676/2007; EC Council Regulation 40/2008).

For 2008 Council Regulation N°40/2008, annex II[a] allocated different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for a complete list).

For 2009 the system has been changed from allocation of days at sea by individual vessel to pools of KWdays. 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. (see section 1.2.1 for complete list). The areas are Kattegat, part of IIIa not covered by Skagerrak 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); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

In addition to these common European rules, additional national management actions have been implemented, with the specific aim of protecting spawning cod in the

Kattegat. In 2008, a new effort restriction system was implemented both in Denmark and Sweden according to which one day present in the Kattegat during the period 1 February 2008 to 30 April counted as 2.5 days. This regulation ceased January 1, 2009 with the introduction of new regulations (KW days and closed areas). The WGBFAS noted that due to these effort restrictions, the usage of *Nephrops* trawls equipped with species sorting grid (which allows most cod to escape from the trawl) increased considerably in the Swedish fishery, as this type of trawl is not effort regulated. This change in fishing pattern is believed to have resulted in less cod discards in 2008 (WGBFAS 2008).

Finally, in 2007, a new rights-based regulation system was introduced in Denmark for the allocation of national quotas. Before that year the quotas were split into 14-days rations which were continuously adjusted to the amount of quota left. In 2007 this system was changed to a complex system were individual rights are attached to the vessel and not to the owner (FKA - Vessel Quota Share), with specific provisions for coastal and recreational fisheries.. 2007 was considered a transition year to the new system. It is acknowledged that this complex system may have dramatically affected the stucture of Danish fisheries, but no quantitative analyses were made available.

7.2 Data available

7.2.1 Catch

The official landings reported to ICES are given in Table 7.1.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Tables 7.1.2 and 7.1.3. At the start of this period, landings were mostly taken in the Kattegat but from the mid-1970s, the major proportion of the landings has been taken in Skagerrak. This proportion increased even more in 2008 (up to 88%), and this may be due to the restrictive management measures implemented in the Kattegat to protect spawning cod.

According to official national statistics, total landings in 2008 were estimated at 8617 t, slightly lower than in 2007. Landings from Denmark have increased, both in absolute weight and relative weight (up to 90% in 2008) due to the decrease of Dutch landings.

Previously, misreporting had been considered to potentially occur in the area between the North Sea and the Skagerrak. Fish taken in ICES rectangle 43F8 for example can be reported as coming from either of the two areas. In recent years a substantial part of the landings from that rectangle has been reported as being caught in Skagerrak. But information from the fishery suggests that the fishery really takes place in the Skagerrak part of the rectangle, and that there is currently no incentive for mis-reporting either from Div. IV to IIIa or visa versa. However, this particular rectangle represents a very large part of the landings for this stock (Figure 7.2.1), and small relative errors in catch allocation to one or another stock following administrative boundaries may potentially lead to dramatic variations in the catch information. Additional checks should be performed using VMS data in a future benchmark assessment.

Danish and Swedish sampling levels for IIIaN and IIIaS are available in Section 1.2, and landings at age are presented on Figure 7.2.2.

Discards time series from Denmark and Sweden over 2002-2008 were made available to the WG (second semester 2004 data missing for Sweden). Total amount was estimated between 1 600 to 2 600 tonnes by year, corresponding to 15-25 % of the catch in weight (Table 7.2.3).

Significant effort has been expended by Denmark and Sweden since 2004 into increasing the quality of age reading for plaice in IIIa, through a series of workshops and otolith exchanges between age readers. Significant improvement in the consistency have been reached, although some uncertainties remain, particularly for Kattegat plaice and for fish older than 6.

It is thus considered that the variability of growth is a more important source of uncertainty in the catch matrix than the age reading process in itself. A thorough analysis of the extent and stratification of the national sampling programs (for Denmark in particular) should be conducted in order to reduce the confidence interval of length distribution at age.

Landings and discards at age were raised using ICES InterCatch database.

7.2.2 Weight at age

Weight at age in landings is presented in Table 7.2.2 and Figure 7.2.3. The procedure for calculating mean weights was revised in 2006 and is described in the Stock Annex. Weight at age in discards is presented in Table 7.2.5 and Figure 7.2.4.

7.2.3 Maturity and natural mortality

Natural mortality is assumed constant for all years and is set at 0.1 for all ages.

The maturity ogive was revised during the 2006 WG, and uses a fixed value per age based on 1994-2005 average of IBTS 1st quarter data. (Table 7.2.7)

7.2.4 Catch, effort and research vessel data

The description of tuning fleets is given in the Stock Annex.

There is no evidence of major issues with regards to misreporting in this stock. However, a number of issues remain for the reliability of the two commercial tuning fleets. First, as noted for the catch at age data, most fisheries take place in the rectangle 43F8 at the border between Skagerrak and the North Sea, and the catches may include an unknown level of individuals belonging to the North Sea stock. Increased concentration of effort on the Skagerrak side of the border may also have occurred based on regulatory opportunities, such as higher TAC and reduced number of days at sea allowed, creating incentives for selecting fishing grounds closer to the homeport. Second, Danish fisheries have been through dramatic changes since 2007, with the introduction of FKA (Vessel Quota Share) and more recently, the implementation of closed areas and KWdays from 2009 on. This may have affected the efficiency of the plaice fishery. No further investigations have been made so far, but LPUE in 2008 have been higher than during the recent period (Figure 7.2.7 and 7.2.8).

In 2007 the WG discussed the limited spatial coverage by the four surveys with regards to main fishing grounds. IBTS sampling in Skagerrak is mostly limited to the Eastern part around Skagen in Northern Denmark, (Figures 7.2.5 and 7.2.6) while most of the fisheries take place in the North Western area close to the North Sea border. This has not been addressed further yet.

In addition, some intersessional work on the reconstruction of Swedish surveys since 1901 (Cardinale et al., in prep.) have evidenced a decrease in the stock abundance on the Eastern side of the stock distribution over the XXth century, but no sign of impaired recruitment across the time series. Largest recruitment indices were indeed mostly observed over the latest time period.

7.3 Data analyses

7.3.1 Reviews of last year's assessment

No assessment was performed in 2008. The issues listed during previous assessments dealt primarily with data issues. They have been addressed whenever possible, but the most important ones would though require a more in-depth intersessional work to be resolved properly, in particular with regards to sampling procedure and investigation of the stock origin of catches in the western Skagerrak / Northeastern North Sea. The WG still highlights these as necessary prerequisite in order to improve the quality of the plaice IIIa assessment.

7.3.2 Exploratory survey-based analyses

No survey-based analyses were performed, but the average CPUE by survey were estimated using indices at age and stock weight at age (Figure 7.3.1). The four indices show a global CPUE increase in the period 2000-2006 compared to the nineties. 2006 is the highest level for all surveys, while 2007 was lower. 2008 indices are slightly inconsistent across surveys, since both spring surveys show a strong decrease to levels close to 1999 while the winter surveys show a relative increase compared to 2007. There is thus a larger uncertainty about the relative status in the Eastern component of the stock in 2008 compared to the last decade.

7.3.3 Exploratory catch-at-age-based analyses

Catch-at-age matrix

The Landings-at-age matrix is shown on the figure 7.2.2., as absolute and relative proportions. The matrix shows a limited ability to track down the cohorts over time, although some improvements were observed in the most recent years. Year classes 2001 and 2003 were tracked as relatively large

Catch curve cohort trends

Log Catch curves by cohort (figure 7.3.2) show an increasing steepness over the period 2000-2005, when the proportion of fish older than 6 years decreased in the catches. This pattern seems to be less pronounced over the last three years.

Assessment model fits

In 2006, an assessment was presented using survey-based assessment only, while in 2007 it was run using commercial LPUE series only. This year, the WG decided not to present a final assessment, but to run an exploratory assessment using all tuning series and following the settings described in the Stock Annex. The commercial tuning series show the same limited internal consistency as the catch at age matrix, with limited tracking of the cohorts (Figure 7.3.4). The surveys are more internally consistent (Figures 7.3.5. and 7.3.6), but show conflicting signals with the catch at age matrix as seen from the residuals plot (Figure 7.3.7).

A retrospective plot of the assessment is shown on figure 7.3.8. It shows that the dramtic variability in Fbar as well as the large retrospective patterns observed around the years 1998-2005 have decreased over the most recent period 2006-2008. But the retrospective pattern on the recruitment estimates remains high, and the actual level of the year classes for the decade is unknown.

7.3.4 Conclusions drawn from exploratory analyses

The major data issues have not been fully resolved yet. However, the exploratory analyses show some signs of improvement in the internal consistency over the most recent years. The surveys show some relative decline of the Eastern part of the stock compared to their highest levels in 2006.

7.3.5 Final assessment

As for previous years, the WG decided not to include a final assessment

7.4 Historic Stock Trends

No historical stock trends are available from the final assessment.

7.5 Recruitment estimates

Not available

7.6 Short-term forecasts

Not performed

7.7 Medium-term forecasts - none

7.8 Biological reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	B_{lim} cannot be accurately defined.	B_{pa} = 24 000 t.
	F_{lim} cannot be accurately defined.	F_{pa} = 0.73.
Target reference points		F_y undefined.

Technical basis

	$\mathbf{B_{pa}}$= smoothed $\mathbf{B_{loss}}$ (no sign of impairment).
	$\mathbf{F_{pa}}$ = $\mathbf{F_{med}}$.

7.9 Quality of the assessment

The issues repeatedly acknowledged during the previous WGs have been addressed but not fully resolved, since they relate to major intrinsic issues in the stock identification and sampling program. In consequence, exploratory analyses provided similar results as in previous years. However, the exploratory analyses show some signs of improvement in the internal consistency over the most recent years, with a decrease of the interannual variability of F and of F and SSB retrospective patterns. This may reflect the recent improvements brought to the age-reading quality, as well as increased focus on the consistency of national sampling programs through the European DCR frame.

7.10 Status of the Stock

It is not possible to provide a reliable status of the stock based on analytical assessment. However, a number of indicators tend to sustain the hypothesis that the stock is not exploited unsustainably. Landings have been stable over a long time period, and always lower than the TAC. The effort of commercial fleets has decreased, and LPUEs have been largely above average in 2008. There has never been sign of impaired recruitment. However, the Eastern component of the stock covered by the surveys may have declined compared to its highest level of 2006.

7.11 Management Considerations

In 2007, ICES identified key issues that would need to be resolved before reaching further improvements in the assessment. The various surveys give a reasonably consistent result for the eastern part of the area. The status of the western part is more uncertain, due to potential mixing with North Sea plaice and limited survey coverage. The landings-at-age matrix does not show proper tracking of the cohorts, probably due to i) mixing of the IIIa stock with the North Sea plaice stock on the main fishing ground in southwestern Skagerrak, and ii) age misspecification due to low sampling levels.

In 2009, The WG still considered these issues as outstanding, although uncertainty due to age reading is likely to have decreased in the recent years. The Working group recommends therefore that scientific effort is conducted towards improvement of the biological knowledge on plaice in the South-Western area / Eastern North Sea. In particular, the harbour sampling program should be screened for reducing the uncertainty in growth variability, and methods should be developed to investigate the stock provenance of plaice catches in this area. Furthermore, survey coverage in that region should be strengthened.

Additional considerations are given for this stock.

Plaice is taken both in a directed fishery and as an important by-catch in a mixed cod-*Nephrops*- plaice fishery. North Sea cod, which is estimated to be below $\mathbf{B}_{lim}$, has a stock area that includes the Skagerrak (Division IIIaN). Kattegat cod is also well below $\mathbf{B}_{lim}$ (Division IIIa South). Management of plaice in IIIa must therefore take account for state of the cod stocks.

There has been suspicion that restrictive by-catch rules on cod in Kattegat create a major incentive to misreport catches in the Western Baltic, although no evidence is available from the industry (ICES_WGBFAS 2008, 2009). The consequences for potential misreporting of plaice have not been investigated, but it is not considered as a major issue. The TAC for plaice is not restrictive, either in the Kattegat or in the Western Baltic, and the amount of landings are small in both areas compared to Skagerrak.

7.12 References

ICES 2008. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), 8-17 April 2008, ICES Headquarters, Copenhagen. ICES CM 2008\ACOM:06. 692 pp.

ICES 2009. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), 22-28 April 2009, ICES Headquarters, Copenhagen. ICES CM 2008\ACOM: (*not available yet*).

Table 7.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2008

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			116	116	808	915	6,794	147	6,941	9,500
2006	7,690	7,689	349	350	34	34			142	142	1,167	1,190	9,382	23	9,405	9,600
2007	6,665	6,664	333	331	31	31			99	100		1,659	7,128		8,785	10,625
2008	7,768	7,767	356	356	23	11			79	79	433	403	8,659	-43	8,616	11,688

Table 7.1.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2008

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030
2003	2,037	253	6			2,296
2004	1,395	137	77			1,609
2005	1,104	100	47			1,251
2006	1,355	175	20			1,550
2007	1,198	172	10			1,380
2008	866	137	6			1,009

* years 1972-1990 landings refers to IIIA

Table 7.1.3. Plaice in Skagerrak. Landings in tonnes. WG estimates, 1972-2008

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5,095	70			3		5,168
1973	3,871	80			6		3,957
1974	3,429	70			5		3,504
1975	4,888	77			6		4,971
1976	9,251	51		717	6		10,025
1977	12,855	142		846	6		13,849
1978	13,383	94		371	9		13,857
1979	11,045	67		763	9		11,884
1980	9,514	71		914	11		10,510
1981	8,115	110		263	13		8,501
1982	7,789	146		127	11		8,073
1983	6,828	155		133	14		7,130
1984	7,560	311		27	22		7,920
1985	9,646	296		136	18		10,096
1986	10,645	202		505	26		11,378
1987	11,327	241		907	27		12,502
1988	9,782	281		716	41		10,820
1989	5,414	320		230	33		5,997
1990	8,729	779		471	69		10,048
1991	5,809	472	15	315	68		6,679
1992	8,514	381	16	537	106		9,554
1993	9,125	287	37	326	79		9,854
1994	8,783	315	37	325	91		9,551
1995	8,468	337	48	302	224		9,379
1996	7,304	260	11		428		8,003
1997	7,306	244	14		249		7,813
1998	6,132	208	11		98		6,449
1999	6,473	233	7		336		7,049
2000	6,680	230	5		67		6,982
2001	9,045	125			61		9,231
2002	6,470	140	3		58		6,671
2003	4,847	143	8		74	1,584	6,656
2004	5,717	179			106	1,511	7,513
2005	4,515	144			116	915	5,690
2006	6,334	175	14		142	1,190	7,855
2007	5,467	159	21		100	1,659	7,406
2008	6,901	219	5		79	403	7,607

Table 7.1.4 Plaice IIIa. Initial and final quota and quota uptake by country.
(source - EU Commision database FIDES - on Danish Fiskeridirektoratet http://www.fd.dk)

Nation		Belgium	Germany		Denmark		EU		UK	Netherlands	Sweden		TAC	
		03AN.	03AN.	03AS.	03AN.	03AS.	03AN.	03AS.	03AN.	03AN.	03AN.	03AS.	03AN.	03AS.
1998	Landings	1	7	21	6.115	1.84	6.327	2.046	.	.	204	186	6.327	2.046
	Initial Quota	70	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Final Quota	0	80	70	10.43	2.45	10.98	2.8	.	.	470	280	11.2	2.8
	Quota use	.	8%	30%	59%	75%	58%	73%	.	.	43%	66%	56%	73%
1999	Landings	.	17	7	6.469	1.511	6.707	1.674	.	2	219	156	6.707	1.674
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	1.68	470	280	11.2	2.8
	Final Quota	.	90	80	10.42	2.44	10.98	2.8	.	0	470	280	11.2	2.8
	Quota use	.	19%	9%	62%	62%	61%	60%	.	.	47%	56%	60%	60%
2000	Landings	.	0	9	6.675	1.656	6.902	1.857	.	.	227	192	6.902	1.857
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Final Quota	.	90	30	10.42	2.49	10.98	2.8	.	.	470	280	11.2	2.8
	Quota use	.	0%	31%	64%	67%	63%	66%	.	.	48%	68%	62%	66%
2001	Landings	.	1	2	9.018	2.085	9.139	2.345	0	.	121	259	9.139	2.345
	Initial Quota	.	40	20	7.31	2.09	9.21	2.35	0	.	390	240	9.4	2.35
	Final Quota	.	22	2	9.028	2.09	9.21	2.35	0	.	160	258	9.4	2.35
	Quota use	.	3%	80%	100%	100%	99%	100%	.	.	75%	100%	97%	100%
2002	Landings	5	24	5	6.476	1.806	6.641	2.015	.	.	137	205	6.641	2.015
	Initial Quota	38	26	16	4.983	1.424	6.272	1.6	.	958	267	160	6.4	1.6
	Final Quota	0	39	21	7.888	1.88	8.279	2.112	.	0	352	210	8.448	2.112
	Quota use	.	61%	22%	82%	96%	80%	95%	.	.	39%	98%	79%	95%
2003	Landings	.	7	6	4.848	2.034	6.344	2.288	.	1.347	142	248	6.344	2.288
	Initial Quota	80	53	33	10.339	2.955	13.014	3.32	.	1.988	554	332	13.28	3.32
	Final Quota	0	53	33	10.419	2.955	13.014	3.32	.	1.988	554	332	13.28	3.32
	Quota use	.	14%	19%	47%	69%	49%	69%	.	68%	26%	75%	48%	69%
2004	Landings	.	76	5	5.726	1.398	7.358	1.54	.	1.383	173	137	7.358	1.54
	Initial Quota	.	38	19	7.397	1.658	9.31	1.863	.	1.422	396	186	9.5	1.863
	Final Quota	.	128	19	7.327	1.658	9.31	1.863	.	1.459	396	186	9.5	1.863
	Quota use	.	59%	28%	78%	84%	79%	83%	.	95%	44%	73%	77%	83%
2005	Landings	1	14	7	4.507	1.1	5.488	1.205	.	828	139	98	5.488	1.205
	Initial Quota	46	30	19	5.917	1.691	7.448	1.9	.	1.138	317	190	7.6	1.9
	Final Quota	0	30	19	5.963	1.691	7.448	1.9	.	1.138	317	190	7.6	1.9
	Quota use	.	47%	36%	76%	65%	74%	63%	.	73%	44%	52%	72%	63%
2006	Landings	.	21	12	6.333	1.355	7.652	1.536	.	1.123	175	169	7.652	1.536
	Initial Quota	.	31	19	5.979	1.709	7.526	1.92	.	1.15	320	192	7.68	1.92
	Final Quota	.	31	19	6.15	1.719	7.526	1.92	.	1.165	180	182	7.68	1.92
	Quota use	.	67%	61%	103%	79%	102%	80%	.	96%	97%	93%	100%	80%
2007	Landings	.	18	11	5441	1201	7222	1383	.	1605	158	171	7222	1383
	Initial Quota	.	34	21	6617	1891	8330	2125	.	1273	355	213	8500	2125
	Final Quota	.	34	23	6241	2063	8330	2289	.	1625	247	213	8500	2125
	Quota use	.	53%	48%	87%	58%	87%	60%	.	99%	64%	80%	85%	65%
2008	Landings		16	6	6904	863				427	217	137		
	Initial Quota		37	23	7280	2081	9163	2338		1400	390	234	9350	2338
	Final Quota		37	23	8400	2131				466	260	184	9350	2338
	Quota use		0.44	0.24	0.82	0.4				0.92	0.83	0.74		

Table 7.2.1. Plaice IIIa 2008 WGNSSK, ANON, COMBSEX, PLUSGROUP. landings.n

	age								
year	2	3	4	5	6	7	8	9	10
1978	489	15692	39531	24919	8011	620	63	63	108
1979	1105	9789	29655	20807	7646	2514	170	75	105
1980	362	4772	16353	12575	6033	2393	949	203	104
1981	190	4048	13098	10970	4306	1427	546	213	216
1982	526	2067	9204	10602	5554	1851	758	301	161
1983	1481	9715	8630	8026	2673	925	531	257	202
1984	2154	12620	11140	4463	2183	985	904	695	457
1985	1400	8641	21798	6232	1715	698	260	197	324
1986	375	4366	14749	19193	4477	633	274	154	239
1987	623	4227	12400	17710	10205	2089	373	242	315
1988	101	3052	12037	13783	6860	2745	946	322	292
1989	1012	3844	7102	6255	2708	1171	549	254	372
1990	3147	8748	8623	9718	3222	981	481	349	428
1991	2309	8611	9583	4663	2893	892	306	156	224
1992	904	3858	11759	17427	4297	1033	296	115	142
1993	1038	3505	10088	13233	6891	1657	376	104	116
1994	1411	6919	8016	9859	8002	2780	448	111	93
1995	446	2277	6606	11530	6622	4929	853	137	116
1996	4527	5353	7971	5283	4751	1812	1355	151	68
1997	529	4733	6379	9465	5104	3072	1369	849	150
1998	563	6710	8219	6856	2971	791	385	234	234
1999	687	2704	8432	8520	7419	1301	380	77	149
2000	1223	3937	8302	11212	3599	888	139	17	36
2001	3981	9172	9399	11001	4744	410	102	19	47
2002	364	5008	8861	7528	4843	1766	448	51	29
2003	3481	4686	9098	9279	4330	969	138	19	16
2004	1724	17816	4271	4056	1994	265	97	11	18
2005	3775	4853	9688	3389	1754	768	169	63	19
2006	1288	13064	9241	7045	1293	673	216	38	28
2007	4788	8085	8282	4398	3407	512	140	61	31
2008	1627	7164	8859	5735	2499	1516	90	98	94

Table 7.2.2. Plaice IIIa 2008 WGNSSK, ANON, COMBSEX, PLUSGROUP . landings.wt

	age								
year	2	3	4	5	6	7	8	9	10
1978	0.24	0.252	0.272	0.327	0.424	0.608	0.764	0.831	0.889
1979	0.231	0.265	0.277	0.309	0.393	0.469	0.681	0.958	1.073
1980	0.277	0.291	0.325	0.367	0.44	0.615	0.68	0.8	0.912
1981	0.236	0.27	0.304	0.367	0.444	0.551	0.689	0.835	0.977
1982	0.275	0.307	0.291	0.324	0.393	0.554	0.717	0.828	0.951
1983	0.287	0.276	0.295	0.358	0.426	0.486	0.534	0.651	1.096
1984	0.282	0.299	0.304	0.372	0.403	0.406	0.383	0.36	0.606
1985	0.278	0.282	0.308	0.354	0.438	0.545	0.681	0.738	0.833
1986	0.25	0.277	0.284	0.31	0.384	0.531	0.707	0.85	0.983
1987	0.322	0.28	0.281	0.292	0.363	0.527	0.711	0.904	1.065
1988	0.252	0.267	0.268	0.29	0.35	0.475	0.567	0.755	1.026
1989	0.274	0.263	0.282	0.32	0.376	0.466	0.635	0.741	0.937
1990	0.292	0.288	0.294	0.337	0.397	0.498	0.684	0.775	1.078
1991	0.263	0.27	0.259	0.274	0.365	0.492	0.584	0.67	1.004
1992	0.309	0.31	0.272	0.28	0.336	0.5	0.646	0.817	0.943
1993	0.267	0.272	0.271	0.295	0.338	0.441	0.565	0.711	1.019
1994	0.275	0.263	0.272	0.289	0.33	0.381	0.516	0.658	0.892
1995	0.263	0.301	0.303	0.289	0.328	0.369	0.5	0.737	0.872
1996	0.269	0.271	0.297	0.388	0.404	0.441	0.435	0.567	0.938
1997	0.3	0.294	0.283	0.299	0.341	0.41	0.465	0.445	0.586
1998	0.26	0.25	0.28	0.328	0.399	0.465	0.516	0.588	0.703
1999	0.271	0.271	0.29	0.29	0.294	0.336	0.37	0.656	0.643
2000	0.259	0.264	0.278	0.304	0.357	0.39	0.52	0.862	0.973
2001	0.257	0.272	0.29	0.322	0.31	0.426	0.59	0.837	0.778
2002	0.246	0.271	0.27	0.287	0.339	0.403	0.596	0.795	1.151
2003	0.243	0.252	0.271	0.29	0.298	0.4	0.464	0.605	0.845
2004	0.241	0.277	0.321	0.348	0.379	0.525	0.788	0.846	0.695
2005	0.235	0.251	0.282	0.315	0.336	0.367	0.495	0.64	1.053
2006	0.238	0.259	0.28	0.332	0.325	0.344	0.442	0.569	0.846
2007	0.239	0.279	0.308	0.309	0.34	0.354	0.514	0.497	0.907
2008	0.26	0.284	0.286	0.32	0.386	0.445	0.535	0.508	0.489

Table 7.2.3. Plaice IIIa, Discards in weight
2007-05-05 09:22:09 units = tonnes

	Country	
year	Denmark	Sweden
2002	2002	486
2003	2089	584
2004	1628	273
2005	1363	302
2006	1282	347
2007	1401	484
..2008	1201	330

Table 7.2.4. Plaice IIIa, Discards number
units = thousands

	age										
year	0	1	2	3	4	5	6	7	8	9	10
2002	4	2592	7175	5886	3001	944	226	64	7	3	2
2003	4	2600	10159	5452	2506	954	251	65	6	2	2
2004	4	1664	4839	5506	2058	793	225	40	4	1	1
2005	4	814	4733	4579	2018	745	213	55	11	1	1
2006	6	739	3650	5247	1812	723	179	40	3	0	0
2007	5	1046	5131	4403	2151	797	229	57	26	10	3
2008	5	741	5049	4187	1913	660	206	48	11	6	3

Table 7.2.5. Plaice IIIa, Discards mean weight
2007-05-05 09:22:10 units = kg

	0	1	2	3	4	5	6	7	8	9	10
2002	0.033	0.065	0.117	0.136	0.147	0.167	0.258	0.272	0.32	0.316	0.3
2003	0.03	0.061	0.116	0.135	0.147	0.157	0.234	0.268	0.3	0.3	0.3
2004	0.03	0.076	0.111	0.135	0.151	0.16	0.18	0.284	0.3	0.3	0.3
2005	0.03	0.078	0.11	0.132	0.151	0.159	0.177	0.213	0.164	0.3	0.44
2006	0.03	0.081	0.115	0.135	0.153	0.164	0.206	0.25	0.271	0.3	0.3
2007	0.03	0.085	0.121	0.143	0.16	0.174	0.177	0.198	0.227	0.239	0.205
2008	0.03	0.07	0.093	0.13	0.155	0.177	0.173	0.28	0.21	0.146	0.154

Table 7.2.6. Plaice IIIa 2008 WGNSSK, ANON, COMBSEX, PLUSGROUP . stock.wt

	age								
year	2	3	4	5	6	7	8	9	10
1978	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1979	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1980	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1981	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1982	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1983	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1984	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1985	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1986	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1987	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1988	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1989	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1990	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1991	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1992	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1993	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1994	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1995	0.081	0.192	0.306	0.26	0.334	0.385	0.403	0.567	0.695
1996	0.099	0.17	0.287	0.327	0.312	0.317	0.311	0.424	0.443
1997	0.123	0.165	0.243	0.299	0.353	0.495	0.572	0.544	0.689
1998	0.063	0.133	0.223	0.297	0.386	0.451	0.43	0.392	0.501
1999	0.09	0.133	0.208	0.294	0.319	0.346	0.414	0.618	0.849
2000	0.064	0.133	0.196	0.295	0.318	0.316	0.845	0.8	0.926
2001	0.085	0.145	0.234	0.299	0.288	0.382	0.655	0.781	0.699
2002	0.064	0.122	0.162	0.304	0.328	0.372	0.389	0.769	0.932
2003	0.092	0.133	0.179	0.287	0.294	0.348	0.415	0.557	0.782
2004	0.065	0.12	0.169	0.34	0.368	0.473	0.68	0.809	0.969
2005	0.083	0.129	0.214	0.301	0.326	0.349	0.455	0.537	0.73
2006	0.075	0.132	0.215	0.333	0.315	0.415	0.515	0.56	0.826
2007	0.066	0.129	0.212	0.309	0.357	0.44	0.504	0.45	0.909
2008	0.056	0.125	0.197	0.318	0.374	0.462	0.597	0.732	1.022

Table 7.2.7. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . maturity

2007-05-05 00:43:50 units= NA

	age								
year	2	3	4	5	6	7	8	9	10
all	0.54	0.74	0.88	0.92	0.94	1	1	1	1

Table 7.2.8. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . tuning

[1] "Final Tuning File"

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DK Gillnetters

1995	2008								
1	1	0	1						
2	10								
236150	41004	162022	481951	1218991	661753	725503	138092	21132	15729
199512	159746	347956	526608	521810	494928	203666	147976	14233	4957
206792	41993	443102	393385	459126	314599	249657	142019	58770	15011
169842	22639	248607	449714	564524	254092	76487	42318	27666	31299
193717	47487	109450	503992	623875	772756	155731	50526	14452	14580
174610	30628	158975	516760	642735	302086	85045	16696	2099	4582
263858	170611	265684	492485	1059222	629625	66119	19361	2947	5080
199439	25874	322449	386538	366741	362332	224494	70754	11011	8426
170502	138544	168218	436703	518599	301809	105409	18907	2335	2511
152678	45145	756831	293827	284613	156901	30654	13285	1506	3642
119359	113387	162549	537575	255771	138559	66752	18560	8054	1921
163118	34391	525195	530686	466561	95788	47550	23536	6328	1710
127209	51305	177146	433268	383912	341224	42487	13976	5308	1360
162827	91680	677422	671484	536109	274896	142787	8049	6317	4531

DK Seiners

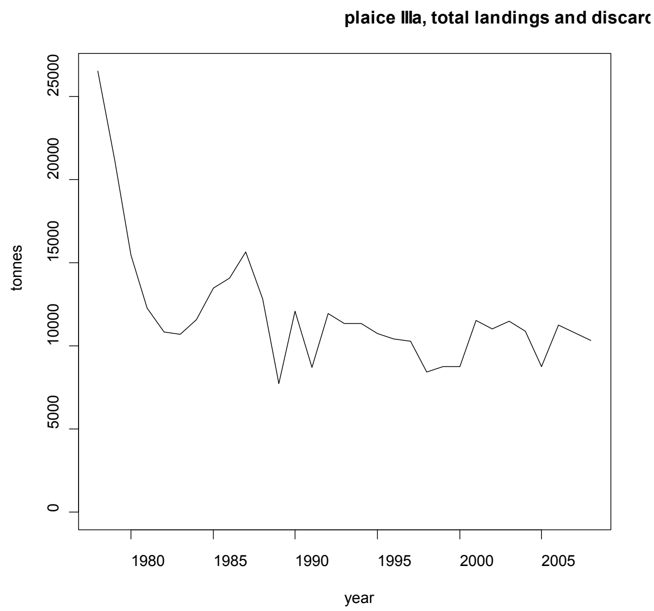
1995	2008								
1	1	0	1						
2	10								
848990	155505	483163	1237122	2102300	1537781	1039883	145632	22771	19269
829741	671949	1146592	1643737	877448	817287	295731	209090	20906	7373
760695	99282	1097581	1727655	2229125	1100779	739059	319951	250184	29125
726990	113924	1884590	2083633	1781242	779096	207230	96901	56672	58032
822345	197769	601501	2398479	2485717	2164017	319256	89023	19404	39372
920377	291648	1236918	2880342	4216432	1227383	377336	53683	2629	4390
1026524	1545624	3602553	3074242	3346357	1336759	127829	30600	6680	9428
887462	108998	1717074	3300009	2939239	1745286	567066	132372	11880	7025
699429	985829	1658716	3194559	3065635	1240986	234046	40482	4406	3225
641455	582551	5697194	1385089	1168507	587432	82853	14087	2057	3006
514275	1476819	1663149	2875087	892939	442738	170333	32412	8271	2719
449215	369650	3752667	2660569	1929726	346736	173716	52471	10513	2232
416847	1130631	2175839	2741921	1129860	837340	108032	26929	10781	2858
492237	1046295	3871426	3011190	1774239	624904	432156	15886	17151	8606

Table 7.2.8 (Cont'd)

KASU_Q4						
1994	2008					
1	1	0.83	1			
1	6					
1	0.88	10.52	5.88	0.37	0.99	0.03
1	1.68	10.33	3.77	0.19	1.1	0.06
1	2.41	38.57	12.67	0.42	0.47	0.1
1	11.09	11.47	4.35	1.26	0.65	0.36
1	17.87	14.8	5.2	3.5	0	0.11
1	101.15	38.86	7.22	0.92	0.56	0.63
1	102.98	129.85	16.63	0	0.49	0.49
1	52.93	99.92	29.79	1.71	0.49	0.85
1	46.14	18.37	25.15	12.39	1.24	0.15
1	42.17	61.79	14.91	6.26	3.38	0.35
1	15.03	70.85	80.23	12.3	12.6	11.7
1	108.73	42.47	8.28	1.38	0.09	0.07
1	56.28	77.13	60.47	11.28	6.31	2.4
1	42.76	45.99	11.39	2.74	0.48	0
1	33.77	107.56	50.54	12.86	1.66	0.12
KASU_Q1						
1996	2008					
1	1	0.25	0.33			
1	6					
1	2.27	23.62	26.53	6.46	2.06	0.81
1	0.05	11.49	19.45	4.39	1.75	0.68
1	-9	-9	-9	-9	-9	-9
1	4.68	25.95	22.42	2.94	1.27	0.15
1	33.05	196.25	47.5	9.06	1.87	1.65
1	11.47	127.73	73.92	6.67	1.7	1.33
1	20.89	45.71	78.3	31.99	2.26	0.44
1	9.67	143.32	38.2	33.56	6.16	0.17
1	7.28	81.75	74.97	25.99	13.14	4.26
1	13.49	163.55	100.77	19.07	4.36	1.75
1	16.17	152.56	217.54	37.31	6	0.4
1	7.65	107.93	116.95	36.77	6.6	1.15
1	20.77	40.83	46.5	16.83	3.75	0.63

Table 7.2.8 (Cont'd)

IBTS_Q1_backshifted						
1990	2008					
1	1	0.99	1			
1	6					
1	9.55	21.09	11.19	3.71	0.29	0.09
1	9.21	18.69	12.32	2.86	0.38	0.11
1	14.58	13.39	13.41	12.1	4.63	0.54
1	19.29	13.75	3.9	2.33	2.54	0.57
1	10.12	21.41	8.92	2.43	1.74	0.79
1	47.74	30.49	9.76	3.34	0.74	0.35
1	20.89	46.75	9.57	3.34	0.18	0.07
1	15.73	17.19	9.5	3.28	0.77	0.23
1	44.6	19.46	5.92	5.68	0.31	0.19
1	131.44	72.73	14.98	5.36	3.37	0.31
1	55.16	91.76	20.41	3.22	2.09	0.79
1	15.57	66.06	44.18	10.8	1.93	1.62
1	95.55	50.85	46.2	33.62	6.34	1.05
1	40.79	116.25	33.62	27.51	25.39	1.61
1	117.05	85.37	51.22	21.28	31.61	9.21
1	37.98	97.57	22.76	13.04	4.18	13.95
1	52.12	83.73	83.43	27.32	15.66	6.02
1	49.43	45.97	20.66	7.63	5.71	2.53
1	17.03	29.41	7.75	3.15	1.36	0.68
IBTS_Q3						
1997	2008					
1	1	0.83	1			
1	6					
1	16.39	17.39	8.42	2.23	0.79	0.45
1	27.92	19.97	5.26	3.66	0.43	0
1	77.47	59.45	14.35	1.53	1.7	0.31
1	-9	-9	-9	-9	-9	-9
1	19.31	109.31	63.62	9.13	3.77	1.03
1	66.31	54.15	33.27	24.38	4.12	0.45
1	14.98	40.93	6.95	9.84	9.28	1.11
1	51.95	39.99	41.41	3.77	5.49	3.96
1	17.76	60.04	13.52	15.78	3.69	3.7
1	24.39	59.55	72.11	18.14	13.09	6.99
1	31.21	53.03	26.68	14.69	5.56	3.32
1	5.11	98.32	33.39	21.08	6.32	1.48


plaice IIIa, total landings and discarc
tonnes
0
5000
10000
15000
20000
25000
1980
1985
1990
1995
2000
2005
year

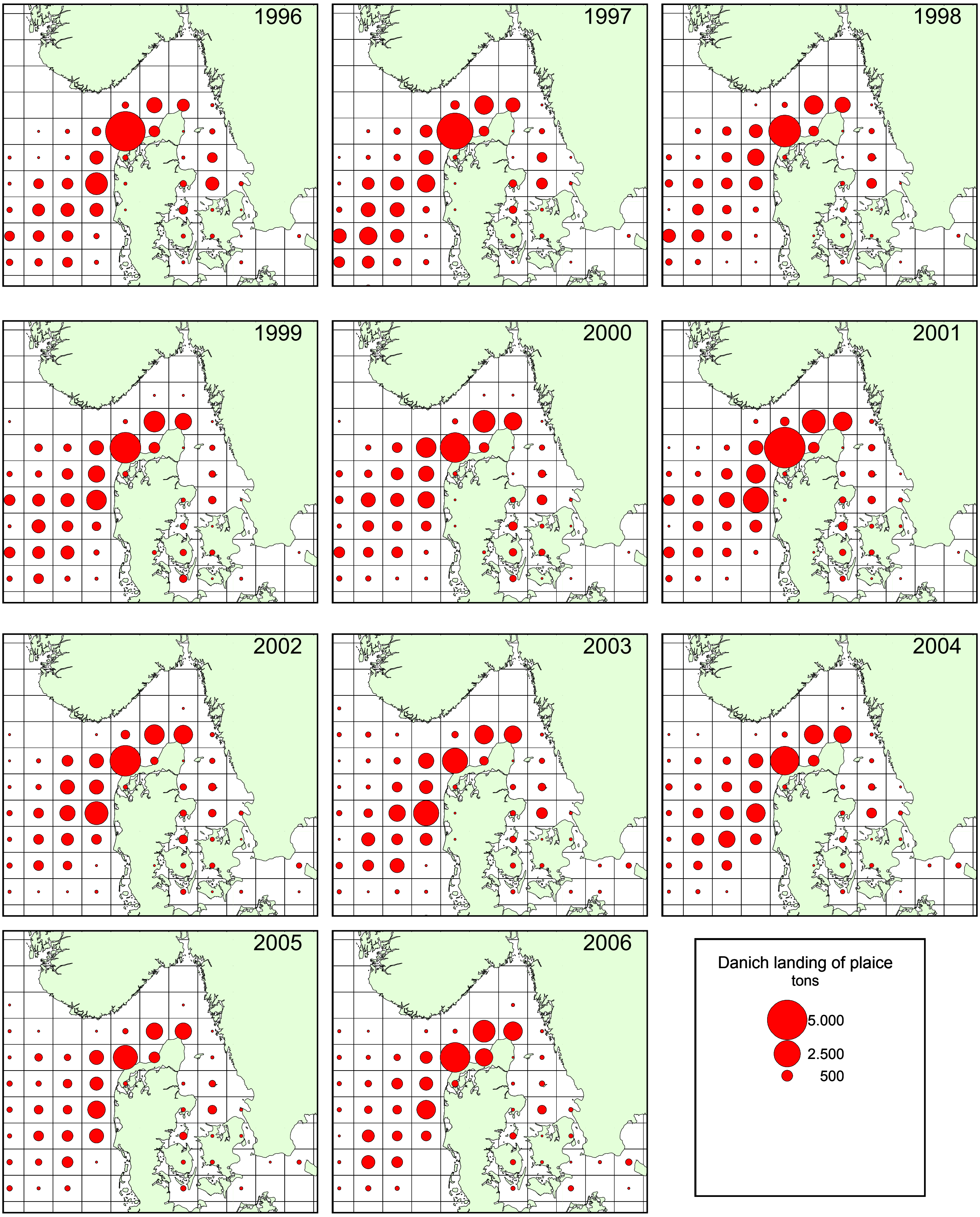
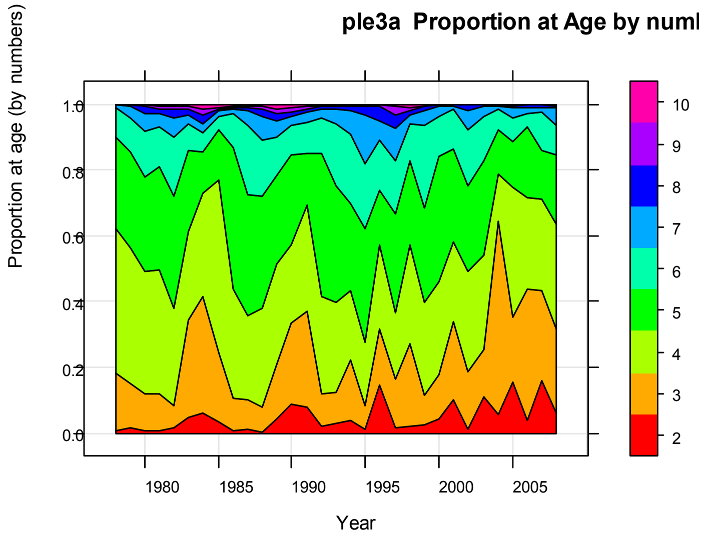


Figure 7.2.1. Annual distribution of Danish plaice landings (from WGNSSK 2007).



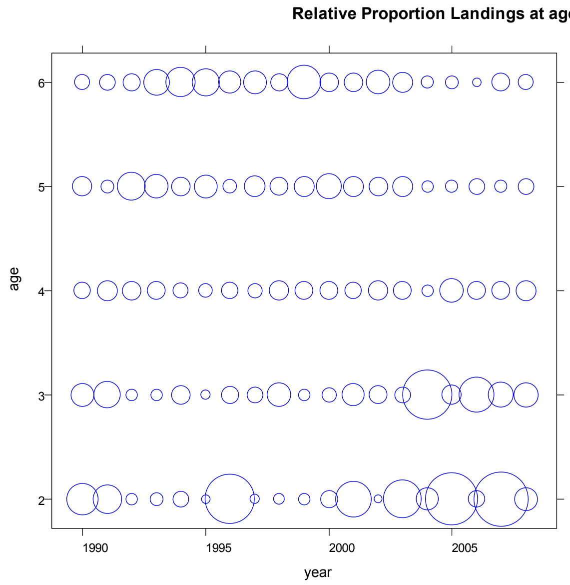


Figure 7.2.2. Plaice IIIa. Relative landings at age.

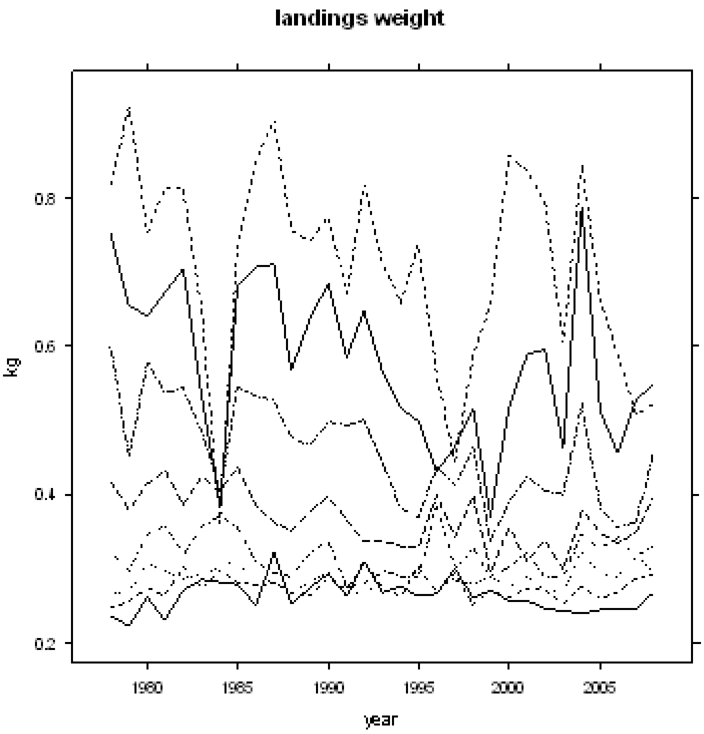


Figure 7.2.3. Landings weight at age

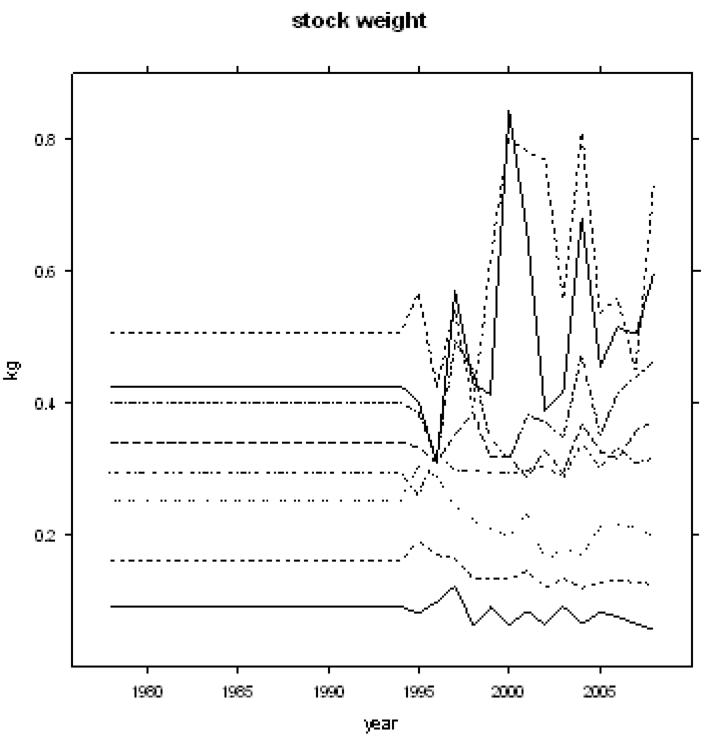


Figure 7.2.4. Stock weight at age

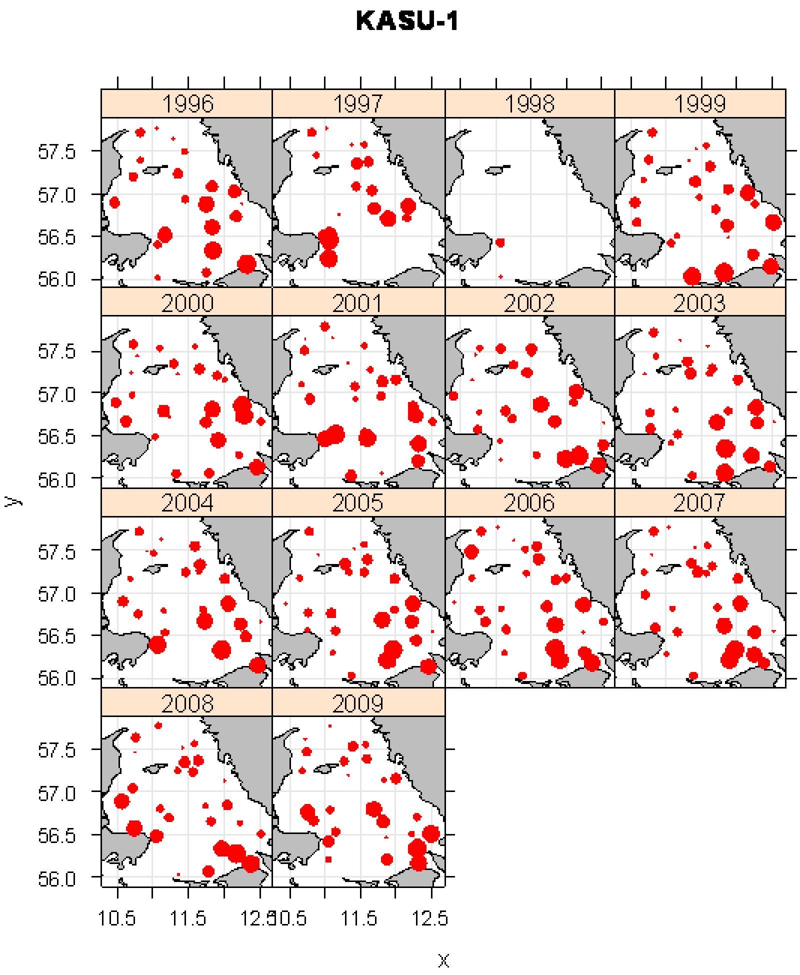


Figure 7.2.5. Plaice IIIa. Distribution and abundance of KASU Q1 catches.

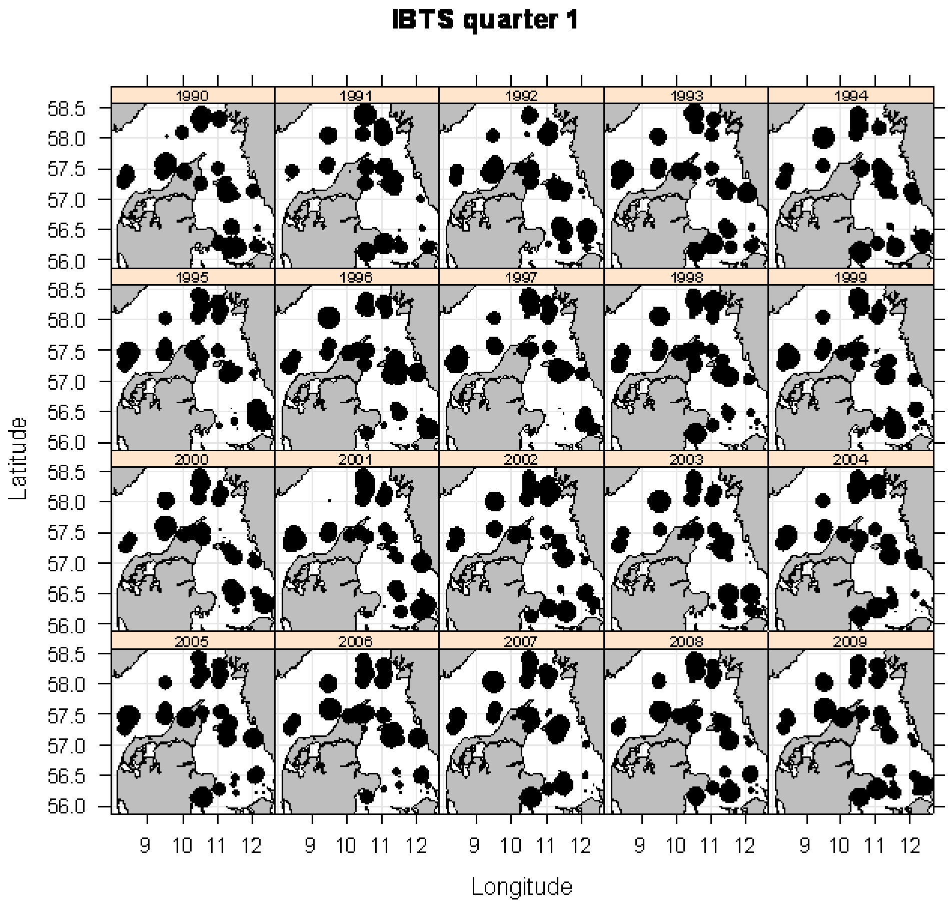


Figure 7.2.6. Plaice IIIa. Distribution and abundance from IBTS Q1

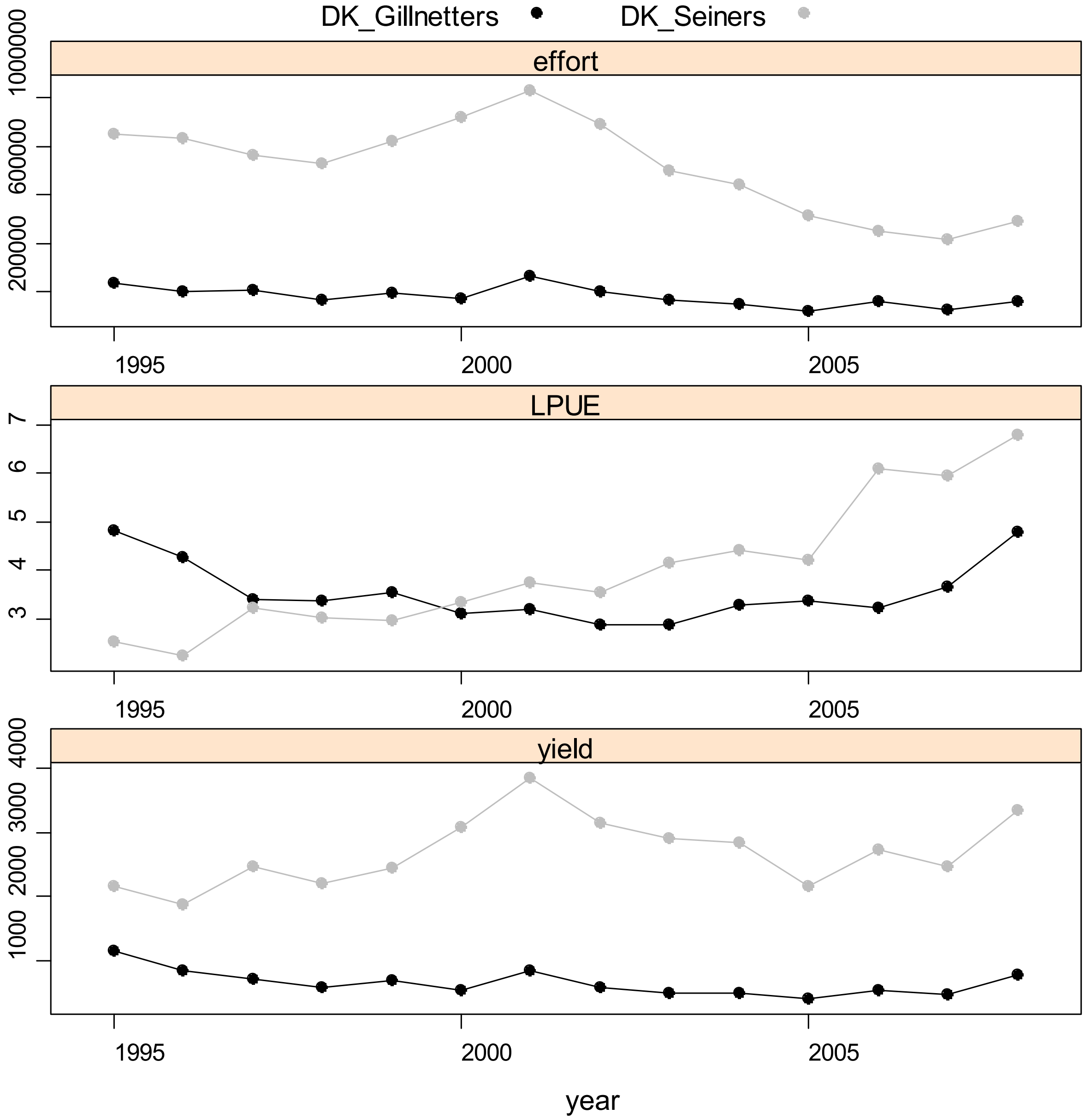


Figure 7.2.7. Plaice IIIa. Effort, landing and LPUE for the Danish commercial tuning fleets.

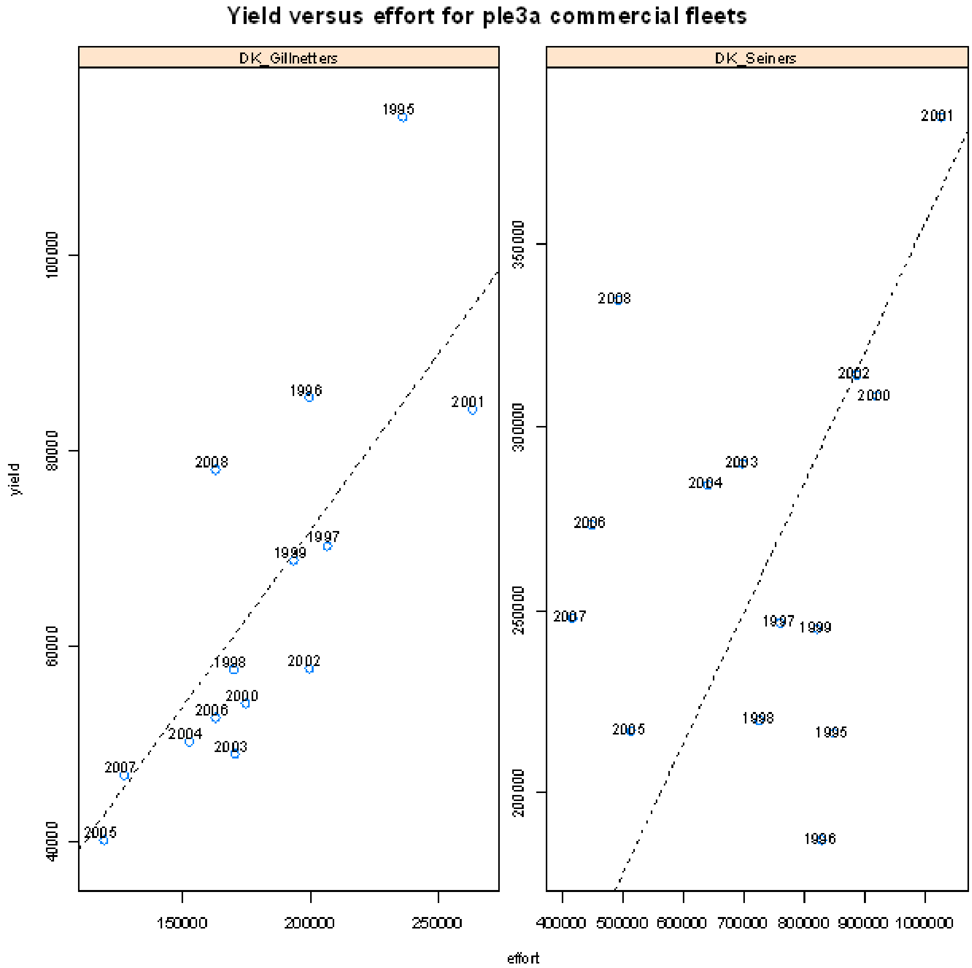


Figure 7.2.8. Plaice IIIa. Yield vs. effort for the commercial tuning fleets.

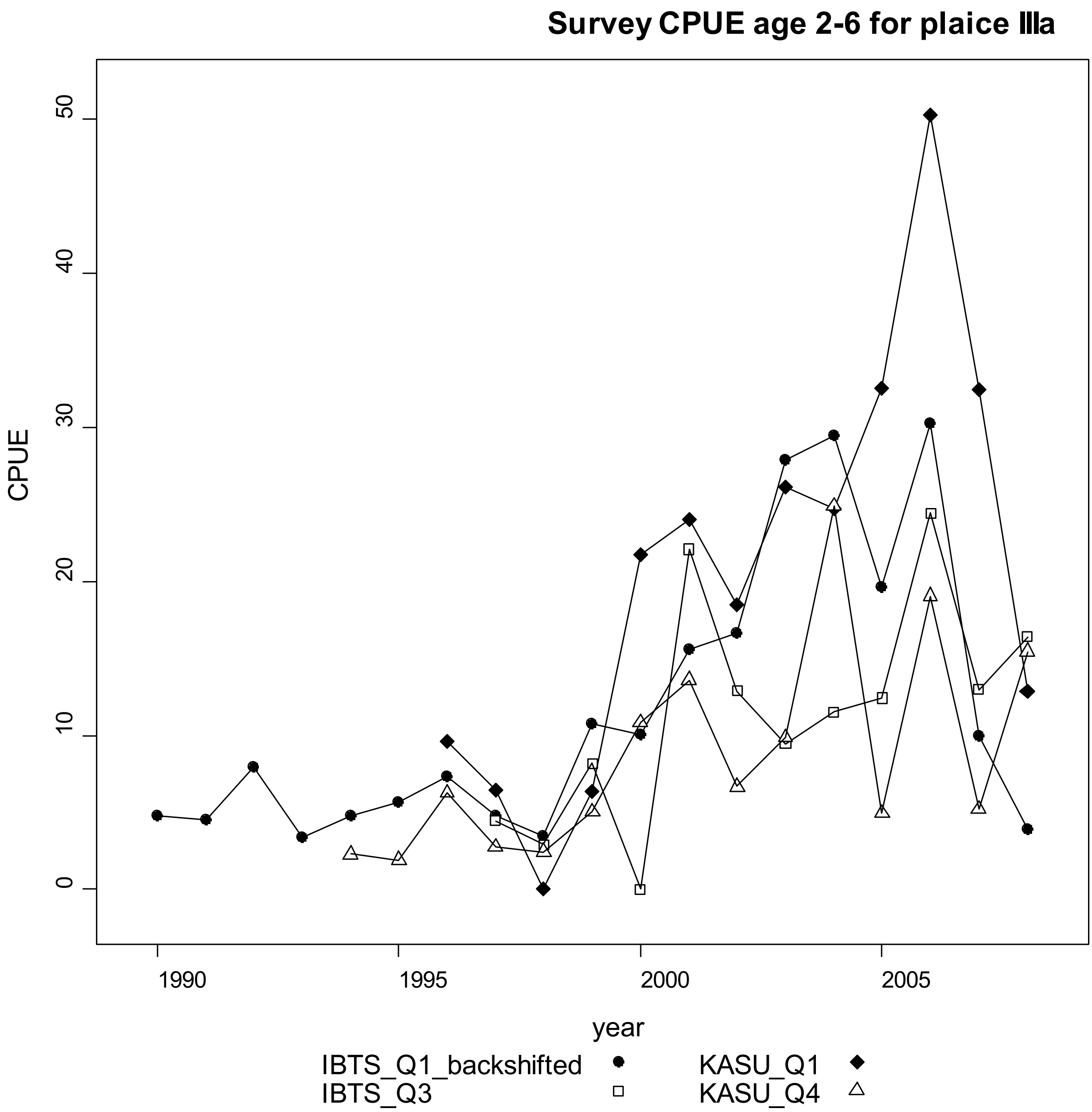


Figure 7.3.1. Plaice IIIa. Combined CPUE index by survey using stock weight at age data.

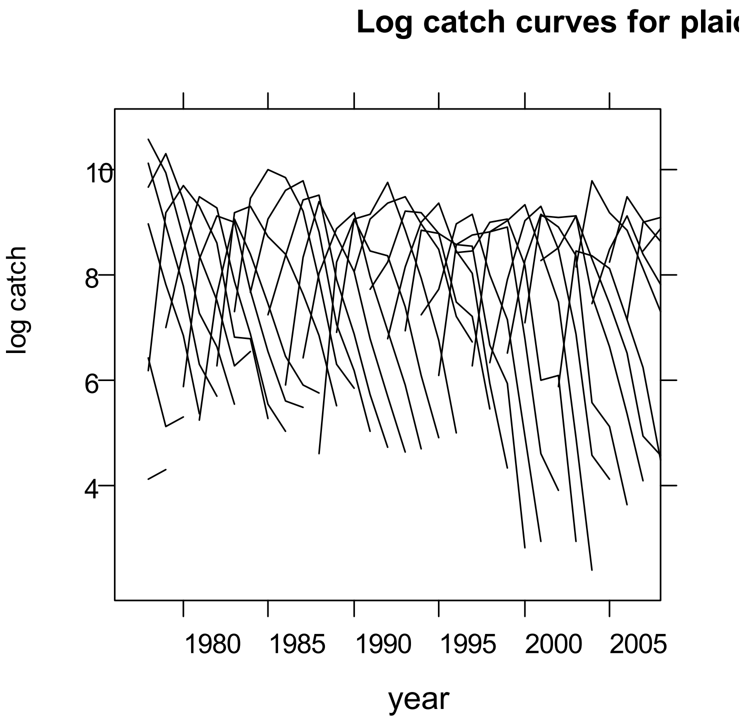
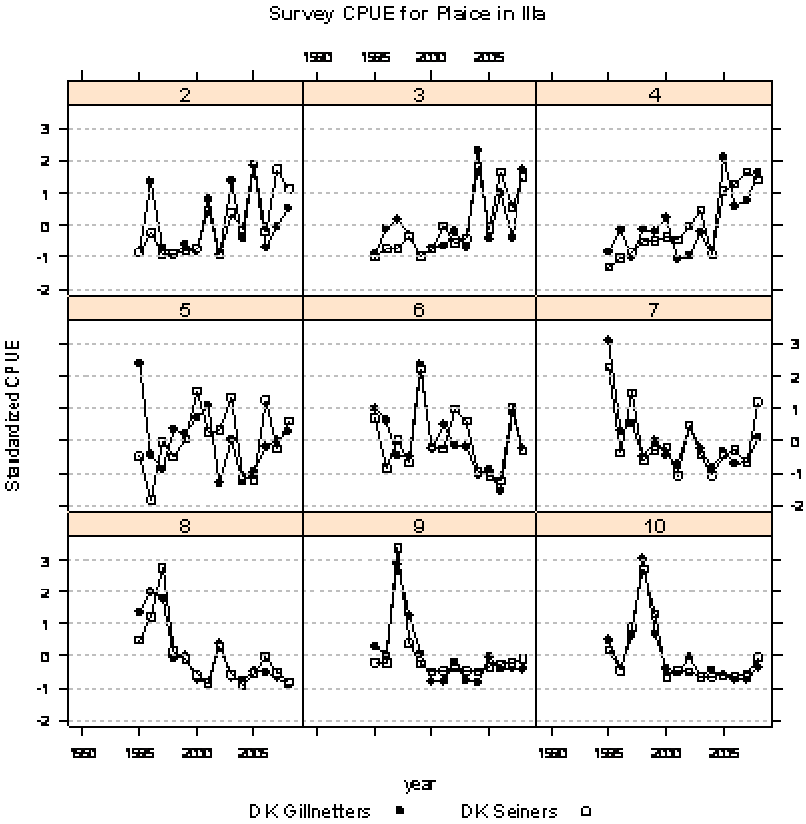


Figure 7.3.2. Plaice IIIa. Log catch curves by cohort in the landings at age



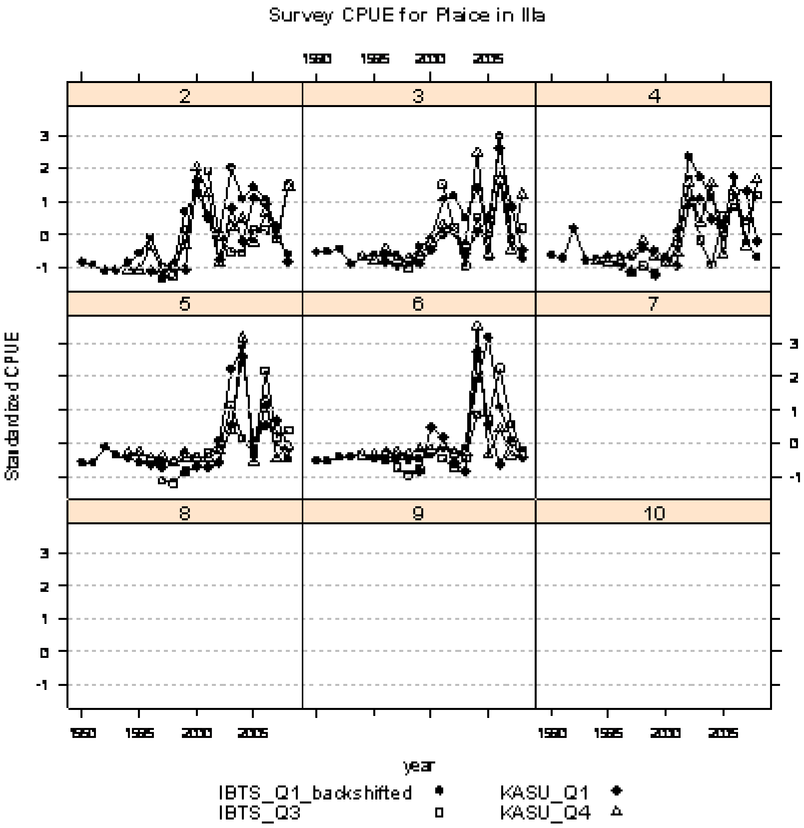
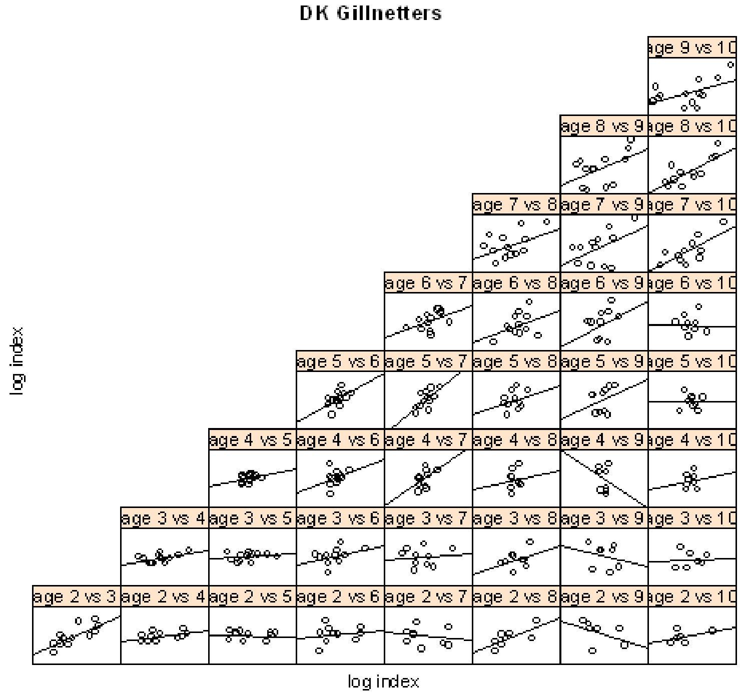


Figure 7.3.3. Plaice IIIa. Standardised Abundance index from tuning series.



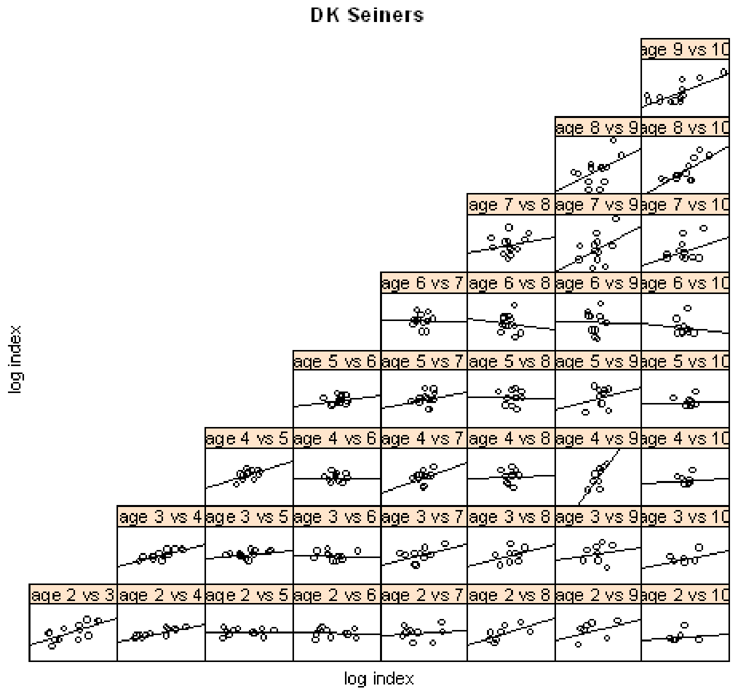
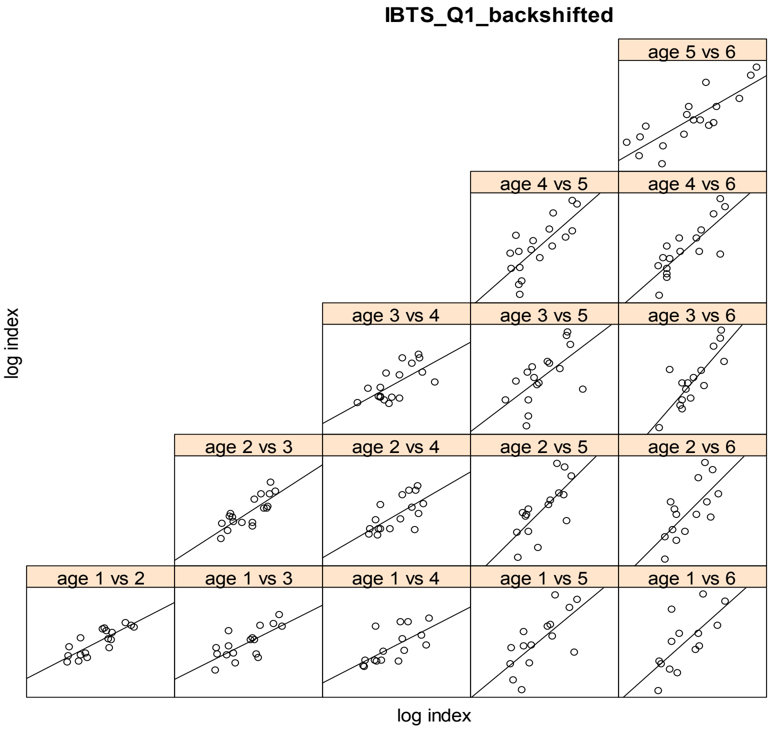


Figure 7.3.4. Plaice IIIa. Internal consistency for the commercial tuning fleets: matrix scatterplots and Log cohort abundance. Up : DK_Gillnetters. Bottom: DK_Seiners.



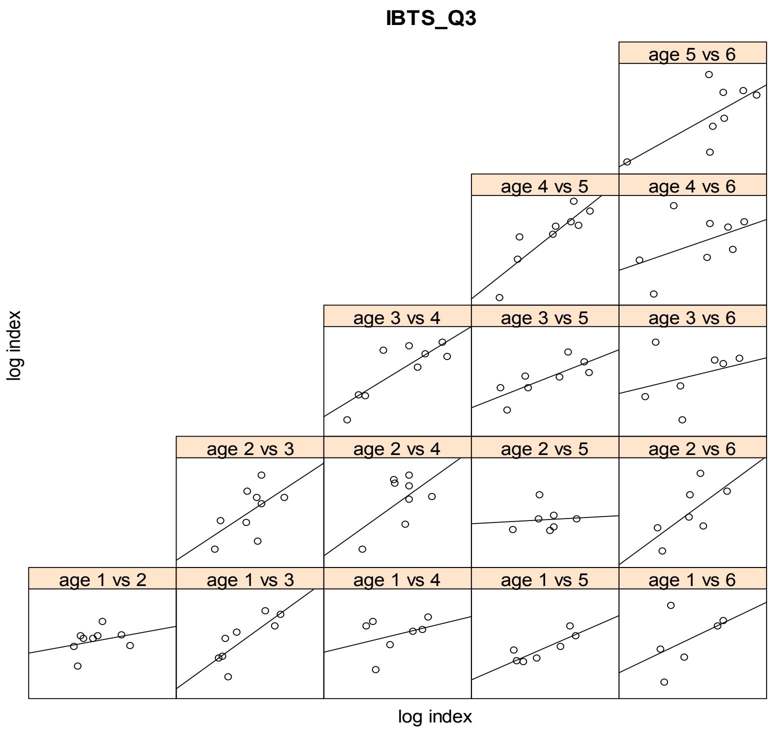
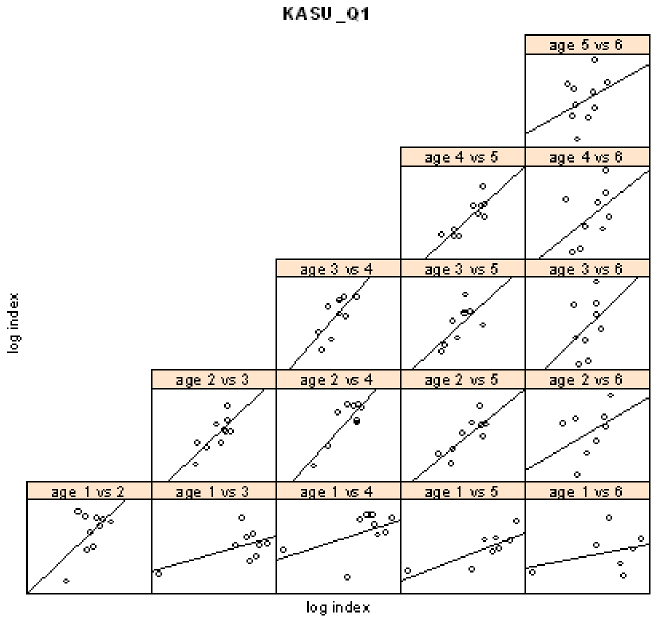


Figure 7.3.5. Plaice IIIa. Internal consistency for the IBTS survey: matrix scatterplots and Log cohort abundance. Top : IBTS Q1 backshifted. Bottom: IBTS Q3.



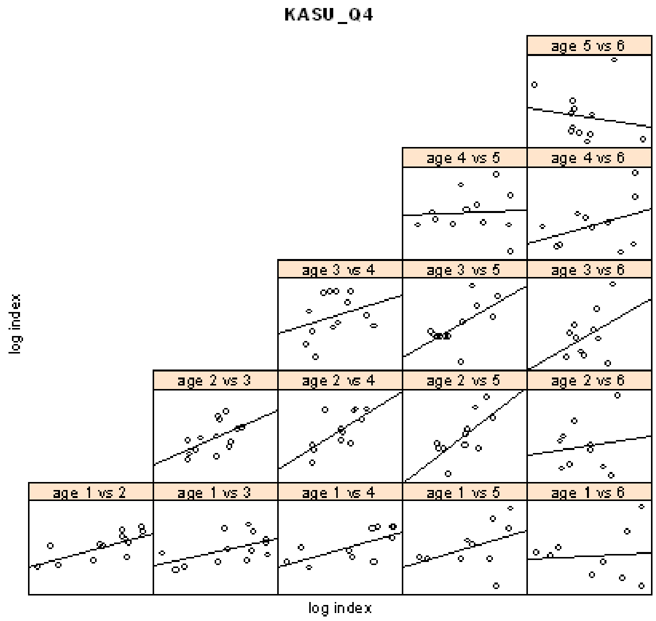


Figure 7.3.6 Internal consistency for the KASU survey: matrix scatterplots and Log cohort abundance. Top: KASU Q1. Bottom: KASU Q4.

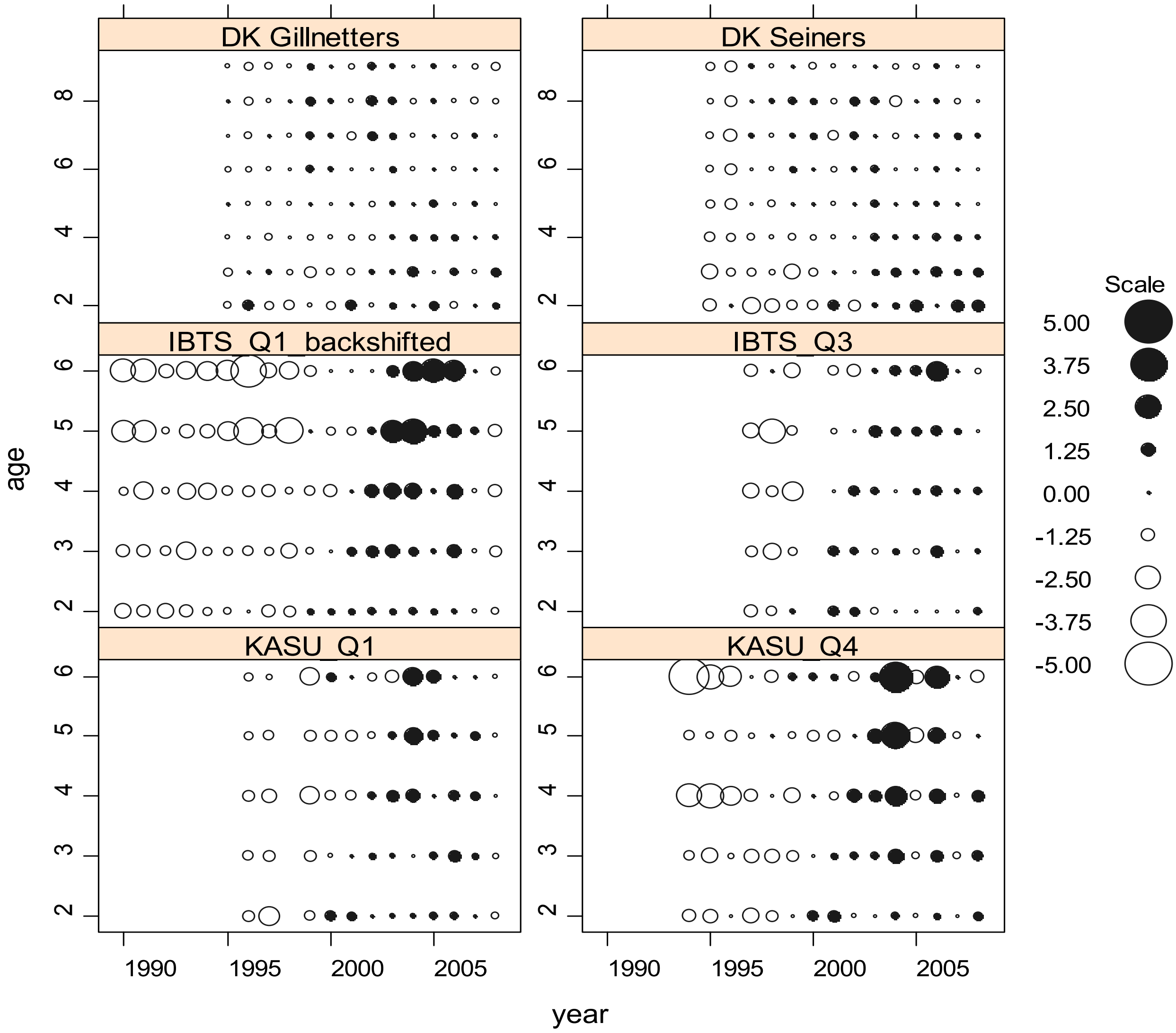


Figure 7.3.7. Plaice IIIa. Log catchability residuals for combined XSA

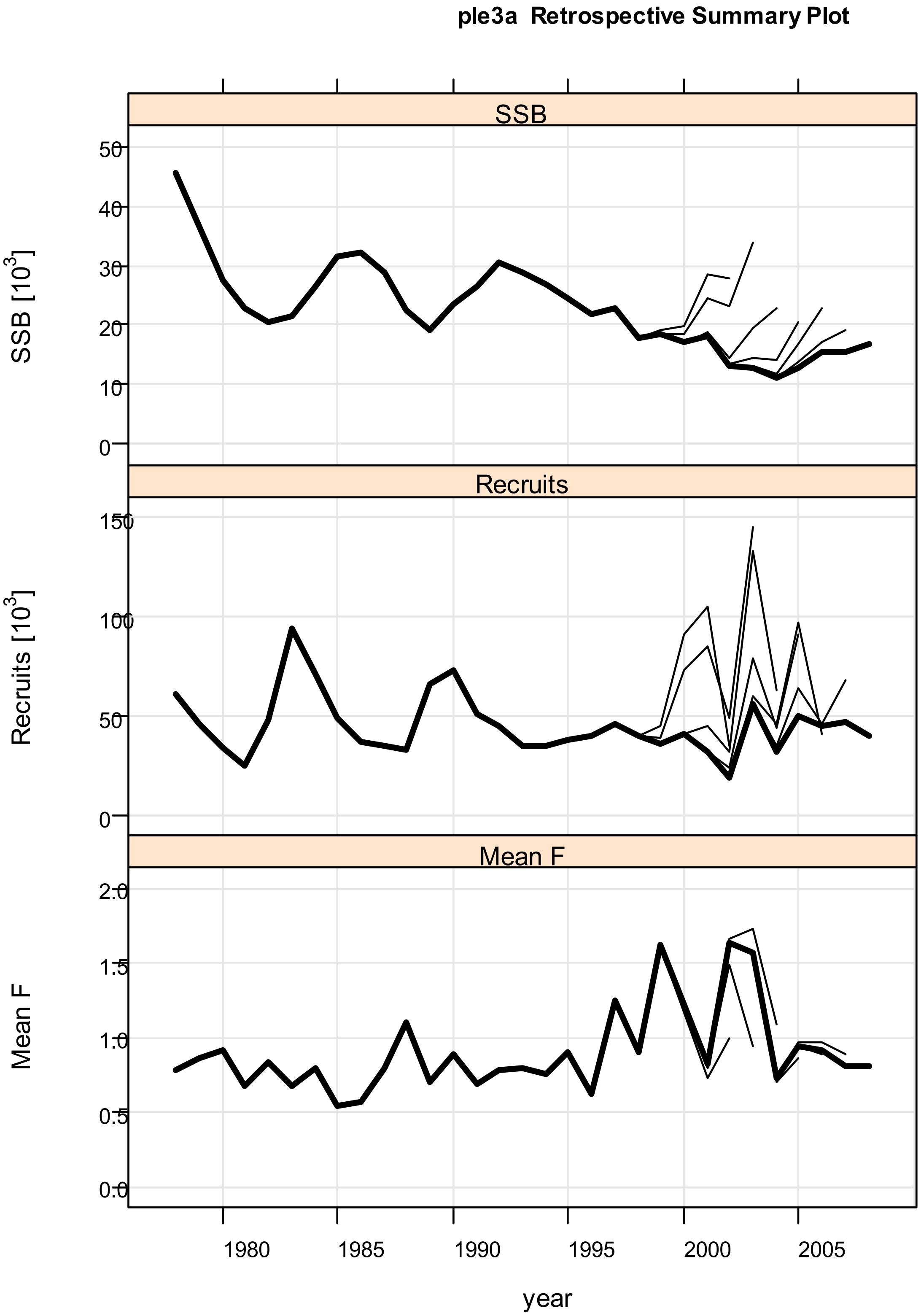


Figure 7.3.8. Plaice IIIa. SPALY run. Log q residuals and retrospective pattern.

8 Plaice in Subarea IV

A Stock Annex is available for North Sea plaice. Therefore only deviations from the stock annex are presented within this Section of the report.

8.1 General

8.1.1 Ecosystem aspects

No new information on ecosystem aspects was presented at the working group in 2009. All available information on ecosystem aspects can be found in the Stock Annex.

8.1.2 Fisheries

No new information on fisheries aspects was presented at the working group in 2009. All available information can be found in the Stock Annex

8.1.3 ICES Advice

The information in this section is taken from the ACOM summary sheet 2008, section 6.4.7.

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

ACOM summary sheet in section 6.4.7: "According to the management plan adopted by the EC in 2007, the fishing mortality in 2009 should be reduced by 10% compared to the fishing mortality estimated for the preceding year (F2007 = F2008 = 0.39) with the constraint that the change in TAC should not be more than 15%. A 10% reduction in fishing mortality corresponds to an F of 0.35 and landings of 55 500 t in 2009, which is within the 15% TAC change (TAC 2008 = 49 000 t)".

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

ACOM summary sheet in section 6.4.7 states: *"The current total fishing mortality (including discards) is estimated to be 0.39, which is above the rate expected to lead to high long-term yields and low risk of stock depletion. "*

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply human consumption landings of less than 86 000 t in 2009, which is expected to maintain SSB above Bpa in 2010, while maintaining F below Fpa.

Advice for mixed fisheries management

The information in this section is taken from the North Sea Advice overview section 6.3

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2009 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *should minimize bycatch or discards of cod;*
- *should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
- *should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);*
- *where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*
- *should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.*

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries, taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

Key points highlighted in the ACFM summary sheet

Based on the most recent estimate of SSB (in 2008) and fishing mortality (in 2007), ICES classifies the stock as having full reproductive capacity and as being harvested sustainably. SSB is now estimated to have increased above the B_{pa}. Fishing mortality is estimated to have decreased to below F_{pa}. Recruitment has been below the long-term average since 2004; however, recruitment in 2007 is of average strength.

Due to a range of factors such as effort limitations, increases in fuel prices, and disproportionate changes in the TACs for the two main target species plaice and sole, the fishing effort of the major fleets has concentrated in the southern part of the North Sea. This is the area where many juvenile fish are found. In addition, juvenile plaice has shown a more offshore distribution in recent years. The combination of a change in fishing pattern and the spatial distribution of juvenile plaice has lead to an increase in discarding of plaice.

Different trends in catch are observed in different areas of the North Sea. Commercial cpue series and a survey in the central part of the North Sea appear to indicate an increase in the plaice stock, whereas a survey in the southern North Sea indicates that the stock has remained at a low level, and a survey in the coastal region indicates a decrease in the plaice stock. This discrepancy adds to noise in the assessment.

8.1.4 Management

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year until an F of *circa* 0.3 is reached. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% of the TAC between consecutive years.

ICES has evaluated the agreed long-term management plan (Council Regulation (EC) No. 676/2007) for plaice and sole. For plaice, the management plan evaluation is not yet conclusive with regards to consistency with the precautionary approach. The Review of an evaluation of the management plan for fisheries exploiting the stocks of plaice and sole in the North Sea (Council Regulation (EC) No 676/272) can be found in annex

The implementation of the management plan resulted in an agreed TAC of 49.000 in 2008 and 55.500 tonnes in 2009.

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. (see section 1.2.1 for complete list). The area's are Kattegat, part of IIIa not covered by Skagerrak 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); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

8.2 Data available

8.2.1 Catch

Total landings of North Sea plaice in 2008 (Table 8.2.1) were estimated by the WG at 48 875t, which is 869 t less than the 2007 landings. The TAC of 49,000 t, 125 t more than the WG estimated landings, was thus almost taken in 2008. The discards time series used in the assessment was derived from Dutch, Danish, German and UK discards observations for 2000–2008.

A considerable proportion of the total landings of Plaice in Subarea IV are attributed to the UK. However, the discards from UK beam trawl and Dutch >100mm fishery is very poorly sampled. For example in 2005, 2007 and 2008 no UK beam trawl vessels were surveyed, and the discard estimates are only based on the Otter trawl fishery.

There is indeed considerable variability in the observed UK discards between the years and those estimates are inconsistent with the existing knowledge on the spatial and temporal patterns in fishing effort and discards (Figure 8.2.2). In the absence of additional information, the WKFLAT 2009 recommended to assume a constant ratio between the UK and Dutch discard numbers at age:

$$\hat{D}_{a,y}^{UK} = \frac{\sum_{y=2002}^{2007} D_{a,y}^{UK}}{\sum_{y=2002}^{2007} D_{a,y}^{NL}} \times D_{a,y}^{NL} \qquad 1.$$

where $D_{a,y}^{UK}$, $\hat{D}_{a,y}^{UK}$, and $D_{a,y}^{NL}$ are the observed and estimated UK, and observed Dutch discard numbers of year y and age a, respectively. This new procedure is implemented in this years assessment.

Figure 8.2.1 presents a time series of landings, catches and discards from these different sources.

To reconstruct the number of plaice discards at age before 2000, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Appendix 1).

The WGNSK2008 review in the Technical minutes argues that 'The estimation and reconstructing the historical discarding values before 1999 is not very clear and should have a high priority in the next benchmark assessment round'. This issue has indeed been addressed in WKFLAT2009.

The conceptual complexity of the current reconstruction of the historic (<2000) discards ((ICES 2005); (van Keeken et al. 2004a)), has lead to development of a new statistical catch at age model, which explicitly incorporates the discard reconstruction into the assessment (Aarts and Poos 2009). The new aspect of the proposed method by (Aarts and Poos 2009) is that it does not assume constant fishing and selectivity in time, but explicitly models the fishing and discard selectivity as a flexible function of time using spline smoothers. The proposed statistical catch at age model includes data on landings and discards separately, and therefore explicitly allows for observation errors on those, and other data sources.

WKFLAT recommends to run the Statistical Catch at Age model (SCA model) in parallel to XSA, and evaluate the stock summaries. Once the Statistical Catch at Age model has been tested for a number of years, it should be adopted as the assessment method on which the management advice is based.

8.2.2 Age compositions

The landing numbers at age are presented in Table 8.2.2.

The discard numbers at age were calculated using the discards raising procedures described above. The discard numbers at age are presented in Table 8.2.3. Catch numbers-at-age are presented as the sum of landings numbers at age and discards numbers at age in Table 8.2.4. Figure 8.2.3 presents the landings-at-age, and discards-at-age. Figure 8.2.4 presents the resulting catch-at-age.

8.2.3 Weight at age

Stock weights at age are presented in Table 8.2.5. Stock weight at age has varied considerably over time, especially for the older ages. There has been a long-term decline in the observed stock weight at age (Figure 8.2.5). This may be due to non-representative sampling of the different sexes in the population, mainly in the Dutch sampling programme. The stock weights of the older ages are based on the market samples in the first quarter. In these market samples, the sex ratio for the older ages is skewed towards the lighter males. Particularly in 2007 the stock weight estimates for several of the older ages were below the weights of the same cohort in the previous year. In 2008 the stock weight at age of most ages were above the 2007 estimates, but in-line with the last 4 years average. Discard, landing, and catch weights at age are presented in Table 8.2.6, 8.2.7 and 8.2.8 respectively. Figure 8.2.5 presents the stock, discards, landings and catch weights at age.

8.2.4 Maturity and natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 8.2.9) is used for the estimation of SSB in North Sea plaice.

8.2.5 Catch, effort and research vessel data

Three different survey indices can been used as tuning fleets are (Table 8.2.10 and Figure 8.2.6.):

- Beam Trawl Survey RV Isis (BTS-Isis)
- Beam Trawl Survey RV Tridens (BTS-Tridens)
- Sole Net Survey in September-October (SNS)

Additional Survey indices that can be used for recruitment estimates are (Table 8.2.11):

- Demersal Fish Survey (DFS)

Traditionally, for the Sole Net Survey (SNS & SNSQ2) Ages 1 to 3 were used for tuning the North Sea plaice assessment; the 0-group index is used in the RCT3. The internal consistency of the survey indices used for tuning appears relatively high for the entire age-range of each individual survey (Figures 8.2.7–8.2.9).

For last year (2008) the observed BTS-Tridens index was very high compared to previous years. An investigation of the raw length distribution corrected for effort (Figure 8.2.10) extracted from the ICES database indeed indicated that large number of individuals were observed onboard the Tridens. Also the 2008 index data point within each internal consistency plot (Figure 8.2.7) didn't show up as an outlier, suggesting that the large number of individuals resulted from high survival of the year class in question.

Commercial LPUE series (consisting of an effort series and landings-at-age series) that can be used as tuning fleets are (Table 8.2.12 and Figure 8.2.11):

- The Dutch beam trawl fleet
- The UK beam trawl fleet excluding all flag vessels

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. Up until 2002, the age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time.

The commercial LPUE data of the Dutch beam trawl-fleet, which dominated the fishery, will most likely be biased due to (individual) quota restrictions and increased fuel prices, which caused fishermen to leave productive fishing grounds in the more northern region.. A method that corrects for such spatial changes in effort has been developed (Quirijns and Poos 2008 WD 1). Under the assumption that discarding is negligible for the older ages, the LPUE represents CPUE, and this time series could be used to tune age structured assessment methods. Also, age-aggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns and Poos 2008, WD 1), by area and fleet component, can be used as indication of stock development (Figure 8.2.12 and Figure 8.2.13)

Effort of the Dutch beam trawl fleet and of the English beam trawl vessels landing in the Netherlands, by area and fleet component, are in Figure 8.2.14 and Figure 8.2.15 shows the spatial distribution of effort.

The age composition of the combined LPUE used in the exploratory analysis is shown in Figure 8.2.16

Plaice LPUE, corrected for directed fishing under a TAC constraint, of the Dutch fleet shows a substantial decrease in the years 1990–1997, after which overall LPUE remains more or less at the same level. In 2004 the Dutch LPUE in the more northern and central North Sea has increased substantially. In 2008 an increase in the more southern North Sea also becomes evident The LPUE pattern of the Dutch fleet appears to correspond well with the stock dynamics of the XSA assessment. On average the LPUE first decreased to about 58% of the level it had in 1990, but has been increasing the last four years from about 1 ton/day up to 1.4 ton/day.

In the benchmark assessment, first attempts were made to include the LPUE into the stock assessment. This resulted in lower SSBs and higher F estimates, which was thought to be caused by reduction in fishing speed due to increased fuel prices and unrecorded discarding of marketable plaice. Consequently the WKFLAT recommended to include the LPUE index in to the assessment process, but to exclude LPUE series the final assessment run upon which management advice is based.

8.3 Data analyses

The assessment of North Sea plaice by XSA was carried out using the FLR version of XSA (1.99.) in R version 2.8.1. All analyses were done in FLR.

8.3.1 Reviews of last year's assessment

Some relevant general and technical comments"One of the main problems seem to be changes in distribution pattern of this stock components and changes in fishery and discarding practice" and "Survey data showing very different profiles for the younger age groups " Changes in the distribution of the stock and fishery will most likely have a major effect on the assessment of the stock, particularly when the different tuning indices cover different areas of the North Sea. This issue has been noted by the Benchmark assessment and the WGBEAM. A combined index based on BTS-Isis and Tridens survey that captures spatial changes in the distribution of the stock has been put forward as a first solution. It is expected that such a combined index will be made available by WGBEAM for the 2010 WGNSSK

- *"…commercial fleet data usable for the older age groups"* The commercial LPUE has been included in the exploratory runs of the assessment.

- *"Discards data have been developed further, which is good. However there is no full time series of discard observations available for the period before 1999. The estimation and reconstructing the historical discarding values before 1999 is not very clear and should have a high priority in the next benchmark assessment round."* A new statistical catch-at-age model (see Aarts & Poos 2009) assuming flexible fishing and discard selectivity functions has been developed and results are included into the exploratory runs.

- *"The weight at age data is also of concern, long term decline of older ages, cohort effect on landing wages and so on. For example the decreasing stock weights at age* *should be explored, just because they have a strong influence on TSB and SSB calculations."* This point has not been addressed by the WKFLAT. Although a long-term decline in weight at age is evident, the most recent data indicated a increase relative to the 2007 observations

- *"Likewise maturity ogive is influenced by decreasing growth rate and it is very unlikely, that maturation process is constant year after year. This needs a more in depth study. It usually change the estimates of SSB and the perception of the stock dynamics"*. This issue has not been addressed by the WKFLAT

8.3.2 Exploratory catch-at-age-based analyses

The following exploratory analysis have been carried out:

1. explore sensitivity to different structural model assumption in XSA
2. explore sensitivity to different combinations of tuning series in XSA
3. explore internal consistency for the age-structured corrected LPUE series and investigating the correlation between LPUE and stock size at age and the effect of including the corrected LPUE on the assessment
4. stock assessment using the statistical catch-at-age model as described in Aarts & Poos (2009).

Structural model assumptions

The effect of setting the plus-group at different ages was studied by running XSA with either a plus group at age 10 or at 15. The setting of the plus group has an effect on both the SSB and F estimates coming from the XSA assessment (Fig 8.3.2). In the beginning of the resulting time series, the SSB is higher with the plus group set at age 15 compared to age 10. In the more recent part of the assessment, the SSB estimates are lower when using a plus group at age 15 compared to age 10. For the estimates of fishing mortality the opposite effect can be found.

Different combinations of tuning series

A series of XSA runs was carried out with all possible permutations of the available survey tuning fleets. The settings of the XSA model were the same as in WGNSSK 2008. The results (Figure 8.3.3) also this year indicate that the selection of tuning fleets does strongly affect the perception of SSB and F in the most recent part of the assessment; The variance in the SSB estimates for the terminal year as a result of the permutations is high. The inclusion of only the BTS –Tridens would lead to a much higher perception of the final year SSB, combined with a much lower F estimate. Inclusion of only the BTS index, or a combination of the indices result in estimates between these two extremes.

Corrected age-structured LPUE data

Internal consistency plots were generated to explore the within year class correlation. The results (Figure 8.3.4) suggest weak correlation with for ages below 4. This is most likely a reflection of the low selectivity for these ages and the fact that most juveniles are not landed. However, ages 4 and older, show strong internal consistency. The explore the benefits for including the LPUE in future XSA analysis, correlations between current estimated stock size (excluding the LPUE) and LPUE is investigated. Age-structured pair-wise plots (Figure 8.3.5) show strong correlation between LPUE and stock size for the ages 4 and older, but the estimated correlations will be strongly influenced by the strong 1996 and 2001 year classes. Inclusion of the corrected LPUE into the assessment leads to a estimated SSB (Figure 8.3.6) which is 244 instead of the 344 observed in the current assessment. The estimates of F increase from 0.25 (current assessment) up to 0.30.

Statistical catch at age-model

The statistical catch at age (SCA) model that can be used to assess the North Sea plaice stock is described in Aarts and Poos (2009). This model uses the same tuning survey indices as the XSA used in the final run. Rather than using the reconstructed discards, the model estimates the discards based on the total mortality that can be estimated from the tuning series, while the fishing mortality can be estimated from the landings, and the background natural mortality is assumed to be constant for all ages and years. The starting values for the optimizer are taken from the Aarts and Poos article, except of course for the recruitment and F estimates in 2008. The SCA model estimates similar stock trends compared to the XSA in the final run. However, the median SSB in 2008 is estimated to be 312 000 tonnes, with 95% confidence bounds between 270 000 and 358 000 t (Figure 8.3.7 top left). The 95% confidence bounds for F range between 0.15 and 0.22 (Figure 8.3.7 top right). Like in the XSA assessment, the BTS- Tridens is characterised by positive residuals for all ages in the final year. Figure 8.3.7 (bottom) shows that the discards are underestimated by the model since 2005. This is mainly caused by an underestimation of age 2 (Figure 8.3.8), which is the age where most discarding (in weight) takes place. This underestimation of age 2 discarding is likely the result of a low number of degrees of freedom that are used to describe the discarding selectivity pattern. In the future, the selectivity pattern for the discards could be described by more degrees of freedom (used in the basic spline). Also, a penalty could be introduced on deviation from the observed total discards in weight.

8.3.3 Conclusions drawn from exploratory analyses

Like in previous years, the plus group was set to 10, which has a minor effect on the assessment of F and SSB in the terminal year. The different survey tuning series available give different perceptions of the development of the stock in the most recent part of the assessment. This difference in the signals from different areas in the North Sea corresponds to the observations from the landings per unit effort from the Dutch beam trawl fleet. Because the working group has not been able to model these differences, all the available survey tuning indices are used to average across the signals. Inclusion of the corrected LPUE leads to large decrease of the perceived size of the stock. The LPUE may be an underestimation in the true LPUE because of unrecorded discards of marketable plaice and reduction in fishing speed due to increases in fuel prices.

8.3.4 Final assessment

The settings for the final assessment that is used for the catch option table, compared to the settings in earlier years is given below:

Year	2009
Catch at age	Landings + (reconstructed) discards based on NL, DK + UK + GE fleets
Fleets	BTS-Isis 1985–2007 1–8 BTS-Tridens 1996–2007 1–9 SNS 1982–2007 1–3
Plus group	10
First tuning year	1982
Last data year	2008
Time series weights	No taper
Catchability dependent on stock size for age <	1
Catchability independent of ages for ages >=	6
Survivor estimates shrunk towards the mean F	5 years / 5 years
s.e. of the mean for shrinkage	2.0
Minimum standard error for population estimates	0.3
Prior weighting	Not applied

The full diagnostics are presented in Table 8.3.1. The log catchability residuals for the tuning fleets in the final run are dominated by negative values for the SNS tuning index in the most recent period, and positive values for the BTS-Tridens in the younger ages (Figure 8.3.9). The high BTS-Tridens tuning index for 1 year old individuals leads to a high residual in the XSA assessment for this survey, year and age. Fishing mortality and stock numbers are shown in Tables 8.3.2 and 8.3.3. respectively. The SSB in 2008 was estimated at 345 kt. Mean F(2–6) was estimated at 0.25. Recruitment of the 2007 year class, in 2008 at the age of 1, was estimated at 891 million in the XSA. Retrospective analysis of the XSA presented in Figure 8.3.11 indicate that historic estimates for SSB during the last three years were much lower compared to the current estimate. Accordingly, the fishing mortality since 2005 estimated in this year are lower than the estimates in the previous assessments. This is likely the result of the increase of younger individuals in the more northern region (surveyed by the Tridens), that have aged and therefore only recently have a high impact on the estimation of the stock size..

8.4 Historic Stock Trends

Table 8.4.1. and Figure 8.4.1. present the trends in landings, mean F(2–6), F(human consumption, 2–6), SSB, TSB and recruitment since 1957. Reported landings gradu-

ally increased up to the late 1980s and then rapidly declined until 1995, in line with the decrease in TAC. The landings show a decline from 1987 onwards. Discards were particularly high in 1997 and 1998 (reconstructed), and in 2001 and2003 (observed), resulting from strong year classes. Fishing mortality increased until the late 1990s and reached its highest observed level in 1997. Since then, the estimates of fishing mortality have been fluctuating strongly. However, overall F has been lower since 2004, rapidly decreasing down to 0.25 in 2008, The peaks during 1997–1998 and 2001 have been mainly caused by peaks in F(discards). The F(human consumption) is estimated to decline since 1997, with little inter-annual variability. This year (2008), the F(human consumption) is the lowest estimate historically. Current fishing mortality is estimated at 0.25 ($F_{hc,2-6}$ = 0.13). The SSB increased to a peak in 1967 when the strong 1963 year class became mature. Since then, SSB declined to a level of around 260 kt in the early 1980s. Due to the recruitment of the strong year-classes 1981 and 1985, SSB again increased to a peak in 1987 of around 442 kt followed by a rapid decline (up to 1996). SSB has fluctuated around 220 kt in the last 10 years. The last four year SSB has rapidly increasing and is currently estimated at 345 kt. In plaice the inter-annual variability in recruitment is relatively small, except for a limited number of strong year classes. Previously only year classes 1963, 1981, 1985 and 1996 were considered to be strong. Including discard data in the assessment alters the recruitment estimates and indicates that 1984, 1986, 1987 were also relatively strong year classes and that the 1985 year class was by far the strongest year class on record. Recruitment shows a periodic change with relatively poor recruitment in the 1960s and relatively strong recruitment in the 1980s. The recruitment level in the 1990s appears to be somewhat lower than in the 1980s. The 1996 and 2001 year classes are estimated to be relatively strong, while the year classes since 2002 appear weak to average. The 2007 year class is below average, estimated at 891 kt.

The North Sea Fishers' Survey for 2008 resulted in a total of 303 responses, most of which are from areas 6b, 7 and 8. The respondents were divided into 3 three groups; the large vessel group was dominated by respondents fishing with beam trawls (70%), stating that the plaice abundance is "more" and "much more". This is a similar response as recorded in the 2007 survey. In terms of the size range of the plaice caught, patterns of responses are broadly similar to those expressed in the 2007 survey and strong modes at "all sizes" are present for each area. There has however been a decrease in the percentages reporting "mostly small" plaice in most areas. In terms of discarding, the model response was that there was "no change" in discarding. These patterns are generally similar to those recorded in the 2007 survey. Of those expressing an opinion, by vessel size, the modal response in each group was that recruitment had been "high". The comments received for plaice from the respondents indicate that abundances were increasing, that there had been "enormous" increases and that abundances are the "highest for 25 years", and that quota for plaice is too low.

8.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 8.5.1. Estimates from the RCT3 analysis of age 1 are presented in Table 8.5.2, and of age 2 in Table 8.5.3. For year class 2008 (age 1 in 2009) the values predicted by the two surveys (SNS and DFS) in RCT3 differ considerably and have high prediction standard errors (Table 8.5.2.), and therefore the geometric mean was accepted for the short-term forecasts (which is quite similar to the RCT3 estimate). Also for year class 2007 (age 2 in 2009), the estimates from SNS 0-group and DFS 0-group differ considerably and have high prediction standard errors, and so do the SNS 1-group and BTS 1-group (also used for the XSA) estimates, but less so. The WG decides to use the XSA estimate for the 2007 year class. In practice the estimates (XSA survivors, RCT3 or geometric mean) are quit similar

The recruitment estimates from the different sources are summarized in the text table below.

Year class	At age in 2009	XSA Survivors	RCT3	GM 1957–2006	Accepted estimate
2007	**2**	**676656**	645091	673614.4	RCT3 estimate
2008	1		1041086	**912907.1**	GM 1957–2006
2009	0			**912907.1**	GM 1957–2006

8.6 Short-term forecasts

Short-term prognoses have been carried out in FLR using FLSTF (1.99). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2008. The proportion of landings at age was taken to be the mean of the last three years, this proportion was used for the calculation of the discard and human consumption partial fishing mortality. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2009 year-class are taken from the long-term geometric mean (1957–2006). Input to the short term forecast is presented in table 8.6.1. The management options are given in Table 8.6.2A-C. The management options are given for three different assumptions on the F values for 2009; A) F_{2008} is assumed to be equal to the estimate for F in 2008, B) F_{2009} is 0.9 times F_{2008}, and C) F_{2009} is set such that the landings in 2009 equal the TAC of that same year. The table below shows the predicted F values in the intermediate year, SSB for 2010 and the corresponding landings for 2009, given the different assumptions about F in the intermediate year in the different scenarios.

Scenario	Assumption	F_{2009}	SSB_{2010}	$Landings_{2009}$
A	$F_{2009} = F_{2008}$	0.25	442 260	59 461
B	$F_{20089} = 0.9F_{2008}$	0.22	451 772	54 080
C	$TAC_{2009} = Landings_{2009}$	0.23	449 258	55 501

The detailed table for a forecast based on Fsq is given in Table 8.6.3A-C. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2008 (see section 8.1.4). Using this ICES rule of application the will presents scenario A as the basis for its forecast.

Yield and SSB, per recruit, under the condition of the current exploitation pattern are given in Figure 8.6.1 and Table 8.6.4. Fmax is estimated at 0.17.

8.7 Medium-term forecasts

No medium term projections were done for this stock because of time constraints.

8.8 Biological reference points

The current reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock-recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at 160 000 t and that $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4 (although the WG acknowledges that, since the noisy discards estimates have been included, the uncertainty of the estimates of stock status is much greater than that, see Dickey-Collas et al. 2008. $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t.

	ICES considered that:	ICES proposed that:
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 160 000 t	$\mathbf{B_{pa}}$ be set at 230 000 t
	$\mathbf{F_{lim}}$ is 0.74	$\mathbf{F_{pa}}$ be set at 0.60
Target reference points		$\mathbf{F_{y}}$ undefined

8.9 Quality of the assessment

Large differences are found in the trends in tuning series over the last seven years. The more northern BTS-Tridens index indicates much higher stock abundances than the two other tuning indices, BTS-Isis and particularly the SNS. The assessment which only includes the BTS-Tridens suggest an estimate of SSB which is about 300 kt higher relative to the SSB estimate tuned using the BTS-Isis and SNS index. This suggests a large spatial heterogeneity of the stock which is either explained by increased northwards migration or a higher survival in the more northern region due to an overall decrease in fishery induced mortality. The spatial difference of the stock trends is corroborated by the area disaggregated LPUE estimates from the Dutch beam trawl fleet. However, the historic development of the stock abundance as estimated by XSA shows good correspondence with the development of the average commercial LPUE of the Dutch beam trawl fleet.

A strong retrospective analysis of the assessment shows considerable recurring bias (Figure 8.3.7.). The current estimates of the biomass over the last three years considerably higher than the previous assessments. This retrospective pattern is the result of the high 2006-2008 tuning indices in general, and the fact that the cohorts being estimated stronger by BTS Tridens than the other surveys now reach the age where the index receives a higher weighting in the assessment.

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. Currently fleet level discard estimates are available for the past eight years. However, total sampling effort of the discards is low, and data is sparse. Also, samples may not always be available from relevant fleets and fisheries within a country. Particularly the UK and Dutch >100mm fishery, comprising >20% of the landings is poorly sampled. The assessment is considered to be uncertain because discards form a substantial part of the total catch but cannot be well estimated from the sparse sampling trips.

8.10 Status of the Stock

SSB in 2009 is estimated around 388 thousand tonnes which is above Bpa (230 000 t). Fishing mortality is estimated to have decrease from 0.31 in 2007 to 0.25 in 2008 (both below Fpa = 0.60), and is currently below the target F of 0.30. At the same time, Fishing mortality of the human consumption part of the catch is estimated to 0.13. Projected landings for 2010 at Fsq are 65 kt, which is slightly higher than to the projected landings for 2009 at Fsq (59 kt) which are much higher than the estimated landings of 2008 (49 kt). Projected discards for 2010 are approximately equal to the projected discards for 2008 at Fsq, but this is mainly based on the estimates of the abundance of year classes 2007 and 2008 coming in. Therefore, development of discarding in the next couple of years will depend on the true size of these year classes.

8.11 Management Considerations

Plaice is mainly taken by beam trawlers in a mixed fishery with sole in the southern and central part of the North Sea.

Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears to be reflected in recent estimates of fishing mortality. There are indications that technical efficiency has increased in this fishery, but these may have been counteracted by decreases in fishing efficiency resulting from reduced fishing speed in an attempt to reduce fuel consumption.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which are selected from 17 cm with a minimum landing size of 27 cm. Recent discards estimates indicate fluctuations around 50% discards in weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort results in increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by movement of juvenile plaice to deeper waters in recent years where they become more susceptible to the fishery. Also the LPUE data show a slower recovery of stock size in the southern regions that may be caused by higher fishing effort in the more coastal regions.

An STECF evaluation of the plaice box has indicated that: "From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of plaice: 1) At present, the Plaice Box still protects the majority of undersized plaice. Approximately 70 % of the undersized plaice are found in the Plaice Box and Wadden Sea. Despite the changed distribution, densities of juvenile plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality." (Grift *et al.* 2004).

The stock dynamics are dependent on the occurrence of strong year classes, but increased stock size in the more northern region of the North sea is most likely the direct consequence of reduced fishing mortality

The mean age in the landings is currently just around age 4, but used to be around age 5 in the beginning of the time series. This change may be caused by the high exploitation levels, but also by the shift in the spatial distribution of fishing effort towards inshore waters and by the shift in the spatial distribution of the fish. A lower exploitation level is expected to improve the survival of plaice, which could enhance the stability in the catches.

A shift in the age and size at maturation of plaice has been observed (Grift *et al.* 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. There is a risk that this is caused by a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole in the North sea to within safe biological limits. This should be reached through an annual reduction of fishing mortality (F) by 10% in relation to the fishing mortality estimated for the preceding year. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2007. The plan sets a maximum change of 15% of the TAC between consecutive years

ICES has evaluated the agreed long-term management plan (Council Regulation (EC) No. 676/2007) for plaice and sole. For plaice, the management plan evaluation is not yet conclusive with regards to consistency with the precautionary approach. The assessment is considered to be highly uncertain most importantly because the different survey tuning series in different areas of the North Sea indicate different trends in the most recent development of the stock. This uncertainty is compounded by a relatively strong retrospective pattern, where this years' assessment result estimates higher SSBs and lower fishing mortalities for the most recent years.

Table 8.2.1. North Sea Plaice. Nominal landings

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK	Others	Total	Un-allocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	23032		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	21519		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	20740		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	17400		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	16853		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	15912		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	17294		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	20638		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	24497	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	26104		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	25632		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	27839		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	31277		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	31128		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	27749		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	24395		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	20992		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	22134		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	19915	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	17061		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	20710		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	19147		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	16740		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	13892		65669	820	66489	73250
2004	4314	12123	231*	3649	23662	1744	1	15284		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	12705		54908	792	55700	59000
2006	3487	11907	132	3599	22764	1614	0	12429		55933	2010	57943	57441
2007	3866	8128	144	2643	21465	1224	4	11557		49031	713	49744	50261
2008	3396	8229	125	3138	20312	1051	20	11411		47682	1193	48875	49000
2009													55500

Table 8.2.2. North Sea plaice. Landing numbers-at-age

2009-05-07 15:10:41 units= thousands

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540
2005	2937	16685	26069	82278	17039	9533	5332	2614	2223	613
2006	355	18987	67465	25254	42525	6555	4967	2053	1235	1319
2007	1286	19205	37309	47053	14971	17142	2459	1856	543	1259
2008	380	10970	42865	37970	29476	5700	6752	912	673	896

Table 8.2.3. North Sea Plaice. Discards numbers-at-age

2009-05-07 15:11:35 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	127321	208401	231769	54869	278	58	0	0	0	0
2000	103422	171828	52354	65871	1632	312	269	168	0	0
2001	30295	352922	187964	75433	54602	212	46	1	0	0
2002	309770	178382	78012	13378	2130	761	119	1	0	0
2003	67615	518194	53760	19942	4213	455	5752	1	0	0
2004	232854	180824	119011	8073	1674	357	43	1	0	0
2005	93541	325997	46007	20842	4707	6077	157	1	0	0
2006	220473	225077	110215	10656	3000	410	754	194	0	0
2007	77312	205140	69312	10735	1437	7151	204	1649	0	0
2008	135406	252629	37393	6237	2282	517	8882	891	0	0

Table 8.2.4. North Sea plaice. Catch numbers-at-age

2009-05-07 15:12:29 units= thousands thousands

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	32356	49911	69038	45627	32732	8910	11029	9028	4973	10859
1958	66199	80681	45860	64619	36249	19659	8178	8000	6110	13148
1959	116086	144327	76829	36896	45836	23042	13873	6408	6596	16180
1960	73939	173852	106824	52019	22388	27848	14186	9013	5087	15153
1961	75578	146873	122406	68444	34311	12889	14680	9748	5996	14660
1962	51265	183468	123475	88495	50859	20814	9060	9035	5257	12801
1963	90913	140523	151249	86890	56476	31987	12848	6833	7047	16592
1964	66035	167982	104642	98560	60419	37414	15819	6595	3980	16886
1965	43708	435879	101464	56592	44597	30418	18361	8554	4213	17587
1966	38496	167269	414367	65887	38069	27495	16500	10784	6467	14928
1967	20199	139527	117836	265413	42006	22313	16175	8004	6728	11175
1968	73971	81666	87037	64670	146055	17197	10341	10102	3925	13365
1969	85195	82395	61934	55418	36358	104038	10410	6086	8192	16092
1970	123645	169774	78921	57440	45747	35235	78886	6311	4185	14840
1971	69356	126559	90636	36150	26485	22984	16913	29730	6414	16910
1972	72235	91998	96098	58620	23610	17071	14380	10903	18585	15651
1973	133620	81548	63107	73738	43544	13884	8885	9848	6084	23978
1974	213362	331531	59200	42410	41686	19775	8005	6321	5568	21980
1975	245950	308254	252159	36069	25672	21311	11873	5923	4106	19695
1976	186699	174564	148703	114411	13953	9945	9120	6391	2947	12552
1977	259848	160665	122606	99565	93022	9271	5912	5022	4061	9191
1978	228015	214691	89600	65116	51346	36080	5940	3352	2419	7468
1979	294484	273115	176441	67344	48475	40242	24228	4161	2807	9288
1980	227350	187465	134673	78210	25167	18068	13761	8458	1864	5377
1981	134395	294168	124146	57977	36176	12469	9564	8092	4874	5903
1982	414641	252348	213631	70653	28871	16824	7589	5470	4482	8653
1983	262614	556026	145750	101311	30163	12978	8216	4193	3013	8287
1984	310783	376742	326860	78078	38960	13730	6465	5544	2720	6565
1985	405506	302760	179882	187424	32720	15622	6871	3650	2698	5798
1986	1119019	558090	212227	120271	85930	24195	9299	4490	2733	6950
1987	361519	1459325	296920	112666	66106	34976	11452	4341	2154	5478
1988	348597	623255	710060	135502	48262	25268	16774	5381	3162	6233
1989	214552	532602	299105	317172	60133	19362	10567	7561	2120	5580
1990	146864	311831	266440	139099	164825	26934	8129	4216	3451	3808
1991	184587	344841	225170	156894	78489	78496	14910	5233	3141	5591
1992	142165	263573	179701	106842	77010	34286	29547	6970	3200	6928
1993	99832	208032	146463	84252	53040	29217	13472	11272	3645	5883
1994	63516	140851	137320	81274	39364	20532	15323	6399	5368	5433
1995	126614	119251	97151	79230	37162	18073	9772	4366	2336	3753
1996	112354	373561	91988	50289	32581	14576	10605	4528	2624	4892
1997	129545	553773	280776	44257	22812	13626	6362	3632	2179	4181
1998	104734	676651	260551	109683	17010	6465	4986	2506	1761	3119
1999	127870	217090	387740	94726	24390	6887	2783	2246	1521	3093
2000	106056	187647	91904	230201	16625	9655	2399	1198	940	2097
2001	34804	388808	240444	123671	144551	7048	4464	1128	637	2309
2002	311003	193978	136274	61739	38681	38638	4763	1789	742	1586
2003	68309	560788	101562	68836	31339	16454	22821	1609	650	859
2004	233397	191141	221343	43238	22201	11650	4830	4556	412	540
2005	96478	342682	72076	103120	21746	15610	5489	2615	2223	613
2006	220828	244064	177680	35910	45525	6965	5721	2247	1235	1319
2007	78598	224345	106621	57788	16408	24293	2663	3505	543	1259
2008	135786	263599	80258	44207	31758	6217	15634	1803	673	896

Table 8.2.5. North Sea plaice. Stock weight-at-age

2009-05-07 15:15:47 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.039	0.099	0.160	0.248	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.042	0.091	0.183	0.279	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.046	0.103	0.177	0.271	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.039	0.108	0.185	0.279	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.038	0.095	0.188	0.313	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.036	0.093	0.176	0.308	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.042	0.100	0.180	0.280	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.025	0.110	0.187	0.304	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.032	0.066	0.202	0.302	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.032	0.097	0.129	0.313	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.030	0.101	0.182	0.210	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.056	0.091	0.178	0.294	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.048	0.153	0.192	0.273	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.044	0.110	0.243	0.281	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.052	0.106	0.259	0.354	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.057	0.154	0.225	0.418	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.037	0.129	0.243	0.320	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.050	0.102	0.224	0.427	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.065	0.138	0.193	0.399	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.083	0.165	0.233	0.316	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.066	0.179	0.274	0.319	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.066	0.148	0.329	0.383	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.063	0.174	0.266	0.375	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.050	0.159	0.299	0.440	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.042	0.136	0.246	0.433	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.049	0.125	0.258	0.361	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.046	0.124	0.250	0.392	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.049	0.126	0.223	0.425	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.050	0.144	0.238	0.326	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.044	0.124	0.252	0.317	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.037	0.103	0.204	0.383	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.037	0.096	0.176	0.269	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.040	0.099	0.193	0.245	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.045	0.109	0.184	0.270	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.050	0.131	0.191	0.269	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.047	0.123	0.204	0.275	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.052	0.117	0.214	0.327	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.054	0.143	0.220	0.297	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.051	0.140	0.260	0.342	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.116	0.234	0.375	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.032	0.116	0.186	0.375	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.039	0.080	0.208	0.339	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.045	0.090	0.153	0.320	0.437	0.524	0.586	0.644	0.664	0.780
2000	0.052	0.105	0.169	0.224	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.062	0.121	0.207	0.237	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.049	0.117	0.218	0.306	0.319	0.403	0.446	0.612	0.685	0.873
2003	0.061	0.112	0.228	0.270	0.344	0.391	0.464	0.600	0.714	0.787
2004	0.048	0.116	0.206	0.313	0.384	0.430	0.489	0.495	0.780	0.875
2005	0.054	0.105	0.219	0.241	0.378	0.422	0.434	0.527	0.621	1.010
2006	0.053	0.129	0.195	0.321	0.354	0.424	0.439	0.506	0.583	0.731
2007	0.048	0.093	0.239	0.241	0.337	0.394	0.458	0.412	0.526	0.548
2008	0.050	0.114	0.200	0.278	0.355	0.429	0.484	0.627	0.598	0.731

Table 8.2.6. North Sea plaice. Landings weight-at-age

2009-05-07 15:13:18 units= NA

age

year	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.183	0.223	0.287	0.392	0.506	0.592	0.654	0.440	1.108
1958	0.000	0.211	0.235	0.275	0.358	0.482	0.546	0.654	0.707	1.055
1959	0.000	0.223	0.251	0.299	0.370	0.483	0.605	0.637	0.766	1.021
1960	0.000	0.201	0.238	0.291	0.389	0.488	0.605	0.688	0.729	1.101
1961	0.000	0.194	0.237	0.307	0.418	0.517	0.613	0.681	0.825	1.088
1962	0.000	0.204	0.240	0.290	0.387	0.523	0.551	0.669	0.751	1.090
1963	0.000	0.258	0.292	0.325	0.407	0.543	0.636	0.680	0.729	1.048
1964	0.000	0.252	0.275	0.314	0.391	0.491	0.633	0.705	0.743	1.012
1965	0.000	0.243	0.284	0.323	0.387	0.474	0.542	0.667	0.730	0.892
1966	0.000	0.236	0.275	0.354	0.444	0.493	0.569	0.635	0.703	0.950
1967	0.000	0.237	0.285	0.328	0.433	0.558	0.609	0.675	0.753	0.998
1968	0.000	0.275	0.307	0.341	0.377	0.532	0.607	0.613	0.706	0.937
1969	0.230	0.311	0.328	0.352	0.380	0.436	0.606	0.693	0.696	0.945
1970	0.307	0.279	0.310	0.347	0.408	0.432	0.486	0.655	0.725	0.869
1971	0.264	0.329	0.368	0.416	0.463	0.531	0.560	0.627	0.722	0.920
1972	0.253	0.304	0.362	0.440	0.507	0.556	0.625	0.664	0.693	0.965
1973	0.286	0.332	0.361	0.426	0.511	0.566	0.636	0.659	0.711	0.884
1974	0.296	0.322	0.367	0.420	0.494	0.574	0.631	0.719	0.733	0.960
1975	0.265	0.319	0.351	0.446	0.526	0.624	0.676	0.747	0.832	1.082
1976	0.272	0.302	0.347	0.385	0.526	0.609	0.657	0.723	0.760	1.005
1977	0.254	0.324	0.354	0.381	0.419	0.557	0.648	0.722	0.716	0.980
1978	0.235	0.304	0.356	0.383	0.422	0.473	0.587	0.662	0.748	0.916
1979	0.235	0.310	0.348	0.387	0.428	0.473	0.549	0.674	0.795	0.959
1980	0.241	0.290	0.349	0.406	0.479	0.552	0.596	0.671	0.782	1.027
1981	0.241	0.279	0.335	0.423	0.514	0.568	0.615	0.653	0.738	1.025
1982	0.281	0.264	0.313	0.427	0.517	0.612	0.668	0.716	0.743	0.990
1983	0.199	0.248	0.298	0.381	0.512	0.600	0.673	0.766	0.810	0.978
1984	0.229	0.259	0.279	0.369	0.483	0.603	0.673	0.714	0.824	1.019
1985	0.242	0.259	0.284	0.330	0.453	0.565	0.664	0.714	0.788	1.001
1986	0.218	0.266	0.300	0.343	0.420	0.482	0.667	0.742	0.843	1.001
1987	0.218	0.246	0.296	0.347	0.397	0.498	0.576	0.719	0.819	0.978
1988	0.218	0.250	0.274	0.347	0.446	0.504	0.599	0.688	0.801	0.999
1989	0.233	0.276	0.305	0.327	0.386	0.525	0.594	0.660	0.780	0.929
1990	0.267	0.281	0.293	0.312	0.360	0.440	0.588	0.681	0.749	0.989
1991	0.219	0.276	0.283	0.295	0.352	0.438	0.509	0.646	0.720	0.887
1992	0.246	0.258	0.285	0.312	0.335	0.417	0.521	0.594	0.702	0.875
1993	0.243	0.267	0.282	0.318	0.348	0.413	0.506	0.616	0.704	0.836
1994	0.223	0.256	0.278	0.330	0.387	0.437	0.489	0.595	0.713	0.883
1995	0.270	0.275	0.299	0.336	0.399	0.451	0.525	0.607	0.729	0.902
1996	0.236	0.276	0.302	0.350	0.414	0.479	0.491	0.580	0.709	0.844
1997	0.206	0.269	0.310	0.361	0.453	0.520	0.598	0.611	0.678	0.917
1998	0.150	0.256	0.305	0.388	0.489	0.597	0.623	0.684	0.689	0.900
1999	0.242	0.249	0.276	0.350	0.449	0.539	0.621	0.672	0.742	0.802
2000	0.221	0.259	0.276	0.305	0.420	0.486	0.664	0.690	0.729	0.862
2001	0.236	0.264	0.289	0.306	0.361	0.477	0.586	0.701	0.787	0.793
2002	0.232	0.259	0.283	0.309	0.341	0.436	0.500	0.678	0.745	0.881
2003	0.227	0.248	0.281	0.319	0.363	0.406	0.477	0.641	0.750	0.837
2004	0.212	0.245	0.280	0.325	0.394	0.433	0.505	0.552	0.789	0.861
2005	0.267	0.262	0.277	0.327	0.385	0.427	0.463	0.545	0.603	0.888
2006	0.257	0.272	0.289	0.338	0.399	0.409	0.475	0.489	0.533	0.755
2007	0.262	0.267	0.303	0.345	0.378	0.452	0.539	0.481	0.590	0.619
2008	0.248	0.265	0.306	0.343	0.404	0.453	0.539	0.727	0.641	0.563

Table 8.2.7. North Sea plaice. Discards weight-at-age

2009-05-07 15:14:08 units= kg

year	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.102	0.147	0.180	0.204	0.231	0.244	0.231	0	0
1958	0.049	0.095	0.158	0.186	0.198	0.244	0.244	0.000	0	0
1959	0.053	0.106	0.155	0.185	0.193	0.231	0.000	0.000	0	0
1960	0.047	0.110	0.159	0.186	0.199	0.210	0.231	0.000	0	0
1961	0.046	0.098	0.160	0.192	0.202	0.212	0.211	0.244	0	0
1962	0.044	0.097	0.155	0.192	0.211	0.219	0.220	0.220	0	0
1963	0.049	0.103	0.156	0.186	0.203	0.231	0.220	0.231	0	0
1964	0.034	0.112	0.160	0.191	0.202	0.220	0.231	0.231	0	0
1965	0.040	0.071	0.165	0.191	0.210	0.220	0.220	0.000	0	0
1966	0.040	0.100	0.126	0.192	0.203	0.231	0.220	0.231	0	0
1967	0.038	0.104	0.157	0.169	0.211	0.219	0.231	0.244	0	0
1968	0.062	0.095	0.156	0.190	0.189	0.244	0.212	0.000	0	0
1969	0.055	0.144	0.161	0.185	0.205	0.210	0.244	0.231	0	0
1970	0.051	0.113	0.178	0.187	0.192	0.000	0.212	0.231	0	0
1971	0.059	0.109	0.182	0.198	0.211	0.000	0.000	0.231	0	0
1972	0.063	0.145	0.173	0.210	0.205	0.244	0.000	0.000	0	0
1973	0.045	0.128	0.178	0.193	0.204	0.231	0.244	0.000	0	0
1974	0.057	0.105	0.173	0.210	0.212	0.231	0.244	0.000	0	0
1975	0.070	0.134	0.162	0.204	0.220	0.244	0.244	0.000	0	0
1976	0.088	0.151	0.175	0.193	0.219	0.244	0.244	0.000	0	0
1977	0.071	0.157	0.185	0.193	0.196	0.211	0.000	0.000	0	0
1978	0.071	0.141	0.196	0.203	0.205	0.211	0.220	0.000	0	0
1979	0.069	0.155	0.184	0.202	0.219	0.231	0.220	0.244	0	0
1980	0.057	0.147	0.190	0.211	0.220	0.000	0.244	0.000	0	0
1981	0.050	0.133	0.178	0.210	0.219	0.244	0.000	0.000	0	0
1982	0.056	0.125	0.182	0.199	0.231	0.231	0.244	0.000	0	0
1983	0.054	0.124	0.180	0.203	0.205	0.244	0.244	0.000	0	0
1984	0.055	0.125	0.172	0.210	0.203	0.000	0.244	0.000	0	0
1985	0.056	0.138	0.176	0.195	0.231	0.244	0.000	0.000	0	0
1986	0.051	0.123	0.180	0.192	0.211	0.244	0.231	0.000	0	0
1987	0.044	0.104	0.165	0.203	0.211	0.231	0.000	0.000	0	0
1988	0.044	0.098	0.154	0.184	0.211	0.231	0.000	0.000	0	0
1989	0.047	0.102	0.163	0.180	0.192	0.244	0.000	0.000	0	0
1990	0.054	0.113	0.159	0.185	0.205	0.231	0.000	0.000	0	0
1991	0.058	0.130	0.162	0.185	0.199	0.220	0.220	0.231	0	0
1992	0.055	0.124	0.167	0.186	0.200	0.210	0.220	0.244	0	0
1993	0.059	0.120	0.171	0.196	0.205	0.231	0.231	0.000	0	0
1994	0.062	0.141	0.175	0.192	0.211	0.231	0.244	0.220	0	0
1995	0.060	0.140	0.185	0.199	0.212	0.231	0.231	0.244	0	0
1996	0.053	0.122	0.178	0.203	0.220	0.231	0.000	0.244	0	0
1997	0.042	0.118	0.160	0.202	0.220	0.244	0.000	0.000	0	0
1998	0.049	0.086	0.168	0.197	0.212	0.000	0.244	0.000	0	0
1999	0.055	0.096	0.144	0.193	0.211	0.244	0.000	0.000	0	0
2000	0.061	0.110	0.152	0.173	0.231	0.000	0.198	0.000	0	0
2001	0.070	0.122	0.167	0.177	0.195	0.231	0.000	0.231	0	0
2002	0.058	0.119	0.171	0.191	0.196	0.211	0.000	0.000	0	0
2003	0.068	0.114	0.174	0.184	0.198	0.204	0.220	0.000	0	0
2004	0.057	0.117	0.167	0.192	0.196	0.211	0.199	0.000	0	0
2005	0.063	0.109	0.172	0.178	0.220	0.204	0.219	0.231	0	0
2006	0.062	0.128	0.162	0.193	0.197	0.199	0.210	0.211	0	0
2007	0.057	0.097	0.177	0.178	0.192	0.197	0.220	0.197	0	0
2008	0.058	0.116	0.165	0.187	0.188	0.231	0.220	0.190	0	0

Table 8.2.8. North Sea plaice. Catch weight-at-age

2009-05-07 15:45:16 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.046	0.109	0.213	0.284	0.386	0.506	0.592	0.654	0.440	1.108
1958	0.049	0.105	0.195	0.272	0.349	0.481	0.546	0.654	0.707	1.055
1959	0.053	0.119	0.193	0.264	0.352	0.482	0.605	0.637	0.766	1.021
1960	0.047	0.113	0.205	0.289	0.380	0.483	0.605	0.688	0.729	1.101
1961	0.046	0.099	0.181	0.306	0.408	0.514	0.613	0.681	0.825	1.088
1962	0.044	0.098	0.180	0.266	0.384	0.520	0.551	0.669	0.751	1.090
1963	0.049	0.108	0.175	0.309	0.399	0.541	0.636	0.680	0.729	1.048
1964	0.034	0.124	0.205	0.272	0.381	0.488	0.633	0.705	0.743	1.012
1965	0.040	0.075	0.214	0.315	0.384	0.471	0.542	0.667	0.730	0.892
1966	0.040	0.103	0.149	0.319	0.435	0.492	0.569	0.635	0.703	0.950
1967	0.038	0.110	0.190	0.237	0.430	0.554	0.609	0.675	0.753	0.998
1968	0.062	0.116	0.226	0.279	0.348	0.531	0.607	0.613	0.706	0.937
1969	0.055	0.174	0.283	0.294	0.376	0.432	0.606	0.693	0.696	0.945
1970	0.051	0.130	0.263	0.343	0.384	0.430	0.486	0.655	0.725	0.869
1971	0.059	0.160	0.281	0.400	0.459	0.529	0.560	0.627	0.722	0.920
1972	0.069	0.208	0.295	0.418	0.500	0.555	0.625	0.664	0.693	0.965
1973	0.047	0.207	0.350	0.423	0.502	0.565	0.636	0.659	0.711	0.884
1974	0.059	0.120	0.355	0.419	0.489	0.573	0.631	0.719	0.733	0.960
1975	0.071	0.151	0.208	0.414	0.523	0.621	0.676	0.747	0.832	1.082
1976	0.091	0.180	0.265	0.354	0.522	0.608	0.657	0.723	0.760	1.005
1977	0.073	0.216	0.245	0.317	0.396	0.552	0.648	0.722	0.716	0.980
1978	0.072	0.187	0.307	0.353	0.417	0.469	0.587	0.662	0.748	0.916
1979	0.070	0.188	0.295	0.337	0.426	0.471	0.549	0.674	0.795	0.959
1980	0.058	0.196	0.348	0.405	0.477	0.550	0.596	0.671	0.782	1.027
1981	0.050	0.183	0.332	0.422	0.510	0.566	0.615	0.653	0.738	1.025
1982	0.058	0.151	0.310	0.423	0.515	0.610	0.668	0.716	0.743	0.990
1983	0.055	0.151	0.273	0.377	0.504	0.598	0.673	0.766	0.810	0.978
1984	0.055	0.147	0.261	0.319	0.473	0.600	0.673	0.714	0.824	1.019
1985	0.056	0.167	0.263	0.329	0.451	0.564	0.664	0.714	0.788	1.001
1986	0.051	0.140	0.273	0.310	0.416	0.481	0.667	0.742	0.843	1.001
1987	0.044	0.112	0.216	0.345	0.393	0.496	0.576	0.719	0.819	0.978
1988	0.044	0.102	0.196	0.273	0.442	0.502	0.599	0.688	0.801	0.999
1989	0.048	0.117	0.213	0.287	0.363	0.524	0.594	0.660	0.780	0.929
1990	0.056	0.130	0.208	0.286	0.356	0.439	0.588	0.681	0.749	0.989
1991	0.059	0.148	0.207	0.266	0.341	0.436	0.509	0.646	0.720	0.887
1992	0.060	0.146	0.223	0.272	0.327	0.412	0.521	0.594	0.702	0.875
1993	0.065	0.158	0.246	0.301	0.343	0.412	0.506	0.616	0.704	0.836
1994	0.066	0.178	0.252	0.328	0.383	0.436	0.489	0.595	0.713	0.883
1995	0.073	0.181	0.281	0.334	0.396	0.450	0.525	0.607	0.729	0.902
1996	0.055	0.139	0.265	0.338	0.411	0.477	0.491	0.580	0.709	0.844
1997	0.043	0.130	0.207	0.359	0.451	0.518	0.598	0.611	0.678	0.917
1998	0.049	0.094	0.204	0.295	0.484	0.594	0.623	0.684	0.689	0.900
1999	0.056	0.102	0.197	0.259	0.446	0.537	0.621	0.672	0.742	0.802
2000	0.065	0.123	0.205	0.267	0.401	0.470	0.612	0.593	0.729	0.862
2001	0.091	0.135	0.194	0.227	0.299	0.470	0.580	0.701	0.787	0.793
2002	0.059	0.130	0.219	0.284	0.333	0.431	0.488	0.677	0.745	0.881
2003	0.070	0.124	0.224	0.280	0.341	0.400	0.412	0.640	0.750	0.837
2004	0.057	0.124	0.219	0.300	0.379	0.426	0.502	0.551	0.789	0.861
2005	0.069	0.116	0.210	0.297	0.349	0.340	0.456	0.544	0.603	0.888
2006	0.062	0.139	0.210	0.295	0.385	0.396	0.440	0.465	0.533	0.755
2007	0.060	0.112	0.221	0.314	0.362	0.377	0.515	0.347	0.590	0.619
2008	0.059	0.122	0.240	0.321	0.388	0.435	0.358	0.462	0.641	0.563

Table 8.2.9. North Sea plaice. Natural mortality at age and maturity ate age vector used in assessments

age	1	2	3	4	5	6	7	8	9	10
natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
maturity	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 8.2.10 North Sea plaice. Survey tuning indices.

2009-05-07 15:49:23

BTS-Isis (Ages 1 – 8 used in the assessment)

		1	2	3	4	5	6	7	8
1985	1	116	179.9	38.81	11.84	1.371	1.048	0.362	0.167
1986	1	667	131.8	51.00	8.89	3.285	0.428	0.338	0.129
1987	1	226	764.3	33.06	4.77	2.039	1.017	0.352	0.087
1988	1	680	147.0	182.31	9.99	2.810	0.814	0.458	0.036
1989	1	468	319.3	38.66	47.30	5.850	0.833	0.311	0.661
1990	1	115	102.6	55.67	22.78	5.572	0.801	0.205	0.374
1991	1	185	122.1	28.55	11.86	4.264	5.710	0.257	0.219
1992	1	177	125.9	27.31	5.62	3.184	2.662	1.136	0.259
1993	1	125	179.1	38.40	6.12	0.931	0.812	0.629	0.465
1994	1	145	64.2	35.24	10.88	2.857	0.638	0.861	0.957
1995	1	252	43.5	14.22	8.11	1.195	0.868	0.356	1.131
1996	1	218	212.3	23.02	4.83	3.404	0.917	0.047	0.173
1997	1	NA	NA	19.91	2.79	0.219	0.390	0.171	0.121
1998	1	343	431.9	47.40	8.91	1.440	0.755	0.145	0.078
1999	1	306	130.0	182.52	3.65	2.107	0.137	0.140	0.029
2000	1	278	74.4	31.38	24.00	0.613	0.175	0.540	0.029
2001	1	223	78.4	19.39	9.97	9.474	0.294	0.143	0.041
2002	1	541	47.7	16.05	5.38	2.734	1.422	0.091	0.138
2003	1	126	170.1	10.78	5.94	1.525	1.214	0.684	0.112
2004	1	226	41.8	66.60	6.62	2.650	1.603	1.021	3.054
2005	1	158	69.6	7.23	13.74	1.167	1.254	0.313	0.164
2006	1	135	39.0	19.50	3.21	6.343	0.934	0.815	0.043
2007	1	329	72.3	21.22	15.53	3.168	6.553	0.737	0.895
2008	1	235	130.6	32.62	9.83	7.805	0.670	1.858	0.316

BTS-Tridens

		1	2	3	4	5	6	7	8	9
1996	1	1.593	5.59	4.40	3.31	2.37	1.84	0.830	0.529	0.177
1997	1	NA	NA	10.41	3.95	2.84	1.93	0.471	1.102	0.424
1998	1	0.557	30.14	9.93	5.57	2.67	1.35	0.911	0.789	0.308
1999	1	2.387	8.29	36.93	6.47	2.65	2.13	0.600	0.771	0.326
2000	1	4.639	9.45	12.74	17.23	2.94	1.89	1.076	0.954	0.247
2001	1	0.672	6.93	9.05	7.23	7.67	1.21	0.691	0.480	0.603
2002	1	18.480	13.54	11.27	6.87	4.23	4.43	0.741	0.723	0.340
2003	1	4.108	34.84	11.91	8.57	4.75	2.72	3.973	0.699	0.703
2004	1	5.689	10.63	29.05	7.92	4.19	2.23	1.131	2.460	0.396
2005	1	7.340	23.70	11.30	16.20	2.57	5.42	1.552	0.536	3.335
2006	1	7.024	17.45	25.06	9.91	11.39	1.93	3.874	0.835	0.716
2007	1	29.707	21.89	17.26	20.79	4.55	9.70	1.829	3.545	0.314
2008	1	18.280	53.91	27.29	19.17	19.54	6.26	13.018	2.691	6.756

Table 8.2.10 North Sea plaice. Survey tuning indices. (Cont'd)

SNS

		1	2	3
1982	1	69993	8642	1261
1983	1	33974	13909	249
1984	1	44965	10413	2467
1985	1	28101	13848	1598
1986	1	93552	7580	1152
1987	1	33402	32991	1227
1988	1	36609	14421	13153
1989	1	34276	17810	4373
1990	1	25037	7496	3160
1991	1	57221	11247	1518
1992	1	46798	13842	2268
1993	1	22098	9686	1006
1994	1	19188	4977	856
1995	1	24767	2796	381
1996	1	23015	10268	1185
1997	1	NA	NA	1391
1998	1	33666	30242	5014
1999	1	32951	10272	13783
2000	1	22855	2493	891
2001	1	11511	2898	370
2002	1	30813	1103	265
2003	1	NA	NA	NA
2004	1	18202	1350	1081
2005	1	10118	1819	142
2006	1	12164	1571	384
2007	1	14175	2134	140
2008	1	14706	2700	

Table 8.2.11. North Sea plaice. DFS index catches (numbers per hour), used only for RCT3.

DFS

	Effort	age 0	age 1
1981	1	605.96	169.78
1982	1	433.67	299.36
1983	1	431.72	163.53
1984	1	261.80	124.19
1985	1	716.29	103.27
1986	1	200.11	288.27
1987	1	516.84	195.87
1988	1	318.36	116.45
1989	1	435.70	125.72
1990	1	465.47	130.13
1991	1	498.49	152.35
1992	1	351.59	137.08
1993	1	262.26	75.16
1994	1	445.66	30.60
1995	1	184.51	37.74
1996	1	572.80	116.89
1997	1	149.19	209.92
1998	1	NA	NA
1999	1	NA	NA
2000	1	183.83	11.31
2001	1	500.43	5.90
2002	1	210.70	17.79
2003	1	359.59	11.31
2004	1	243.15	14.97
2005	1	129.25	NA
2006	1	232.28	NA
2007	1	175.65	NA
2008	1	186.87	NA

Table 8.2.12 North Sea plaice. Commercial tuning fleets (not used in the final assessment)

2009-05-07 15:50:09

NL Beam Trawl

		2	3	4	5	6	7	8	9
1989	72.5	557.8	1016	1820	318.1	132.9	72.3	37.45	13.06
1990	71.1	308.8	844	701	1076.2	171.4	51.8	25.18	16.33
1991	68.5	401.5	619	776	448.1	497.7	100.4	28.53	16.60
1992	71.1	341.4	623	448	382.1	171.9	133.4	34.66	13.97
1993	76.9	358.3	605	407	256.2	142.8	78.5	46.96	13.33
1994	81.4	370.9	591	441	188.8	97.5	75.8	35.21	23.70
1995	81.2	277.3	536	417	178.0	81.0	42.1	19.08	11.47
1996	72.1	368.9	383	290	193.9	73.7	50.5	18.95	13.09
1997	72.0	320.8	634	252	95.6	60.2	28.0	13.54	6.39
1998	70.2	217.8	463	381	91.0	32.6	19.4	9.53	4.47
1999	67.3	64.5	1134	271	164.3	44.6	14.8	12.38	7.52
2000	64.6	138.9	263	1118	89.6	60.1	11.4	5.20	3.31
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.7	177.0	575	383	250.8	292.2	18.5	9.96	2.75
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	48.1	102.5	925	228	150.5	73.8	30.6	44.51	1.95
2005	49.1	154.2	222	727	96.2	59.2	34.1	14.81	23.54
2006	44.1	245.7	593	190	452.9	45.9	50.7	16.30	28.55
2007	42.9	201.6	416	464	109.7	208.1	23.1	26.62	7.53
2008	30.2	186.9	624	420	337.4	44.6	80.9	11.69	5.86

English Beam trawl excl Flag-vessels

		4	5	6	7	8	9	10	11	12
1990	102.3	27.0	92.7	17.46	11.08	7.06	8.23	2.45	1.662	0.958
1991	123.6	21.9	28.6	53.39	10.72	6.77	3.45	4.94	1.828	1.481
1992	151.5	19.2	29.3	18.40	24.25	6.39	3.68	3.20	3.281	1.096
1993	146.6	23.4	20.9	17.26	6.30	12.80	4.33	2.73	2.435	1.739
1994	131.4	23.1	22.0	13.49	9.53	4.51	6.47	3.28	1.438	1.218
1995	105.0	34.0	15.8	14.05	9.71	5.90	3.16	3.60	2.733	1.362
1996	82.9	13.3	19.0	10.74	10.08	6.55	4.68	2.50	3.305	1.966
1997	76.3	16.4	11.1	13.97	7.85	8.99	6.62	2.77	1.940	3.001
1998	68.8	23.6	13.0	8.97	8.69	5.04	6.03	4.61	1.948	1.599
1999	68.6	14.7	15.2	6.66	4.77	5.35	3.76	3.27	2.813	1.429
2000	57.8	63.2	15.0	9.95	4.41	2.44	3.48	1.87	1.782	2.526
2001	54.1	14.7	45.0	8.89	6.21	2.48	1.72	2.07	0.906	1.682
2002	30.6	23.4	20.8	29.61	5.13	4.12	1.41	1.73	1.503	1.340

Table 8.3.1. North Sea plaice. XSA diagnostics from final run

```
FLR XSA Diagnostics 2009-05-10 14:43:25
CPUE data from xsa.indices
Catch data for 52 years. 1957 to 2008. Ages 1 to 10.
        fleet first age last age first year last year alpha beta
1    BTS-Isis         1        8       1985      2008  0.66 0.75
2 BTS-Tridens         1        9       1996      2008  0.66 0.75
3         SNS         1        3       1982      2008  0.66 0.75
 Time series weights :  Tapered time weighting not applied
Catchability analysis :
    Catchability independent of size for all ages
    Catchability independent of age for ages >=   6
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 =   2
    Minimum standard error for population
    estimates derived from each fleet =  0.3
   prior weighting not applied
Regression weights
     year
age   1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
  all    1    1    1    1    1    1    1    1    1    1

 Fishing mortalities
    year
age   1999  2000  2001  2002  2003  2004  2005  2006  2007  2008
  1  0.173 0.120 0.070 0.212 0.141 0.216 0.138 0.281 0.083 0.175
  2  0.476 0.367 0.730 0.592 0.635 0.632 0.497 0.532 0.453 0.390
  3  0.521 0.336 0.987 0.539 0.631 0.490 0.457 0.461 0.414 0.257
  4  1.179 0.595 0.899 0.650 0.509 0.533 0.393 0.385 0.236 0.268
  5  0.656 0.574 0.831 0.701 0.720 0.270 0.497 0.268 0.270 0.177
  6  0.512 0.520 0.451 0.483 0.649 0.568 0.275 0.259 0.200 0.139
  7  0.322 0.297 0.428 0.555 0.519 0.352 0.507 0.137 0.133 0.172
  8  0.470 0.199 0.198 0.270 0.325 0.163 0.291 0.355 0.105 0.113
  9  0.495 0.325 0.139 0.174 0.133 0.115 0.100 0.194 0.121 0.024
  10 0.495 0.325 0.139 0.174 0.133 0.115 0.100 0.194 0.121 0.024
```

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8	9	10
1999	844549	602709	1003918	143812	53307	18076	10637	6299	4093	8285
2000	983135	642546	338852	539553	40021	25034	9805	6977	3563	7924
2001	540793	788694	402904	219184	269234	20398	13467	6590	5174	18724
2002	1712546	456223	343794	135845	80686	106112	11753	7939	4889	10432
2003	546025	1253741	228290	181450	64190	36213	59260	6104	5482	7234
2004	1261256	429086	600993	109956	98704	28271	17116	31913	3992	5225
2005	789082	919217	206434	333253	58363	68193	14499	10893	24542	6759
2006	947769	622218	505773	118228	203449	32124	46855	7898	7368	7854
2007	1031601	647519	330845	288628	72819	140784	22442	36954	5009	11597
2008	890569	858667	372496	197940	206192	50281	104278	17773	30103	40053

Estimated population abundance at 1st Jan 2009

year \ age	1	2	3	4	5	6	7	8	9	10
2009	0	676666	526223	260713	137060	156366	39588	79489	14369	26614

Fleet: BTS-Isis

Log catchability residuals.

age \ year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-1.225	-0.401	-0.642	0.569	0.579	-0.721	-0.065	0.033	0.068	0.362	-0.081
2	0.346	-0.291	0.567	-0.276	0.586	-0.248	0.106	0.304	0.746	0.106	-0.175
3	0.001	0.395	-0.291	0.514	-0.280	0.137	-0.201	-0.030	0.430	0.417	-0.082
4	-0.247	-0.198	-0.591	-0.129	0.482	0.441	-0.068	-0.481	-0.197	0.531	0.349
5	-0.529	-0.166	-0.279	0.252	0.642	-0.333	0.022	0.036	-0.907	0.333	-0.284
6	0.324	-0.677	-0.302	-0.103	0.062	-0.363	0.794	0.491	-0.219	-0.246	0.125
7	0.073	-0.109	-0.009	-0.352	-0.317	-0.690	-0.735	-0.062	-0.425	0.808	-0.096
8	-0.132	-0.205	-0.762	-1.278	0.735	0.495	0.095	0.090	-0.355	0.400	1.924

age \ year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.348	NA	0.651	0.468	0.182	0.524	0.359	-0.005	-0.205	-0.147	-0.389
2	0.464	NA	0.467	0.358	-0.341	-0.237	-0.283	0.007	-0.328	-0.673	-0.838
3	0.531	-0.364	0.673	0.841	0.036	-0.160	-0.506	-0.429	0.324	-0.851	-0.752
4	0.222	-0.171	0.549	-0.085	0.065	0.302	-0.014	-0.302	0.324	-0.153	-0.576
5	0.887	-1.459	0.490	0.540	-0.466	0.547	0.418	0.076	-0.119	-0.253	0.030
6	0.515	-0.177	0.700	-0.942	-1.017	-0.342	-0.392	0.642	1.110	-0.222	0.224
7	-1.972	-0.435	-0.457	-0.524	0.891	-0.663	-0.890	-0.516	1.009	0.102	-0.375
8	-0.108	-0.295	-0.616	-1.470	-1.763	-1.360	-0.282	-0.189	1.348	-0.411	-1.383

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

age	2007	2008
1	0.279	0.154
2	-0.316	-0.052
3	-0.276	-0.075
4	0.002	-0.056
5	0.364	0.159
6	0.654	-0.640
7	0.258	-0.327
8	-0.067	-0.370

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7	8
Mean_Logq	-8.1987	-8.3941	-9.0162	-9.5955	-10.1459	-10.4172	-10.4172	-10.4172
S.E_Logq	0.4725	0.4205	0.4437	0.3368	0.5263	0.5655	0.6217	0.8682

Fleet: BTS-Tridens

Log catchability residuals.

age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-1.431	NA	-1.934	-0.548	-0.073	-1.443	0.818	0.408	-0.051	0.618	0.491
2	-1.216	NA	-0.238	-0.437	-0.446	-0.706	0.414	0.379	0.262	0.207	0.315
3	-0.439	-0.328	-0.205	-0.071	-0.180	-0.236	-0.174	0.355	0.180	0.281	0.184
4	-0.355	-0.020	-0.118	0.290	-0.464	-0.217	0.034	-0.133	0.305	-0.186	0.353
5	-0.269	0.310	0.316	-0.022	0.308	-0.457	0.062	0.420	-0.454	-0.255	-0.178
6	-0.067	0.144	0.002	0.525	0.085	-0.206	-0.534	0.171	0.164	-0.036	-0.329
7	-0.379	-0.701	0.102	-0.347	0.301	-0.367	-0.071	-0.036	-0.168	0.424	-0.095
8	-0.269	0.636	0.419	0.532	0.452	-0.179	0.095	0.363	-0.147	-0.506	0.305
9	-0.220	0.192	0.009	0.120	-0.139	0.249	-0.242	0.341	0.071	0.376	0.106

age	2007	2008
1	1.710	1.435
2	0.446	1.021
3	0.202	0.431
4	0.097	0.415
5	-0.066	0.284
6	-0.233	0.316
7	-0.112	0.341
8	0.031	0.493
9	-0.383	0.824

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6	7	8	9
Mean_Logq	-12.0354	-10.3515	-9.7014	-9.3980	-9.3530	-9.1383	-9.1383	-9.1383	-9.1383
S.E_Logq	1.1528	0.6172	0.2835	0.2797	0.3083	0.2822	0.3227	0.3588	0.3173

Fleet: SNS

Log catchability residuals.

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.379	0.094	0.456	-0.424	-0.151	-0.338	-0.139	0.180	-0.033	0.974	0.917	0.552
2	0.523	0.212	0.382	0.712	-0.216	0.355	0.333	0.630	0.066	0.652	1.026	0.759
3	0.200	-1.282	0.235	0.207	0.000	-0.189	1.281	0.936	0.664	0.260	0.877	0.183

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.553	-0.187	-0.383	NA	0.546	0.454	-0.101	-0.224	-0.292	NA	-0.510	-0.684
2	0.479	0.010	0.365	NA	0.738	0.750	-0.806	-0.605	-1.120	NA	-0.829	-1.388
3	0.095	-0.306	0.960	0.37	1.823	1.654	-0.130	-0.723	-1.213	NA	-0.401	-1.385

year

age	2006	2007	2008
1	-0.582	-0.652	-0.404
2	-1.120	-0.909	-1.000
3	-1.284	-1.901	-0.932

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3
Mean_Logq	-3.5056	-4.4166	-5.5043
S.E_Logq	0.4837	0.7401	0.9610

Terminal year survivor and F summaries:

Age 1 Year class = 2007

source

	survivors	N	scaledWts
BTS-Isis	789210	1	0.457
BTS-Tridens	2842406	1	0.074
SNS	451584	1	0.437
fshk	687492	1	0.032

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

```
 Age 2 Year class = 2006

source
            survivors N scaledWts
BTS-Isis       574220 2     0.511
BTS-Tridens   1686158 2     0.167
SNS            245406 2     0.302
fshk           340430 1     0.020

 Age 3 Year class = 2005

source
            survivors N scaledWts
BTS-Isis       209739 3     0.373
BTS-Tridens    402633 3     0.467
SNS            122110 3     0.148
fshk           120060 1     0.012

 Age 4 Year class = 2004

source
            survivors N scaledWts
BTS-Isis       110089 4     0.402
BTS-Tridens    191170 4     0.517
SNS             45843 3     0.073
fshk            82325 1     0.009

Age 5 Year class = 2003

source
            survivors N scaledWts
BTS-Isis       132043 5     0.358
BTS-Tridens    189347 5     0.586
SNS             61524 3     0.048
fshk            60259 1     0.007

 Age 6 Year class = 2002

source
            survivors N scaledWts
BTS-Isis        26792 6     0.310
BTS-Tridens     49262 6     0.668
SNS             12884 2     0.015
fshk            12343 1     0.007
```

Table 8.3.1. North Sea plaice. XSA diagnostics from final run (Cont'd)

Age 7 Year class = 2001

source

	survivors	N	scaledWts
BTS-Isis	85986	7	0.283
BTS-Tridens	78121	7	0.694
SNS	56987	2	0.016
fshk	37946	1	0.007

Age 8 Year class = 2000

source

	survivors	N	scaledWts
BTS-Isis	15234	8	0.250
BTS-Tridens	14303	8	0.733
SNS	8663	2	0.010
fshk	6087	1	0.007

Age 9 Year class = 1999

source

	survivors	N	scaledWts
BTS-Isis	20825	8	0.211
BTS-Tridens	29134	9	0.771
SNS	15561	3	0.012
fshk	3372	1	0.005

Table 8.3.2. North Sea plaice. Fishing mortality estimates in final XSA run
2009-05-07 15:58:10 units= f

age										
year	1	2	3	4	5	6	7	8	9	10
1957	0.077	0.229	0.255	0.304	0.347	0.208	0.274	0.314	0.290	0.290
1958	0.105	0.250	0.302	0.358	0.374	0.321	0.268	0.291	0.323	0.323
1959	0.152	0.310	0.355	0.376	0.412	0.383	0.350	0.309	0.367	0.367
1960	0.108	0.318	0.353	0.384	0.366	0.419	0.383	0.359	0.383	0.383
1961	0.097	0.289	0.344	0.357	0.417	0.330	0.361	0.437	0.381	0.381
1962	0.096	0.319	0.373	0.398	0.434	0.426	0.362	0.350	0.395	0.395
1963	0.149	0.364	0.418	0.434	0.423	0.474	0.450	0.452	0.448	0.448
1964	0.032	0.399	0.448	0.469	0.540	0.488	0.403	0.390	0.459	0.459
1965	0.068	0.267	0.397	0.412	0.355	0.508	0.417	0.352	0.410	0.410
1966	0.071	0.356	0.388	0.430	0.477	0.343	0.506	0.409	0.435	0.435
1967	0.054	0.352	0.405	0.408	0.476	0.504	0.310	0.435	0.428	0.428
1968	0.197	0.287	0.344	0.361	0.366	0.323	0.410	0.289	0.351	0.351
1969	0.149	0.313	0.327	0.341	0.315	0.428	0.295	0.399	0.356	0.356
1970	0.223	0.435	0.492	0.505	0.462	0.504	0.594	0.261	0.467	0.467
1971	0.196	0.332	0.388	0.388	0.407	0.395	0.428	0.412	0.407	0.407
1972	0.232	0.381	0.401	0.413	0.419	0.443	0.408	0.478	0.434	0.434
1973	0.113	0.394	0.433	0.542	0.545	0.413	0.387	0.480	0.475	0.475
1974	0.221	0.399	0.491	0.515	0.597	0.452	0.394	0.465	0.486	0.486
1975	0.355	0.501	0.531	0.557	0.600	0.618	0.477	0.503	0.553	0.553
1976	0.333	0.407	0.426	0.432	0.383	0.434	0.518	0.452	0.445	0.445
1977	0.323	0.472	0.495	0.500	0.666	0.420	0.441	0.533	0.514	0.514
1978	0.305	0.429	0.465	0.471	0.461	0.520	0.462	0.427	0.470	0.470
1979	0.427	0.639	0.666	0.676	0.684	0.708	0.705	0.606	0.679	0.679
1980	0.239	0.470	0.668	0.623	0.509	0.519	0.494	0.503	0.531	0.531
1981	0.178	0.487	0.579	0.601	0.584	0.452	0.507	0.536	0.538	0.538
1982	0.242	0.518	0.701	0.679	0.605	0.524	0.484	0.540	0.569	0.569
1983	0.237	0.520	0.569	0.759	0.614	0.533	0.465	0.479	0.572	0.572
1984	0.301	0.553	0.584	0.604	0.660	0.557	0.490	0.582	0.581	0.581
1985	0.263	0.474	0.494	0.699	0.485	0.535	0.531	0.501	0.552	0.552
1986	0.285	0.610	0.634	0.639	0.720	0.713	0.626	0.705	0.773	0.773
1987	0.217	0.643	0.681	0.733	0.783	0.642	0.784	0.595	0.782	0.782
1988	0.232	0.618	0.664	0.678	0.718	0.697	0.649	0.964	1.064	1.064
1989	0.211	0.581	0.605	0.626	0.646	0.627	0.628	0.608	1.225	1.225
1990	0.161	0.473	0.573	0.557	0.693	0.597	0.518	0.486	0.548	0.548
1991	0.239	0.606	0.658	0.700	0.626	0.747	0.693	0.660	0.724	0.724
1992	0.214	0.554	0.653	0.670	0.797	0.545	0.621	0.727	1.001	1.001
1993	0.220	0.487	0.607	0.649	0.742	0.716	0.377	0.450	0.963	0.963
1994	0.163	0.485	0.611	0.716	0.637	0.637	0.933	0.275	0.356	0.356
1995	0.122	0.460	0.645	0.770	0.753	0.602	0.632	0.664	0.137	0.137
1996	0.096	0.547	0.688	0.730	0.749	0.668	0.768	0.600	0.984	0.984
1997	0.065	0.796	0.929	0.748	0.775	0.724	0.613	0.575	0.575	0.575
1998	0.153	0.495	1.002	1.084	0.639	0.456	0.561	0.459	0.538	0.538
1999	0.173	0.476	0.521	1.179	0.656	0.512	0.322	0.470	0.495	0.495
2000	0.120	0.367	0.336	0.595	0.574	0.520	0.297	0.199	0.325	0.325
2001	0.070	0.730	0.987	0.899	0.831	0.451	0.428	0.198	0.139	0.139
2002	0.212	0.592	0.539	0.650	0.701	0.483	0.555	0.270	0.174	0.174
2003	0.141	0.635	0.631	0.509	0.720	0.649	0.519	0.325	0.133	0.133
2004	0.216	0.632	0.490	0.533	0.270	0.568	0.352	0.163	0.115	0.115
2005	0.138	0.497	0.457	0.393	0.497	0.275	0.507	0.291	0.100	0.100
2006	0.281	0.532	0.461	0.385	0.268	0.259	0.137	0.355	0.194	0.194
2007	0.083	0.453	0.414	0.236	0.270	0.200	0.133	0.105	0.121	0.121
2008	0.175	0.390	0.257	0.268	0.177	0.139	0.172	0.113	0.024	0.024

Table 8.3.3. North Sea plaice. Stock number estimates in the final XSA runs

2009-05-07 15:58:59 units= thousands age

year	age 1	2	3	4	5	6	7	8	9	10
1957	457973	256778	322069	182986	117504	49780	48438	35192	20763	45210
1958	698110	383613	184865	225749	122171	75186	36568	33338	23255	49887
1959	863386	568706	270362	123650	142799	76063	49331	25309	22555	55137
1960	757298	670799	377298	171551	76786	85609	46907	31440	16805	49877
1961	860575	614899	441591	239779	105744	48183	50972	28949	19875	48420
1962	589153	706789	416673	283132	151855	63044	31337	32158	16921	41052
1963	688365	484323	465009	259569	172009	89026	37245	19737	20503	48075
1964	2231496	536379	304564	276885	152215	101919	50127	21480	11359	47990
1965	694571	1956326	325547	176042	156783	80258	56631	30309	13162	54735
1966	586775	586898	1355536	198051	105458	99441	43686	33776	19288	44345
1967	401292	494317	371936	832382	116531	59210	63824	23833	20304	33590
1968	434274	343890	314554	224453	500702	65484	32351	42364	13951	47348
1969	648862	322584	233482	201828	141577	314122	42894	19435	28723	56232
1970	650568	506075	213509	152350	129907	93519	185265	28910	11797	41652
1971	410258	471044	296421	118119	83213	74029	51103	92596	20155	52937
1972	366600	305244	305831	181997	72492	50101	45121	30152	55504	46555
1973	1311938	263001	188685	185316	108917	43135	29095	27148	16911	66361
1974	1132612	1059987	160403	110700	97539	57132	25823	17874	15197	59725
1975	864628	821873	643754	88826	59824	48604	32884	15751	10161	48494
1976	692495	548393	450442	342632	46063	29711	23707	18461	8618	36555
1977	988392	449002	330156	266126	201195	28407	17423	12776	10625	23935
1978	911977	647159	253445	182111	146091	93563	16885	10142	6783	20851
1979	890115	608296	381353	144096	102840	83347	50339	9628	5988	19695
1980	1125334	525288	290614	177227	66324	46943	37136	22503	4753	13646
1981	866020	801983	296978	134854	85966	36073	25289	20512	12316	14843
1982	2030236	655766	445843	150625	66871	43373	20779	13785	10863	20865
1983	1306336	1442615	353321	200203	69084	33045	23242	11583	7270	19892
1984	1258598	932216	776424	181056	84781	33818	17555	13215	6492	15588
1985	1846346	843201	485136	391618	89557	39653	17540	9735	6684	14292
1986	4750659	1284914	474966	267860	176068	49910	21020	9335	5336	13479
1987	1950224	3234130	631767	227890	127964	77574	22145	10174	4175	10546
1988	1769839	1420748	1538209	289207	99032	52905	36921	9144	5076	9916
1989	1187325	1269821	692688	716399	132792	43700	23835	17452	3156	8221
1990	1036310	870248	642354	342252	346521	62955	21124	11515	8599	9441
1991	913820	797991	490810	327781	177368	156759	31343	11381	6409	11335
1992	776857	651274	394029	229915	147346	85828	67174	14178	5320	11419
1993	531067	567698	338579	185596	106405	60070	45046	32675	6199	9922
1994	442720	385566	315788	167039	87791	45826	26562	27945	18844	19008
1995	1162817	340171	214893	155114	73833	41992	21934	9458	19199	30796
1996	1290188	931722	194365	102030	64987	31457	20805	10551	4405	8143
1997	2148532	1060536	487714	88367	44484	27811	14598	8737	5240	10003
1998	776201	1820845	432847	174220	37859	18552	12203	7157	4451	7845
1999	844549	602709	1003918	143812	53307	18076	10637	6299	4093	8285
2000	983135	642546	338852	539553	40021	25034	9805	6977	3563	7924
2001	540793	788694	402904	219184	269234	20398	13467	6590	5174	18724
2002	1712546	456223	343794	135845	80686	106112	11753	7939	4889	10432
2003	546025	1253741	228290	181450	64190	36213	59260	6104	5482	7234
2004	1261256	429086	600993	109956	98704	28271	17116	31913	3992	5225
2005	789082	919217	206434	333253	58363	68193	14499	10893	24542	6759
2006	947769	622218	505773	118228	203449	32124	46855	7898	7368	7854
2007	1031601	647519	330845	288628	72819	140784	22442	36954	5009	11597
2008	890569	858667	372496	197940	206192	50281	104278	17773	30103	40053
2009	NA	676656	526211	260705	137053	156361	39583	79483	14367	61988

Table 8.4.1. North Sea plaice. Stock summary table.

	recruits	ssb	catch	landings	discards	fbar2-6	fbar hc2-6	fbar dis2-3	Y/ssb
1957	457973	274205	78423	70563	7860	0.27	0.22	0.12	0.26
1958	698110	288540	88240	73354	14886	0.32	0.24	0.19	0.25
1959	863386	296825	109238	79300	29938	0.37	0.24	0.24	0.27
1960	757298	308164	117138	87541	29597	0.37	0.27	0.23	0.28
1961	860575	321353	118331	85984	32347	0.35	0.24	0.27	0.27
1962	589153	372863	125272	87472	37800	0.39	0.25	0.29	0.23
1963	688365	370372	148170	107118	41052	0.42	0.27	0.36	0.29
1964	2231496	363076	147357	110540	36817	0.47	0.30	0.32	0.30
1965	694571	344012	139820	97143	42677	0.39	0.28	0.25	0.28
1966	586775	361547	166784	101834	64950	0.40	0.24	0.34	0.28
1967	401292	416560	163178	108819	54359	0.43	0.25	0.32	0.26
1968	434274	402516	139503	111534	27969	0.34	0.21	0.22	0.28
1969	648862	377425	142896	121651	21245	0.34	0.25	0.17	0.32
1970	650568	333925	160026	130342	29684	0.48	0.35	0.28	0.39
1971	410258	316330	136932	113944	22988	0.38	0.29	0.22	0.36
1972	366600	319043	142495	122843	19652	0.41	0.33	0.19	0.39
1973	1311938	268690	143883	130429	13454	0.47	0.41	0.13	0.49
1974	1132612	278608	157804	112540	45264	0.49	0.41	0.20	0.40
1975	864628	293068	195154	108536	86618	0.56	0.37	0.43	0.37
1976	692495	310834	167089	113670	53419	0.42	0.30	0.27	0.37
1977	988392	316735	176691	119188	57503	0.51	0.34	0.31	0.38
1978	911977	303134	159727	113984	45743	0.47	0.36	0.22	0.38
1979	890115	296622	213422	145347	68075	0.67	0.49	0.36	0.49
1980	1125334	271634	171235	139951	31284	0.56	0.49	0.16	0.52
1981	866020	260703	172671	139747	32924	0.54	0.47	0.16	0.54
1982	2030236	262013	204286	154547	49739	0.61	0.51	0.22	0.59
1983	1306336	311165	218424	144038	74386	0.60	0.49	0.26	0.46
1984	1258598	322582	226930	156147	70783	0.59	0.44	0.28	0.48
1985	1846346	344928	220928	159838	61090	0.54	0.44	0.23	0.46
1986	4750659	369768	296876	165347	131529	0.66	0.50	0.34	0.45
1987	1950224	442035	342985	153670	189315	0.70	0.49	0.51	0.35
1988	1769839	387569	311635	154475	157160	0.68	0.40	0.52	0.40
1989	1187325	408029	277738	169818	107920	0.62	0.38	0.46	0.42
1990	1036310	378736	228734	156240	72494	0.58	0.39	0.39	0.41
1991	913820	346093	229607	148004	81603	0.67	0.43	0.47	0.43
1992	776857	279778	183284	125190	58094	0.64	0.43	0.40	0.45
1993	531067	241954	152242	117113	35129	0.64	0.50	0.28	0.48
1994	442720	216682	134392	110392	24000	0.62	0.51	0.24	0.51
1995	1162817	207539	120316	98356	21960	0.65	0.56	0.21	0.47
1996	1290188	180465	133797	81673	52124	0.68	0.52	0.35	0.45
1997	2148532	197379	179957	83048	96909	0.79	0.51	0.69	0.42
1998	776201	226574	175002	71534	103468	0.74	0.39	0.60	0.32
1999	844549	202179	151708	80662	71046	0.67	0.38	0.38	0.40
2000	983135	231029	126142	81148	44994	0.48	0.32	0.26	0.35
2001	540793	271129	182578	81963	100615	0.78	0.32	0.72	0.30
2002	1712546	196790	125884	70217	55667	0.59	0.38	0.43	0.36
2003	546025	222231	145390	66502	78888	0.63	0.39	0.46	0.30
2004	1261256	203118	117702	61436	56266	0.50	0.30	0.43	0.30
2005	789082	236119	111060	55700	55360	0.42	0.21	0.38	0.24
2006	947769	247639	121205	57943	63262	0.38	0.20	0.39	0.23
2007	1031601	253712	90283	49744	40539	0.31	0.15	0.34	0.20
2008	890569	344871	96040	48874	47166	0.25	0.13	0.25	0.14

Table 8.5.1. North Sea plaice. Input table for RCT3 analysis.

year	Age1	Age2	SNS0	SNS1	SNS2	BTS1	BTS2	DFS0
1968	648862	506075	-11	-11	9732	-11	-11	-11
1969	650568	471044	-11	9311	28164	-11	-11	-11
1970	410258	305244	1200	13538	10785	-11	-11	-11
1971	366600	263001	4456	13207	5046	-11	-11	-11
1972	1311938	1059987	7757	65639	16509	-11	-11	-11
1973	1132612	821873	7183	15366	8168	-11	-11	-11
1974	864628	548393	2568	11628	2403	-11	-11	-11
1975	692495	449002	1314	8537	3424	-11	-11	-11
1976	988392	647159	11166	18537	12678	-11	-11	-11
1977	911977	608296	4373	14012	9829	-11	-11	-11
1978	890115	525288	3267	21495	12882	-11	-11	-11
1979	1125334	801983	29058	59174	18785	-11	-11	-11
1980	866020	655766	4210	24756	8642	-11	-11	-11
1981	2030236	1442615	35506	69993	13909	-11	-11	605.96
1982	1306336	932216	24402	33974	10413	-11	-11	433.67
1983	1258598	843201	32942	44965	13848	-11	179.9	431.72
1984	1846346	1284914	7918	28101	7580	115.58	131.77	261.8
1985	4750659	3234130	47256	93552	32991	667.44	764.29	716.29
1986	1950224	1420748	8820	33402	14421	225.82	146.99	200.11
1987	1769839	1269821	21335	36609	17810	680.17	319.27	516.84
1988	1187325	870248	15670	34276	7496	467.88	102.64	318.36
1989	1036310	797991	24585	25037	11247	115.31	122.05	435.7
1990	913820	651274	9368	57221	13842	185.45	125.93	465.47
1991	776857	567698	17257	46798	9686	176.97	179.1	498.49
1992	531067	385566	6473	22098	4977	124.76	64.22	351.59
1993	442720	340171	9234	19188	2796	145.21	43.55	262.26
1994	1162817	931772	26781	24767	10268	252.16	212.32	445.66
1995	1290188	1060536	12541	23015	-11	218.28	-11	184.51
1996	2148532	1820845	84042	-11	30242	-11	431.9	572.8
1997	776201	602709	14328	33666	10272	342.51	130	149.19
1998	844549	642546	25522	32951	2493	305.9	74.4	-11
1999	983135	788694	39262	22855	2898	277.61	78.44	-11
2000	540793	456223	24214	11511	1103	222.71	47.74	183.83
2001	1712546	1253741	99628	30813	-11	541.25	170.08	500.43
2002	546025	429086	31350	-11	1350	126.11	41.75	210.7
2003	1261256	919217	-11	18202	1819	226.2	69.6	359.59
2004	789082	622218	13537	10118	1571	158.45	38.99	243.15
2005	-11	-11	27391	12164	2134	135.11	72.29	129.25
2006	-11	-11	51124	14175	2700	329.34	130.6	232.28
2007	-11	-11	40581	14706	-11	235.37	-11	175.65
2008	-11	-11	50179	-11	-11	-11	-11	186.87

Table 8.5.2. North Sea plaice. RCT3 results for age 1.

```
Analysis by RCT3 ver3.1 of data from file :
ple_iv1.txt
North Sea Plaice Age 1
Data for    6 surveys over   40 years :  1969 - 2008
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/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights
SNS0       .96   4.72    .89   .271     34  10.82   15.14     .948     .193
DFS0      2.36    .13    .90   .292     22   5.24   12.51    1.012     .170
                                        VPA Mean =   13.83     .523     .637
Year     Weighted      Log      Int      Ext      Var      VPA       Log
Class     Average      WAP      Std      Std     Ratio               VPA
         Prediction            Error    Error
2008     1041086     13.86      .42      .56     1.81
```

Table 8.5.3. North Sea plaice. RCT3 results for age 2.

```
Analysis by RCT3 ver3.1 of data from file :
 ple_iv2.txt
 North Sea Plaice Age 2

 Data for    6 surveys over   40 years :  1969 - 2008
 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 =   2007
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 SNS0      .85   5.48    .74   .346     34  10.61   14.49     .787     .155
 SNS1     1.25    .82    .58   .435     34   9.60   12.83     .618     .252
 BTS1     1.59   4.86    .73   .357     20   5.47   13.57     .792     .154
 DFS0     2.41   -.41    .94   .260     22   5.17   12.04    1.063     .085
                                        VPA Mean =   13.51     .522     .353
 Year     Weighted      Log      Int     Ext     Var     VPA      Log
 Class     Average      WAP      Std     Std    Ratio             VPA
          Prediction             Error   Error
 2007      645091     13.38      .31     .33     1.13
```

Table 8.6.1. North Sea plaice. Input to the short term forecast (f values presented are for Fsq)

age	year	f	f.disc	f.land	stock.n	catch.wt	landings.wt	discards.wt	stock.wt	mat	M
1	2009	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1
2	2009	0.359	0.33	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1
3	2009	0.296	0.17	0.12	526211	0.22	0.30	0.17	0.21	0.5	0.1
4	2009	0.232	0.05	0.18	260705	0.31	0.34	0.19	0.28	1.0	0.1
5	2009	0.187	0.01	0.17	137053	0.38	0.39	0.19	0.35	1.0	0.1
6	2009	0.156	0.02	0.13	156361	0.40	0.44	0.21	0.42	1.0	0.1
7	2009	0.116	0.03	0.09	39583	0.44	0.52	0.22	0.46	1.0	0.1
8	2009	0.150	0.05	0.10	79483	0.42	0.57	0.20	0.52	1.0	0.1
9	2009	0.088	0.00	0.09	14367	0.59	0.59	0.00	0.57	1.0	0.1
10	2009	0.088	0.00	0.09	61988	0.65	0.65	0.00	0.67	1.0	0.1
1	2010	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1
2	2010	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1
3	2010	0.296	0.17	0.12	427562	0.22	0.30	0.17	0.21	0.5	0.1
4	2010	0.232	0.05	0.18	354273	0.31	0.34	0.19	0.28	1.0	0.1
5	2010	0.187	0.01	0.17	187021	0.38	0.39	0.19	0.35	1.0	0.1
6	2010	0.156	0.02	0.13	102874	0.40	0.44	0.21	0.42	1.0	0.1
7	2010	0.116	0.03	0.09	121013	0.44	0.52	0.22	0.46	1.0	0.1
8	2010	0.150	0.05	0.10	31908	0.42	0.57	0.20	0.52	1.0	0.1
9	2010	0.088	0.00	0.09	61916	0.59	0.59	0.00	0.57	1.0	0.1
10	2010	0.088	0.00	0.09	63239	0.65	0.65	0.00	0.67	1.0	0.1
1	2011	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1
2	2011	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1
3	2011	0.296	0.17	0.12	453366	0.22	0.30	0.17	0.21	0.5	0.1
4	2011	0.232	0.05	0.18	287857	0.31	0.34	0.19	0.28	1.0	0.1
5	2011	0.187	0.01	0.17	254143	0.38	0.39	0.19	0.35	1.0	0.1
6	2011	0.156	0.02	0.13	140381	0.40	0.44	0.21	0.42	1.0	0.1
7	2011	0.116	0.03	0.09	79617	0.44	0.52	0.22	0.46	1.0	0.1
8	2011	0.150	0.05	0.10	97551	0.42	0.57	0.20	0.52	1.0	0.1
9	2011	0.088	0.00	0.09	24856	0.59	0.59	0.00	0.57	1.0	0.1
10	2011	0.088	0.00	0.09	103656	0.65	0.65	0.00	0.67	1.0	0.1

Table 8.6.2A. North Sea plaice. Results from the short term forecast assuming $F_{2009} = F_{2008}$

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2009
2009	1	0.246	0.25	0.25	59461	43755	103149	388131

	year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2011
2	2010	0.2	0.049	0.05	0.05	14137	9688	23827	442260	572497
5	2010	0.3	0.074	0.08	0.07	20984	14325	35312	442260	560768
8	2010	0.4	0.098	0.10	0.10	27688	18830	46521	442260	549320
11	2010	0.5	0.123	0.13	0.12	34252	23206	57462	442260	538145
14	2010	0.6	0.148	0.15	0.15	40680	27459	68143	442260	527237
17	2010	0.7	0.172	0.18	0.17	46974	31591	78569	442260	516587
20	2010	0.8	0.197	0.20	0.20	53139	35606	88749	442260	506190
23	2010	0.9	0.221	0.23	0.22	59176	39508	98689	442260	496037
26	2010	1.0	0.246	0.25	0.25	65090	43301	108394	442260	486124
29	2010	1.1	0.271	0.28	0.27	70882	46987	117872	442260	476443
32	2010	1.2	0.295	0.30	0.30	76555	50571	127129	442260	466989
35	2010	1.3	0.320	0.33	0.32	82113	54054	136170	442260	457756
38	2010	1.4	0.344	0.35	0.34	87558	57441	145001	442260	448737
41	2010	1.5	0.369	0.38	0.37	92893	60734	153627	442260	439927
44	2010	1.6	0.394	0.40	0.39	98119	63936	162055	442260	431321
47	2010	1.7	0.418	0.43	0.42	103241	67050	170289	442260	422913
50	2010	1.8	0.443	0.46	0.44	108259	70078	178334	442260	414698
53	2010	1.9	0.467	0.48	0.47	113176	73024	186196	442260	406672
56	2010	2.0	0.492	0.51	0.49	117995	75889	193879	442260	398829

Table 8.6.2B. North Sea plaice. Results from the short term forecast assuming $F_{2009} = 0.9 * F_{2008}$

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2009
2009	0.9	0.221	0.23	0.22	54080	39922	93941	388131

	year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2011
2	2010	0.2	0.049	0.05	0.05	14493	9867	24363	451772	584656
5	2010	0.3	0.074	0.08	0.07	21513	14590	36106	451772	572651
8	2010	0.4	0.098	0.10	0.10	28385	19177	47566	451772	560933
11	2010	0.5	0.123	0.13	0.12	35114	23634	58753	451772	549496
14	2010	0.6	0.148	0.15	0.15	41703	27965	69673	451772	538331
17	2010	0.7	0.172	0.18	0.17	48155	32172	80332	451772	527432
20	2010	0.8	0.197	0.20	0.20	54473	36261	90740	451772	516791
23	2010	0.9	0.221	0.23	0.22	60661	40235	100901	451772	506402
26	2010	1.0	0.246	0.25	0.25	66721	44096	110823	451772	496257
29	2010	1.1	0.271	0.28	0.27	72657	47850	120512	451772	486350
32	2010	1.2	0.295	0.30	0.30	78471	51499	129975	451772	476676
35	2010	1.3	0.320	0.33	0.32	84167	55045	139217	451772	467228
38	2010	1.4	0.344	0.35	0.34	89746	58494	148244	451772	457999
41	2010	1.5	0.369	0.38	0.37	95212	61846	157061	451772	448985
44	2010	1.6	0.394	0.40	0.39	100568	65106	165676	451772	440180
47	2010	1.7	0.418	0.43	0.42	105815	68276	174092	451772	431578
50	2010	1.8	0.443	0.46	0.44	110956	71359	182315	451772	423173
53	2010	1.9	0.467	0.48	0.47	115994	74357	190350	451772	414962
56	2010	2.0	0.492	0.51	0.49	120931	77274	198202	451772	406938

Table 8.6.2C. North Sea plaice. Results from the short term forecast assuming a F for 2009 such that the landings in 2009 equal the TAC for 2009

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2009
2009	0.926	0.228	0.23	0.23	55501	40937	96376	388131

	year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2011
2	2010	0.2	0.049	0.05	0.05	14399	9820	24221	449258	581439
5	2010	0.3	0.074	0.08	0.07	21373	14520	35896	449258	569507
8	2010	0.4	0.098	0.10	0.10	28200	19085	47290	449258	557861
11	2010	0.5	0.123	0.13	0.12	34886	23521	58411	449258	546493
14	2010	0.6	0.148	0.15	0.15	41432	27831	69268	449258	535397
17	2010	0.7	0.172	0.18	0.17	47842	32018	79866	449258	524563
20	2010	0.8	0.197	0.20	0.20	54120	36088	90213	449258	513987
23	2010	0.9	0.221	0.23	0.22	60268	40042	100316	449258	503660
26	2010	1.0	0.246	0.25	0.25	66289	43886	110180	449258	493577
29	2010	1.1	0.271	0.28	0.27	72187	47622	119814	449258	483730
32	2010	1.2	0.295	0.30	0.30	77964	51253	129222	449258	474114
35	2010	1.3	0.320	0.33	0.32	83623	54783	138410	449258	464722
38	2010	1.4	0.344	0.35	0.34	89167	58215	147385	449258	455549
41	2010	1.5	0.369	0.38	0.37	94599	61552	156153	449258	446589
44	2010	1.6	0.394	0.40	0.39	99920	64797	164718	449258	437837
47	2010	1.7	0.418	0.43	0.42	105133	67952	173085	449258	429286
50	2010	1.8	0.443	0.46	0.44	110242	71020	181261	449258	420932
53	2010	1.9	0.467	0.48	0.47	115248	74004	189251	449258	412769
56	2010	2.0	0.492	0.51	0.49	120154	76907	197058	449258	404794

Table 8.6.3A. North Sea plaice. Detailed STF table, assuming $F_{2009} = F_{2008}$

Age	f	fdis	fland	stck n	catch wt	land wt	dis wt	stock wt	mat	M	catch n	catch	land n	land	dis n	dis	SSB	TSB
Year 2009																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1	194833	24219	13315	3568	181519	20633	37893	75786
3	0.296	0.17	0.12	526211	0.22	0.30	0.17	0.21	0.5	0.1	128479	28771	54120	16207	74359	12492	55603	111206
4	0.232	0.05	0.18	260705	0.31	0.34	0.19	0.28	1.0	0.1	51501	15969	40796	13957	10705	1991	72997	72997
5	0.187	0.01	0.17	137053	0.38	0.39	0.19	0.35	1.0	0.1	22264	8426	20592	8102	1672	322	47786	47786
6	0.156	0.02	0.13	156361	0.40	0.44	0.21	0.42	1.0	0.1	21555	8682	18419	8070	3135	655	64994	64994
7	0.116	0.03	0.09	39583	0.44	0.52	0.22	0.46	1.0	0.1	4114	1799	3049	1578	1065	231	18221	18221
8	0.150	0.05	0.10	79483	0.42	0.57	0.20	0.52	1.0	0.1	10534	4472	6844	3870	3690	736	40934	40934
9	0.088	0.00	0.09	14367	0.59	0.59	0.00	0.57	1.0	0.1	1158	681	1158	681	0	0	8175	8175
10	0.088	0.00	0.09	61988	0.65	0.65	0.00	0.67	1.0	0.1	4999	3226	4999	3226	0	0	41529	41529
Year 2010																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1	206592	25681	14118	3783	192474	21878	40180	80359
3	0.296	0.17	0.12	427562	0.22	0.30	0.17	0.21	0.5	0.1	104393	23377	43974	13169	60419	10150	45179	90358
4	0.232	0.05	0.18	354273	0.31	0.34	0.19	0.28	1.0	0.1	69985	21701	55438	18966	14547	2706	99196	99196
5	0.187	0.01	0.17	187021	0.38	0.39	0.19	0.35	1.0	0.1	30381	11498	28099	11056	2282	439	65208	65208
6	0.156	0.02	0.13	102874	0.40	0.44	0.21	0.42	1.0	0.1	14181	5712	12119	5309	2063	431	42761	42761
7	0.116	0.03	0.09	121013	0.44	0.52	0.22	0.46	1.0	0.1	12576	5500	9321	4824	3255	705	55706	55706
8	0.150	0.05	0.10	31908	0.42	0.57	0.20	0.52	1.0	0.1	4229	1795	2747	1554	1481	295	16433	16433
9	0.088	0.00	0.09	61916	0.59	0.59	0.00	0.57	1.0	0.1	4993	2936	4993	2936	0	0	35230	35230
10	0.088	0.00	0.09	63239	0.65	0.65	0.00	0.67	1.0	0.1	5099	3292	5099	3292	0	0	42366	42366
Year 2011																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1	206592	25681	14118	3783	192474	21878	40180	80359
3	0.296	0.17	0.12	453366	0.22	0.30	0.17	0.21	0.5	0.1	110693	24788	46628	13963	64065	10763	47906	95811
4	0.232	0.05	0.18	287857	0.31	0.34	0.19	0.28	1.0	0.1	56865	17632	45045	15410	11820	2199	80600	80600
5	0.187	0.01	0.17	254143	0.38	0.39	0.19	0.35	1.0	0.1	41285	15624	38184	15024	3101	596	88611	88611
6	0.156	0.02	0.13	140381	0.40	0.44	0.21	0.42	1.0	0.1	19352	7795	16537	7245	2815	588	58352	58352
7	0.116	0.03	0.09	79617	0.44	0.52	0.22	0.46	1.0	0.1	8274	3619	6132	3174	2142	464	36651	36651
8	0.150	0.05	0.10	97551	0.42	0.57	0.20	0.52	1.0	0.1	12928	5489	8399	4750	4529	903	50239	50239
9	0.088	0.00	0.09	24856	0.59	0.59	0.00	0.57	1.0	0.1	2004	1179	2004	1179	0	0	14143	14143
10	0.088	0.00	0.09	103656	0.65	0.65	0.00	0.67	1.0	0.1	8358	5395	8358	5395	0	0	69444	69444

Table 8.6.3B. North Sea plaice. Detailed STF table, assuming $F_{2009} = 0.9 * F_{2008}$

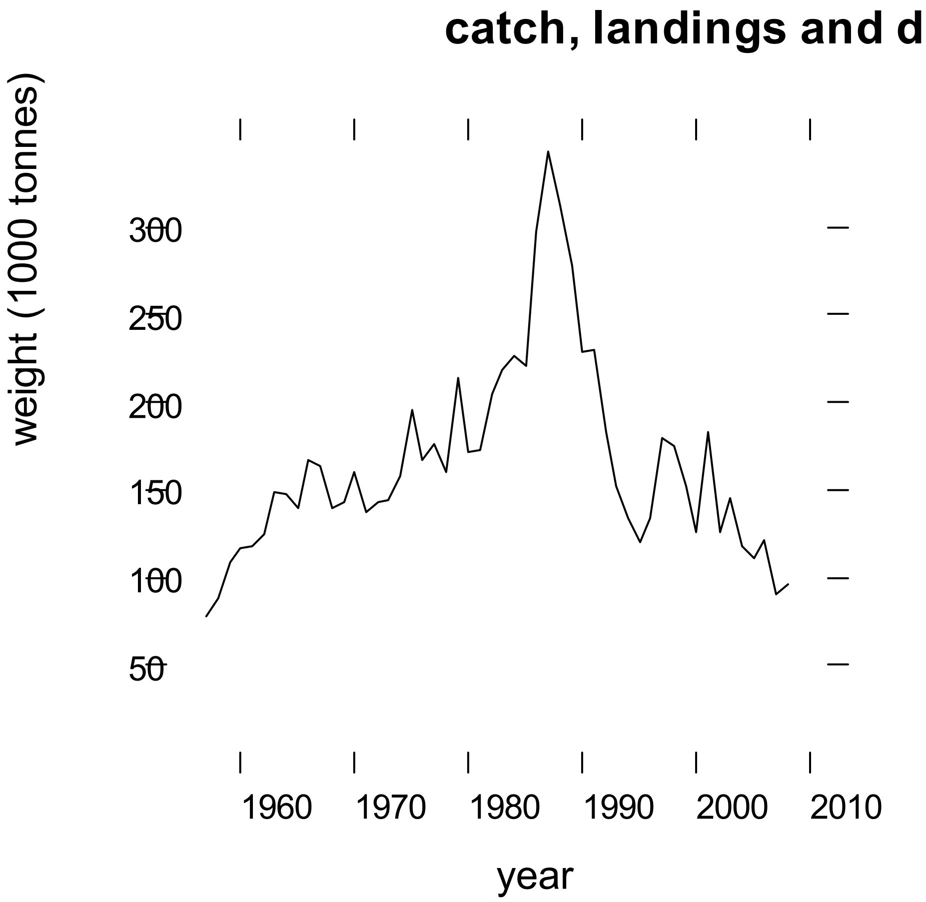
Age	f	fdis	fland	stck	catch	land	dis	stock	mat	M	catch	catch	land	land	dis	dis	SSB	TSB
				n	wt	wt	wt	wt			n		n		n			
Year 2009																		
1	0.127	0.13	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	103555	6254	717	183	102838	6067	0	45950
2	0.323	0.30	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1	178292	22163	12184	3265	166108	18881	37893	75786
3	0.266	0.15	0.11	526211	0.22	0.30	0.17	0.21	0.5	0.1	117243	26255	49387	14790	67856	11400	55603	111206
4	0.209	0.04	0.17	260705	0.31	0.34	0.19	0.28	1.0	0.1	46863	14531	37122	12700	9741	1812	72997	72997
5	0.168	0.01	0.16	137053	0.38	0.39	0.19	0.35	1.0	0.1	20217	7651	18698	7357	1519	292	47786	47786
6	0.141	0.02	0.12	156361	0.40	0.44	0.21	0.42	1.0	0.1	19545	7873	16702	7317	2843	594	64994	64994
7	0.104	0.03	0.08	39583	0.44	0.52	0.22	0.46	1.0	0.1	3723	1628	2759	1428	964	209	18221	18221
8	0.135	0.05	0.09	79483	0.42	0.57	0.20	0.52	1.0	0.1	9549	4054	6204	3508	3345	667	40934	40934
9	0.080	0.00	0.08	14367	0.59	0.59	0.00	0.57	1.0	0.1	1047	616	1047	616	0	0	8175	8175
10	0.080	0.00	0.08	61988	0.65	0.65	0.00	0.67	1.0	0.1	4518	2916	4518	2916	0	0	41529	41529
Year 2010																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	727673	0.12	0.27	0.11	0.11	0.5	0.1	209523	26045	14319	3837	195204	22188	40750	81499
3	0.296	0.17	0.12	443193	0.22	0.30	0.17	0.21	0.5	0.1	108210	24232	45582	13650	62628	10521	46831	93661
4	0.232	0.05	0.18	364903	0.31	0.34	0.19	0.28	1.0	0.1	72085	22352	57101	19535	14984	2787	102173	102173
5	0.187	0.01	0.17	191413	0.38	0.39	0.19	0.35	1.0	0.1	31095	11768	28759	11316	2336	449	66739	66739
6	0.156	0.02	0.13	104814	0.40	0.44	0.21	0.42	1.0	0.1	14449	5820	12347	5409	2102	439	43568	43568
7	0.116	0.03	0.09	122919	0.44	0.52	0.22	0.46	1.0	0.1	12774	5587	9468	4900	3306	716	56584	56584
8	0.150	0.05	0.10	32279	0.42	0.57	0.20	0.52	1.0	0.1	4278	1816	2779	1572	1499	299	16624	16624
9	0.088	0.00	0.09	62850	0.59	0.59	0.00	0.57	1.0	0.1	5068	2980	5068	2980	0	0	35762	35762
10	0.088	0.00	0.09	63801	0.65	0.65	0.00	0.67	1.0	0.1	5145	3321	5145	3321	0	0	42743	42743
Year 2011																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1	206592	25681	14118	3783	192474	21878	40180	80359
3	0.296	0.17	0.12	459798	0.22	0.30	0.17	0.21	0.5	0.1	112264	25140	47290	14162	64974	10916	48585	97171
4	0.232	0.05	0.18	298381	0.31	0.34	0.19	0.28	1.0	0.1	58944	18277	46692	15974	12252	2279	83547	83547
5	0.187	0.01	0.17	261769	0.38	0.39	0.19	0.35	1.0	0.1	42524	16093	39330	15475	3194	614	91270	91270
6	0.156	0.02	0.13	143678	0.40	0.44	0.21	0.42	1.0	0.1	19806	7978	16925	7415	2881	602	59722	59722
7	0.116	0.03	0.09	81119	0.44	0.52	0.22	0.46	1.0	0.1	8430	3687	6248	3234	2182	473	37342	37342
8	0.150	0.05	0.10	99087	0.42	0.57	0.20	0.52	1.0	0.1	13132	5576	8531	4824	4601	917	51030	51030
9	0.088	0.00	0.09	25145	0.59	0.59	0.00	0.57	1.0	0.1	2028	1192	2028	1192	0	0	14307	14307
10	0.088	0.00	0.09	104895	0.65	0.65	0.00	0.67	1.0	0.1	8458	5460	8458	5460	0	0	70274	70274

Table 8.6.3C. North Sea plaice. Detailed STF table, forecast assuming a F for 2009 such that the landings in 2009 equal the TAC for 2009

Age	f	fdis	fland	stck	catch	land	dis	stock	mat	M	catch	catch	land	land	dis	dis	SSB	TSB
				n	wt	wt	wt	wt			n		n		n			
Year 2009																		
1	0.130	0.13	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	106381	6425	736	188	105644	6233	0	45950
2	0.333	0.31	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1	182682	22709	12484	3345	170198	19346	37893	75786
3	0.274	0.16	0.12	526211	0.22	0.30	0.17	0.21	0.5	0.1	120219	26921	50641	15165	69578	11689	55603	111206
4	0.215	0.04	0.17	260705	0.31	0.34	0.19	0.28	1.0	0.1	48089	14911	38093	13032	9996	1859	72997	72997
5	0.173	0.01	0.16	137053	0.38	0.39	0.19	0.35	1.0	0.1	20757	7855	19198	7554	1559	300	47786	47786
6	0.145	0.02	0.12	156361	0.40	0.44	0.21	0.42	1.0	0.1	20075	8086	17155	7515	2920	610	64994	64994
7	0.107	0.03	0.08	39583	0.44	0.52	0.22	0.46	1.0	0.1	3826	1673	2835	1467	990	215	18221	18221
8	0.139	0.05	0.09	79483	0.42	0.57	0.20	0.52	1.0	0.1	9808	4164	6372	3603	3436	685	40934	40934
9	0.082	0.00	0.08	14367	0.59	0.59	0.00	0.57	1.0	0.1	1076	633	1076	633	0	0	8175	8175
10	0.082	0.00	0.08	61988	0.65	0.65	0.00	0.67	1.0	0.1	4644	2998	4644	2998	0	0	41529	41529
Year 2010																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	724992	0.12	0.27	0.11	0.11	0.5	0.1	208751	25949	14266	3823	194485	22106	40600	81199
3	0.296	0.17	0.12	439043	0.22	0.30	0.17	0.21	0.5	0.1	107196	24005	45155	13522	62041	10423	46392	92784
4	0.232	0.05	0.18	362087	0.31	0.34	0.19	0.28	1.0	0.1	71529	22179	56661	19384	14868	2766	101384	101384
5	0.187	0.01	0.17	190253	0.38	0.39	0.19	0.35	1.0	0.1	30906	11696	28585	11247	2321	446	66335	66335
6	0.156	0.02	0.13	104302	0.40	0.44	0.21	0.42	1.0	0.1	14378	5791	12287	5383	2092	437	43355	43355
7	0.116	0.03	0.09	122416	0.44	0.52	0.22	0.46	1.0	0.1	12722	5564	9429	4880	3293	713	56352	56352
8	0.150	0.05	0.10	32182	0.42	0.57	0.20	0.52	1.0	0.1	4265	1811	2771	1567	1494	298	16574	16574
9	0.088	0.00	0.09	62604	0.59	0.59	0.00	0.57	1.0	0.1	5048	2969	5048	2969	0	0	35622	35622
10	0.088	0.00	0.09	63653	0.65	0.65	0.00	0.67	1.0	0.1	5133	3313	5133	3313	0	0	42644	42644
Year 2011																		
1	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1	206592	25681	14118	3783	192474	21878	40180	80359
3	0.296	0.17	0.12	458104	0.22	0.30	0.17	0.21	0.5	0.1	111850	25047	47115	14109	64735	10875	48406	96813
4	0.232	0.05	0.18	295587	0.31	0.34	0.19	0.28	1.0	0.1	58392	18106	46255	15824	12138	2258	82764	82764
5	0.187	0.01	0.17	259749	0.38	0.39	0.19	0.35	1.0	0.1	42196	15969	39027	15356	3169	610	90566	90566
6	0.156	0.02	0.13	142807	0.40	0.44	0.21	0.42	1.0	0.1	19686	7929	16823	7370	2864	598	59360	59360
7	0.116	0.03	0.09	80723	0.44	0.52	0.22	0.46	1.0	0.1	8389	3669	6218	3218	2171	470	37160	37160
8	0.150	0.05	0.10	98682	0.42	0.57	0.20	0.52	1.0	0.1	13078	5553	8497	4805	4582	913	50821	50821
9	0.088	0.00	0.09	25069	0.59	0.59	0.00	0.57	1.0	0.1	2021	1189	2021	1189	0	0	14264	14264
10	0.088	0.00	0.09	104569	0.65	0.65	0.00	0.67	1.0	0.1	8432	5443	8432	5443	0	0	70055	70055

Table 8.6.4. North Sea plaice. Yield and spawning biomass per recruit reference points

	Fish Mort Ages 2-6	Yield/R	SSB/R
Average last 3 years	0.31	0.09	0.55
Fmax	0.17	0.10	1.25
F0.1	0.12	0.10	1.74
Fmed	0.42	0.07	0.32


catch, landings and d
weight (1000 tonnes)
300
250
200
150
100
50
1960
1970
1980
1990
2000
2010
year

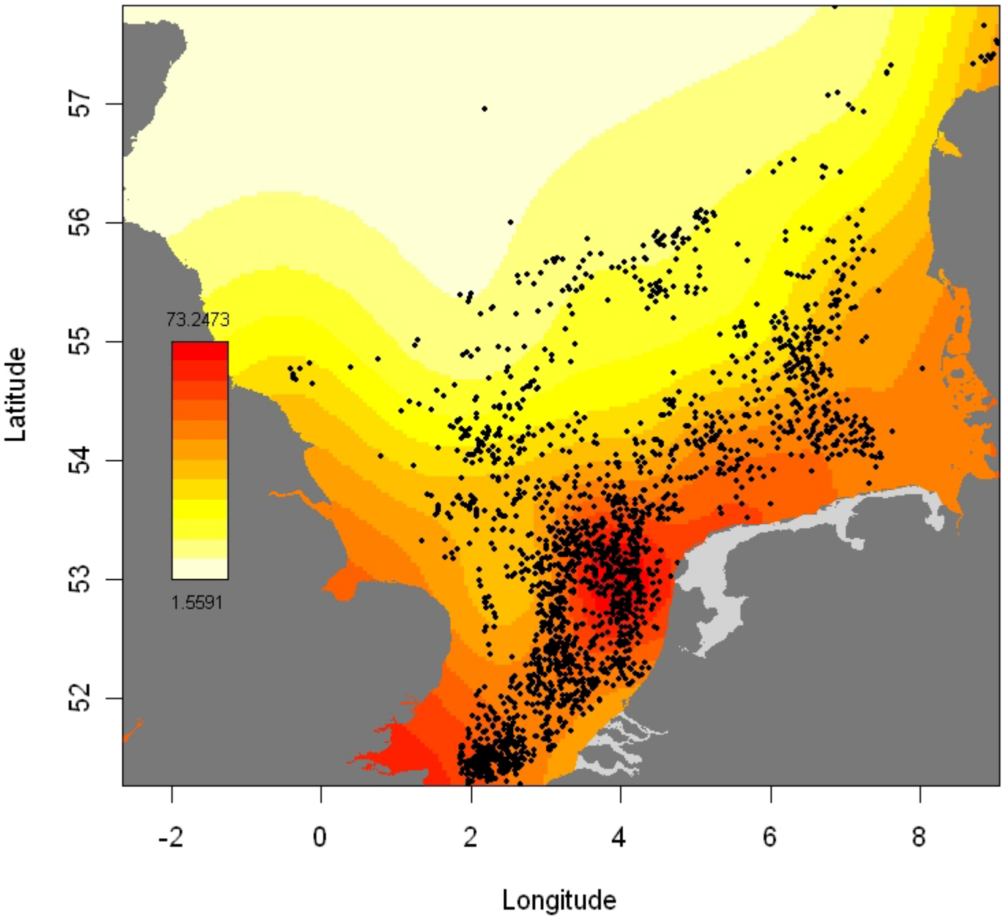
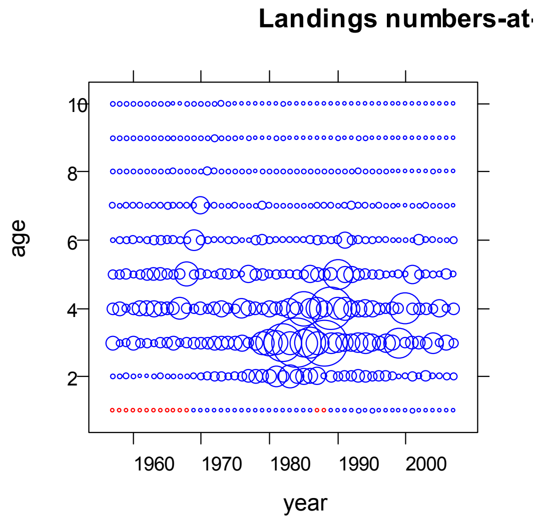


Figure 8.2.2 North Sea plaice. Model predictions of plaice discard percentages and distribution of the PVis data plotted on top. Predictions are made for the beginning of June 2008 (one month before the most recent data point) for a vessel with 9 tickler chains from the ground rope (and no chain mat) and the absolute discard levels only apply to those conditions. Source: Aarts & van Helmond, IMARES report in prep.



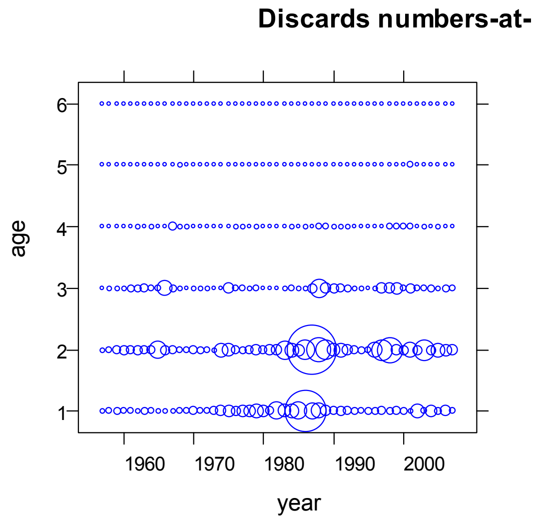


Figure 8.2.3 North Sea plaice. Landing numbers-at-age (left) and discards numbers-at-age (right).

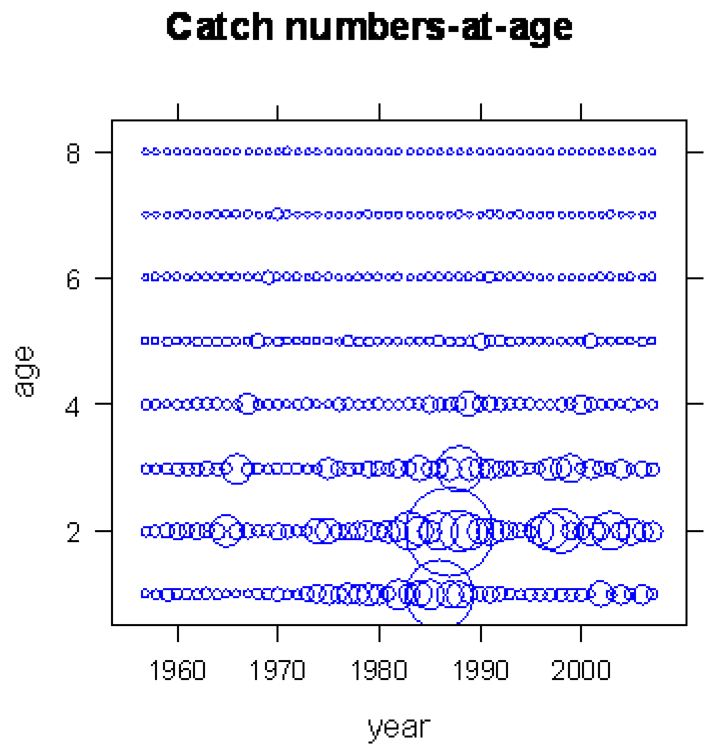
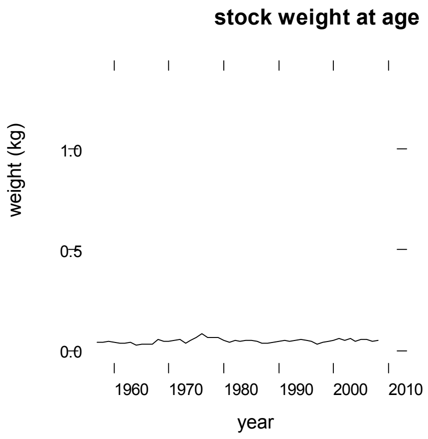


Figure 8.2.4 North Sea plaice. Catch numbers-at-age.


stock weight at age
weight (kg)
1.0
0.5
0.0
1960
1970
1980
1990
2000
2010
year

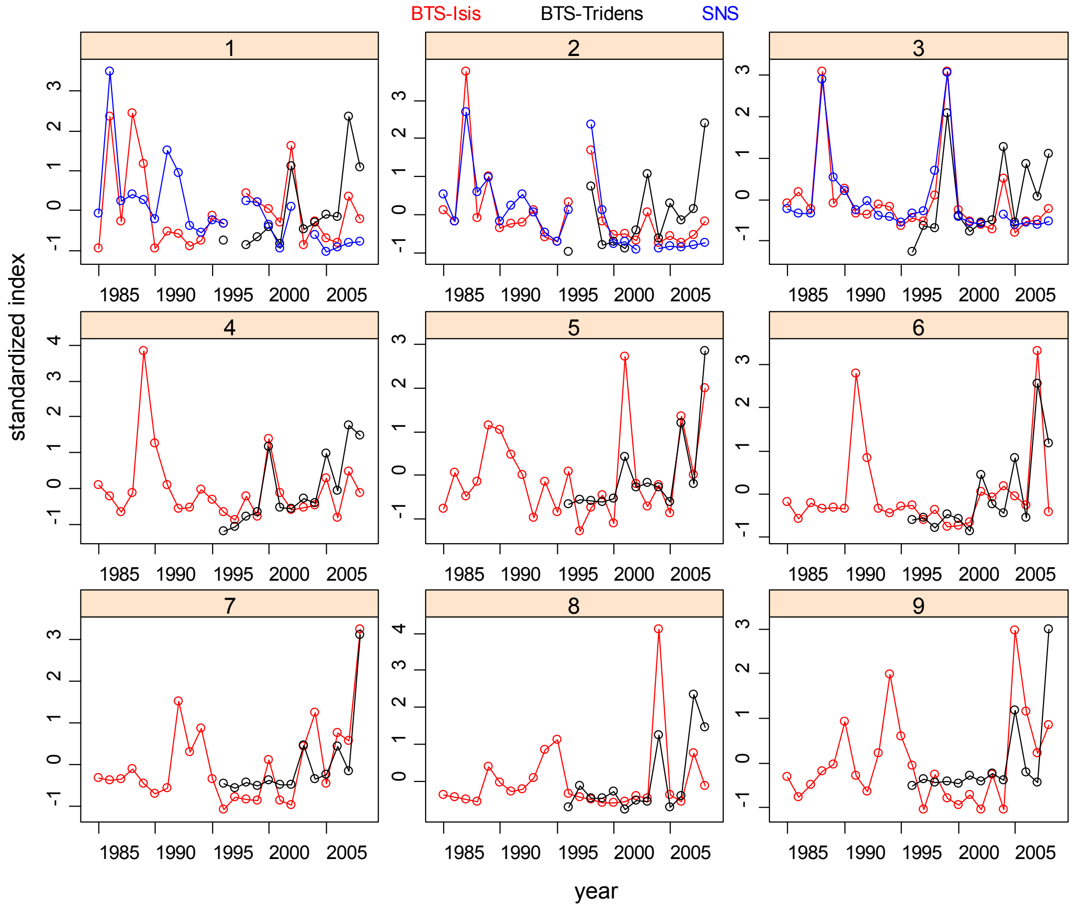


Figure 8.2.6 North Sea plaice. Standardized survey tuning indices used for tuning XSA: BTS-Isis (red), BTS-Tridens (black) and SNS (blue).

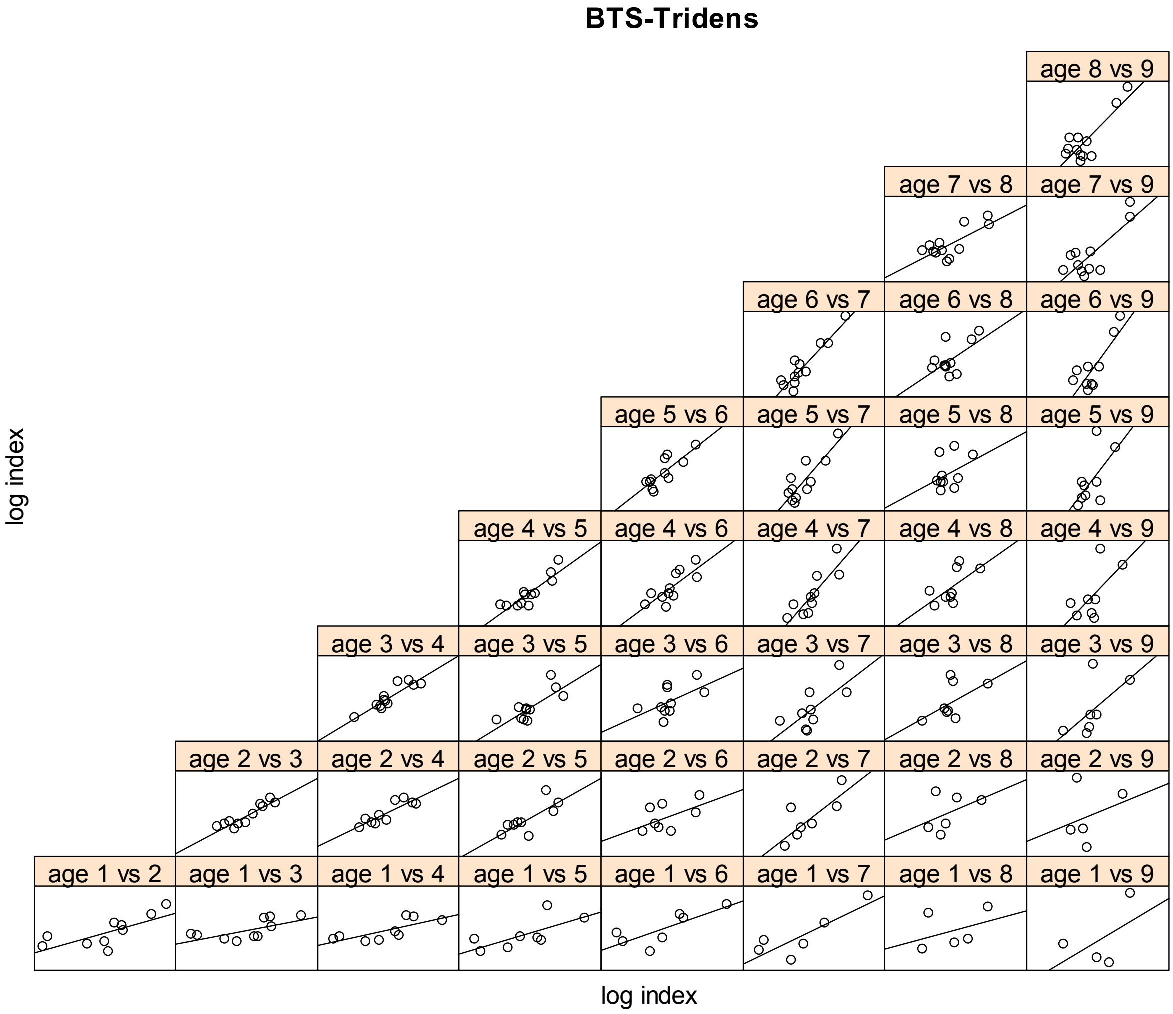


Figure 8.2.7 North Sea plaice. Internal consistency plot for the BTS-Tridens survey.

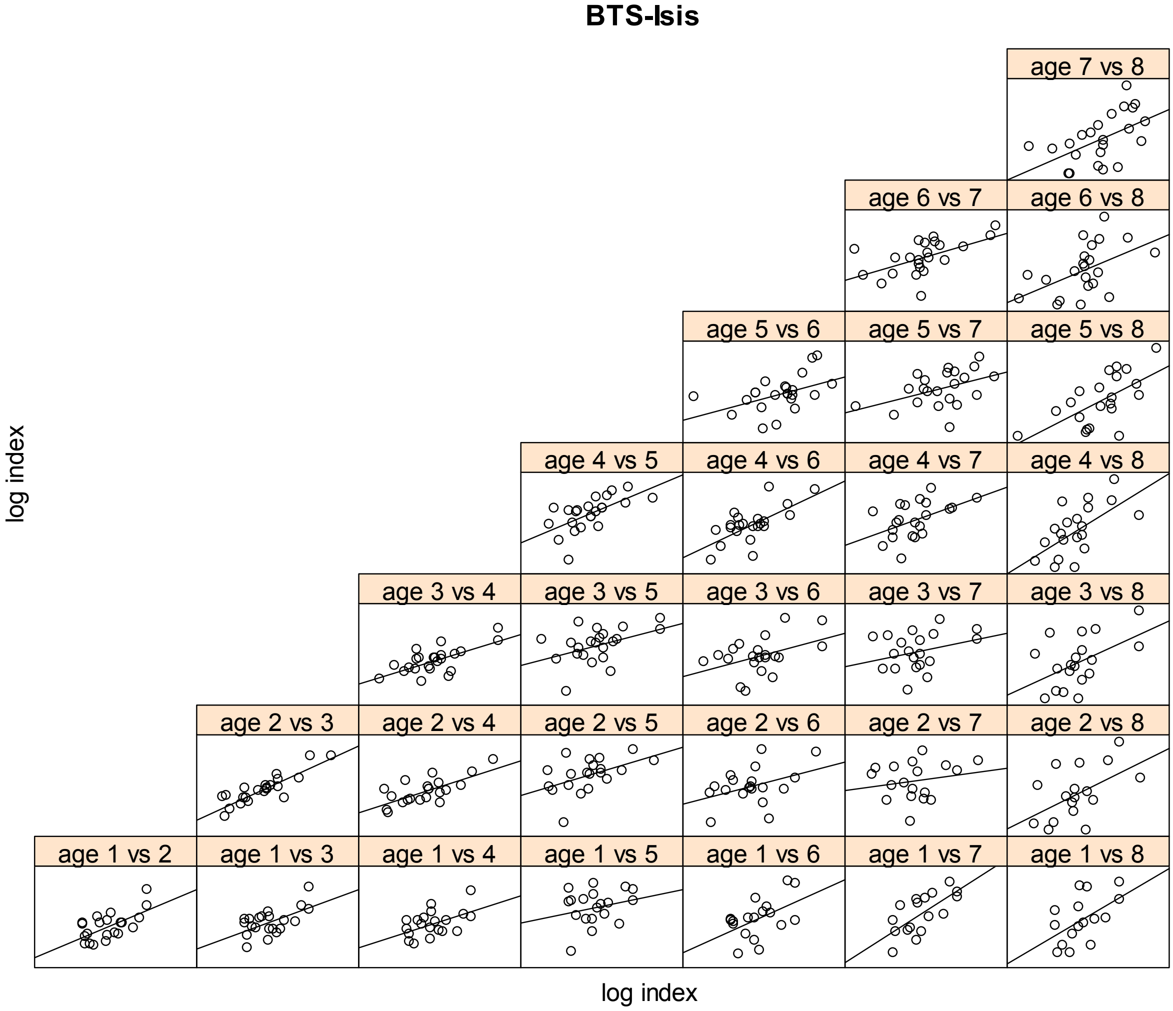


Figure 8.2.8. North Sea plaice. Internal consistency plot for the BTS-Isis survey.

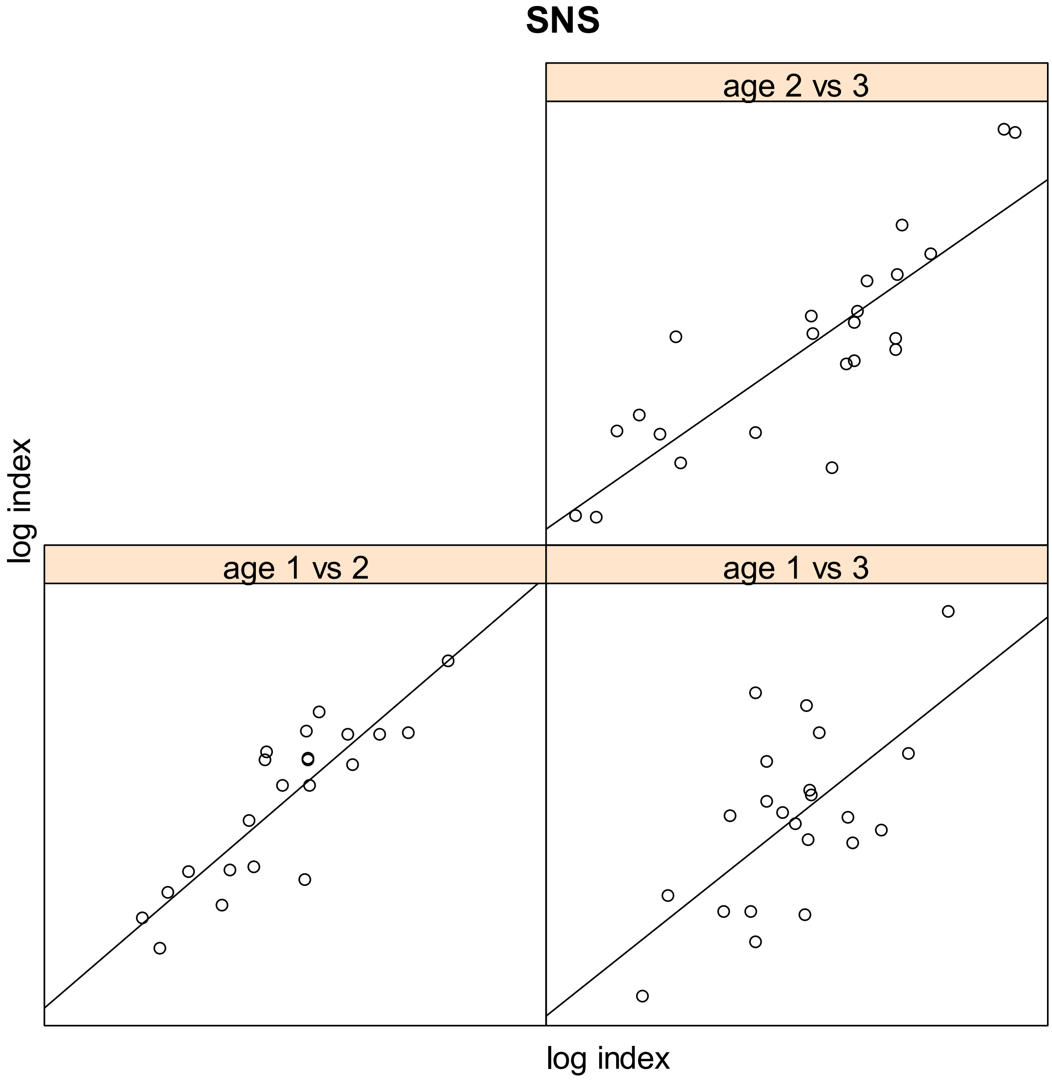


Figure 8.2.9. North Sea plaice. Internal consistency plot for the SNS survey.

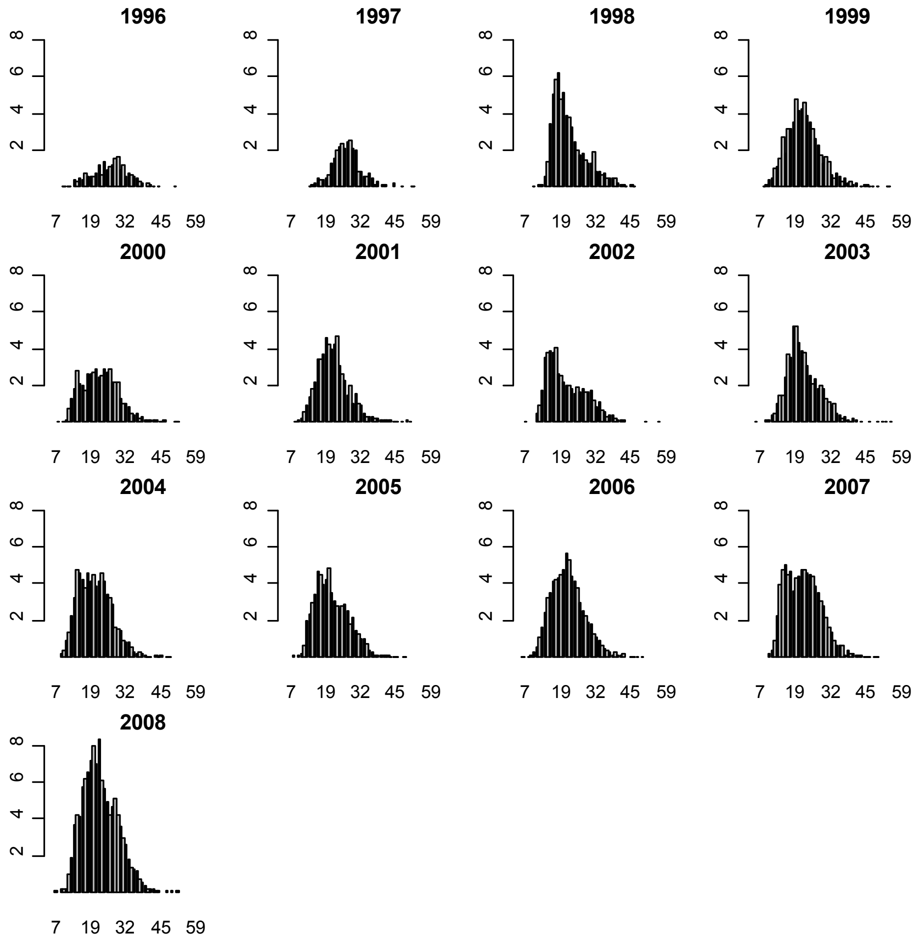


Figure 8.2.10 North Sea plaice. Length distribution per haul for the BTS-Tridens survey extracted from the ICES database.

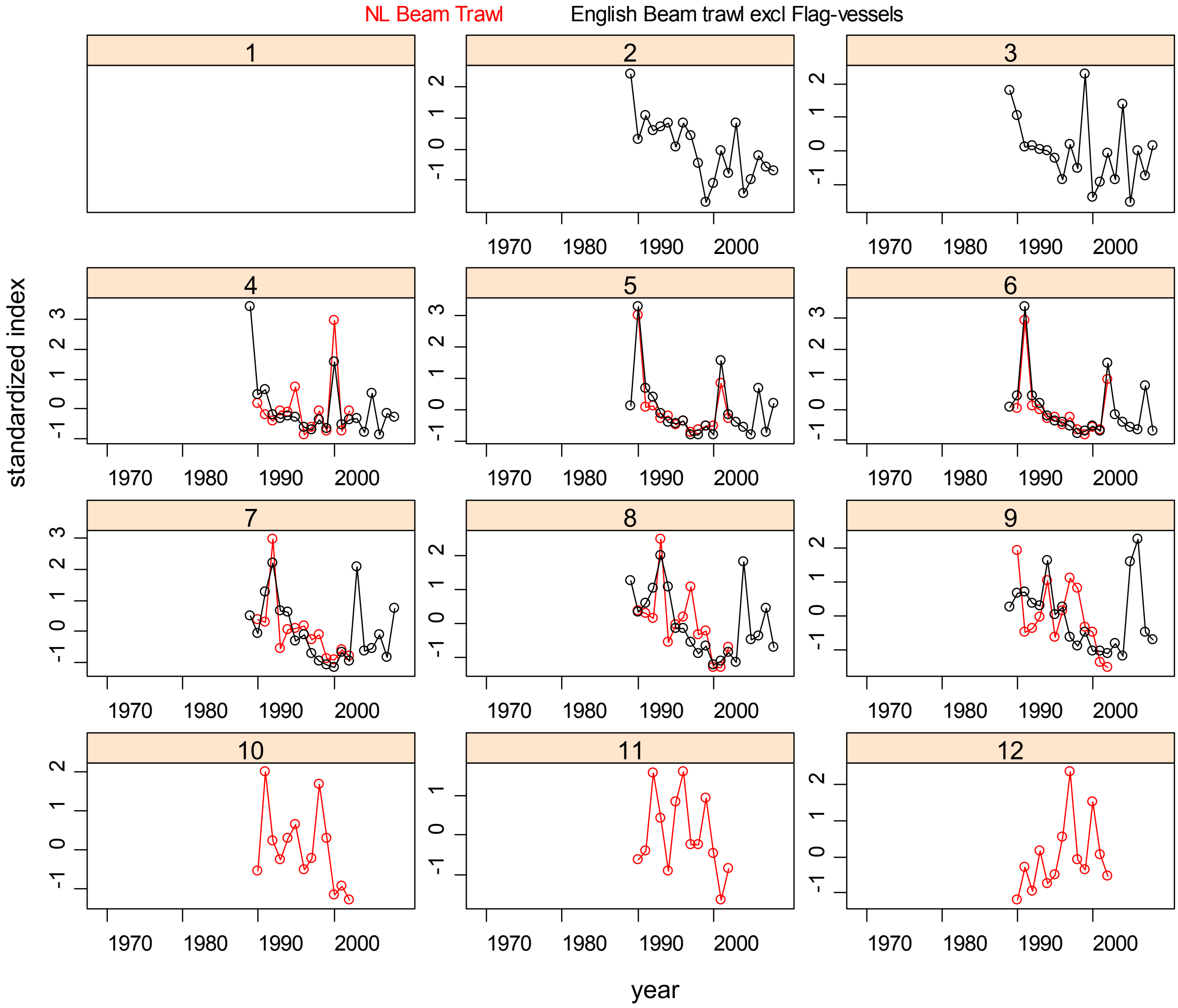


Figure 8.2.11 North Sea plaice. Standardized commercial tuning indices available for tuning: Dutch beam trawl fleet (red) and UK beam trawl fleet excluding all flag vessels (black).

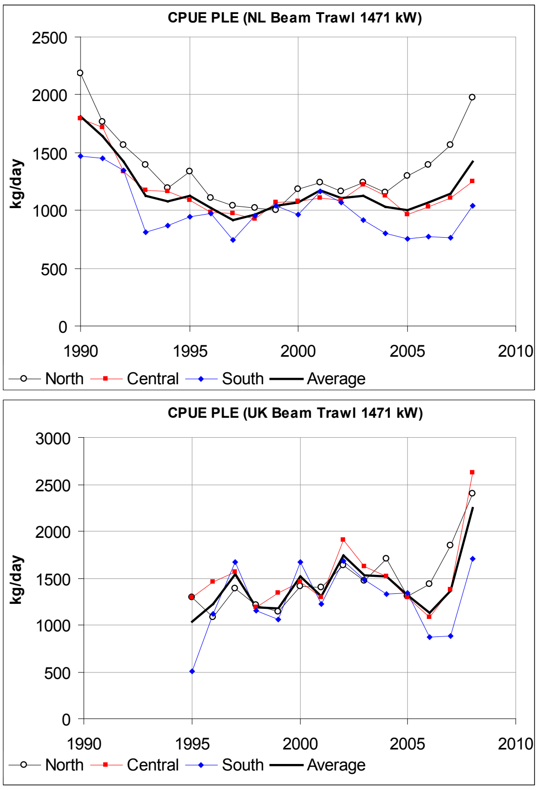


Figure 8.2.12. North Sea plaice. LPUE of the Dutch (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS Taken from Quirijns and Poos 2009,Working paper 1

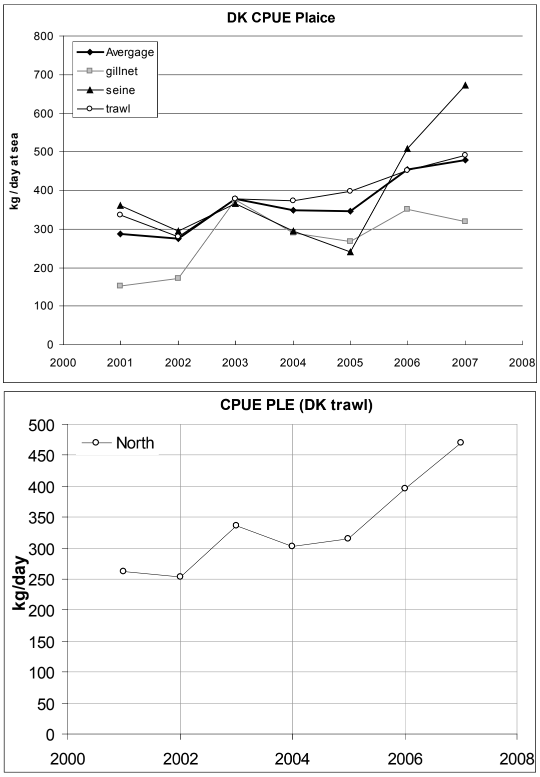


Figure 8.2.13 Danish CPUE. Left: average plaice CPUE (bold line), and split up by gear: trawl, gillnet and seines. Right: plaice CPUE in the northern North Sea by trawlers. Source: Danish log-book data. Taken from Quirijns and Poos 2009,Working paper 1

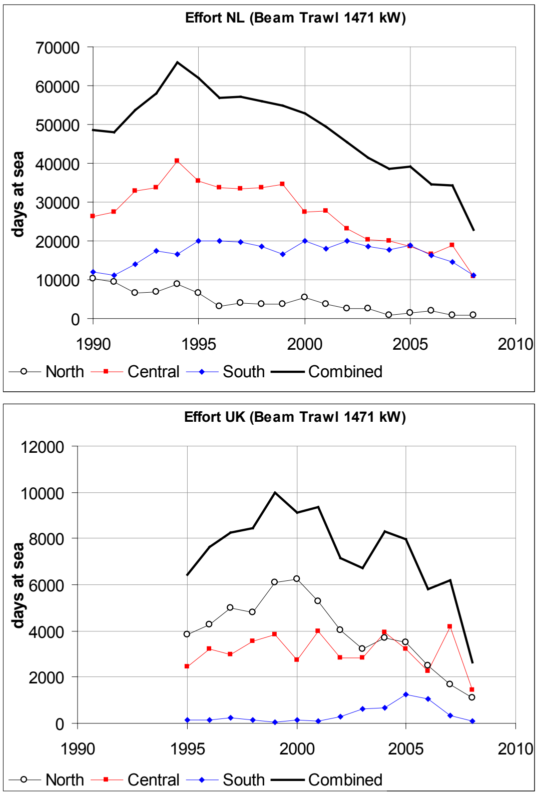


Figure 8.2.14. North Sea plaice. Effort (days at sea per 1471 kW vessel) for the Dutch fleet (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS. Taken from Quirijns and Poos 2009, Working paper 1.

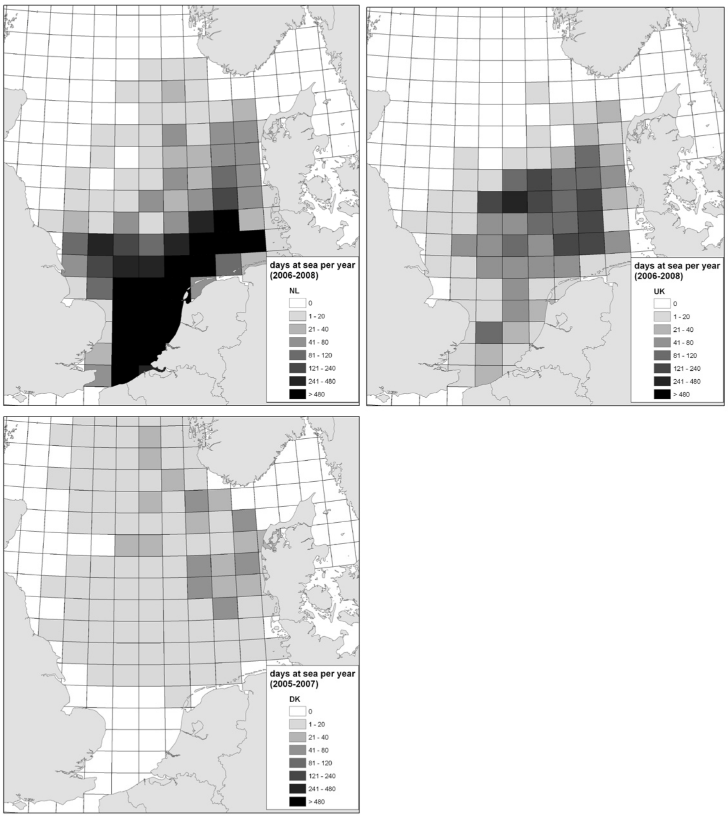


Figure 8.2.15. North Sea plaice. Annual fishing effort by the North Sea trawling fleet: Dutch vessels (left); UK flag vessels (middle); and Danish vessels (right). Expressed in days at sea, averaged over the period 2006-2008 (except for Danish data which cover the period 2005-2007). Source: EC logbook data.

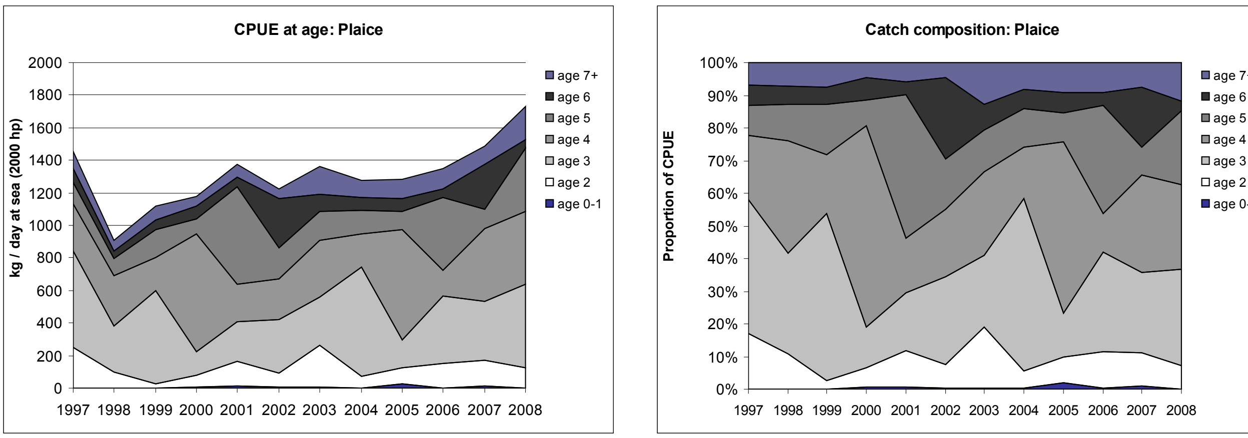


Figure 8.2.16. North Sea plaice. Age composition of Dutch Plaice LPUE and Catch composition.

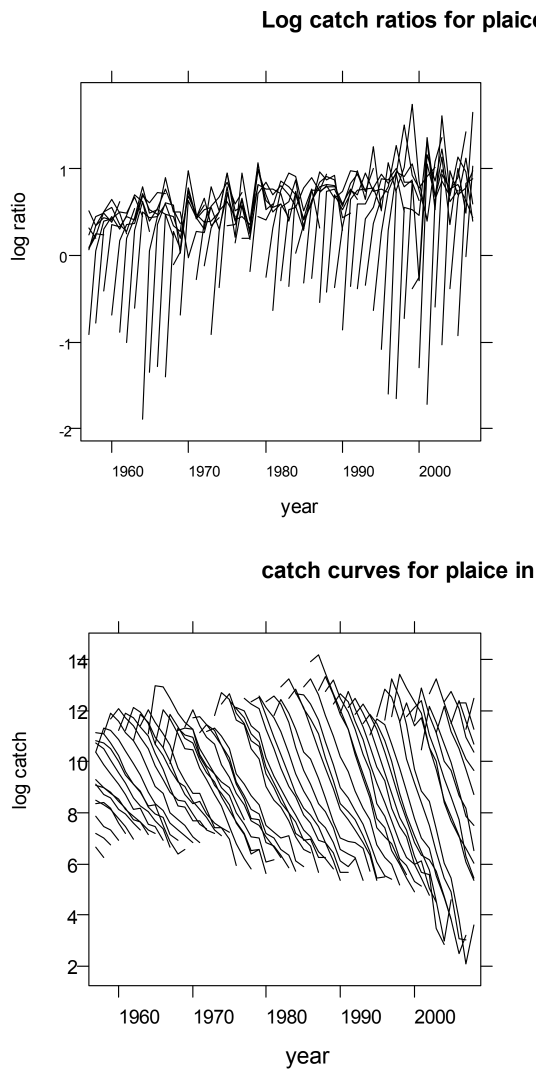


Figure 8.3.1. North Sea plaice. Log catch ratios (left panel) and catch curves (right panel).

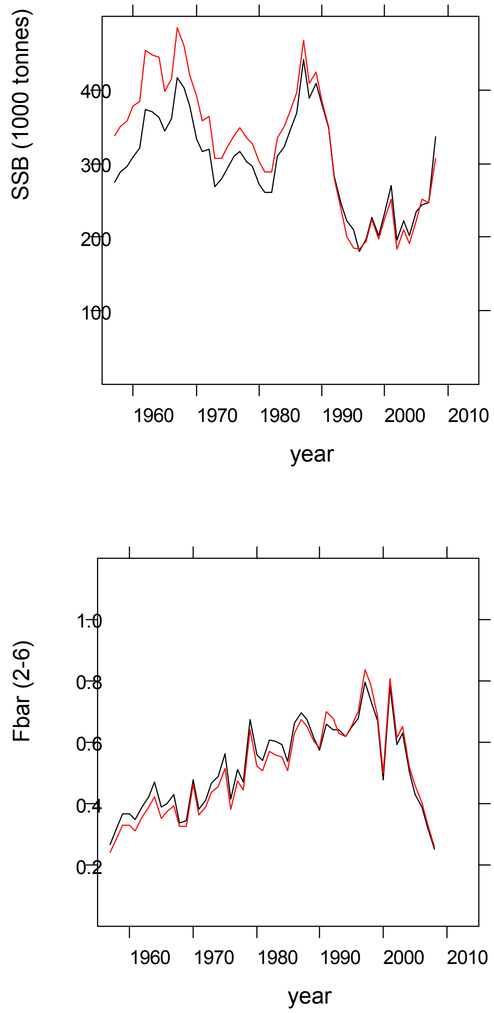
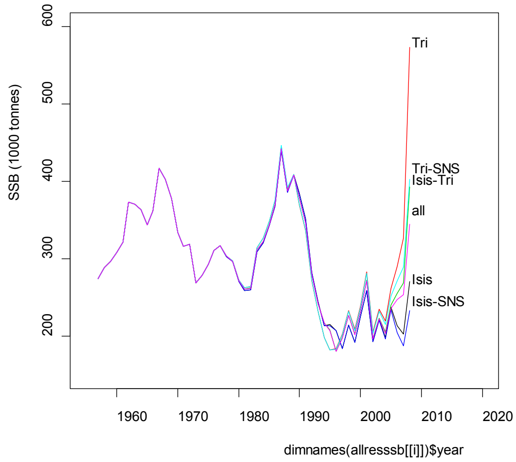


Figure 8.3.2. North Sea plaice. XSA results with respect to SSB (left) and F (right) estimate for different plus group settings used in the assessment. Red line indicates plus group at age 15, black line indicates plus group at age 10.



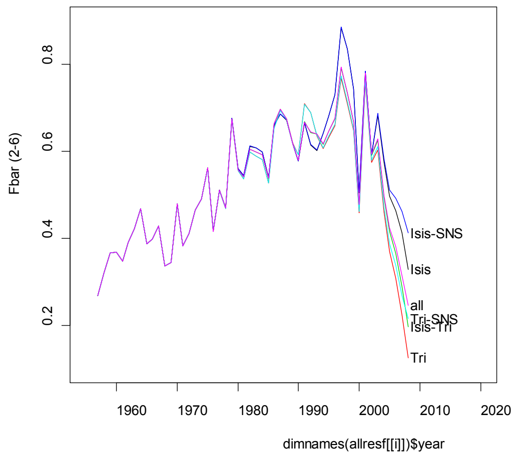


Figure 8.3.3 North Sea plaice XSA results with respect to SSB (left) and F (right) estimates for different permutations of the available survey tuning indices. XSA run with only SNS survey tuning index is omitted because no reliable SSB or F estimates are available owing to the limited age range (only ages 1–3). Labels indicate used tuning indices.

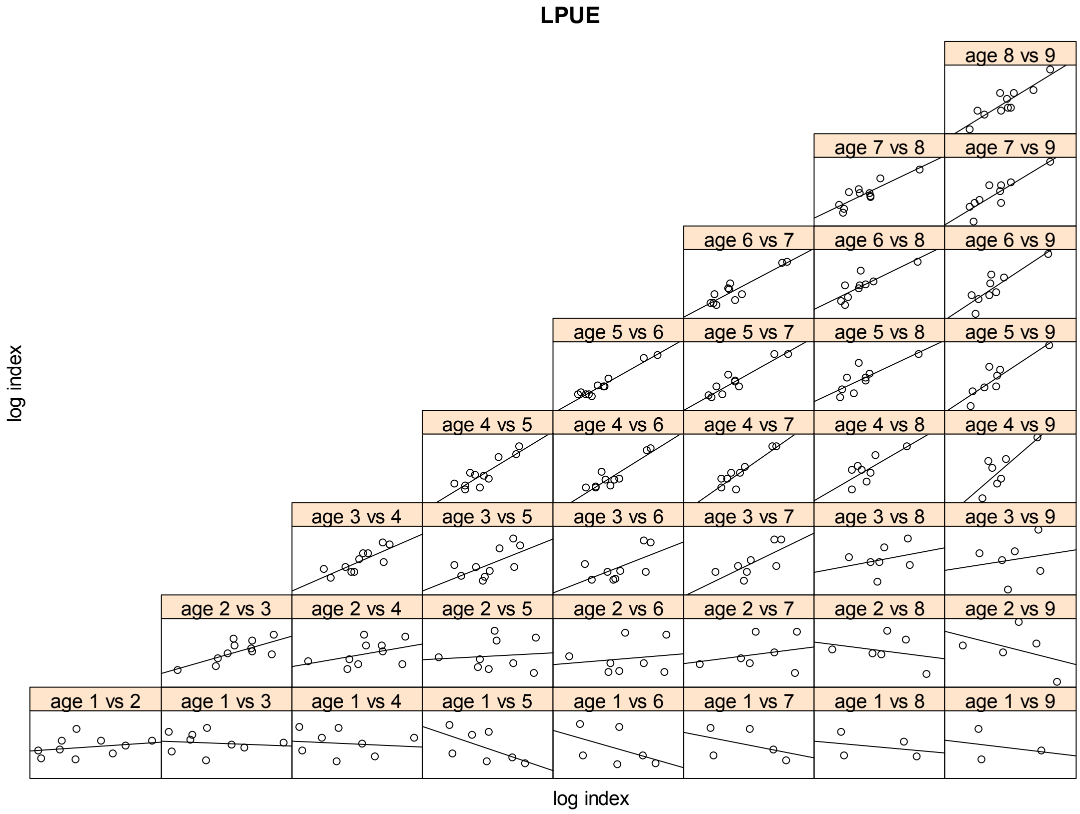


Figure 8.3.4. North Sea plaice. Internal consistency plot for the corrected age structured LPUE

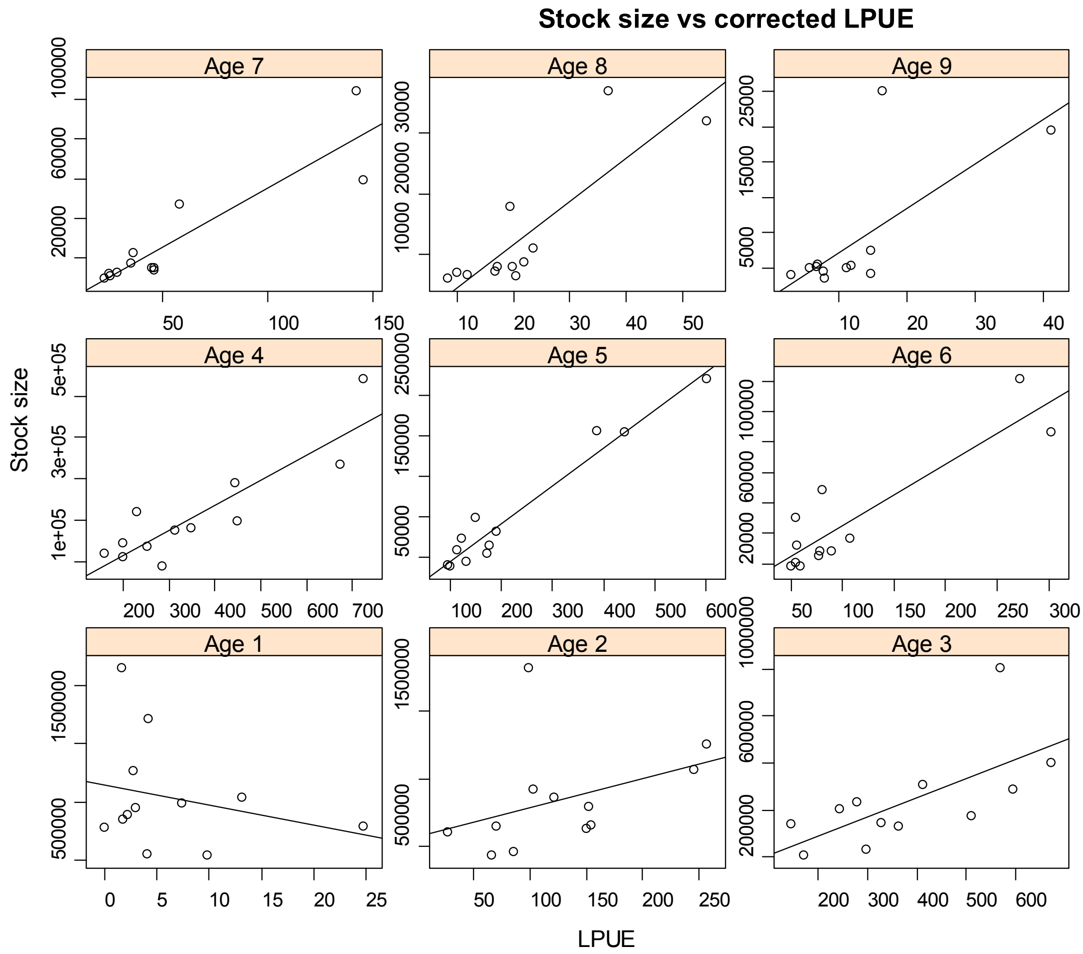
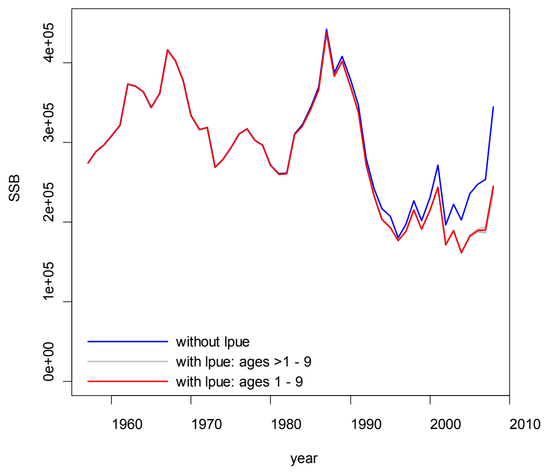


Figure 8.3.5. North Sea plaice. Stock size as a function of the corrected LPUE (working document) for ages 1–9.



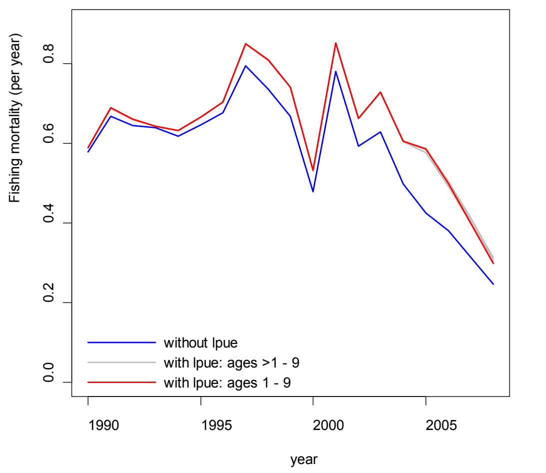


Figure 8.3.6 North Sea plaice. XSA output. A comparison of SSB (left) and Fbar (right) estimates obtained by running XSA with the BTS and SNS survey tuning indices only (blue line: without lpue) and with the LPUE in addition to the BTS and SNS tuning indices (grey and red lines: with lpue). The LPUE was used as a tuning index for ages 1 – 9 inclusive (red line: ages 1 – 9), and for ages 2 – 9, 3 – 9 , etc. (grey lines: with lpue: ages >1 – 9).

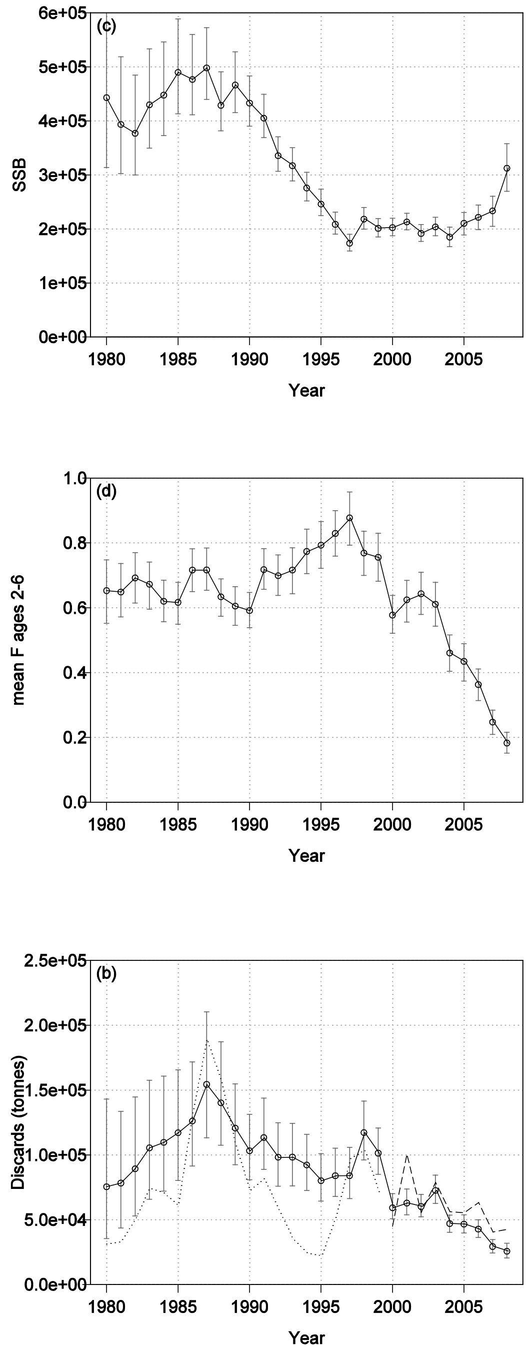


Figure 8.3.7 North Sea plaice. SCA output. A comparison of the median estimate of SSB (top left), Fbar (top right) and Discard (bottom) estimates obtained by running the Statistical catch at age model. Vertical bars represent the 95% confidence interval of the estimation. The dashed line in the SCA discard estimates shows the observed discards and the dotted line the reconstructed discards using the current method used in the XSA (see Aarts & Poos 2009)

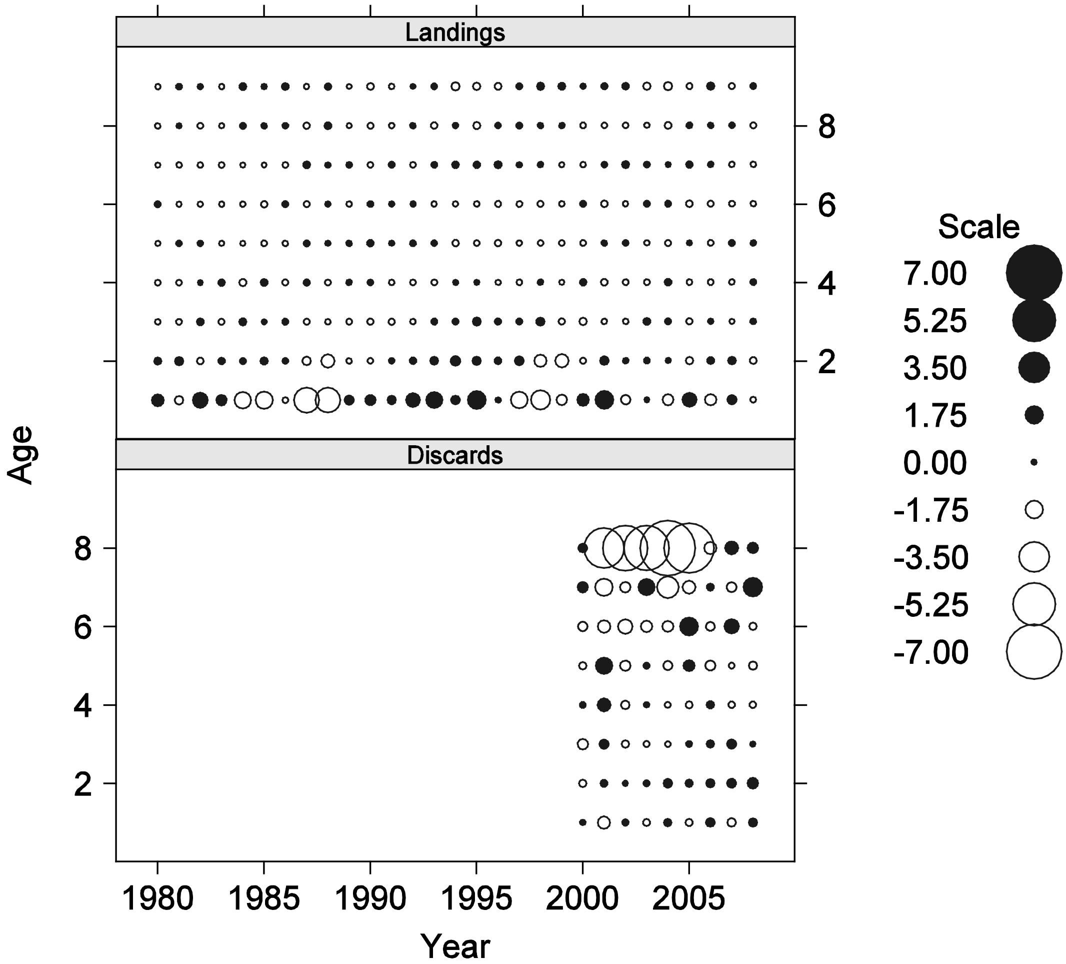


Figure 8.3.8 North Sea plaice. SCA output. Model log residuals of the landings and discard data (see Aarts & Poos 2009).

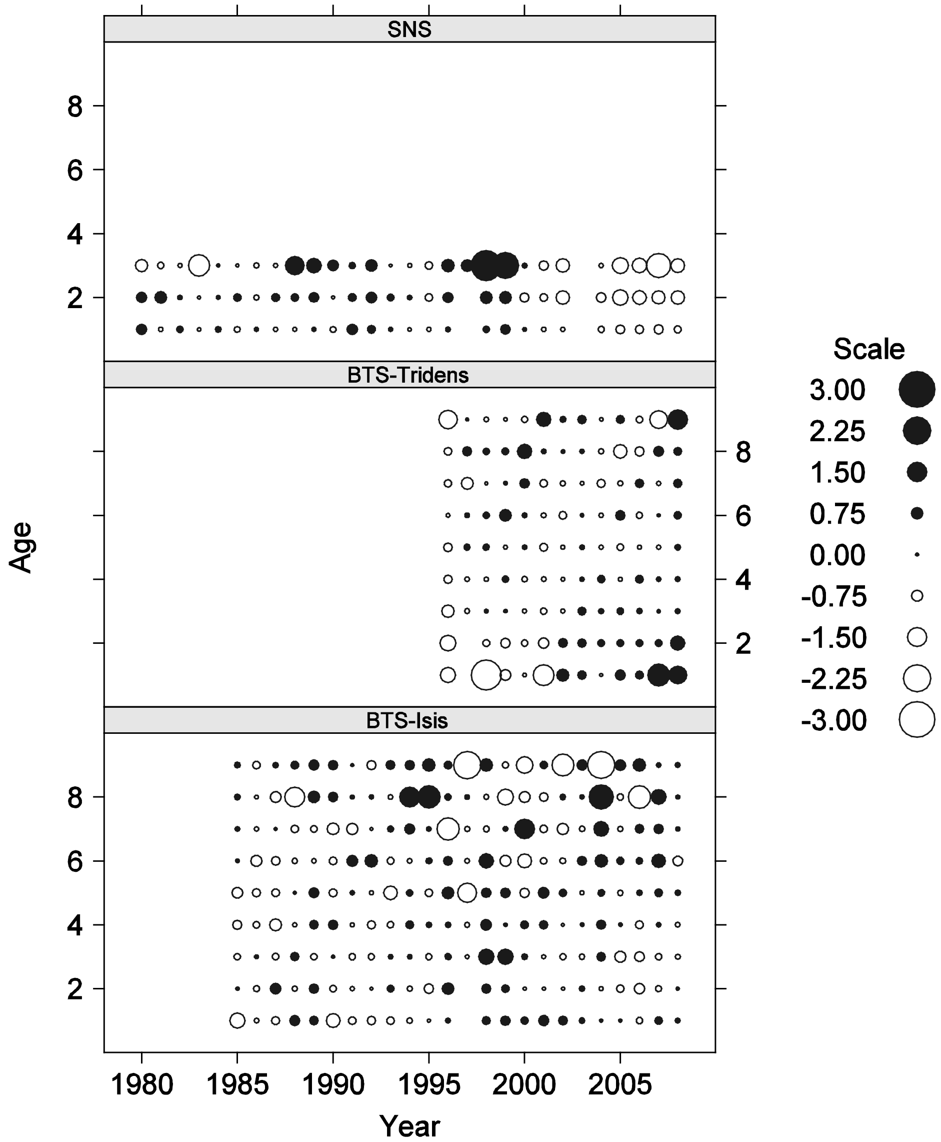


Figure 8.3.9. North Sea plaice. SCA output. Log catchability residuals for the final XSA run from the three tuning series.

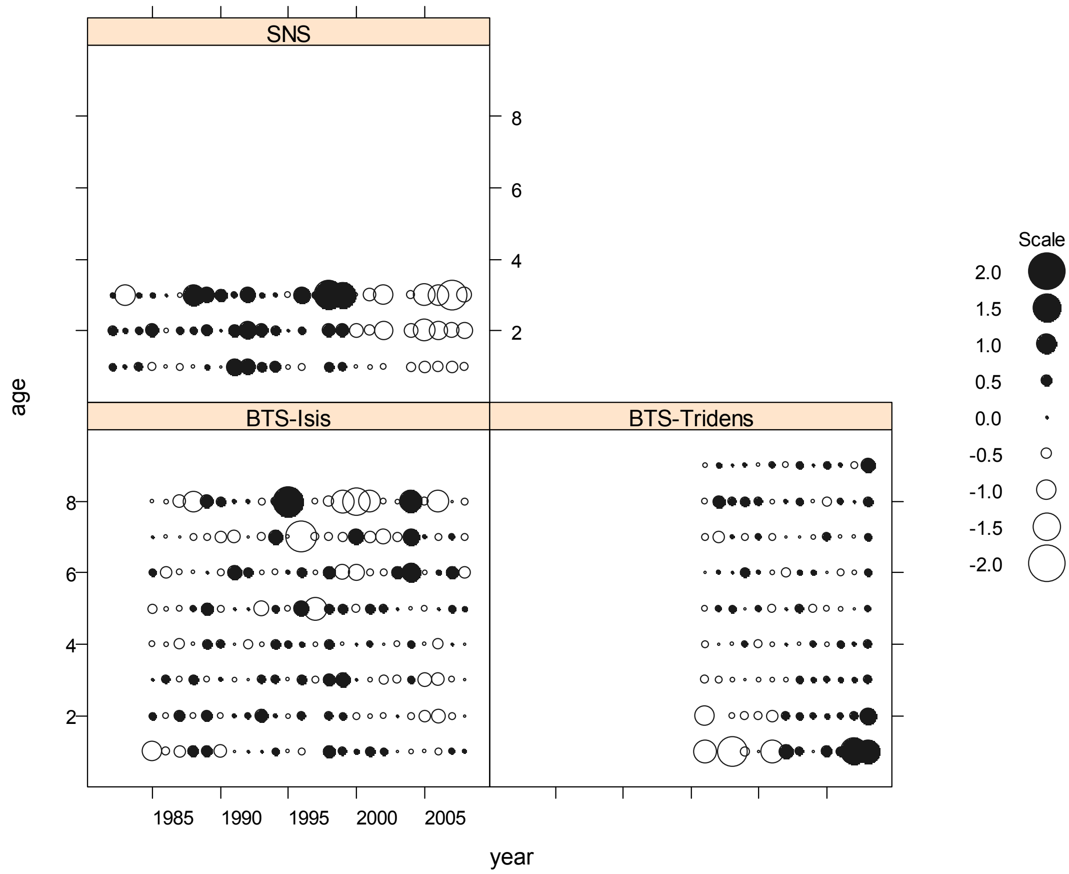


Figure 8.3.10. North Sea plaice. Log catchability residuals for the final XSA run from the three tuning series.

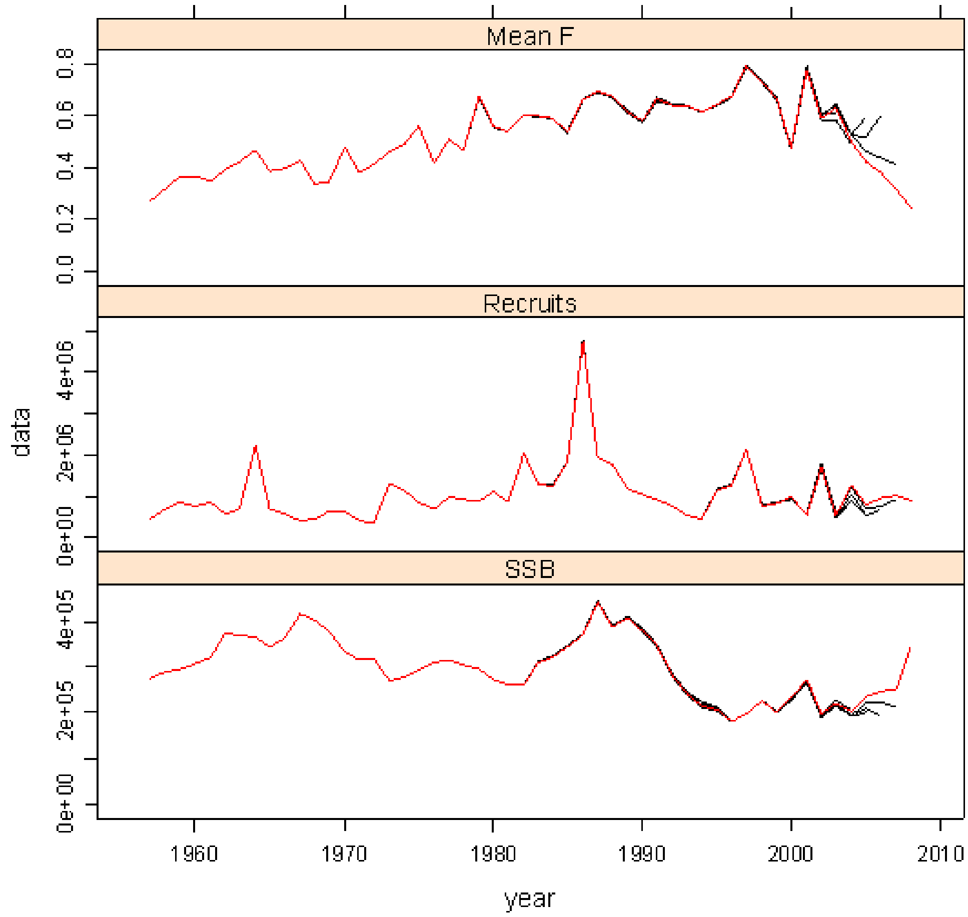
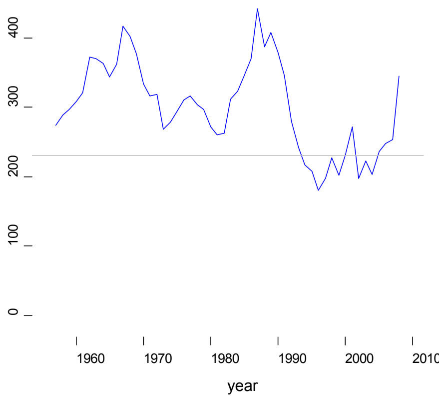
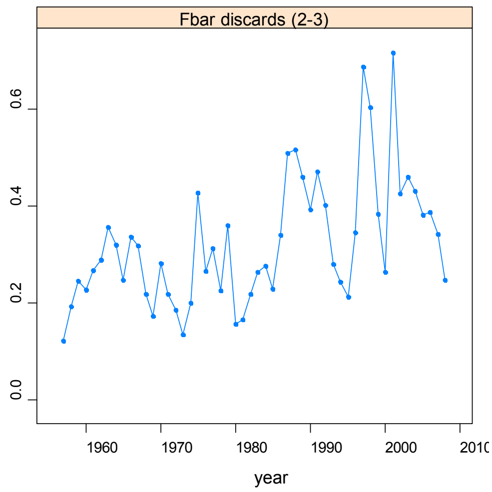


Figure 8.3.11. North Sea plaice. Retrospective pattern of the final XSA run with respect to SSB, recruitment and F.



0
100
200
300
400
1960
1970
1980
1990
2000
2010
year



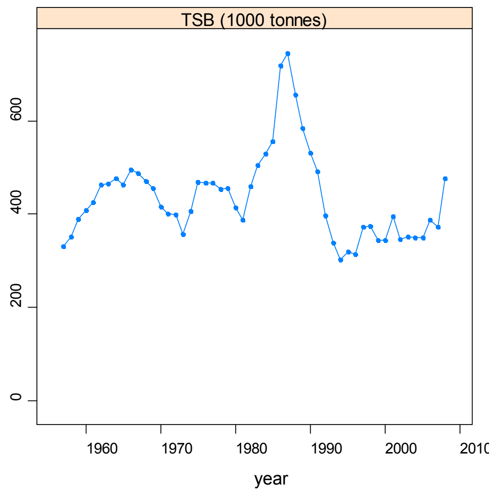


Figure 8.4.2. North Sea plaice. Stock summary figure. Time series on human consumption (left) fishing mortality and total stock biomass (right)

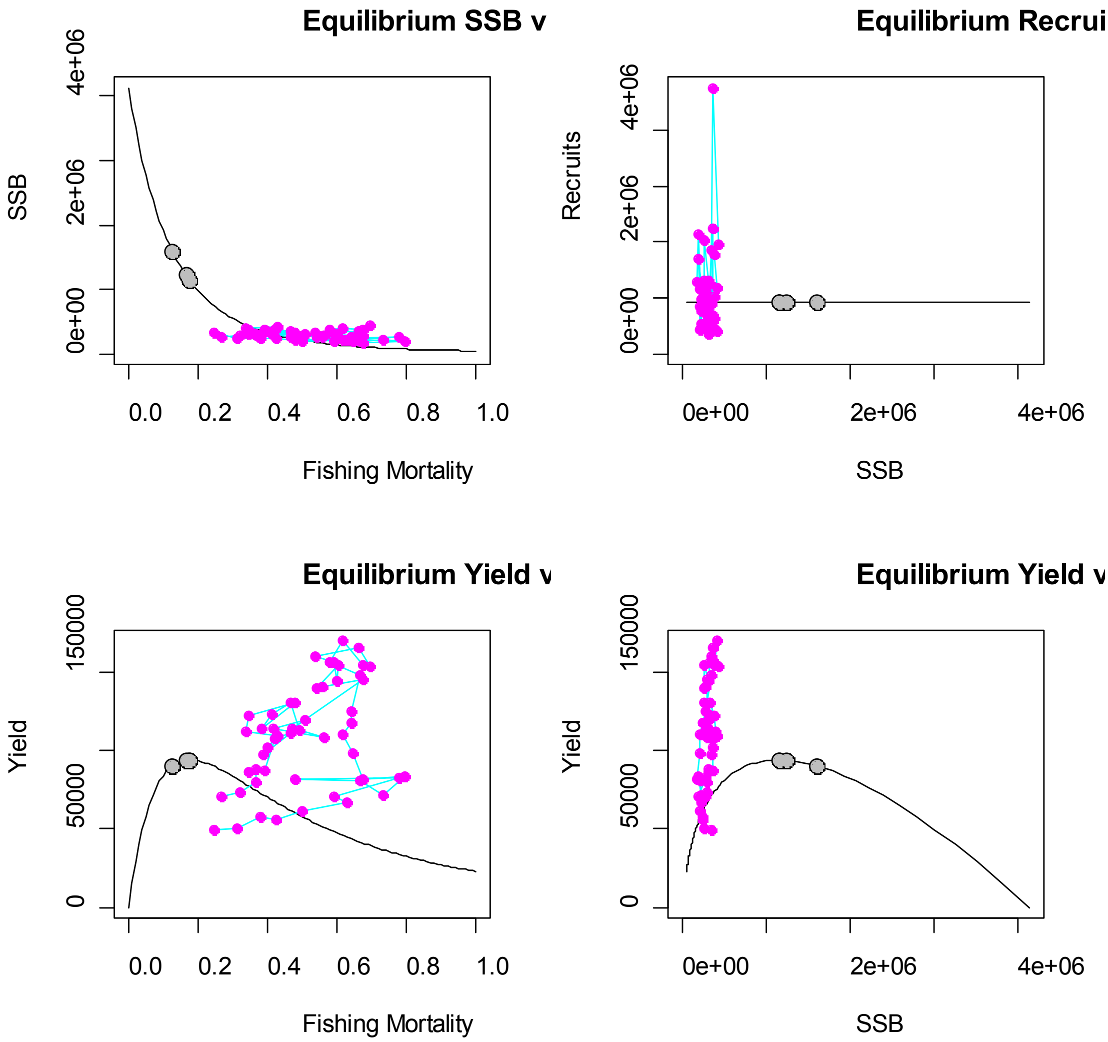


Figure 8.6.1 North Sea plaice. Yield per recruit analysis.

9 Sole in Subarea VIId

The assessment of sole in subarea VIId is presented here as an update assessment following the WKFLAT 2009 benchmark of this stock.

All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

9.1 General

9.1.1 Ecosystem aspects

No new information on ecosystem aspects was presented at the working group in 2009.

All available information on ecological aspects can be found in the Stock Annex.

9.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex.

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they are constrained to the inshore areas.

For the twelfth consecutive year, neither France, Belgium nor UK was able to take up their quota (see section 9.2.1).

9.1.3 ICES advice

In the advice for 2008 ICES considered the stock as having full reproductive capacity and being harvested sustainably. In the advice for 2009 ICES considered the stock as having full reproductive capacity and at risk of being harvested unsustainably.

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 is estimated at 0.41, just above the range that would lead to high long-term yields and low risk of stock depletion.

Exploitation boundaries in relation to precautionary limits

The fishing mortality in 2009 should be below Fpa corresponding to landings less than 4380 t in 2009, which is expected to keep SSB above Bpa in 2010.

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a bycatch.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2009 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *should minimize bycatch or discards of cod;*
- *should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
- *should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);*
- *where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*
- *should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skateand undulate ray.*

9.1.4 Management

No explicit management objectives are set for this stock.

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2008 and 2009 are 6593t and 5274t respectively. Technical measures in force for this stock are minimum mesh sizes, minimum landing size. The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 80mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

For 2008 Council Regulation (EC) N°40/2008 allocates different days at sea depending on gear, mesh size and catch composition. (see section 1.2.1 for complete list). The days at sea limitations for the major fleets operating in subarea VIId could be summarised as follows: Days at sea limitations for Trawls or Danish seines varies between 86 and unlimited days per year. Beam trawlers have an unlimited number of days permit. Maximum days at sea for Gillnets vary between 117 and 140 days per year. Trammel nets are allowed a maximum of 205 days for Member States whose quotas are less than 5% of the Community share of the TACs of both plaice and sole; otherwise the limit is 180 days. Long-lines have a maximum of 173 days per year.

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. (see section 1.2.1 for complete list). The area's are Kattegat, part of IIIa not covered by Skagerrak 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); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

9.2 Data available

9.2.1 Catch

French landings submitted to the Working Group for 2007 were revised upward by 20% to 2867t and UK landings by 1% to 759t. The 2007 values for the numbers at age were therefore also updated. Total landings now amount to 5166t instead of 4686t.

The 2008 landings used by the Working Group were 4510t (Table 9.2.1) which is 32% below the agreed TAC of 6593t and 8% below the predicted landings at a status quo fishing mortality in 2008 (4898t). The contribution of France, Belgium and the UK to the landings in 2007 is 55%, 30% and 15% respectively.

Landing data reported to ICES are shown in Table 9.2.1 together with the total landings estimated by the Working Group. As in last year's assessment, misreporting by UK beam trawlers from Division VIIe into VIId have been taken into account and corrected accordingly (see also section 9.11). It should be noted that historically there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. In the UK buyers and sellers registration is considered to have reduced this significantly since 2005. Substantial progress has been made in recent years by including all return rates of the small vessels.

Discard estimates since 2005 are available for the UK and French static gear and the French Otter trawl (Figure 9.2.1a-c). Numbers are raised to the sampled trips. It should be noted that the number of sampled trips is low. Discard from the Belgian beam trawler fleet could not been processed in time for the working group due to the shift of the working group to an earlier time in the year. The data will be available later in the year when time and manpower permits to compile the data.

The available information suggests that discards are not a substantial part of the catch for this high valued species. Although French otter trawl discards information suggest that occasionally discarding of predominantly 1-year old fish occur in the first and second quarter these otter trawls only comprise 13% of the sole landings in VIId. Observer information from one single UK beam trawl trip in the 4th quarter indicates high discard rates of sole. However it should be noted that markets at that time of the year were heavily affecting discards of flatfish, including sole. The information from that single trip is therefore not representative for the UK beam trawl fleet at any time in the year. The Working Group decided not to include discards in the assessment at this stage due to the scarcity of the data but will monitor the situation in the future.

Sampling levels for those countries providing age compositions will be provided in the September report.

9.2.2 Age compositions

Quarterly data for 2008 were available for landing numbers and weight at age, for the French, Belgian, and UK fleets. These comprise 100% of the international landings. Age compositions of the landings are presented in Table 9.2.2.

9.2.3 Weight at age

Weight at age in the catch is presented in Table 9.2.3 and weight at age in the stock in Table 9.2.4. The procedure for calculating mean weights is described in the Stock Annex.

9.2.4 Maturity and natural mortality

As in previous assessments, a knife-edged maturity-ogive was used at age 3.

Natural mortality are assumed at fixed values (0.1) for all ages in time.

9.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 9.2.5a,b and Figures 9.2.2a-c. Revisions have been made to the French effort and LPUE series for 2002 up to 2007 and for the UK effort and LPUE series for 2007. There were no revisions to the Belgium data series. Effort for the Belgian beam trawl fleet increased to the highest level in 2007 with a slight decrease in 2008. This is mainly due to the unrestrictive "days at sea" EU regulation in ICES subdivision VIId from 2005 until 2007, as well as the good fishing opportunities for sole in that area. The mobile Belgian fleet are predominantly fishing in the most favourable area which is subdivision VIId at the moment. The UK (E&W) beam trawl fleet effort has increased from the late 80's, reaching its peak in 1997. Since then, effort has decreased and fluctuated around 60% of its peak level. Information has been provided on effort and LPUE from the recent period of the French fleets in the Eastern Channel. This short data series will be extended historically and for recent years and therefore will provide information on the trends in the main French fisheries.

The Belgian LPUE has been fluctuated around the mean with no strong trend until recently when catch rates have been increasing consistent with the UK beam trawl fleet up to 2005. Both fleets show a decrease in 2006 and 2007 with a slight increase in the last year. The recent time series of the French beam trawl LPUE has been decreasing until 2006 with a slight increase in the last two years. The French OTB and GTR show also a slight increase in the last few years.

Survey and commercial data used for calibration of the assessment are presented in Table 9.2.6.

The data for 2007 for the UK beam trawl series was revised. The UK survey component of the Young fish survey (YFS) was last conducted in 2006. In the absence of any update of the UK component, it was decided at the Benchmark working group (WKFLAT – February 2009) that the UK component should still be used in the assessment independently from the French component of the YFS index. It was also noted that the lack of information from the UK YFS will affect the quality of the recruitment estimates and therefore the forecast. (see also section 9.3.2).

Investigations at the WKFLAT of a possible horse power correction for the Belgian beam trawl fleet indicate that a more realistic approach could be implemented. Due to lack of time and manpower, the recalculation could not be conducted for this assessment. However the Working Group considered it as a priority for implementation at the next update assessment.

9.3 Data analyses

9.3.1 Reviews of last year's assessment

The RG noted that similar pattern of trends in residuals for sole and plaice in this area were observed and requested that the WG should look into this feature in VIId at the benchmark assessment. Unfortunately this was not addressed at the WKFLAT. Due to work pressure at this year's meeting, the Working Group was also unable to fully evaluate this feature. However, the Working Group agreed fully to address this issue as soon as possible.

9.3.2 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

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. As last year, the log-catch ratios for the fully recruited ages (3-10) did not show any patterns or large residuals (in ICES files).

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and untapered), using data for each of the four fleets individually (in ICES files). Apart from the first few year's in the Belgian series (1982-1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl fleet (UK-BT) in 2000. The UK(E&W) beam trawl survey (UK-BTS) showed year effects for 3 consecutive year (1999, 2000 and 2001). It was also noted that the log catchability residual of the separate Young Fish Survey components (YFS-UK and YFS-FR) were noisier than the combined Young Fish Survey index, used in previous assessments.

The time series of the standardized indices for ages 1 to 6 from the five tuning fleets (BEL-BT commercial, UK-BT commercial, UK-BTS survey, YFS-UK survey and the YFS-FR survey) are plotted in Figure 9.2.3. All tuning fleets appear to track the year classes reasonably well for ages 2 to 6. For age 1, the two Young Fish Survey components from UK and France are not always consistent in estimating the year class strength. Investigations of the standardised indices from both the separate components of the Young Fish Survey and the combined index for age 1 (ICES files), show that the combined index and the UK component estimate year class strength more similar then the French component. Internal consistency plots for the 2 commercial fleets and the UK beam trawl survey are presented in Figure 9.2.4-6. The internal consistency of the Belgian beam trawl fleet appears relatively high for the older ages. The UK commercial fleet and the UK beam trawl survey show high consistencies for the entire age-range.

The catchability residuals for the proposed final XSA are shown in Figure 9.3.1a-b and the XSA tuning diagnostics are given in Table 9.3.1.

In general, estimates between fleets are consistent for ages 2 and above (Figure 9.3.3), apart from the estimates from the YFS-FR for ages 3, 4 and 8. In this year's assessment the estimates for the recruiting year class 2007 were estimated by the UK beam trawl survey (UK-BTS) and the French component of the Young Fish Survey (YFS-FR) which have both an equal weighting of about 45% to the final survivor estimates. F-shrinkage giving 9% of the weighting.

At age 2, the weak 2006 year-class is estimated somewhat stronger by the UK beam trawl fleet than the other tuning fleets. Most of the weighting is given by the commercial UK BT fleet (42%) and the UK BTS survey (38%). Apart from age 1 (9%), F shrinkage gets low weights for all ages (< 3%). The weighting of the 3 surveys decreases for the older ages as the commercial fleets are given more weight (Figure 9.3.2).

9.3.3 Exploratory survey-based analyses

In 2005, exploratory SURBA-runs (v3.0) were carried out on the UK(E&W) Beam-trawl Survey (UK-BTS) (1988-2004) and the International Young Fish Survey (1988-2004) to investigate whether the surveys-only analysis suggests different trends in Recruitment, SSB and fishing mortality. From the diagnostics on Mean Z, it was concluded that the surveys could not estimate any trend in fishing mortality. Given also that the SSB and recruitment trends from both XSA and SURBA runs showed similar patterns, the Working Group decided to accept the XSA as the final assessment.

In this update assessment Surba runs were not executed.

9.3.4 Conclusion drawn from exploratory analyses

The XSA analyses was taken as the final assessment, giving mostly consistent survivor estimates between fleets for all ages. The estimates of recruiting age 1 (year class 2007) are far below average values in the time series. (Table 9.3.4).

9.3.5 Final assessment

The final settings used in this year's assessment are specified as in the stock annex and are detailed below:

	2009 assessment		
Fleets	Years	Ages	α-β
BEL-BT commercial	86-08	2-10	0-1
UK-BT commercial	86-08	2-10	0-1
UK-BTS survey	88-08	1-6	0.5-0.75
YFS – survey (combined index UK-FR)			
YFS-UK - survey	87-06	1-1	0.5-0.75
YFS-FR - survey	87-08	1-1	0.5-0.75
-First data year	1982		
-Last data year	2008		
-First age	1		
-Last age	11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

The final XSA output is given in Table 9.3.2 (fishing mortalities) and Table 9.3.3 (stock numbers). A summary of the XSA results is given in Table 9.3.4 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 9.3.3.

Retrospective patterns for the final run are shown in Figure 9.3.4. There is good consistency between estimates in successive years. However, separating the Young Fish Survey into two survey indices in this year's assessment, together with the 2007 landings revisions', revised fishing mortality, SSB and recruitment for 2007 by 17%, 14x% and 65% respectively.

9.4 Historical Stock Trends

Trends in landings, SSB, F(3-8) and recruitment are presented Table 9.3.4 and Figure 9.3.3.

For most of the time series, fishing mortality has been fluctuating between Fpa (0.4) and Flim (0.57). In the early 90's it dropped below Fpa. Since 1999 it decreased steadily from 0.55 to around 0.4 in 2001 after which it remained stable until 2005. In the last 3 years fishing mortality has increased again above the Fpa value.

Recruitment has fluctuated around 25 million recruits with occasional strong year classes. Three of the highest values in the time series have been recorded in the last 7 years. The two last recruitments were estimated far below average.

The spawning stock biomass has been stable for most of the time series. Since 2001 SSB has increased due to average and above average year classes to well above Bpa (8000 t).

9.5 Recruitment estimates

The 2006 year class in 2007 was confirmed by XSA to be below average with 15 million fish at age 1 which is the fourth lowest in the time series. 98% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2007 year class in 2008 was estimated by XSA to be 9 million one year olds which is the lowest in the time series. F shrinkage gets 9% of the weight; the other 92% is coming from surveys. The XSA survivor estimates for this year class were used for further prediction.

The long term GM recruitment (24 million, 1982-2006) was assumed for the 2008 and subsequent year classes.

For comparison, RCT3 runs were carried out. Input to the RCT3 model is given in Table 9.5.1 and results are presented in Table 9.5.2a-b. However RCT3 estimates were not taken forward into predictions since they performed poorly in recent assessments. Although the RCT3 results are not used for prediction, it should be noted that the French Young fish survey (YFS-FR) at age 0 (not included in the XSA) confirms a weak 2007 year class. Hence there is still a marked difference between the RCT3 and the XSA estimates for that year class. The 2008 year class is predicted to be above average by the YFS-FR at age 0.

The working group estimates of year class strength used for prediction can be summarised as follows:

Year class	At age in 2009	**XSA**	**GM 82-06**	**RCT3**	Accepted Estimate
2006	3	9377	15297	-	XSA
2007	2	8005	20553	15956	XSA
2008	1	-	23623	28036	GM 1982-06
2009 & 2010	recruits	-	23623	-	GM 1982-06

9.6 Short term forecasts

The short term prognosis was carried out according to the specifications in the stock annex. As fishing mortality has fluctuated in the last three years, the selection pattern for prediction has been taken as a 3 year unscaled average. Weights at age in the catch and in the stock are averages for the years 2006-2008.

Input to the short term predictions and the sensitivity analysis are presented in Table 9.6.1. Results are presented in Table 9.6.2 (management options) and Table 9.6.3 (detailed output).

Assuming *status quo* F, implies a catch in 2009 of 4200t (the agreed TAC is 5274t) and a catch of 3650t in 2010. Assuming *status quo* F will result in a SSB in 2010 and 2011 of 7910t and 7860t respectively.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2010 and SSB in 2011 are given in Table 9.6.4. The assumed GM recruitment accounts for 22 % of the landings in 2010 and 36 % of the 2011 SSB.

Results of a sensitivity analysis are presented in Figure 9.6.1 (probability profiles). The approximate 90% confidence intervals of the expected status quo yield in 2010 are 2800t and 4500t. There is about 55% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2011.

9.7 Medium-term forecasts and Yield per recruit analyses

This year, no Medium-term forecasts were carried out for this stock.

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2009, are given in Table 9.7.1 and Figure 9.7.1. F_{max} is calculated by this year's assessment to be 0.27 (0.47 = F_{sq}).

9.8 Biological reference points

		Basis
Flim	0.55	Fishing mortality at or above which the stock has shown continued decline.
Fpa	0.40	F is considered to provide approximately 95% probability of avoiding Flim
Blim	-	Not defined
Bpa	8000	Lowest observed biomass at which there is no indication of impaired recruitment.
Fmax	0.27	
F2008	0.45	
Fsq	0.47	

9.9 Quality of the assessment

- Revisions in 2007 landings for France and UK (E&W) together with the change in tuning fleet indices (see section 9.2.5) resulted in an upward revision of fishing mortality in 2007 by 26% and a downward revision of SSB by 14%. Recruitment in 2007 was revised upward by 78%.
- Sampling for sole landings in division VIId are considered to be at a reasonable level.
- Information available on discards for 2008 suggest, as in previous years that discards are not substantial and therefore discards are not incorporated in the assessment. Discard information from French otter trawls suggest however that some discarding of 1 year old sole is taking place in the first 2 quarters of the year. Although the observed discarding at age 1 will not affect the assessment substantially, they will have an impact on forecasts, but the low level of discards are not considered a significant factor in catch forecasts.
- The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year's assessment apart from the upward revision of the 2006 year class by 78%.

- Except year class 2002 and 2003, all year classes from 1998 to 2005 are estimated to be at or above long term average which explains the increase in SSB since 1998. Although the 2006 year class is revised upward by this year's assessment by 78%, it is still predicted to be the fourth weakest in the time series by two survey indices and two commercial indices. Year class 2007 is predicted by two surveys to be the lowest in the time series. Last year this year class was assumed to be GM in the forecast, resulting in status quo landings of 4380 t in 2009. The opposite revisions of year classes 2006 and 2007 by this year's assessment result in a predicted landings in 2009 of 4200 t.
- The UK component of the YFS index is not available for 2007 and 2008, resulting in the unavailability of the combined YFS-index. This combined index has been estimating the incoming year class strength very consistently, hereby providing reliable estimates to the forecasts. Although results of using the YFS indices separately (YFS-FR for 1987-present and YFS-UK for 1987-2006), did not show apparent changes in retrospective patterns, it was noted that the lack of information from the UK YFS will affect the quality of the recruitment estimates and therefore the forecast.
- The use of a more realistic effort correction for Belgian beam trawl fleet is likely to improve the tuning results for that fleet. These effort corrections should be implemented at the next update assessment.
- There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 9.9.1).
- The historical performance of this assessment is rather noisy (Figure 9.9.2) but has been more constant in recent years.
- There is misreporting from adjacent areas. The Working group has addressed this by modifying landings data accordingly. Since 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly. This was done back to 1986. For VIId sole, UK(E&W) beam trawl and otter trawl data are processed together (as trawl), so the landings from these two rectangles were removed from the trawl data on a quarterly basis, and the age compositions adjusted to take that into account.

9.10 Status of the Stock

Fishing mortality has been stable between 2000 and 2005 around Fpa. In the last 3 years fishing mortality has increased to values between Fpa (0.4) and Flim (0.57).

The spawning stock biomass has been stable for most of the time series and SSB is presently well above Bpa. The strong 2004 and 2005 year class increased SSB to around record high level of the time series in 2008. The two following weak year classes 2006 and 2007 are predicted to decrease SSB to around Bpa levels in 2010 and 2011 assuming a status quo fishing mortality

9.11 Management Considerations

- There is misreporting from adjacent areas. The Working group has addressed this by modifying landings data accordingly. Since 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly.

- There is a greater than 50% probability that SSB will decrease to B_{pa} in the short term due to the weak year classes 2006 and 2007.
- EU 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 new regime has not reduced effort directed at sole for beam trawls in this area in 2009.
- Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of (undersized) plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice. Measures to reduce discarding of plaice in the sole fishery would greatly benefit the plaice stock and future yields. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Table 9.2.1 Sole VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France		UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	383		309	3	854	30	884	
1975	132	464		244	1	841	41	882	
1976	203	599		404	.	1206	99	1305	
1977	225	737		315	.	1277	58	1335	
1978	241	782		366	.	1389	200	1589	
1979	311	1129		402	.	1842	373	2215	
1980	302	1075		159	.	1536	387	1923	
1981	464	1513		160	.	2137	340	2477	
1982	525	1828		317	4	2674	516	3190	
1983	502	1120		419	.	2041	1417	3458	
1984	592	1309		505	.	2406	1169	3575	
1985	568	2545		520	.	3633	204	3837	
1986	858	1528		551	.	2937	995	3932	
1987	1100	2086		655	.	3841	950	4791	3850
1988	667	2057		578	.	3302	551	3853	3850
1989	646	1610		689	.	2945	860	3805	3850
1990	996	1255		785	.	3036	611	3647	3850
1991	904	2054		826	.	3784	567	4351	3850
1992	891	2187		706	10	3794	278	4072	3500
1993	917	2322		610	13	3862	437	4299	3200
1994	940	2382		701	14	4037	346	4383	3800
1995	817	2248		669	9	3743	677	4420	3800
1996	899	2322		877	.	4098	699	4797	3500
1997	1306	1702		933	.	3941	823	4764	5230
1998	541	1703		803	.	3047	316	3363	5230
1999	880	2251		769	.	3900	235	4135	4700
2000	1021	2190		621	.	3832	-356	3476	4100
2001	1313	2482		822	.	4617	-592	4025	4600
2002	1643	2780		976	.	5399	-666	4733	5200
2003	1657	3475		1114	1	6247	-1209	5038	5400
2004	1485	3070		1112	.	5667	-841	4826	5900
2005	1221	2832		567	.	4620	-236	4384	5700
2006	1547	2627		678	.	4852	-18	4834	5720
2007	1530	2968		801	1	5300	-134	5166	6220
2008	1367	2284	**	715	.	4366	144	4510	6593

* Unallocated mainly due misreporting

** Preliminary

Table 9.2.2 - Sole VIId - Landing numbers at age (kg)

Run title : Sole in VIId - 2009WG - Sol7d.txt

At 8/05/2009 13:10

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988
AGE							
1	155	0	24	49	49	9	95
2	2625	852	1977	3693	1251	3117	2162
3	5256	3452	3157	5211	5296	3730	7174
4	1727	3930	2610	1646	3195	3271	1602
5	570	897	1900	1027	904	2053	1159
6	653	735	742	1860	768	1042	856
7	549	627	457	144	1056	1090	388
8	240	333	317	158	155	784	255
9	122	108	136	156	190	111	256
10	83	89	99	69	212	163	83
+gp	202	193	238	128	372	459	275
0 TOTALNUM	12182	11216	11657	14141	13448	15829	14305
TONSLAND	3190	3458	3575	3837	3932	4791	3853
SOPCOF %	97	99	99	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	163	1245	383	105	85	31	838	9	24	33
2	3484	2851	7166	4046	5028	694	2977	1825	1489	1376
3	3220	5580	4105	8789	6442	6203	4375	7764	6068	5609
4	4399	1151	4160	1888	5444	5902	4765	3035	5008	2704
5	1434	1496	604	1993	1008	3404	2968	3206	2082	1636
6	840	301	996	288	563	584	1980	1823	1670	609
7	571	390	257	368	162	567	375	1283	916	558
8	201	260	247	135	188	109	278	271	775	441
9	166	129	258	171	116	147	88	319	239	354
10	224	126	92	95	62	93	106	112	169	239
+gp	282	489	382	231	129	258	241	344	267	301
0 TOTALNUM	14984	14018	18650	18109	19227	17992	18991	19991	18707	13860
TONSLAND	3805	3647	4351	4072	4299	4383	4420	4797	4764	3363
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
1	168	138	168	707	379	1030	206	608	175	149
2	3268	3586	6042	7011	10957	4254	3468	7370	6511	2699
3	8506	4852	6194	7513	5086	8623	4034	3753	7316	8502
4	3307	4395	1595	3767	3178	2545	5458	2821	2990	4140
5	1311	1076	2491	1414	1805	2272	1543	3433	1500	1266
6	869	505	728	655	671	1108	1143	1103	2038	848
7	350	319	290	298	588	371	633	796	751	749
8	672	148	128	129	198	448	218	403	467	356
9	351	328	56	97	70	94	283	191	257	164
10	192	150	81	57	88	88	127	208	162	133
+gp	359	248	265	197	245	233	271	307	230	247
0 TOTALNUM	19353	15745	18038	21845	23265	21066	17384	20993	22397	19253
TONSLAND	4135	3476	4025	4733	5038	4826	4383	4833	5166	4510
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 9.2.3 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId - 2009WG - Sol7d.txt

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Table 2 Catch weights at age (kg)

YEAR		1982	1983	1984	1985	1986	1987	1988
AGE								
	1	0.102	0.000	0.100	0.090	0.135	0.095	0.102
	2	0.171	0.173	0.178	0.182	0.180	0.175	0.152
	3	0.225	0.230	0.234	0.230	0.212	0.236	0.226
	4	0.312	0.302	0.314	0.281	0.306	0.295	0.278
	5	0.386	0.404	0.380	0.368	0.363	0.353	0.36
	6	0.428	0.436	0.436	0.394	0.387	0.407	0.409
	7	0.439	0.435	0.417	0.516	0.437	0.411	0.459
	8	0.509	0.524	0.538	0.543	0.520	0.482	0.514
	9	0.502	0.537	0.529	0.594	0.502	0.465	0.553
	10	0.463	0.583	0.565	0.595	0.523	0.538	0.563
+gp		0.6729	0.6283	0.7135	0.8005	0.6015	0.6176	0.6647
0 SOPCOFAC		0.9713	0.991	0.9884	0.998	1.0006	1.0004	1.0001

Table 2 Catch weights at age (kg)

YEAR		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE											
	1	0.106	0.120	0.114	0.103	0.085	0.099	0.129	0.142	0.139	0.132
	2	0.154	0.178	0.161	0.153	0.147	0.150	0.176	0.165	0.153	0.159
	3	0.192	0.238	0.208	0.203	0.197	0.186	0.179	0.178	0.188	0.172
	4	0.271	0.289	0.266	0.267	0.247	0.235	0.230	0.229	0.233	0.235
	5	0.293	0.349	0.354	0.290	0.335	0.288	0.255	0.269	0.292	0.286
	6	0.358	0.339	0.394	0.403	0.384	0.355	0.333	0.324	0.343	0.343
	7	0.388	0.470	0.421	0.391	0.537	0.381	0.357	0.361	0.390	0.383
	8	0.472	0.465	0.430	0.462	0.553	0.505	0.385	0.405	0.404	0.417
	9	0.515	0.487	0.434	0.459	0.515	0.484	0.490	0.435	0.503	0.484
	10	0.547	0.518	0.478	0.463	0.766	0.496	0.494	0.465	0.474	0.435
+gp		0.7014	0.5621	0.5656	0.5661	0.6666	0.6156	0.6536	0.5854	0.6509	0.6162
0 SOPCOFAC		0.9994	0.9995	1.0001	1.0001	1.0002	1.0001	0.9997	0.9999	1	1.0013

Table 2 Catch weights at age (kg)

YEAR		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE											
	1	0.130	0.145	0.108	0.120	0.114	0.120	0.135	0.139	0.163	0.148
	2	0.151	0.142	0.152	0.162	0.170	0.179	0.172	0.162	0.190	0.164
	3	0.189	0.176	0.211	0.204	0.208	0.205	0.208	0.192	0.202	0.200
	4	0.215	0.223	0.283	0.253	0.257	0.255	0.253	0.249	0.227	0.244
	5	0.260	0.332	0.288	0.316	0.277	0.296	0.303	0.284	0.276	0.262
	6	0.280	0.377	0.334	0.375	0.357	0.304	0.337	0.328	0.294	0.321
	7	0.290	0.424	0.367	0.376	0.381	0.348	0.368	0.353	0.315	0.435
	8	0.341	0.427	0.374	0.393	0.438	0.403	0.433	0.402	0.378	0.411
	9	0.358	0.384	0.493	0.469	0.482	0.492	0.570	0.457	0.441	0.377
	10	0.374	0.459	0.511	0.420	0.494	0.509	0.445	0.450	0.439	0.498
+gp		0.5354	0.68	0.5445	0.5308	0.5274	0.525	0.5369	0.557	0.5206	0.5127
0 SOPCOFAC		0.9992	1.0009	1.0005	0.9995	1.0002	0.9983	0.9989	1	1.0026	1.0009

Table 9.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId - 2009WG - Sol7d.txt

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Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988
AGE							
1	0.059	0.070	0.067	0.065	0.070	0.072	0.05
2	0.114	0.135	0.131	0.129	0.136	0.139	0.145
3	0.167	0.197	0.192	0.192	0.198	0.203	0.223
4	0.217	0.255	0.249	0.254	0.256	0.262	0.268
5	0.263	0.309	0.304	0.315	0.309	0.318	0.365
6	0.306	0.359	0.355	0.376	0.358	0.370	0.425
7	0.347	0.406	0.403	0.436	0.403	0.417	0.477
8	0.384	0.448	0.448	0.495	0.443	0.461	0.498
9	0.418	0.487	0.490	0.554	0.480	0.500	0.572
10	0.4500	0.5220	0.5290	0.6110	0.5120	0.5360	0.636
+gp	0.53	0.6008	0.6265	0.7798	0.5761	0.6156	0.7498

Table 3 Stock weights at age (kg)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.113	0.138	0.138	0.144	0.130	0.116	0.126	0.155	0.139	0.140
3	0.182	0.232	0.225	0.199	0.189	0.161	0.129	0.176	0.165	0.158
4	0.269	0.305	0.279	0.277	0.246	0.215	0.220	0.258	0.220	0.233
5	0.323	0.400	0.380	0.305	0.366	0.273	0.234	0.286	0.264	0.299
6	0.335	0.361	0.384	0.454	0.377	0.316	0.333	0.308	0.317	0.374
7	0.480	0.476	0.410	0.405	0.545	0.368	0.357	0.366	0.376	0.363
8	0.504	0.535	0.449	0.459	0.560	0.530	0.330	0.391	0.404	0.357
9	0.586	0.571	0.474	0.430	0.559	0.461	0.614	0.438	0.563	0.450
10	0.536	0.507	0.451	0.528	0.813	0.470	0.382	0.466	0.494	0.372
+gp	0.7135	0.5765	0.6203	0.5269	0.5664	0.6122	0.6292	0.6304	0.6536	0.5768

Table 3 Stock weights at age (kg)

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.128	0.122	0.127	0.136	0.151	0.137	0.157	0.161	0.163	0.158
3	0.180	0.148	0.157	0.179	0.207	0.185	0.203	0.185	0.195	0.191
4	0.205	0.208	0.216	0.209	0.249	0.236	0.241	0.246	0.239	0.250
5	0.253	0.402	0.226	0.258	0.314	0.265	0.267	0.272	0.286	0.295
6	0.277	0.440	0.223	0.254	0.376	0.267	0.309	0.326	0.297	0.368
7	0.298	0.395	0.231	0.301	0.399	0.273	0.349	0.339	0.340	0.401
8	0.324	0.554	0.253	0.234	0.418	0.331	0.401	0.394	0.400	0.476
9	0.336	0.443	0.256	0.326	0.446	0.504	0.608	0.416	0.433	0.463
10	0.323	0.420	0.301	0.404	0.444	0.409	0.425	0.461	0.446	0.403
+gp	0.5118	0.6822	0.4204	0.4170	0.5032	0.4501	0.5602	0.5553	0.5182	0.5668

Table 9.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971						
1972						
1973						
1974						
1975						5.02
1976						6.56
1977						6.87
1978						8.22
1979						7.30
1980						12.81
1981						19.00
1982						23.94
1983						23.64
1984						28.00
1985						25.29
1986					2.79	23.54
1987					5.64	27.11
1988					5.09	38.52
1989					5.65	35.67
1990					7.27	30.33
1991	10.69				7.67	24.29
1992	10.52				8.78	21.99
1993	10.22				6.40	20.02
1994	10.61				5.43	25.17
1995	12.38				6.89	24.17
1996	14.09				10.31	25.00
1997	10.92				10.25	30.89
1998	11.71				7.31	18.12
1999	10.63				5.86	21.39
2000	13.78				5.65	30.54
2001	11.38				7.64	32.39
2002		14.91	23.88	4.06	7.90	33.68
2003		15.35	23.18	4.16	6.69	47.50
2004		15.07	21.16	4.00	4.87	41.60
2005		16.60	17.57	3.16	6.00	35.80
2006		16.87	20.74	3.68	5.94	48.80
2007		17.18	20.72	3.39	5.00	57.90
2008		13.16	16.43	3.44	6.02	48.50

[1]in Kg/1000 h*KW-04
[1] Beam trawl >= 10m in millions hp hrs >10% sole
[3]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23
[4] Days at sea (x 10^3)

Table 9.2.5b Sole in VIId. LPUE indices

Year	France[1] Beam trawl	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971						
1972						
1973						
1974						
1975						24.09
1976						27.28
1977						29.99
1978						26.27
1979						37.42
1980						23.26
1981						24.52
1982						23.65
1983						22.37
1984						21.61
1985						22.90
1986					39.48	33.48
1987					32.82	36.56
1988					27.67	15.89
1989					26.59	16.82
1990					26.88	25.94
1991	18.52				22.09	22.56
1992	18.12				25.29	29.11
1993	21.60				23.75	34.77
1994	17.78				31.83	27.89
1995	18.46				28.39	24.70
1996	19.79				25.79	29.80
1997	14.41				25.40	32.57
1998	17.33				25.71	23.51
1999	30.40				27.29	26.41
2000	19.10				27.46	24.49
2001	46.10				26.58	24.58
2002		101.29	30.39	152.67	31.63	27.33
2003		111.29	31.43	142.72	32.81	33.13
2004		102.13	26.96	132.65	38.80	30.86
2005		101.53	27.47	124.39	40.51	31.97
2006		90.48	30.39	90.06	39.01	27.47
2007		99.68	32.31	110.72	35.58	23.43
2008		107.17	34.39	116.23	37.61	24.58

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[4] in Kilos/days at sea

Table 9.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE 7d,TUNING - Tun7d.txt - 2009WG

105	1													
BEL BT														
1980	2008													
1	1	0	1											
2	15													
12.8	69.3	46.1	298.7	189.6	57.4	24.7	10.3	5.1	8.6	3.1	5.5	2.4	2.6	37.9
19.0	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9.0	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128.0	93.4	155.9	112.6	38.8	60.1	15.2	14.0	7.4	12.5	5.9	54.3
23.6	190.4	373.0	818.9	65.5	54.0	81.7	73.2	23.5	20.2	27.0	5.0	1.0	7.1	33.0
28.0	603.8	347.2	311.2	436.0	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9.0	8.2	42.4
25.3	382.9	612.1	213.0	209.1	260.2	58.2	34.1	48.0	31.0	16.9	19.6	9.2	7.7	21.3
23.4	215.0	1522.3	675.0	233.7	170.6	194.0	30.1	53.1	64.2	32.6	12.7	2.6	43.0	29.3
27.1	843.6	451.0	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56.0	56.1	54.5	9.3	109.0
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47.0	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748.0	276.6	225.0	53.1	36.4	12.7	4.7	0.0	0.0	4.7	27.0
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39.0	22.4	22.2	25.4	2.8	24.0	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21.0	19.8	22.2	18.0	5.6	0.3	21.4
22.0	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6.0	5.7	3.2	16.7
20.0	1654.5	1520.4	889.5	215.5	78.5	38.9	40.8	37.8	11.3	8.7	13.3	1.5	3.0	22.4
22.2	196.9	1183.2	1598.5	912.9	201.0	160.0	39.5	33.8	46.2	16.0	10.2	14.9	8.8	18.6
24.2	206.2	542.7	671.3	590.9	409.4	100.6	40.3	25.4	14.2	9.3	5.0	11.9	3.4	8.0
25.0	284.1	975.5	628.7	560.1	354.3	316.8	68.3	77.6	34.2	26.2	15.8	10.8	1.1	4.2
30.9	196.0	1282.3	966.1	500.2	422.3	301.1	144.7	56.6	29.3	25.8	12.1	12.6	3.4	1.4
18.1	254.1	450.3	375.4	175.1	54.8	116.1	95.9	59.1	12.4	16.0	7.7	2.9	4.4	19.2
21.4	367.7	1043.6	640.2	308.3	94.6	48.7	90.6	68.3	28.2	44.7	22.9	4.7	8.5	11.3
30.5	569.1	1170.7	1225.1	239.1	139.4	68.4	66.6	74.4	46.0	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375.0	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
33.7	1267.7	1612.6	804.3	286.3	122.4	95.7	45.2	24.8	28.6	15.8	13.8	8.0	6.0	2.6
47.5	2157.2	1848.1	1368.5	737.0	395.3	191.8	97.9	15.0	47.9	33.5	30.8	37.9	0.0	1.2
41.6	959.7	1846.2	778.1	1050.9	331.1	82.3	93.5	30.7	51.2	22	34.8	0.7	8.3	0.7
35.8	1150.8	1156.5	1259.7	309.1	201.7	156.5	74.2	37.9	16.4	44.8	1.3	6.2	0.8	3.3
48.8	1341.0	1050.9	1009.4	885.8	434.9	370.7	147.7	79.2	75.7	35.9	25.4	27.4	19.5	4.1
57.9	1736.5	1888.6	808.5	415.2	550.6	207.8	258.0	117.2	47.6	36.6	21.5	9.2	5.5	31.4
48.5	249.7	1383.2	1435	427.6	217.5	324.1	137.3	75.7	65.6	48.5	7.5	7.0	0.0	24.7
UK BT														
1986	2008													
1	1	0	1											
2	15													
2.8	30.0	144.8	100.5	28.0	28.8	39.4	1.2	2.4	5.2	2.5	2.8	1.5	1.7	5.3
5.6	251.8	106.0	143.5	99.2	18.6	14.6	37.6	1.4	0.4	3.3	1.1	1.5	3.3	2.4
5.1	112.3	281.3	56.4	62.9	39.6	9.0	11.5	16.2	2.0	0.2	4.6	4.9	0.0	0.2
5.7	162.3	78.1	144.2	18.2	31.7	23.1	5.1	4.2	16.3	1.0	0.6	2.2	2.7	12.9
7.3	112.6	327.4	47.7	66.1	14.1	15.1	15.1	4.1	7.4	22.2	1.9	0.4	3.4	7.6
7.7	349.0	139.2	195.2	8.4	30.7	5.1	7.4	10.9	2.7	1.9	8.4	0.3	0.0	5.0
8.8	240.1	516.6	81.3	167.5	11.1	20.3	6.4	14.6	4.9	2.2	1.5	3.3	0.1	2.5
6.4	174.9	222.5	218.9	34.6	52.7	5.2	10.7	4.5	3.0	3.3	1.1	1.3	2.1	2.8
5.4	33.6	260.9	144.1	113.3	27.5	45.5	4.4	10.5	3.2	4.1	3.7	2.4	1.6	9.3
6.9	181.1	106.9	220.4	107.6	94.6	18.3	37.5	5.4	9.4	2.0	4.3	4.4	0.9	7.7
10.3	295.8	251.3	79.5	169.0	84.6	67.4	17.5	33.2	4.1	8.8	4.2	5.4	3.6	11.9
10.3	268.5	331.1	158.5	42.4	125.2	50.8	48.7	11.6	23.0	2.7	7.1	1.1	3.8	7.6
7.3	252.6	169.4	97.5	65.2	22.1	51.7	28.8	22.4	5.8	12.5	2.0	5.3	1.5	9.0
5.9	170.0	300.0	105.6	43.6	31.8	12.3	26.3	12.9	7.3	3.4	3.8	0.7	2.5	4.1
5.7	152.1	178.8	171.4	54.7	25.8	18.2	6.9	21.6	9.7	5.7	2.3	4.2	0.6	7.9
7.6	284.3	268.0	101.0	111.9	44.0	19.0	19.6	5.8	14.7	12.1	5.0	1.4	3.0	4.7
7.9	314.6	449.0	222.2	71.7	54.9	22.9	18.6	6.0	3.1	5.2	2.3	2.4	0.4	2.9
6.7	386.0	220.8	149.5	64.8	27.2	32.0	15.0	5.6	5.8	0.9	4.2	2.8	1.9	5.1
4.9	111.9	440.4	103.2	62.2	32.6	9.6	18.2	4.3	3.2	2.9	0.5	3.3	1.2	4.2
6.0	170.7	178.3	376.4	69.4	72.3	35.4	17.4	15.6	11.2	4.3	7.9	2.7	3.2	10.9
5.9	395.2	350.5	113.5	189.0	31.7	28.1	13.6	9.0	5.4	2.8	0.8	1.5	0.3	2.9
5.0	167.8	303.7	114.9	34.6	102.8	24.0	23.6	9.4	1.3	4.1	2.8	0.9	1.8	6.0
6.0	148.1	595.2	179.4	39.5	24.0	33.3	12.2	4.3	6.2	4.4	1.2	2.2	0.1	3.5

Table 9.2.6 - Sole VIId - tuning files - continued

Bolded numbers = used in XSA

UK BTS						
1988	**2008**					
1	**1**	**0.5**	**0.75**			
1	**6**					
1	**8.20**	**14.20**	**9.90**	**0.80**	**1.30**	**0.60**
1	**2.60**	**15.40**	**3.40**	**1.70**	**0.60**	**0.20**
1	**12.10**	**3.70**	**3.40**	**0.70**	**0.80**	**0.20**
1	**8.90**	**22.80**	**2.20**	**2.30**	**0.30**	**0.50**
1	**1.40**	**12.00**	**10.00**	**0.70**	**1.10**	**0.30**
1	**0.50**	**17.50**	**8.40**	**7.00**	**0.80**	**1.00**
1	**4.80**	**3.20**	**8.30**	**3.30**	**3.30**	**0.20**
1	**3.50**	**10.60**	**1.50**	**2.30**	**1.20**	**1.50**
1	**3.50**	**7.30**	**3.80**	**0.70**	**1.30**	**0.90**
1	**19.00**	**7.30**	**3.20**	**1.30**	**0.20**	**0.50**
1	**2.00**	**21.20**	**2.50**	**1.00**	**0.90**	**0.10**
1	**28.10**	**9.40**	**13.20**	**2.50**	**1.70**	**1.30**
1	**10.49**	**22.03**	**4.15**	**4.24**	**1.03**	**0.58**
1	**9.09**	**21.01**	**8.36**	**1.20**	**1.91**	**0.54**
1	**31.76**	**11.42**	**5.42**	**3.45**	**0.27**	**0.71**
1	**6.47**	**28.48**	**4.13**	**2.46**	**1.58**	**0.30**
1	**7.35**	**8.49**	**7.71**	**1.57**	**1.45**	**0.99**
1	**25**	**5.04**	**2.86**	**3.47**	**1.63**	**1.02**
1	**6.3**	**29.2**	**2.8**	**2**	**1.9**	**0.3**
1	**2.1**	**21.9**	**12.9**	**1.2**	**0.8**	**1.2**
1	**2.9**	**6.5**	**7.2**	**4.8**	**0.2**	**0.5**
YFS-UK						
1981	**2006**					
1	**1**	**0.5**	**0.75**			
0	**1**					
1	0.11	0.45				
1	4.63	0.36				
1	25.45	1.52				
1	4.33	4.04				
1	7.65	2.94				
1	6.45	1.45				
1	16.85	**1.38**				
1	2.59	**1.87**				
1	6.67	**0.62**				
1	6.7	**1.90**				
1	1.81	**3.69**				
1	2.26	**1.50**				
1	14.19	**1.33**				
1	13.07	**2.68**				
1	7.53	**2.91**				
1	1.85	**0.57**				
1	4.23	**1.12**				
1	7.97	**1.12**				
1	2.63	**1.47**				
1	1.16	**2.47**				
1	4.75	**0.38**				
1	4.45	**4.15**				
1	4.55	**1.44**				
1	6.98	**2.72**				
1	9.97	**4.07**				
1	3.09	**2.21**				
YFS-FR						
1987	**2008**					
1	**1.00**	**0.50**	**0.75**			
0	1					
1	0.75	**0.07**				
1	0.04	**0.17**				
1	17.43	**0.14**				
1	0.57	**0.54**				
1	1.04	**0.38**				
1	0.48	**0.22**				
1	0.27	**0.03**				
1	4.04	**0.70**				
1	3.50	**0.28**				
1	0.28	**0.15**				
1	0.07	**0.03**				
1	10.52	**0.10**				
1	2.84	**0.35**				
1	2.41	**0.31**				
1	4.32	**1.21**				
1	0.94	**0.11**				
1	0.21	**0.32**				
1	7.29	**0.15**				
1	0.05	**0.82**				
1	1.04	**0.83**				
1	0.03	**0.08**				
1	6.58	**0.06**				

Table 9.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

8/05/2009 13:09

Extended Survivors Analysis

Sole in VIId - 2009WG - Sol7d.txt

Catch data for 27 years. 1982 to 2008. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2008	2	10	0	1
UK BT	1986	2008	2	10	0	1
UK BTS	1988	2008	1	6	0.5	0.75
YFS-UK	1987	2008	1	1	0.5	0.75
YFS-FR	1987	2008	1	1	0.5	0.75

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 = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 72 iterations

Regression weights

	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.007	0.005	0.007	0.016	0.02	0.059	0.006	0.017	0.013	0.018
2	0.238	0.174	0.258	0.377	0.323	0.286	0.255	0.252	0.232	0.242
3	0.541	0.58	0.451	0.519	0.457	0.404	0.426	0.428	0.377	0.473
4	0.636	0.527	0.336	0.483	0.383	0.386	0.427	0.528	0.634	0.337
5	0.561	0.385	0.571	0.497	0.398	0.46	0.38	0.463	0.525	0.535
6	0.58	0.386	0.433	0.253	0.412	0.403	0.392	0.454	0.489	0.565
7	0.529	0.384	0.355	0.281	0.336	0.374	0.377	0.462	0.567	0.296
8	0.444	0.394	0.232	0.235	0.273	0.411	0.348	0.388	0.479	0.511
9	0.381	0.359	0.226	0.247	0.173	0.18	0.438	0.517	0.407	0.272
10	0.302	0.247	0.125	0.336	0.33	0.305	0.348	0.591	1.005	0.339

1

XSA population numbers (Thousands)

YEAR \ AGE	1.00E+00	2.00E+00	3.00E+00	4.00E+00	5.00E+00	6.00E+00	7.00E+00	8.00E+00	9.00E+00	1.00E+01
1999	2.63E+04	1.62E+04	2.14E+04	7.39E+03	3.21E+03	2.08E+03	8.96E+02	1.97E+03	1.17E+03	7.74E+02
2000	3.10E+04	2.36E+04	1.16E+04	1.13E+04	3.54E+03	1.66E+03	1.05E+03	4.77E+02	1.14E+03	7.21E+02
2001	2.61E+04	2.79E+04	1.79E+04	5.87E+03	6.02E+03	2.18E+03	1.02E+03	6.49E+02	2.91E+02	7.23E+02
2002	4.68E+04	2.35E+04	1.95E+04	1.03E+04	3.79E+03	3.08E+03	1.28E+03	6.47E+02	4.65E+02	2.10E+02
2003	2.03E+04	4.17E+04	1.46E+04	1.05E+04	5.77E+03	2.09E+03	2.16E+03	8.73E+02	4.63E+02	3.29E+02
2004	1.90E+04	1.80E+04	2.73E+04	8.35E+03	6.48E+03	3.51E+03	1.25E+03	1.40E+03	6.01E+02	3.52E+02
2005	3.87E+04	1.62E+04	1.22E+04	1.65E+04	5.13E+03	3.70E+03	2.12E+03	7.79E+02	8.39E+02	4.55E+02
2006	37200	34800	11300	7230	9730	3180	2260	1320	498	490
2007	14800	33100	24500	6690	3860	5540	1820	1290	808	269
2008	9000	13200	23700	15200	3210	2070	3080	936	724	487

Estimated population abundance at 1st Jan 2009

0	8000	9380	13400	9820	1700	1060	2070	508	499

Taper weighted geometric mean of the VPA populations:

22400	20600	15800	8640	4600	2700	1620	956	603	374

Standard error of the weighted Log(VPA populations) :

0.4221	0.3833	0.3614	0.4252	0.4384	0.4636	0.4889	0.4779	0.4746	0.5166

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Log catchability residuals.

Fleet : BEL BT

Age		1986	1987	1988
	1	at this age		
	2	0.02	0.57	-0.74
	3	0.71	-0.22	-0.45
	4	0.17	0.34	-0.75
	5	-0.11	0.57	-0.24
	6	-0.12	0.91	-0.22
	7	-0.19	0.6	0.06
	8	0.02	-0.08	-0.77
	9	0.8	0.27	-0.72
	10	0.1	2.33	1.3

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	1	at this age									
	2	-2.58	1.1	-0.78	-0.05	1.3	-0.31	-0.77	-0.13	-0.75	-0.35
	3	-0.01	0.08	0.82	0.09	0.24	-0.04	-0.3	-0.06	0.37	-0.23
	4	-0.42	-0.16	0.05	0.38	-0.06	0.54	-0.36	0.25	0.33	0.25
	5	0.99	-0.1	-0.06	0.23	-0.05	0.25	-0.08	-0.14	0.45	-0.17
	6	0.29	-0.18	0.64	-0.48	-0.84	0.41	0.08	0.13	0.15	-0.25
	7	0.35	0.58	0.08	-0.21	0.03	0.05	-0.02	0.27	0.24	-0.21
	8	-0.06	-0.23	0	-0.15	-0.23	0.32	-1.08	-0.02	-0.17	0.09
	9	-0.36	0.35	-0.63	0	0.7	-0.17	0.21	-0.11	0.07	-0.01
	10	-2.07	-0.14	0.56	-0.61	-0.52	1.4	-0.74	1.16	-0.92	-0.08

Age		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	1	No data for this fleet at this age									
	2	0.37	0.05	0.48	0.85	0.44	0.59	1.01	0.08	0.21	-0.63
	3	0.02	0.42	0.03	0.09	0.14	0.12	0.12	-0.21	-0.59	-0.65
	4	0.5	0.32	-0.36	-0.13	-0.01	-0.21	-0.24	0.1	-0.17	-0.37
	5	0.45	-0.34	0.1	-0.28	-0.14	0.26	-0.61	-0.47	-0.45	-0.05
	6	-0.08	0.09	0.7	-0.82	0.47	-0.1	-0.5	0.14	-0.34	-0.07
	7	0.02	-0.22	0.17	-0.23	-0.38	-0.53	-0.26	0.27	-0.22	-0.24
	8	-0.19	0.55	-0.64	-0.32	-0.17	-0.49	-0.02	-0.15	0.3	0.18
	9	0.03	-0.23	-0.58	-0.58	-1.46	-0.87	-0.72	0.26	-0.05	-0.26
	10	-0.49	-0.3	-1.33	0.39	0.12	0.24	-0.99	0.27	0.41	0.02

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	10
Mean Log q	-7.0581	-5.8047	-5.6597	-5.5424	-5.7492	-5.6959	-5.6959	-5.6959	-5.6959
S.E(Log q)	0.8391	0.3662	0.3362	0.3731	0.4497	0.292	0.3882	0.554	0.9687

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	0.85	0.374	7.49	0.23	23	0.73	-7.06
3	1.47	-1.556	3.98	0.34	23	0.52	-5.8
4	0.95	0.301	5.83	0.64	23	0.33	-5.66
5	1.12	-0.551	5.21	0.52	23	0.42	-5.54
6	1.07	-0.319	5.59	0.47	23	0.49	-5.75
7	0.99	0.09	5.72	0.74	23	0.3	-5.7
8	1.25	-1.305	5.58	0.57	23	0.44	-5.84
9	1.36	-1.154	5.68	0.33	23	0.71	-5.87
10	-2.84	-5.529	6.74	0.09	23	1.8	-5.69
1							

Fleet : UK BT

Age		1986	1987	1988
	1	at this age		
	2	-0.38	0.37	0.57
	3	0.47	-0.12	0.3
	4	0.52	0.4	-0.05
	5	0.28	0.53	0.41
	6	0.36	-0.3	0.25
	7	0.64	-0.31	-0.15
	8	-0.78	0.38	0.25
	9	0.12	-0.77	0.07
	10	0	-1.19	0.46

Age		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	1	No data for this fleet at this age									
	2	-0.06	-0.22	-0.09	-0.41	-0.37	-1.22	-0.2	0.24	0.12	-0.01
	3	-0.07	0.05	-0.32	-0.15	-0.56	-0.16	-0.69	-0.55	0.11	-0.32
	4	0.23	-0.13	0.04	-0.44	-0.19	-0.32	-0.09	-0.8	-0.24	-0.06
	5	-0.49	0	-1.22	0.48	-0.36	-0.04	-0.15	-0.07	-0.53	0.13
	6	0.1	-0.41	-0.29	-0.63	0.04	-0.03	0.01	-0.28	0.18	-0.12
	7	0.21	-0.28	-0.96	-0.21	-0.56	0.49	-0.18	-0.11	-0.15	0.18
	8	-0.27	0.01	-0.59	-0.42	-0.14	-0.17	0.39	-0.21	0.13	0.08
	9	-0.38	-0.18	0.15	0.43	0	0.36	0.21	0.21	-0.12	0.21
	10	0.31	0.47	0.01	-0.23	-0.42	0.43	0.4	0.22	0.23	0.36

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1 : at this age										
2	0.34	-0.14	0.06	0.35	0.12	0.03	0.33	0.41	-0.23	0.38
3	0.06	0.21	-0.19	0.24	-0.04	0.32	0.02	0.78	0.02	0.58
4	0.12	0.17	-0.1	0.16	-0.13	0.05	0.47	0.15	0.46	-0.23
5	0.17	0.26	0.22	0.17	-0.23	-0.04	0.06	0.47	-0.1	0.03
6	0.26	0.23	0.21	-0.03	-0.11	-0.13	0.4	-0.24	0.57	-0.05
7	0.23	0.43	0.19	0.08	0.08	-0.24	0.33	0.08	0.36	-0.14
8	0.16	0.25	0.61	0.53	0.2	0.3	0.61	-0.14	0.65	0.14
9	-0.06	0.5	0.19	-0.26	-0.2	-0.4	0.46	0.49	0.16	-0.76
10	-0.25	0.11	0.17	-0.09	0.25	-0.1	0.71	0.02	-0.43	0.03

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	10
Mean Log q	-6.5028	-5.7878	-5.7904	-5.9263	-5.8886	-5.9843	-5.9843	-5.9843	-5.9843
S.E(Log q)	0.3894	0.3614	0.3128	0.3946	0.2856	0.3601	0.3928	0.3625	0.4045

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	1.09	-0.391	6.18	0.46	23	0.43	-6.5
3	0.99	0.054	5.83	0.52	23	0.37	-5.79
4	0.97	0.218	5.9	0.66	23	0.31	-5.79
5	0.72	2.127	6.63	0.73	23	0.26	-5.93
6	0.78	2.346	6.34	0.84	23	0.2	-5.89
7	0.77	2.014	6.32	0.78	23	0.26	-5.98
8	0.8	1.596	6.1	0.75	23	0.3	-5.9
9	0.82	1.37	6.04	0.74	23	0.29	-5.96
10	0.9	0.739	5.93	0.71	23	0.36	-5.92
1							

Fleet : UK BTS

Age	1986	1987	1988
1	99.99	99.99	0.27
2	99.99	99.99	1.01
3	99.99	99.99	0.65
4	99.99	99.99	-0.29
5	99.99	99.99	0.48
6	99.99	99.99	0.11
7 : at this age			
8 : at this age			
9 No data for this fleet at this age			
10 No data for this fleet at this age			

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.44	0.14	0.06	-1.76	-2.09	-0.29	-0.27	-0.27	1.04	-0.78
2	0.18	-0.78	0.09	-0.38	0.06	-1.03	-0.24	-0.27	-0.3	0.36
3	0.62	-0.49	-0.38	0.11	0.05	0.12	-0.98	-0.34	-0.12	-0.48
4	-0.05	0.03	0.04	-0.63	0.61	-0.01	-0.33	-0.79	-0.27	-0.23
5	0.21	-0.1	-0.19	-0.04	0.05	0.44	-0.38	-0.26	-1.16	0.19
6	-0.79	-0.27	0.08	0.35	0.32	-0.85	0.23	-0.05	-0.58	-1.08
7 : at this age										
8 : at this age										
9 : at this age										
10 : at this age										

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	1.49	0.34	0.36	1.04	0.29	0.5	0.98	-0.35	-0.53	0.29
2	0.09	0.53	0.36	0	0.31	-0.09	-0.52	0.47	0.22	-0.07
3	0.76	0.24	0.43	-0.05	-0.07	-0.1	-0.28	-0.22	0.5	0.01
4	0.57	0.61	-0.12	0.46	0.05	-0.17	-0.03	0.3	-0.07	0.32
5	1.05	0.34	0.54	-1	0.29	0.13	0.43	-0.01	0.09	-1.11
6	1.29	0.59	0.27	0.09	-0.28	0.39	0.35	-0.68	0.17	0.33
7 : at this age										
8 : at this age										
9 : at this age										
10 : at this age										

Table 9.3.1 - Sole VIId - 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
Mean Log q	-8.2606	-7.333	-7.7558	-8.1033	-8.181	-8.2442
S.E(Log q)	0.8665	0.463	0.4329	0.3781	0.5542	0.5609

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	0.63	1.264	8.95	0.38	21	0.54	-8.26
2	0.78	1.023	7.91	0.54	21	0.36	-7.33
3	0.84	0.726	8.08	0.51	21	0.37	-7.76
4	0.78	1.508	8.32	0.71	21	0.29	-8.1
5	0.89	0.419	8.21	0.45	21	0.51	-8.18
6	0.98	0.067	8.24	0.42	21	0.57	-8.24
1							

Fleet : YFS-UK

Age	1986	1987	1988
1	99.99	0.64	0.09
2	: at this age		
3	: at this age		
4	: at this age		
5	: at this age		
6	: at this age		
7	: at this age		
8	: at this age		
9	: at this age		
10	: at this age		

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.58	-0.41	0.48	-0.39	0.18	0.42	0.85	-0.79	-0.5	-0.06
2	: at this age									
3	: at this age									
4	: at this age									
5	: at this age									
6	: at this age									
7	: at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	-0.16	0.19	-1.51	0.3	0.08	0.81	0.47	-0.1	99.99	99.99
2	No data for this fleet at this age									
3	: at this age									
4	: at this age									
5	: at this age									
6	: at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	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
Mean Log q	-9.5596
S.E(Log q)	0.5817

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	1.22	-0.498	9.43	0.22	20	0.72	-9.56

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Fleet : YFS-FR

Age	1986	1987	1988
1	99.99	-0.3	-0.26
2	at this age		
3	at this age		
4	at this age		
5	at this age		
6	at this age		
7	at this age		
8	at this age		
9	at this age		
10	at this age		

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.03	0.37	0.24	-0.27	-1.57	1.12	0.55	-0.08	-2.07	-0.44
2	at this age									
3	at this age									
4	at this age									
5	at this age									
6	at this age									
7	at this age									
8	at this age									
9	at this age									
10	at this age									

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.44	0.15	1.69	-1.29	0.62	-0.05	0.9	0.96	-0.45	-0.24
2	at this age									
3	at this age									
4	at this age									
5	at this age									
6	at this age									
7	at this age									
8	at this age									
9	at this age									
10	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
Mean Log q	-11.6011
S.E(Log q)	0.8746

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	0.73	0.82	11.19	0.32	22	0.65	-11.6

Terminal year survivor and F summaries :

Age 1 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
BEL BT	1	0	0	0	0	0	0
UK BT	1	0	0	0	0	0	0
UK BTS	10735	0.887	0	0	1	0.458	0.013
YFS-UK	1	0	0	0	0	0	0
YFS-FR	6270	0.894	0	0	1	0.45	0.022
F shrinkage mean	6136	2				0.092	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8005	0.6	0.19	3	0.319	0.018

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 2 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
BEL BT	5019	0.857	0	0	1	0.091	0.413
UK BT	13764	0.398	0	0	1	0.423	0.171
UK BTS	7907	0.418	0.19	0.45	2	0.382	0.281
YFS-UK	1	0	0	0	0	0	0
YFS-FR	5950	0.894	0	0	1	0.083	0.359
F shrinkage mean	8274	2				0.021	0.27

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9377	0.26	0.17	6	0.646	0.242

Age 3 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
BEL BT	7849	0.344	0.291	0.84	2	0.244	0.708
UK BT	17211	0.272	0.397	1.46	2	0.366	0.385
UK BTS	14090	0.306	0.118	0.39	3	0.285	0.454
YFS-UK	12135	0.596	0	0	1	0.065	0.511
YFS-FR	35103	0.894	0	0	1	0.029	0.207
F shrinkage mean	15517	2				0.012	0.419

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13382	0.17	0.15	10	0.919	0.473

Age 4 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
BEL BT	6431	0.248	0.11	0.44	3	0.294	0.478
UK BT	9392	0.213	0.172	0.81	3	0.379	0.35
UK BTS	15049	0.247	0.089	0.36	4	0.275	0.232
YFS-UK	15647	0.596	0	0	1	0.031	0.224
YFS-FR	24280	0.894	0	0	1	0.014	0.15
F shrinkage mean	6504	2				0.007	0.473

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9823	0.13	0.12	13	0.878	0.337

Age 5 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
BEL BT	1555	0.225	0.11	0.49	4	0.345	0.574
UK BT	2367	0.205	0.157	0.76	4	0.378	0.411
UK BTS	1079	0.247	0.238	0.97	5	0.241	0.75
YFS-UK	3821	0.596	0	0	1	0.017	0.274
YFS-FR	1623	0.894	0	0	1	0.008	0.555
F shrinkage mean	2138	2				0.01	0.447

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1702	0.13	0.12	16	0.91	0.535

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	949	0.215	0.122	0.57	5	0.303	0.615
UK BT	1045	0.185	0.041	0.22	5	0.465	0.572
UK BTS	1254	0.248	0.095	0.38	6	0.207	0.497
YFS-UK	1153	0.596	0	0	1	0.01	0.531
YFS-FR	1973	0.894	0	0	1	0.005	0.343
F shrinkage me	1494	2				0.01	0.432

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1062	0.12	0.05	19	0.402	0.565

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1550	0.19	0.047	0.25	6	0.417	0.378
UK BT	2701	0.174	0.141	0.81	6	0.435	0.234
UK BTS	2239	0.239	0.088	0.37	6	0.13	0.276
YFS-UK	2799	0.596	0	0	1	0.007	0.227
YFS-FR	571	0.894	0	0	1	0.003	0.81
F shrinkage mean	1347	2				0.007	0.424

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2071	0.11	0.08	21	0.693	0.296

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	478	0.183	0.108	0.59	7	0.439	0.535
UK BT	557	0.175	0.084	0.48	7	0.45	0.475
UK BTS	436	0.235	0.174	0.74	6	0.094	0.575
YFS-UK	112	0.596	0	0	1	0.005	1.392
YFS-FR	2749	0.894	0	0	1	0.002	0.116
F shrinkage mean	731	2				0.01	0.381

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
508	0.12	0.06	23	0.549	0.511

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	542	0.184	0.106	0.57	8	0.398	0.253
UK BT	458	0.173	0.211	1.22	8	0.518	0.293
UK BTS	594	0.239	0.07	0.29	6	0.071	0.233
YFS-UK	602	0.596	0	0	1	0.004	0.231
YFS-FR	582	0.894	0	0	1	0.002	0.238
F shrinkage mean	380	2				0.009	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
499	0.12	0.09	25	0.778	0.272

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	274	0.182	0.033	0.18	9	0.351	0.38
UK BT	327	0.167	0.056	0.34	9	0.574	0.327
UK BTS	484	0.237	0.084	0.35	6	0.061	0.232
YFS-UK	266	0.596	0	0	1	0.004	0.389
YFS-FR	488	0.894	0	0	1	0.002	0.23
F shrinkage mean	231	2				0.01	0.437

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
314	0.12	0.04	27	0.333	0.339

Table 9.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId - 2009WG - Sol7d.txt

At 8/05/2009 13:10

Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988
AGE							
1	0.0129	0	0.0012	0.004	0.002	0.0009	0.0039
2	0.1860	0.0821	0.114	0.2227	0.1199	0.152	0.2602
3	0.3107	0.3524	0.4312	0.4333	0.5032	0.5444	0.5406
4	0.4844	0.3582	0.4355	0.372	0.4581	0.5913	0.4208
5	0.2314	0.4428	0.2616	0.2709	0.3196	0.5321	0.3794
6	0.2278	0.4636	0.7118	0.3908	0.2973	0.6533	0.3912
7	0.4671	0.3168	0.5197	0.2517	0.3567	0.7833	0.477
8	0.4101	0.5094	0.2335	0.3016	0.4163	0.4333	0.3672
9	0.3463	0.2906	0.3564	0.1544	0.6309	0.5254	0.2178
10	0.3375	0.4059	0.4179	0.2745	0.2886	1.7939	0.8467
+gp	0.3375	0.4059	0.4179	0.2745	0.2886	1.7939	0.8467
0 FBAR 3- 8	0.3553	0.4072	0.4322	0.3367	0.3919	0.5896	0.4294

Table 8 Fishing mortality (F) at age

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	0.0102	0.0300	0.0116	0.0033	0.0053	0.0012	0.0464	0.0005	0.0009	0.0019
2	0.1714	0.2220	0.2156	0.1467	0.1914	0.0495	0.1397	0.1215	0.0960	0.0594
3	0.6715	0.4019	0.5036	0.3946	0.3259	0.3392	0.4367	0.5660	0.6435	0.5437
4	0.6654	0.4751	0.5235	0.4046	0.4023	0.4944	0.4199	0.5444	0.7823	0.5884
5	0.7288	0.4389	0.4349	0.4529	0.3485	0.4189	0.4392	0.4910	0.7953	0.5593
6	0.4615	0.2861	0.5199	0.3384	0.1970	0.3105	0.4071	0.4689	0.4540	0.4989
7	0.4353	0.3579	0.3748	0.3263	0.2882	0.2776	0.2990	0.4460	0.4038	0.2385
8	0.4306	0.3209	0.3584	0.3065	0.2457	0.2855	0.1904	0.3262	0.4704	0.3075
9	0.3845	0.4809	0.5360	0.4002	0.4164	0.2754	0.3493	0.3092	0.4714	0.3613
10	0.2683	0.4998	0.6670	0.3405	0.2197	0.6119	0.2912	0.8867	0.2384	1.0953
+gp	0.2683	0.4998	0.6670	0.3405	0.2197	0.6119	0.2912	0.8867	0.2384	1.0953
0 FBAR 3- 8	0.5655	0.3801	0.4525	0.3706	0.3013	0.3543	0.3654	0.4737	0.5915	0.4560

Table 8 Fishing mortality (F) at age

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	FBAR 06-08
AGE											
1	0.0067	0.0047	0.0068	0.0160	0.0198	0.0588	0.0056	0.0173	0.0125	0.0176	0.0158
2	0.2376	0.1741	0.2582	0.3769	0.3234	0.2858	0.2553	0.2517	0.2319	0.2420	0.2419
3	0.5409	0.5801	0.4509	0.5190	0.4572	0.4036	0.4257	0.4275	0.3768	0.4727	0.4257
4	0.6362	0.5272	0.3364	0.4827	0.3829	0.3865	0.4275	0.5278	0.6343	0.3371	0.4997
5	0.5609	0.3853	0.5706	0.4972	0.3984	0.4597	0.3800	0.4633	0.5252	0.5352	0.5079
6	0.5797	0.3860	0.4331	0.2531	0.4122	0.4035	0.3923	0.4544	0.4887	0.5650	0.5027
7	0.5291	0.3837	0.3552	0.2813	0.3364	0.3736	0.3766	0.4616	0.5672	0.2957	0.4415
8	0.4439	0.3944	0.2324	0.2353	0.2725	0.4107	0.3483	0.3883	0.4787	0.5106	0.4592
9	0.3807	0.3587	0.2258	0.2474	0.1732	0.1795	0.4378	0.5166	0.4071	0.2722	0.3986
10	0.3022	0.2470	0.1253	0.3355	0.3304	0.3049	0.3477	0.5908	1.0051	0.3388	0.6449
+gp	0.3022	0.2470	0.1253	0.3355	0.3304	0.3049	0.3477	0.5908	1.0051	0.3388	
0 FBAR 3- 8	0.5484	0.4428	0.3964	0.3781	0.3766	0.4063	0.3917	0.4538	0.5118	0.4527	

Table 9.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId - 2009WG - Sol7d.txt

At 8/05/2009 13:10

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988
AGE							
1	12725	21324	21514	12913	25731	10975	25798
2	16262	11367	19295	19444	11638	23236	9922
3	20691	12218	9475	15578	14081	9340	18060
4	4729	13722	7771	5570	9139	7703	4903
5	2901	2636	8678	4549	3474	5230	3859
6	3370	2083	1532	6045	3139	2284	2780
7	1547	2428	1185	680	3700	2110	1075
8	750	877	1600	638	479	2344	872
9	438	450	477	1146	427	286	1375
10	305	280	305	302	889	206	153
+gp	739	606	730	559	1555	570	502
0 TOTAL	64456	67991	72562	67426	74253	64284	69300

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AGE										
1	16807	44246	34847	33639	16773	26557	19420	18912	27767	17985
2	23253	15052	38851	31166	30338	15096	24000	16774	17104	25102
3	6921	17726	10908	28337	24352	22668	12999	18884	13442	14060
4	9517	3200	10731	5965	17280	15907	14610	7600	9702	6391
5	2913	4427	1800	5753	3602	10457	8779	8687	3990	4015
6	2389	1272	2583	1055	3310	2300	6224	5120	4811	1630
7	1701	1363	864	1389	680	2459	1526	3748	2899	2765
8	604	996	862	538	907	461	1686	1024	2171	1752
9	547	355	654	545	358	642	314	1261	668	1227
10	1001	337	199	346	331	214	441	200	838	378
+gp	1256	1301	820	839	686	589	1000	610	1320	471
0 TOTAL	66908	90274	103119	109572	98616	97350	90998	82822	84712	75775

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	GMST 82-06	AMST 82-06
AGE													
1	26257	30990	26119	46812	20282	18965	38702	37184	14773	9003	0*	23623	25330
2	16243	23598	27909	23474	41685	17991	16180	34823	33067	13201	8005	20552	21992
3	21404	11588	17942	19506	14571	27295	12232	11342	24499	23727	9377	15297	16225
4	7386	11276	5870	10342	10503	8347	16495	7231	6693	15208	13382	8532	9276
5	3211	3538	6022	3794	5775	6481	5131	9734	3860	3211	9823	4699	5177
6	2077	1658	2177	3080	2088	3508	3703	3175	5542	2065	1702	2657	2936
7	896	1052	1020	1278	2164	1251	2120	2263	1824	3076	1062	1576	1767
8	1971	477	649	647	873	1398	779	1317	1291	936	2071	946	1067
9	1165	1144	291	465	463	601	839	498	808	724	508	591	665
10	774	721	723	210	329	352	455	490	269	487	499	375	431
+gp	1443	1188	2362	724	912	929	967	720	378	901	895		
0 TOTAL	82825	87231	91086	110333	99644	87119	97605	108776	93002	72538	47323		

* Replaced with GM in prediction

Table 9.3.4 - Sole VIId - Summary

Run title : Sole in VIId - 2009WG - Sol7d.txt

At 8/05/2009 13:10

Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12725	10417	7812	3190	0.4083	0.3553
1983	21324	12604	9577	3458	0.3611	0.4072
1984	21514	12952	8983	3575	0.3980	0.4322
1985	12913	13327	9980	3837	0.3845	0.3367
1986	25731	13968	10584	3932	0.3715	0.3919
1987	10975	13007	8987	4791	0.5331	0.5896
1988	25798	12868	10139	3853	0.3800	0.4294
1989	16807	11903	8435	3805	0.4511	0.5655
1990	44246	13913	9623	3647	0.3790	0.3801
1991	34847	15878	8774	4351	0.4959	0.4525
1992	33639	17363	11193	4072	0.3638	0.3706
1993	16773	17938	13156	4299	0.3268	0.3013
1994	26557	15637	12558	4383	0.3490	0.3543
1995	19420	15104	11109	4420	0.3979	0.3654
1996	18912	15694	12149	4797	0.3949	0.4737
1997	27767	14317	10551	4764	0.4515	0.5915
1998	17985	12527	8114	3363	0.4145	0.4560
1999	26257	12432	9040	4135	0.4574	0.5484
2000	30990	12941	8513	3476	0.4083	0.4428
2001	26119	12467	7616	4025	0.5285	0.3964
2002	46812	14022	8489	4733	0.5576	0.3781
2003	20282	17578	10270	5038	0.4906	0.3766
2004	18965	14756	11343	4826	0.4254	0.4063
2005	38702	15746	11270	4383	0.3889	0.3917
2006	37184	17144	9678	4833	0.4994	0.4538
2007	14773	17057	10928	5166	0.4727	0.5118
2008	9003	15298	12762	4510	0.3534	0.4527
2009	23623[1]	13074[2]	10607[2]			0.4728
Arith. Mean	24498	14568	10196	4210	0.4186	0.4234
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Geometric mean 1982-2006

[2] From forecast

[3] $F_{(06-08)}$ NOT rescaled to F_{2008}

Table 9.5.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	YF-FR0	YF-FR1	bts1	bts2
1981	12725	11367	3.33	0.07	-11	-11
1982	21324	19295	1.04	0.02	-11	-11
1983	21514	19444	0.79	-11	-11	-11
1984	12913	11638	-11	-11	-11	-11
1985	25731	23236	-11	-11	-11	-11
1986	10975	9922	-11	0.07	-11	14.20
1987	25798	23253	0.75	0.17	8.20	15.40
1988	16807	15052	0.04	0.14	2.60	3.70
1989	44246	38851	17.43	0.54	12.10	22.80
1990	34847	31166	0.57	0.38	8.90	12.00
1991	33639	30338	1.04	0.22	1.40	17.50
1992	16773	15096	0.48	0.03	0.50	3.20
1993	26557	24000	0.27	0.70	4.80	10.60
1994	19420	16774	4.04	0.28	3.50	7.30
1995	18912	17104	3.50	0.15	3.50	7.30
1996	27767	25102	0.28	0.03	19.00	21.20
1997	17985	16243	0.07	0.10	2.00	9.44
1998	26257	23598	10.52	0.35	28.14	22.03
1999	30990	27909	2.84	0.31	10.49	21.01
2000	26119	23474	2.41	1.21	9.09	11.42
2001	46812	41685	4.32	0.11	31.76	28.48
2002	20282	17991	0.94	0.32	6.47	8.49
2003	18965	16180	0.21	0.15	7.35	5.04
2004	38702	34823	7.29	0.82	25.00	29.20
2005	-11	-11	0.05	0.83	6.30	21.86
2006	-11	-11	1.04	0.08	2.14	6.50
2007	-11	-11	0.03	0.06	2.90	-11
2008	-11	-11	6.58	-11	-11	-11

Table 9.5.2a - Sole VIId – RCT3 output (1 year olds)

Analysis by RCT3 ver3.1 of data from file :

S7DREC1.txt

7D Sole (1year olds)

Data for 4 surveys over 28 years : 1981 - 2008

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 = 2006

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
YF-FR0	.95	9.15	.72	.194	21	.71	9.83	.775	.079
YF-FR1	4.05	9.12	.76	.214	21	.08	9.43	.827	.070
bts1	.57	8.98	.38	.439	18	1.14	9.63	.431	.257
bts2	.89	7.82	.38	.506	19	2.01	9.62	.424	.266
					VPA Mean =		10.05	.381	.328

Yearclass = 2007

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
YF-FR0	.95	9.15	.72	.194	21	.03	9.18	.799	.102
YF-FR1	4.05	9.12	.76	.214	21	.06	9.36	.830	.094
bts1	.57	8.98	.38	.439	18	1.36	9.75	.426	.358
bts2									
					VPA Mean =		10.05	.381	.446

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**
YF-FR0	**.95**	**9.15**	**.72**	**.194**	**21**	**2.03**	**11.08(64861)**	**.801**	**.185**
YF-FR1									
bts1									
bts2									
					VPA Mean =		**10.05(23156)**	**.381**	**.815**

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	17446	9.77	.22	.11	.24		
2007	17844	9.79	.25	.17	.45		
2008	**28036**	**10.24**	**.34**	**.40**	**1.35**		

Table 9.5.2b - Sole VIId – RCT3 output (2 year olds)

Analysis by RCT3 ver3.1 of data from file :

S7Drec2.txt

7D Sole (2year olds)

Data for 4 surveys over 28 years : 1981 - 2008

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 = 2006

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
YF-FR0	.98	9.01	.74	.186	21	.71	9.71	.798	.075
YF-FR1	4.07	9.01	.76	.213	21	.08	9.32	.831	.069
bts1	.58	8.84	.39	.430	18	1.14	9.51	.442	.245
bts2	.88	7.74	.37	.521	19	2.01	9.51	.412	.282
					VPA Mean =		9.94	.381	.329

Yearclass = 2007

	I-----------Regression----------I					**I-----------Prediction------------------I**			
Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
YF-FR0	**.98**	**9.01**	**.74**	**.186**	**21**	**.03**	**9.04 (8434)**	**.822**	**.098**
YF-FR1	**4.07**	**9.01**	**.76**	**.213**	**21**	**.06**	**9.24(10301)**	**.834**	**.096**
bts1	**.58**	**8.84**	**.39**	**.430**	**18**	**1.36**	**9.63(15214)**	**.436**	**.349**
bts2									
					VPA Mean =		**9.94(20744)**	**.381**	**.458**

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
YF-FR0	.98	9.01	.74	.186	21	2.03	10.99	.825	.176
YF-FR1									
bts1									
bts2									
					VPA Mean =		9.94	.381	.824

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	15574	9.65	.22	.11	.24		
2007	**15956**	**9.68**	**.26**	**.17**	**.45**		
2008	24973	10.13	.35	.40	1.34		

Table 9.6.1 - Sole in VIId
Input for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23623	0.39	WS1	0.050	0.00
N2	8005	0.60	WS2	0.161	0.02
N3	9377	0.26	WS3	0.190	0.03
N4	13382	0.17	WS4	0.245	0.02
N5	9823	0.13	WS5	0.284	0.04
N6	1702	0.13	WS6	0.330	0.11
N7	1062	0.12	WS7	0.360	0.10
N8	2071	0.12	WS8	0.423	0.11
N9	508	0.12	WS9	0.437	0.05
N10	499	0.12	WS10	0.437	0.07
N11	895	0.12	WS11	0.547	0.05
H.cons selectivity			Weight in the HC catch		
sH1	0.0158	0.24	WH1	0.150	0.08
sH2	0.2419	0.1	WH2	0.172	0.09
sH3	0.4257	0.17	WH3	0.198	0.03
sH4	0.4997	0.25	WH4	0.240	0.05
sH5	0.5079	0.09	WH5	0.274	0.04
sH6	0.5027	0.15	WH6	0.314	0.06
sH7	0.4415	0.26	WH7	0.368	0.17
sH8	0.4592	0.14	WH8	0.397	0.04
sH9	0.3986	0.32	WH9	0.425	0.10
sH10	0.6449	0.45	WH10	0.462	0.07
sH11	0.6449	0.45	WH11	0.530	0.04
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
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
M11	0.1	0.1	MT11	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF08	1	0.08	K08	1	0.1
HF09	1	0.08	K09	1	0.1
HF10	1	0.08	K10	1	0.1
Recruitment in 2007 and 2008					
R09	23623	0.39			
R10	23623	0.39			

Table 9.6.2 Sole in VIId - Management option table

MFDP version 1a
Run: Sole7D_Fin_SQ
Sole in VIId
Time and date: 15:51 08/05/2009
Fbar age range: 3-8

2009				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
13074	10607	1.0000	0.4728	4194

2010					2011	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
12469	7907	0.0000	0.0000	0	16413	11798
.	7907	0.1000	0.0473	440	15930	11320
.	7907	0.2000	0.0946	861	15468	10864
.	7907	0.3000	0.1418	1265	15026	10427
.	7907	0.4000	0.1891	1651	14604	10010
.	7907	0.5000	0.2364	2021	14199	9611
.	7907	0.6000	0.2837	2376	13812	9229
.	7907	0.7000	0.3309	2716	13441	8863
.	7907	0.8000	0.3782	3042	13086	8514
.	7907	0.9000	0.4255	3354	12746	8179
.	7907	1.0000	0.4728	3653	12421	7859
.	7907	1.1000	0.5201	3940	12109	7553
.	7907	1.2000	0.5673	4216	11810	7259
.	7907	1.3000	0.6146	4480	11524	6978
.	7907	1.4000	0.6619	4733	11250	6709
.	7907	1.5000	0.7092	4976	10987	6452
.	7907	1.6000	0.7565	5210	10735	6205
.	7907	1.7000	0.8037	5434	10493	5969
.	7907	1.8000	0.8510	5649	10262	5742
.	7907	1.9000	0.8983	5855	10039	5525
.	7907	2.0000	0.9456	6054	9826	5318

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 0.90

.	7907	0.85	0.4019	3199	12914	8345

Bpa = 8 000 t

Table 9.6.3 Sole in VIId. Detailed results

MFDP version 1a
Run: Sole7D_Fin_SQ
Time and date: 15:51 08/05/2009
Fbar age range: 3-8

Year: 2009 F multiplier: 1 Fbar: 0.4728

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0158	352	53	23623	1181	0	0	0	0
2	0.2419	1640	282	8005	1286	0	0	0	0
3	0.4257	3104	615	9377	1785	9377	1785	9377	1785
4	0.4997	5029	1207	13382	3279	13382	3279	13382	3279
5	0.5079	3738	1024	9823	2793	9823	2793	9823	2793
6	0.5027	643	202	1702	562	1702	562	1702	562
7	0.4415	362	133	1062	382	1062	382	1062	382
8	0.4592	728	289	2071	877	2071	877	2071	877
9	0.3986	159	68	508	222	508	222	508	222
10	0.6449	227	105	499	218	499	218	499	218
11	0.6449	407	216	895	489	895	489	895	489
Total		16391	4194	70947	13074	39319	10607	39319	10607

Year: 2010 F multiplier: 1 Fbar: 0.4728

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0158	352	53	23623	1181	0	0	0	0
2	0.2419	4310	741	21040	3380	0	0	0	0
3	0.4257	1883	373	5687	1082	5687	1082	5687	1082
4	0.4997	2083	500	5543	1358	5543	1358	5543	1358
5	0.5079	2796	766	7346	2089	7346	2089	7346	2089
6	0.5027	2019	635	5349	1767	5349	1767	5349	1767
7	0.4415	318	117	932	335	932	335	932	335
8	0.4592	217	86	618	262	618	262	618	262
9	0.3986	372	158	1184	518	1184	518	1184	518
10	0.6449	140	65	309	135	309	135	309	135
11	0.6449	301	160	662	362	662	362	662	362
Total		14792	3653	72292	12469	27629	7907	27629	7907

Year: 2011 F multiplier: 1 Fbar: 0.4728

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0158	352	53	23623	1181	0	0	0	0
2	0.2419	4310	741	21040	3380	0	0	0	0
3	0.4257	4949	980	14948	2845	14948	2845	14948	2845
4	0.4997	1264	303	3362	824	3362	824	3362	824
5	0.5079	1158	317	3043	865	3043	865	3043	865
6	0.5027	1510	475	4000	1321	4000	1321	4000	1321
7	0.4415	998	367	2927	1054	2927	1054	2927	1054
8	0.4592	191	76	542	229	542	229	542	229
9	0.3986	111	47	353	154	353	154	353	154
10	0.6449	327	151	719	314	719	314	719	314
11	0.6449	209	111	461	252	461	252	461	252
Total		15379	3621	75018	12421	30355	7859	30355	7859

Input units are thousands and kg - output in tonnes

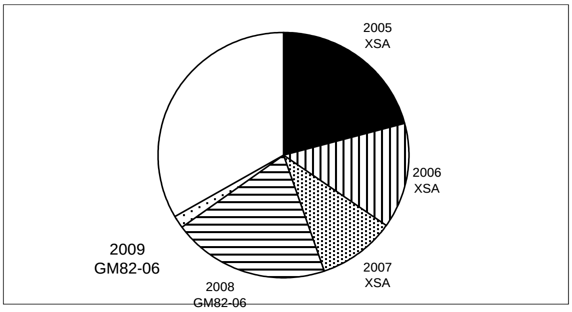
Table 9.6.4 **Sole VIId**
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2005	2006	2007	2008	2009
Stock No. (thousands) of 1 year-olds	37184	14773	9003	23623	23623
Source	XSA	XSA	XSA	GM82-06	GM82-06
Status Quo F:					
% in 2009 landings	28.8	14.7	6.7	1.3	-
% in 2010 landings	21.0	13.7	10.2	20.3	1.5
% in 2009 SSB	30.9	16.8	0.0	0.0	-
% in 2010 SSB	26.4	17.2	13.7	0.0	0.0
% in 2011 SSB	16.8	11.0	10.5	36.2	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2010 landings



b) 2011 SSB

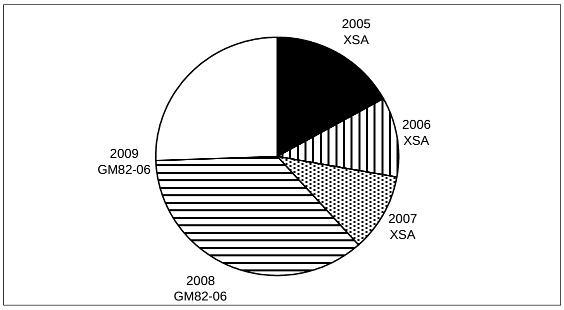


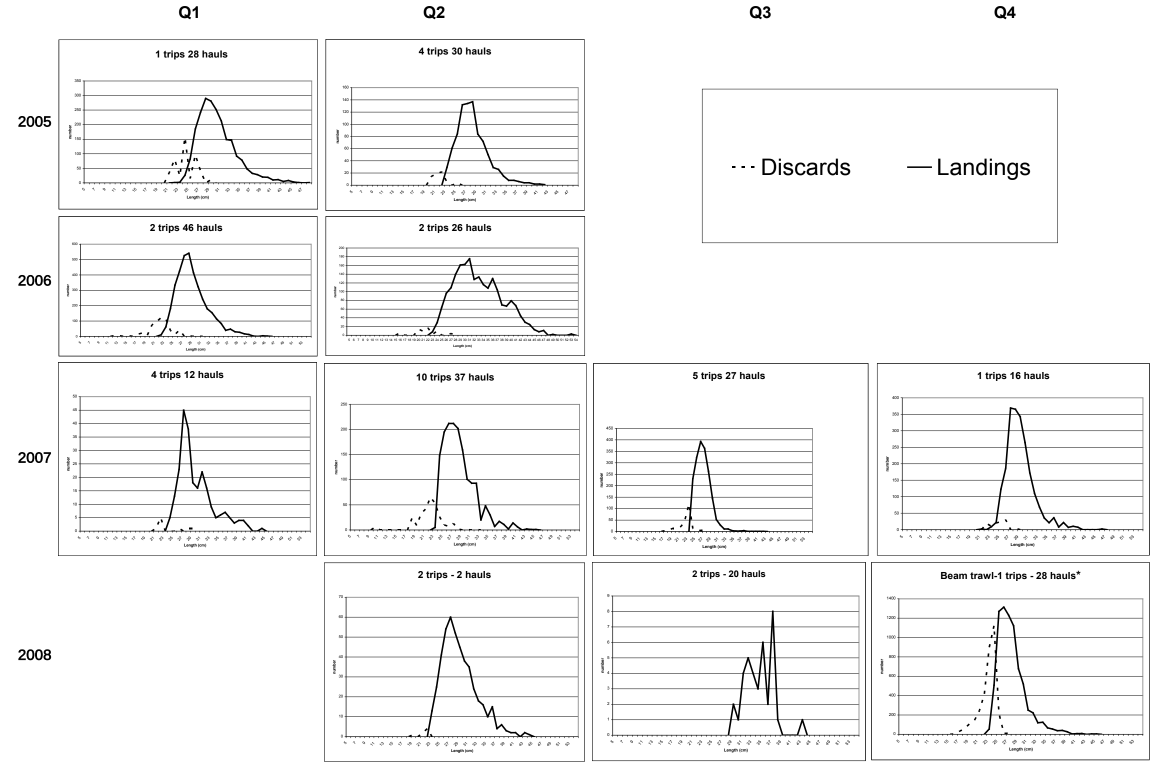
Table 9.7.1 - Sole in VIId Yield per recruit summary table

MFYPR version 2a
Run: Sole7D_Fin_Yield
Time and date: 15:53 08/05/2009
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.8192	8.6035	3.6238	8.6035	3.6238
0.1000	0.0473	0.2969	0.1097	7.5432	2.3214	5.6398	2.1262	5.6398	2.1262
0.2000	0.0946	0.4351	0.1457	6.1643	1.6698	4.2623	1.4748	4.2623	1.4748
0.3000	0.1418	0.5174	0.1596	5.3448	1.3072	3.4442	1.1125	3.4442	1.1125
0.4000	0.1891	0.5729	0.1652	4.7931	1.0778	2.8939	0.8833	2.8939	0.8833
0.5000	0.2364	0.6132	0.1671	4.3930	0.9205	2.4952	0.7263	2.4952	0.7263
0.6000	0.2837	0.6439	0.1674	4.0881	0.8067	2.1918	0.6127	2.1918	0.6127
0.7000	0.3309	0.6683	0.1669	3.8476	0.7209	1.9527	0.5271	1.9527	0.5271
0.8000	0.3782	0.6880	0.1661	3.6526	0.6542	1.7591	0.4607	1.7591	0.4607
0.9000	0.4255	0.7044	0.1651	3.4912	0.6012	1.5991	0.4078	1.5991	0.4078
1.0000	0.4728	0.7183	0.1642	3.3553	0.5580	1.4647	0.3649	1.4647	0.3649
1.1000	0.5201	0.7301	0.1632	3.2393	0.5223	1.3500	0.3295	1.3500	0.3295
1.2000	0.5673	0.7404	0.1623	3.1389	0.4924	1.2511	0.2997	1.2511	0.2997
1.3000	0.6146	0.7494	0.1615	3.0512	0.4669	1.1647	0.2745	1.1647	0.2745
1.4000	0.6619	0.7574	0.1607	2.9738	0.4450	1.0888	0.2528	1.0888	0.2528
1.5000	0.7092	0.7645	0.1600	2.9050	0.4260	1.0213	0.2340	1.0213	0.2340
1.6000	0.7565	0.7709	0.1594	2.8433	0.4093	0.9610	0.2176	0.9610	0.2176
1.7000	0.8037	0.7767	0.1588	2.7877	0.3946	0.9068	0.2030	0.9068	0.2030
1.8000	0.8510	0.7819	0.1582	2.7372	0.3814	0.8577	0.1901	0.8577	0.1901
1.9000	0.8983	0.7867	0.1577	2.6911	0.3697	0.8130	0.1786	0.8130	0.1786
2.0000	0.9456	0.7912	0.1572	2.6489	0.3591	0.7722	0.1682	0.7722	0.1682

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.4728
FMax	0.5753	0.272
F0.1	0.2077	0.0982
F35%SPR	0.2507	0.1185

Figure 9.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies for static gear (2005 - 2006 - 2007 - 2008) and one beam trawl trip in 2008



* One single trip (beam trawl) at the end of the year when markets were affecting discarding of flatfish including sole. This data is not representative for UK beam trawl fleet operating in VIId.

Figure 9.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies for Otter trawl (2005 - 2006 - 2007 - 2008)

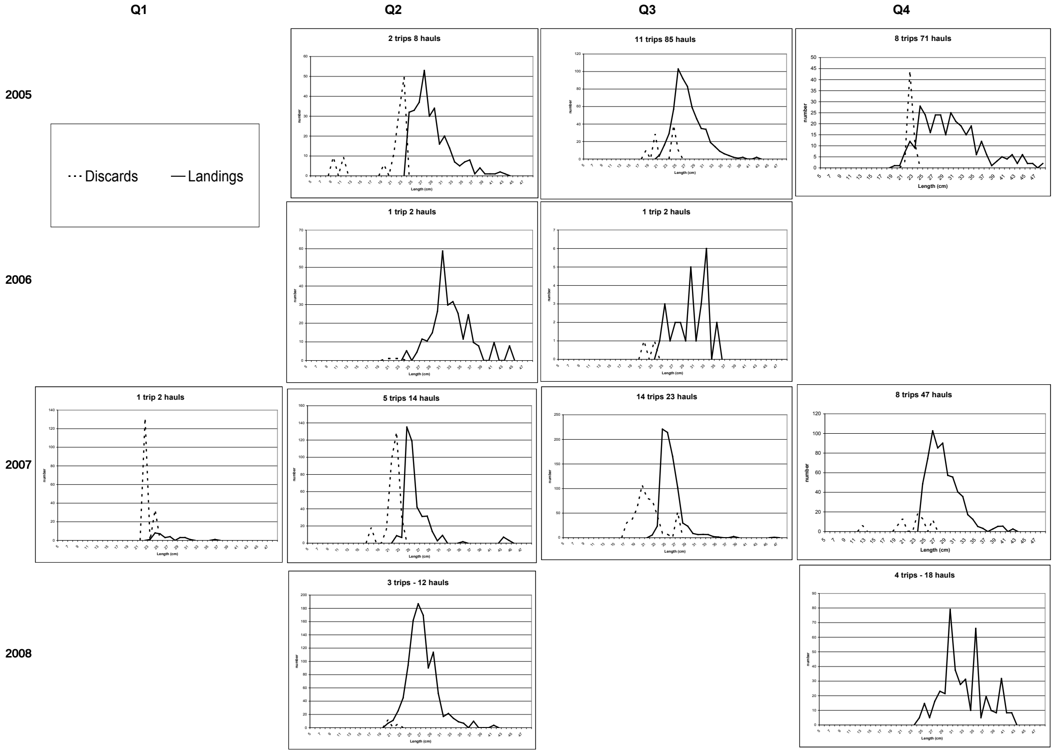


Figure 9.2.1c - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies fo Gillnets (2005 - 2007 - 2008)

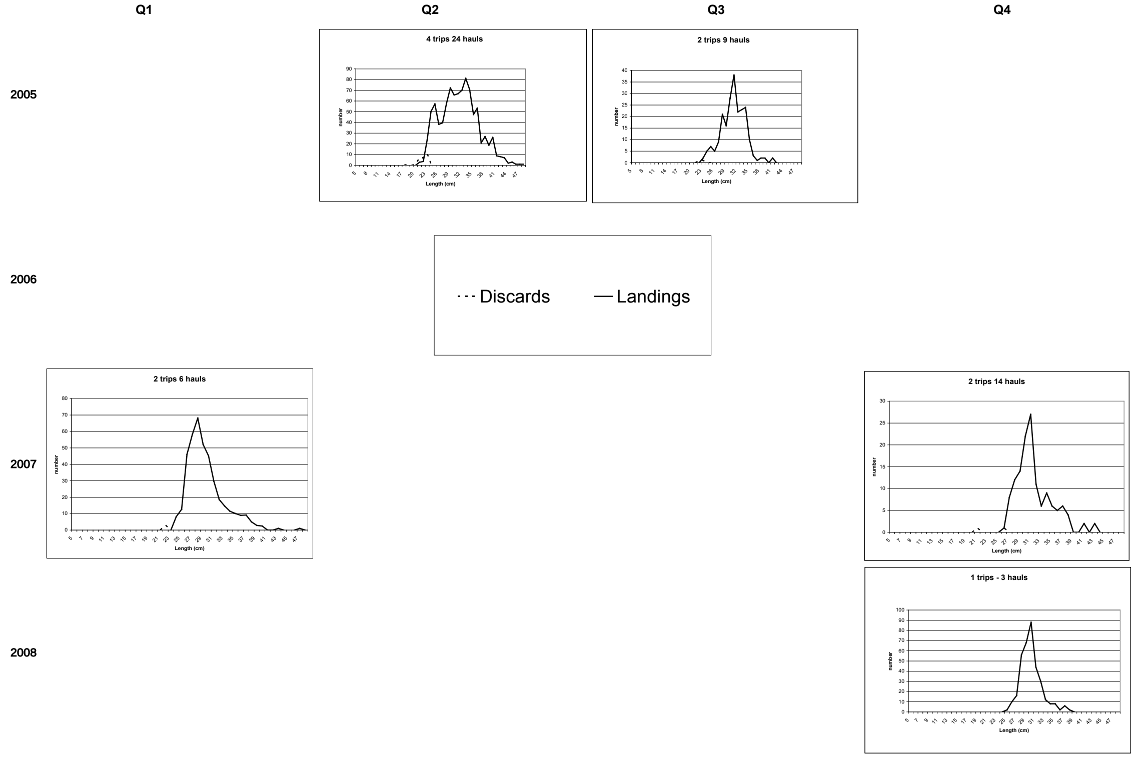


Figure 9.2.2a

Sole VIId - Effort series

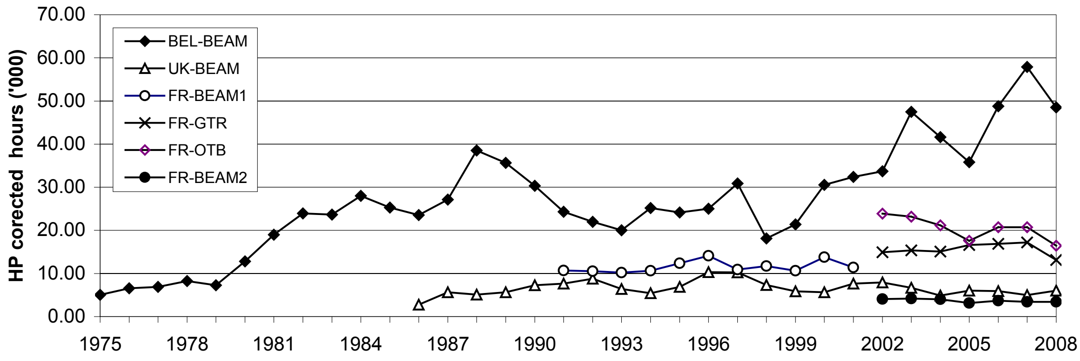


Figure 9.2.2b

Sole VIId - Relative Effort series

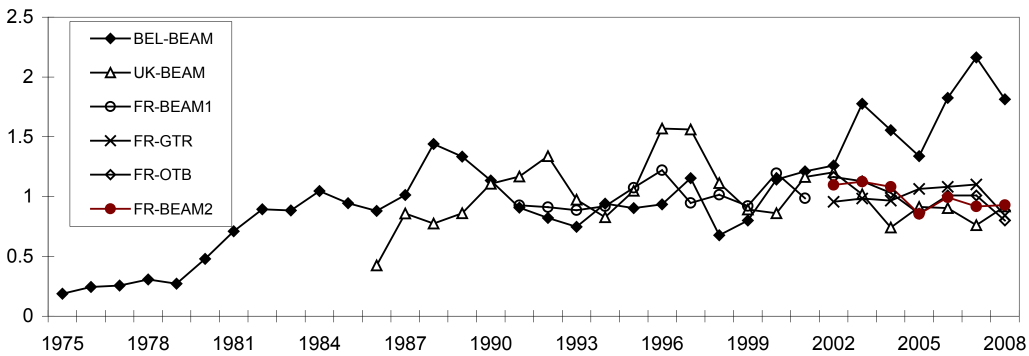
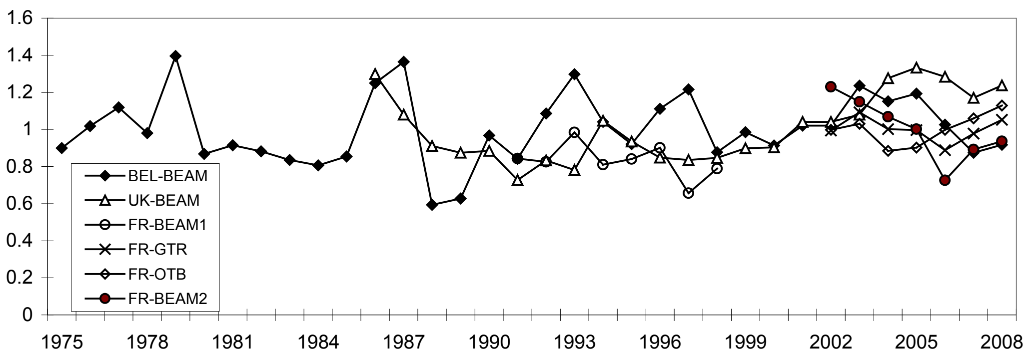


Figure 9.2.2c

Sole VIId - Relative LPUE series



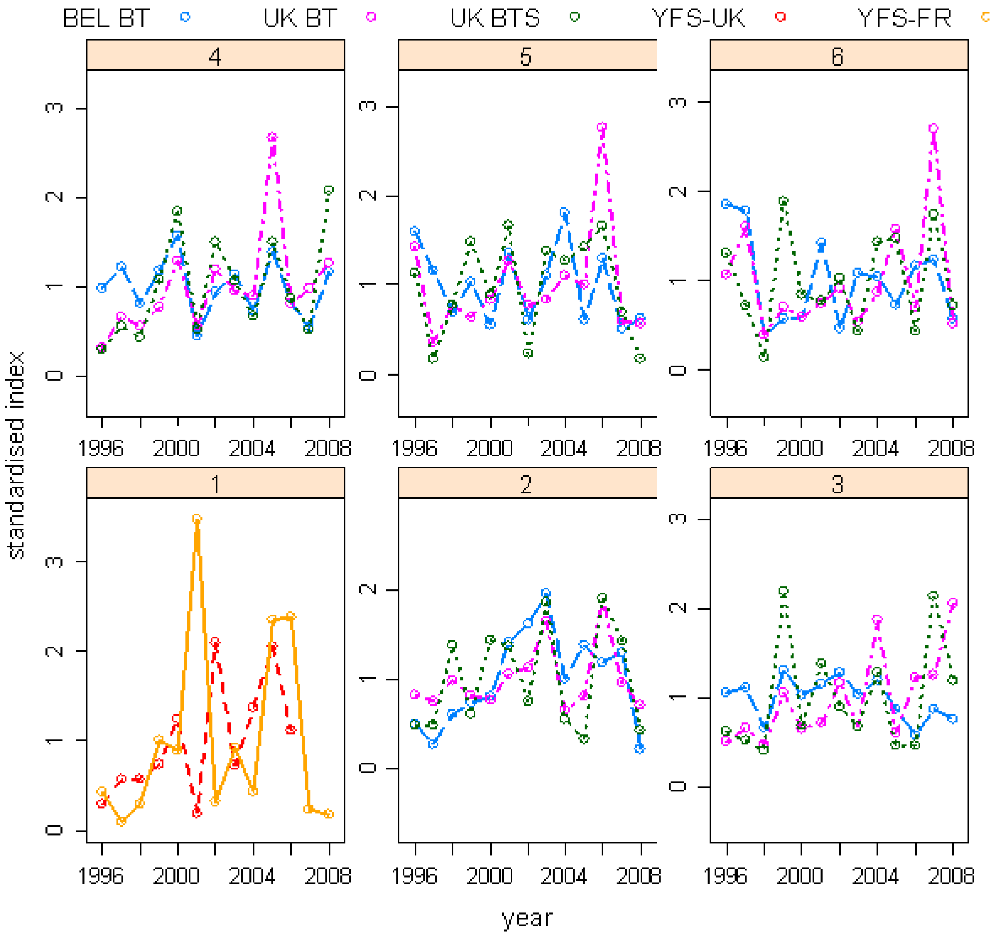


Figure 9.2.3 Sole in VIId. Standardized tuning indices used for tuning XSA: BEL-BT (blue), UK-BT (pink), UK-BTS (green) YFS-UK (red) and YFS-FR (orange).

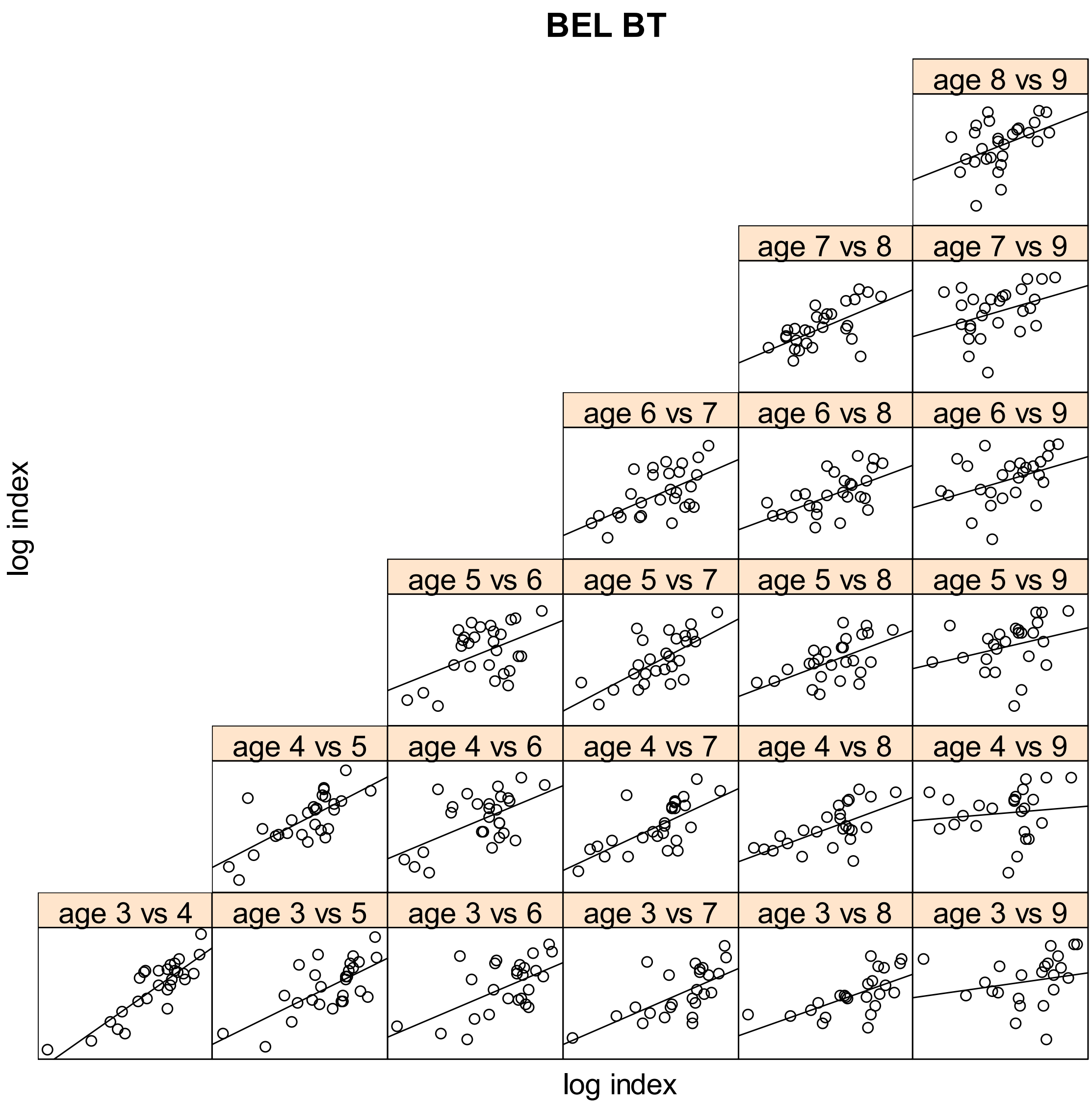


Figure 9.2.4 Sole in VIId. Internal consistency plot for the Belgian commercial fleet (BEL-BT).

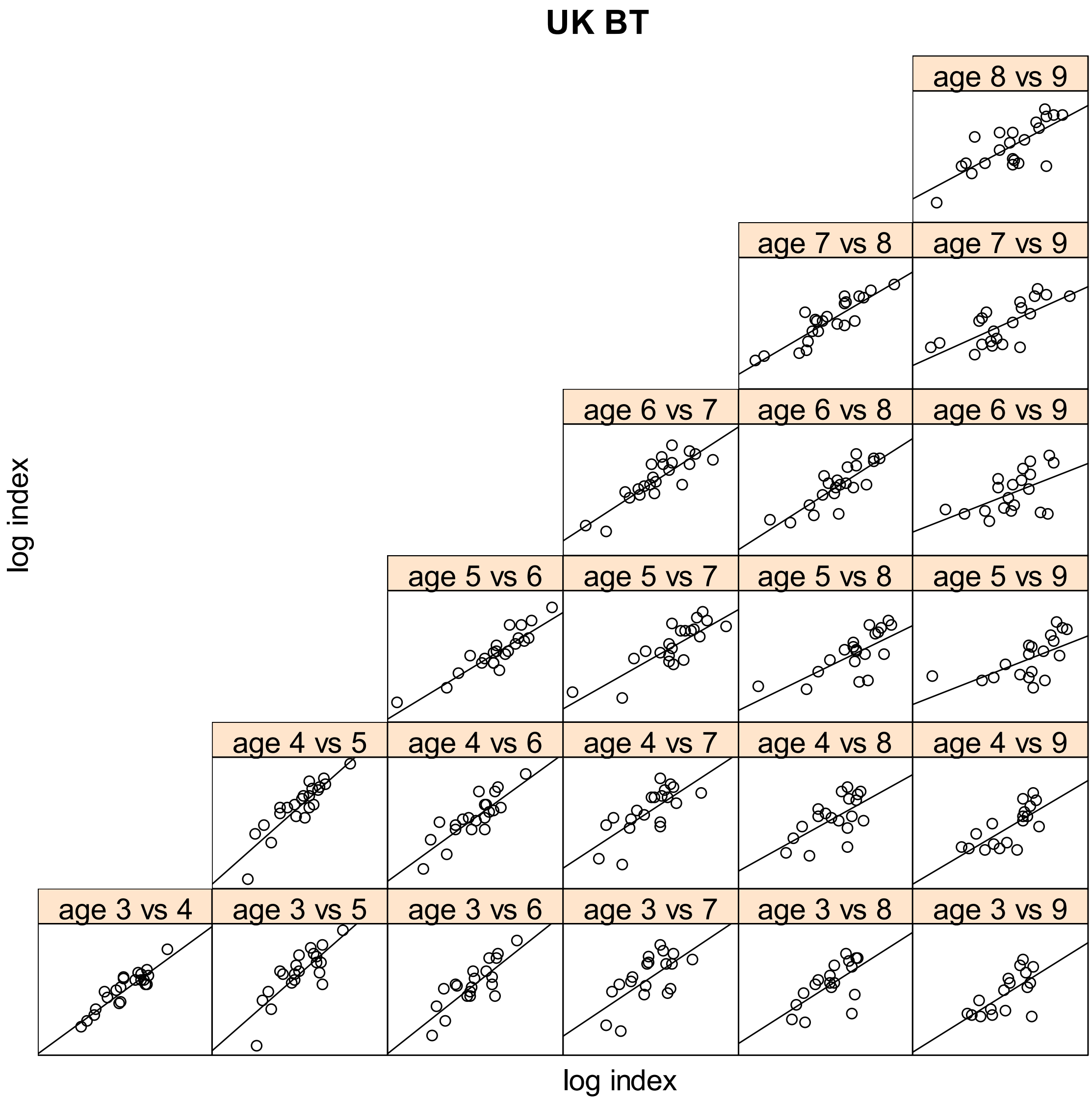


Figure 9.2.5 Sole in VIId. Internal concistency plot for the UK commercial fleet (UK-BT).

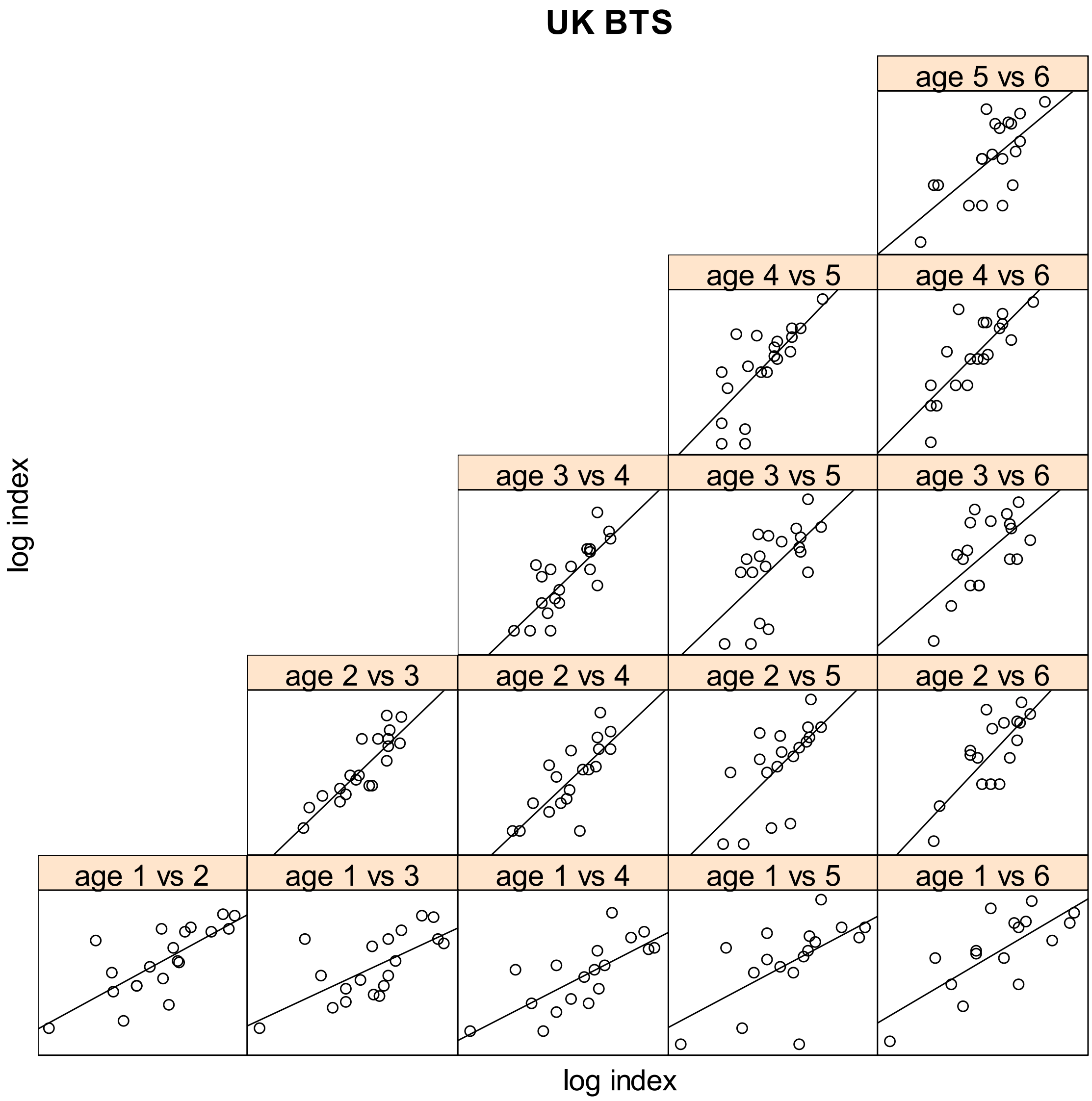


Figure 9.2.6 Sole in VIId. Internal concistency plot for the UK beam trawl survey (UK-BTS).

Figure 9.3.1a - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

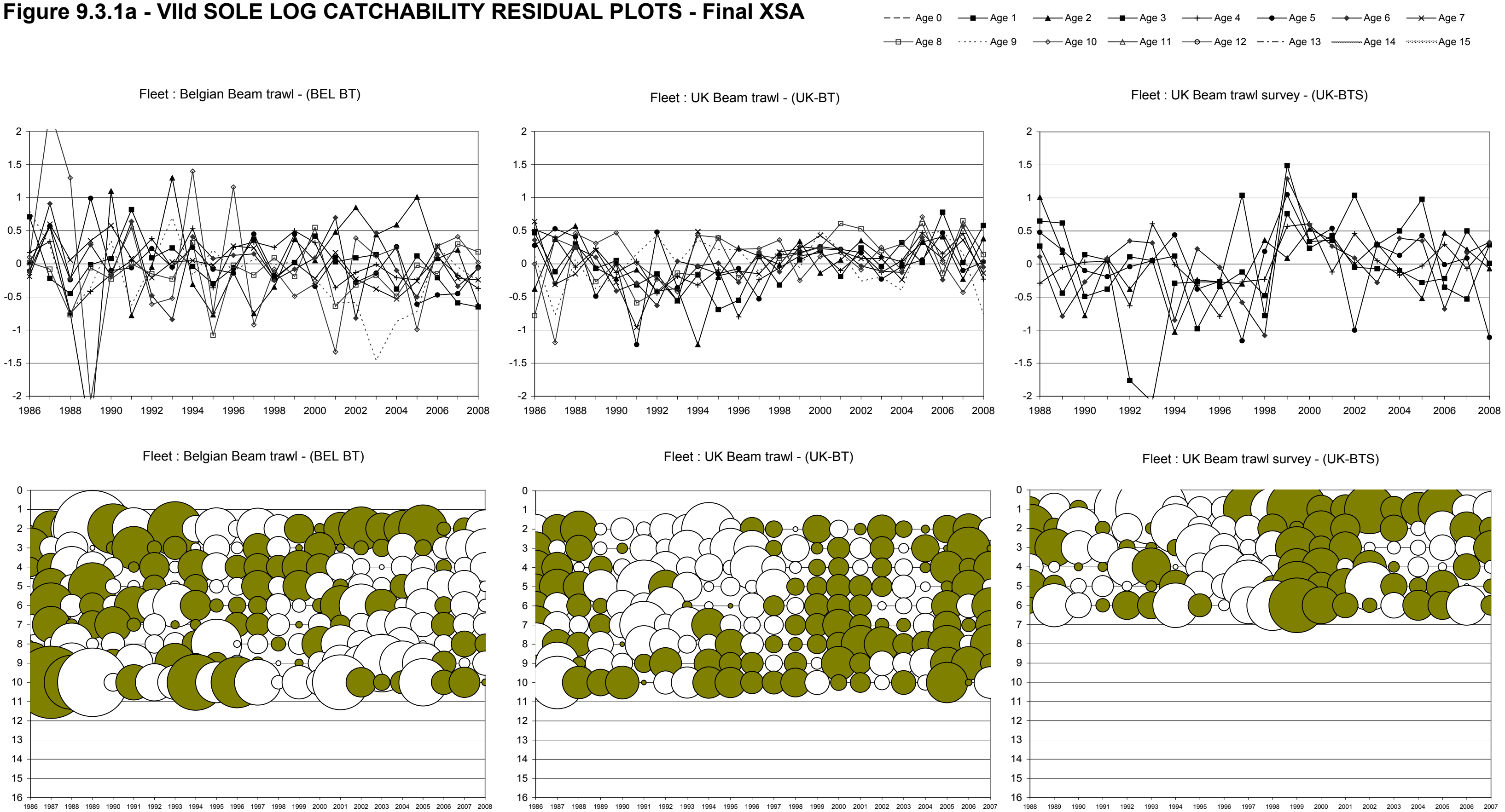


Figure 9.3.1b - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

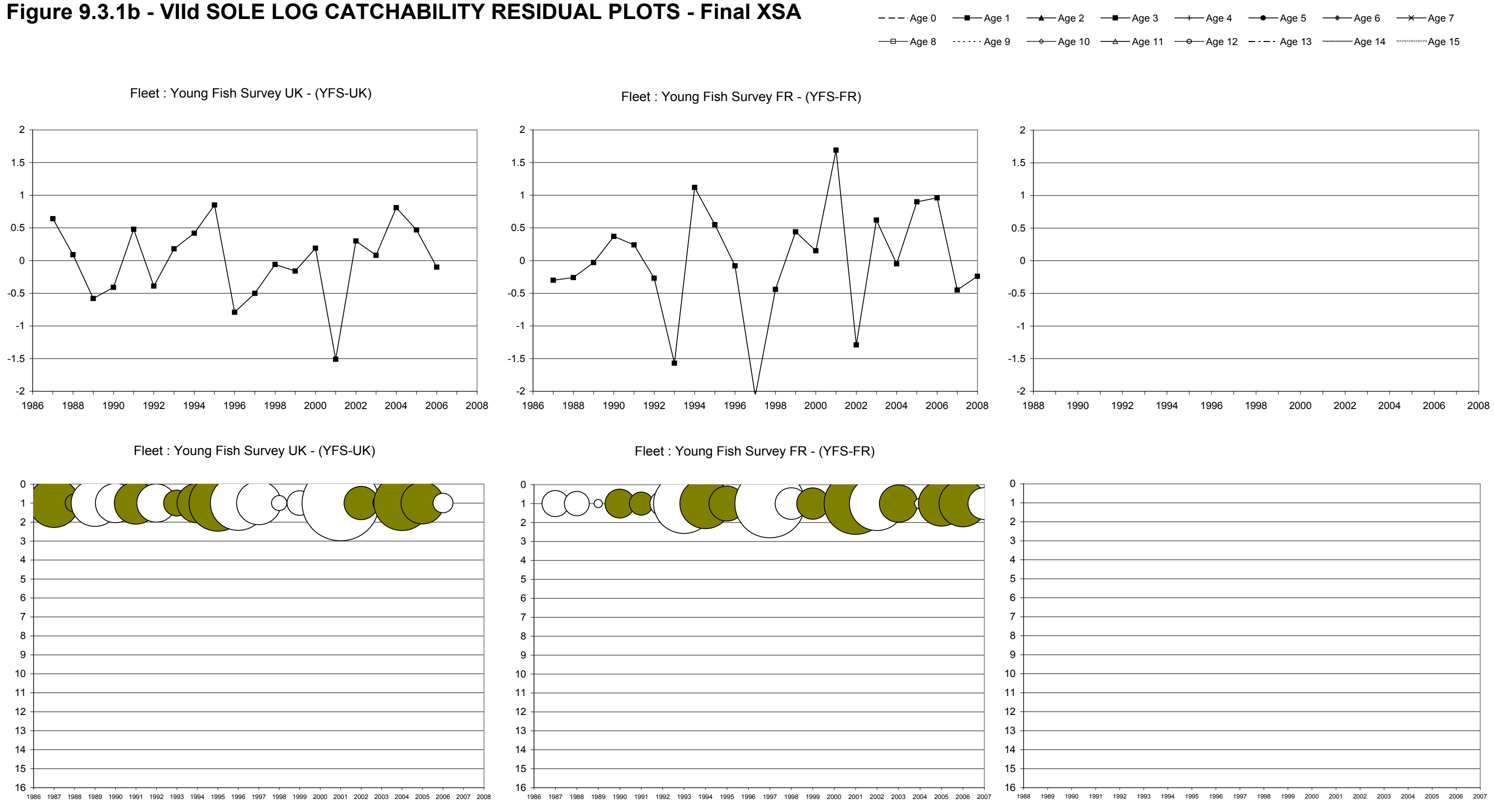
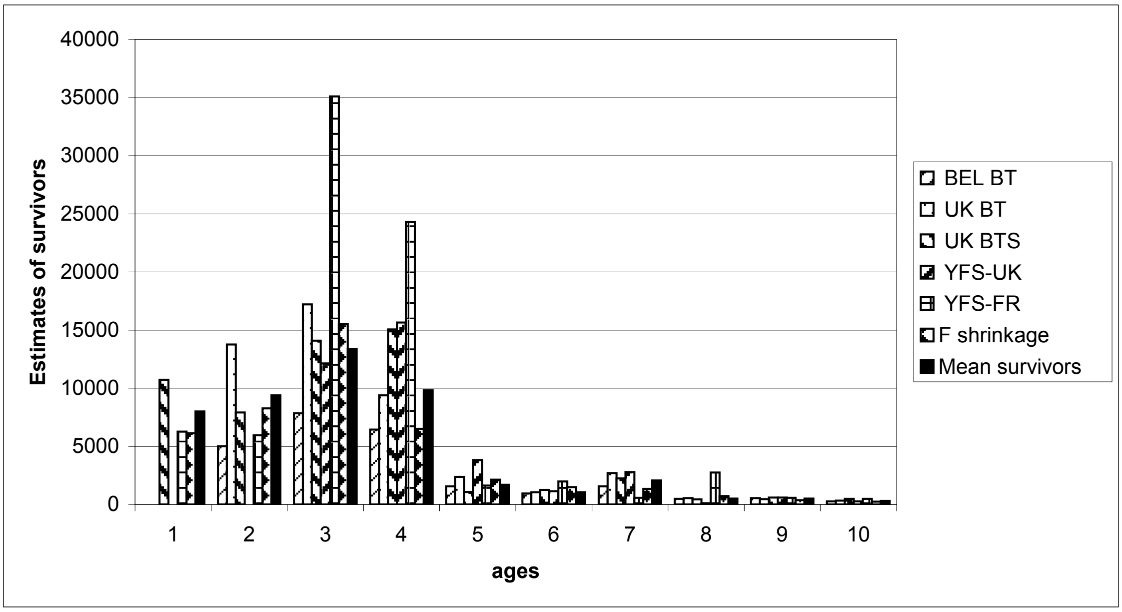


Figure 9.3.2 Sole in VIId. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run



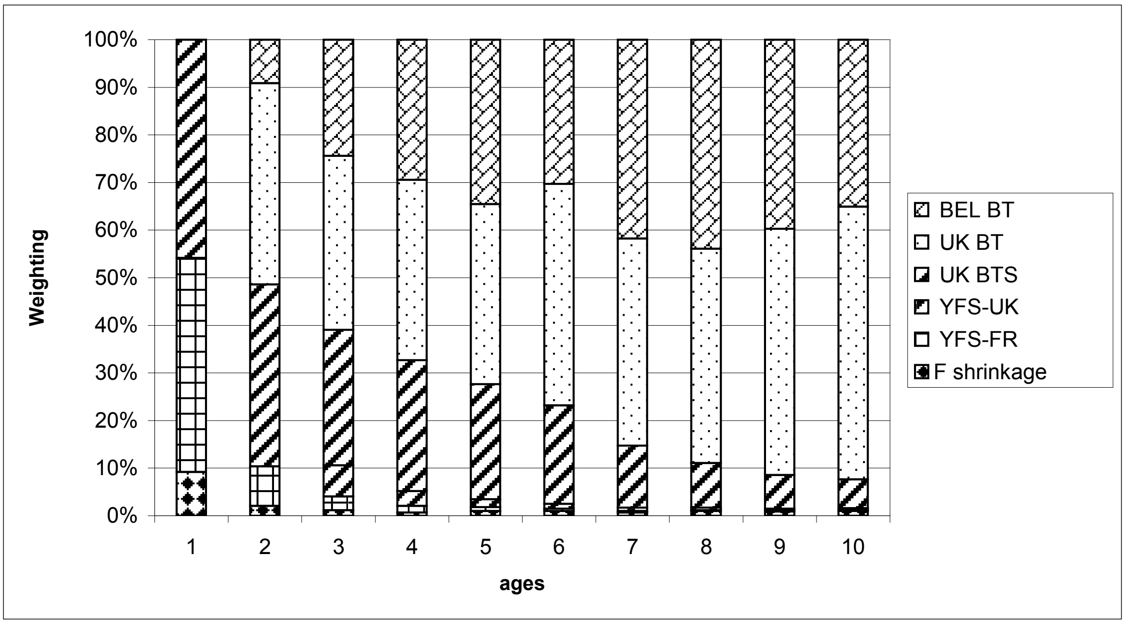


Figure 9.3.3 Sole in VIId. Summary plots

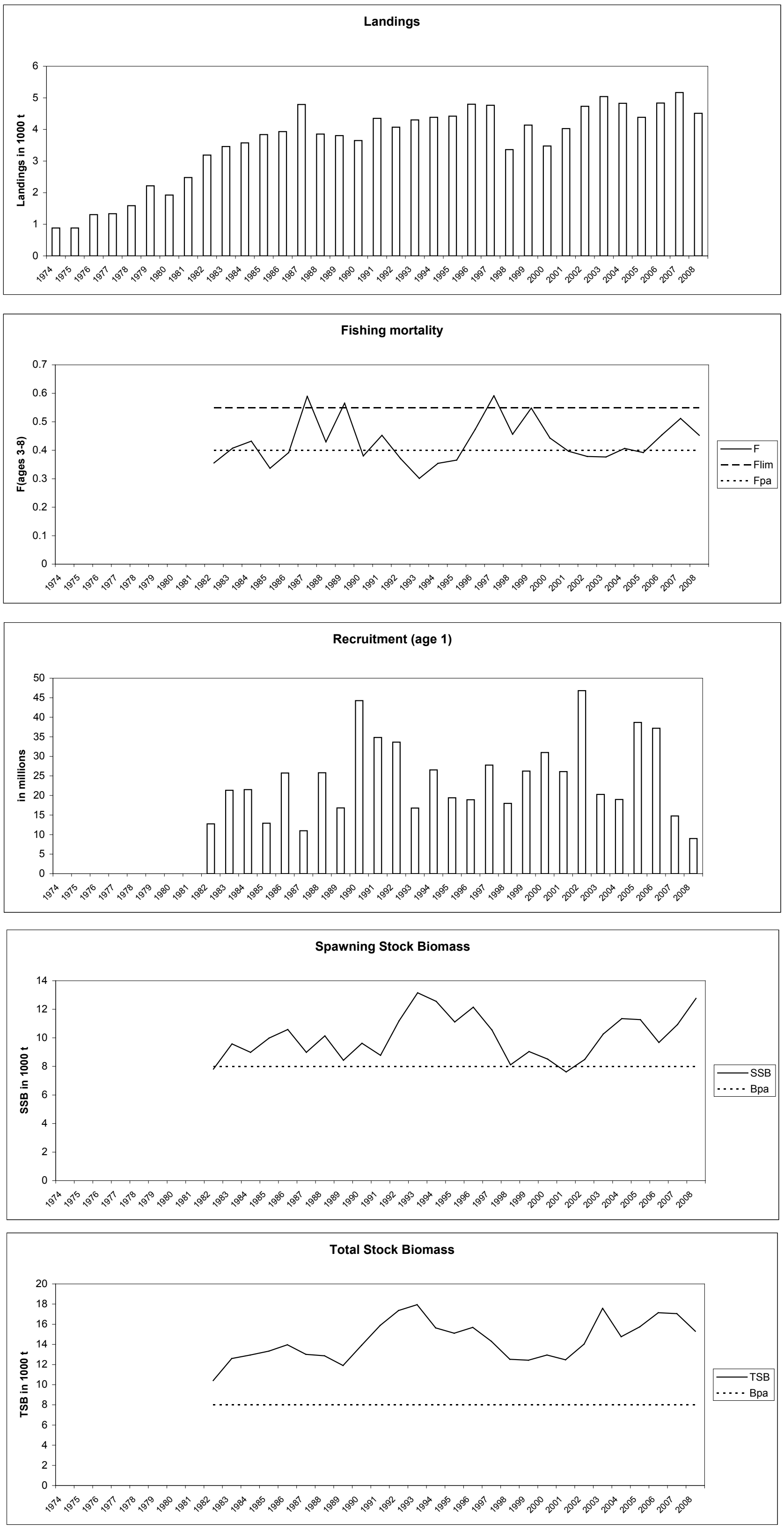


Figure 9.3.4 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)

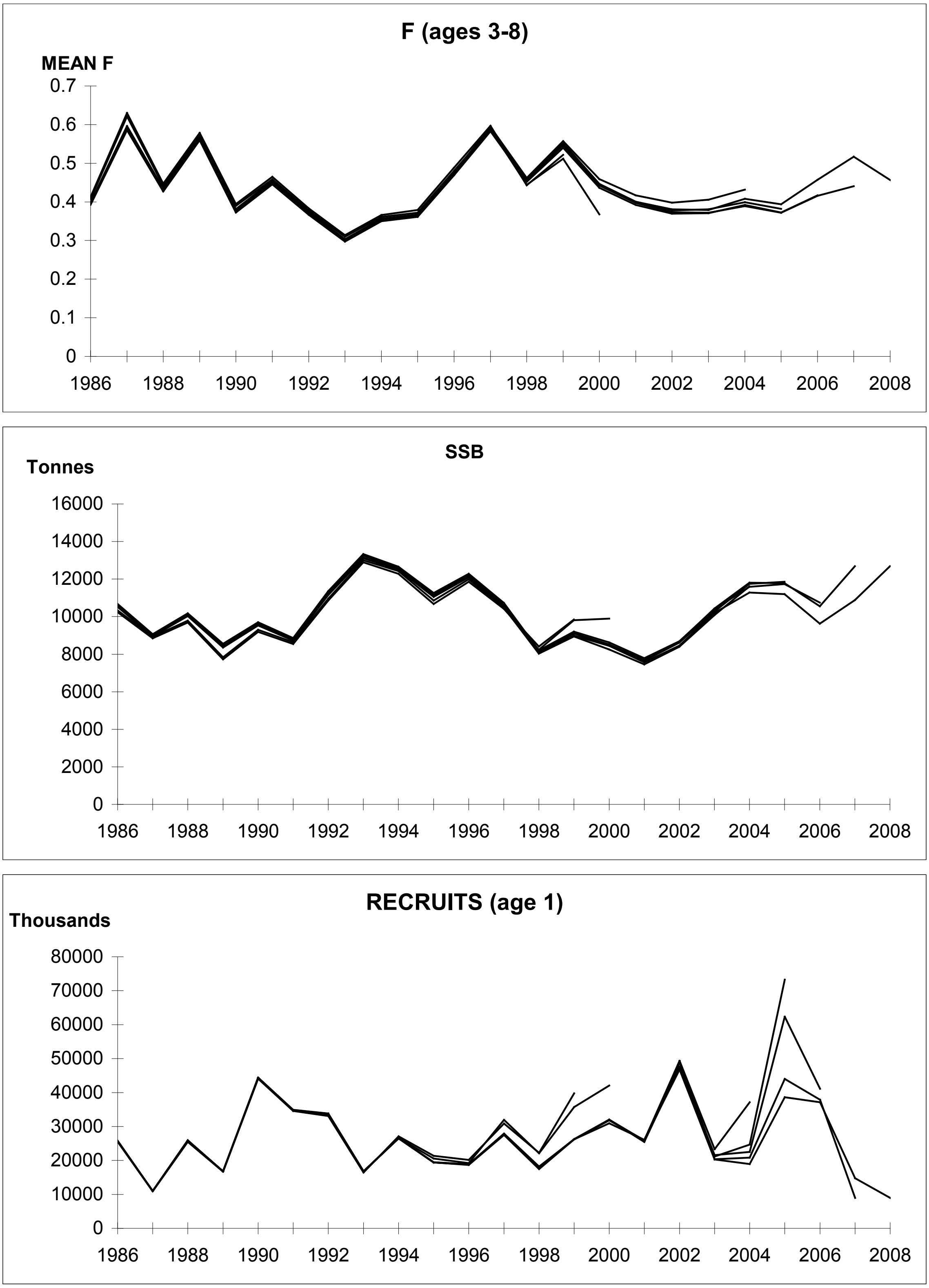
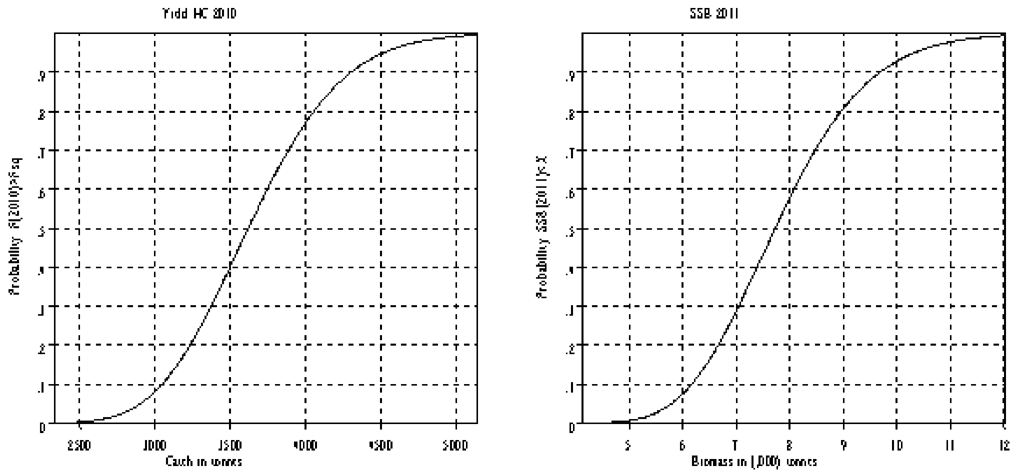
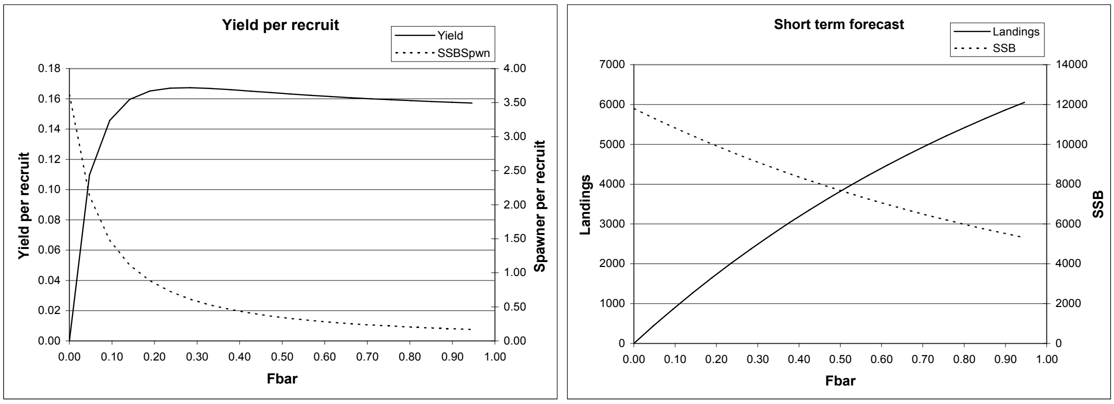


Figure 9.6.1 - Sole VIId - Probability profiles for short term forecast.



Data from file:D:\[illegible] & prof

Figure 9.7.1 - Sole in VIId Yield per recruit and short term forecast plots



MFYPR version 2a
Run: Sole7D_Fin_Yield
Time and date: 15:53 08/05/2009

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.4728
FMax	0.5753	0.2720
F0.1	0.2077	0.0982
F35%SPR	0.2507	0.1185

MFDP version 1a
Run: Sole7D_Fin_SQ
Sole in VIId
Time and date: 15:51 08/05/2009
Fbar age range: 3-8

Input units are thousands and kg - output in tonnes

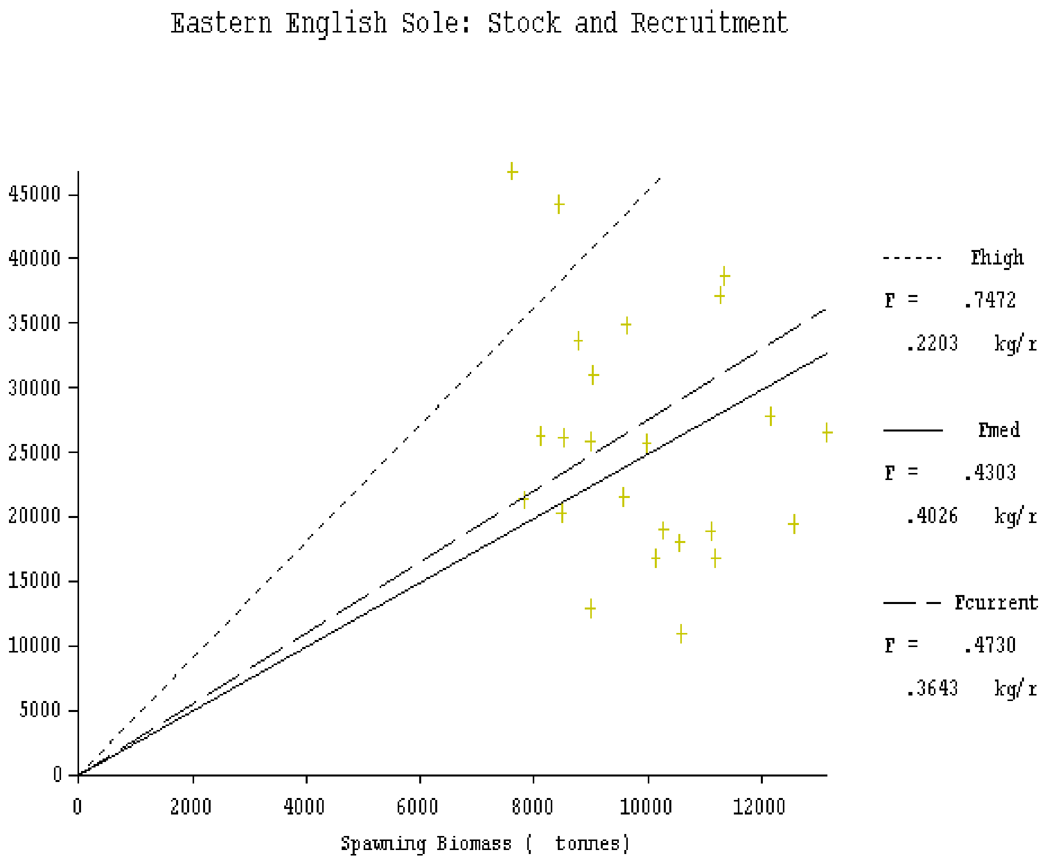
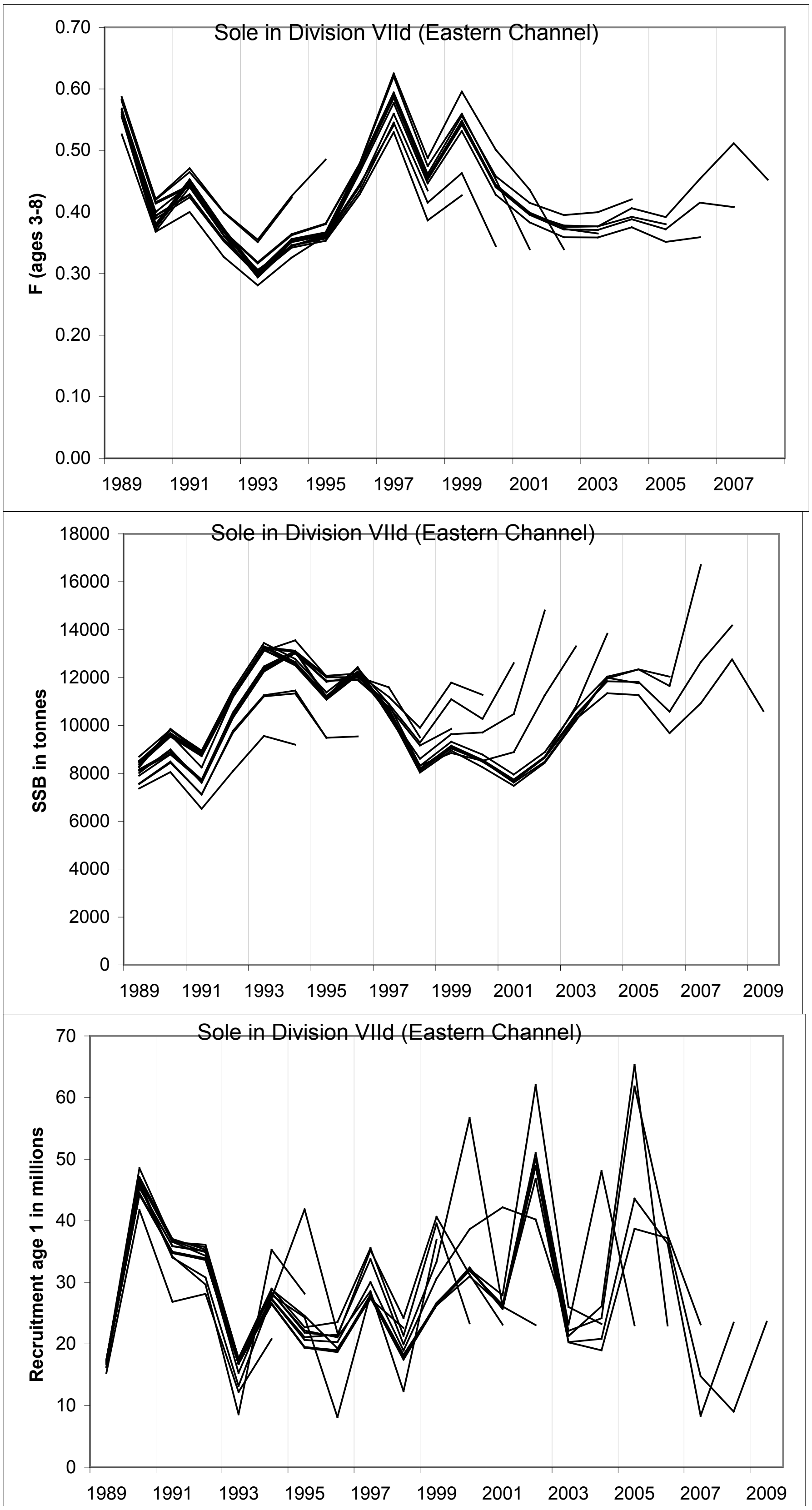


Figure 9.9.1 - Sole VIId Stock/recruitment plot

Figure 9.9.2 Sole in VIId. Historical Performance of assessment of successive WG assessment and forecast



10 Sole in Subarea IV

The assessment of sole in Subarea IV is presented as an update assessment with minor analysis requested by the review group. The most recent benchmark assessment was carried out in 2003. A benchmark for this stock is scheduled for 2010.

10.1 General

10.1.1 Ecosystem aspects

Sole growth rates in relation to changes in environmental factors were analysed by Rijnsdorp *et al*. (2004). Based on market sampling data it was concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and conditions have been intermediate between the troughs (1960) and peaks (mid 1970s). Growth rates of the juvenile age groups were negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with sea temperature in the 2nd and 3rd quarters, but for the older fish no temperature effect was detected. The overall pattern of the increase in growth and the later decline correlated with temporal patterns in eutrophication; in particular the discharge of dissolved phosphates from the Rhine. Trends in the stock indicators e.g. SSB and recruitment, did not coincide, however, with observed patterns in eutrophication.

In recent years no changes in the spatial distribution of juvenile and adult soles have been observed (Grift et al. 2004, Verver *et al*, 2001). The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after its closure to large beamers and remained stable at a level of 60–70% (Grift *et al*., 2004). The different length groups showed different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while groups of 10 and 15 cm were stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

Mollet *et al* (2007) used the reaction norm approach to investigate the change in maturation in North Sea sole and showed that age and size at first maturity significantly shifted to younger ages and smaller sizes. These changes occurred from 1980 onwards. Size at 50% probability of maturation at age 3 decreased from 29 to 25 cm.

10.1.2 Fisheries

Sole is mainly caught by beam trawlers. A large proportion of the fishing effort on sole is exerted by the Dutch beam trawl fleet targeting sole and plaice with 80 mm mesh size. Fishing effort by the Dutch fleet peaked in the mid 1990s and has decreased thereafter and is now at a level comparable to the 1980s. In addition to the Dutch Beam trawl fleet sole is also caught by Belgian and German beam trawlers, by UK otter trawlers, and by a Danish fleet fishing with fixed nets, catch sole.

The days at sea regulations, high oil prices, and different patterns in the history of changes in the TACs between plaice and sole have led to a transfer of effort from the southern to the northern North Sea. Here, sole and juvenile plaice tend to be more abundant leading to an increase in discarding of small plaice.

A change in efficiency of the commercial Dutch beam trawl fleet has been described by Rijnsdorp *et al* (2006) and was analyzed by the 2006 working group. Although the efficiency change improved XSA estimates, it was not included in the final assessment for data consistency reasons.

10.1.3 ICES Advice

Based on the most recent estimate of SSB (in 2008) and fishing mortality (in 2007), ICES classifies the stock as having reduced reproductive capacity and as being at risk of being harvested unsustainably. SSB has fluctuated around the precautionary reference points for the last decade. Fishing mortality has declined since 1995 and is currently estimated to be above F_{pa}. The year classes of 2003 and 2004 are weak, year class 2005 is strong, and the assessment indicates that the year class 2006 is below average.

Single-stock exploitation boundaries

Exploitation boundaries in relation to the agreed management plan

According to the management plan adopted by the EC in 2007, fishing mortality in 2009 should be reduced by 10% compared to the fishing mortality estimated for the preceding year (Fsq = mean F(05–07) = F2008 = 0.47) with the constraint that the change in TAC should not be more than 15%. The 10% reduction in fishing mortality corresponds to a fishing mortality of 0.42 and landings of 14 000 t in 2009, which is an approximate 9% TAC change (TAC 2007 = 12 800 t). The expected SSB in 2010 would be around 28 900 t, which is below Bpa.

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

The current fishing mortality is above the range that is expected to lead to high long-term yields and low risk of stock depletion.

Exploitation boundaries in relation to precautionary limits

To rebuild the stock to above B_{pa} in 2010 requires a fishing mortality of 0.21, which implies landings of less than 7500 t in 2009.

Conclusion on exploitation boundaries

According to the evaluation the agreed management plan can be provisionally accepted as precautionary for sole and could be used as a basis for the management of the stock in the short term. ICES therefore advises according to this plan and advises landings of 14 000 t in 2009.

Mixed fishery advice:

The information in this section is taken from the North Sea Advice overview section 6.3

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2009 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *should minimize bycatch or discards of cod;*
- *should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*

- *should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);*
- *where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*
- *should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.*

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries, taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

10.1.4 Management

The TAC for 2009 was set at 14 000 tonnes (TAC = 12 800 tonnes in 2008), which is 1 200 tonnes higher than the agreed TAC of 2008 (Table 10.2.1).

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The first phase aims to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year until an F of *circa* 0.2 is reached. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% in TAC between consecutive years.

Articles 1 to 9 of Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea. Official Journal L 157 , 19/06/2007 P. 0001–0006

CHAPTER I

SUBJECT-MATTER AND OBJECTIVE

Article 1

Subject-matter

This Regulation establishes a multiannual plan for the fisheries exploiting the stocks of plaice and sole that inhabit the North Sea.

For the purposes of this Regulation, "North Sea" means the area of the sea delineated by the International Council for the Exploration of the Sea as Subarea IV.

Article 2

Safe biological limits

1) *For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:*

the spawning biomass of the stock of plaice exceeds 230000 tonnes;

the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;

the spawning biomass of the stock of sole exceeds 35000 tonnes;

the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1.

Article 3

Objectives of the multiannual plan in the first stage

2) *The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.*

3) *The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10% each year, with a maximum TAC variation of 15% per year until safe biological limits are reached for both stocks.*

Article 4

Objectives of the multiannual plan in the second stage

4) *The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.*

5) *The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.*

6) *The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.*

Article 5

Transitional arrangements

7) *When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles 4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.*

8) *The Commission's proposal for review shall be accompanied by a full impact assessment and shall take into account the opinion of the North Sea Regional Advisory Council.*

CHAPTER II

TOTAL ALLOWABLE CATCHES

Article 6

Setting of total allowable catches (TACs)

Each year, the Council shall decide, by qualified majority on the basis of a proposal from the Commission, on the TACs for the following year for the plaice and sole stocks in the North Sea in accordance with Articles 7 and 8 of this Regulation.

Article 7

Procedure for setting the TAC for plaice

9) The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

a) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;

b) that TAC the application of which will result in the level of fishing mortality rate of 0,3 on ages two to six years in its year of application.

Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

Where application of paragraph 1 would result in a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is 15 % less than the TAC of that year.

Article 8

Procedure for setting the TAC for sole

10) The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

c) that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;

d) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

Where the application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

CHAPTER III

FISHING EFFORT LIMITATION

Article 9

Fishing effort limitation

11) The TACs referred to in Chapter II shall be complemented by a system of fishing effort limitation established in Community legislation.

12) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on an adjustment to the maximum level of fishing effort available for fleets where either or both plaice and sole comprise an important part of the landings or where substantial discards are made and subject to the system of fishing effort limitation referred to in paragraph 1.

13) The Commission shall request from STECF a forecast of the maximum level of fishing effort necessary to take catches of plaice and sole equal to the European Community's share of the TACs established according to Article 6. This request *shall be formulated taking account of other relevant Community legislation governing the conditions under which quotas may be fished.*

14)*The annual adjustment of the maximum level of fishing effort referred to in paragraph 2 shall be made with regard to the opinion of STECF provided according to paragraph 3.*

15)*The Commission shall each year request the STECF to report on the annual level of fishing effort deployed by vessels catching plaice and sole, and to report on the types of fishing gear used in such fisheries.*

16)*Notwithstanding paragraph 4, fishing effort shall not increase above the level allocated in 2006.*

17)*Member States whose quotas are less than 5% of the European Community's share of the TACs of both plaice and sole shall be exempted from the effort management regime.*

18)*A Member State concerned by the provisions of paragraph 7 and engaging in any quota exchange of sole or plaice on the basis of Article 20(5) of Regulation (EC) No 2371/2002 that would result in the sum of the quota allocated to that Member State and the quantity of sole or plaice transferred being in excess of 5% of the European Community's share of the TAC shall be subject to the effort management regime.*

19)*The fishing effort deployed by vessels in which plaice or sole are an important part of the catch and which fly the flag of a Member State concerned by the provisions of paragraph 7 shall not increase above the level authorised in 2006.*

ICES evaluated the management plan for North Sea plaice and sole at the end of May 2008. It was accepted for sole and ICES concluded that it was in accordance with the precautionary approach (unpublished review of an evaluation of the management plan for fisheries exploiting the stocks of plaice and sole in the North Sea (EC 676/2007) by ICES in 2008, see also Machiels et al. ICES WGNSSK, 2008, WD2).

The minimum landing size of North Sea sole is 24 cm. A closed area has been in operation since 1989 (the plaice box) and since 1995 this area has been closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregated beam length of beam trawlers to 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9 m.

Effort has been restricted because of implementation of a days-at-sea regulation for the cod recovery plan and fishing effort limitation of the long term management plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 676/2007; EC Council Regulation 40/2008).

For 2008 Council Regulation N°40/2008, annex II[a] allocates different days at sea depending on gear, mesh size and catch composition. (see section 2.1.2 for a complete list). The days at sea limitations for the major fleets operating in ICES sub-area IV can be summarised as follows: Beam trawlers can fish between 119–143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

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. (see section 1.2.1 for complete list). The area's are Kattegat, part of IIIa not covered by Skagerak 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); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

Technical measures applicable to the flatfish beam trawl fishery before 2000 were an exemption to use 80 mm mesh cod-end when fishing south of 55°North. From January 2000, the exemption area extends from 55°North to 56°North, east of 5°East latitude. Fishing with 80 mm mesh cod-end is permitted within that area provided that the landings comprise at least 70% of a mix of species, which are defined in the technical measures of the European Community (EC Council Regulation 1543/2000). In January 2002 the cod recovery plan was instigated, which allowed a maximum cod by-catch of 20% of the total catch. In the area extending from 55°North to 56° North, east of 5°East latitude, a maximum cod by-catch of 5% is allowed. Minimum cod-end mesh in this area is 100 mm, while above 56°North the minimum cod-end mesh is 120 mm (EC Council Regulation 2056/2001) .

10.2 Data available

10.2.1 Catch

Landings data by country and TACs are presented in Table 10.2.1 and total landings are presented in Figure 10.2.1a. In 2008 approximately 110% of the TAC was taken. The discards percentages observed in the Dutch discard sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size were much lower for sole (for 2002–2008, between 10–17% by weight, see Table 10.2.2) than for plaice. No significant trends in discard percentages were observed. Inclusion of a stable time series of discards in the assessment will have minor effect on the relative trends in stock indicators (Kraak *et a*l 2002; Van Keeken *et al* 2003). The main reason for not including discards in the assessment is that the discarding is relatively low in all periods for which observations are available. In addition, gaps in the discard sampling programs result in incomplete time series.

10.2.2 Age compositions

The age composition of the landings is presented in Table 10.2.3. Age compositions and mean weight at age in the landings were available on a quarterly basis from Denmark, France, Germany (sexes combined) and The Netherlands (by sex). Age compositions on an annual basis were available from Belgium (by sex). Overall, the samples are thought to be representative of around 85% of the total landings in 2008. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total (see also section 1.2.4). Recently the sole population (Figure 10.2.1) has been dominated by the strong 2005 year class which were age 3 in 2008 (~35 million). Log catch ratios and catch curves for sole ages 2 to 9 are summarised in Figures 10.2.2 a and b (1957 to 2008).

10.2.3 Weight at age

Weights at age in the landings (Table 10.2.4) are measured weights from the various national market sampling programs. Weights at age in the stock (Table 10.2.5) are the 2nd quarter landings weights. Over the entire time series, weights were higher during the 1980s compared to time periods before and after (see Figure 10.2.1 c & d). Estimates of weights for older ages fluctuate more because of smaller samples sizes due to decreasing numbers of older fish in the stock and landings.

10.2.4 Maturity and natural mortality

As in previous North Sea sole assessments, a knife-edged maturity-ogive was used, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Mollet *et. al*. (2007) described the shift of the age at maturity towards younger ages and the results should be considered in the next benchmark assessment. Natural mortality in the period 1957–2008 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (1962–1963) (ICES-FWG 1979).

10.2.5 Catch, effort and research vessel data

One commercial and two survey series were used to tune the assessment. Effort for the Dutch commercial beam trawl fleet is expressed as total HP effort days. Effort nearly doubled between 1978 and 1994 and has declined since 1996. Effort during 2008 was <40% of the maximum (1994) in the series (Table 10.2.6 and 10.2.7 cont.). A decline of circa 25% was recorded in 2008 following the decommissioning that took place during 2008.

Trends in commercial LPUE of the Dutch beam trawl fleet by area are shown in Figure 10.2.3. The data are based on various sources (Quirijns and Poos, 2008, WD1). There is a clear separation in LPUE between areas, with the southern area producing a substantially higher LPUE than the northern area. Average LPUE of a standardized NL beam trawler (1471 kW) over the period 1999 to 2007 was 266 kg day^{-1}, and the data have a significant ($P<0.01$) temporal trend of -6.1 kg day^{-1} year^{-1}. The LPUE estimated for 2008 (313 kg day^{-1}) was above the mean (266 kg day^{-1})..

The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6m beam trawl carried out in the 3rd quarter. In 2003 the SNS survey was carried out during the 2nd quarter and data from this year were omitted (Table 10.2.7 and Figure 10.2.4). The research vessel survey time series have been revised by WGBEAM (ICES-WGBEAM, 2007), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys.

10.3 Data analyses

The assessment of North Sea sole was carried out using the FLR version of XSA (2.8.1) in R version 2.8.1.

Reviews of last year's assessment

Comments made in 2008 by the RGNSSK (Technical Minutes), which accepted last year's assessment, are summarised below in quotes, and it is explained how this WG addressed the comments.

"Assessment made as an update assessment. Revision of Fs upwards and SSB downwards. The historic performance of the assessment show rather noisy history. There's a considerable difference between the signals of stock development, when various combinations of information are used in XSA. Tuning with only the survey fleets gives considerably higher recent Fs than tuning with only LPUE. The present assessment is of course in-between".

"A strong year class 2005 will increase the SSB in 2009". This has been confirmed out by this year's assessment .

"A new benchmark assessment might be appropriate in 2009. The following issues could be put on the shopping list: Explore the change of plus group from age 15 to age 10 and impact on the perception of the stock development. Change in mean weight at age and the use of knife-edge maturity on stock dynamics and forecast. How inclusion of discarding affect R indices and SSB (maybe minor?). If the assessment are run in the future with only survey data, obvious output is very high Fs and the development is not so rosy for future." A benchmark assessment has not yet been done but will take place in 2010. At that time a Stock Annex for sole will be constructed.

10.3.1 Exploratory catch-at-age-based analysis

3 tuning indices were included in the assessment. Exploratory analyses were carried out to explore the sensitivity of an assessment with and without the commercial NL BT LpUE series. Depending on the inclusion of the commercial NL BT series the perception of last years fishing mortalities estimates differ. The standardized log catchability residual plots of the 3 tuning series included as single fleets in the assessments is shown in figure 10.3.1 and the log catchability residual plot for the combined fleets of the 3 tuning series is shown in figure 10.3.3. Figure 10.3.2 shows the XSA retrospective analysis of fishing mortality for different combinations of indices. Figure 10.3.4 presents the retrospective analysis of F, SSB and recruitment when the 3 fleets of the tuning series were combined. The plot shows that mean F was slightly overestimated in 2007 but underestimated before that.

10.3.2 Exploratory survey-based analyses

No survey-based analysis was carried out in this year's WG.

10.3.3 Conclusions drawn from exploratory analyses

The WG concluded that the 2008 update assessment would be done by including NL beam trawl LPUE as commercial tuning series.

Final assessment

Catch at age analysis was carried out with XSA using the settings given below.

YEAR	2007	2008	2009
Catch at age	Landings	Landings	Landings
Fleets	BTS-Isis 1985–2006 SNS 1982–2006 Nl-BT 1990–2006	BTS-Isis 1985–2007 SNS 1982–2007 Nl-BT 1990–2007	BTS-Isis 1985–2008 SNS 1982–2008 Nl-BT 1990–2008
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2006	2007	2008
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	2	2	2
Catchability independent of ages for ages >=	7	7	7
Survivor estimates shrunk towards the mean F	5 years / 5 ages	5 years / 5 ages	5 years / 5 ages
s.e. of the mean for shrinkage	2.0	2.0	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 10.3.1. A summary of the input data is given in Figure 10.2.1. Figure 10.3.2 shows the log catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers per age group are shown in Tables 10.3.2 and 10.3.3 respectively. The SSB in 2007 was estimated at around 19 000 t (Table 10.4.1) which has increased to around 40 000 t in 2008. Mean F(2–6) was estimated at 0.34 which is the lowest since the 1960s. Recruitment of the 2007 year class, in 2008 (age 1), was estimated at 91 million. Retrospective analysis is presented in Figure 10.3.4. Underestimation of mean *F* from 2000 to 2006 were observed and an overestimation in 2007. In the same period overestimation biases of the SSB estimates were found. Recruit estimates were relatively unbiased.

10.4 Historic Stock Trends

Table 10.4.1. and Figure 10.4.1 present the trends in landings, mean F(2–6), recruitment and SSB since 1957.

Reported landings increased to the end of the 1960s, showed a period of lower landings until the end of the 1980s and a period of higher landings (30 000 t) again during the early 1990s. In 2008 landings were estimated to be around 14 100 t.

Recruitment was high in 1959 and 1964 and SSB increased from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was high in 1988 and 1992. Between 1990–1995 a period of higher SSB was observed. The SSB in 2007 decreased by about 6000 t compared to 2006. The SSB in 2008 is estimated at around 40 000 t. The year-classes 2003 and 2004 show a low recruitment level for 2 consecutive years. Recruitment in 2008 of the 2007 year class at the age of 1 was estimated at 91 million, slightly lower than the long term geometric mean of 93.8 million.

The mean fishery mortality on age 2–6 increased with large variation from circa 0.4–0.5 per year around 1970 to 0.5 to 0.6 per year up to 2000. In recent years fishing mortality has decreased gradually. Fishing mortality decreased from 0.41 per year in 2007 to 0.34 per year in 2008 (Table 10.4.1).

10.5 Recruitment estimates

Recruitment estimation was carried out using RCT3. Input to the RCT3 model is presented in Table 10.5.1. Results are presented in Table 10.5.2 for age-1 and Table 10.5.3 for age-2. Average recruitment of 1-year-old-fish in the period 1957–2006 was around 93.8 million (geometric mean). For year class 2008 (age 1 in 2009) the value predicted by the RCT3 (67 300) was approximately 30% lower than the geometric mean (Table 10.5.2.). The estimate was based on the estimate of the DFS0 survey (27 million) and showed a large standard error (1) , and therefore the geometric mean was accepted for the short-term forecasts.

For year class 2007 (age 2 in 2009), the data are also noisy (high s.e. of the predicted value, Table 10.5.3.). Apart from DFS0 data the RCT3 estimate is based on the same data as the XSA; the WG finds it undesirable to use the same data twice and therefore accepts the XSA estimate. The year class strength estimates from the different sources are summarized in the table below and the estimates used for the short-term forecast are bold-underlined.

YEAR CLASS	AGE IN 2009	XSA THOUSANDS	RCT3 THOUSANDS	GM(1957 – 2006) THOUSANDS
2007	2	**<u>80 500</u>**	<u>74 500</u>	83 800
2008	1		67 300	**<u>93 800</u>**
2009	Recruit			**<u>93 800</u>**

10.6 Short-term forecasts

The short-term forecasts were carried out with FLR using FLSTF (1.9.9). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years. Weight-at-age in the stock and weight-at-age in the catch were taken to be the mean of the last three years. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2007 year-class are taken from the long-term geometric mean (1957–2006: 93.8 million).

Input to the short term forecast is presented in Table 10.6.1. The management options are given in Table 10.6.2 (A-C). The management options are given for three different assumptions on the F values for 2009; A) F2009 is assumed to be equal to Fsq, the average estimate for F from 2006 to 2008 scaled to 2008; B) F2009 is 0.9 times Fsq; and C) F2009 is set such that the landings in 2009 equal the TAC of that same year. The table below shows the predicted F values in the intermediate year, SSB for 2010 and the corresponding landings for 2009, given the different assumptions about F in the intermediate year in the different scenarios.

Scenario	Assumption	F_{2010}	SSB_{2011}	$Landings_{2010}$
A	$F_{2009} = F_{sq}$	0.34	38 300	15 500
B	$F_{2009} = 0.9F_{sq}$	0.304	39 200	15 900
C	$F\sim Landings_{2009} = TAC_{2009}$	0.31	39 100	15 800

The detailed tables for a forecast based on these 3 scenarios are given in Table 10.6.3A-C. At status quo fishing mortality in 2009 and 2010, SSB is expected to remain stable at 37 700 t in 2010. The 2011 SSB is predicted to be 38 300 t. The landings at Fsq are expected to be around 15 100 t in 2009 which is above the 2009 TAC (14 000) and equal to last year's status quo forecast (15 200 t). The landings in 2010 are predicted to be around 15 500 t at Fsq.

Figure 10.6.1 shows the projected contribution of different sources of information to estimates of the landings in 2009 and of the SSB in 2010, when fishing at Fsq in 2009. The landings in 2009 will consist for a large part of uncertain year classes (2005–2008), and for almost 20% of year classes for which the geometric mean was taken (2008–2009). Other stock number estimates originate from XSA. The contribution of year classes 2008 and 2009 to SSB forecast in 2011 is approximately 35%. These forecasts are subject to revision by ACFM in October 2009 when new survey information becomes available.

Yield and SSB, per recruit, under the condition of the current exploitation pattern and assuming Fsq as exploitation rate in 2009 are given in Figure 10.6.2 (see also Table 10.6.4). Fmax is poorly defined at 0.6.

10.7 Medium-term forecasts

No medium term projections were done this year.

10.8 Biological reference points

The current reference points are $\mathbf{B_{lim}} = \mathbf{B_{loss}} = 25\,000$ t and $\mathbf{B_{pa}}$ is set at 35 000 t using the default multiplier of 1.4. $\mathbf{F_{pa}}$ was proposed to be set at 0.4 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.4 is consistent with an SSB of around 35 000 t.

	Type	Value	Technical basis
Precautionary Approach	Blim	25 000	Bloss
	Bpa	35 000	Bpa 1.4*Blim
	Flim	Not defined	
	Fpa	0.4	Fpa=0.4 implies Bpa+ $P(SSB_{MT} > Bpa) < 10\%$
	Fy	0.2	EU management plan
Targets			

10.9 Quality of the assessment

This year's assessment of North Sea sole was carried out as an update assessment. Retrospective patterns from previous years suggested that F was over-erestimated last year but underestimated in previous years, while SSB was overestimated. The historic performance of the assessment is summarized in Figure 10.3.4.

The XSA assessment showed an increase in SSB in 2008 (40 000t) compared to 2007 (20 000t) caused by the maturity of the strong 2005 year class and the enhanced survival due to the reduction in fishing effort.

During the next benchmark assessment for this stock, attention should be paid to the following issues:

- In 2003 the plus-group was set from age 15 to age 10. The choice to reduce the plusgroup to age 10 needs further attention, although the current WG thinks that the very small number of older fish currently present in the stock will lead to a limited impact...
- Follow changes in technical efficiency in the commercial fleets and look for external evidence.
- Trends in mean weights and maturity and how that could affect the assessment and forecasts. In particular it would be interesting to examine the impact of sex ratios and the faster growth and larger ultimate size of females.
- Explore the effects of including discards.
- Investigate the considerable differences in retrospective patterns of XSA results when run survey or commercial LPUE series separately.
- Study the effects of using an un-scaled F in the forecast procedure.

10.10 Status of the Stock

Fishing mortality was estimated at 0.34 in 2008 which is below Fpa (=0.4). The SSB in 2008 was estimated at about 40 000 t which is above both Blim (25 000t) and Bpa (35 000 t). Two weak year classes in 2003 and 2004 were followed by a strong year class in 2005 the impact of which is now being seen in the SSB estimations. Projected landings for 2010 at Fsq are 15 500t, slightly lower than projected landings for 2009 (15 100)

10.11 Management Considerations

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea. Fishing effort (kWdays) has been substantially reduced since 1995 and this fall continued between 2007 and 2008 due to an extensive decommissioning scheme.. Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. The combination of days-at-sea regulations, higher oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a shift in fishing effort towards the southern North Sea. This concentration of fishing effort result in higher plaice discards because juveniles are mainly distributed in this area.

The sole stock dynamics is heavily dependent on the occasional occurrence of strong year classes.

The mean age in the landings is currently just above age 3, but used to be around age 6 in the beginning of the time series. A lower exploitation level is expected to improve the survival of sole to the spawning population, which could enhance the stability in the catches.

The peaks in the historical time-series of SSB of North Sea sole correspond with the occasional occurrence of strong year classes. Due to high fishing mortality, SSB declined during the nineties. The fishery opportunities and SSB are now dependent on incoming year classes and can therefore fluctuate considerably between years. The SSB and landings in recent years have been dominated by the 2001 and 2005 year classes. The predicted SSB in 2011 is largely dependent on the above-average recruitment of the 2005 year class.

For sole there will be new recruitment information from the 3rd quarter surveys. ICES will only issue an updated advice if these surveys provide a very different perspective on the short-term developments.

Table 10.2.1 Sole in Sub-Area IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1900	524	686	266	17686	403	2	21467	112	21579	21000
1983	1740	730	332	619	16101	435		19957	4970	24927	20000
1984	1771	818	400	1034	14330	586	1	18940	7899	26839	20000
1985	2390	692	875	303	14897	774	3	19934	4314	24248	22000
1986	1833	443	296	155	9558	647	2	12934	5266	18200	20000
1987	1644	342	318	210	10635	676	4	13829	3539	17368	14000
1988	1199	616	487	452	9841	740	28	13363	8227	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806	14000
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828		1458	16283	645	501	21634	1841	23475	22000
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532	22000
2001	1874	772	411	958	13345	597	394	18351	1593	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	728	749	12469	521	363	17138	782	17920	15850
2004	1477	808	655	949	12860	535	544	17828	-681	17147	17000
2005	1374	831	676	756	10917	667	357	15579	776	16355	18600
2006	980	585	648	475	8299	910		11933	667	12600	17670
2007	955	413	401	458	10365	1203	5	13800	835	14635	15000
2008	1379	507	714	513	9456	851	15	13435	710	14145	12800

TAC 2009: 14000

Table 10.2.2 Sole in sub-area IV: Overview of landings and discards numbers and weights (kg) per hour and there percentages in the Dutch discards

		Numbers			Weight		
Period	trips	Landings	Discards	%D	Landings	Discards	%D
	n	$n \cdot h^{-1}$	$n \cdot h^{-1}$		$kg \cdot h^{-1}$	$kg \cdot h^{-1}$	
1976–1979	21	116	8	6%	38	1	3%
1980–1983	22	84	23	21%	27	3	9%
1989–1990	6	286	83	22%	72	11	13%
1999–2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%
2005	9	99	29	23%	20	2	11%
2006	9	64	26	29%	16	2	13%
2007	10	94	27	23%	22	2	10%

Table 10.2.3 Sole in sub-area IV: Landings numbers at age (thousands)

2008 - 04 - 22 15:40:01 units= thousands

age

year	1	2	3	4	5	6	7	8	9	10
1957	**0**	**1415**	**10148**	**12642**	**3762**	**2924**	**6518**	**1733**	**509**	**6288**
1958	0	1854	8440	14169	9500	3484	3008	4439	2253	6557
1959	0	3659	12025	10401	8975	5768	1206	2025	2574	5615
1960	0	12042	14133	16798	9308	8367	4846	1593	1056	7901
1961	0	959	49786	19140	12404	4695	3944	4279	836	7254
1962	0	1594	6210	59191	15346	10541	4826	4112	2087	7494
1963	0	676	8339	8555	46201	8490	6658	2423	3393	8384
1964	55	155	2113	5712	3809	17337	3126	1810	818	3015
1965	0	47100	1089	1599	5002	2482	12500	1557	1525	3208
1966	0	12278	133617	990	1181	3689	744	6324	702	2450
1967	0	3686	25683	85127	1954	536	1919	760	5047	2913
1968	1037	17148	13896	24973	48571	462	245	1644	324	6523
1969	396	23922	21451	5326	12388	25139	331	244	1190	5272
1970	1299	6140	25993	8235	1784	3231	11960	246	140	5234
1971	420	33369	14425	12757	4485	1442	2327	7214	192	4594
1972	358	7594	36759	7075	4965	1565	523	1232	4706	2801
1973	703	12228	12783	16187	4025	2324	994	765	1218	5790
1974	101	15380	21540	5487	7061	1922	1585	658	401	4814
1975	264	22954	28535	11717	2088	3830	790	907	508	3445
1976	1041	3542	27966	14013	4819	966	1909	550	425	2663
1977	1747	22328	12073	15306	7440	1779	319	1112	256	2115
1978	27	25031	29292	6129	6639	4250	1738	611	646	1602
1979	9	8179	41170	16060	2996	3222	1747	816	241	1527
1980	637	1209	12511	17781	7297	1450	2197	1409	367	1203
1981	423	29217	3259	6866	8223	3661	948	886	766	908
1982	2660	26435	45746	1843	3535	4789	1678	615	605	1278
1983	389	34408	41386	21189	624	1378	1950	978	386	1176
1984	191	30734	43931	22554	8791	741	854	1043	524	894
1985	165	16618	43213	20286	9403	3556	209	379	637	975
1986	374	9363	18497	17702	7747	5515	2270	110	283	1682
1987	94	29053	22046	8899	6512	3119	1567	903	81	694
1988	10	13219	47182	15232	4381	3882	1551	891	524	317
1989	117	46387	18263	22654	4624	1653	1437	647	458	468
1990	863	11939	104454	9767	9194	3349	1043	1198	554	845
1991	120	13163	25420	77913	6724	3675	1736	719	730	1090
1992	980	6832	44378	16204	38319	2477	3041	741	399	1180
1993	54	50451	16768	31409	13869	24035	1489	1184	461	842
1994	718	7804	87403	13550	18739	5711	11310	464	916	908
1995	4801	12767	16822	68571	6308	7307	1995	6015	295	668
1996	172	18824	16190	16964	27257	3858	4780	943	3305	988
1997	1590	6047	23651	7325	5108	12793	1201	2326	333	1688
1998	244	56648	15141	14934	3496	1941	4768	794	1031	846
1999	287	15762	72470	8187	6111	1212	664	1984	331	812
2000	2351	15073	32738	42803	3288	2477	804	435	931	714
2001	884	25846	21595	19876	16730	1427	834	274	168	724
2002	1055	11053	32852	12290	8215	6448	673	597	89	364
2003	1048	32330	17498	16090	5820	3906	2430	400	128	451
2004	516	14950	47970	9524	7457	2165	901	961	389	389
2005	1156	7417	23141	29523	4262	3948	1524	616	785	401
2006	6814	9690	10109	9340	10640	1572	1533	704	363	538
2007	317	39888	10887	6447	5741	5513	824	729	501	544
2008	1919	6118	35504	5258	3755	2788	2477	574	730	668

Table 10.2.4 Sole in sub-area IV: Landing weights at age (kg)

2009-05-10 11:49:05 units= kg

year	1	2	3	4	5	6	7	8	9	10
	age									
1957	0.000	0.154	0.177	0.204	0.248	0.279	0.290	0.335	0.436	0.408
1958	0.000	0.145	0.178	0.220	0.254	0.273	0.314	0.323	0.388	0.413
1959	0.000	0.162	0.188	0.228	0.261	0.301	0.328	0.321	0.373	0.426
1960	0.000	0.153	0.185	0.235	0.254	0.277	0.301	0.309	0.381	0.418
1961	0.000	0.146	0.174	0.211	0.255	0.288	0.319	0.304	0.346	0.419
1962	0.000	0.155	0.165	0.208	0.241	0.295	0.320	0.321	0.334	0.412
1963	0.000	0.163	0.171	0.219	0.258	0.309	0.323	0.387	0.376	0.485
1964	0.153	0.175	0.213	0.252	0.274	0.309	0.327	0.346	0.388	0.480
1965	0.000	0.169	0.209	0.246	0.286	0.282	0.345	0.378	0.404	0.480
1966	0.000	0.177	0.190	0.180	0.301	0.332	0.429	0.399	0.449	0.501
1967	0.000	0.192	0.201	0.252	0.277	0.389	0.419	0.339	0.424	0.491
1968	0.157	0.189	0.207	0.267	0.327	0.342	0.354	0.455	0.465	0.508
1969	0.152	0.191	0.196	0.255	0.311	0.373	0.553	0.398	0.468	0.523
1970	0.154	0.212	0.218	0.285	0.350	0.404	0.441	0.463	0.443	0.533
1971	0.145	0.193	0.237	0.322	0.358	0.425	0.420	0.490	0.534	0.547
1972	0.169	0.204	0.252	0.334	0.434	0.425	0.532	0.485	0.558	0.629
1973	0.146	0.208	0.238	0.346	0.404	0.448	0.552	0.567	0.509	0.586
1974	0.164	0.192	0.233	0.338	0.418	0.448	0.520	0.559	0.609	0.653
1975	0.129	0.182	0.225	0.320	0.406	0.456	0.529	0.595	0.629	0.669
1976	0.143	0.190	0.222	0.306	0.389	0.441	0.512	0.562	0.667	0.665
1977	0.147	0.188	0.236	0.307	0.369	0.424	0.430	0.520	0.562	0.619
1978	0.152	0.196	0.231	0.314	0.370	0.426	0.466	0.417	0.572	0.666
1979	0.137	0.208	0.246	0.323	0.391	0.448	0.534	0.544	0.609	0.763
1980	0.141	0.199	0.244	0.331	0.371	0.418	0.499	0.550	0.598	0.684
1981	0.143	0.187	0.226	0.324	0.378	0.424	0.442	0.516	0.542	0.630
1982	0.141	0.188	0.216	0.307	0.371	0.409	0.437	0.491	0.580	0.656
1983	0.134	0.182	0.217	0.301	0.389	0.416	0.467	0.489	0.505	0.642
1984	0.153	0.171	0.221	0.286	0.361	0.386	0.465	0.555	0.575	0.634
1985	0.122	0.187	0.216	0.288	0.357	0.427	0.447	0.544	0.612	0.645
1986	0.135	0.179	0.213	0.299	0.357	0.407	0.485	0.543	0.568	0.610
1987	0.139	0.185	0.205	0.277	0.356	0.378	0.428	0.481	0.393	0.657
1988	0.127	0.175	0.217	0.270	0.354	0.428	0.484	0.521	0.559	0.712
1989	0.118	0.173	0.216	0.288	0.336	0.375	0.456	0.492	0.470	0.611
1990	0.124	0.183	0.227	0.292	0.371	0.413	0.415	0.514	0.476	0.620
1991	0.127	0.186	0.210	0.263	0.315	0.436	0.443	0.467	0.507	0.558
1992	0.146	0.178	0.213	0.258	0.298	0.380	0.409	0.460	0.487	0.556
1993	0.097	0.167	0.196	0.239	0.264	0.300	0.338	0.441	0.496	0.603
1994	0.143	0.180	0.202	0.228	0.257	0.300	0.317	0.432	0.409	0.510
1995	0.151	0.186	0.196	0.247	0.265	0.319	0.344	0.356	0.444	0.591
1996	0.163	0.177	0.202	0.234	0.274	0.285	0.318	0.370	0.390	0.594
1997	0.151	0.180	0.206	0.236	0.267	0.296	0.323	0.306	0.384	0.440
1998	0.128	0.182	0.189	0.252	0.262	0.289	0.336	0.292	0.335	0.504
1999	0.163	0.179	0.212	0.229	0.287	0.324	0.354	0.372	0.372	0.453
2000	0.145	0.170	0.200	0.248	0.290	0.299	0.323	0.368	0.402	0.427
2001	0.143	0.185	0.202	0.270	0.275	0.333	0.391	0.414	0.433	0.493
2002	0.140	0.183	0.211	0.243	0.281	0.312	0.366	0.319	0.571	0.536
2003	0.136	0.182	0.214	0.256	0.273	0.317	0.340	0.344	0.503	0.431
2004	0.127	0.180	0.209	0.252	0.263	0.284	0.378	0.367	0.327	0.425
2005	0.172	0.185	0.207	0.243	0.241	0.282	0.265	0.377	0.318	0.401
2006	0.156	0.190	0.220	0.263	0.291	0.322	0.293	0.358	0.397	0.397
2007	0.154	0.180	0.205	0.237	0.253	0.273	0.295	0.299	0.281	0.326
2008	0.150	0.182	0.225	0.245	0.260	0.311	0.314	0.283	0.280	0.386

Table 10.2.5 Sole in sub-area IV: Stock weights at age (kg)

2009 - 05 - 07 08:59:01 units= kg

year	1	2	3	4	5	6	7	8	9	10
1957	0.025	0.070	0.147	0.187	0.208	0.253	0.262	0.355	0.390	0.365
1958	0.025	0.070	0.164	0.205	0.226	0.228	0.297	0.318	0.393	0.422
1959	0.025	0.070	0.159	0.198	0.239	0.271	0.292	0.276	0.303	0.426
1960	0.025	0.070	0.163	0.207	0.234	0.240	0.268	0.242	0.360	0.431
1961	0.025	0.070	0.148	0.206	0.235	0.232	0.259	0.274	0.281	0.396
1962	0.025	0.070	0.148	0.192	0.240	0.301	0.293	0.282	0.273	0.441
1963	0.025	0.070	0.148	0.193	0.243	0.275	0.311	0.363	0.329	0.465
1964	0.025	0.070	0.159	0.214	0.240	0.291	0.305	0.306	0.365	0.474
1965	0.025	0.140	0.198	0.223	0.251	0.297	0.337	0.358	0.526	0.460
1966	0.025	0.070	0.160	0.149	0.389	0.310	0.406	0.377	0.385	0.505
1967	0.025	0.177	0.164	0.235	0.242	0.399	0.362	0.283	0.381	0.459
1968	0.025	0.122	0.171	0.248	0.312	0.280	0.629	0.416	0.410	0.486
1969	0.025	0.137	0.174	0.252	0.324	0.364	0.579	0.415	0.469	0.521
1970	0.025	0.137	0.201	0.275	0.341	0.367	0.423	0.458	0.390	0.554
1971	0.034	0.148	0.213	0.313	0.361	0.410	0.432	0.474	0.483	0.533
1972	0.038	0.155	0.218	0.313	0.419	0.443	0.443	0.443	0.508	0.602
1973	0.039	0.149	0.226	0.322	0.371	0.433	0.452	0.472	0.446	0.536
1974	0.035	0.146	0.218	0.329	0.408	0.429	0.499	0.565	0.542	0.618
1975	0.035	0.148	0.206	0.311	0.403	0.446	0.508	0.582	0.580	0.650
1976	0.035	0.142	0.201	0.301	0.379	0.458	0.508	0.517	0.644	0.665
1977	0.035	0.147	0.202	0.291	0.365	0.409	0.478	0.487	0.531	0.644
1978	0.035	0.139	0.211	0.290	0.365	0.429	0.427	0.385	0.542	0.644
1979	0.045	0.148	0.211	0.300	0.352	0.429	0.521	0.562	0.567	0.743
1980	0.039	0.157	0.200	0.304	0.345	0.394	0.489	0.537	0.579	0.645
1981	0.050	0.137	0.200	0.305	0.364	0.402	0.454	0.522	0.561	0.622
1982	0.050	0.130	0.193	0.270	0.359	0.411	0.429	0.476	0.583	0.642
1983	0.050	0.140	0.200	0.285	0.329	0.435	0.464	0.483	0.510	0.636
1984	0.050	0.133	0.203	0.268	0.348	0.386	0.488	0.591	0.567	0.664
1985	0.050	0.127	0.185	0.267	0.324	0.381	0.380	0.626	0.554	0.642
1986	0.050	0.133	0.191	0.278	0.345	0.423	0.495	0.487	0.587	0.686
1987	0.050	0.154	0.191	0.262	0.357	0.381	0.406	0.454	0.332	0.620
1988	0.050	0.133	0.193	0.260	0.335	0.409	0.417	0.474	0.486	0.654
1989	0.050	0.133	0.195	0.290	0.350	0.340	0.411	0.475	0.419	0.595
1990	0.050	0.148	0.203	0.294	0.357	0.447	0.399	0.494	0.481	0.653
1991	0.050	0.139	0.184	0.254	0.301	0.413	0.447	0.522	0.548	0.573
1992	0.050	0.156	0.194	0.257	0.307	0.398	0.406	0.472	0.500	0.540
1993	0.050	0.128	0.184	0.229	0.265	0.293	0.344	0.482	0.437	0.583
1994	0.050	0.143	0.174	0.209	0.257	0.326	0.349	0.402	0.494	0.459
1995	0.050	0.151	0.179	0.240	0.253	0.321	0.365	0.357	0.545	0.545
1996	0.050	0.147	0.178	0.208	0.274	0.268	0.321	0.375	0.402	0.546
1997	0.050	0.150	0.190	0.225	0.252	0.303	0.319	0.325	0.360	0.424
1998	0.050	0.140	0.173	0.234	0.267	0.281	0.328	0.273	0.336	0.455
1999	0.050	0.131	0.187	0.216	0.259	0.296	0.340	0.322	0.369	0.464
2000	0.050	0.139	0.185	0.226	0.264	0.275	0.287	0.337	0.391	0.376
2001	0.050	0.144	0.185	0.223	0.263	0.319	0.327	0.421	0.410	0.530
2002	0.050	0.145	0.197	0.245	0.267	0.267	0.299	0.308	0.435	0.435
2003	0.050	0.146	0.194	0.240	0.256	0.288	0.330	0.312	0.509	0.470
2004	0.050	0.137	0.195	0.240	0.245	0.305	0.316	0.448	0.356	0.601
2005	0.050	0.150	0.189	0.234	0.237	0.258	0.276	0.396	0.369	0.428
2006	0.050	0.148	0.197	0.250	0.270	0.319	0.286	0.341	0.409	0.456
2007	0.050	0.152	0.179	0.216	0.242	0.245	0.275	0.252	0.257	0.364
2008	0.050	0.154	0.200	0.217	0.239	0.289	0.283	0.243	0.262	0.356

Table 10.2.6 Sole in subarea IV: Effort and CpUE series

NL beam

year	Effort HP days (·10^6)	LpUE kg· 1000HP days^{-1}
1990	71.1	423.0
1991	68.5	386.0
1992	71.1	339.8
1993	76.9	338.3
1994	81.4	331.2
1995	81.2	298.3
1996	72.1	244.6
1997	72.0	165.2
1998	70.2	250.8
1999	67.3	283.6
2000	64.6	259.3
2001	61.4	263.8
2002	56.7	243.2
2003	51.6	279.9
2004	48.1	309.0
2005	49.1	260.2
2006	44.1	190.4
2007	42.9	258.4
2008	30.2	313.1

Table 10.2.7 Sole in subarea IV: Tuning data. BTS and SNS surveys and commercial series from NL beam trawl

2009-05-07 11:04:17 BTS-ISIS units= NA

		1	2	3	4	5	6	7	8	9
1985	1	2.65	7.89	3.541	1.669	0.620	0.279	0.000	0.000	0.000
1986	1	7.88	4.49	1.726	0.826	0.590	0.221	0.108	0.000	0.018
1987	1	6.97	12.55	1.834	0.563	0.583	0.222	0.228	0.058	0.000
1988	1	83.11	12.51	2.684	1.032	0.123	0.149	0.132	0.103	0.014
1989	1	9.02	68.08	4.191	4.096	0.677	0.128	0.242	0.000	0.051
1990	1	22.60	22.36	20.090	0.611	0.682	0.511	0.078	0.055	0.013
1991	1	3.71	23.19	5.843	6.011	0.103	0.137	0.064	0.040	0.011
1992	1	74.44	23.20	9.879	2.332	2.903	0.061	0.142	0.065	0.016
1993	1	4.99	27.36	0.987	4.367	2.376	4.295	0.024	0.090	0.057
1994	1	5.88	4.99	15.422	0.133	1.412	0.095	1.006	0.010	0.000
1995	1	27.86	8.46	7.039	6.718	0.476	0.913	0.314	0.966	0.049
1996	1	3.51	6.17	1.909	1.488	2.493	0.308	0.406	0.051	0.299
1997	1	173.94	5.37	3.234	0.800	0.769	0.403	0.105	0.038	0.045
1998	1	14.12	29.21	1.998	1.346	0.079	0.016	0.424	0.000	0.000
1999	1	11.41	19.26	16.626	0.629	2.061	0.334	0.224	0.651	0.003
2000	1	14.46	6.53	4.207	1.587	0.283	0.153	0.064	0.008	0.162
2001	1	8.17	10.71	2.335	1.683	0.737	0.081	0.040	0.030	0.000
2002	1	21.90	4.17	3.431	0.906	0.356	0.359	0.022	0.060	0.000
2003	1	10.76	10.55	2.506	1.752	0.380	0.202	0.337	0.000	0.022
2004	1	3.65	4.40	3.618	0.630	0.650	0.122	0.072	0.075	0.000
2005	1	3.14	3.29	2.375	1.337	0.137	0.139	0.078	0.046	0.000
2006	1	16.82	2.44	0.300	0.763	0.516	0.163	0.095	0.000	0.008
2007	1	5.80	19.97	1.510	0.608	0.333	0.572	0.034	0.010	0.000
2008	1	15.04	8.87	12.822	1.386	0.217	0.294	0.202	0.008	0.051

SNS units= NA

		1	2	3	4
1970	1	5410	734	238	35
1971	1	893	1844	110	3
1972	1	1455	272	149	0
1973	1	5587	935	84	37
1974	1	2348	361	65	0
1975	1	529	848	166	47
1976	1	1399	74	229	27
1977	1	3743	776	104	43
1978	1	1548	1355	294	28
1979	1	94	408	301	77
1980	1	4313	89	109	61
1981	1	3737	1413	50	20
1982	1	5856	1146	228	7
1983	1	2621	1123	121	40
1984	1	2493	1100	318	74
1985	1	3619	716	167	49
1986	1	3705	458	69	31
1987	1	1948	944	65	21
1988	1	11227	594	282	82
1989	1	2831	5005	208	53
1990	1	2856	1120	914	100
1991	1	1254	2529	514	624
1992	1	11114	144	360	195
1993	1	1291	3420	154	213
1994	1	652	498	934	10
1995	1	1362	224	143	411
1996	1	218	349	30	36
1997	1	10279	154	190	26
1998	1	4095	3126	142	99
1999	1	1649	972	456	10
2000	1	1639	126	166	118
2001	1	970	655	107	35
2002	1	7542	379	195	0
2003	1	NA	NA	NA	NA
2004	1	1367	623	396	69
2005	1	568	163	124	0
2006	1	4167	382	80	105
2007	1	848	911	33	40
2008	1	1259	258	325	0

Table 10.2.7 cont.

Commercial series from NL beam trawl

2009-05-07 11:55:50 NL Beam Trawl units= NA

	E	2	3	4	5	6	7	8	9
1990	71.1	**127.6**	**1190**	**101.9**	**92.6**	**23.5**	**8.93**	**11.52**	**5.288**
1991	68.5	**107.1**	**251**	**872.3**	**67.7**	**31.2**	**9.97**	**4.55**	**5.723**
1992	71.1	**71.0**	**477**	**156.6**	**419.6**	**20.5**	**29.27**	**6.27**	**3.080**
1993	76.9	**510.9**	**142**	**313.8**	**125.2**	**242.2**	**11.53**	**10.56**	**3.069**
1994	81.4	**66.2**	**858**	**91.1**	**159.8**	**38.1**	**109.74**	**2.33**	**6.437**
1995	81.2	**120.4**	**140**	**658.7**	**35.0**	**63.2**	**11.05**	**57.66**	**1.810**
1996	72.1	**219.7**	**126**	**154.9**	**294.2**	**21.8**	**44.01**	**6.55**	**38.474**
1997	72.0	**62.6**	**256**	**62.6**	**46.2**	**135.7**	**6.90**	**25.00**	**1.319**
1998	70.2	**720.4**	**129**	**158.4**	**26.0**	**16.3**	**48.36**	**3.01**	**4.801**
1999	67.3	**175.6**	**820**	**61.7**	**66.3**	**10.8**	**4.99**	**22.69**	**1.976**
2000	64.6	**190.5**	**458**	**336.6**	**31.7**	**24.5**	**7.04**	**4.98**	**9.923**
2001	61.4	**305.0**	**222**	**243.8**	**213.0**	**11.7**	**8.24**	**2.21**	**1.515**
2002	56.7	**158.8**	**437**	**140.0**	**106.4**	**89.6**	**7.48**	**6.77**	**0.952**
2003	51.6	**502.8**	**224**	**241.1**	**65.8**	**54.7**	**38.02**	**4.36**	**1.202**
2004	48.1	**232.6**	**774**	**117.1**	**105.2**	**24.7**	**13.31**	**11.27**	**2.807**
2005	49.1	**103.1**	**333**	**428.3**	**77.3**	**40.8**	**18.76**	**5.89**	**12.607**
2006	44.1	**154.0**	**177**	**152.1**	**186.5**	**21.6**	**21.43**	**11.84**	**6.100**
2007	42.9	**775.6**	**178**	**104.5**	**85.3**	**86.2**	**7.81**	**7.60**	**2.960**
2008	30.2	**156.2**	**952**	**107.8**	**61.7**	**42.0**	**47.52**	**6.56**	**5.861**

Commercial series from NL beam trawl (spatially-weighted). Not used in the final run assessment.

2009-05-07 12:16 NL Beam Trawl Spatially weighted units= NA

	E	2	3	4	5	6	7	8	9
1997	72.0	18.1	84.2	23.4	18.9	60.3	3.3	11.5	0.8
1998	70.2	152.0	31.9	51.8	9.4	6.2	22.0	1.3	2.6
1999	67.3	39.0	230.2	20.5	25.7	4.9	2.7	12.0	1.0
2000	64.6	36.6	96.0	162.9	12.2	11.4	3.7	2.3	6.1
2001	61.4	65.8	54.3	72.0	70.3	4.8	3.9	1.0	0.8
2002	56.7	33.0	114.2	43.0	35.6	33.8	3.3	2.8	0.7
2003	51.6	95.1	50.4	63.9	18.2	17.0	13.5	1.6	0.8
2004	48.1	42.9	165.8	30.0	28.9	7.3	5.2	4.5	1.0
2005	49.1	20.4	69.9	104.4	13.7	12.7	4.0	2.7	3.6
2006	44.1	30.9	40.6	39.8	54.4	6.8	7.0	4.0	2.1
2007	42.9	135.7	38.6	26.4	24.1	26.1	2.8	2.8	1.0
2008	30.2	32.8	249.0	32.5	20.0	16.3	18.7	2.4	2.5

Table 10.3.1. Sole in sub area IV: XSA diagnostics

CPUE data from xsa.indices

Catch data for 52 years. 1957 to 2008. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	BTS-ISIS	1	9	1985	2008	0.66	0.75
2	SNS	1	4	1970	2008	0.66	0.75
3	NL Beam Trawl	2	9	1990	2008	0	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 1

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 = 2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.004	0.020	0.015	0.006	0.013	0.012	0.025	0.033	0.006	0.022
2	0.175	0.239	0.284	0.230	0.225	0.230	0.207	0.263	0.243	0.126
3	0.608	0.579	0.559	0.620	0.601	0.533	0.584	0.425	0.467	0.316
4	0.710	0.790	0.748	0.637	0.625	0.685	0.651	0.436	0.467	0.382
5	0.785	0.614	0.734	0.710	0.627	0.588	0.667	0.455	0.465	0.482
6	0.575	0.763	0.522	0.618	0.783	0.444	0.632	0.489	0.400	0.382
7	0.524	0.844	0.555	0.441	0.441	0.361	0.570	0.475	0.455	0.280
8	0.485	0.691	0.691	0.886	0.453	0.277	0.398	0.498	0.385	0.586
9	1.234	0.391	0.554	0.443	0.412	0.958	0.340	0.384	0.709	0.732
10	1.234	0.391	0.554	0.443	0.412	0.958	0.340	0.384	0.709	0.732

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8	9	10
1999	82581	103065	167236	16936	11815	2913	1711	5431	491	1192
2000	123824	74450	78264	82386	7536	4878	1483	916	3027	2313
2001	63480	109804	53027	39674	33830	3691	2057	577	415	1781
2002	187821	56599	74769	27439	16992	14697	1983	1068	262	1066
2003	85663	168944	40699	36404	13137	7561	7165	1154	399	1399
2004	46679	76515	122114	20181	17635	6351	3126	4171	664	658
2005	49955	41746	55012	64863	9201	8863	3687	1971	2860	1456
2006	221770	44101	30718	27765	30607	4271	4264	1887	1198	1769
2007	60383	194184	30687	18179	16238	17573	2369	2400	1037	1119
2008	90949	54335	137762	17411	10317	9232	10657	1360	1478	1344

Estimated population abundance at 1st Jan 2009

year \ age	1	2	3	4	5	6	7	8	9	10
2009	0	80469	43345	90880	10752	5763	5701	7287	685	643

```
Fleet:  BTS-ISIS

 Log catchability residuals.

   year
age   1985   1986   1987   1988   1989   1990   1991   1992   1993   1994  1995   1996
  1 -0.499 -0.458  0.022 -0.081 -0.132 -0.043 -0.250  0.039 -0.102  0.110 0.488 -0.035
  2  0.197 -0.623 -0.210  0.574  0.353  0.683  0.195  1.138 -0.267 -0.368 0.483 -0.336
  3 -0.056 -0.131 -0.450 -0.559  0.583  0.116  0.340  0.334 -1.027  0.210 0.990  0.234
  4  0.275 -0.430 -0.256  0.026  0.919 -0.433 -0.214  0.255  0.417 -2.079 0.438  0.636
  5 -0.085  0.211  0.059 -0.888  0.416  0.010 -1.247 -0.168  1.267  0.199 0.087  0.438
  6  0.201 -0.135  0.112 -0.457 -0.068  0.989 -0.837 -0.820  1.055 -0.802 0.624  0.710
  7     NA -0.084  0.390  0.110  0.454 -0.110 -0.454 -0.228 -0.984  0.110 1.186  0.453
  8     NA     NA  0.075  0.101     NA -0.404 -0.073  0.283 -0.019 -1.059 0.668  0.391
  9     NA -0.121     NA -0.416 -0.154 -1.043 -1.211 -0.107  1.015     NA 1.500  0.089
   year
age   1997   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  1  0.613  0.040  0.162  0.002  0.190 -0.094  0.113  0.026 -0.086 -0.321  0.063
  2  0.053  0.135  0.509 -0.202 -0.065 -0.384 -0.553 -0.632 -0.332 -0.647 -0.041
  3  0.166  0.203  0.742  0.107 -0.107 -0.023  0.258 -0.522 -0.109 -1.708 -0.061
  4  0.441  0.396  0.108 -0.492  0.268 -0.061  0.307 -0.083 -0.522 -0.386 -0.168
  5  1.105 -0.858  1.881  0.225 -0.235 -0.291 -0.027  0.188 -0.663 -0.688 -0.485
  6 -0.368 -1.728  1.499  0.336 -0.192 -0.016  0.189 -0.380 -0.450  0.339  0.117
  7  0.287  0.310  1.476  0.591 -0.410 -1.051  0.393 -0.377 -0.315 -0.331 -0.784
  8 -1.026     NA  1.359 -1.115  0.669  0.884     NA -0.684 -0.338     NA -2.071
  9  1.393     NA -1.089  0.487     NA     NA  0.532     NA     NA -1.599     NA
   year
age   2008
  1  0.231
  2  0.339
  3  0.470
  4  0.639
  5 -0.448
  6  0.082
  7 -0.629
  8 -1.584
  9  0.288


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3       4       5        6       7       8       9
Mean_Logq -8.9000 -9.4591 -9.7382 -9.9113 -10.0973 -9.9763 -9.9763 -9.9763
S.E_Logq   0.4708  0.5666  0.5972  0.7076   0.7017  0.6300  0.9034  0.9389

 Regression statistics
 Ages with q dependent on year class strength
         slope intercept
Age 1 0.6799813  9.854946


 Fleet:  SNS

 Log catchability residuals.

   year
age  1970   1971   1972   1973   1974   1975   1976   1977  1978   1979   1980   1981
  1 0.268  0.164 -0.012  0.486 -0.021 -0.097 -0.321  0.056 0.374 -0.118  0.073  0.006
  2 0.762  0.815  0.018  0.628 -0.649  0.215 -1.348  0.094 0.422  0.290  0.093  0.391
  3 0.503  0.159 -0.281  0.256 -0.704 -0.124  0.243  0.271 0.461  0.308  0.283  0.777
  4 0.083 -2.578     NA -0.421     NA  0.244 -0.787 -0.200 0.131  0.365 -0.048 -0.198
   year
age   1982   1983  1984   1985   1986   1987   1988   1989   1990   1991   1992   1993
  1  0.239 -0.150 0.336  0.440 -0.048  0.184 -0.219  0.091 -0.267 -0.034 -0.039 -0.006
  2  0.179  0.207 0.228  0.517 -0.186 -0.077  0.247  0.463  0.409  0.699 -1.224  0.374
  3 -0.011 -0.724 0.400 -0.193 -0.434 -0.873  0.105  0.497 -0.057  0.827 -0.061  0.033
  4 -0.013 -0.406 0.067 -0.085 -0.545 -0.378  0.661 -0.260  0.924  0.689  0.941  0.564
   year
age   1994   1995   1996   1997  1998   1999   2000   2001   2002 2003  2004   2005
  1 -0.228 -0.197 -0.721  0.115 0.253 -0.001 -0.296 -0.091  0.219   NA 0.320 -0.201
  2  0.047 -0.429 -0.488 -0.778 0.621  0.243 -1.430 -0.139 -0.061   NA 0.134 -0.617
  3  0.324  0.011 -1.002  0.249 0.476  0.063 -0.208 -0.273  0.027   NA 0.183 -0.144
  4 -1.499  0.811  0.082  0.182 0.953 -0.866  0.077 -0.438     NA   NA 0.873     NA

year
age   2006   2007   2008
  1 -0.215 -0.130 -0.211
  2  0.219 -0.408 -0.478
  3 -0.112 -0.967 -0.288
  4  0.799  0.278     NA


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3       4
Mean_Logq -4.7123 -5.4686 -5.9980
```

S.E_Logq 0.5633 0.4437 0.7432

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 1	0.7362234	5.812331

Fleet: NL Beam Trawl

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-0.509	-1.198	-0.673	-0.283	-0.717	0.166	0.273	-0.428	0.375	-0.222	0.215
3	-0.263	-0.366	-0.258	-0.520	-0.250	-0.494	-0.111	0.033	-0.147	0.128	0.291
4	-0.215	-0.136	-0.420	-0.213	-0.476	0.063	0.260	-0.142	0.197	-0.251	-0.102
5	-0.193	0.078	-0.284	0.050	-0.211	-0.739	0.062	0.026	-0.225	0.182	-0.181
6	-0.301	-0.477	-0.122	-0.017	0.004	-0.235	-0.210	0.300	0.052	-0.126	0.254
7	-0.242	-0.325	0.183	0.220	-0.075	-0.204	0.208	-0.429	0.144	-0.302	0.324
8	0.045	-0.253	-0.049	-0.135	-0.516	-0.116	0.240	0.502	-0.416	0.039	0.395
9	0.065	0.102	0.188	0.037	0.149	0.106	0.073	-0.254	-0.162	0.318	-0.246

age \ year	2001	2002	2003	2004	2005	2006	2007	2008
2	0.318	0.302	0.359	0.383	0.163	0.537	0.662	0.277
3	-0.050	0.309	0.239	0.351	0.329	0.207	0.234	0.339
4	0.288	0.053	0.309	0.203	0.318	0.035	0.097	0.133
5	0.276	0.260	0.000	0.157	0.535	0.119	-0.025	0.113
6	-0.307	0.386	0.629	-0.140	0.110	0.143	0.070	-0.013
7	0.029	-0.083	0.259	0.002	0.275	0.219	-0.211	0.010
8	0.046	0.631	-0.075	-0.492	-0.336	0.452	-0.284	0.228
9	-0.065	-0.117	-0.320	0.256	0.027	0.191	-0.243	0.096

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	2	3	4	5	6	7	8	9
Mean_Logq	-6.0179	-5.1125	-4.9857	-4.9552	-5.1483	-5.2391	-5.2391	-5.2391
S.E_Logq	0.5031	0.2965	0.2437	0.2709	0.2690	0.2334	0.3419	0.1875

Terminal year survivor and F summaries:

Age 1 Year class = 2007

source	survivors	N	scaledWts
BTS-ISIS	112941	1	0.396
SNS	60395	1	0.493
fshk	103186	1	0.015
nshk	83433	1	0.096

Age 2 Year class = 2006

source	survivors	N	scaledWts
BTS-ISIS	52419	2	0.416
SNS	33464	2	0.430
NL Beam Trawl	57165	1	0.143
fshk	22081	1	0.011

Age 3 Year class = 2005

source	survivors	N	scaledWts
BTS-ISIS	82279	3	0.293
SNS	66613	3	0.349
NL Beam Trawl	136670	2	0.350
fshk	49059	1	0.009

Age 4 Year class = 2004

source	survivors	N	scaledWts
BTS-ISIS	10612	4	0.253
SNS	6909	3	0.221
NL Beam Trawl	13198	3	0.516
fshk	6435	1	0.010

Age 5 Year class = 2003

source	survivors	N	scaledWts
BTS-ISIS	3742	5	0.213
SNS	6335	4	0.176
NL Beam Trawl	6554	4	0.601
fshk	4730	1	0.010

```
 Age  6 Year class = 2002

source
               survivors N scaledWts
BTS-ISIS            4784 6     0.195
SNS                 6977 3     0.067
NL Beam Trawl       5904 5     0.727
fshk                3602 1     0.010

 Age  7 Year class = 2001

source
               survivors N scaledWts
BTS-ISIS            4796 7     0.185
SNS                 9335 2     0.041
NL Beam Trawl       8013 6     0.765
fshk                4013 1     0.009

 Age  8 Year class = 2000

source
               survivors N scaledWts
BTS-ISIS             369 8     0.159
SNS                  796 3     0.023
NL Beam Trawl        764 7     0.803
fshk                1098 1     0.015

 Age  9 Year class = 1999

source
               survivors N scaledWts
BTS-ISIS             427 9     0.130
SNS                  527 3     0.015
NL Beam Trawl        678 8     0.839
fshk                1315 1     0.016
```

Table 10.3.2. Sole in sub area IV: fishing mortality at age

2009-05-07 10:58:00 units= f

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.000	0.021	0.127	0.255	0.259	0.228	0.292	0.167	0.241	0.241
1958	0.000	0.017	0.149	0.235	0.276	0.361	0.345	0.295	0.303	0.303
1959	0.000	0.034	0.130	0.246	0.205	0.239	0.182	0.366	0.248	0.248
1960	0.000	0.029	0.158	0.241	0.323	0.267	0.289	0.344	0.294	0.294
1961	0.000	0.018	0.145	0.295	0.252	0.239	0.174	0.397	0.272	0.272
1962	0.000	0.019	0.141	0.229	0.363	0.313	0.367	0.247	0.304	0.304
1963	0.000	0.053	0.179	0.422	0.402	0.509	0.482	0.457	0.479	0.479
1964	0.000	0.020	0.326	0.250	0.486	0.365	0.516	0.325	0.390	0.390
1965	0.000	0.107	0.169	0.389	0.321	0.600	0.432	0.465	0.443	0.443
1966	0.000	0.124	0.437	0.204	0.490	0.369	0.318	0.360	0.349	0.349
1967	0.000	0.114	0.366	0.488	0.683	0.382	0.296	0.549	0.481	0.481
1968	0.011	0.308	0.695	0.643	0.506	0.296	0.268	0.395	0.423	0.423
1969	0.008	0.333	0.691	0.554	0.682	0.472	0.318	0.412	0.490	0.490
1970	0.010	0.153	0.643	0.549	0.320	0.331	0.382	0.368	0.391	0.391
1971	0.011	0.334	0.559	0.672	0.580	0.411	0.375	0.371	0.483	0.483
1972	0.005	0.238	0.660	0.521	0.531	0.361	0.228	0.310	0.391	0.391
1973	0.007	0.206	0.691	0.607	0.562	0.450	0.364	0.533	0.505	0.505
1974	0.001	0.188	0.592	0.640	0.516	0.508	0.560	0.388	0.524	0.524
1975	0.007	0.278	0.553	0.664	0.473	0.518	0.358	0.643	0.518	0.518
1976	0.010	0.107	0.565	0.512	0.559	0.370	0.468	0.402	0.629	0.629
1977	0.013	0.263	0.554	0.616	0.498	0.364	0.179	0.485	0.294	0.294
1978	0.001	0.236	0.573	0.537	0.524	0.524	0.644	0.535	0.513	0.513
1979	0.001	0.225	0.660	0.632	0.485	0.461	0.375	0.632	0.368	0.368
1980	0.004	0.128	0.555	0.590	0.584	0.406	0.582	0.521	0.577	0.577
1981	0.003	0.255	0.521	0.598	0.530	0.579	0.450	0.434	0.529	0.529
1982	0.018	0.231	0.697	0.557	0.626	0.597	0.507	0.523	0.527	0.527
1983	0.003	0.310	0.597	0.724	0.327	0.470	0.458	0.554	0.648	0.648
1984	0.003	0.290	0.719	0.677	0.669	0.708	0.529	0.421	0.576	0.576
1985	0.002	0.320	0.741	0.771	0.591	0.554	0.387	0.418	0.436	0.436
1986	0.002	0.145	0.622	0.687	0.674	0.739	0.739	0.322	0.559	0.559
1987	0.001	0.238	0.520	0.614	0.513	0.559	0.421	0.656	0.370	0.370
1988	0.000	0.238	0.659	0.736	0.618	0.582	0.530	0.399	0.904	0.904
1989	0.001	0.126	0.529	0.684	0.454	0.441	0.391	0.388	0.326	0.326
1990	0.005	0.137	0.408	0.531	0.580	0.617	0.489	0.580	0.596	0.596
1991	0.002	0.090	0.425	0.536	0.761	0.426	0.671	0.654	0.754	0.754
1992	0.003	0.120	0.435	0.467	0.486	0.625	0.665	0.600	0.836	0.836
1993	0.001	0.182	0.423	0.556	0.827	0.570	0.859	0.522	0.833	0.833
1994	0.013	0.140	0.480	0.636	0.673	0.880	0.509	0.633	0.883	0.883
1995	0.054	0.306	0.445	0.763	0.610	0.534	0.786	0.495	0.969	0.969
1996	0.004	0.275	0.696	0.979	0.699	0.841	0.714	0.980	0.492	0.492
1997	0.006	0.154	0.578	0.698	0.805	0.744	0.604	0.821	1.047	1.047
1998	0.002	0.279	0.615	0.790	0.762	0.732	0.607	0.932	0.977	0.977
1999	0.004	0.175	0.608	0.710	0.785	0.575	0.524	0.485	1.234	1.234
2000	0.020	0.239	0.579	0.790	0.614	0.763	0.844	0.691	0.391	0.391
2001	0.015	0.284	0.559	0.748	0.734	0.522	0.555	0.691	0.554	0.554
2002	0.006	0.230	0.620	0.637	0.710	0.618	0.441	0.886	0.443	0.443
2003	0.013	0.225	0.601	0.625	0.627	0.783	0.441	0.453	0.412	0.412
2004	0.012	0.230	0.533	0.685	0.588	0.444	0.361	0.277	0.958	0.958
2005	0.025	0.207	0.584	0.651	0.667	0.632	0.570	0.398	0.340	0.340
2006	0.033	0.263	0.425	0.436	0.455	0.489	0.475	0.498	0.384	0.384
2007	0.006	0.243	0.467	0.467	0.465	0.400	0.455	0.385	0.709	0.709
2008	**0.022**	**0.126**	**0.316**	**0.382**	**0.482**	**0.382**	**0.280**	**0.586**	**0.732**	**0.732**

Table 10.3.3 Sole in sub area IV: stock numbers at age

2009-05-07 10:58:50 units=thousands

age year	1	2	3	4	5	6	7	8	9	10
1957	128909	72454	89307	59106	17318	15057	27046	11836	2500	30811
1958	128643	116642	64213	71155	41456	12092	10843	18272	9062	26295
1959	488757	116401	103779	50074	50906	28474	7627	6950	12311	26788
1960	61714	442245	101843	82464	35415	37524	20278	5754	4362	32546
1961	99488	55841	388705	78708	58638	23191	25995	13738	3691	31943
1962	22895	90020	49615	304357	53011	41259	16518	19769	8361	29933
1963	20420	20717	79938	38986	219090	33369	27306	10356	13976	32249
1964	539075	8302	7992	27183	10396	59616	8153	6856	2665	9788
1965	121959	487723	7365	5221	19163	5783	37451	4404	4482	9390
1966	39901	110353	396507	5628	3203	12581	2872	21997	2504	8709
1967	75135	36104	88172	231674	4151	1775	7875	1891	13888	7981
1968	99262	67985	29162	55351	128652	1897	1096	5300	988	19813
1969	50787	88830	45204	13169	26329	70207	1277	759	3232	14254
1970	137795	45577	57621	20497	6849	12039	39613	841	455	16935
1971	42148	123446	35399	27412	10713	4501	7820	24467	527	12543
1972	76525	37737	79957	18309	12669	5428	2701	4863	15276	9059
1973	104859	68902	26923	37382	9837	6740	3422	1946	3228	15274
1974	109939	94211	50714	12201	18427	5072	3888	2151	1033	12346
1975	40816	99381	70616	25398	5821	9957	2761	2011	1321	8913
1976	113311	36681	68089	36753	11836	3280	5366	1747	957	5960
1977	140375	101538	29821	35007	19926	6125	2049	3039	1057	8711
1978	47256	125355	70637	15499	17116	10952	3850	1551	1692	4178
1979	11723	42733	89615	36051	8194	9172	5867	1831	822	5191
1980	151694	10599	30887	41925	17344	4564	5235	3647	880	2870
1981	149346	136652	8440	16047	21022	8752	2750	2647	1960	2312
1982	152751	134731	95856	4537	7988	11199	4437	1587	1552	3263
1983	142179	135684	96764	43219	2352	3866	5578	2418	851	2578
1984	70791	128279	90042	48188	18951	1535	2187	3192	1258	2135
1985	80833	63873	86837	39685	22149	8785	684	1166	1896	2891
1986	159654	72984	41987	37468	16612	11096	4566	420	695	4110
1987	72553	144105	57132	20396	17063	7662	4794	1973	275	2352
1988	454627	65559	102756	30724	9991	9245	3966	2848	926	556
1989	108296	411354	46746	48096	13311	4872	4673	2113	1729	1761
1990	177757	97879	328084	24925	21970	7646	2836	2861	1297	1967
1991	70476	160020	77208	197503	13263	11134	3733	1574	1449	2150
1992	354171	63655	132271	45680	104595	5604	6579	1726	741	2174
1993	69289	319535	51099	77470	25920	58191	2715	3060	857	1554
1994	57057	62644	241137	30286	40221	10260	29791	1040	1642	1616
1995	96104	50944	49259	135050	14515	18568	3852	16197	500	1122
1996	49508	82392	33952	28570	56971	7133	9850	1587	8934	2659
1997	271749	44633	56645	15321	9714	25622	2785	4366	539	2709
1998	114161	244377	34634	28757	6895	3931	11015	1377	1738	1414
1999	82581	103065	167236	16936	11815	2913	1711	5431	491	1192
2000	123824	74450	78264	82386	7536	4878	1483	916	3027	2313
2001	63480	109804	53027	39674	33830	3691	2057	577	415	1781
2002	187821	56599	74769	27439	16992	14697	1983	1068	262	1066
2003	85663	168944	40699	36404	13137	7561	7165	1154	399	1399
2004	46679	76515	122114	20181	17635	6351	3126	4171	664	658
2005	49955	41746	55012	64863	9201	8863	3687	1971	2860	1456
2006	221770	44101	30718	27765	30607	4271	4264	1887	1198	1769
2007	60383	194184	30687	18179	16238	17573	2369	2400	1037	1119
2008	90949	54335	137762	17411	10317	9232	10657	1360	1478	1344
2009	NA	80468	43345	90880	10752	5763	5701	7286	685	1228

Table 10.4.1. Sole in sub area IV: XSA summary

year	recruitment	ssb	catch	landings	tsb	fbar2-6	Y/ssb
1957	128909	55107	11601	12067	63402	0.178	0.22
1958	128643	60919	14216	14287	72300	0.207	0.23
1959	488757	65580	13702	13832	85947	0.171	0.21
1960	61714	73398	18740	18620	105898	0.204	0.25
1961	99488	117099	23246	23566	123495	0.190	0.20
1962	22895	116830	27039	26877	123703	0.213	0.23
1963	20420	113628	26380	26164	115588	0.313	0.23
1964	539075	37127	11740	11342	51185	0.289	0.31
1965	121959	30029	17767	17043	101359	0.317	0.57
1966	39901	84243	33705	33340	92965	0.325	0.40
1967	75135	82958	32704	33439	91227	0.406	0.40
1968	99262	72306	33285	33179	83081	0.490	0.46
1969	50787	55267	27014	27559	68707	0.546	0.50
1970	137795	50680	19683	19685	60369	0.399	0.39
1971	42148	43742	23374	23652	63445	0.511	0.54
1972	76525	47437	21320	21086	56194	0.462	0.44
1973	104859	36775	18950	19309	51131	0.504	0.53
1974	109939	36110	18237	17989	53712	0.489	0.50
1975	40816	38365	20559	20773	54502	0.497	0.54
1976	113311	38944	16959	17326	48118	0.423	0.44
1977	140375	34623	17672	18003	54463	0.459	0.52
1978	47256	36195	20370	20280	55274	0.479	0.56
1979	11723	44954	22321	22598	51806	0.492	0.50
1980	151694	33584	15496	15807	41164	0.453	0.47
1981	149346	22921	15009	15403	49109	0.496	0.67
1982	152751	32855	21286	21579	58007	0.541	0.66
1983	142179	39956	24828	24927	66061	0.486	0.62
1984	70791	43464	26747	26839	64065	0.613	0.62
1985	80833	41082	24497	24248	53235	0.595	0.59
1986	159654	34554	18316	18201	52243	0.573	0.53
1987	72553	29658	17462	17368	55478	0.489	0.59
1988	454627	38765	21612	21590	70216	0.567	0.56
1989	108296	34075	22156	21805	94200	0.447	0.64
1990	177757	89643	35485	35120	113017	0.454	0.39
1991	70476	77479	34096	33513	103246	0.448	0.43
1992	354171	76772	29787	29341	104411	0.427	0.38
1993	69289	54752	31858	31491	99117	0.511	0.58
1994	57057	74337	33405	33002	86148	0.562	0.44
1995	96104	58934	30690	30467	71432	0.532	0.52
1996	49508	38310	22913	22651	52897	0.698	0.59
1997	271749	28071	15050	14901	48354	0.596	0.53
1998	114161	20882	21049	20868	60803	0.636	1.00
1999	82581	41918	23717	23475	59548	0.571	0.56
2000	123824	39217	22859	22641	55756	0.597	0.58
2001	63480	30762	20582	19944	49748	0.569	0.65
2002	187821	31412	17092	16945	49010	0.563	0.54
2003	85663	25758	17940	17920	54707	0.572	0.70
2004	46679	38402	18744	18757	51218	0.496	0.49
2005	49955	33520	16722	16355	42280	0.548	0.49
2006	221770	25778	12246	12594	43393	0.414	0.49
2007	60383	19585	14725	14635	52120	0.408	0.75
2008	90949	40676	13924	14144	53592	0.338	0.35

Table 10.5.1. Sole in sub area IV: RCT3 input table

Year

Class	N age 1	N age 2	DFS 0	SNS 1	SNS 2	BTS 1
1969	137795	123446	-11.00	5410	1844	-11.00
1970	42148	37737	-11.00	893	272	-11.00
1971	76525	68902	-11.00	1455	935	-11.00
1972	104859	94211	-11.00	5587	361	-11.00
1973	109939	99381	-11.00	2348	848	-11.00
1974	40816	36681	-11.00	529	74	-11.00
1975	113311	101538	168.84	1399	776	-11.00
1976	140375	125355	82.28	3743	1355	-11.00
1977	47256	42733	33.80	1548	408	-11.00
1978	11723	10599	96.87	94	89	-11.00
1979	151694	136652	392.08	4313	1413	-11.00
1980	149346	134731	404.00	3737	1146	-11.00
1981	152751	135684	293.93	5856	1123	-11.00
1982	142179	128279	328.52	2621	1100	-11.00
1983	70791	63873	104.38	2493	716	-11.00
1984	80833	72984	186.53	3619	458	2.65
1985	159654	144105	315.03	3705	944	7.88
1986	72553	65559	73.22	1948	594	6.97
1987	454627	411354	523.86	11227	5005	83.11
1988	108296	97879	50.07	2831	1120	9.02
1989	177757	160020	77.80	2856	2529	22.60
1990	70476	63655	21.09	1254	144	3.71
1991	354171	319535	391.93	11114	3420	74.44
1992	69289	62644	25.30	1291	498	4.99
1993	57057	50944	25.13	652	224	5.88
1994	96104	82392	69.11	1362	349	27.86
1995	49508	44633	19.07	218	154	3.51
1996	271749	244377	59.62	10279	3126	173.94
1997	114161	103065	44.08	4095	972	14.12
1998	82581	74450	-11.00	1649	126	11.41
1999	123824	109804	-11.00	1639	655	14.46
2000	63480	56599	15.51	970	379	8.17
2001	187821	168944	85.31	7542	-11	21.90
2002	85663	76515	64.97	-11	624	10.76
2003	46679	41746	16.82	1369	163	3.65
2004	49955	44101	40.10	568	382	3.14
2005	-11	-11	46.81	4167	911	16.82
2006	-11	-11	14.69	849	259	5.81
2007	-11	-11	23.51	1259	-11	15.04
2008	-11	-11	26.74	-11	-11	-11

Table 10.5.2. Sole in sub area IV: RCT3 analysis – age 1

```
Analysis by RCT3 ver3.1 of data from file : altin_1.txt
 Sole North Sea Age 1 Data for 1 surveys over 40 years :  1969 - 2008
 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
 Series Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
               cept   Error           Pts  Value   Value    Error   Weights
 DFS0   1.16   6.34   1.02   .347     28   3.32   10.20    1.101     .276
                                    VPA Mean =   11.47     .679     .724
 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction           Error   Error
  2008       67348     11.12     .58     .57      .96
```

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 2

```
Analysis by RCT3 ver3.1 of data from file :
 altin_2.txt

 Sole North Sea-Age 2

 Data for    4 surveys over   40 years :  1969 - 2008
 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 =   2007
       I-----------Regression----------I  I-----------Prediction---------I

 Series Slope  Inter-    Std  Rsquare  No.  Index Predicted   Std     WAP
               cept   Error            Pts  Value   Value    Error   Weights

 DFS0   1.16   6.24   1.02   .348      28   3.20    9.95    1.102     .048
 SNS1    .73   5.79    .34   .809      35   7.14   11.00     .357     .454
 BTS1    .70   9.66    .36   .770      21   2.78   11.60     .393     .374

                                   VPA Mean =   11.36     .680     .125

 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction           Error   Error
 2007       74556     11.22     .24     .23      .90
```

Table 10.6.1. Sole in sub area IV: STF Input table (F values presented are for Fsq)

age	year	f	stock.n	stock.wt	lands.wt	mat	M
1	2009	0.018	93786	0.05	0.16	0	0.1
2	2009	0.184	80468	0.15	0.19	0	0.1
3	2009	0.352	43345	0.19	0.22	1	0.1
4	2009	0.374	90880	0.23	0.25	1	0.1
5	2009	0.408	10752	0.25	0.27	1	0.1
6	2009	0.370	5763	0.28	0.31	1	0.1
7	2009	0.352	5701	0.28	0.30	1	0.1
8	2009	0.428	7286	0.28	0.32	1	0.1
9	2009	0.531	685	0.31	0.32	1	0.1
10	2009	0.531	1228	0.39	0.37	1	0.1
1	2010	0.018	93786	0.05	0.16	0	0.1
2	2010	0.184	83372	0.15	0.19	0	0.1
3	2010	0.352	60573	0.19	0.22	1	0.1
4	2010	0.374	27595	0.23	0.25	1	0.1
5	2010	0.408	56564	0.25	0.27	1	0.1
6	2010	0.370	6468	0.28	0.31	1	0.1
7	2010	0.352	3601	0.28	0.30	1	0.1
8	2010	0.428	3627	0.28	0.32	1	0.1
9	2010	0.531	4298	0.31	0.32	1	0.1
10	2010	0.531	1018	0.39	0.37	1	0.1
1	2011	0.018	93786	0.05	0.16	0	0.1
2	2011	0.184	83372	0.15	0.19	0	0.1
3	2011	0.352	62759	0.19	0.22	1	0.1
4	2011	0.374	38562	0.23	0.25	1	0.1
5	2011	0.408	17175	0.25	0.27	1	0.1
6	2011	0.370	34027	0.28	0.31	1	0.1
7	2011	0.352	4042	0.28	0.30	1	0.1
8	2011	0.428	2291	0.28	0.32	1	0.1
9	2011	0.531	2140	0.31	0.32	1	0.1
10	2011	0.531	2828	0.39	0.37	1	0.1

Table 10.6.2. (A) Sole in sub area IV: STF option table, assuming F(2009) = F(sq)

fmult	year	ssb	f2-6	recruit	landings
1	2009	37670	0.338	93786.1	15137

	year	fmult	f2-6	landings	ssb	ssb2011
2	2010	0.0	0.000	0	37664	53220
5	2010	0.1	0.034	1797	37664	51482
8	2010	0.2	0.068	3533	37664	49805
11	2010	0.3	0.101	5209	37664	48188
14	2010	0.4	0.135	6829	37664	46627
17	2010	0.5	0.169	8393	37664	45122
20	2010	0.6	0.203	9904	37664	43669
23	2010	0.7	0.236	11365	37664	42267
26	2010	0.8	0.270	12776	37664	40915
29	2010	0.9	0.304	14140	37664	39609
32	2010	1.0	0.338	15458	37664	38349
35	2010	1.1	0.371	16732	37664	37132
38	2010	1.2	0.405	17964	37664	35958
41	2010	1.3	0.439	19155	37664	34825
44	2010	1.4	0.473	20306	37664	33730
47	2010	1.5	0.506	21420	37664	32673
50	2010	1.6	0.540	22497	37664	31653
53	2010	1.7	0.574	23538	37664	30667
56	2010	1.8	0.608	24546	37664	29715
59	2010	1.9	0.642	25521	37664	28796
62	2010	2.0	0.675	26464	37664	27908

Table 10.6.2. (B) Sole in sub area IV: STF option table, assuming F(2009) = 0.9*F(sq)

fmult	year	ssb	f2-6	recruit	landings
0.9	2009	37670	0.304	93786.1	13841

year	fmult	f2-6	landings	ssb	ssb2011
2010	0.0	0.000	0	38875	54481
2010	0.1	0.034	1847	38875	52695
2010	0.2	0.068	3630	38875	50971
2010	0.3	0.101	5352	38875	49309
2010	0.4	0.135	7015	38875	47706
2010	0.5	0.169	8622	38875	46159
2010	0.6	0.203	10174	38875	44666
2010	0.7	0.236	11674	38875	43226
2010	0.8	0.270	13122	38875	41837
2010	0.9	0.304	14522	38875	40496
2010	1.0	0.338	15875	38875	39202
2010	1.1	0.371	17183	38875	37953
2010	1.2	0.405	18447	38875	36747
2010	1.3	0.439	19669	38875	35584
2010	1.4	0.473	20850	38875	34460
2010	1.5	0.506	21993	38875	33376
2010	1.6	0.540	23097	38875	32328
2010	1.7	0.574	24166	38875	31317
2010	1.8	0.608	25199	38875	30341
2010	1.9	0.642	26199	38875	29397
2010	2.0	0.675	27166	38875	28486

Table 10.6.2. (C) Sole in sub area IV: STF option table, assuming F(2009)~Landings for 2009=TAC for 2009

fmult	year	ssb	f2-6	recruit	landings
0.797	2009	37670	0.308	93786.1	14000

year	fmult	f2-6	landings	ssb	ssb2010
2010	0.0	0.000	0	38726	54326
2010	0.1	0.034	1841	38726	52546
2010	0.2	0.068	3618	38726	50828
2010	0.3	0.101	5335	38726	49171
2010	0.4	0.135	6992	38726	47573
2010	0.5	0.169	8594	38726	46031
2010	0.6	0.203	10141	38726	44544
2010	0.7	0.236	11636	38726	43109
2010	0.8	0.270	13080	38726	41724
2010	0.9	0.304	14475	38726	40387
2010	1.0	0.338	15824	38726	39097
2010	1.1	0.371	17128	38726	37852
2010	1.2	0.405	18388	38726	36650
2010	1.3	0.439	19606	38726	35490
2010	1.4	0.473	20784	38726	34371
2010	1.5	0.506	21922	38726	33289
2010	1.6	0.540	23024	38726	32245
2010	1.7	0.574	24089	38726	31237
2010	1.8	0.608	25119	38726	30264
2010	1.9	0.642	26115	38726	29324
2010	2.0	0.675	27079	38726	28415

Table 10.6.3. (A) Sole in sub area IV: STF detailed, assuming F(2009) = F(sq)

age	year	f	stock.n	stock.wt	lands.wt	mat	M	lands.n	lands	SSB	TSB
1	2009	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2009	0.184	80468	0.15	0.19	0	0.1	12890	2403	0	12178
3	2009	0.352	43345	0.19	0.22	1	0.1	12263	2692	8322	8322
4	2009	0.374	90880	0.23	0.25	1	0.1	27079	6814	20690	20690
5	2009	0.408	10752	0.25	0.27	1	0.1	3441	935	2692	2692
6	2009	0.370	5763	0.28	0.31	1	0.1	1702	521	1639	1639
7	2009	0.352	5701	0.28	0.30	1	0.1	1616	492	1604	1604
8	2009	0.428	7286	0.28	0.32	1	0.1	2422	769	2030	2030
9	2009	0.531	685	0.31	0.32	1	0.1	270	87	212	212
10	2009	0.531	1228	0.39	0.37	1	0.1	484	181	481	481
1	2010	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2010	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2010	0.352	60573	0.19	0.22	1	0.1	17137	3762	11630	11630
4	2010	0.374	27595	0.23	0.25	1	0.1	8222	2069	6282	6282
5	2010	0.408	56564	0.25	0.27	1	0.1	18103	4917	14160	14160
6	2010	0.370	6468	0.28	0.31	1	0.1	1910	585	1839	1839
7	2010	0.352	3601	0.28	0.30	1	0.1	1021	311	1013	1013
8	2010	0.428	3627	0.28	0.32	1	0.1	1206	383	1011	1011
9	2010	0.531	4298	0.31	0.32	1	0.1	1693	549	1330	1330
10	2010	0.531	1018	0.39	0.37	1	0.1	401	150	399	399
1	2011	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2011	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2011	0.352	62759	0.19	0.22	1	0.1	17755	3898	12050	12050
4	2011	0.374	38562	0.23	0.25	1	0.1	11490	2891	8779	8779
5	2011	0.408	17175	0.25	0.27	1	0.1	5497	1493	4299	4299
6	2011	0.370	34027	0.28	0.31	1	0.1	10050	3077	9675	9675
7	2011	0.352	4042	0.28	0.30	1	0.1	1145	349	1137	1137
8	2011	0.428	2291	0.28	0.32	1	0.1	761	242	638	638
9	2011	0.531	2140	0.31	0.32	1	0.1	843	273	662	662
10	2011	0.531	2828	0.39	0.37	1	0.1	1114	417	1108	1108

Table 10.6.3. (B) Sole in sub area IV: STF detailed, assuming F(2009) = 0.9*F(sq)

age	year	f	stock.n	stock.wt	lands.wt	mat	M	lands.n	lands	SSB	TSB
1	2009	0.016	93786	0.05	0.16	0	0.1	1411	219	0	4689
2	2009	0.166	80468	0.15	0.19	0	0.1	11703	2181	0	12178
3	2009	0.316	43345	0.19	0.22	1	0.1	11218	2463	8322	8322
4	2009	0.337	90880	0.23	0.25	1	0.1	24796	6240	20690	20690
5	2009	0.367	10752	0.25	0.27	1	0.1	3156	857	2692	2692
6	2009	0.333	5763	0.28	0.31	1	0.1	1558	477	1639	1639
7	2009	0.317	5701	0.28	0.30	1	0.1	1478	450	1604	1604
8	2009	0.385	7286	0.28	0.32	1	0.1	2223	706	2030	2030
9	2009	0.478	685	0.31	0.32	1	0.1	249	81	212	212
10	2009	0.478	1228	0.39	0.37	1	0.1	446	167	481	481
1	2010	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2010	0.184	83520	0.15	0.19	0	0.1	13379	2494	0	12639
3	2010	0.352	61698	0.19	0.22	1	0.1	17455	3832	11846	11846
4	2010	0.374	28582	0.23	0.25	1	0.1	8516	2143	6507	6507
5	2010	0.408	58721	0.25	0.27	1	0.1	18793	5104	14700	14700
6	2010	0.370	6738	0.28	0.31	1	0.1	1990	609	1916	1916
7	2010	0.352	3737	0.28	0.30	1	0.1	1059	322	1051	1051
8	2010	0.428	3757	0.28	0.32	1	0.1	1249	397	1047	1047
9	2010	0.531	4486	0.31	0.32	1	0.1	1767	573	1388	1388
10	2010	0.531	1073	0.39	0.37	1	0.1	423	158	421	421
1	2011	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2011	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2011	0.352	62870	0.19	0.22	1	0.1	17786	3904	12071	12071
4	2011	0.374	39279	0.23	0.25	1	0.1	11703	2945	8942	8942
5	2011	0.408	17790	0.25	0.27	1	0.1	5693	1546	4453	4453
6	2011	0.370	35324	0.28	0.31	1	0.1	10434	3194	10044	10044
7	2011	0.352	4210	0.28	0.30	1	0.1	1193	363	1184	1184
8	2011	0.428	2377	0.28	0.32	1	0.1	790	251	662	662
9	2011	0.531	2216	0.31	0.32	1	0.1	873	283	686	686
10	2011	0.531	2957	0.39	0.37	1	0.1	1165	437	1159	1159

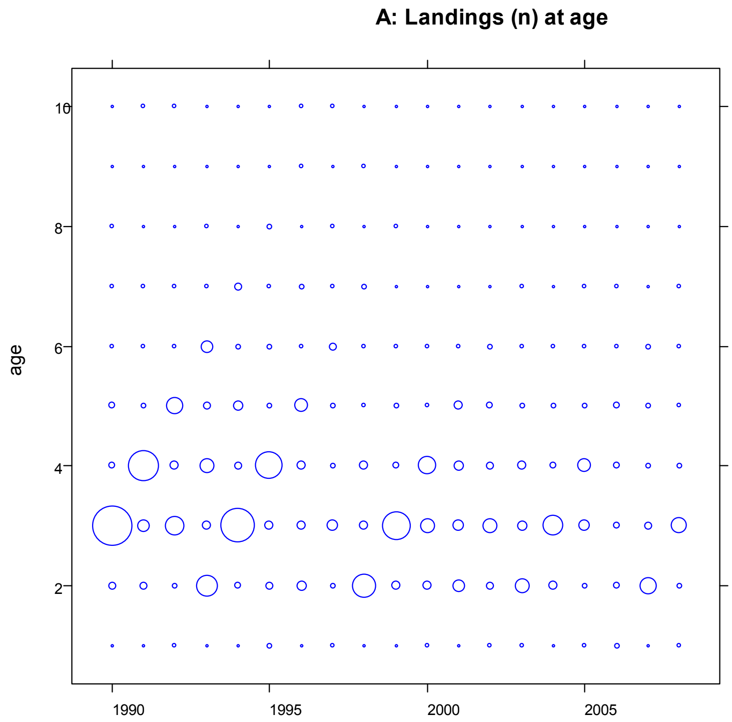
Table 10.6.3. (C) Sole in sub area IV: STF detailed, assuming F(2009) = TAC

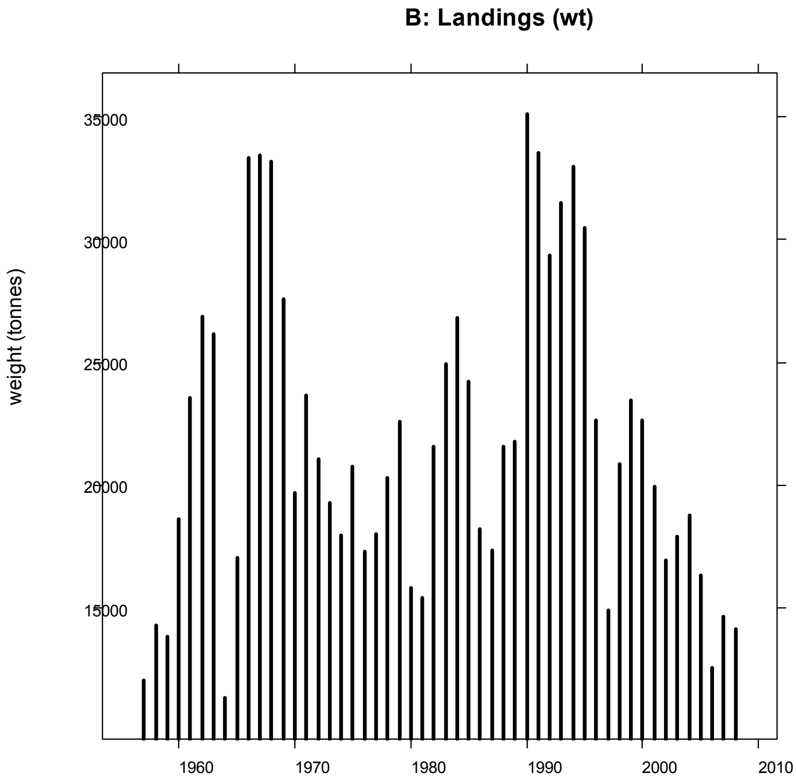
age	year	f	stock.n	stock.wt	lands.wt	mat	M	lands.n	lands	SSB	TSB
1	2009	0.016	93786	0.05	0.16	0	0.1	1430	222	0	4689
2	2009	0.168	80468	0.15	0.19	0	0.1	11848	2208	0	12178
3	2009	0.321	43345	0.19	0.22	1	0.1	11346	2491	8322	8322
4	2009	0.341	90880	0.23	0.25	1	0.1	25077	6310	20690	20690
5	2009	0.372	10752	0.25	0.27	1	0.1	3191	867	2692	2692
6	2009	0.338	5763	0.28	0.31	1	0.1	1576	482	1639	1639
7	2009	0.321	5701	0.28	0.30	1	0.1	1495	455	1604	1604
8	2009	0.390	7286	0.28	0.32	1	0.1	2247	714	2030	2030
9	2009	0.485	685	0.31	0.32	1	0.1	251	81	212	212
10	2009	0.485	1228	0.39	0.37	1	0.1	451	169	481	481
1	2010	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2010	0.184	83502	0.15	0.19	0	0.1	13376	2493	0	12637
3	2010	0.352	61561	0.19	0.22	1	0.1	17416	3823	11820	11820
4	2010	0.374	28461	0.23	0.25	1	0.1	8480	2134	6480	6480
5	2010	0.408	58455	0.25	0.27	1	0.1	18708	5081	14633	14633
6	2010	0.370	6705	0.28	0.31	1	0.1	1980	606	1906	1906
7	2010	0.352	3720	0.28	0.30	1	0.1	1054	321	1047	1047
8	2010	0.428	3741	0.28	0.32	1	0.1	1243	395	1042	1042
9	2010	0.531	4463	0.31	0.32	1	0.1	1758	570	1381	1381
10	2010	0.531	1066	0.39	0.37	1	0.1	420	157	418	418
1	2011	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2011	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2011	0.352	62857	0.19	0.22	1	0.1	17783	3904	12068	12068
4	2011	0.374	39191	0.23	0.25	1	0.1	11677	2938	8923	8923
5	2011	0.408	17714	0.25	0.27	1	0.1	5669	1540	4434	4434
6	2011	0.370	35165	0.28	0.31	1	0.1	10386	3180	9998	9998
7	2011	0.352	4189	0.28	0.30	1	0.1	1187	362	1179	1179
8	2011	0.428	2367	0.28	0.32	1	0.1	787	250	659	659
9	2011	0.531	2207	0.31	0.32	1	0.1	869	282	683	683
10	2011	0.531	2941	0.39	0.37	1	0.1	1159	434	1153	1153

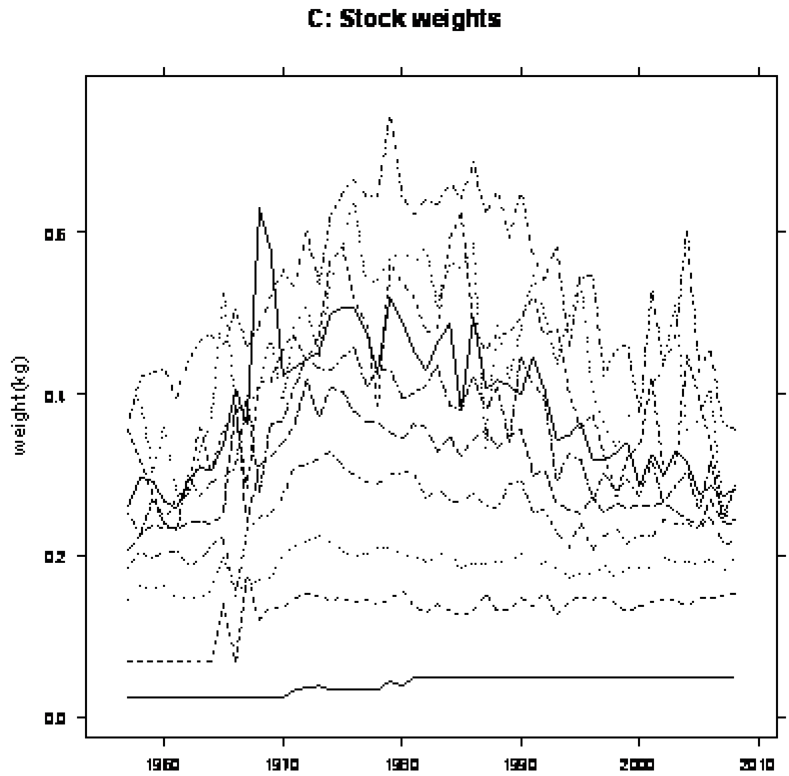
Table 10.6.4 Yield and spawning biomass per Recruit F-reference points (2009):

	Fish Mort Ages 2–6	Yield/R	SSB/R
Average last 3 years	0.39	0.17	0.36
F_{max} *	0.59	0.17	0.24
$F_{0.1}$	0.11	0.14	1.02
F_{med}	0.32	0.17	0.43

*Poorly defined


A: Landings (n) at age
age
10
8
6
4
2
1990
1995
2000
2005


B: Landings (wt)
weight (tonnes)
35000
30000
25000
20000
15000
1960
1970
1980
1990
2000
2010



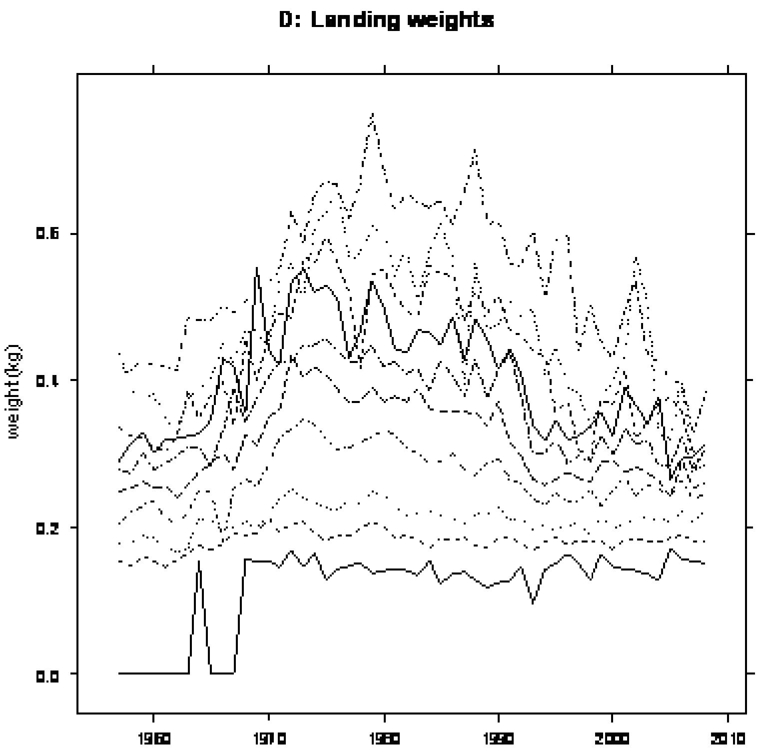
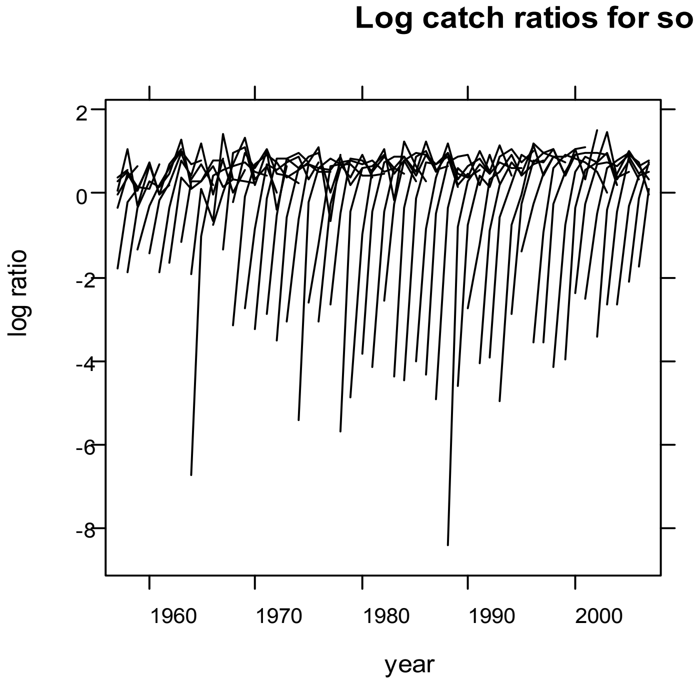


Figure 10.2.1. Sole in Sub-Area IV. A: bubble plot of landings (n) by age and year; B: time series of landings (total tonnages) 1957-2008; C: time-series of stock-weights by age 1957-2008; D: time-series of landing-weights by age 1957-2008.



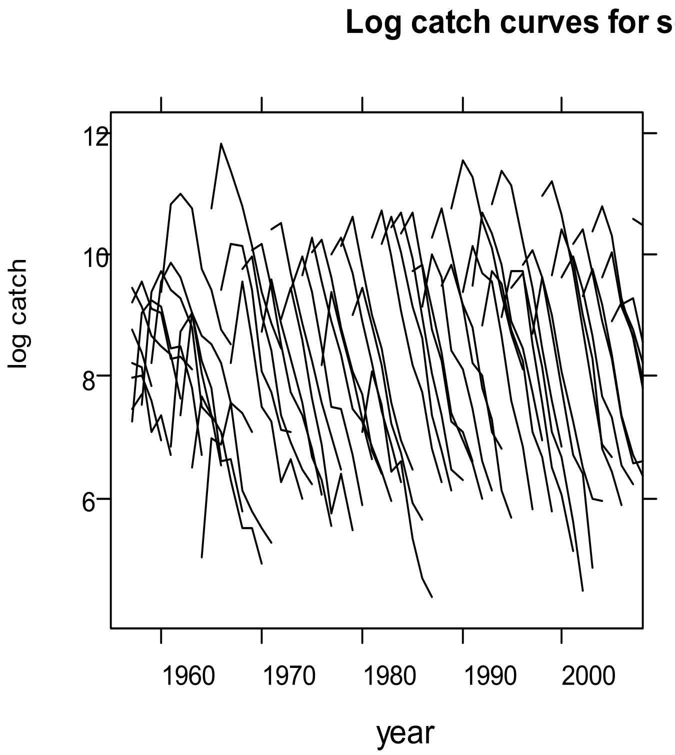


Figure 10.2.2. Sole in Sub-Area IV: Log catch ratios (left) and catch curves (right) from 1957 to 2008.

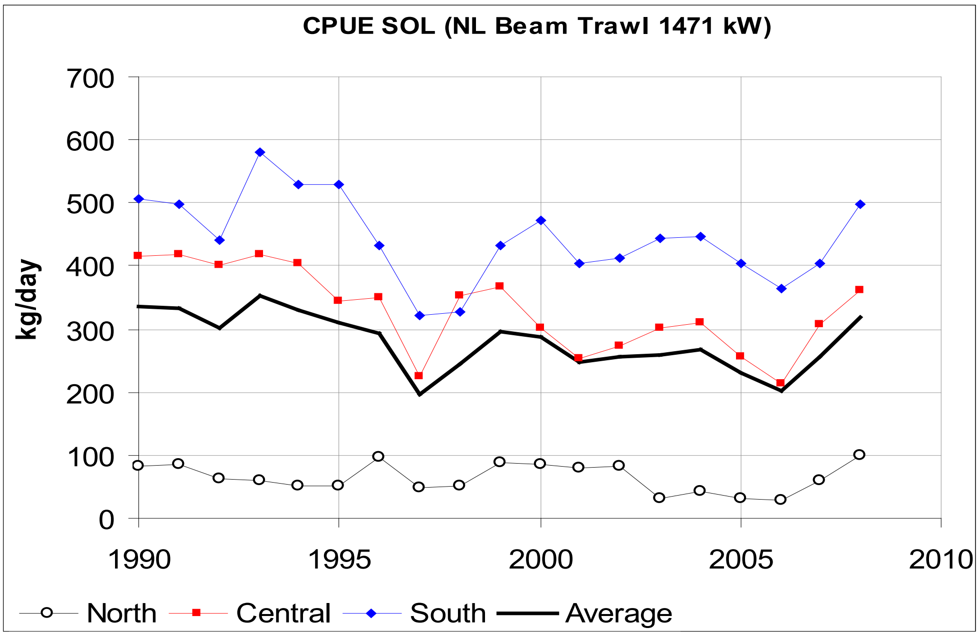


Figure 10.2.3. Sole in Sub-Area IV: LpUE series in North Central and Southern North Sea 1990-2008. LpUE trends in the Dutch beam trawl fleet (only large vessels, 2000 HP,) based on landings and effort records in the Dutch logbook database from vessels landings into the Netherlands. Three (North Sea) areas are considered: a) (north, open circles), b) (central, red squares) and c) (south, diamond blue). Black line indicates the overall trend in LpUE)

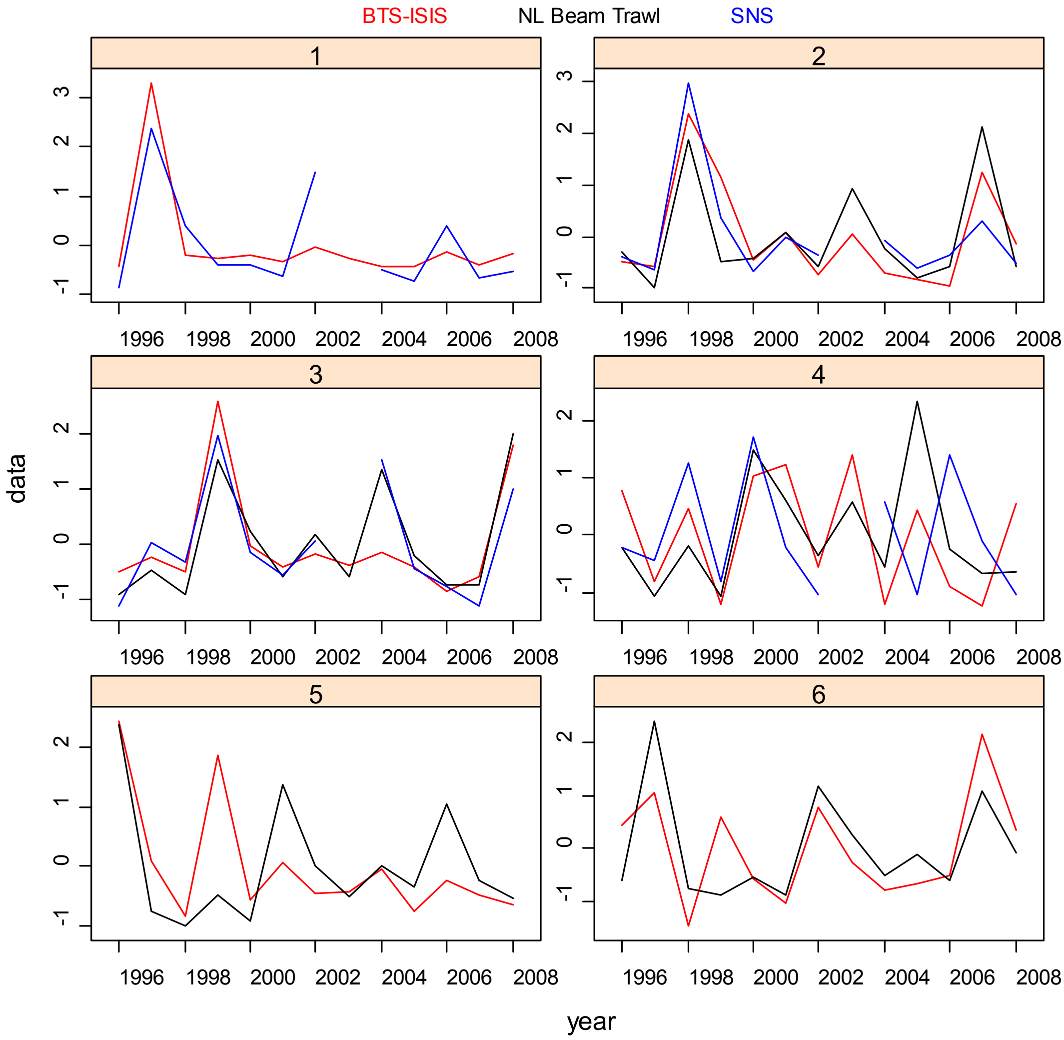


Figure 10.2.4 Sole in sub-area IV. Time series of the standardized indices age 1 to 6 from the three tuning fleets used in the final XSA assessment (BTS-ISIS, SNS and NL beam trawl).

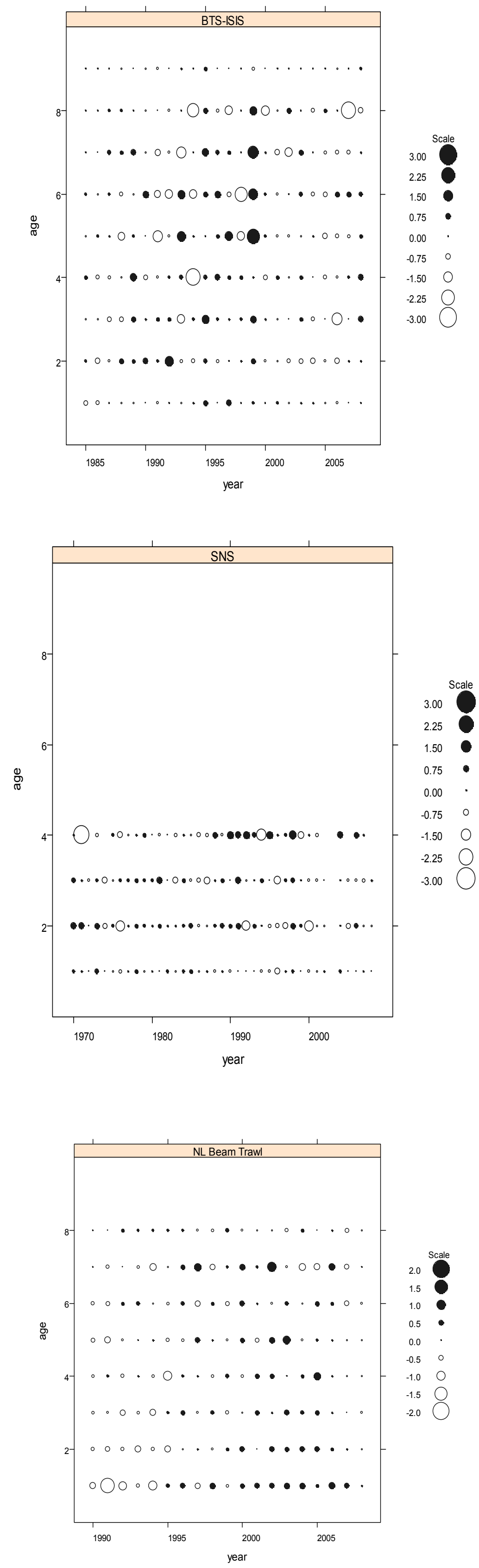


Figure 10.3.1 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the single fleet runs. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

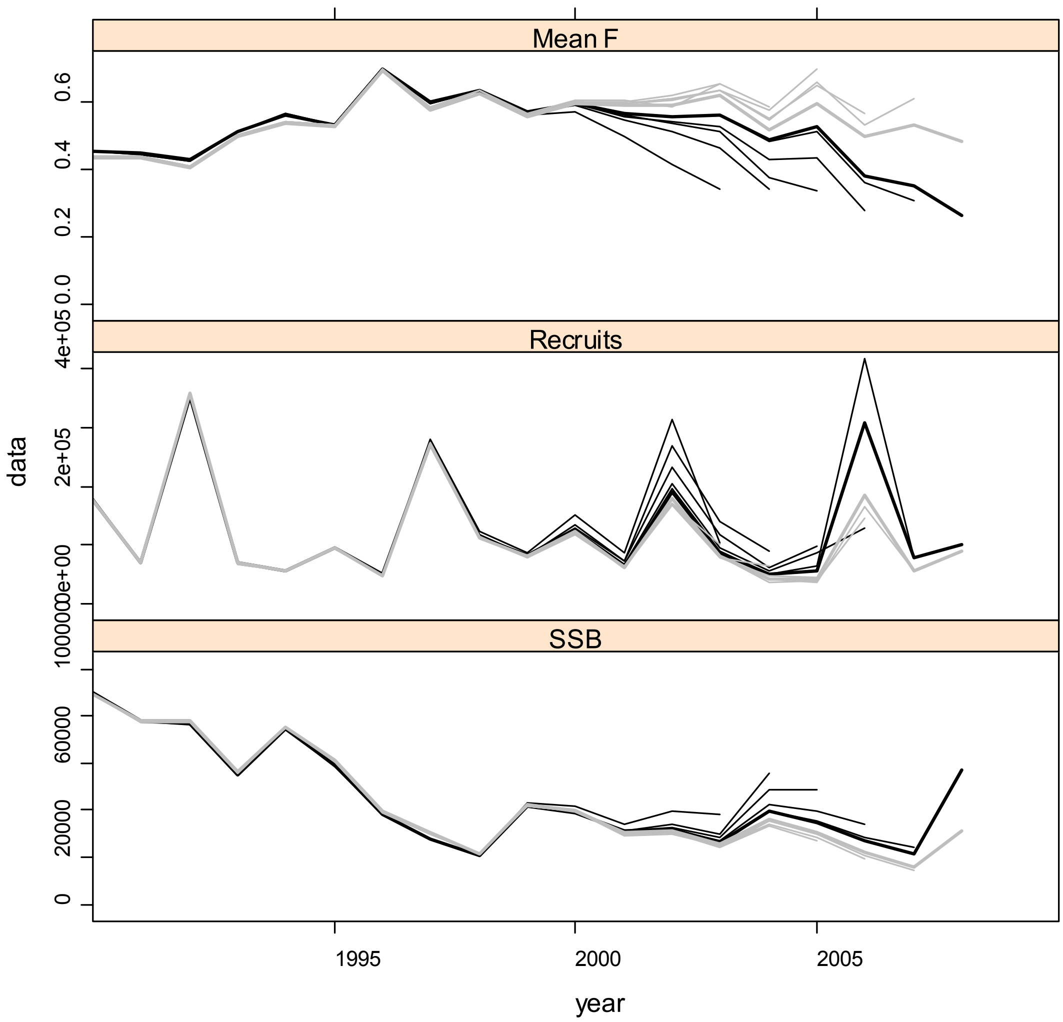


Figure 10.3.2 Sole in sub-area IV. XSA retrospective analysis of assessment estimates of fishing mortality using different combinations of indices. Grey lines: using survey indices only. Black lines: using commercial indices only.

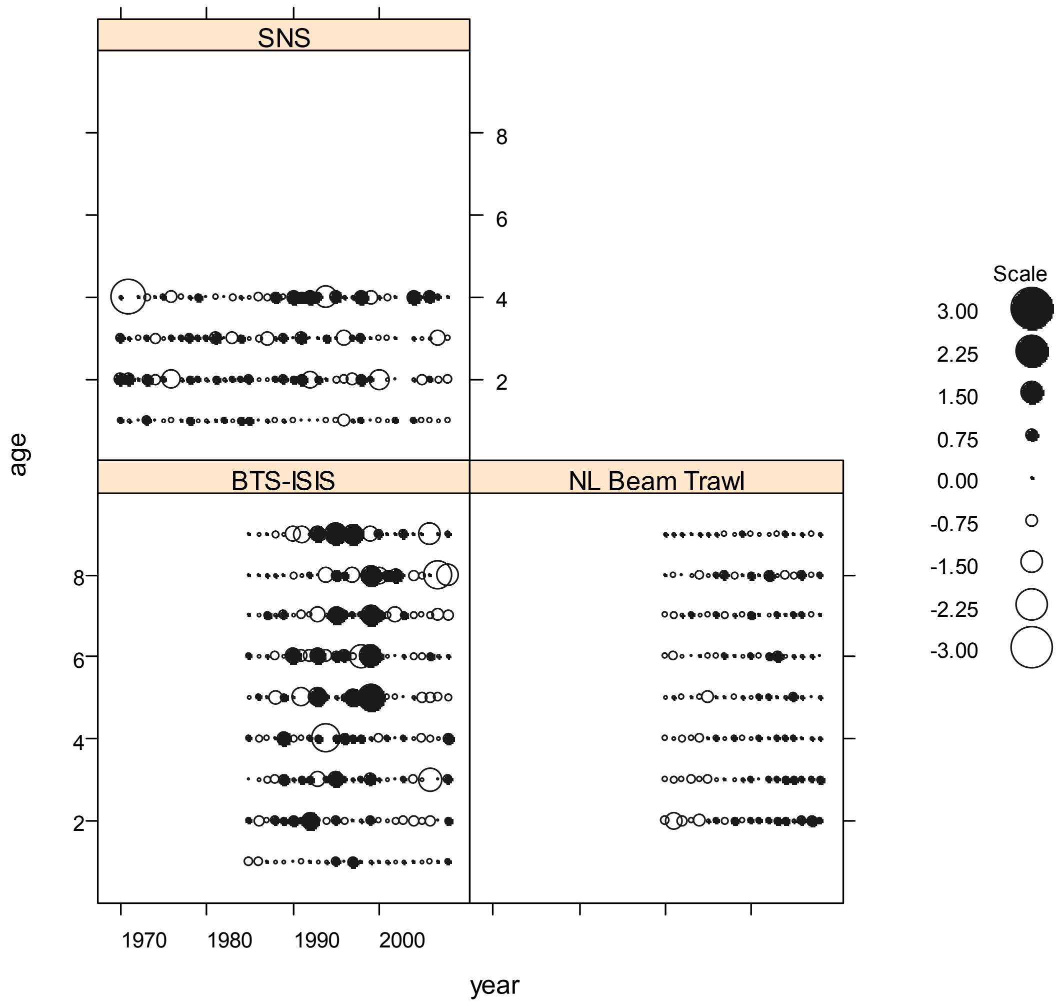


Figure 10.3.3 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the final run. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

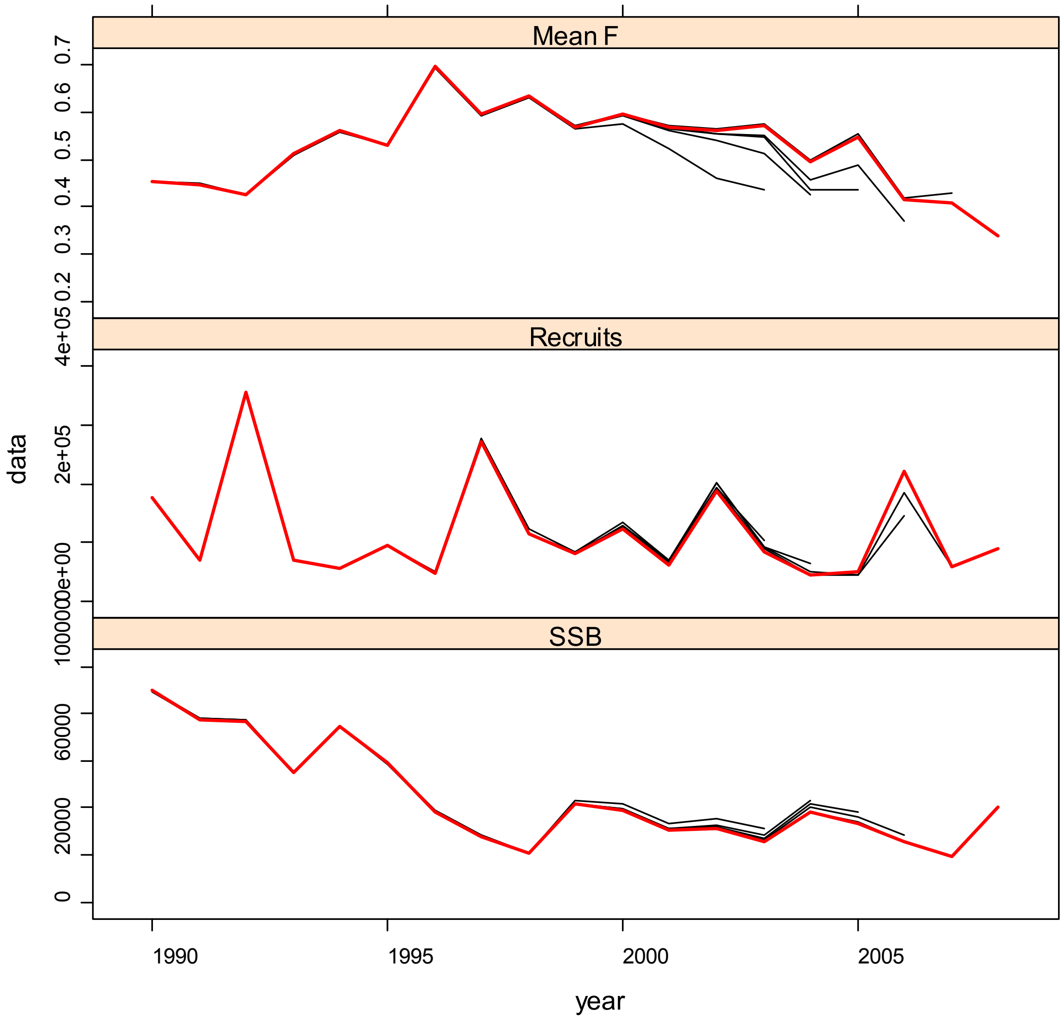


Figure 10.3.4 Sole in sub-area IV. Retrospective analysis of F, SSB and recruitment for 1990–2008

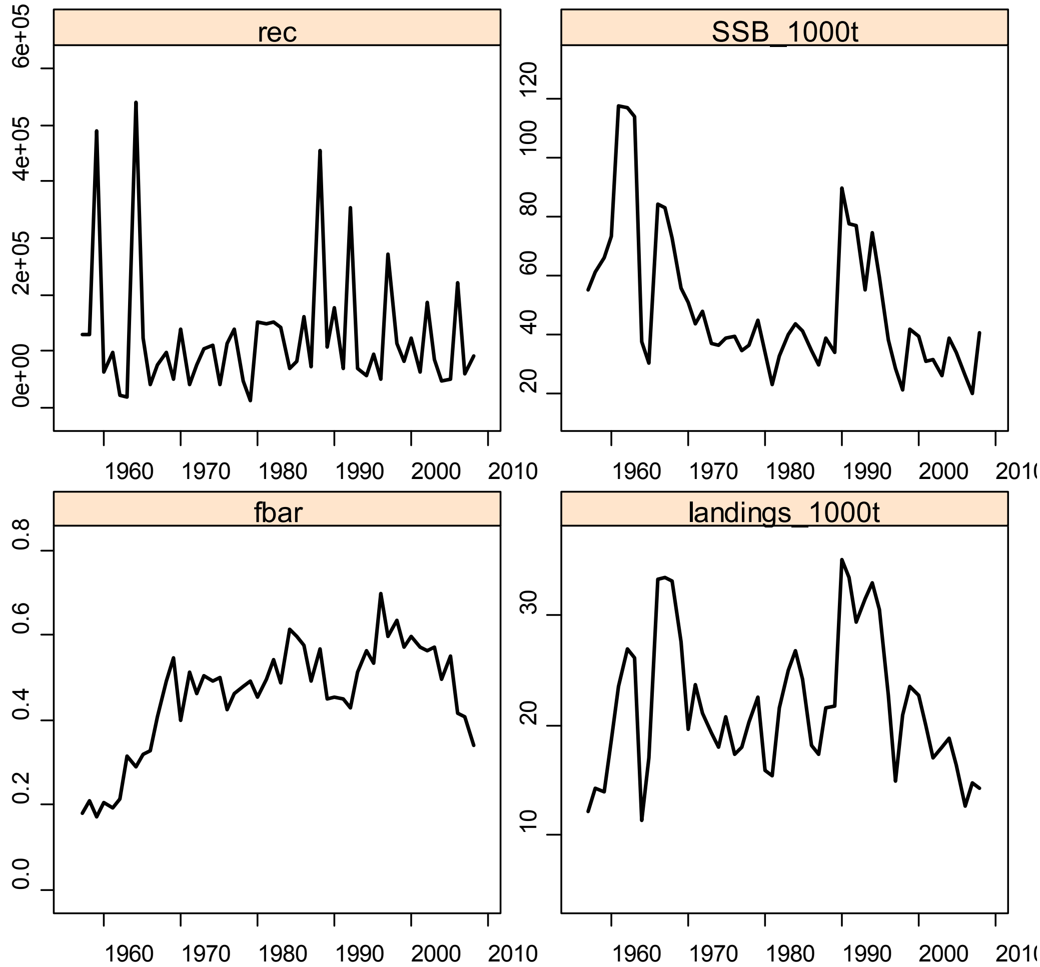
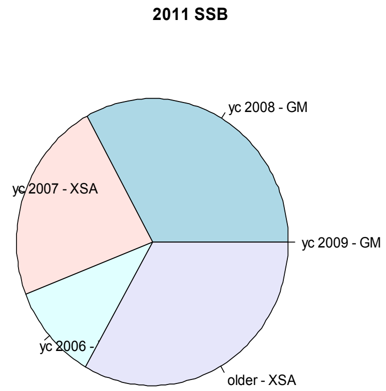


Figure 10.4.1 Sole in sub-area IV 1957-2008. XSA summary plots. Time series of SSB (top left), TSB (top right), mean fishing mortality (bottom left) and recruitment (bottom right).



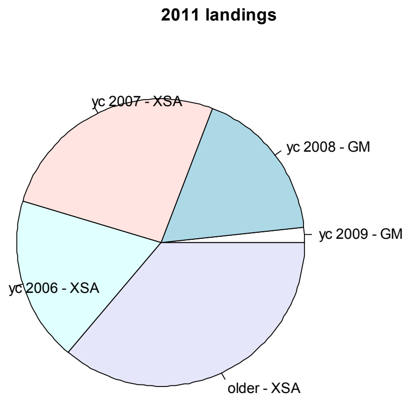
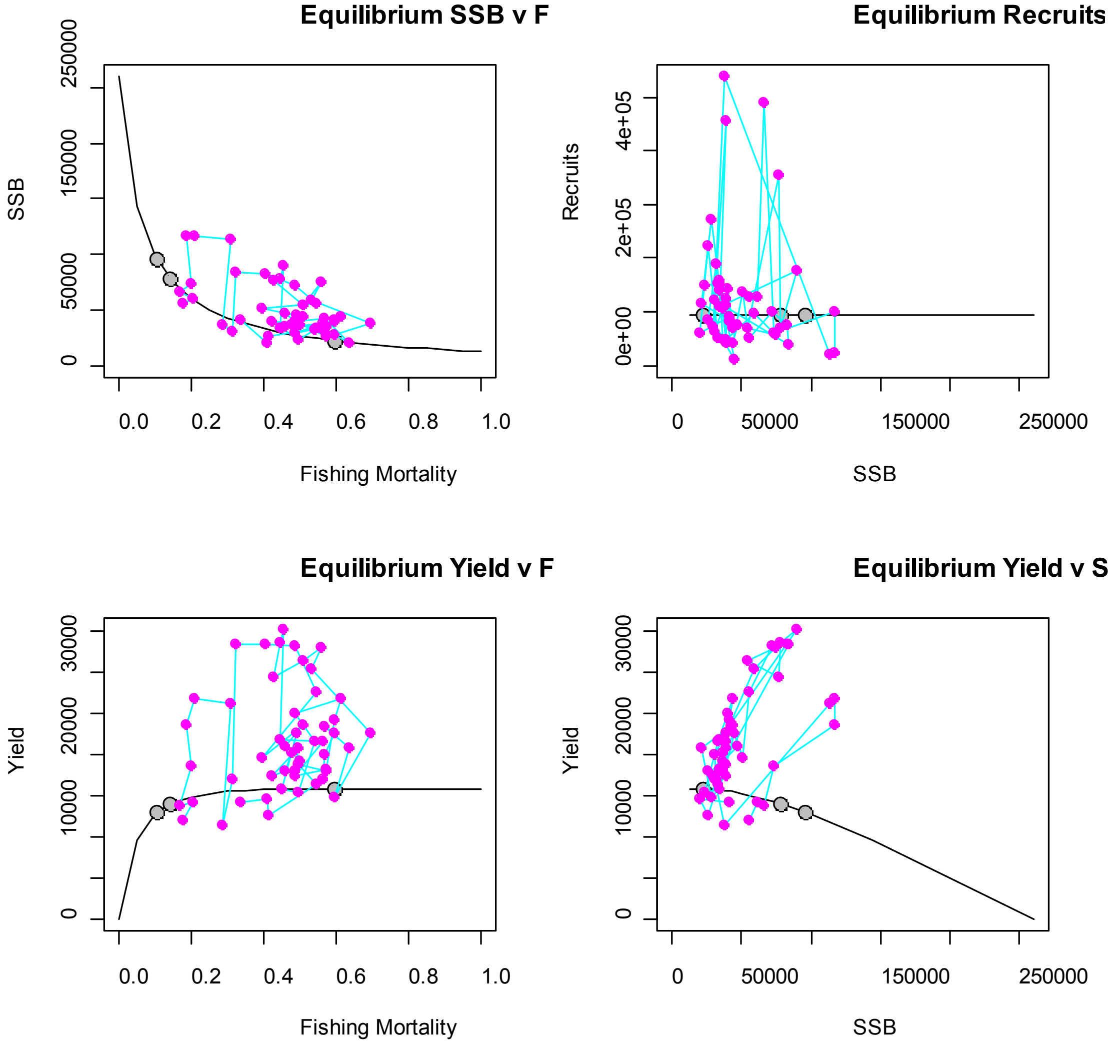


Figure 10.6.1 Sole in sub-area IV. Relative year class contribution to 2011 predicted SSB (left) and 2011 landings (right). Stock numbers of 1 year olds: (2004/XSA) 46 700, (2005/XSA) 50 000, (2006/XSA) 22 1770 (2007/XSA) 60 400, (2008/XSA) 90 900 & (2009/GM) 91 800.



Reference point	F multiplier	Absolute F
Fbar(2 – 6)	1.0	0.43
FMax	1.4	0.60
F0.1	0.34	0.15

Figure 10.6.2 Sole in sub-area IV. YPR results.

11 Saithe in Subareas IV, VI and Division IIIa

The 2009 assessment of saithe in Subareas IV and VI and Division IIIa is formally classified as an update assessment, using the same settings and tuning series as last year. The assessment of the 2008 working group meeting was accepted by the ACOM review group in June 2008.

11.1 Ecosystem aspects

The geographical distributions of juvenile (< age 3) and adult saithe differ. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. At around age 3 the individuals gradually migrate from the coastal areas to the northern part of the North Sea (57°N - 62°N).

The age at first maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian Trench. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group appears along the coasts (of Norway, Shetland and Scotland). The mechanisms behind the 0-group's migration from oceanic to coastal areas remain unknown, but it seems like they are actively swimming towards the coasts. The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to the Norwegian coast.

Tagging experiments by various countries have shown that exchange takes place between all saithe stock components in the northeast Atlantic. In particular, exchange between the saithe stock north of 62°N (Northeast Arctic saithe) and saithe in the North Sea has been observed.

A sharp decline in the mean weight at age was observed from the mid-1990s, but now seems to be halted. There is insufficient information to establish whether this decline is linked to changes in the environment. The reduced growth rates have an effect on stock productivity and the consequences need to be further explored. However, there are no indications that the observed decline in weight at age is density dependent (Evaluation of the EU-Norway saithe management plan).

The impact of a large saithe stock on prey species such as Norway pout and herring is unknown. Poor spatial and temporal sampling of stomach data of saithe make the estimation of the saithe diet uncertain (ICES CM 2006/RMC:02).

11.1.1 Fisheries

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water along the Northern Shelf edge and the Norwegian Trench. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3-4) often are targeted during the rest of the year. In recent years the French fishery has deployed less effort along the Norwegian Trench, while the German and Norwegian fisheries have maintained their effort there.

The main fishery developed in the beginning of the 1970s. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2-4). In the Norwegian coastal purse seine fishery inside the 4 nm limit (south of 62°N), the minimum landing size is 32 cm. For other gears in the Norwegian zone (south of 62°N) the current minimum landing size is 40 cm, while in the EU zone it is 35 cm.

Since the fish are distributed inshore until they are about 3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

In 2008 the landings were estimated to be around 112 000 t in Sub-area IV and Division IIIa, and 7 000 t in Sub-Area VI, which both are well below the TACs for these areas (135 900 and 14 100 t respectively). Significant discards are observed only in Scottish trawlers. However, as Scottish discarding rates are not considered representative of the majority of the saithe fisheries, these have not been used in the assessment. Ages 1 and 2 are mainly distributed close to the shores and are very scarce in the main fishing areas for saithe. Therefore, these age-groups are not relevant for discarding practices in the North Sea.

ICES advice for 2010

ICES considered the stock as having full reproductive capacity and as being harvested sustainably.

Exploitation boundaries in relation to existing management plans

At the present SSB level, F should be no more than 0.3 to be in accordance with the management plan. This corresponds to landings of 139 000 t in 2010.

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

The current fishing mortality (2005-2007 average) is estimated at 0.27, which is close to the management plan target rate expected to lead to high long-term yields (F = 0.3).

Exploitation boundaries in relation to precautionary limits

The exploitation boundaries in relation to precautionary limits imply landings of less than 175 000 t in 2009, and the SSB is expected to remain above B_{pa} (200 000 t) in 2009.

ICES conclusion on exploitation boundaries

ICES has evaluated the agreed management plan to be in accordance to the precautionary approach, and the target fishing mortality in the management plan is expected to give high long-term yield in the present situation with a stock that is above B_{pa}. ICES therefore recommends to limit landings in 2009 to 139 000 t.

11.1.2 Management

Management of saithe is by TAC and technical measures. The fishery is not regulated by days at sea for vessels that have less bycatch than 5% of each cod, plaice and sole. The agreed TAC for saithe in Sub-area IV and Division IIIa for 2008 was 135 900 t. In Division Vb and Subareas VI, XII, and XIV the TAC for 2008 was 14 100 t. For 2009 the TACs are 125 934 t and 13 066 t, respectively. Current technical measures are described in Section 2.

In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix a TAC that is no more tha 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*

This arrangement enters into force on 1 January 2005."

11.1.3 Evaluation of the Management plan

This assessment is run in terms with the management plan which is consistent with the precautionary approach in the short term conditional on the absence of major changes in the productivity and the absence of measurement and implementation error (ICES Advice 2008, Book 6, Paragraph 6.3.3.3.).

11.2 Data available

11.2.1 Catch

Landings data by country and TACs are presented in Table 11.2.1. Minor revisions were applied to the 2007 landings. In the data provided, landings from the industrial fleet are only specified when saithe is delivered separately, and therefore bycatch of saithe that has not been separated from the bulk catch, will not be reported as saithe.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.2. Landings-at-age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK (Scotland) for Area VI. The differences between the sum-of-products (SOP) and the working group estimate is about 7% in 2008. The reason for the discrepancy is not clear and it is not known if weights or numbers should be corrected. Hence, no correction is made. Figure 11.2.1 shows that the proportions of older saithe (age>5) in the catches have increased in recent years, which partly reflects the reduction in the purse seine fishery since the early 1990s.

11.2.3 Weight at age

Weights at age in the catch are presented in Table 11.2.3 and Figure 11.2.2. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 4 and older, but the decline now seems to be halted.

11.2.4 Maturity and natural mortality

A natural mortality rate of 0.2 is used for all ages and years, and the following maturity ogive is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

11.2.5 Catch, effort and research vessel data

Fleet data used for calibration of the assessment are presented in Table 11.2.4. Three commercial series of effort and catch at age and two series of survey indices were available:

Commercial fleets:

- French fresh fish trawl, age range: 3-9, year range 1990-2008 ("FRATRB")
- German bottom trawl, age range: 3-9, year range 1995-2008 ("GEROTB")
- Norwegian bottom trawl, age range: 3-9, year range 1980-2008 ("NORTRL")

  (Part 1 : 1980-1992, part 2 : 1993-2008)

Surveys:

- Norwegian acoustic survey, age range 3-6, year range 1995-2008 ("NORACU")
- IBTS quarter 3, age range: 3-5, year range 1991-2008 ("IBTSq3")

There was a 7% downwards revision to the 2007 German commercial indices.

Trends in relative LPUE and effort for the commercial fleets are shown in Figure 11.2.3. The LPUE shows an increasing trend for all fleets over more than a decade, while the effort is decreasing in the same period.

11.3 Data analyses

This year's assessment is classified as an update assessment, the consistency in the input data is analysed using catch curves, correlation plots and standardised tuning indices.

11.3.1 Reviews of last year's assessment

The Review Group in ACOM had the following technical comments:

One of the problems in assessment and forecast is the poor reliability of the recruitment at age 3.

The quality of 2008 assessment is affected very much by the uncertainty about the size of the 2004 year class. A new acoustic survey has been carried out in May 2006, 2007 and 2008 and results are available in autumn 2008. This may modify assessment and short term forecast. Should be revisited in autumn!!

Changes in weight at age, and a substantial decrease in length at age over time should be explored. These changes have an effect on maturity rates and fixed maturity ogive in use is perhaps not the best solution.

Conclusions

The assessment is accepted as reliable and consistent.

The responses of the Working Group:

The 2004 year class problem was revisited in the autumn, but due to conflicting evidence, no change was made to the assessment. There are obvious problems with the estimation of the youngest age groups in the assessment. The cause of this is unclear and needs further investigation.

The HCR evaluation estimated the weight at age as the average of the last three years and did not include a density dependent mean weight as they did not find evidence of a direct relationship between density and weight at age.

The reduction in weight at age may have shifted the maturity ogive. This is an obvious task for as benchmark assessment, which also should consider the possibility of estimating annual maturity ogives.

11.3.2 Exploratory survey-based analyses

Log-abundance indices by cohort for the tuning series are shown in Figure 11.3.1. The pattern is similar to the pattern in the catch data curves (Figure 11.3.9), with partial recruitment of age 3 for recent cohorts. The curves for the most recent cohorts of the NORTRL time series show a pattern that differs markedly from earlier cohorts in the NORTRL series and from the curves of the other tuning series (Figure 11.3.1). This indicates considerable changes in the exploitation pattern or data problems in the Norwegian trawler fleet and led to the exclusion of the series from tuning. However, the reintroduction of the fleet in the tuning should be considered at a future benchmark assessment.

Within-survey correlations for the available tuning series are shown in Figures 11.3.2 – 11.3.6. For the FRATRB the relationship between cohort values from one age to the next is significant, except for the ages 3 to 4 (Figure 11.3.6). The poor relationship between the two youngest ages can be explained by variation in the recruitment to the fishery. For the other tuning series, there is a better relationship between the ages 3 and 4, but not as strong as between the older ages (Figures 11.3.2 – 11.3.5). For the NORACU series there is also a poor relationship between age 5 and 6, which may be explained by the movement of older fish out of the survey area (Fig. 11.3.3).

The two survey time series are relatively consistent (Fig. 11.3.7). They are, however, not entirely independent since the age-disaggregation of both indices is based on the same age and length samples. The relative CPUEs in the commercial tuning series are compared in Figure 11.3.8. For age 3 and 9 the consistency between the series is poor, but better for the age groups in-between.

In last year's assessment, the time series of the GEROTB and FRATRL and the surveys indicated a very strong 2004 cohort, while in the NORTRL series it appeared medium strong at best (Figure. 11.3.8), which gave rise to some uncertainty. This year, only in the German commercial index this cohort appears as strong; in the landings it is not extraordinary.

11.3.3 Exploratory catch-at-age-based analyses

Catch curves (log catch-numbers-at-age linked by cohort) for the total catch-at-age matrix are shown in Figure 11.3.9. The plot shows that age 3 is partly recruited to the fishery for recent cohorts, but fully recruited for some of the earlier cohorts. Moreover the catch curves are less steep in recent years compared to earlier. The negative slopes in the catch curves, which give an indication of total mortality inferred from the catch data, are shown in Figure 11.3.10. The trend in the gradients is in agreement with the trend in estimated fishing mortality.

A separable VPA was run to check the consistency in the catch data, and the resulting log catch residuals did not indicate problems with the data in terms of large year effects etc.

Single fleet XSAs were run with each of the available 3 commercial tuning fleets using the same settings as in the final assessment last year. There is a change in the residual pattern for the NORTRL from large values for the younger age-classes in the beginning of the time series to smaller residuals in more recent years. For the FRATRB, the older ages have large negative residuals caused by the targeting of small- to medium-sized saithe in the French trawler fleet. No clear signals emerge for the German trawler fleet. The survey time series has a too narrow age range for single fleet runs, where the lack of tuning information for too many ages leads to unreliable results.

11.3.4 Conclusions drawn from exploratory analyses

The catch curves of the total landings data indicate changes in the relative exploitation of age 3 with time. A likely explanation of this apparent change in exploitation pattern is that the proportion of catches taken by purse seine decreased significantly in the early 1990s, and purse seiners mainly target young saithe. Therefore, it may now be more appropriate to use a reference F that does not include age 3. Such a change of the reference F will affect the biological reference points and is outside the scope of this update assessment.

The explorations of the within and between consistencies in the available tuning series indicate that the abundance indices of age 3 are uncertain, and that age 4 indices seem to give more reliable information about year class strength.

11.3.5 Final assessment

The settings in final XSA assessment in 2009 are the same as in 2008. Settings from the 2007 assessment are also presented.

Year of assessment:	2007	2008	2009
Assessment model:	XSA	no change	no change
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	no change	no change
	GERotb (age range: 3-9, 1995 onwards)	no change	no change
	NORacu (age range: 3-6, 1996 onwards)	no change	no change
	IBTSq3 (age range: 3-5, 1992 onwards)	no change	no change
Age range:	3-10+	no change	no change
Catch data:	1967-2006	1967-2007	1967-2008
Fbar:	3-6	no change	no change
Time series weights:	Tricubic over 20 years	no change	no change
Power model for ages:	No	no change	no change
Catchability plateau:	Age 7	no change	no change
Survivor est. shrunk towards the mean F:	5 years / 3 ages	no change	no change
S.e. of mean (F-shrinkage):	1.0	no change	no change
Min. s.e. of population estimates:	0.3	no change	no change
Prior weighting:	No	no change	no change
Number of iterations before convergence:	51	47	47

Outputs from the final run are given in Table 11.3.1 (diagnostics), Table 11.3.2 (fishing mortality at age), Table 11.3.3 (population numbers at age), and Table 11.3.4 (stock summary).

The log catchability residuals from the final XSA-run are shown in Figure 11.3.11, the relative weights of F-shrinkage by tuning fleets are in Figure 11.3.12, a retrospective analysis in Figure 11.3.13 and the historical performance of the assessment in Figure 11.3.14.

11.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figure 11.4.1 (and Table 11.3.4). The reported landings increased from 1967 to the highest observed landing levels in the mid-1970s. After 1976 the landings decreased rapidly to a stable level between 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled off in 1989 to a fairly stable level where they have stayed since. During the last 7 years (2002-2008), TAC levels have been higher than the reported landings.

The fishing mortality shows the same trends as landings in the period 1967-1985, while it has decreased nearly continuously since 1985 until present, dropping below F_{lim} in 1993 and below F_{pa} in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 after which it decreased to below B_{lim} in 1990. After

1991 SSB increased to above B_{pa} in 2001. Since then the increase has continued, and the SSB in 2009 is about 1.3*B_{pa}.

Both the level and the variation in estimated recruitment (at age 3) are higher before about 1985 than after, e.g., the six strongest year classes observed all occurred in the earliest period. The 2004 year class is not as strong as suggested last year and emerges at about 40% above the geometrical long-term mean (1988-2006). The 2005 year class appears to be very poor.

11.5 Recruitment estimates

Since there are no indications of the 2005 year class to be strong, the provision taken last year to apply RCT3 against using an overestimated age 4 number was not continued. (This precaution was based on the observation in retrospection that strong recruitments tend to be overestimated in VPA.) Instead, as was usual in former years, the VPA number was accepted for age 4 at the start of the forecast period.

Reliable abundance information does not exist for the 2006 and 2007 year classes. It was therefore decided to use the geometric mean of recruits (age 3 from the final assessment) from the period 1988-2006 as the estimated recruitment for these year classes. The reason for excluding data before 1988 is that the recruitment dynamics (level and variation) seems quite different before and after 1988.

11.6 Short-term forecasts

The short-term prognosis was performed using the same settings as last year. Inputs are presented in Table 11.6.1. Average weight at age over the last three years was used in the forecast. Fishing mortalities at age were estimated as an arithmetic average over the last three years. Number at age 3 (recruitment) is taken as the geometric mean of age 3 from the period 1988-2006.

Population numbers at the beginning of the forecast period are the XSA survivor estimates from the final assessment.

The management options are given in Table 11.6.2. Status quo fishing mortality (F_{sq}) in 2009 and 2010 is expected to lead to landings of about 100 000 tonnes in 2010 and a drop to 235 000 t in the expected spawning stock biomass in 2010. A fishing mortality in 2010 according to the EU-Norway management plan is expected to lead to landings of 106 000 t and an SSB of 223 000 t in 2011. However, due to the TAC constraint, landings according to the management plan in 2010 are 118 000 t and the SSB in 2011 is 212 000 t.

11.7 Medium-term forecasts

No medium-term forecasts were carried out.

11.8 Biological reference points

The biological reference points were derived in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

These reference points refer to an Fbar from ages 3 to 6. The proportion of catches taken by purse seine decreased significantly in the early 1990s. This caused a change in the exploitation pattern as the purse seiners mainly targeted young saithe. Therefore, it may be more appropriate to use a reference F that does not include age 3.

The influence on the maturity ogive from the observed decrease in the weight at age is unknown, but it is reasonable to believe that the spawning capacity of the stock will be affected.

The change of the reference F and the possible change in maturity may affect the biological reference points but revising reference points is outside the scope of this update assessment.

11.9 Quality of the assessment

The retrospective features for F and SSB (Figure 11.3.14) seem fairly good for the most recent years, except for the recruitment.

The poor reliability of the recruitment (age 3) estimate is a major problem for the saithe assessment. To improve the reliability of the information about year class strength before age 4, IMR in Norway has since 2006 carried out an acoustic recruitment survey for saithe (ages 2-4) along the Norwegian west coast. The usefulness of this survey has not yet been evaluated and at least another couple of years are needed before it can be fully evaluated.

Another problem with the assessment is the necessity to use commercial CPUE for tuning, as the survey series that are used only contain usable information for ages 3-6. There are many reasons for why commercial CPUE may fail to track changes in abundance. A serious one would be hyperstability; that is commercial catch rates remain high while population abundance drops, which may occur when vessels are able to locate high fish concentrations independently of population size. Hyperstability may be demonstrated if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite-based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets.

11.10 Status of the Stock

The general perception of the status of the saithe stock remains unchanged from last year's assessment. Fishing mortality is estimated to be well below F_{pa} and the spawning stock biomass is estimated to be well above B_{pa}.

11.11 Management Considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The total landings in 2008 in areas IIIa and IV are considerably lower than the TAC, as was also the case in the 6 previous years. Information from fishermen indicates that low prices for saithe combined with high fuel prices may be causing this, but there are also claims that the abundance of saithe has been reduced in the most recent years.

By-catch of other demersal fish species occurs in the trawl fishery for saithe. Saithe is also taken as unintentional by-catch in other fisheries, and discards may occur if the vessels do not have a saithe quota.

The spawning stock of saithe in the North Sea is expected to remain above B_{pa} if the TAC for 2010 is set according to the agreed management plan.

Since recruitment at age 3 tends to be poorly estimated in the XSA, the size of the 2005 year class is uncertain, but since the year class is estimated to be rather poor, only very large relative errors will make a large impact on the forecast. Since the Norwegian acoustic survey will not be conducted in 2009, significant new information on this year class is not expected this year.

In 2008 ICES carried out an evaluation of the management plans agreed between Norway and the European Community (ICES Advice, 2008. Book 6.), and the response is described below:

Recent reductions in recruitment levels and growth rates indicate that the productivity of the saithe stock in the North Sea, Skagerrak, and West of Scotland has declined. Assuming continuation of the current selection pattern and growth rates, annual yields are expected to be relatively stable at about 100 000 t for fishing mortalities between 0.1 and 0.4. A target F below 0.3, or an increase in the upper SSB threshold (i.e., above the current B_{pa} = 200 000t), are likely to give similar yields with lower risks in the medium term.

The 15% TAC change constraint is likely to be invoked in ~50% of the years in which the harvest control rule is applied. TAC constraints less than 15% would require a lower target fishing mortality in order to balance the increased risk to the stock. The equilibrium yield from the saithe stock is fairly insensitive to the TAC constraint. Given the relatively low productivity of saithe (low mean recruitment and low weight -at-age) in recent times, the limited treatment of measurement errors in the assessment, and implementation errors in the fishery, the harvest control rule should be reviewed again within 4 years after the evaluation.

Table 11.2.1 Nominal landings (in tonnes) of Saithe in Subarea IV and Division IIIa and SubareaVI, 1999-2008, as officially reported to ICES, and WG estimates

SAITHE IV and IIIa

Country	1999	2000	2001	2002	2003	2004*	2005*	2006	2007*	2008*
Belgium	200	122	24	107	45	22	28	16	18	7
Denmark	4494	3529	3575	5668	6954	7991	7498	7471	5458	8069
Faroe Islands	1101	-	289	872	495	558	184	62	15	108
France	243051*	19200	20472	25441	18001	13628	10768	15739	13043	15302
Germany	10481	9273	9479	10999	8956	9589	12401	14390	12790	14141
Greenland	-	6012*	15262*	62	1616	403	-	-	-	-
Ireland	-	1	-	-	-	1	-	0	-	81
Netherlands	7	11	20	6	1*	3	40	28	5	3
Norway	56150	43665	44397	60013	61735	62783	67365	61268	45395	62055
Poland	862	747	727	752	734*	0	1100	-	-	1407
Russia	-	67	-	-	-	-	35	2	5	5
Sweden	1929	1468	1627	1863	1876	2249	2114	1695	1380	1639
UK (E/W/NI)	2874	1227	1186	2521	1215	457	1190	9129**	9628**	11701**
UK (Scotland)	5420	5484	5219	6596	5829	5924	7703			
Total reported	107823	85395	88541	114900	107467	103608	110575	109800	87377	114517
Unallocated	-509	2281	1030	1291	-5809	-3646	968	7312	6241	-2263
W.G. Estimate	107314	87676	89571	116191	101658	99962	111543	117112	93618	112254
TAC	110000	85000	87000	135000	165000	190000	145000	123250	123250	135900

*Preliminary, 1reportedbyTACarea, IIa(EC), IIIa-d(EC) and IV, 2Preliminary data reported in IVa
**Scotland+E/W/NI combined

Table 11.2.1 continued

SAITHE VI

Country	1999	2000	2001	2002	2003	2004*	2005*	2006	2007*	2008*
Faroe Islands	2	-	-	-	2	34	21	76	32	23
France	34671*	3310	5157	3062	3499	3053	3452	5782	3956	2617
Germany	250	305	466	467	54	4	373	532	580	147
Ireland	320	410	399	91	170	95	168	243	322	208
Netherlands	-	-	-	-	-	-	-	-	-	1
Norway	126	58	31	12	28	16	20	28	377	78
Russia	3	25	1	1	6	6	25	7	2	50
Spain	23	3	15	4	6	2	3	-	-	-
UK (E/W/NI)	503	276	273	307	263	37	203	2748**	1419**	2887**
UK (Scotland)	2084	2463	2246	1567	1189	1563	4433			
Total reported	6778	6850	8588	5513	5215	4810	8699	9416	6688	6011
Unallocated	564	-960	-1770	-327	35	-296	-2960	848	98	1040
W.G.Estimate	7342	5890	6818	5186	5250	4514	5739	8568	6786	7051
TAC	7500	7000	9000	14000	17119	20000	15044	12787	12787	14100

*Preliminary, 1reported by TAC area, IIa(EC), IIIa-d(EC) and IV
**Scotland+E/W/NI combined

SAITHE IV, IIIa and VI

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
WGestimate	114656	93566	96389	121377	106908	104476	117282	125680	100404	119305
TAC	117500	92000	96000	149000	182119	210000	160044	136037	136037	150000

Table 11.2.2 Saithe in Sub-Areas IV, VI and Division IIIa. Landed numbers (in thousands) at age.

2009-05-11 22:25:00 units= thousands

year \ age	3	4	5	6	7	8	9	10
1967	17330	16220	15531	2303	1594	292	198	183
1968	23223	21231	13184	6023	429	242	123	145
1969	30235	17681	11057	7609	5738	791	626	150
1970	37249	76661	15000	12128	3894	1792	318	267
1971	69808	57792	32737	4736	4248	2843	1874	774
1972	48075	66095	25317	21207	3672	2944	1641	1607
1973	54332	37698	26849	16061	8428	2000	1357	2381
1974	66938	33740	14123	20688	14666	5199	1477	1955
1975	56987	25864	10319	7566	13657	9357	3501	2687
1976	207823	53060	11696	6253	3976	5362	3586	3490
1977	27461	54967	14755	5490	3777	3447	3812	4701
1978	35059	27269	18062	3312	1138	1033	768	3484
1979	16332	14216	11182	8699	2805	733	540	2089
1980	17494	12341	9015	6718	5658	1150	509	2302
1981	26178	8339	6739	3675	3335	3396	657	2536
1982	31895	40587	9174	5978	2145	1454	982	1254
1983	28242	20604	26013	5678	4893	1494	1036	1327
1984	80933	32172	12957	13011	1657	1252	335	646
1985	134024	55605	13281	4765	3005	682	399	742
1986	55434	91223	15186	5381	2603	1456	445	900
1987	31220	97470	13990	3158	1811	1240	910	700
1988	32578	26408	35323	3828	1908	1104	776	680
1989	22128	30752	13187	10951	1557	739	419	488
1990	40808	19583	11322	4714	2776	745	281	364
1991	46117	29871	7467	3583	1716	953	367	458
1992	18404	33614	12753	3193	1524	696	518	422
1993	37823	20828	11845	3125	1568	1511	814	1026
1994	19958	40194	13034	4297	947	346	427	794
1995	26664	26034	14797	3774	3494	674	552	800
1996	11066	38861	11786	7731	3163	808	210	491
1997	15036	19299	30177	3676	2640	1012	291	288
1998	10363	31017	16367	16077	2231	1206	567	277
1999	9429	13872	26684	8389	10070	2346	891	657
2000	7064	17295	8940	12339	3159	3226	641	441
2001	16052	17646	22421	3349	3586	1772	1614	245
2002	19914	42331	8871	8899	2437	2976	1865	1623
2003	11661	20209	25759	6269	7061	1512	1979	1039
2004	5315	14987	17696	13412	3820	4104	1118	806
2005	13933	12508	16861	17796	11585	2838	2248	460
2006	9871	28211	12355	9364	11375	5958	1545	1432
2007	17486	7982	21443	7367	5639	5230	1800	975
2008	9692	24765	8119	17113	4561	3418	2407	1737

Table 11.2.3 Saithe in Sub-Areas IV, VI and Division IIIa. Landings weights at age (kg).

2009-05-11 22:28:31 units= kg

year \ age	3	4	5	6	7	8	9	10
1967	0.930	1.362	2.104	3.186	3.754	5.316	5.891	7.719
1968	1.278	1.652	1.989	3.009	4.040	4.428	6.136	7.406
1969	0.966	1.557	2.261	2.713	3.559	4.406	5.220	6.767
1970	0.941	1.441	2.059	2.718	3.599	4.463	5.687	6.845
1971	0.840	1.348	2.178	2.936	3.766	4.634	5.172	6.163
1972	0.808	1.196	1.961	2.369	3.794	4.228	4.630	6.326
1973	0.821	1.406	1.641	2.571	3.357	4.684	4.814	6.445
1974	0.861	1.561	2.383	2.753	3.429	4.498	5.713	7.857
1975	0.893	1.498	2.490	3.300	3.765	4.296	5.540	7.562
1976	0.702	1.309	2.260	3.071	4.035	4.383	5.112	7.147
1977	0.760	1.256	1.935	3.111	4.162	4.605	4.859	6.542
1978	0.821	1.327	2.155	3.340	4.522	4.900	5.449	7.400
1979	1.107	1.623	2.238	3.095	4.050	5.274	6.308	7.955
1980	0.955	1.821	2.391	3.030	4.090	5.126	5.939	8.148
1981	0.961	1.821	2.717	3.587	4.536	5.478	6.980	8.724
1982	1.086	1.575	2.529	3.220	4.207	5.125	5.905	8.823
1983	1.028	1.718	2.149	3.138	3.691	4.632	5.505	8.453
1984	0.795	1.614	2.297	2.690	3.896	4.665	6.183	8.474
1985	0.663	1.265	1.950	2.772	3.407	4.950	5.865	8.854
1986	0.694	1.035	1.794	2.432	3.572	4.209	5.651	8.218
1987	0.674	0.876	1.824	3.075	4.210	5.330	6.128	8.603
1988	0.779	0.981	1.386	2.791	4.024	5.254	6.322	8.649
1989	0.895	1.036	1.420	1.998	3.914	5.017	6.430	8.431
1990	0.844	1.196	1.583	2.247	3.242	4.858	6.315	8.416
1991	0.791	1.158	1.752	2.365	3.165	4.222	6.066	8.191
1992	0.964	1.189	1.607	2.242	3.668	4.330	5.412	7.045
1993	0.899	1.260	1.754	2.636	3.185	3.980	5.080	6.891
1994	0.944	1.119	1.601	2.434	3.617	4.787	6.548	8.326
1995	1.002	1.294	1.816	2.562	3.555	4.767	5.267	7.891
1996	0.967	1.187	1.807	2.368	2.952	4.705	6.092	8.382
1997	0.905	1.145	1.452	2.587	3.556	4.525	6.158	8.866
1998	0.892	0.966	1.393	1.744	2.949	3.883	4.996	7.227
1999	0.881	1.061	1.211	1.754	2.337	3.493	4.844	6.745
2000	1.027	1.127	1.539	1.684	2.594	3.084	4.773	7.461
2001	0.802	1.072	1.313	2.095	2.546	3.485	4.141	6.141
2002	0.806	0.859	1.324	1.752	2.289	3.109	3.921	3.747
2003	0.718	0.954	1.083	1.661	2.248	3.348	3.773	4.294
2004	0.877	1.015	1.257	1.582	2.475	3.103	4.286	5.556
2005	0.666	1.073	1.301	1.601	1.998	3.009	3.796	4.885
2006	0.893	0.999	1.348	1.738	2.077	2.578	3.784	5.349
2007	0.744	1.098	1.158	1.628	2.004	2.670	3.267	4.987
2008	0.889	1.098	1.431	1.653	2.295	2.827	3.362	4.295

Table 11.2.4 Saithe in Sub-Areas IV,VI and Division IIIa. Tuning data, effort and index values. Data in bold are used in the final assessment.

2009-05-11 20:40:59

FRATRB_IV units= NA

		3	4	5	6	7	8	9
1990	**21758**	**0.1553**	**0.1136**	**0.0646**	**0.01397**	**0.013342**	**0.001504**	**0.000681**
1991	**15248**	**0.0906**	**0.1665**	**0.0480**	**0.02441**	**0.008578**	**0.004438**	**0.000782**
1992	**7902**	**0.0908**	**0.1874**	**0.0631**	**0.00931**	**0.003088**	**0.000903**	**0.000727**
1993	**13527**	**0.2896**	**0.1666**	**0.0859**	**0.00766**	**0.000614**	**0.000639**	**0.000457**
1994	**14417**	**0.1228**	**0.2534**	**0.0958**	**0.03011**	**0.002698**	**0.000369**	**0.000188**
1995	**14632**	**0.2154**	**0.1150**	**0.0630**	**0.01542**	**0.004811**	**0.001646**	**0.000910**
1996	**16241**	**0.0551**	**0.2639**	**0.0648**	**0.03300**	**0.006627**	**0.001517**	**0.000933**
1997	**12903**	**0.0843**	**0.1484**	**0.2461**	**0.01473**	**0.006503**	**0.001281**	**0.001065**
1998	**13559**	**0.0590**	**0.1872**	**0.1379**	**0.10922**	**0.003854**	**0.001698**	**0.000766**
1999	**14588**	**0.0584**	**0.0846**	**0.1828**	**0.04251**	**0.027397**	**0.001660**	**0.000938**
2000	**8695**	**0.1023**	**0.2292**	**0.1195**	**0.13745**	**0.024701**	**0.020761**	**0.003652**
2001	**6366**	**0.1137**	**0.2104**	**0.3727**	**0.04241**	**0.022762**	**0.004014**	**0.004599**
2002	**11022**	**0.2972**	**0.6874**	**0.1107**	**0.11269**	**0.015905**	**0.013739**	**0.003714**
2003	**10536**	**0.1440**	**0.3071**	**0.2235**	**0.02509**	**0.030857**	**0.007642**	**0.010714**
2004	**5234**	**0.0854**	**0.1868**	**0.1951**	**0.09450**	**0.017689**	**0.006807**	**0.003778**
2005	**3015**	**0.1350**	**0.2191**	**0.2133**	**0.14209**	**0.069557**	**0.005202**	**0.004730**
2006	**5710**	**0.2945**	**0.5503**	**0.0966**	**0.02531**	**0.034901**	**0.006945**	**0.002319**
2007	**8255**	**0.5089**	**0.1261**	**0.3401**	**0.02917**	**0.012090**	**0.000372**	**NA**
2008	**7016**	**0.1252**	**0.2170**	**0.0350**	**0.13538**	**0.023503**	**0.004887**	**0.004749**

NORTRL_IV1 units= NA

		3	4	5	6	7	8	9
1980	18317	0.01015	0.0704	0.0359	0.05350	0.04351	0.01425	0.003276
1981	28229	0.00312	0.0299	0.0476	0.01743	0.02373	0.02476	0.004216
1982	47412	0.13971	0.2534	0.0577	0.04455	0.00719	0.00494	0.000401
1983	43099	0.10211	0.1152	0.1897	0.04524	0.05492	0.01116	0.008283
1984	47803	0.43043	0.1533	0.0462	0.07025	0.00906	0.00929	0.002217
1985	66607	0.40668	0.3213	0.0797	0.02356	0.00956	0.00084	0.000691
1986	57468	0.09217	0.5153	0.0625	0.01423	0.00684	0.00212	0.000435
1987	30008	0.08814	0.6150	0.0739	0.00966	0.00783	0.00670	0.006598
1988	18402	0.17020	0.1110	0.1203	0.00766	0.00853	0.00402	0.007282
1989	17781	0.03650	0.1196	0.0470	0.03903	0.01738	0.00866	0.003656
1990	10249	0.07845	0.0762	0.0902	0.05064	0.01981	0.00615	0.001171
1991	28768	0.49875	0.1727	0.0415	0.01801	0.00706	0.00177	0.001947
1992	35621	0.09677	0.2676	0.1132	0.03052	0.01305	0.00463	0.003060

NORTRL_IV2 units= NA

		3	4	5	6	7	8	9
1993	24572	0.3107	0.1639	0.1171	0.0414	0.0214	0.01485	0.010256
1994	30628	0.1286	0.5256	0.1396	0.0302	0.0082	0.00235	0.006628
1995	32489	0.1338	0.2883	0.1666	0.0256	0.0506	0.00840	0.006248
1996	40400	0.0938	0.3572	0.1093	0.0684	0.0283	0.00468	0.000396
1997	36026	0.0803	0.1462	0.2731	0.0394	0.0248	0.00830	0.001999
1998	24510	0.0561	0.3378	0.2225	0.2310	0.0399	0.01995	0.009914
1999	21513	0.0378	0.1206	0.3193	0.1101	0.1674	0.05429	0.016083
2000	15520	0.0183	0.1049	0.1323	0.2745	0.0687	0.07751	0.014240
2001	23106	0.2081	0.2263	0.2819	0.0405	0.0534	0.02203	0.016879
2002	38114	0.1053	0.3165	0.0911	0.0990	0.0257	0.04282	0.027549
2003	41645	0.0391	0.1309	0.2510	0.0865	0.1064	0.01902	0.024109
2004	32726	0.0203	0.0818	0.1744	0.2010	0.0689	0.08067	0.020045
2005	34964	0.0344	0.0881	0.1481	0.2632	0.1989	0.04942	0.041014
2006	30190	0.0264	0.1363	0.1273	0.1527	0.2421	0.13163	0.026863
2007	26354	0.0593	0.0547	0.1777	0.1330	0.1007	0.11843	0.033657
2008	32550	0.0709	0.3181	0.1126	0.2567	0.0662	0.04974	0.037911

GER_OTB_IV units= NA

		3	4	5	6	7	8	9
1995	21167	0.0547	0.1114	0.0638	0.0278	0.00718	0.00142	0.000756
1996	19064	0.0268	0.1661	0.0567	0.0271	0.01348	0.00776	0.002151
1997	21707	0.0376	0.1140	0.1675	0.0135	0.00751	0.00322	0.001106
1998	20153	0.0293	0.1362	0.0692	0.0881	0.01181	0.00496	0.001935
1999	18596	0.0153	0.0573	0.1217	0.0507	0.05458	0.00414	0.001936
2000	12223	0.0443	0.1788	0.0673	0.0995	0.01980	0.02659	0.003109
2001	11008	0.0810	0.1207	0.2105	0.0338	0.04833	0.02262	0.014081
2002	12789	0.0508	0.2860	0.0962	0.0860	0.00774	0.01095	0.005395
2003	14560	0.0343	0.0961	0.1806	0.0301	0.02692	0.00398	0.004945
2004	13708	0.0244	0.1488	0.1406	0.0787	0.01459	0.01714	0.003429
2005	11700	0.0371	0.0436	0.1387	0.1319	0.06726	0.01752	0.010171
2006	10815	0.0346	0.1456	0.0638	0.0618	0.06334	0.03236	0.013592
2007	12606	0.0743	0.0566	0.2231	0.0482	0.03213	0.03308	0.013882
2008	12871	0.0371	0.2448	0.0487	0.1291	0.02750	0.01709	0.017326

NORACU units= NA

		3	4	5	6
1995	1	56244	4756	1214	174
1996	1	21480	29698	6125	4593
1997	1	22585	16188	24939	3002
1998	1	15180	48295	13540	11194
1999	1	16933	21109	27036	4399
2000	1	34551	82338	14213	13842
2001	1	72108	28764	17405	3870
2002	1	82501	163524	17479	4475
2003	1	67774	107730	41675	4581
2004	1	34153	43811	31636	6413
2005	1	48446	36560	27859	10174
2006	1	18909	58132	11378	7922
2007	1	77958	12070	32445	2384
2008	1	7122	18989	4180	10262

IBTSq3 units= NA

		3	4	5
1991	1	1.95	0.402	0.064
1992	1	1.08	2.760	0.516
1993	1	7.96	2.781	1.129
1994	1	1.12	1.615	0.893
1995	1	13.96	2.501	1.559
1996	1	3.83	6.533	1.112
1997	1	3.76	3.351	7.461
1998	1	1.03	3.921	1.333
1999	1	2.10	2.019	2.949
2000	1	3.48	8.836	1.081
2001	1	21.50	6.173	3.937
2002	1	10.75	18.974	1.327
2003	1	19.27	23.802	13.402
2004	1	4.98	6.896	3.158
2005	1	8.89	6.870	4.994
2006	1	10.64	29.820	2.934
2007	1	34.02	5.594	11.763
2008	1	3.47	5.860	1.122

Table 11.3.1 Saithe in Sub-Areas IV, VI and Division IIIa. XSA diagnostics.

FLR XSA Diagnostics 2009-05-11 22:41:02

CPUE data from xsa.indices

Catch data for 42 years. 1967 to 2008. Ages 3 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	FRATRB_IV	3	9	1990	2008	0	1
2	GER_OTB_IV	3	9	1995	2008	0	1
3	NORACU	3	6	1996	2008	0.5	0.75
4	IBTSq3	3	5	1992	2008	0.5	0.75

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

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 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3	0.078	0.087	0.084	0.126	0.110	0.070	0.076	0.213	0.118	0.160
4	0.376	0.200	0.323	0.330	0.181	0.202	0.235	0.216	0.266	0.244
5	0.548	0.445	0.431	0.266	0.343	0.239	0.367	0.385	0.254	0.477
6	0.470	0.531	0.297	0.303	0.306	0.301	0.403	0.358	0.418	0.331
7	0.530	0.323	0.286	0.367	0.419	0.310	0.463	0.489	0.381	0.498
8	0.796	0.320	0.303	0.408	0.409	0.462	0.400	0.463	0.438	0.420
9	0.943	0.521	0.262	0.607	0.527	0.610	0.499	0.395	0.245	0.369
10	0.943	0.521	0.262	0.607	0.527	0.610	0.499	0.395	0.245	0.369

XSA population number (NA)

year \ age	3	4	5	6	7	8	9	10
1999	139349	48902	69938	24712	27046	4723	1613	1170
2000	94158	105558	27486	33116	12642	13032	1744	1189
2001	221180	70698	70774	14414	15948	7492	7750	1172
2002	186590	166562	41916	37658	8771	9813	4531	3896
2003	123594	134749	98067	26291	22780	4976	5342	2774
2004	86544	90639	92037	56982	15852	12262	2705	1929
2005	211248	66048	60648	59342	34517	9523	6326	1282
2006	56975	160348	42758	34398	32483	17778	5228	4808
2007	173990	37716	105756	23828	19690	16302	9164	4932
2008	72416	126629	23657	67183	12842	11018	8614	6166

Estimated population abundance at 1st Jan 2009

year \ age	3	4	5	6	7	8	9	10
2009	0	50520	81267	12022	39521	6388	5929	4875

Fleet: FRATRB_IV

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.292	-0.397	-0.091	0.614	0.111	-0.159	-0.823	-0.793	-0.290
4	0.243	0.320	0.263	0.230	0.318	-0.206	-0.379	-0.270	-0.424
5	0.073	0.085	0.240	0.215	0.290	-0.389	-0.162	-0.035	0.085
6	-0.276	0.341	-0.304	-0.415	0.372	-0.343	0.238	-0.538	0.226
7	0.651	0.369	-0.687	-1.804	-0.333	-0.178	-0.049	-0.157	-0.933
8	-0.459	0.301	-1.283	-1.473	-1.616	-0.167	-0.320	-0.860	-0.767
9	-0.115	-0.427	-0.843	-1.211	-1.740	0.112	-0.092	0.067	-0.602

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	-1.018	-0.062	-0.811	0.340	0.020	-0.165	-0.597	1.558	0.944
4	-0.306	-0.160	0.212	0.542	-0.120	-0.211	0.280	0.306	0.303
5	0.030	0.493	0.679	-0.086	-0.199	-0.319	0.246	-0.189	0.105
6	0.021	0.929	0.479	0.499	-0.642	-0.092	0.322	-0.879	-0.342
7	-0.083	0.481	0.150	0.426	0.158	-0.085	0.575	-0.042	-0.650
8	-1.028	0.275	-0.822	0.186	0.279	-0.715	-0.759	-1.066	-3.917
9	-0.463	0.639	-0.739	-0.261	0.599	0.273	-0.401	-0.969	NA

age \ year	2008
3	0.438
4	-0.376
5	-0.571
6	0.117
7	0.494
8	-0.958
9	-0.763

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8	9
Mean_Logq	-13.5314	-12.6872	-12.5340	-12.9777	-13.3766	-13.3766	-13.3766
S.E_Logq	0.6549	0.3100	0.3032	0.4640	0.6078	0.9569	0.6168

Fleet: GER_OTB_IV

Log catchability residuals.

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-0.240	-0.257	-0.311	0.300	-1.070	0.392	0.139	-0.137	-0.125	-0.130
4	0.422	-0.182	0.125	-0.083	-0.037	0.251	0.316	0.325	-0.623	0.221
5	-0.047	0.033	-0.090	-0.275	-0.047	0.250	0.437	0.103	-0.082	-0.316
6	0.193	-0.012	-0.683	-0.042	0.144	0.552	0.199	0.175	-0.515	-0.328
7	-0.087	0.352	-0.322	-0.123	0.297	-0.050	0.593	-0.603	-0.288	-0.587
8	-0.627	1.003	-0.247	-0.004	-0.423	0.213	0.598	-0.350	-0.682	-0.101
9	-0.383	0.434	-0.205	0.016	-0.048	0.169	0.071	-0.197	-0.484	-0.134

age \ year	2005	2006	2007	2008
3	-0.600	0.705	0.309	0.510
4	-0.675	-0.364	0.160	0.404
5	0.146	-0.273	0.013	0.090
6	0.193	-0.040	0.105	0.015
7	0.232	0.244	0.017	0.342
8	0.146	0.164	0.261	-0.015
9	0.056	0.490	-0.119	0.222

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6	7	8	9
Mean_Logq	-14.8205	-13.3466	-12.8640	-12.9239	-13.0671	-13.0671	-13.0671

S.E_Logq	0.4701	0.3629	0.2083	0.3190	0.3632	0.4603	0.2787

Fleet: NORACU

Log catchability residuals.

age \ year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	-0.341	-0.686	-0.214	-0.837	0.273	0.153	0.484	0.690	0.336	-0.204
4	-0.784	-0.708	0.004	0.095	0.577	0.003	0.888	0.590	0.100	0.256
5	-0.350	-0.176	-0.081	0.288	0.516	-0.237	0.189	0.256	-0.021	0.349
6	0.595	0.135	0.228	0.039	0.930	0.342	-0.469	-0.085	-0.525	-0.041

age \ year	2006	2007	2008
3	0.251	0.492	-0.998
4	-0.179	-0.272	-1.044
5	-0.186	-0.126	-0.539
6	0.227	-0.570	-0.201

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5	6
Mean_Logq	-1.0970	-0.5763	-0.7729	-1.3472
S.E_Logq	0.5454	0.5665	0.3065	0.4377

Fleet: IBTSq3

Log catchability residuals.

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	-1.492	0.066	-1.556	0.122	-0.478	-0.892	-1.319	-1.336	-0.434	0.531
4	-0.427	-0.380	-1.219	-0.536	-0.625	-0.610	-0.834	-0.578	0.019	0.137
5	-0.548	-0.162	-0.423	-0.141	-0.285	0.388	-0.628	-0.156	-0.289	0.048

age \ year	2002	2003	2004	2005	2006	2007	2008
3	0.034	1.021	-0.001	-0.310	1.264	1.252	-0.129
4	0.408	0.754	-0.076	0.258	0.827	0.632	-0.547
5	-0.618	0.892	-0.554	0.401	0.229	0.631	-0.083

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	3	4	5
Mean_Logq	-9.5931	-9.1573	-9.4518
S.E_Logq	0.9090	0.5938	0.4519

Terminal year survivor and F summaries:

Age 3 Year class = 2005

source	survivors	N	scaledWts
FRATRB_IV	78294	1	0.152
GER_OTB_IV	84105	1	0.361
NORACU	18630	1	0.273
IBTSq3	44403	1	0.107
fshk	70227	1	0.108

Age 4 Year class = 2004

source	survivors	N	scaledWts
FRATRB_IV	67414	2	0.336
GER_OTB_IV	117648	2	0.321
NORACU	59715	2	0.181
IBTSq3	78255	2	0.120
fshk	90534	1	0.042

Age 5 Year class = 2003

source

	survivors	N	scaledWts
FRATRB_IV	11365	3	0.280
GER_OTB_IV	14538	3	0.329
NORACU	8156	3	0.243
IBTSq3	15919	3	0.119
fshk	19527	1	0.029

Age 6 Year class = 2002

source

	survivors	N	scaledWts
FRATRB_IV	45205	4	0.257
GER_OTB_IV	35607	4	0.386
NORACU	33570	4	0.250
IBTSq3	70084	3	0.085
fshk	35800	1	0.022

Age 7 Year class = 2001

source

	survivors	N	scaledWts
FRATRB_IV	6973	5	0.273
GER_OTB_IV	6338	5	0.436
NORACU	5157	4	0.194
IBTSq3	7875	3	0.063
fshk	8015	1	0.034

Age 8 Year class = 2000

source

	survivors	N	scaledWts
FRATRB_IV	4210	6	0.244
GER_OTB_IV	6107	6	0.496
NORACU	8121	4	0.167
IBTSq3	8228	3	0.055
fshk	5637	1	0.037

Age 9 Year class = 1999

source

	survivors	N	scaledWts
FRATRB_IV	3321	7	0.209
GER_OTB_IV	5543	7	0.610
NORACU	5367	4	0.107
IBTSq3	4519	3	0.036
fshk	4183	1	0.038

Table 11.3.2 Saithe in Sub-Areas IV, VI and Division IIIa. Fishing mortality (F) at age.

2009-05-11 22:42:34 units= f

year	age 3	4	5	6	7	8	9	10
1967	0.163	0.263	0.378	0.484	0.416	0.260	0.389	0.389
1968	0.255	0.307	0.355	0.245	0.152	0.100	0.167	0.167
1969	0.118	0.314	0.260	0.357	0.391	0.464	0.407	0.407
1970	0.152	0.490	0.483	0.507	0.313	0.202	0.343	0.343
1971	0.268	0.373	0.400	0.274	0.332	0.397	0.336	0.336
1972	0.371	0.440	0.277	0.492	0.354	0.405	0.420	0.420
1973	0.499	0.563	0.320	0.284	0.369	0.332	0.330	0.330
1974	0.688	0.675	0.424	0.439	0.456	0.411	0.438	0.438
1975	0.427	0.629	0.446	0.424	0.587	0.597	0.541	0.541
1976	0.911	0.931	0.661	0.538	0.414	0.483	0.482	0.482
1977	0.297	0.655	0.737	0.771	0.747	0.784	0.775	0.775
1978	0.543	0.545	0.464	0.355	0.348	0.463	0.392	0.392
1979	0.265	0.442	0.450	0.426	0.582	0.398	0.472	0.472
1980	0.340	0.328	0.563	0.540	0.549	0.503	0.535	0.535
1981	0.183	0.269	0.299	0.473	0.570	0.769	0.609	0.609
1982	0.387	0.479	0.534	0.475	0.563	0.526	0.526	0.526
1983	0.307	0.466	0.657	0.763	0.937	1.031	0.920	0.920
1984	0.573	0.692	0.609	0.838	0.524	0.664	0.682	0.682
1985	0.645	1.046	0.699	0.473	0.462	0.425	0.457	0.457
1986	0.239	1.399	0.956	0.694	0.516	0.427	0.550	0.550
1987	0.364	0.869	0.847	0.523	0.531	0.499	0.522	0.522
1988	0.375	0.606	0.950	0.589	0.706	0.737	0.684	0.684
1989	0.379	0.745	0.709	0.918	0.509	0.665	0.704	0.704
1990	0.472	0.688	0.688	0.598	0.626	0.490	0.578	0.578
1991	0.459	0.774	0.618	0.482	0.453	0.454	0.479	0.479
1992	0.247	0.731	0.941	0.591	0.388	0.334	0.481	0.481
1993	0.323	0.491	0.623	0.630	0.661	0.854	0.836	0.836
1994	0.243	0.682	0.663	0.483	0.393	0.291	0.626	0.626
1995	0.141	0.576	0.580	0.405	0.960	0.543	1.072	1.072
1996	0.118	0.314	0.563	0.696	0.714	0.607	0.320	0.320
1997	0.108	0.309	0.430	0.339	0.544	0.524	0.458	0.458
1998	0.175	0.337	0.470	0.430	0.356	0.517	0.637	0.637
1999	0.078	0.376	0.548	0.470	0.530	0.796	0.943	0.943
2000	0.087	0.200	0.445	0.531	0.323	0.320	0.521	0.521
2001	0.084	0.323	0.431	0.297	0.286	0.303	0.262	0.262
2002	0.126	0.330	0.266	0.303	0.367	0.408	0.607	0.607
2003	0.110	0.181	0.343	0.306	0.419	0.409	0.527	0.527
2004	0.070	0.202	0.239	0.301	0.310	0.462	0.610	0.610
2005	0.076	0.235	0.367	0.403	0.463	0.400	0.499	0.499
2006	0.213	0.216	0.385	0.358	0.489	0.463	0.395	0.395
2007	0.118	0.266	0.254	0.418	0.381	0.438	0.245	0.245
2008	0.160	0.244	0.477	0.331	0.498	0.420	0.369	0.369

Table 11.3.3 Saithe in Sub-Areas IV, VI and Division IIIa. Stock numbers at age.

2009-05-11 22:42:34 units= NA

year \ age	3	4	5	6	7	8	9	10
1967	127456	77470	54512	6638	5177	1407	680	621
1968	114114	88671	48750	30578	3351	2796	888	1041
1969	300688	72416	53388	27984	19585	2356	2070	490
1970	291835	218825	43291	33705	16026	10843	1213	1008
1971	327931	205231	109793	21871	16622	9597	7256	2974
1972	171372	205322	115736	60268	13622	9765	5286	5132
1973	152852	96808	108298	71849	30155	7829	5330	9288
1974	148740	75983	45149	64373	44292	17063	4601	6037
1975	181239	61210	31681	24186	33985	22993	9266	7036
1976	384110	96821	26711	16601	12956	15467	10359	9984
1977	118014	126437	31260	11286	7934	7009	7811	9495
1978	92451	71774	53781	12243	4273	3078	2620	11785
1979	77643	43970	34089	27689	7027	2469	1586	6075
1980	67133	48791	23136	17791	14799	3215	1358	6076
1981	172784	39135	28780	10786	8488	6997	1592	6075
1982	109900	117777	24496	17465	5505	3931	2656	3357
1983	118183	61119	59703	11754	8890	2567	1903	2398
1984	205166	71206	31397	25343	4486	2851	750	1426
1985	311635	94744	29188	13981	8977	2174	1202	2215
1986	287798	133875	27257	11880	7135	4631	1163	2324
1987	112969	185470	27066	8575	4858	3486	2474	1882
1988	115054	64243	63655	9500	4163	2339	1732	1497
1989	77604	64721	28703	20155	4315	1682	916	1053
1990	119906	43514	25163	11568	6592	2124	708	907
1991	138452	61246	17907	10357	5206	2886	1065	1318
1992	92781	71626	23115	7905	5237	2710	1500	1210
1993	151493	59310	28228	7385	3583	2909	1589	1971
1994	102360	89809	29713	12393	3219	1515	1014	1863
1995	224246	65747	37161	12534	6259	1778	927	1319
1996	110295	159470	30272	17036	6847	1963	846	1966
1997	162820	80288	95401	14120	6952	2744	876	860
1998	71182	119701	48272	50802	8234	3303	1331	642
1999	139349	48902	69938	24712	27046	4723	1613	1170
2000	94158	105558	27486	33116	12642	13032	1744	1189
2001	221180	70698	70774	14414	15948	7492	7750	1172
2002	186590	166562	41916	37658	8771	9813	4531	3896
2003	123594	134749	98067	26291	22780	4976	5342	2774
2004	86544	90639	92037	56982	15852	12262	2705	1929
2005	211248	66048	60648	59342	34517	9523	6326	1282
2006	56975	160348	42758	34398	32483	17778	5228	4808
2007	173990	37716	105756	23828	19690	16302	9164	4932
2008	72416	126629	23657	67183	12842	11018	8614	6166

Table 11.3.4 Saithe in Sub-Areas IV, VI and Division IIIa. Stock summary.

	recruitment	ssb	catch	landings	tsb	fbar3-6	Y/ssb
1967	127456	150838	88339	88326	395635	0.322	0.59
1968	114114	211723	113742	113751	520415	0.291	0.54
1969	300688	263959	130579	130588	694142	0.262	0.49
1970	291835	312007	235006	234962	890607	0.408	0.75
1971	327931	429569	265359	265381	1018304	0.329	0.62
1972	171372	474093	261917	261877	903657	0.395	0.55
1973	152852	534485	242509	242499	847490	0.416	0.45
1974	148740	554906	298347	298351	833739	0.556	0.54
1975	181239	472066	271607	271584	743441	0.482	0.58
1976	384110	351532	343889	343967	752269	0.760	0.98
1977	118014	263121	216394	216395	509431	0.615	0.82
1978	92451	268089	155123	155141	463823	0.477	0.58
1979	77643	241049	128352	128360	419124	0.396	0.53
1980	67133	235143	131896	131908	396742	0.443	0.56
1981	172784	241188	132271	132278	495100	0.306	0.55
1982	109900	210413	174338	174351	511582	0.469	0.83
1983	118183	214208	180041	180044	467080	0.548	0.84
1984	205166	176557	200845	200834	465759	0.678	1.14
1985	311635	160711	220865	220869	490237	0.716	1.37
1986	287798	151680	198609	198596	486882	0.822	1.31
1987	112969	153043	167503	167514	384766	0.651	1.09
1988	115054	148010	135176	135172	320289	0.630	0.91
1989	77604	114932	108894	108877	257677	0.687	0.95
1990	119906	102875	103830	103800	262861	0.611	1.01
1991	138452	100562	108071	108048	282262	0.583	1.07
1992	92781	102305	99745	99742	277076	0.628	0.97
1993	151493	108043	111498	111491	324630	0.517	1.03
1994	102360	116568	109621	109622	315878	0.518	0.94
1995	224246	134909	121795	121810	455397	0.425	0.90
1996	110295	154066	114971	114997	442087	0.423	0.75
1997	162820	193789	107348	107327	464434	0.296	0.55
1998	71182	192533	106128	106123	383320	0.353	0.55
1999	139349	201499	110530	110716	398069	0.368	0.55
2000	94158	187822	85781	91322	403910	0.316	0.49
2001	221180	209592	91740	95042	482348	0.284	0.45
2002	186590	202663	107984	115395	497909	0.256	0.57
2003	123594	232871	98830	105569	467133	0.235	0.45
2004	86544	275550	94807	104237	473384	0.203	0.38
2005	211248	279259	115603	124532	513490	0.270	0.45
2006	56975	276982	122417	125680	487251	0.293	0.45
2007	173990	264365	94609	101202	469664	0.264	0.38
2008	72416	260586	111412	119305	464461	0.303	0.46

Table 11.6.1 Saithe in Sub-Areas IV, VI and Division IIIa. Input data for short term forecast.

age	year	f	stock.n	stock.wt	landings.wt	mat	M
3	2009	0.163	121834	0.84	0.84	0.00	0.2
4	2009	0.242	50520	1.07	1.07	0.15	0.2
5	2009	0.372	81267	1.31	1.31	0.70	0.2
6	2009	0.369	12022	1.67	1.67	0.90	0.2
7	2009	0.456	39520	2.13	2.13	1.00	0.2
8	2009	0.440	6387	2.69	2.69	1.00	0.2
9	2009	0.337	5928	3.47	3.47	1.00	0.2
10	2009	0.337	8363	4.88	4.88	1.00	0.2

Table 11.6.2 Saithe in Sub-Areas IV, VI and Division IIIa. Management option table.

year	fmult	f3-6	landings	ssb
2009	1	0.287	110110	263377

year	fmult	f3-6	landings	ssb	ssb2011
2010	0.0000000	0.000	0	234548	319588
2010	0.7000000	0.201	74592	234548	251222
2010	0.8000000	0.229	83952	234548	242792
2010	0.9000000	0.258	93021	234548	234660
2010	1.1000000	0.315	110325	234548	219248
2010	1.2000000	0.344	118579	234548	211946
2010	1.3000000	0.373	126580	234548	204902
2010	1.4000000	0.401	134336	234548	198104
2010	1.0000000	0.287	101809	234548	226816
2010	0.3489926	0.100	39279	234548	283339
2010	0.5234889	0.150	57328	234548	266863
2010	1.0469778	0.300	105843	234548	223227
2010	1.1516755	0.330	114623	234548	215442
2010	0.6979852	0.200	74400	234548	251395
2010	1.3959703	0.400	134028	234548	198373
2010	1.1952996	0.3425	118197	234548	212284

Table 11.6.3 Saithe in Sub-Areas IV, VI and Division IIIa. Stock numbers of recruits and their source for recent year classes used in predictions, and relative (%) contributions to landings and SSB (by weight) of these year classes.

Year-class	2003	2004	2005	2006	2007
Stock no. (thousands) of 3 years old	56975	173990	72416	121834	121834
Source	XSA	XSA	XSA	GM88-06	GM88-06
Status Quo F:					
% in 2009 landings	5.08	27.11	9.45	12.62	-
% in 2010 landings	4.39	19.61	10.96	16.03	12.77
% in 2009 SSB	6.87	28.34	3.06	0	-
% in 2010 SSB	6.17	29.45	12.72	5.77	0.00
% in 2011 SSB	4.19	24.34	12.17	22.05	5.97

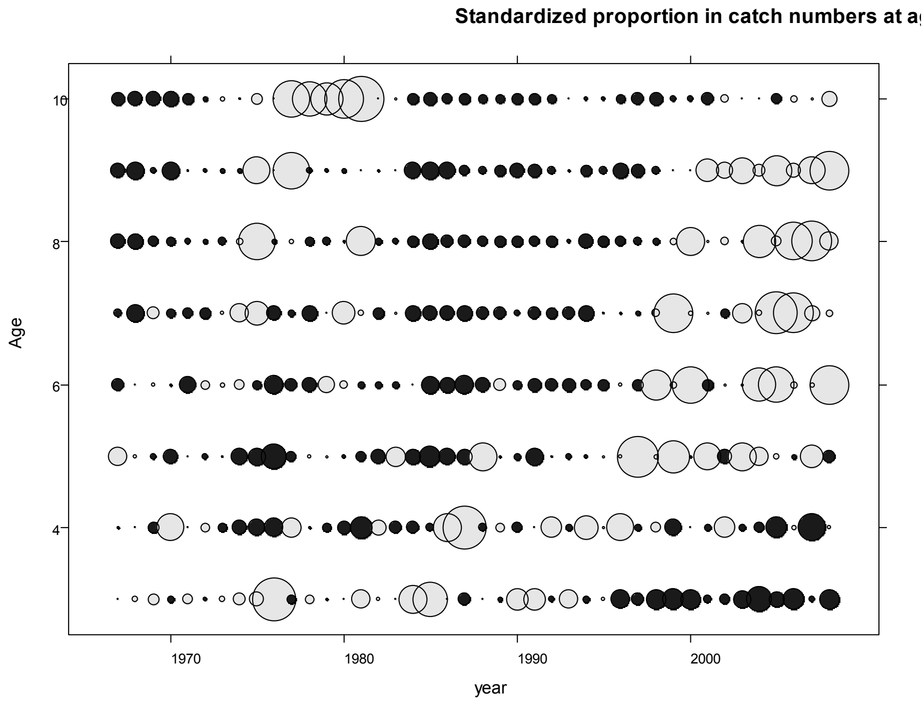


Figure 11.2.1. Saithe in Subarea IV, VI and Division IIIa. Standardised proportion of catch at age (scaled to zero mean for each age). Grey circles are positive numbers and black are negative.

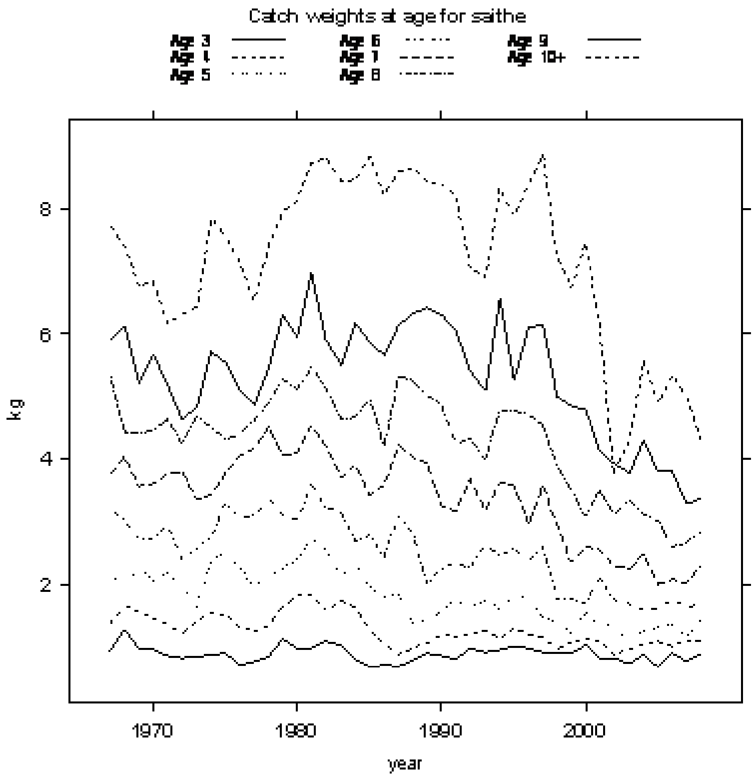


Figure 11.2.2. Saithe in Sub-Area IV, VI and Division IIIa. Trends in mean weights at age in landings.

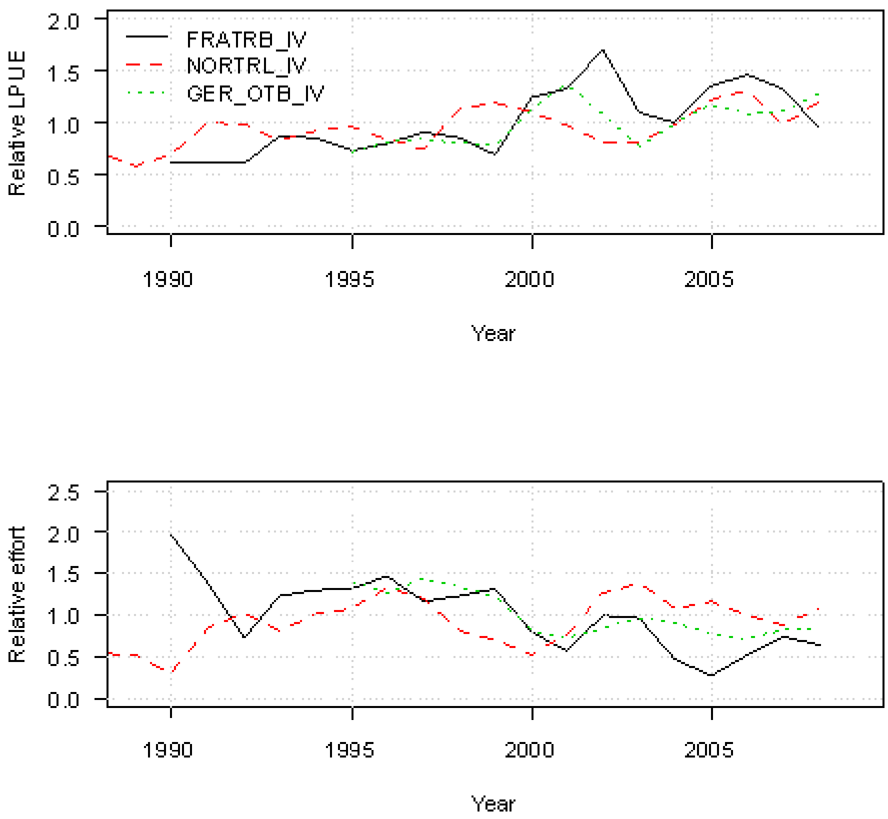


Figure 11.2.3. Saithe in Subarea IV, VI and Division IIIa. Relative trends in total landings per unit effort and effort for the commercial tuning fleets.

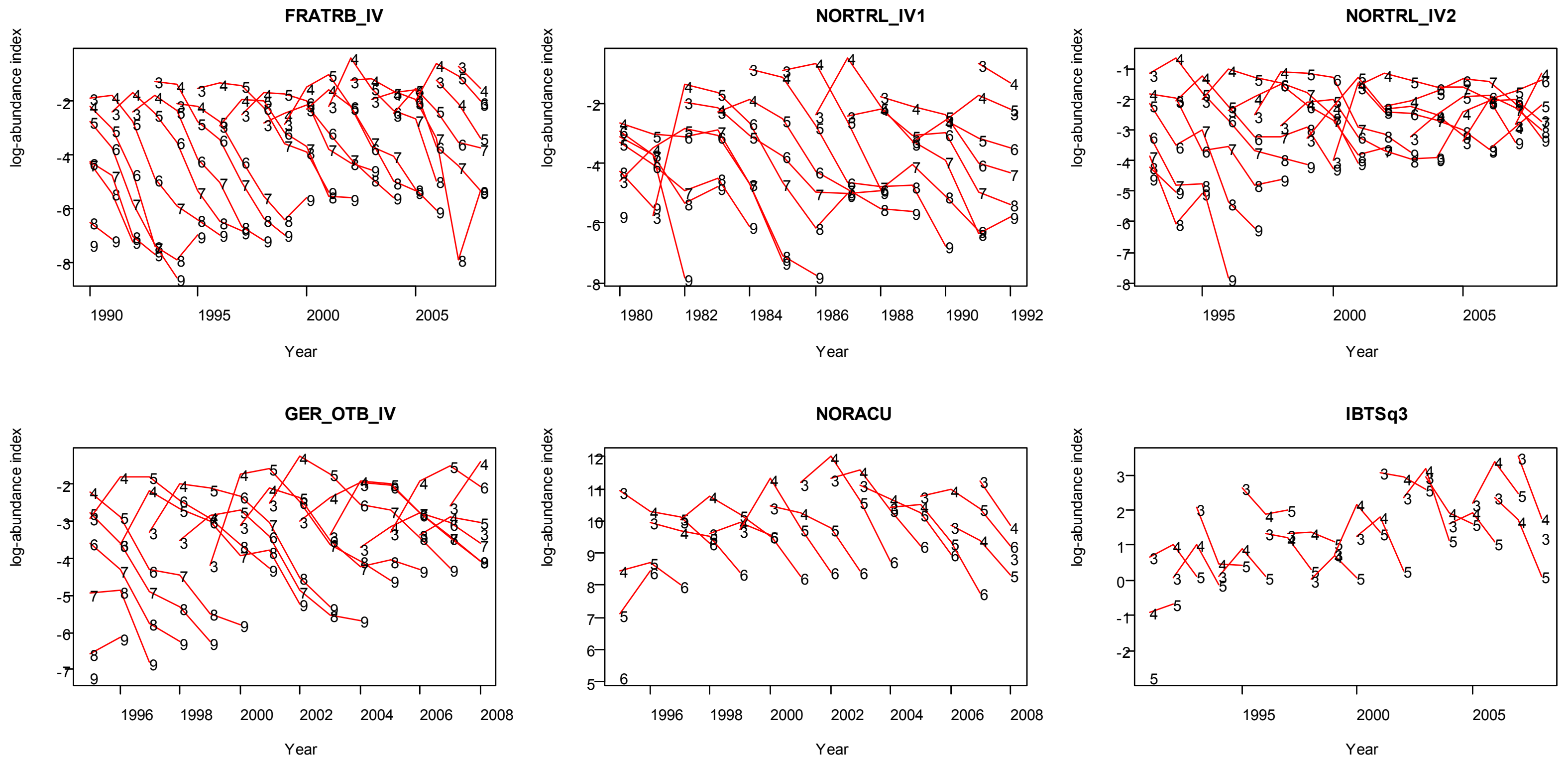


Figure 11.3.1 Saithe in Sub-Area IV, VI and Division IIIa. Log-abundance indices by cohort for each of the available tuning series.

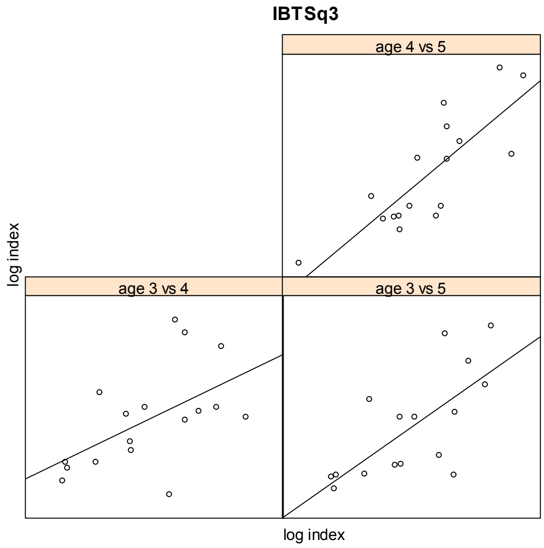


Figure 11.3.2. Saithe in Sub-Area IV, VI and Division IIIa. Within-survey correlations for IBTSq3 for the period 1991-2007. **Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

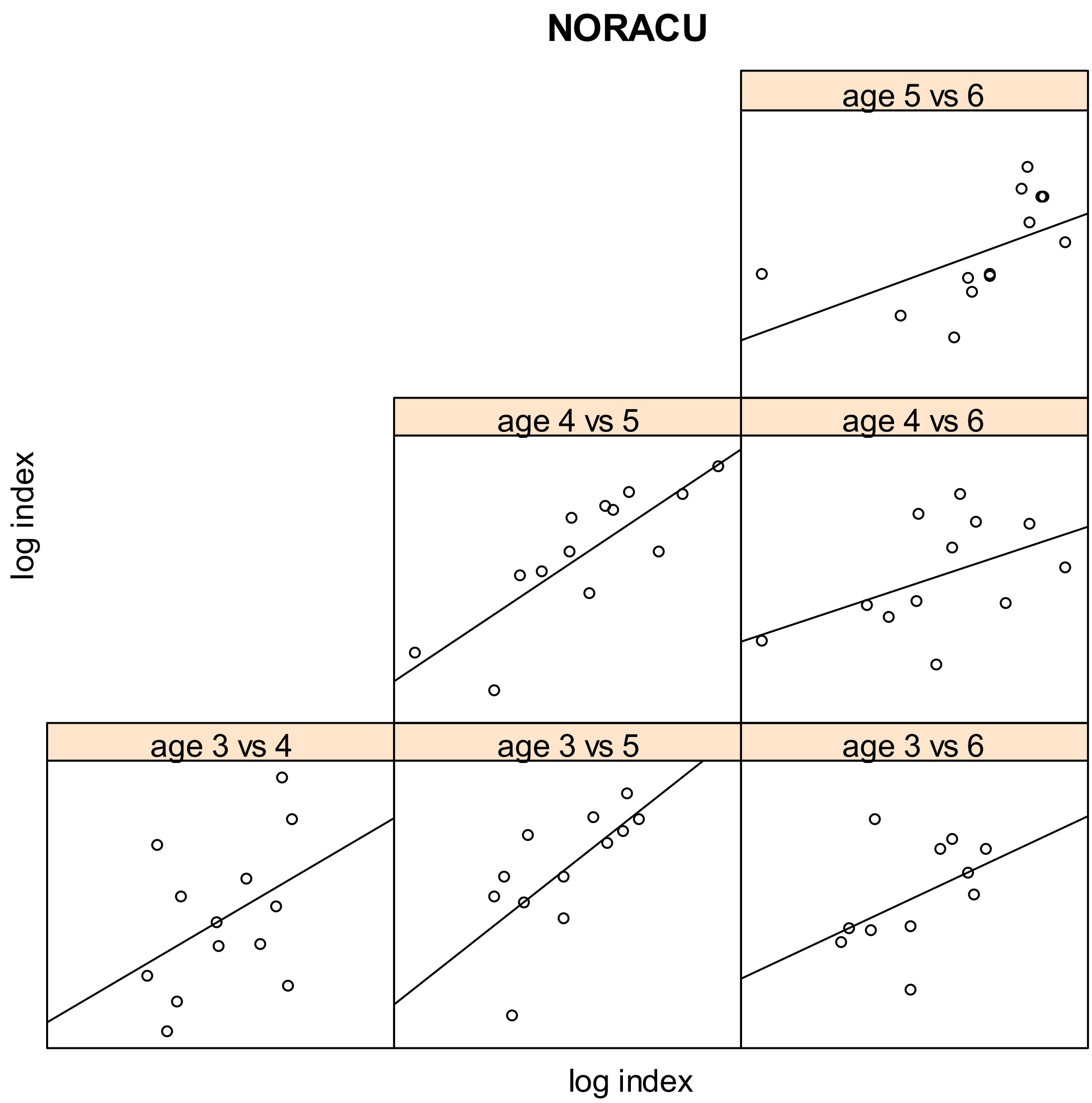


Figure 11.3.3. Saithe in Sub-Area IV, VI and Division IIIa. Within-survey correlations for NORACU for the period 1994-2007. **Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

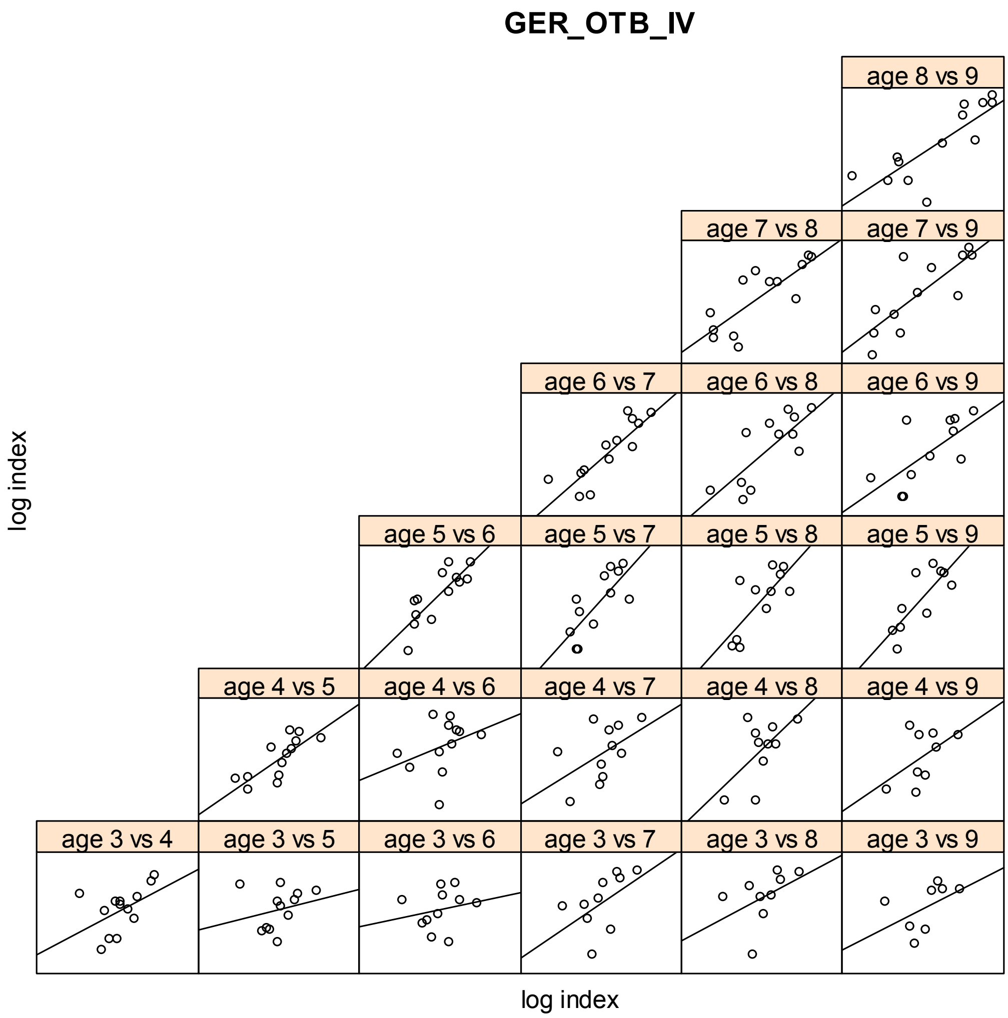


Figure 11.3.4. Saithe in Sub-Area IV, VI and Division IIIa. Within-survey correlations for GEROTB. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

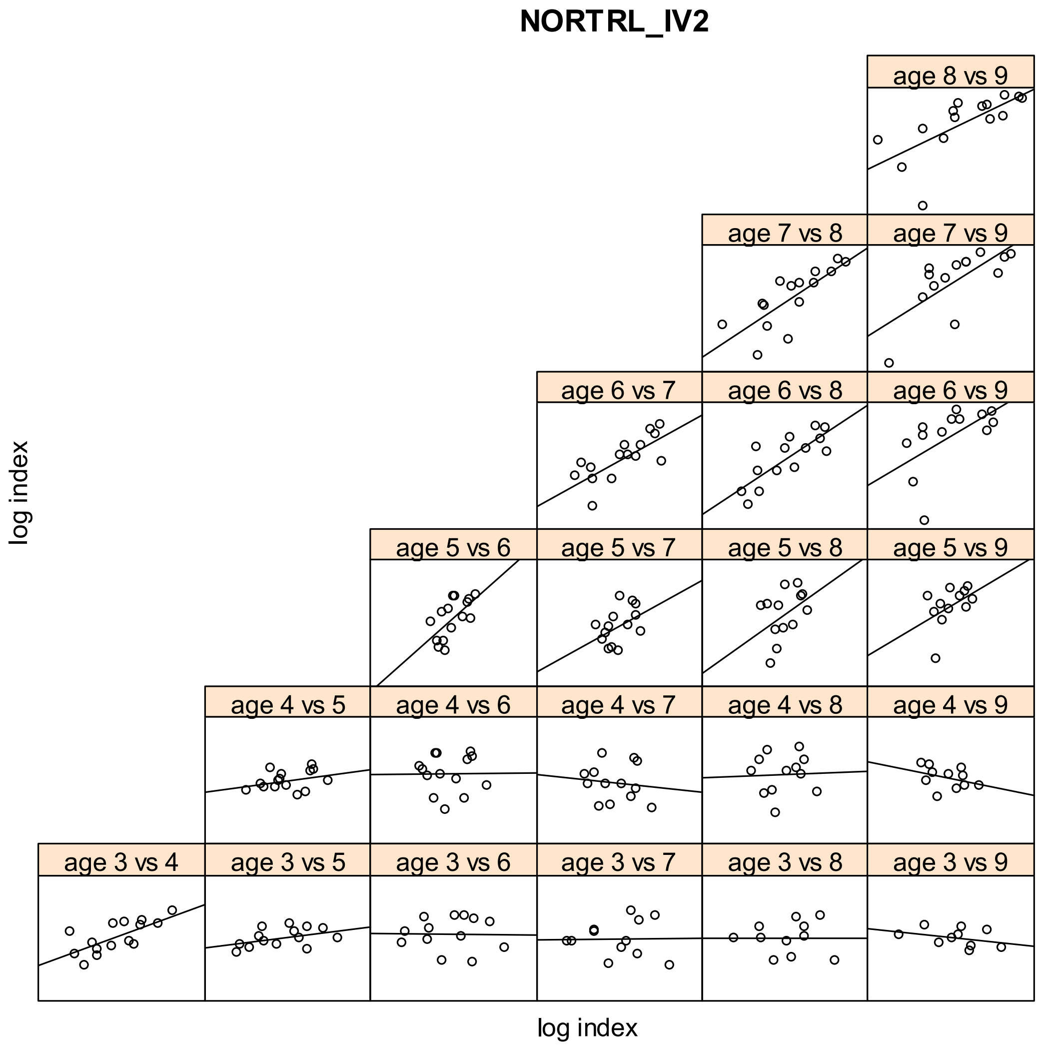


Figure 11.3.5. Saithe in Sub-Area IV, VI and Division IIIa. Within–survey correlations for NORTRL (1993-2007). **Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

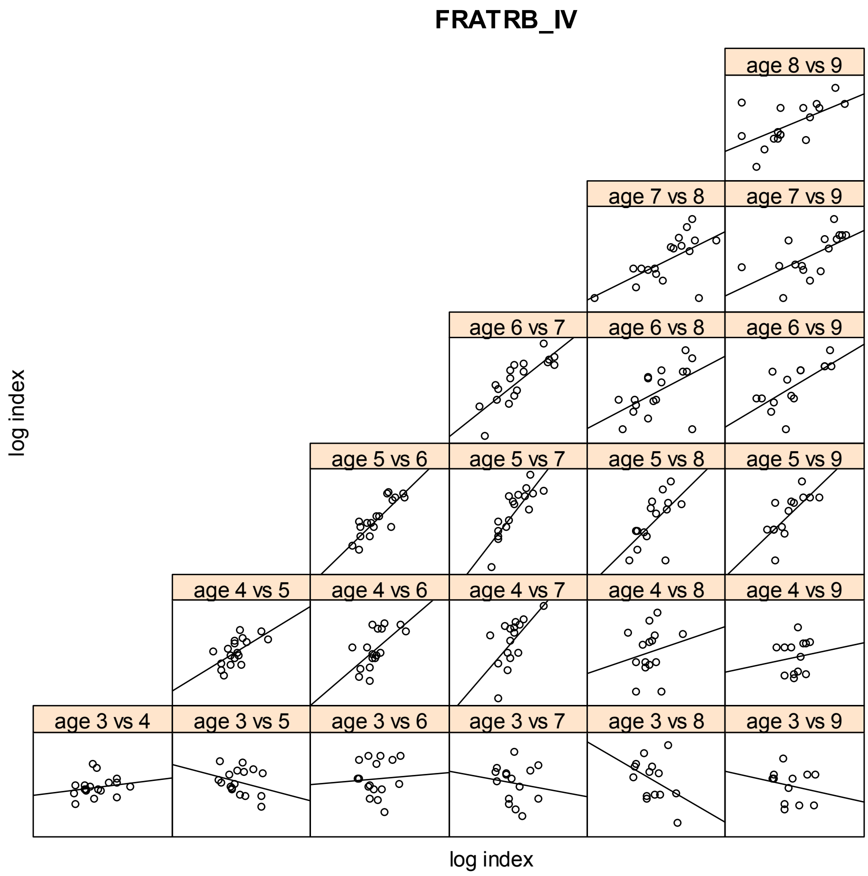


Figure 11.3.6. Saithe in Sub-Area IV, VI and Division IIIa. Within--survey correlations for FRATRL. Correlations in the catch-at-age matrix comparing estimates at different ages for the same year-classes (cohorts). The straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

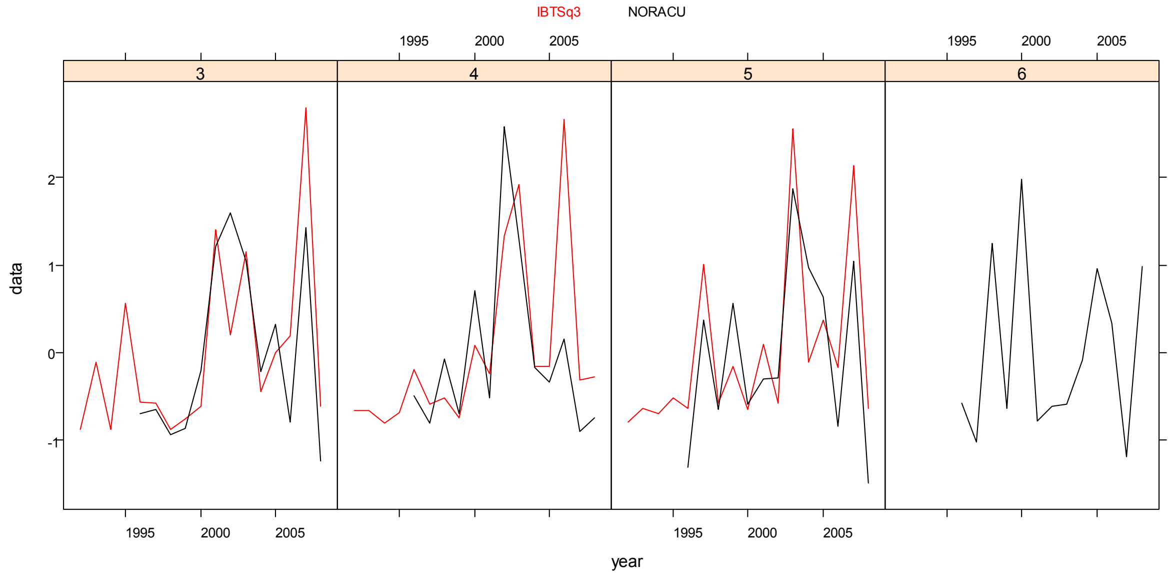


Figure 11.3.7. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the two survey time series.

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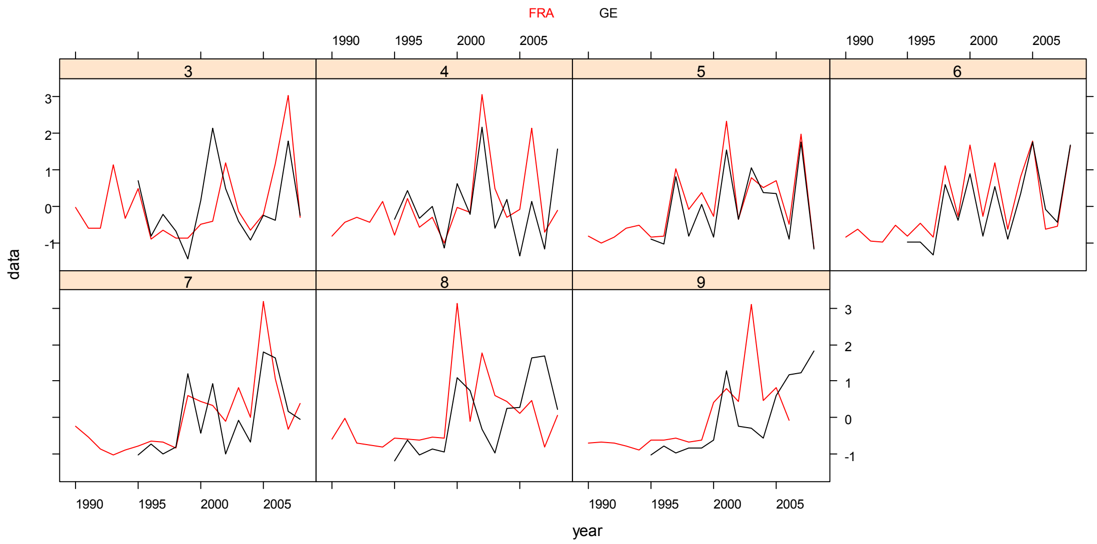

Figure 11.3.8. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the commercial tuning series.

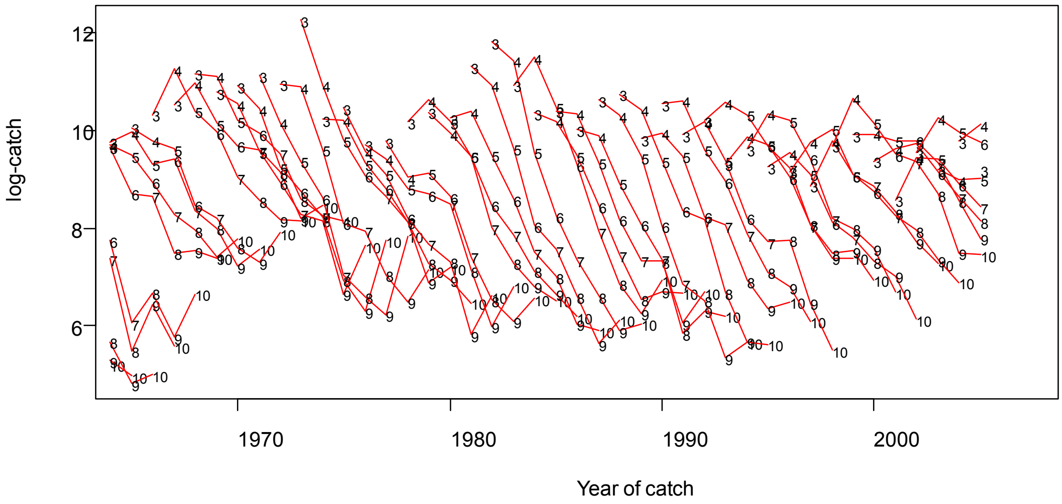

Figure 11.3.9. Saithe in Sub-Area IV, VI and Division IIIa. Log number by cohort for total catches.

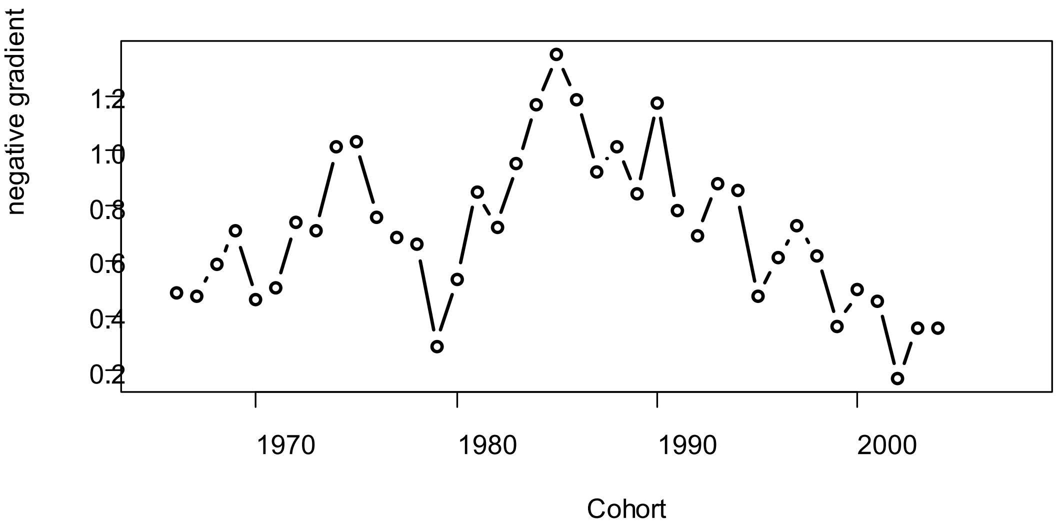

Figure 11.3.10. Saithe in Sub-Area IV, VI and Division IIIa. Negative gradients of log-numbers per cohort in the catches for the age-range 4-7.

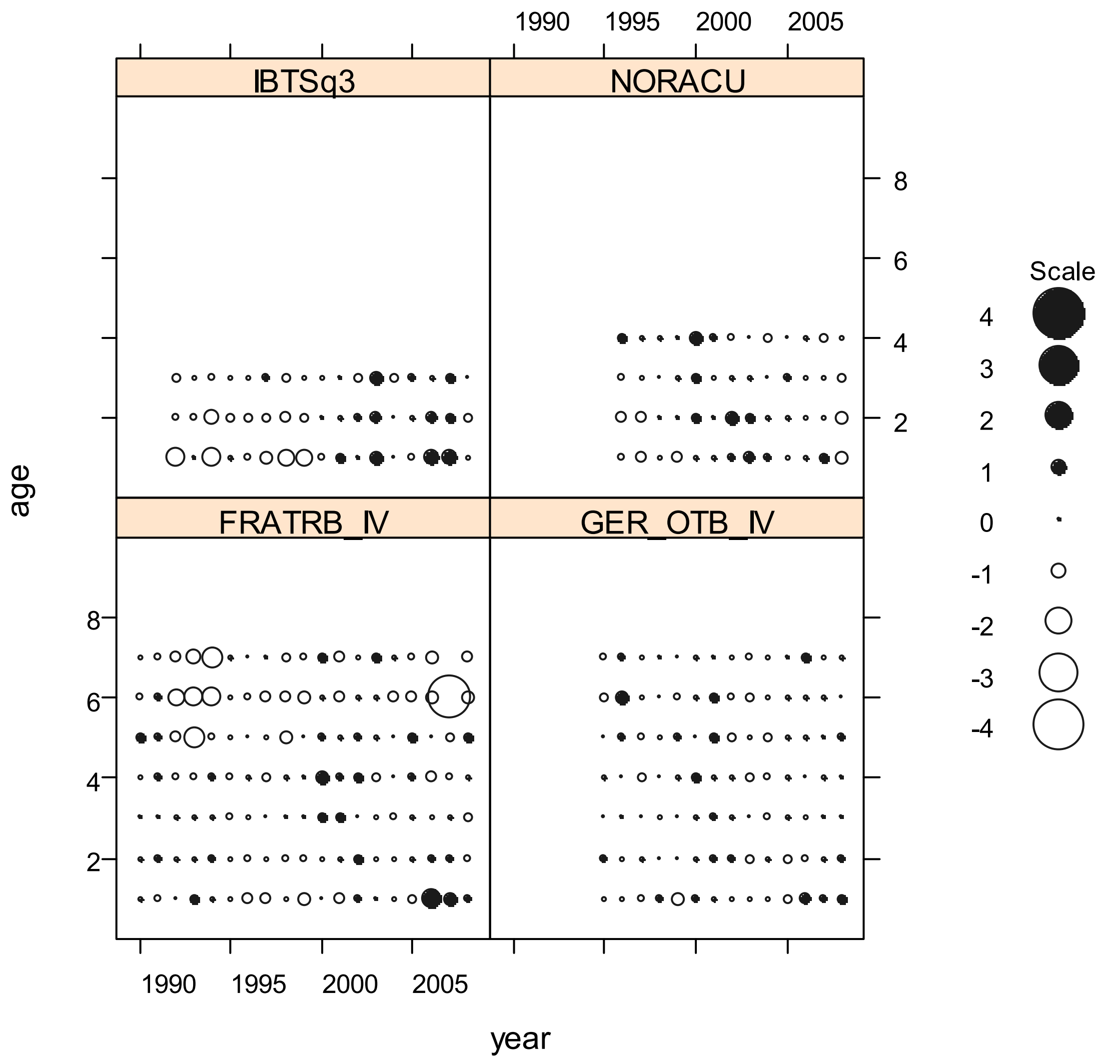

Figure 11.3.11. Saithe in Sub-Area IV, VI and Division IIIa. Log catchability residuals from the final XSA run, (SPALY). Note that the residual age 3 in year 2007(-3.8) is removed in the plot to make the signal in the other residuals clearer.

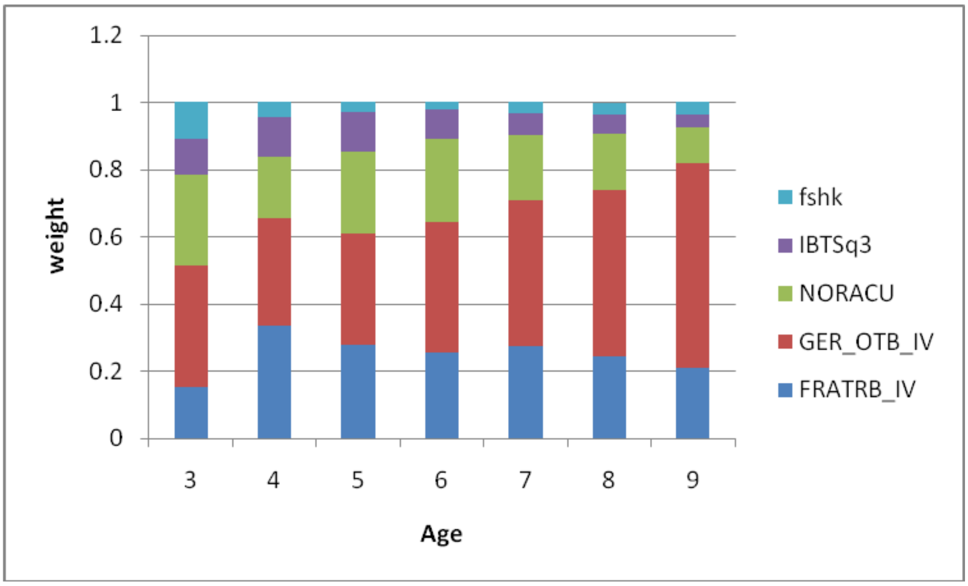

Figure 11.3.12. Saithe in Sub-Area IV, VI and Division IIIa. Relative weights of F-shrinkage and tuning fleets in the final XSA run.

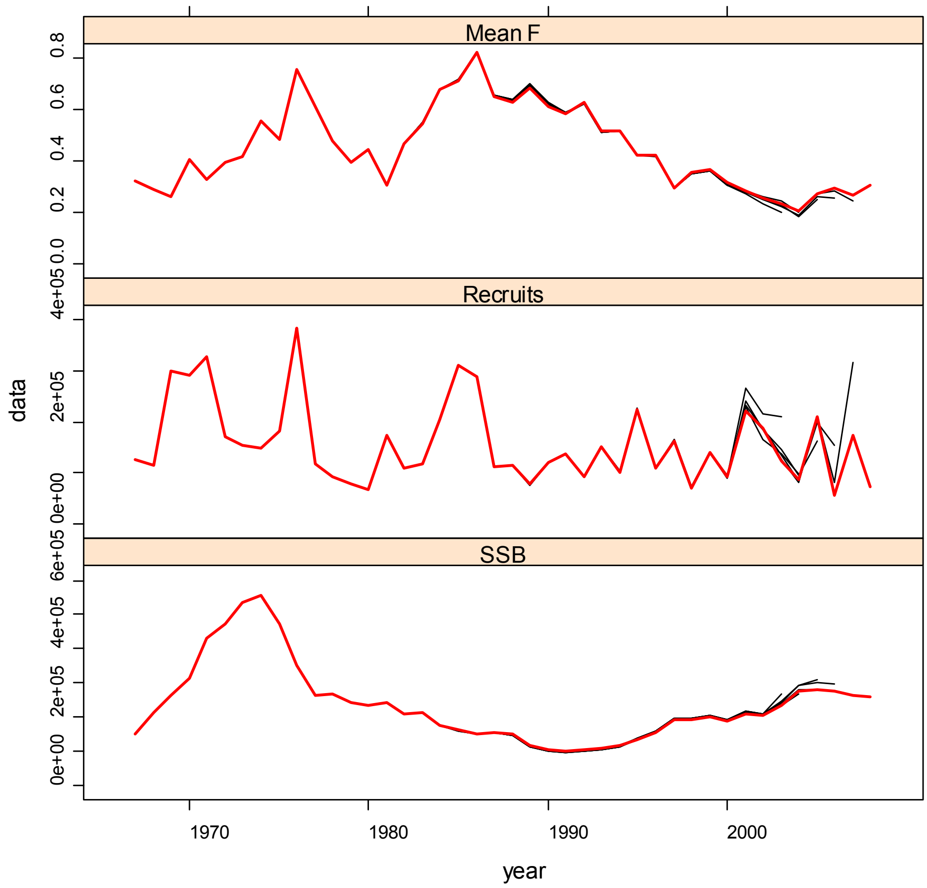

Figure 11.3.13. Saithe in Sub-Area IV, VI and Division IIIa. Retrospective analysis of the final XSA run.

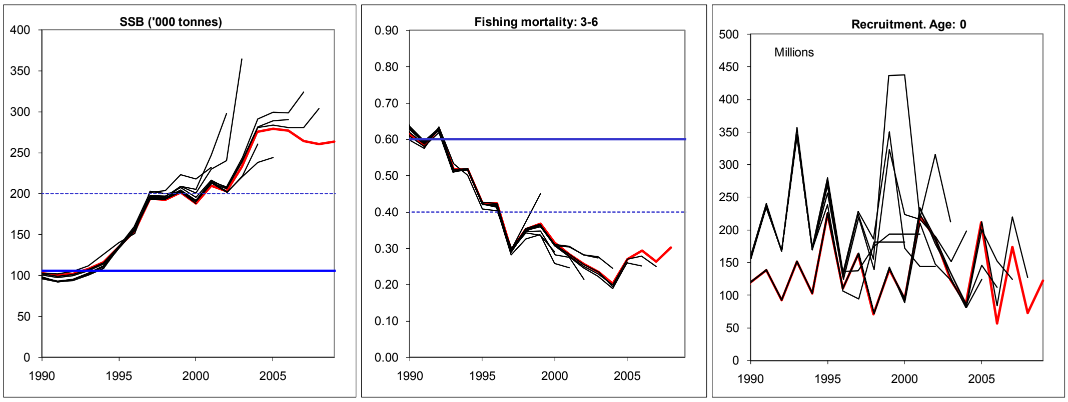

Figure 11.3.14. Saithe in Sub-Area IV, VI and Division IIIa. Assessments generated in successive working groups. Red circles represent forecasts for the assessment year.

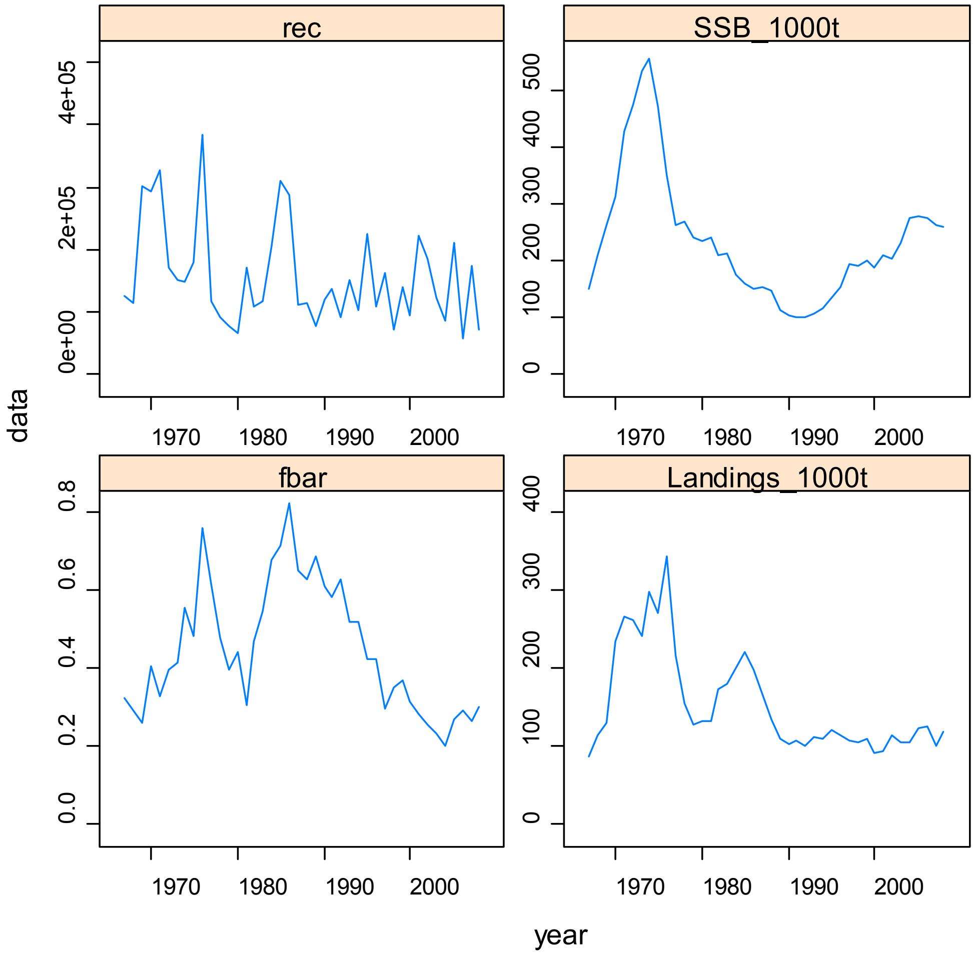

Figure 11.4.1. Stock summary for saithe in Sub-Area IV, VI and Division IIIa. The red dots in the yield graph are TACs.

12 Whiting in Subarea IV and Divisions VIId and IIIa

This assessment relates to whiting in the North Sea (ICES Subarea IV) and eastern Channel (ICES Division VIId). The current assessment is formally classified as an update assessment. A benchmark was held for this stock in January 2009. The conclusions from the benchmark were that the assessment was consistent since 1995 and offers a reliable basis for determining stock status, including estimation of current stock size and fishing mortality.

12.1 General

12.1.1 Stock Definition

No new information was presented at the working group. A summary of available information on stock-definition can be found in the Stock Annex prepared at WKROUND (2009)

12.1.2 Ecosystem aspect

No new information was presented at the working group. A summary of available information on ecosystem aspects is presented in the Stock Annex prepared at WKROUND (2009).

12.1.3 Fisheries

Information on the fishery is contained in the Stock Annex prepared at WKROUND (2009). Here follows detailed information on recent issues concerning the fishery.

The recent low TACs combined with local aggregations of whiting on the East English Coast and East of Shetland has resulted in a rapid uptake of the whiting quota this year. In the first five months of 2008 34% of the UK North Sea quota was taken. In 2009, in the first five months 52% of the UK North Sea quota was taken. Furthermore, several fleets have taken their annual allocation within this period.

12.1.3.1 Changes in fleet dynamics

The following is taken from the WGFTFB (2008):

In Belgium the use of bigger meshes in the top panel of beam trawler gear is expected to reduce the by-catch of roundfish species, especially haddock and whiting.

In Scotland there has been a shift for Scottish vessels from using 100 mm-110 mm for whitefish on the west coast ground (Area VI) to 80 mm prawn codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. The implications are that there will be increased effort in the North Sea with more effort by less selective gears; this implies increased bycatches and discards.

There was a new 2008 Scottish Conservation Credits scheme, with a number of implications:

In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. Implications: White-fish selection may improve because from July 2008, all nets in the 80mm range will have to have a 110 mm square mesh panel installed.

Scottish seiners have been granted a derogation from the 2 net rule until the end of January 2009 to continue to carry 2 nets (e.g. 100 –119 mm as well as 120 mm). They are required to record landings from each net on a separate log-sheet and to carry observers when requested. Implications: Potential for misreporting by mesh category

From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. Implication: that there may have been greater effort exerted on haddock, whiting, monk, flats and *Nephrops*.

There were further additions to the Scottish Conservation Credits scheme for 2009:

Changes in gear that are required to qualify for the Scottish Conservation Credits Scheme (CCS; see Section 13.1.4) are likely to reduce bycatch (and therefore) discards of whiting in the *Nephrops* fishery in particular. In 2008 Scottish vessels were included in the CCS unless they opted out of it, and as only one or two vessels have chose to do so, compliance was been close to 100%. In 2009, the CCS is the only option available to Scottish skippers

Technical Conservation Measures

The option of 18 extra days if a 120 mm SMP at 4–9m was used with a 95 mm x 5 mm double codend was not taken up by the Scottish prawn fleet in 2007. The main reasons were that prawns would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not make up for. In 2008 this option attracted 39 extra days but was in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110 mm SMP is used with an 80 mm codend. Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110 mm SMP.

A large number of 110 mm SMPs were bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet

Information for previous years is available in the stock annex.

12.1.3.2 Industry Contributed Reports

The Fisheries Science Partnership's North East Cod survey has been running since 2003, and covers a small but commercially important area of the North Sea on the north east coast of England. The survey does not only measure cod, but also give an index of whiting abundance for ages 0 to 7+. The final report (De oliviera *et al*., 2009) documents the spatial distribution and abundance of whiting from 2003 to 2008. This publication shows that the local abundance of whiting has increased in this area, particularly over the years 2005 to 2008; this is also noted in the North Sea Stock survey (Laurensen 2008). The survey also notes a particularly large amount of age 1 whiting in the study area in 2008.

Several letters were received highlighting the effect of the reduced TAC for whiting in specific areas of the North Sea over the last five years. This problem is specifically evident where whiting abundance has been increasing in contrast the wider North Sea stock abundance. Whiting has been attracting high market value in the last three years and the value of whiting quota has increased substantially. This has resulted in higher discarding in some areas simply through the unavailability of affordable quota. These letters ask that managers provide means for whiting quota reaching these areas.

12.1.4 ICES Advice

12.1.4.1 ICES advice for 2008:

The present assessment is indicative of recent trends. There has been a declining trend of SSB to the lowest level observed since 1995. The recruitment has been very low since the 2002 year class. Despite lower catches and fishing mortality from 2002 2005, this low recruitment has resulted in a declining SSB.

ICES advice for 2009:

In the absence of defined reference points, the state of the stock cannot be evaluated. An analytical assessment estimates SSB in 2008 a being at the lowest level since the beginning of the time-series in 1990. Fishing mortality has decreased through the time-series, but increased in recent years to twice F_{max}. Recruitment has been very low since 2001.

12.1.5 Management

Management of whiting is by TAC and technical measures. The agreed TACs for whiting in Subarea IV and Division IIa (EU waters) was 17 850 t in 2008 and 15 170 t in 2009 and where EC vessels may take no more than 9 250 t from the Norwegian waters of Subarea IV. There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (19 940 t in 2008 and 16 940 t in 2009).

TACs for this stock are split between two areas: (i) Subarea IV and Division IIa (EU waters) and, (ii) Divisions VIIb-k. Since 1996 when the North Sea and eastern Channel whiting assessments were first combined into one. The human consumption landings in Divisions IV and VIId are calculated as 78% and 22% of the combined area totals. The figures used as the basis for the division of the TAC are the average proportion of the official landings for the past three years.

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003; for 2005 in Annex IVa of Council Regulation (EC) no 27/2005 and for 2006 in Annex IIa of Council Regulation (EC) 51/2006. Currently, vessels fishing with towed gears for roundfish in Subareas IV and VIId and Division IIa (EU waters) are restricted to 103 days at sea per year, excluding derogations. The minimum landing size for whiting in the North Sea is 27 cm. The minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

Whiting are a by-catch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

In 2008 the following European Council regulation applied (EU40/2008, annex III, part A section 9):

Reduction of whiting discards in the North Sea

In the North Sea, Member States shall undertake in 2008 trials and experiments as necessary on technical adaptations of the trawls, Danish seines or similar gears with a mesh size equal to or greater than 80 mm and less than 90 mm in order to reduce the discards of whiting by at least 30%.

Member States shall make the results of the trials and experiments laid down in point 1 available to the Commission no later than 31 August 2008.

The Council shall, on the basis of a proposal from the Commission, decide on appropriate technical adaptations to reduce discards of whiting in conformity with the objective laid down in point 1.

Conservation credit scheme

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS). By May 2009, 46 further RTCs had been implemented (with a target of 150 for the year) , and the CCS been adopted by 439 Scottish and around 30 English and Welsh vessels. It has two central themes aimed at reducing the capture of cod through (i) avoiding areas with elevated abundances of cod through the use of compulsory Real Time Closures (RTCs) and voluntary 'amber zones' and (ii) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally. Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock. Whether this effect is positive or negative remains to be seen; however, early indications suggest that improved gear selectivity is likely to contribute to reductions in fishing mortality and discard levels, particularly of haddock and whiting, and there is evidence that the exploitation patterns for haddock and whiting across all participating vessels have improved since the introduction of the CCS scheme.

In early 2008, a one-net rule was introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

12.2 Data available

12.2.1 Catch data issues for 2008

The approach to the raising of discards for whiting was essentially the same as for 2007. The notable difference was that numbers at age and mean weights at age were provided for discards of whiting for VIId and IV by UK(E&W).

England and Wales discards

UK(E&W) provide their discards data for cod for IV and VIId combined as one fishing area, and this is dealt with accordingly in the aggregation files for cod. At the request of the stock coordinator, UK(E&W) provided discards data for these fishing areas separately for whiting for the years 2002 to 2008, in order to help specifically with the issue of un-estimated discards in Division VIId. The UK(E&W) discards data for VIId were however not used for raising for this Division as there was not enough time to apply this procedure for all the data supplied. This will be done for net years assessment. For Subarea IV, Scottish, French, German, Danish and UK(E&W) discards were used for the discards raising process.

French whiting discards

France provided discards data including numbers at age and mean weights at age for fishing years 2003 to 2007 for ICES Subarea IV and Division VIId separately. These data would be very useful for a benchmark assessment of whiting. Since age and weight distributions of discarded whiting were provided for 2008 by UK(E&W) these data have been used to estimate French discards of whiting in VIId.

12.2.2 Catch

Total nominal landings are given in Table 12.2.1 for the North Sea (Subarea IV) and Eastern Channel (Division VIId). Industrial bycatch is almost entirely due to the Danish sandeel, sprat and Norway pout fisheries.

In the 2009 roundfish benchmark workshop (WKROUND, 2009) it was decided to truncate the catch data from 1990. This is due to unresolved discrepancies between survey and catch data in prior to 1990.

Working group estimates of weights and numbers of the catch components for the North Sea and Eastern Channel are given in Tables 12.2.2 and 12.2.3, both tables cover the period 1990 to 2008. Total catch is similar to that of last year: decreases in human consumption landings from the North Sea have been offset by increased landings from the Eastern Channel and increased discards. The reported tonnages of the catch components remain among the lowest in the series due to a restrictive TAC, and whiting industrial by-catch remains low following the reopening of the fishery for Norway pout in 2008. For the Eastern Channel, the total catch (landings) in 2008 is an increase on the last two years and is close to the mean of the series.

Discard data apply to the North Sea only. However, discard data has been supplied by France and England back to 2002 and this will be incorporated in next years' assessment.

Figure 12.2.1 plots the trends in the commercial catch for each component, note that estimates of discards from VIId are not included. Each component shows a general decline. Industrial by-catch can be seen to be removing proportionately less through time. Human consumption landings have fluctuated around 45% of the total catch during the period 1990–2004, rising to 60% in the recent years. The proportion of discards has increased over the last ten years, but has been decreasing in the most recent period.

12.2.3 Age compositions

Age compositions in the landings are supplied by Scotland, England, The Netherlands and Germany. Age compositions in the discards are supplied by Scotland, England, Germany and Denmark. And for industrial bycatch, age compositions were supplied by Denmark.

Limited sampling of the industrial bycatch component has resulted in the 2006 data appearing as an outlier and the 2007 and 2008 data was deemed unreliable. This applies to both the age compositions and the estimates of mean weights at age. Thus the data for 2006 to 2008 have been replaced with an estimate $\hat{n}_{a,y}$ given by:

$$\hat{n}_{a,y} = \hat{N}_y \hat{p}_{a,y},$$

where $\hat{p}_{a,y}$ is the mean proportion at age over the years 1990 to 2005, and $\hat{N}_y$ is estimated to give a sums of products correction (SOP) factor of 1 by

$$\hat{N}_y = \frac{\sum_a \hat{p}_{a,y} \hat{w}_{a,y}}{W_y},$$

where W_y is the reported weight of industrial bycatch. Here $\hat{w}_{a,y}$ have been estimated by taking the mean weights at age in the industrial bycatch over the period 1995 to 2005 (zero weights are taken as missing values).

Proportion in number at ages 1 to 8+ in the catch, human consumption landings, discards and industrial by-catch as provided to the working group are plotted in Figure 12.2.2. Landings of whiting during 1990–2002 have generally consisted of around 80% in number of 1 to 4 year olds. Since 2002 the proportion has declined to approximately 60% in 2006 after the introduction of the 120 mm mesh. However, in 2007, due to an increased number of 2 and 3 year olds this proportion has risen to historical levels. The proportion of age 1 in the landings of the last four years are around the highest in the series. Discards at age 1 have been increasing over the last three years.

Total international catch numbers at age (IV and VIId combined) are presented in Table 12.2.4. Total catch comprises human consumption landings, discards and industrial by-catch for reduction purposes. Discards are for the North Sea (area IV) only. Total international human consumption landings (North Sea and Eastern Channel combined) are given in Table 12.2.5. Discard numbers at age for the North Sea are presented in Table 12.2.6. Industrial by-catch numbers at age for the North Sea are presented in Table 12.2.7.

12.2.4 Weight at age

Mean weights at age (Subarea IV and Division VIId combined) in the catch are presented in Table 12.2.8. These are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 12.2.9, and for the discards and industrial by-catch in the North Sea in Tables 12.2.10 and 12.2.11. These are shown graphically in Figure 12.2.3, which indicates a recent increase in mean weight at age in the landings and catch for all ages, and a reasonably constant mean weights for all other ages in the other catch components. From 1992 ages 6 and above in the catch and landings have shown a periodic increase and decrease in mean weight.

Unrepresentative sampling of industrial bycatch in 2006 to 2008 resulted in poor estimates of the mean weights at age and these have been replaced by the mean weight at age for the period 1995 to 2005 (zero weights are taken as missing values).

Mean weight at age in the catch by cohort is plotted in figure 12.2.4. This figure shows declining mean weights in early cohorts at older ages, slow growth for the 1999 to 2002 cohorts, and steeper growth for the most recent cohorts.

12.2.5 Maturity and natural mortality

Values for maturity remain unchanged from those used in recent assessments and are:

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1	1	1	1	1	1

Their derivation is given in the Stock Annex.

Values of Natural mortality are taken from WGSAM (2008), and are smoothed estimates of annual natural mortality estimated from the key SMS for the North Sea and are given in table 12.2.12.

12.2.6 Catch, effort and research vessel data

Since this is an update assessment, this section will concentrate mainly on those data that are used in the assessment.

Two survey series are used within this assessment:

Quarter 1 international bottom trawl survey (IBTS Q1): ages 1-5, covering the period 1990-2008. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.

Quarter 3: international bottom trawl survey (IBTS Q3) ages 1-5, covering the period 1991-2008. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.

Survey tuning indices used in the assessment are presented in Table 12.2.13. The report of the 2001 meeting of this WG (ICES WGNSSK 2002), and the ICES advice for 2002 (ICES ACFM 2001) provides arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis see also section 14.2.4. Such arguments remain valid and only survey data have been considered for tuning purposes. All available tuning series are summarised in Table 12.2.13 and are presented in the Stock Annex prepared at the WKROUND (2009).

Density maps for the IBTS Q1 survey are shown in Figure 12.2.5. These plots show low recruitment in recent years (2005 to 2007), but also show an apparent shift in where the recruiting year class is found. In 2007, perhaps the lowest densities of age 1 whiting were seen, but in 2008 this year class was found particularly in the southern North Sea at moderate densities (similar to that of the 2001 year class, a year class from a period of much higher recruitment). Recruitment in 2008 is much improved from 2005 to 2007 and this year class persisted to moderate numbers of age 2. Recruitment in 2009 also appears to be good. Numbers of ages three and older have been variable and patchy.

Density maps for the IBTS Q3 survey are shown in Figure 12.2.6. These plots also show a decline in the numbers of age three plus whiting since 2004. Young whiting in quarter three seem to be restricted to the eastern coast of the UK with sparse observations north east of the Dogger Bank. The IBTS Q3 survey detects a moderate recruitment in 2008 that was apparently missed at age 1 by the IBTS Q1 survey.

12.3 Data analyses

12.3.1 Summary of 2009 benchmark workshop

The benchmark workshop focused on trying to resolve the historical discrepancy between catch and surveys (see Figure 12.3.1). There are three potential sources of this discrepancy: changes in bias in the estimate of catch magnitude; changes in survey catchability; or changes in natural mortality due to predation and or regime shift. To address these issues the group decided to:

- use estimates of natural mortality from WGSAM (2008), the multispecies assessment working group;
- investigate the historical perception of the catch data, in particular the industrial by-catch data, from previous North Sea working group reports;
- investigate the potential for changes in catchability in the IBTS surveys.

The group also looked at changes in the distribution of commercial landings (Figure 12.3.2) with respect to survey abundance, and whiting spawning areas (as estimated by the distribution of whiting eggs, Figure 12.3.3).

Given the length of the workshop it was not possible to answer all questions rigorously; however future work was suggested (investigation of survey catchability and historical perception of catch data quality) and is currently underway. In the event that the discrepancy between surveys and catch is resolved biomass and fishing mortality precautionary reference points may be reinstated, in the mean time, it was suggested that yield per recruit fishing mortality reference points be investigated. Specifically, a time series of Fmax and F0.1 should be made available to the assessment working group. This work will appear in section 12.8 of this report.

The final conclusions of the benchmark working group were that the current assessment methodology was appropriate for assessing stock trends and for short term forecast purposes. These details are contained in the stock annex prepared at WKROUND (2009).

12.3.2 Reviews of last year's assessment – what were the comments?

Several comments were made by the RGNSSK regarding last years' assessment. These are summarised below. Review group comments are *italicized* and WG responses, where appropriate, follow in plain text.

Extrapolation of discard data mainly sampled in the northern area is a source of uncertainty because the fishery in the southern area is mostly carried out with different gears and smaller mesh sizes. No discard information was available for Division VIId.

The WG agrees, and adds that discard information for VIId from France and UK (England and Wales) has been made newly available to the WG. This information should be in a usable form for next years' assessment working group.

The RG commented that issues on stock structure have not been resolved, and suggested that there may be a need to take this into account in advice and management.

The WG agrees that the issue of stock structure is unclear, however, what is clear is that the stock is exploited mainly in three distinct areas of the North Sea and Eastern Channel. These areas show as aggregations in the IBTS surveys, and that wider North Sea density is much reduced since 1990.

The RG recommends considering methods to include the most recent survey information in the assessment.

The current assessment method is XSA which does not use survey data in the most recent year. The WG was not in a position to change the assessment method so the only possibility is to treat the IBTS quarter 1 survey as if it was in quarter 4 of the previous year with all ages reduced as necessary. With the current assessment set up this would mean using ages 2-5 as ages 1-4, and so would lose a time series of indices at age 1. Since recruitment estimation is important for this fishery this approach was not considered further.

12.3.3 Exploratory survey-based analyses

Catch curve analyses are shown in Figures 12.3.4 to 12.3.5. These show consistent tracking of year classes (since catch curves are mostly smooth) with the exception being the IBTS Q1 index of age 1 for the 2006 year class. The IBTS Q1 and Q3 surveys give an indication of declining mortality until the 2003 year-class. Also evident are the low 2002 – 2006 year classes. It appears from these figures that there is improved recruitment with the 2007 year-class.

The 2006 year-class appeared as a very low index at age 1 and a moderately high index at age 2 by the IBTS Q1 survey. This is unusual for the time series and is expected to result in large residuals and will likely induce retrospective patterns in recruitment. In the IBTS Q3 indices this year class did not look substantially different from the 2002 – 2005 year classes.

The consistency within surveys is assessed using correlation plots. Only survey indices used in the final assessment are presented as this is an update assessment. The IBTS Q1 and Q3 surveys both show good internal consistency across all ages (Figure 12.3.6 and 12.3.7).

12.3.4 Exploratory catch-at-age-based analyses

Catch curves for the catch data are plotted in Figure 12.3.8 and shows numbers-at-age on the log scale linked by cohort. This shows partial recruitment to the fishery up to age 2. Also evident is the persistence of the 1999 to 2001 year classes in the catch and the recent low catches of the 2002 – 2006 year classes.

Within cohort correlations between ages are presented in Figure 12.3.9. In general catch numbers correlate well between cohorts with the relationship breaking down as you compare cohorts across increasing years.

Single fleet XSA runs were conducted to compare trends in the catch data with trends in the survey data. These used the same procedure as this years' final assessment. Summary plots of these runs are presented in Figure 12.3.10. The population trends from each survey are consistent; however, the absolute levels of the F and SSB estimates differ. The IBTS Q1 gives a higher F, lower SSB and lower recruitment than the IBTS Q3. Residual patterns (Figure 12.3.11) show the noisy 2006 year class.

12.3.5 Conclusions drawn from exploratory analyses

Catch curve analysis and correlation plots show that both surveys and catch data track cohorts well and are internally consistent, with the possible exception of the 2006 year class. This will have implications for the estimation of recruitment at age 1 in 2007.

12.3.6 Final assessment

The final assessment was an XSA fitted to the combined landings, discard and industrial by-catch data for the period 1990–2008. This is the same procedure as last year and that agreed at WKROUND (2009). The settings are contained in the table below. Those from previous years are also presented.

	year range used	2006	2007	2008	**This year(2009)**
Catch at age data		1980-2005 Ages 1 to 8+	1980-2006 Ages 1 to 8+	1980-2007 Ages 1 to 8+	**1990-2008** **Ages 1 to 8+**
Calibration period		1990-2005	1990-2006	1990-2007	**1990-2008**
ENGGFS Q3 GRT (1990-1991	-	Ages 1 to 6	-	-	-
ENGGFS Q3 (GOV)	-	Ages 1 to 6	Ages 1 to 6	Ages 1 to 6	-
SCOGFS Q3 (Scotia II)	-	Ages 1 to 6	-	-	-
SCOGFS Q3 (Scotia III)	-	Ages 1 to 6	Ages 1 to 6	Ages 1 to 6	-
IBTS Q1	**1990-2008**	Ages 1 to 5	Ages 1 to 5	Ages 1 to 5	**Ages 1 to 5**
IBTS Q3	**1991-2008**	-	-	-	**Ages 1 to 5**
Catchability independent of stock size		Age 1	Age 1	Age 1	**Age 1**
Catchability plateau		Age 4	Age 4	Age 4	**Age 4**
Weighting		Tricubic over 16 years	Tricubic over 17 years	Tricubic over 18 years	**No taper weighting**
Shrinkage		Last 3 years and 4 ages	Last 3 years and 4 ages	Last 3 years and 4 ages	**Last 3 years and 4 ages**
Shrinkage SE		2.0	2.0	2.0	**2.0**
Minimum SE for fleet survivors estimates		0.3	0.3	0.3	**0.3**

Full diagnostics for the final XSA run are given in Table 12.3.1. Residual plots are presented in Figure 12.3.12. These show contrasting trends between the IBTS Q1 and Q3 surveys in the recent years: IBTS Q1 has negative residuals for 2005 and 2006, while the IBTS Q3 survey has all positive residuals from ages 3 to 5 from 2005 to 2008. The IBTS Q3 survey also has positive residuals for all ages in the final year.

Fishing mortality estimates are presented in Table 12.3.2, the stock numbers in Table 12.3.3 and the assessment summary in Table 12.3.4 and Figure 12.3.13. Fishing mortality at age is plotted in Figure 12.3.14. Fishing mortality can be seen to be increasing sharply on ages 2 - 5, with a slower increase on ages 6 and 7. Fishing mortality on age 7 is very noisy in the beginning of the series.

A retrospective analysis is shown in Figure 12.3.15. This shows a consistent bias in recruitment over the last five years. The large bias in last years retrospective was expected as it is known that the IBTS Q1 survey index for age 1 was too low for the size of the cohort. For the last three years mean F seems to have been overestimated, while spawning stock biomass was underestimated (as was total stock biomass).

12.4 Historic Stock Trends

A plot of estimated F-at-age over the years 1991 to 2008 is presented in Figure 12.4.1. This figure shows the recent decline in F at older ages and an increase in F at ages 2 to 4, highlighting an apparent change in selection pattern in this fishery. In order to see this change in selection more clearly, trends in F(2–6), F(2–4) and F(5–7) are presented in Figure 12.4.2.

Contribution of age classes to TSB and SSB is shown in Figure 12.4.3 and as proportions in Figure 12.4.4. This shows the important contribution of ages 1 and 2 to the TSB. This figure also shows an increase in the contribution of ages 6 and over to stock biomass from 2002, coming from the period of increased recruitment in 1999 to 2002. The contribution of this period of recruitment looks to have reduce in the most recent year.

Historic trends for F, SSB and recruitment are presented in Figure 12.2.10.

12.5 Recruitment estimates

The RCT3 estimate of recruitment in 2009 was 1 297 million. The geometric mean of the last 5 years is 1 002 million. RCT input tables are presented in Table 12.5.1, and RCT3 output is presented in Table 12.5.2.

It was agreed to use the RCT3 estimates for recruitment in 2009, and the geometric mean (2004 to 2008) for recruitment in 2010 and 2011.

The following table summarises recruitment assumptions for the short term forecast together with XSA estimated recruitment from the previous two years – values used for recruitment are in **bold**.

year class	XSA (millions)	RCT3 (millions)	Geometric mean
2006	605	-	-
2007	1553	1608	-
2008	-	**1297**	-
2009	-		**1002**
2010	-		**1002**

12.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2008 were used as input population numbers for ages 2 and older. Recruitment assumptions are detailed in section 12.5.

The exploitation pattern was chosen as the mean exploitation pattern over the years 2006–2008. Given the recent increases in F(2–6) this exploitation pattern was scaled to the mean F(2–6) in 2008 for forecasts.

Partial F at age for each catch component was estimated by splitting the forecast F at age using the mean proportion in the catch of each catch component over the years 2006 – 2008.

Mean weights at age are generally consistent over the recent period but there are trends at some ages (Figure 12.2.3). The mean over the last three years was used for the purposes of forecasting.

The input to the forecast is shown in Table 12.6.1. Results are presented in Table 12.6.2.

No TAC constraint was applied in the intermediate year since it is not considered that fishing will stop when the TAC is reached. It is thought that any predicted landings over the TAC are likely to appear as discards in 2009. This means that estimated landings in 2009 will be overestimated, however the estimate of total catch will not be.

The TAC for 2009 for area IV and VIId was 15 560 t. This is calculated as 78% of the TAC for Subarea IV and Division IIa (15 170 t) and 22% of the TAC for Divisions VIIb-k combined (16 950 t). Assuming $F_{2009}=F_{2008}$ and unconstrained landings results in human consumption landings in 2009 of 18 680 t from a total catch of 31 390 t resulting in an SSB in 2010 of 87 400 t, a reduction from 91 670 t as estimated for 2009. For the same fishing mortality in 2010, human consumption landings are predicted to be 18 040 t resulting in an SSB in 2011 of 78 340 t. Under the assumptions of the prediction, SSB in 2011 will increase by 16% (as compared to that estimated for 2010) in the absence of fishing in 2010.

The intermediate year forecast predicts that at status quo fishing mortality, human consumption landings will exceed the TAC for 2009 by 3 500 t.

As a measure of the consistency of the forecast: the catch estimated by last years forecast using an F of 0.47 (= F2008), was 24 300 t, comprising human consumption landings of 14 100 t. This compares to estimated catch in 2008 based on sampling in 2008 of 26 880 t comprising human consumption landings of 16 900 t.

12.7 Medium-term forecasts

No medium-term forecasts were carried out on this stock.

12.8 Biological reference points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

B_{lim} = 225,000 t; B_{pa} = 315,000 t; F_{lim} = 0.90; F_{pa} = 0.65.

The WG considers that these reference points are not applicable to the current assessment (see discussion in 12.9)

F0.1 and Fmax was estimated based on the F at age from the final XSA assessment in each year back to 1993. The time series of F0.1 and Fmax is presented in Figure 12.8.1. To give an idea of the precision of these estimates, a statistical catch at age model (TSA) was fitted to the data and the estimates of the variance-covariance matrix of F at age in each year was used to simulate the distribution of F0.1 and Fmax. These values differ in the final year due to differences in the model formulation and should not be concerning as the TSA model settings were not investigated so is not to be considered as an assessment.

F0.1 can be seen to have been stable historically at around 0.4, but recently has increase to around 0.7. Due to the shape of the yield per recruit curve, a maximum is often not reached, thus Fmax is not defined for several years. It is not clear whether yield per recruit F reference points are applicable to this stock since Fmax is undefined in most years, and the estimate of F0.1 is very variable in recent years (see Figure 12.8.2).

Further work is being conducted on the interpretation of F0.1 for this stock.

12.9 Quality of the assessment

Previous meetings of this WG and the benchmark workshop (WKROUND, 2009) have concluded that the survey data and commercial catch data contain different signals concerning the stock. Analyses by working group members and by the SGSIMUW in 2005 indicate that data since the early- to mid- 1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from 1990. This has been taken forward into prediction for catch option purposes. However, due to the lack of concordance in the data pre-dating the early 1990s, the working group considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

Despite the minimum mesh-size increase in 2002 in the towed demersal roundfish gears and the decline in industrial by-catch activity in the Norway pout and sandeel fisheries have declined, the estimates of F on ages 2 to 4 appears to be increasing disproportionately to that on older ages.

Given the spatial structure of the whiting stock and of the fleets exploiting it, it is important to have data that covers all fleets. Considering that age 1 and age 2 whiting make up a large proportion of the total stock biomass, good information of the discarding practices of the major fleets is important. Discard information was supplied by France for 2003 – 2007 but was not included due issues with historical databases. This information may affect our perception of the numbers and exploitation of the younger age classes. This is most likely to affect the reliability of the forecast and estimates of recruitment.

Survey information for VIId was not available in a form that could be used by the working group. Due to the recent changes in distribution of the stock, tuning information from this area would be extremely useful, and could improve the estimate of recruitment in the most recent year.

Age distributions and mean weights at age have been estimated for the industrial bycatch since 2006. This is due to low sampling levels of the Danish industrial bycatch fisheries. Although the fishery only comprises around 0.03% by weight of the total catch, the bycatch of whiting is entirely young fish. This means that no cohort information is coming from the industrial component of the catch and this is likely to have reduced our ability to estimate the recruitment of the last three year classes.

The historic performance of the assessment is summarised in Figure 12.9.1.

12.10 Status of the Stock

The working group considers the status of the stock unknown with respect to biological reference points, for the reasons given in section 12.9. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, is at a historical low level relative to the period since 1990. Fishing mortality, previously estimated to be low relative to the period since 1990, now appears to have increased, particularly at younger ages.

The recent estimates of older whiting (ages 6 and above) is unprecedented in the assessment period. These fish have come from a period of moderate recruitment (1999 to 2002) implying that further moderate recruitments may be sufficient to allow an improvement in the stock.

12.11 Management Considerations

Mean F has decreased from historical levels, but has been increasing over the past three years. Despite lower catches and fishing mortality from 2002 to 2005, a series of low recruitments is determining the stock dynamics and has resulted in SSB declining to its lowest level. Recent recruitment has been impaired; contributing factors may be low stock size and environmental factors.

Catches of whiting have been declining since 1980 (from 224 000 t in 1980 to 27 000 t in 2007, including discards and industrial bycatch). Distribution maps of survey IBTS indices show a change in distribution of the stock which is now located mainly in the north-western North Sea. Catch rates from localized fleets may not represent trends in the overall North Sea and English Channel population (Figure 6.4.5.4). The localized distribution of the population is known to be resulting in substantial differences in the quota uptake rate. This is likely to result in localized discarding problems that should be monitored carefully.

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries, and the Norway pout fishery. The current minimum mesh-size in the targeted demersal roundfish fishery in the northern North Sea has resulted in reduced discards from that sector compared with the historical discard rates. Mortality has increased on younger ages due to increased discarding in the recent year as a result of recent changes in fleet dynamics of *Nephrops* fleets and small mesh fisheries in the southern North Sea. The bycatch of whiting in the Norway pout and sandeel fisheries is dependent on activity in that fishery, which has recently declined after strong reductions in the fisheries.

Catches of whiting in the North Sea are also likely to be affected by the effort reduction seen in the targeted demersal roundfish and flatfish fisheries, although this will in part be offset by increases in the number of vessels switching to small mesh fisheries.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear in the North Sea and Skagerrak, should be encouraged for whiting.

ICES has developed a generic approach to evaluate whether new survey information that becomes available in September forms a basis to update the advice. ICES will publish new advice in November 2009 if this is the case.

12.12 Whiting in Division IIIa

The new data available for this stock are too sparse to revise the advice from last year and therefore no assessment of this stock was undertaken.

Total landings are shown in Table 12.12.1.

Table 12.2.1 Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES, and agreed TAC.

Subarea IV

Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Belgium	268	529	536	454	270	248	144	105	92	45	107
Denmark	46	58	105	105	96	89	62	57	251	78	42
Faroe Islands	1	1	0	0	17	5	0	0	0	0	0
France	1908	0	2527	3455	3314	2675	1721	1059	2445	2876	1788
Germany	103	176	424	402	354	334	296	149	252	75	76
Netherlands	1941	1795	1884	2478	2425	1442	977	802	702	618	656
Norway	65	68	33	44	47	38	23	16	18	11	92
Sweden	0	9	4	6	7	10	2	1	2	1	2
UK (E.&W)	2909	2268	1782	1301	1322	680	1209	2653			
UK (Scot-land)	16696	17206	17158	10589	7756	5734	5057	5361			
UK (Total)									11481	12101	10386
Total	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**	**15242**	**15805**	**13149**
Unallocated landings	-78	3870	57	586	312	-596	-261	308	-95	381	250
WG estimate of H.Cons. landings	23860	25980	24510	19420	15920	10660	9230	10510	15147	16186	13399
WG estimate of discards	12710	23580	23210	16490	17510	24090	14260	10610	9540	6400	7990
WG estimate of Ind. By-catch	3140	5180	8890	7360	7330	2740	1220	880	2190	1230	1020
WG estimate of total catch	**39710**	**54740**	**56610**	**43270**	**40760**	**37490**	**24710**	**22000**	**26877**	**23816**	**22409**

Division VIId

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	53	48	65	75	58	66	45	45	71	75	68
France	4495	-	5875	6338	5172	6478	-	3819	3019	2648	3510
Netherlands	32	6	14	67	19	175	132	125	117	118	162
UK (E.&W)	185	135	118	134	112	109	80	86	71	59	
UK (Scot-land)	+	-	-	-	-	-	-	-	-	-	
UK (Total)											87
Total	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**	**3279**	**2899**	**3827**
Unallocated	-165	4241	-1772	-814	439	-1118	4076	716	164	355	644
W.G. esti-mate	**4600**	**4430**	**4300**	**5800**	**5800**	**5710**	**4350**	**4790**	**3443**	**3254**	**4471**

Table 12.2.1 (Cont'd) Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES, and agreed TAC.

Subarea IV and Division VIId

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
W.G. estimate	44370	59108	60857	49011	46271	43208	29060	26793	32320	27562	26877

Annual TAC for Subarea IV and Division IIa

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TAC	60,000	44,000	30,000	29,700	41,000	16,000	16,000	28,500	23,800	23,800	17,850	15,173

Annual TAC for Divisions VIIb-k combined

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TAC	27,000	25,000	22,000	21,000	31,700	31,700	27,000	21,600	19,940	19,940	19,940	16,949

Table 12.2.2 Whiting in IV and VIId. WG estimates of catch components by weight ('000s tonnes).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.Cons		
1990	43.42	55.84	50.72	149.98	3.48	153.46	7.4%
1991	47.30	33.64	38.31	119.25	5.72	124.97	10.8%
1992	46.45	30.61	26.90	103.96	5.74	109.70	11.0%
1993	47.99	42.87	20.10	110.96	5.21	116.17	9.8%
1994	42.62	33.01	10.35	85.98	6.62	92.60	13.4%
1995	41.05	30.26	26.56	97.87	5.39	103.26	11.6%
1996	36.12	28.18	4.70	69.00	4.95	73.95	12.1%
1997	31.30	17.22	5.96	54.48	4.62	59.10	12.9%
1998	23.86	12.71	3.14	39.71	4.60	44.31	16.2%
1999	25.98	23.58	5.18	54.74	4.43	59.17	14.6%
2000	24.51	23.21	8.89	56.61	4.30	60.91	14.9%
2001	19.42	16.49	7.36	43.27	5.80	49.07	23.0%
2002	15.92	17.51	7.33	40.76	5.80	46.56	26.7%
2003	10.66	24.09	2.74	37.49	5.71	43.20	34.9%
2004	9.23	14.26	1.22	24.71	4.35	29.06	32.0%
2005	10.51	10.61	0.88	22.00	4.79	26.79	31.3%
2006	15.15	9.54	2.19	26.88	3.44	30.32	18.5%
2007	16.19	6.40	1.23	23.82	3.25	27.07	16.7%
2008	13.40	7.99	1.02	22.41	4.47	26.88	25.0%
min.	9.23	6.40	0.88	22.00	3.25	26.79	7.4%
mean	27.42	23.05	11.83	62.31	4.88	67.19	18.0%
max.	47.99	55.84	50.72	149.98	6.62	153.46	34.9%

Table 12.2.3 Whiting in IV and VIId. WG estimates of catch components by number (millions).

	Sub Area IV (North Sea)				VIId (Eastern Channel)	Total	VIId as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.cons.		
1990	163.6	393.7	438.5	995.8	13.6	1009.4	7.7%
1991	181.2	235.2	142.0	558.4	17.9	576.3	9.0%
1992	162.8	208.7	219.0	590.5	19.4	609.9	10.6%
1993	155.1	295.0	140.4	590.5	17.8	608.3	10.3%
1994	138.1	227.1	95.9	461.1	24.0	485.1	14.8%
1995	128.6	180.7	121.2	430.5	18.5	449.0	12.6%
1996	119.5	174.7	38.4	332.6	22.4	355.0	15.8%
1997	107.8	90.8	54.8	253.4	22.6	276.0	17.3%
1998	85.4	80.3	32.6	198.3	23.0	221.3	21.2%
1999	98.3	163.8	97.1	359.2	18.9	378.1	16.1%
2000	91.6	140.6	54.9	287.1	22.1	309.2	19.4%
2001	73.5	97.5	67.7	238.7	28.6	267.3	28.0%
2002	56.8	95.1	68.7	220.6	19.7	240.3	25.8%
2003	34.4	205.9	26.8	267.1	22.8	289.9	39.9%
2004	30.6	54.2	18.6	103.4	16.4	119.8	34.9%
2005	36.7	58.2	12.3	107.2	19.6	126.8	34.8%
2006	52.3	57.4	21.7	131.4	11.7	143.1	18.3%
2007	53.7	48.3	12.1	114.1	12.7	126.8	19.1%
2008	42.6	59.7	10.0	112.3	16.2	128.5	27.6%
min.	30.6	48.3	10.0	103.4	11.7	119.8	7.7%
mean	95.4	150.9	88.0	334.3	19.4	353.7	20.2%
max.	181.2	393.7	438.5	995.8	28.6	1009.4	39.9%

Table 12.2.4 Whiting in IV and VIId. Total catch numbers at age (thousands).

year	1	2	3	4	5	6	7	8+
1990	253745	505010	129126	86324	32270	2002	735	112
1991	128507	191193	187195	36830	26209	5519	542	273
1992	239792	165354	89563	93636	11967	6878	2609	117
1993	217539	167577	124287	46543	46136	3946	1519	771
1994	163609	147177	90611	47533	17384	17264	998	460
1995	137481	139010	111489	35728	15161	5159	4515	474
1996	72645	113956	98476	48575	14235	4695	1294	1113
1997	53408	74200	82944	42154	18492	3358	1020	460
1998	71430	44697	42771	36459	17756	6392	1426	407
1999	178079	91355	45627	34175	18528	7547	2049	676
2000	66789	124365	63526	23888	16232	8791	4322	1265
2001	84121	86178	58908	20559	9177	4814	2232	1268
2002	49857	61239	82940	34006	8007	2043	1457	754
2003	72709	104040	53560	42048	14306	2372	474	397
2004	25440	16412	24354	25738	19126	7284	1193	298
2005	34555	33605	12420	18407	15058	9102	3056	653
2006	39635	38534	22803	8530	15180	12060	4761	1528
2007	38900	33535	24506	9966	3990	7632	5172	3057
2008	52684	26399	22769	13630	4360	1856	3884	2920

Table 12.2.5 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

year	1	2	3	4	5	6	7	8+
1990	6949	54361	45423	50603	17747	1407	622	110
1991	11610	43110	91129	26170	21697	4687	405	273
1992	9603	45154	48838	60806	9956	6223	1496	110
1993	5980	29305	64353	33514	34651	2990	1361	771
1994	17126	31660	46217	36814	14169	14706	928	446
1995	8832	28132	58538	28014	13767	4954	4402	467
1996	12516	26768	47594	36288	12022	4453	1116	1113
1997	6522	23543	48238	31904	15824	2957	1017	443
1998	17081	19894	25016	24713	14717	5446	1213	301
1999	16689	26966	25863	23792	14708	6660	1882	591
2000	15406	31989	28500	14327	11841	6657	3774	1159
2001	12257	28499	27332	17518	8640	4506	2092	1250
2002	2606	10343	30858	22328	6703	1710	1328	638
2003	403	11610	13991	18981	9514	1862	444	396
2004	3972	2813	9633	13312	11860	4411	747	274
2005	11001	10355	5588	10774	10080	5810	2315	425
2006	11104	11078	8544	5394	12329	10217	4144	1199
2007	10390	14783	16555	7701	3325	6709	4244	2648
2008	13255	12358	14159	9133	3574	1523	2511	2241

Table 12.2.6 Whiting in IV and VIId. Discard numbers at age (thousands), representing North Sea discards only.

year	1	2	3	4	5	6	7	8+
1990	79488	245128	33194	23488	12012	253	87	0
1991	76938	77383	74005	4900	1828	89	60	0
1992	98967	57629	26527	22976	1199	350	1064	2
1993	124426	101119	49064	8992	10709	519	131	0
1994	77783	97847	36762	9528	2856	2337	6	0
1995	46209	77320	48600	6943	1318	205	113	6
1996	30480	82020	48240	11319	2192	240	179	0
1997	19347	28836	30616	9175	2392	399	2	17
1998	29979	18755	16361	10992	2976	934	213	106
1999	84613	51740	14422	8844	3077	857	166	85
2000	33848	75869	23590	2898	2257	1548	474	107
2001	27570	44645	21930	2528	385	268	140	19
2002	8670	31959	43444	9491	1098	211	128	116
2003	54781	87376	36989	21853	4400	461	31	1
2004	8603	9086	13669	12279	7267	2862	446	24
2005	12622	22530	6342	7604	4944	3236	730	219
2006	15107	22137	12323	2411	2659	1791	611	328
2007	21006	15779	6868	1861	557	894	924	408
2008	33212	11579	7713	4161	697	308	1370	678

Table 12.2.7 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands). Representing the industrial fishery in the North Sea.

year	1	2	3	4	5	6	7	8+
1990	167308	205520	50508	12233	2511	342	26	2
1991	39959	70701	22062	5761	2684	743	78	0
1992	131221	62571	14198	9854	812	305	49	6
1993	87133	37153	10870	4037	776	437	27	0
1994	68701	17670	7632	1192	359	222	64	14
1995	82439	33558	4351	772	76	0	0	0
1996	29648	5168	2643	968	21	2	0	0
1997	27539	21820	4091	1075	276	2	0	0
1998	24370	6047	1395	754	63	12	0	0
1999	76776	12648	5342	1539	743	30	0	0
2000	17535	16508	11436	6663	2134	586	74	0
2001	44294	13034	9646	513	152	40	0	0
2002	38580	18937	8638	2186	205	122	0	0
2003	17525	5054	2580	1214	390	49	0	0
2004	12865	4514	1052	148	0	11	0	0
2005	10932	719	490	29	34	56	10	8
2006	13423	5318	1936	725	192	52	6	1
2007	7503	2973	1082	405	107	29	4	1
2008	6217	2463	897	336	89	24	3	1

Table 12.2.8 Whiting in IV and VIId. Total catch mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.083	0.137	0.209	0.250	0.279	0.408	0.489	0.600
1991	0.103	0.169	0.218	0.290	0.306	0.338	0.365	0.400
1992	0.082	0.185	0.256	0.278	0.331	0.346	0.314	0.502
1993	0.073	0.175	0.252	0.319	0.329	0.350	0.403	0.381
1994	0.080	0.170	0.254	0.323	0.371	0.367	0.414	0.416
1995	0.087	0.181	0.257	0.341	0.385	0.429	0.434	0.420
1996	0.093	0.167	0.236	0.302	0.388	0.405	0.428	0.430
1997	0.091	0.178	0.243	0.295	0.333	0.381	0.382	0.418
1998	0.091	0.180	0.236	0.281	0.314	0.339	0.330	0.367
1999	0.076	0.175	0.232	0.256	0.289	0.303	0.308	0.287
2000	0.113	0.182	0.238	0.288	0.287	0.277	0.277	0.273
2001	0.072	0.191	0.227	0.284	0.269	0.300	0.287	0.294
2002	0.067	0.156	0.222	0.281	0.313	0.361	0.357	0.345
2003	0.053	0.114	0.195	0.260	0.298	0.352	0.383	0.365
2004	0.109	0.190	0.240	0.265	0.304	0.298	0.304	0.358
2005	0.120	0.196	0.238	0.246	0.282	0.302	0.303	0.321
2006	0.113	0.183	0.229	0.281	0.290	0.359	0.343	0.313
2007	0.091	0.205	0.256	0.324	0.344	0.310	0.313	0.323
2008	0.107	0.215	0.281	0.316	0.403	0.408	0.319	0.355

Table 12.2.9 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.201	0.220	0.260	0.292	0.335	0.449	0.522	0.601
1991	0.204	0.250	0.252	0.309	0.318	0.349	0.388	0.400
1992	0.195	0.248	0.290	0.307	0.342	0.358	0.383	0.502
1993	0.195	0.251	0.287	0.348	0.359	0.388	0.422	0.381
1994	0.184	0.250	0.297	0.345	0.393	0.382	0.413	0.412
1995	0.172	0.255	0.298	0.367	0.398	0.437	0.437	0.422
1996	0.170	0.222	0.274	0.328	0.407	0.413	0.448	0.430
1997	0.171	0.207	0.261	0.314	0.348	0.398	0.381	0.421
1998	0.164	0.209	0.259	0.304	0.330	0.360	0.344	0.424
1999	0.184	0.237	0.270	0.280	0.302	0.314	0.317	0.295
2000	0.166	0.226	0.271	0.300	0.292	0.315	0.278	0.274
2001	0.160	0.217	0.268	0.286	0.269	0.303	0.291	0.295
2002	0.199	0.223	0.269	0.304	0.325	0.376	0.365	0.344
2003	0.209	0.239	0.263	0.309	0.310	0.373	0.389	0.366
2004	0.210	0.221	0.250	0.295	0.333	0.335	0.339	0.368
2005	0.208	0.247	0.275	0.267	0.311	0.338	0.320	0.366
2006	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.331
2007	0.199	0.264	0.280	0.351	0.361	0.319	0.332	0.338
2008	0.223	0.265	0.324	0.356	0.431	0.424	0.359	0.374

Table 12.2.10 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea discards only.

year	1	2	3	4	5	6	7	8+
1990	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0.000
1991	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0.000
1992	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183
1993	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0.000
1994	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0.000
1995	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290
1996	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0.000
1997	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.352
1998	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.206
1999	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.227
2000	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264
2001	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243
2002	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.352
2003	0.057	0.098	0.169	0.215	0.262	0.257	0.293	0.051
2004	0.178	0.233	0.240	0.232	0.257	0.241	0.246	0.245
2005	0.110	0.175	0.208	0.217	0.223	0.235	0.246	0.225
2006	0.099	0.162	0.196	0.251	0.247	0.253	0.273	0.246
2007	0.055	0.166	0.207	0.222	0.241	0.238	0.222	0.223
2008	0.072	0.181	0.213	0.230	0.265	0.328	0.244	0.293

Table 12.2.11 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.073	0.123	0.181	0.199	0.280	0.355	0.335	0.473
1991	0.101	0.136	0.213	0.269	0.265	0.279	0.322	0.000
1992	0.066	0.150	0.228	0.242	0.335	0.219	0.255	0.282
1993	0.044	0.155	0.259	0.264	0.308	0.235	0.392	0.000
1994	0.042	0.132	0.242	0.374	0.521	0.555	0.440	0.555
1995	0.069	0.159	0.310	0.373	0.511	0.000	0.000	0.000
1996	0.059	0.143	0.235	0.233	0.347	0.250	0.000	0.000
1997	0.048	0.144	0.250	0.321	0.348	0.588	0.000	0.000
1998	0.045	0.105	0.200	0.304	0.286	0.000	0.000	0.000
1999	0.027	0.077	0.146	0.196	0.286	0.000	0.000	0.000
2000	0.041	0.164	0.242	0.289	0.339	0.000	0.588	0.000
2001	0.040	0.164	0.132	0.320	0.351	0.386	0.000	0.000
2002	0.044	0.101	0.184	0.293	0.415	0.380	0.000	0.000
2003	0.035	0.101	0.189	0.302	0.418	0.462	0.000	0.000
2004	0.032	0.083	0.143	0.264	0.362	0.380	0.000	0.000
2005	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530
2006	0.043	0.121	0.196	0.277	0.362	0.401	0.564	0.530
2007	0.043	0.121	0.196	0.277	0.362	0.401	0.564	0.530
2008	0.043	0.121	0.196	0.277	0.362	0.401	0.564	0.530

Table 12.2.12 Whiting in IV and VIId. Natural mortality at age. These data come from the key run of the multispecies working group (WGSAM, 2008), data is available up to 2007. Natural mortality for 2008 is assumed equal to that in 2007.

year	1	2	3	4	5	6	7	8+
1990	1.312	0.495	0.381	0.373	0.362	0.345	0.334	0.306
1991	1.321	0.485	0.374	0.367	0.358	0.341	0.332	0.308
1992	1.332	0.479	0.368	0.361	0.354	0.339	0.330	0.310
1993	1.347	0.475	0.363	0.357	0.352	0.336	0.329	0.312
1994	1.364	0.473	0.359	0.353	0.350	0.335	0.328	0.314
1995	1.383	0.472	0.356	0.350	0.348	0.333	0.328	0.315
1996	1.405	0.471	0.354	0.347	0.347	0.332	0.328	0.316
1997	1.429	0.470	0.351	0.344	0.345	0.331	0.328	0.317
1998	1.455	0.470	0.349	0.341	0.343	0.330	0.328	0.317
1999	1.483	0.471	0.346	0.337	0.342	0.330	0.328	0.317
2000	1.514	0.474	0.344	0.334	0.340	0.331	0.329	0.317
2001	1.548	0.480	0.344	0.331	0.340	0.333	0.332	0.318
2002	1.584	0.490	0.344	0.329	0.341	0.336	0.336	0.321
2003	1.619	0.502	0.345	0.329	0.342	0.340	0.340	0.324
2004	1.651	0.516	0.348	0.329	0.344	0.345	0.345	0.327
2005	1.679	0.531	0.350	0.329	0.347	0.350	0.350	0.331
2006	1.705	0.546	0.353	0.329	0.350	0.355	0.356	0.335
2007	1.731	0.562	0.356	0.330	0.353	0.360	0.361	0.339
2008	1.731	0.562	0.356	0.330	0.353	0.360	0.361	0.339

Table 12.2.13 Whiting in IV and VIId. Tuning series used in the assessment and forecast. Data used in the assessment is in bold.

International bottom trawl survey (IBTS) quarter 1

year	**effort**	**1**	**2**	**3**	**4**	**5**	6+
1990	100	**519**	**862**	**198**	**92**	**17**	4
1991	100	**1008**	**686**	**480**	**71**	**38**	8
1992	100	**907**	**666**	**240**	**151**	**13**	14
1993	100	**1076**	**523**	**245**	**65**	**59**	11
1994	100	**722**	**627**	**181**	**68**	**12**	9
1995	100	**679**	**448**	**239**	**58**	**12**	6
1996	100	**502**	**486**	**245**	**70**	**23**	10
1997	100	**288**	**342**	**163**	**60**	**18**	9
1998	100	**543**	**161**	**125**	**54**	**15**	9
1999	100	**676**	**305**	**95**	**57**	**26**	11
2000	100	**757**	**538**	**182**	**53**	**20**	15
2001	100	**649**	**598**	**299**	**98**	**26**	26
2002	100	**671**	**417**	**275**	**67**	**22**	10
2003	100	**132**	**299**	**237**	**133**	**48**	13
2004	100	**185**	**90**	**173**	**100**	**49**	22
2005	100	**168**	**56**	**31**	**56**	**38**	29
2006	100	**223**	**92**	**33**	**17**	**28**	27
2007	100	**42**	**166**	**71**	**19**	**9**	25
2008	100	**268**	**206**	**66**	**22**	**8**	15
2009	100	259	192	57	26	10	12

International bottom trawl survey (IBTS) quarter 3

year	**effort**	0	**1**	**2**	**3**	**4**	**5**	6+
1991	100	537	**703**	**159**	**79**	**15**	**5**	1
1992	100	1379	**601**	**296**	**72**	**57**	**10**	6
1993	100	919	**639**	**177**	**66**	**15**	**16**	3
1994	100	611	**678**	**220**	**75**	**20**	**5**	3
1995	100	729	**620**	**291**	**107**	**22**	**6**	3
1996	100	317	**546**	**278**	**129**	**34**	**7**	4
1997	100	2063	**333**	**181**	**109**	**28**	**11**	4
1998	100	2632	**331**	**150**	**53**	**31**	**11**	5
1999	100	2499	**1204**	**191**	**54**	**24**	**10**	4
2000	100	1968	**942**	**327**	**64**	**14**	**7**	5
2001	100	3031	**645**	**282**	**95**	**19**	**4**	8
2002	100	264	**732**	**237**	**125**	**34**	**5**	3
2003	100	363	**246**	**302**	**135**	**66**	**16**	5
2004	100	711	**162**	**48**	**64**	**45**	**31**	12
2005	100	163	**180**	**71**	**28**	**45**	**29**	34
2006	100	203	**173**	**85**	**32**	**13**	**23**	25
2007	100	819	**99**	**66**	**34**	**12**	**6**	23
2008	100	770	**389**	**39**	**30**	**14**	**4**	15

Table 12.2.14 Whiting in IV and VIId. Summary of available tuning series.

Country	Fleet	Name / Code	Time of year	Year range	Age Range
England	Groundfish survey	ENGGFS GRT ENGGFS GOV	Q3 Q3	1977–1991 1992–2008	0–10 0–10
France	Groundfish survey Trawlers[6]	FRAGFS 7d FRATRO IV FRATRB IV FRATRO 7d	Q3 - - -	1988–2007[1] 1986–2006[1] 1978–2001 1986–2006	0–3 0–8 1–9 1–7
International	Groundfish survey[2] Q II survey[4] Q IV survey[5]	IBTS_QI IBTS_Q3 IBTS_Q2_SCO IBTS_Q4_ENG	Q1 Q3 Q2 Q4	1983–2009 1991-2008 1991–1997 1991–1996	1–6[3] 1–6[3] 1–6 0–7
Scotland	Groundfish survey Seiners[6] Light trawlers[6]	SCOGFS Scotia II SCOGFS Scotia III SCOSEI IV SCOLTR IV	Q3 Q3 - -	1982–1997 1998–2008 1978–2008 1978–2008	0–8 0–8 1–9 1–9

[1] Excluding 2002.

[2] Formerly IYFS

[3] Age 6 is a plus group

[4] Scottish sub-set of IBTS data – discontinued in 1997.

[5] English sub-set of IBTS data – discontinued in 1996.

[6] Commercial tuning indices are tabled in the stock annex.

Table 12.3.1 Whiting in IV and VIId. XSA tuning diagnostics.

```
FLR XSA Diagnostics 2009-05-10 14:38:09

CPUE data from index.xsa

Catch data for 19 years. 1990 to 2008. Ages 1 to 8.

    fleet first age last age first year last year alpha beta
1 IBTS_Q1         1        5       1990      2008     0 0.25
2 IBTS_Q3         1        5       1991      2008   0.5 0.75


 Time series weights :

   Tapered time weighting not applied

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   4

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   3 years or the  4 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

    Minimum standard error for population
    estimates derived from each fleet =  0.3

   prior weighting not applied

Regression weights
     year
age   1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  1999  2000  2001  2002  2003  2004  2005  2006  2007  2008
  1 0.139 0.045 0.072 0.049 0.234 0.067 0.074 0.091 0.166 0.084
  2 0.348 0.324 0.175 0.164 0.354 0.190 0.316 0.301 0.290 0.486
  3 0.488 0.572 0.318 0.326 0.269 0.165 0.280 0.498 0.432 0.449
  4 0.610 0.620 0.431 0.361 0.320 0.233 0.211 0.374 0.506 0.552
  5 0.669 0.822 0.621 0.347 0.296 0.274 0.243 0.317 0.354 0.521
  6 0.693 1.002 0.753 0.313 0.190 0.283 0.239 0.375 0.311 0.332
  7 0.776 1.587 0.941 0.644 0.127 0.160 0.216 0.224 0.327 0.310
  8 0.776 1.587 0.941 0.644 0.127 0.160 0.216 0.224 0.327 0.310


 XSA population number (Thousand)
      age
year        1      2      3      4     5     6     7     8
  1999 2883491 393070 140607  88564 45040 17809  4473  1439
  2000 3238855 569609 173294  61068 34340 16385  6406  1792
  2001 2617140 681585 256530  69320 23522 10743  4322  2383
  2002 2295109 518015 353964 132324 32360  9002  3627  1835
  2003  782531 448491 269546 181099 66344 16268  4708  3906
  2004  900710 122691 190570 145754 94694 35067  9580  2374
  2005 1123767 161694  60558 114153 83101 51010 18714  3955
  2006 1063475 194703  69314  32243 66549 46080 28319  8983
  2007  605401 176386  83430  29581 15960 34158 22216 12933
  2008 1553445  90861  75258  37920 12814  7869 17451 12925


 Estimated population abundance at 1st Jan  2009
      age
year      1      2     3     4     5    6    7    8
  2009     0 252984 31877 33651 15703 5349 3939 8920
```

Table 12.3.1 (cont.) Whiting in IV and VIId. XSA tuning diagnostics.

Fleet: IBTS_Q1

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.265	0.439	0.385	0.448	0.121	0.188	0.263	-0.023	0.259	0.035
2	-0.380	0.281	0.209	0.122	0.164	-0.111	0.107	0.125	-0.349	-0.025
3	-0.063	0.034	0.185	0.096	0.005	0.031	0.108	-0.188	-0.118	-0.154
4	-0.155	0.284	-0.066	0.015	0.102	0.048	-0.055	-0.203	-0.243	0.014
5	-0.695	0.255	-0.342	-0.026	-0.538	-0.433	0.157	-0.368	-0.645	-0.102

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.024	0.090	0.256	-0.271	-0.089	-0.403	-0.057	-1.147	-0.251
2	0.167	0.077	-0.010	-0.174	-0.100	-0.830	-0.515	0.171	1.071
3	0.302	0.374	-0.030	0.086	0.106	-0.437	-0.512	0.076	0.101
4	0.307	0.774	-0.271	0.105	0.024	-0.308	-0.250	-0.021	-0.101
5	-0.067	0.538	0.034	0.093	-0.253	-0.383	-0.444	-0.156	-0.095

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5
Mean_Logq	-12.8018	-11.6394	-11.6519	-11.8435	-11.8435
S.E_Logq	0.3726	0.3855	0.2178	0.2551	0.3197

Fleet: IBTS_Q3

Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.079	-0.132	-0.189	-0.064	-0.018	0.228	0.016	-0.334	0.556	0.155
2	-0.503	0.031	-0.289	-0.278	0.066	0.147	0.073	0.139	0.121	0.276
3	-0.935	-0.150	-0.265	0.020	0.108	0.325	0.247	-0.231	0.108	0.123
4	-0.322	-0.129	-0.486	-0.121	-0.009	0.169	-0.089	0.058	0.059	-0.150
5	-0.597	0.404	-0.320	-0.369	-0.046	-0.067	0.090	-0.069	-0.167	-0.180

age \ year	2001	2002	2003	2004	2005	2006	2007	2008
1	0.028	0.294	0.415	-0.230	-0.324	-0.280	-0.207	0.165
2	-0.138	-0.039	0.472	-0.168	0.032	0.035	-0.115	0.138
3	-0.035	-0.075	0.237	-0.218	0.154	0.304	0.154	0.127
4	-0.048	-0.173	0.152	-0.063	0.171	0.304	0.361	0.315
5	-0.341	-0.629	-0.240	0.027	0.079	0.106	0.225	0.102

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5
Mean_Logq	-11.9358	-11.8475	-12.0599	-12.2694	-12.2694
S.E_Logq	0.2574	0.2253	0.2962	0.2234	0.2728

Table 12.3.1 (cont.) **Whiting in IV and VIId. XSA tuning diagnostics.**

```
 Terminal year survivor and F summaries:

 Age 1 Year class =2007

source
        scaledWts survivors yrcls
IBTS_Q1     0.375    196826  2007
IBTS_Q3     0.610    298345  2007
fshk        0.015    165747  2007

 Age 2 Year class =2006

source
        scaledWts survivors yrcls
IBTS_Q1     0.357     93019  2006
IBTS_Q3     0.620     36596  2006
fshk        0.023     54937  2006

 Age 3 Year class =2005

source
        scaledWts survivors yrcls
IBTS_Q1     0.498     37214  2005
IBTS_Q3     0.484     38197  2005
fshk        0.018     37667  2005

 Age 4 Year class =2004

source
        scaledWts survivors yrcls
IBTS_Q1     0.490     14199  2004
IBTS_Q3     0.490     21522  2004
fshk        0.019     25966  2004

 Age 5 Year class =2003

source
        scaledWts survivors yrcls
IBTS_Q1     0.381      4863  2003
IBTS_Q3     0.596      5924  2003
fshk        0.023     10118  2003

 Age 6 Year class =2002

source
     scaledWts survivors yrcls
fshk         1      4230  2002

 Age 7 Year class =2001

source
     scaledWts survivors yrcls
fshk         1      5399  2001
```

Table 12.3.2 Whiting in IV and VIId. Final XSA fishing mortality.

year	1	2	3	4	5	6	7	8+	Fbar(2-6)
1990	0.182	0.511	0.813	0.911	1.146	0.878	0.956	0.956	0.852
1991	0.093	0.461	0.480	0.735	1.052	0.738	0.765	0.765	0.693
1992	0.190	0.369	0.544	0.589	0.704	1.180	1.281	1.281	0.677
1993	0.154	0.449	0.716	0.776	0.832	0.647	1.189	1.189	0.684
1994	0.124	0.328	0.625	0.850	0.977	1.152	0.387	0.387	0.786
1995	0.119	0.329	0.589	0.669	0.932	1.176	1.554	1.554	0.739
1996	0.091	0.307	0.540	0.686	0.772	1.110	1.529	1.529	0.683
1997	0.089	0.287	0.503	0.570	0.756	0.486	0.953	0.953	0.520
1998	0.084	0.224	0.340	0.520	0.610	0.794	0.461	0.461	0.498
1999	0.139	0.348	0.488	0.610	0.669	0.693	0.776	0.776	0.562
2000	0.045	0.324	0.572	0.620	0.822	1.002	1.587	1.587	0.668
2001	0.072	0.175	0.318	0.431	0.621	0.753	0.941	0.941	0.460
2002	0.049	0.164	0.326	0.361	0.347	0.313	0.644	0.644	0.302
2003	0.234	0.354	0.269	0.320	0.296	0.190	0.127	0.127	0.286
2004	0.067	0.190	0.165	0.233	0.274	0.283	0.160	0.160	0.229
2005	0.074	0.316	0.280	0.211	0.243	0.239	0.216	0.216	0.258
2006	0.091	0.301	0.498	0.374	0.317	0.375	0.224	0.224	0.373
2007	0.166	0.290	0.432	0.506	0.354	0.311	0.327	0.327	0.379
2008	0.084	0.486	0.449	0.552	0.521	0.332	0.310	0.310	0.468

Table 12.3.3 Whiting in IV and VIId. Final XSA stock numbers.

year	1	2	3	4	5	6	7	8+
1990	2941840	1617786	280601	173991	56693	4070	1412	209
1991	2798122	660357	591674	85006	48166	12541	1198	389
1992	2694253	680411	256473	251931	28256	11759	4261	400
1993	2990761	587793	291413	103060	97421	9800	2575	851
1994	2777957	666998	233414	99068	33209	29834	3666	564
1995	2448666	627547	299478	87252	29758	8811	6745	1794
1996	1680329	545083	281714	116394	31489	8267	1947	1028
1997	1284012	376240	250309	115238	41412	10290	1955	304
1998	1831742	281472	176455	106564	46190	13762	4545	543
1999	2883491	393070	140607	88564	45040	17809	4473	2065
2000	3238855	569609	173294	61068	34340	16385	6406	1483
2001	2617140	681585	256530	69320	23522	10743	4322	942
2002	2295109	518015	353964	132324	32360	9002	3627	1211
2003	782531	448491	269546	181099	66344	16268	4708	1361
2004	900710	122691	190570	145754	94694	35067	9580	2951
2005	1123767	161694	60558	114153	83101	51010	18714	5781
2006	1063475	194703	69314	32243	66549	46080	28319	10622
2007	605401	176386	83430	29581	15960	34158	22216	15860
2008	1553445	90861	75258	37920	12814	7869	17451	11165
2009	0	252984	31877	33651	15703	5349	3939	8920

Note that stock numbers in 2009 are estimates of survivors from 2008.

Table 12.3.4 Whiting in IV and VIId. Final XSA summary table.

	recruitment (age 1)	tsb	ssb	catch	landings	discards	industrial bycatch	Y/ssb	fbar(2-6)
1990	2942	586247	351202	153460	46900	55840	50720	0.13	0.85
1991	2798	573014	307582	124970	53020	33640	38310	0.17	0.69
1992	2694	497459	290762	109700	52190	30610	26900	0.18	0.68
1993	2991	464345	261806	116170	53200	42870	20100	0.20	0.68
1994	2778	451934	245073	92600	49240	33010	10350	0.20	0.79
1995	2449	452256	253569	103260	46440	30260	26560	0.18	0.74
1996	1680	365776	219413	73950	41070	28180	4700	0.19	0.68
1997	1284	297221	187871	59100	35920	17220	5960	0.19	0.52
1998	1832	309809	157403	44310	28460	12710	3140	0.18	0.50
1999	2883	363609	163066	59170	30410	23580	5180	0.19	0.56
2000	3239	545065	211039	60910	28810	23210	8890	0.14	0.67
2001	2617	407604	229483	49070	25220	16490	7360	0.11	0.46
2002	2295	365437	222115	46560	21720	17510	7330	0.10	0.30
2003	783	220046	179044	43200	16370	24090	2740	0.09	0.29
2004	901	249056	159813	29060	13580	14260	1220	0.08	0.23
2005	1124	255404	132850	26790	15300	10610	880	0.12	0.26
2006	1063	229617	119812	30320	18590	9540	2190	0.16	0.37
2007	605	150349	98424	27070	19440	6400	1230	0.20	0.38
2008	1553	236789	87292	26880	17870	7990	1020	0.20	0.47
min	605	150349	87292	26790	13580	6400	880	0.08	0.23
mean	2027	369528	204085	67187	32303	23054	11831	0.16	0.53
max	3239	586247	351202	153460	53200	55840	50720	0.20	0.85
units	millions	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes		

Table 12.5.1 Whiting in IV and VIId. RCT3 input table

Whi4&7d (age 1)

4	19	2			
1990	2942	**1007.62**	**665.71**	**-11**	**703.37**
1991	2798	**907.30**	**522.81**	**536.99**	**600.87**
1992	2694	**1075.62**	**627.41**	**1379.46**	**638.72**
1993	2991	**721.71**	**448.48**	**919.19**	**677.65**
1994	2778	**678.59**	**485.97**	**610.74**	**619.79**
1995	2449	**502.36**	**342.21**	**729.25**	**545.71**
1996	1680	**287.73**	**160.70**	**316.50**	**332.97**
1997	1284	**543.12**	**305.45**	**2062.67**	**330.60**
1998	1832	**676.27**	**537.86**	**2631.69**	**1203.50**
1999	2883	**756.87**	**598.39**	**2498.55**	**941.66**
2000	3239	**648.65**	**416.82**	**1968.07**	**645.00**
2001	2617	**670.59**	**298.87**	**3031.44**	**732.14**
2002	2295	**131.60**	**89.73**	**264.06**	**246.16**
2003	783	**184.61**	**55.97**	**363.41**	**161.56**
2004	901	**167.63**	**92.38**	**711.28**	**179.50**
2005	1124	**223.01**	**166.13**	**162.59**	**172.79**
2006	1063	**42.19**	**205.56**	**202.83**	**99.48**
2007	605	**267.75**	**192.19**	**819.06**	**389.38**
2008	-11	**259.37**	**-11**	**769.57**	**-11**

ibtsq1age1
ibtsq1age2
ibtsq3age0
ibtsq3age1

Table 12.5.2 Whiting in IV and VIId. RCT3 output table.

```
Analysis by RCT3 ver3.1 of data from file :

whirec1.txt

Whi4&7d (age 1)

Data for    4 surveys over   19 years :  1990 - 2008

Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                    included
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =   2007

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series          cept   Error           Pts  Value   Value    Error   Weights

ibtsq1     .73   3.15    .45   .536     17   5.59    7.25     .502     .233
ibtsq1     .82   2.97    .41   .585     17   5.26    7.26     .454     .284
ibtsq3    1.05    .59    .91   .225     16   6.71    7.60    1.008     .058
ibtsq3     .81   2.68    .34   .675     17   5.97    7.51     .371     .425

                                       VPA Mean =    7.58     .473     .000


Yearclass =   2008

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series          cept   Error           Pts  Value   Value    Error   Weights

ibtsq1     .91   2.05    .59   .469     18   5.56    7.11     .644     .824
ibtsq1
ibtsq3    1.45  -2.16   1.28   .160     17   6.65    7.46    1.397     .176
ibtsq3

                                       VPA Mean =    7.51     .535     .000
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2007	1608	7.38	.24	.08	.10	605	6.41
2008	1297	7.17	.59	.14	.05		

Table 12.6.1 Whiting in IV and VIId. Short term forecast input

MFDP version 1a
Run: whi09
Time and date: 15:18 10/05/2009
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2009

Age	N	M	Mat	PF	PM	SWt
1	1297000	1.73	0.11	0	0	0.104
2	252984	0.56	0.92	0	0	0.201
3	31877	0.36	1	0	0	0.255
4	33651	0.33	1	0	0	0.307
5	15703	0.35	1	0	0	0.346
6	5349	0.36	1	0	0	0.359
7	3939	0.36	1	0	0	0.325
8	8920	0.34	1	0	0	0.330

Catch

Age	Sel	CWt	DSel	DCWt
1	0.036	0.213	0.071	0.075
2	0.158	0.261	0.205	0.170
3	0.300	0.296	0.206	0.205
4	0.379	0.334	0.144	0.234
5	0.369	0.363	0.075	0.251
6	0.338	0.373	0.055	0.273
7	0.262	0.348	0.070	0.246
8	0.269	0.348	0.063	0.254

Industrialbycatch

Age	Sel	CWt
1	0.028	0.043
2	0.044	0.121
3	0.030	0.196
4	0.025	0.277
5	0.007	0.362
6	0.002	0.401
7	0.000	0.564
8	0.000	0.530

2010

Age	N	M	Mat	PF	PM	SWt
1	1002000	1.73	0.11	0	0	0.104
2	.	0.56	0.92	0	0	0.201
3	.	0.36	1	0	0	0.255
4	.	0.33	1	0	0	0.307
5	.	0.35	1	0	0	0.346
6	.	0.36	1	0	0	0.359
7	.	0.36	1	0	0	0.325
8	.	0.34	1	0	0	0.330

Catch

Age	Sel	CWt	DSel	DCWt
1	0.036	0.213	0.071	0.075
2	0.158	0.261	0.205	0.170
3	0.300	0.296	0.206	0.205
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Industrialbycatch

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2011

Age	N	M	Mat	PF	PM	SWt
1	1002000	1.73	0.11	0	0	0.104
2	.	0.56	0.92	0	0	0.201
3	.	0.36	1	0	0	0.255
4	.	0.33	1	0	0	0.307
5	.	0.35	1	0	0	0.346
6	.	0.36	1	0	0	0.359
7	.	0.36	1	0	0	0.325
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Catch

Age	Sel	CWt	DSel	DCWt
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Industrialbycatch

Age	Sel	CWt
1	0.028	0.043
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5	0.007	0.362
6	0.002	0.401
7	0.000	0.564
8	0.000	0.530

Input units are thousands and kg - output in tonnes

Table 12.6.2 Whiting in IV and VIId. Short term forecast output.

2009

Biomass	SSB	Catch FMult	Catch Fbar	Yeild	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield
215775	91656	1	0.467	31391	0.3088	18680	0.14	10832	1.0	0.02	1879

2010 (2011 columns at right)

	Biomass	SSB	Catch FMult	Catch Fbar	Yeild	Landings FBar	Yield	Discards FBar	Yield	Industrialbycatch FMult	Landings FBar	Yield	2011 Biomass	2011 SSB
	183373	87400	0.00	0.02	1948	0.00	0	0.00	0	1	0.02	1948	197222	101702
		87400	0.10	0.07	5187	0.03	2094	0.01	1174	1	0.02	1919	194425	98935
		87400	0.20	0.11	8319	0.06	4117	0.03	2310	1	0.02	1892	191736	96275
		87400	0.30	0.16	11346	0.09	6071	0.04	3411	1	0.02	1864	189150	93718
		87400	0.40	0.20	14275	0.12	7959	0.05	4478	1	0.02	1838	186662	91259
		87400	0.50	0.24	17107	0.15	9783	0.07	5512	1	0.02	1812	184269	88894
stable SSB		**87400**	**0.57**	**0.27**	**18899**	**0.17**	**10936**	**0.08**	**6167**	**1**	**0.02**	**1796**	**182763**	**87405**
		87400	0.60	0.29	19848	0.19	11546	0.08	6515	1	0.02	1787	181967	86619
25% reduction in TAC		**87400**	**0.61**	**0.29**	**20037**	**0.19**	**11668**	**0.08**	**6584**	**1**	**0.02**	**1785**	**181809**	**86463**
		87400	0.70	0.33	22502	0.22	13252	0.10	7487	1	0.02	1763	179751	84431
		87400	0.80	0.38	25070	0.25	14901	0.11	8430	1	0.02	1739	177618	82326
		87400	0.90	0.42	27557	0.28	16497	0.12	9345	1	0.02	1715	175565	80300
F status quo		**87400**	**1.00**	**0.47**	**29968**	**0.31**	**18041**	**0.14**	**10234**	**1**	**0.02**	**1693**	**173588**	**78349**
		87400	1.10	0.51	32303	0.34	19536	0.15	11096	1	0.02	1671	171683	76472
		87400	1.20	0.56	34565	0.37	20983	0.16	11933	1	0.02	1649	169849	74664
		87400	1.30	0.60	36760	0.40	22385	0.18	12747	1	0.02	1628	168082	72922
F0.1		**87400**	**1.40**	**0.65**	**38887**	**0.43**	**23743**	**0.19**	**13537**	**1**	**0.02**	**1607**	**166379**	**71245**
		87400	1.50	0.69	40952	0.46	25060	0.21	14305	1	0.02	1587	164738	69629
		87400	1.60	0.73	42954	0.49	26336	0.22	15051	1	0.02	1567	163155	68072
15% reduction in TAC		**87400**	**1.70**	**0.78**	**44898**	**0.53**	**27573**	**0.23**	**15777**	**1**	**0.02**	**1548**	**161629**	**66571**
		87400	1.80	0.82	46786	0.56	28773	0.25	16484	1	0.02	1529	160158	65124
		87400	1.90	0.87	48619	0.59	29937	0.26	17171	1	0.02	1511	158738	63729
		87400	2.00	0.91	50399	0.62	31067	0.27	17839	1	0.02	1493	157369	62384

Input units are thousands and kg - output in tonnes

Table 12.6.3 Whiting in IV and VIId. Yield per recruit input.

MFDP version 1a
Run: whi09
Time and date: 15:18 10/05/2009
Fbar age range (Total) : 2-6
Fbar age range Fleet 1 : 2-6
Fbar age range Fleet 2 : 2-6

2009

Age	N	M	Mat	PF	PM	SWt
1	1297000	1.73	0.11	0	0	0.104
2	252984	0.56	0.92	0	0	0.201
3	31877	0.36	1	0	0	0.255
4	33651	0.33	1	0	0	0.307
5	15703	0.35	1	0	0	0.346
6	5349	0.36	1	0	0	0.359
7	3939	0.36	1	0	0	0.325
8	8920	0.34	1	0	0	0.330

Catch

Age	Sel	CWt	DSel	DCWt
1	0.036	0.213	0.071	0.075
2	0.158	0.261	0.205	0.170
3	0.300	0.296	0.206	0.205
4	0.379	0.334	0.144	0.234
5	0.369	0.363	0.075	0.251
6	0.338	0.373	0.055	0.273
7	0.262	0.348	0.070	0.246
8	0.269	0.348	0.063	0.254

Industrialbycatch

Age	Sel	CWt
1	0.028	0.043
2	0.044	0.121
3	0.030	0.196
4	0.025	0.277
5	0.007	0.362
6	0.002	0.401
7	0.000	0.564
8	0.000	0.530

2010

Age	N	M	Mat	PF	PM	SWt
1	1002000	1.73	0.11	0	0	0.104
2	.	0.56	0.92	0	0	0.201
3	.	0.36	1	0	0	0.255
4	.	0.33	1	0	0	0.307
5	.	0.35	1	0	0	0.346
6	.	0.36	1	0	0	0.359
7	.	0.36	1	0	0	0.325
8	.	0.34	1	0	0	0.330

Catch

Age	Sel	CWt	DSel	DCWt
1	0.036	0.213	0.071	0.075
2	0.158	0.261	0.205	0.170
3	0.300	0.296	0.206	0.205
4	0.379	0.334	0.144	0.234
5	0.369	0.363	0.075	0.251
6	0.338	0.373	0.055	0.273
7	0.262	0.348	0.070	0.246
8	0.269	0.348	0.063	0.254

Industrialbycatch

Age	Sel	CWt
1	0.028	0.043
2	0.044	0.121
3	0.030	0.196
4	0.025	0.277
5	0.007	0.362
6	0.002	0.401
7	0.000	0.564
8	0.000	0.530

2011

Age	N	M	Mat	PF	PM	SWt
1	1002000	1.73	0.11	0	0	0.104
2	.	0.56	0.92	0	0	0.201
3	.	0.36	1	0	0	0.255
4	.	0.33	1	0	0	0.307
5	.	0.35	1	0	0	0.346
6	.	0.36	1	0	0	0.359
7	.	0.36	1	0	0	0.325
8	.	0.34	1	0	0	0.330

Catch

Age	Sel	CWt	DSel	DCWt
1	0.036	0.213	0.071	0.075
2	0.158	0.261	0.205	0.170
3	0.300	0.296	0.206	0.205
4	0.379	0.334	0.144	0.234
5	0.369	0.363	0.075	0.251
6	0.338	0.373	0.055	0.273
7	0.262	0.348	0.070	0.246
8	0.269	0.348	0.063	0.254

Industrialbycatch

Age	Sel	CWt
1	0.028	0.043
2	0.044	0.121
3	0.030	0.196
4	0.025	0.277
5	0.007	0.362
6	0.002	0.401
7	0.000	0.564
8	0.000	0.530

Input units are thousands and kg - output in tonnes

Table 12.6.4 Whiting in IV and VIId. Yield per recruit output.

Catch	Landings			Discards			Industrialbycatch	Landings								
FMult	Fbar	CatchNos	Yield	Fbar	CatchNos	Yield	FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0	0	0	0	0	0	0	1	0.022	0.023	0.002	1.481	0.233	0.577	0.138	0.577	0.138
0.1	0.031	0.011	0.003	0.014	0.009	0.001	1	0.022	0.022	0.002	1.437	0.219	0.533	0.124	0.533	0.124
0.2	0.062	0.019	0.006	0.027	0.017	0.002	1	0.022	0.022	0.002	1.401	0.208	0.498	0.113	0.498	0.113
0.3	0.093	0.026	0.008	0.041	0.024	0.003	1	0.022	0.021	0.002	1.372	0.199	0.469	0.104	0.469	0.104
0.4	0.124	0.032	0.009	0.055	0.031	0.004	1	0.022	0.021	0.002	1.347	0.191	0.444	0.096	0.444	0.096
0.5	0.154	0.037	0.011	0.069	0.037	0.005	1	0.022	0.020	0.002	1.327	0.185	0.424	0.090	0.424	0.090
0.6	0.185	0.042	0.012	0.082	0.043	0.006	1	0.022	0.020	0.002	1.309	0.179	0.406	0.084	0.406	0.084
0.7	0.216	0.045	0.013	0.096	0.048	0.007	1	0.022	0.020	0.002	1.293	0.175	0.390	0.080	0.390	0.080
0.8	0.247	0.049	0.013	0.110	0.054	0.007	1	0.022	0.019	0.002	1.279	0.171	0.377	0.076	0.377	0.076
0.9	0.278	0.052	0.014	0.123	0.059	0.008	1	0.022	0.019	0.002	1.267	0.167	0.365	0.072	0.365	0.072
1.0	0.309	0.054	0.015	0.137	0.064	0.008	1	0.022	0.019	0.001	1.256	0.164	0.354	0.069	0.354	0.069
1.1	0.340	0.057	0.015	0.151	0.068	0.009	1	0.022	0.018	0.001	1.247	0.161	0.344	0.066	0.344	0.066
1.2	0.371	0.059	0.016	0.164	0.073	0.009	1	0.022	0.018	0.001	1.238	0.159	0.336	0.064	0.336	0.064
1.3	0.401	0.061	0.016	0.178	0.077	0.010	1	0.022	0.018	0.001	1.230	0.156	0.328	0.061	0.328	0.061
1.4	0.432	0.063	0.016	0.192	0.081	0.010	1	0.022	0.018	0.001	1.222	0.154	0.320	0.059	0.320	0.059
1.5	0.463	0.065	0.017	0.206	0.085	0.010	1	0.022	0.017	0.001	1.215	0.153	0.314	0.058	0.314	0.058
1.6	0.494	0.066	0.017	0.219	0.089	0.011	1	0.022	0.017	0.001	1.209	0.151	0.308	0.056	0.308	0.056
1.7	0.525	0.068	0.017	0.233	0.093	0.011	1	0.022	0.017	0.001	1.203	0.149	0.302	0.054	0.302	0.054
1.8	0.556	0.070	0.018	0.247	0.096	0.012	1	0.022	0.017	0.001	1.198	0.148	0.297	0.053	0.297	0.053
1.9	0.587	0.071	0.018	0.260	0.100	0.012	1	0.022	0.017	0.001	1.193	0.146	0.292	0.052	0.292	0.052
2.0	0.618	0.073	0.018	0.274	0.103	0.012	1	0.022	0.016	0.001	1.188	0.145	0.287	0.050	0.287	0.050

Reference point	F multiplier	Absolute F
FMax	>=1000000	
F0.1	1.395	0.65
F35%SPR	2.190	1.12

Weights in kilograms

Table 12.12.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark (1)			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	3,340	3,895	66	959	1	4,921
1993	261	1,987	2,248	42	756	1	3,047
1994	174	1,900	2,074	21	440	1	2,536
1995	85	2,549	2,634	24	431	1	3,090
1996	55	1,235	1,290	21	182	-	1,493
1997	38	264	302	18	94	-	414
1998	35	354	389	16	81	-	486
1999	37	695	732	15	111	-	858
2000	59	777	836	17	138	1	992
2001	61	970[1]	1,031[1]	27	126	+	1,184[1]
2002	101	975[1]	1,076[1]	23	127	1	1,227[1]
2003	93	654[1]	747[1]	20	71	2	840[1]
2004	93	1,120[1]	1,213[1]	17	74	1	1,305[1]
2005	49	907[1]	956[1]	13	73	0	1,042[1]
2006	59[1]	290[1]	349[1]	n/a	n/a	n/a	349[1]
2007			54	14	82	1	151
2008			53	14	52	n/a	119

[1] Values from 1992 updated by WGNSSK (2007)

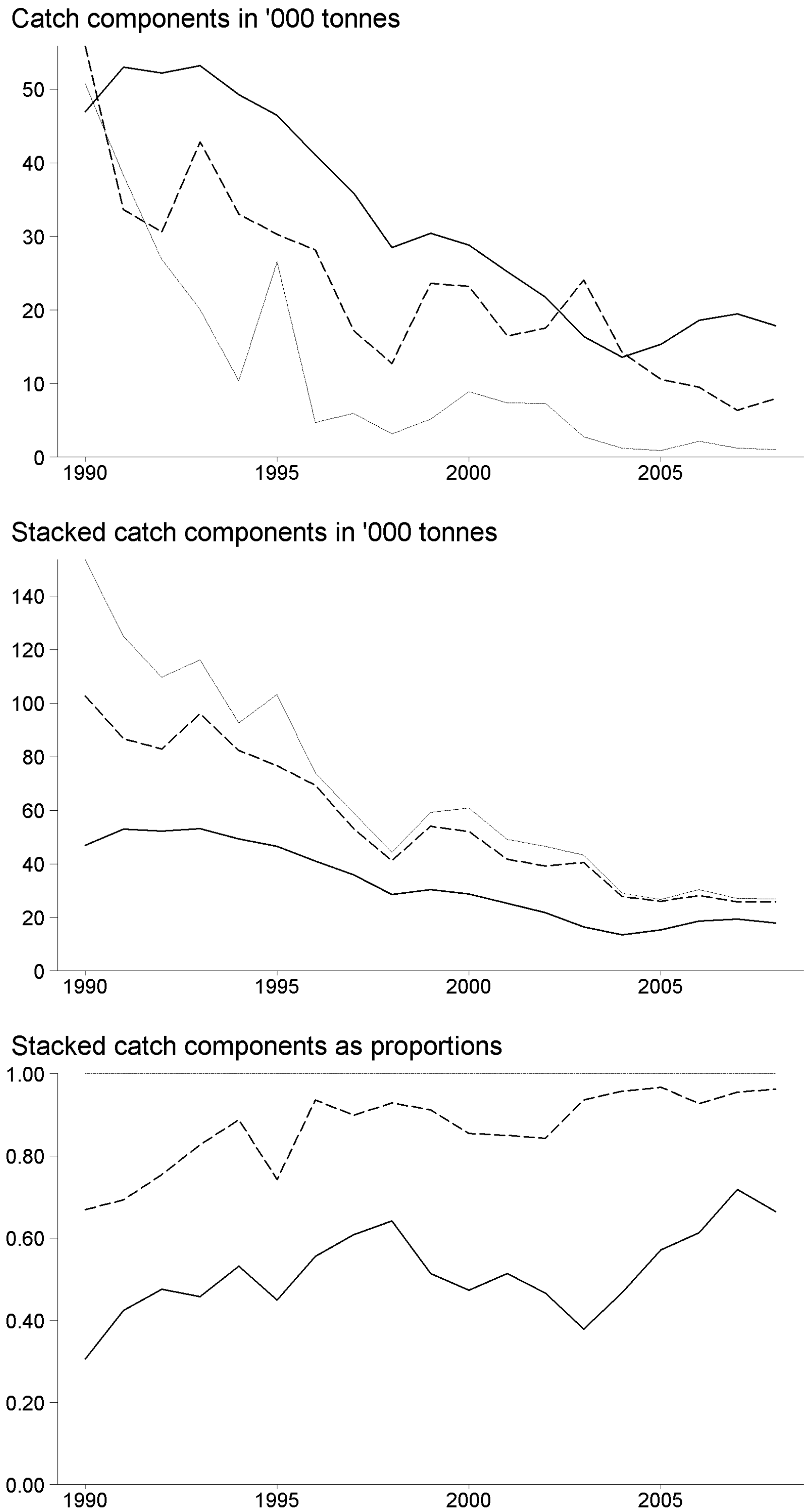


Figure 12.2.1 Whiting in IV and VIId. The contribution of each catch component to the total catch. Human consumption landings (black line) is always at the bottom, followed by discards (dashed line) and lastly industrial bycatch (grey line).

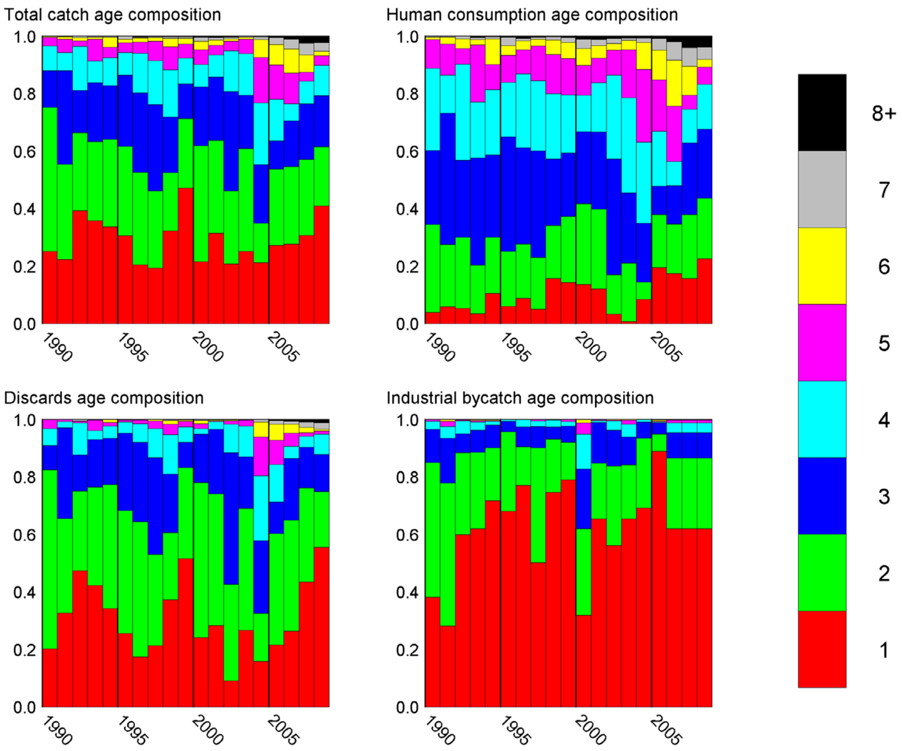


Figure 12.2.2 Whiting in IV and VIId. Proportion at age by number for each catch component. The colour for each age is given on the right.

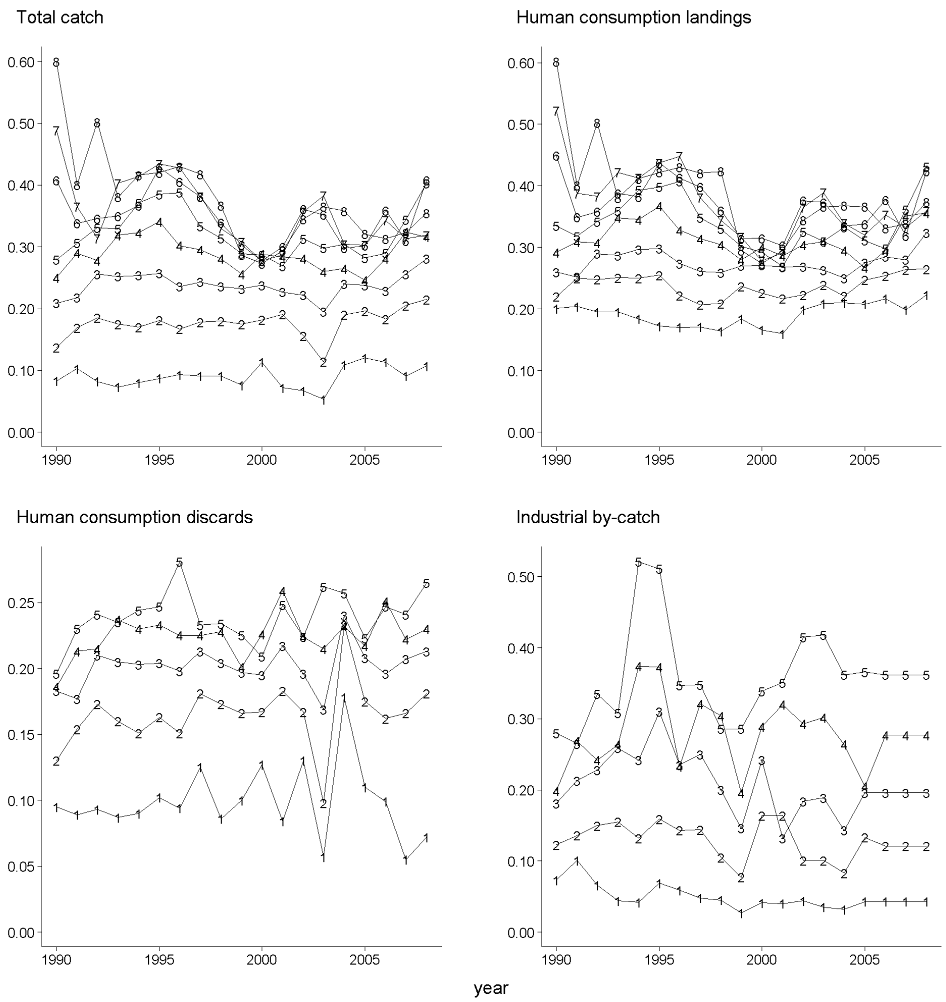


Figure 12.2.3 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights.

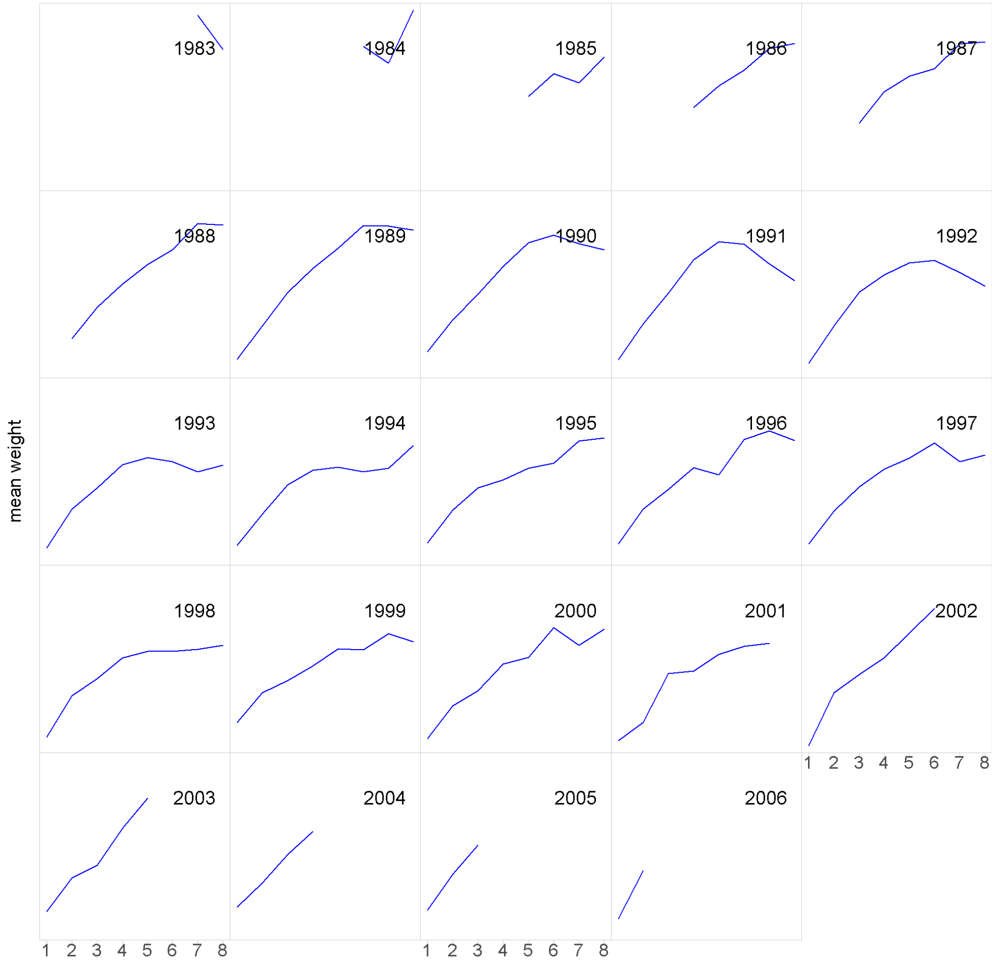


Figure 12.2.4 **Whiting in IV and VIId. Mean weights at age (ages 1 – 8+) in the catch by cohort.**

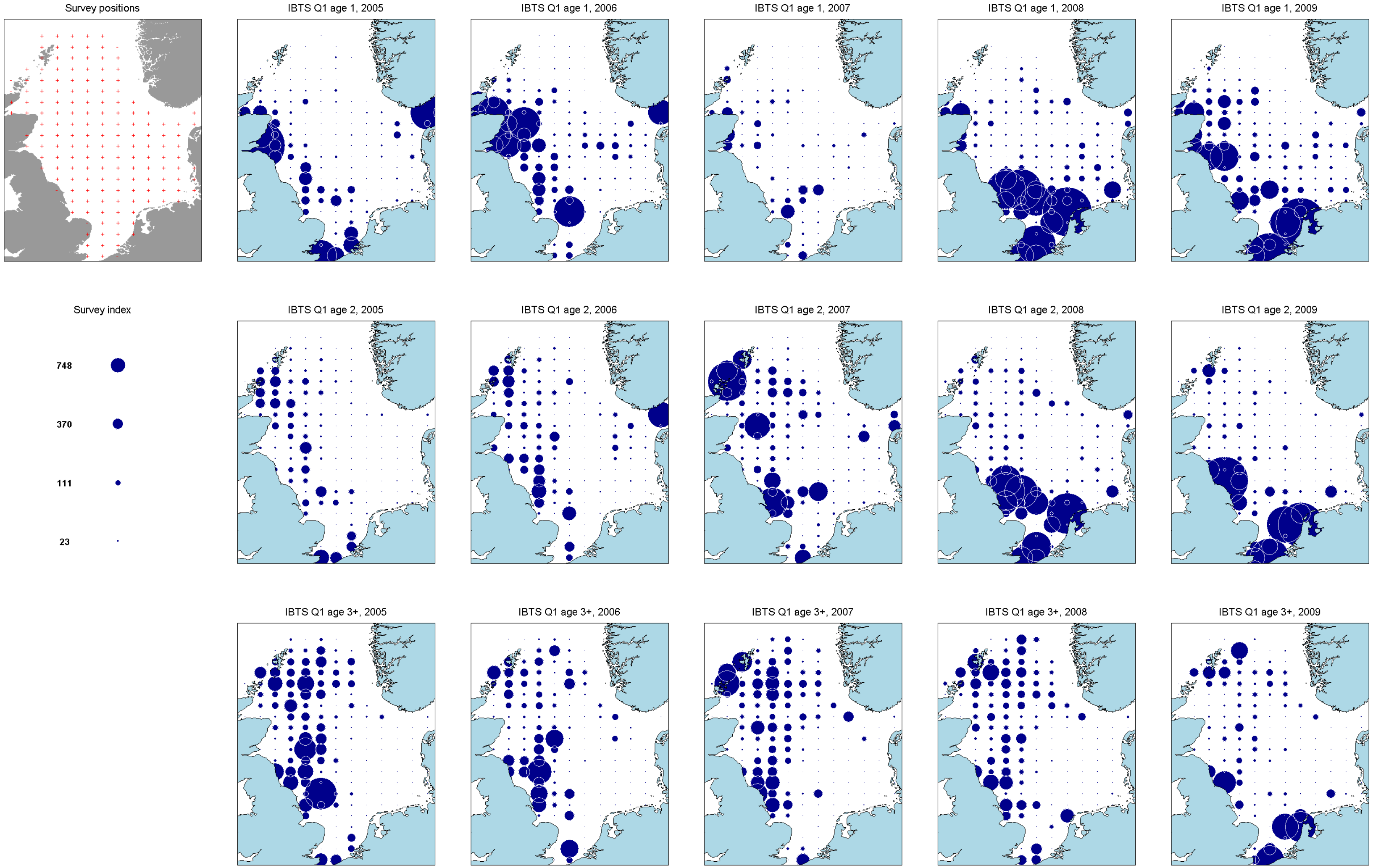


Figure 12.2.5 Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.

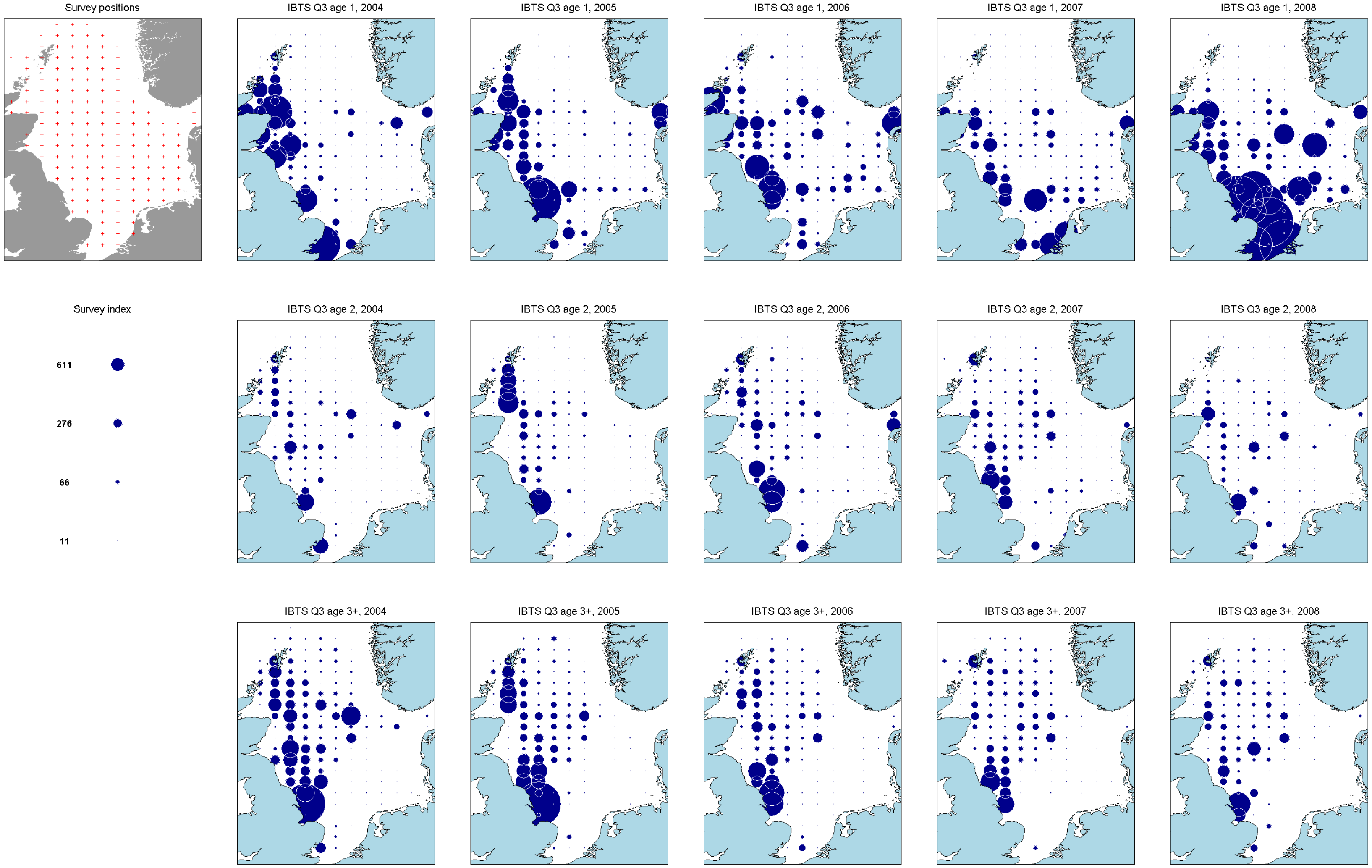


Figure 12.2.6 **Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.**

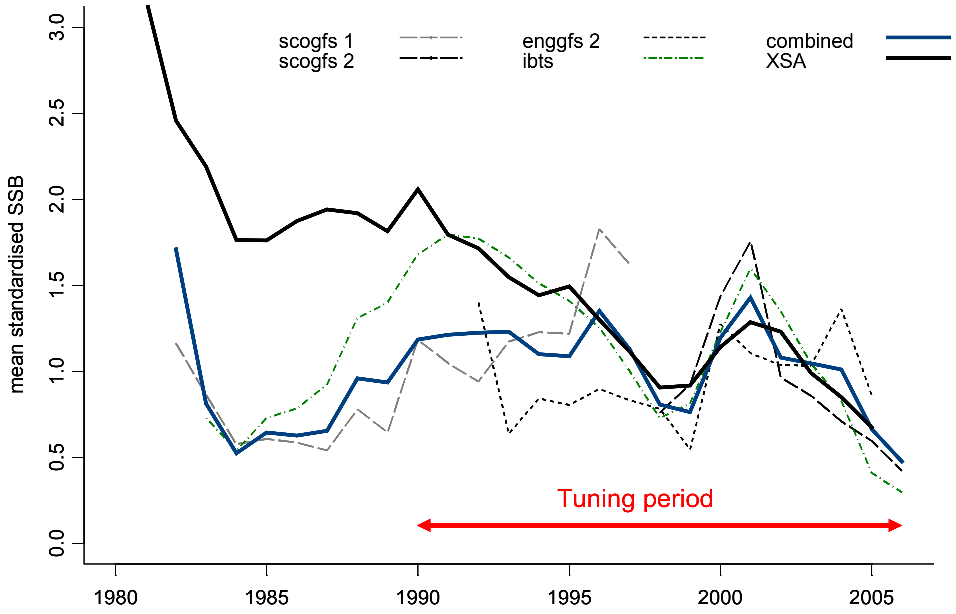


Figure 12.3.1 **Whiting in IV and VIId. Analysis conducted in WGNSSK (2007) showing catch based estimates of spawning stock biomass (black line) along side survey based estimates of spawning stock biomass (blue, and dashed lines), the blue line showing an estimate based on all the surveys. These are scaled so that the mean of each line over the years 1996 – 2006 is one.**

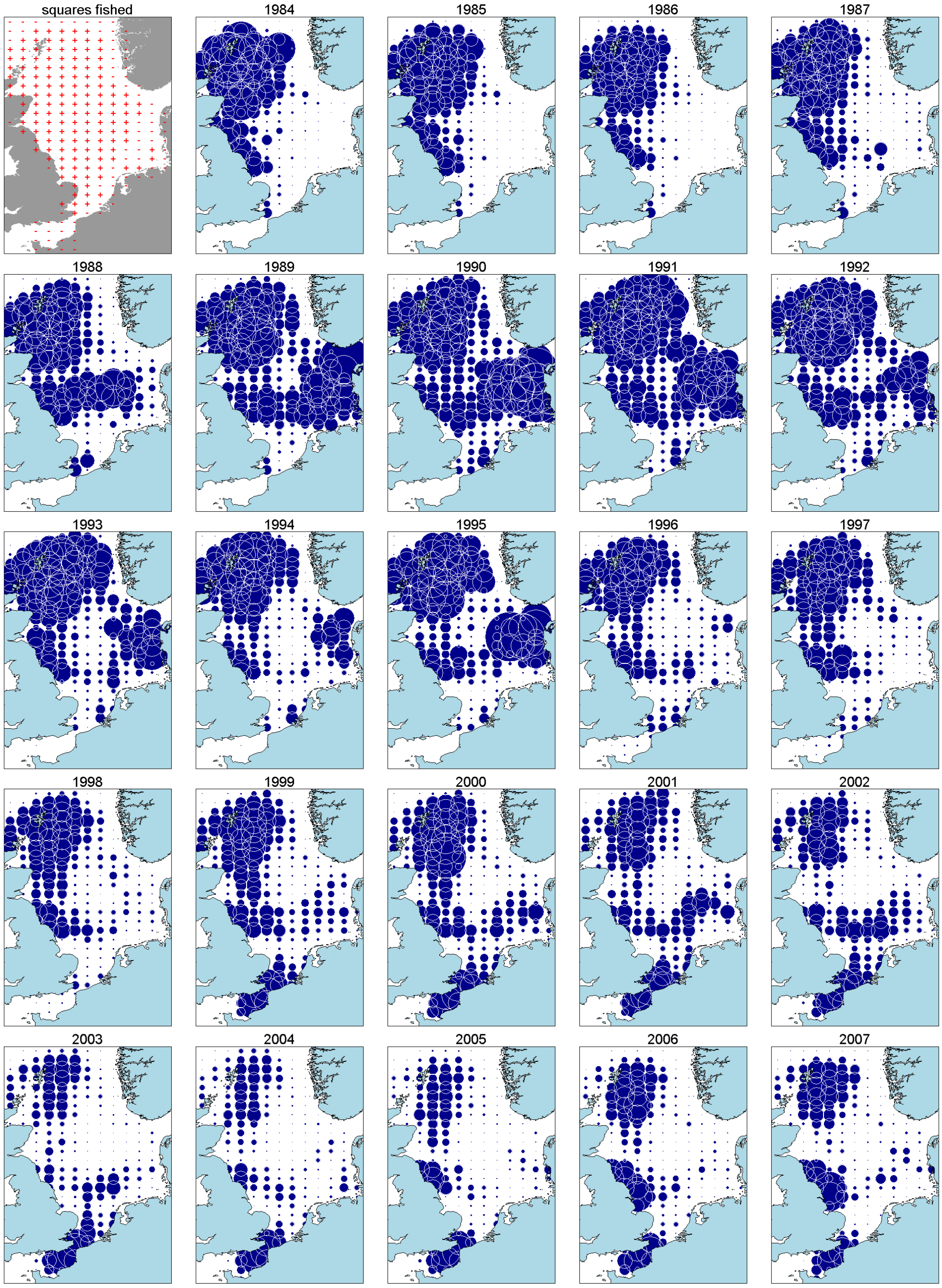


Figure 12.3.2 Whiting in Subarea IV and Division VIId. Commercial landings (human consumption and industrial fisheries in tonnes) by ICES statistical rectangle over the years 1984 to 2007. The same scaling is used in each map. In the top left plot a '+' indicates where landings are reported / available in every year (1984 – 2007), '-' indicates that for some years no landings were reported / available for that square. Danish industrial bycatch was available from 1988. French human consumption landings were available from 1999.

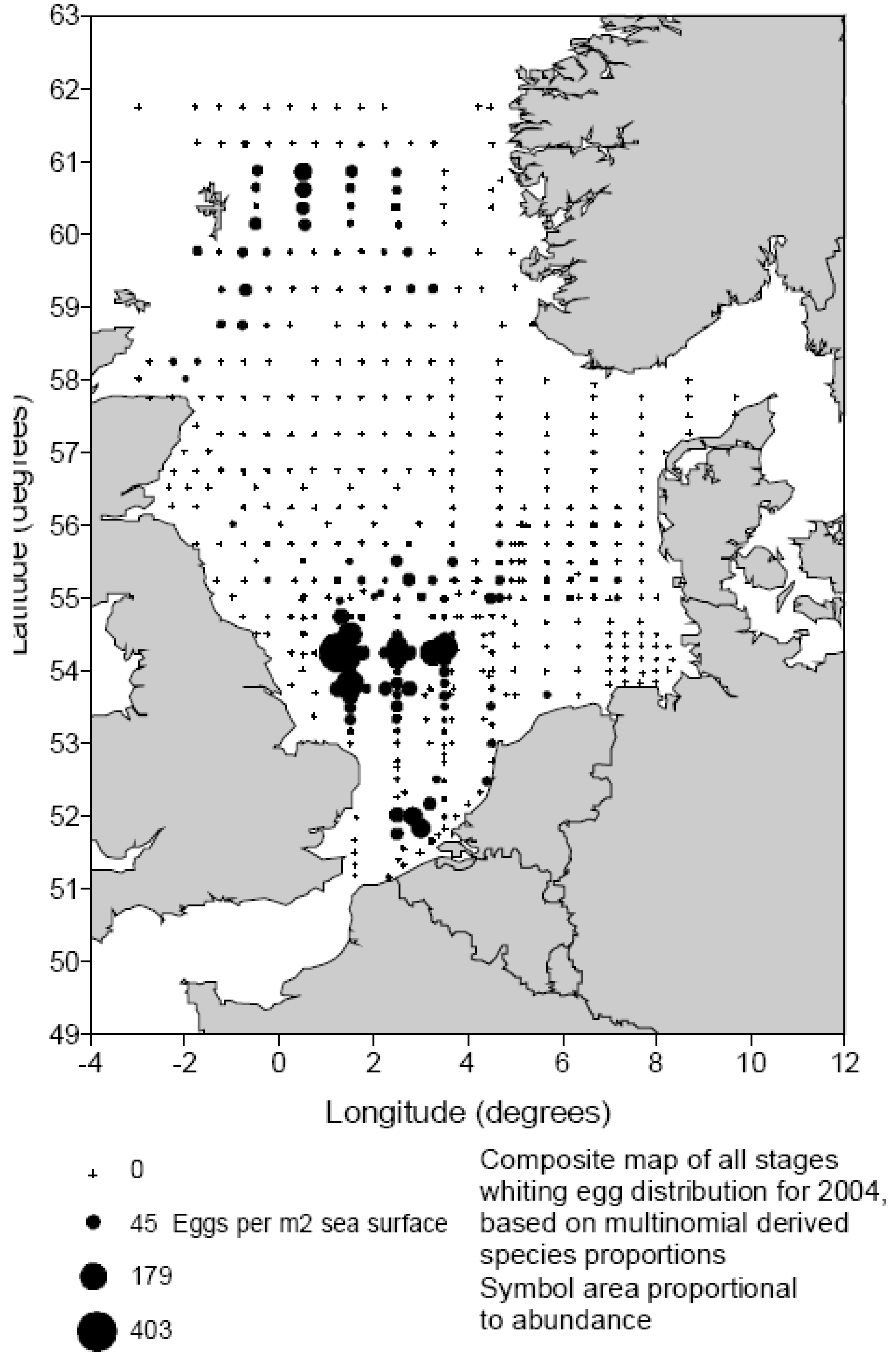


Figure 12.3.3 Whiting in Subarea IV and Division VIId. Density of whiting eggs from the 2004 ICES icthyoplankton survey.

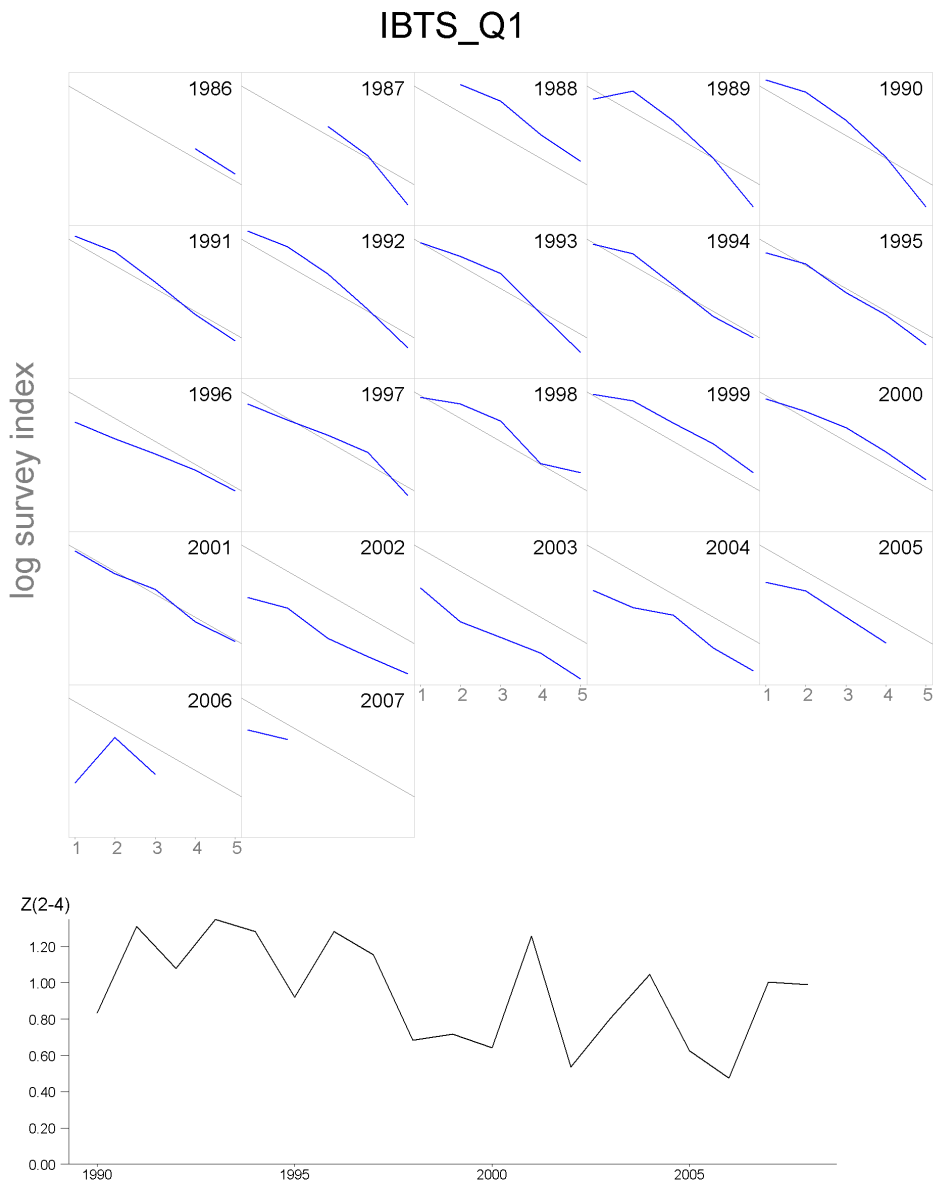


Figure 12.3.4 Whiting in IV and VIId. Top panel: Log indices by cohort for the IBTS Quarter 1 survey (ages 1 to 5). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 4, Z at age was estimated as log index (y, a) – log index (y+1, a+1).

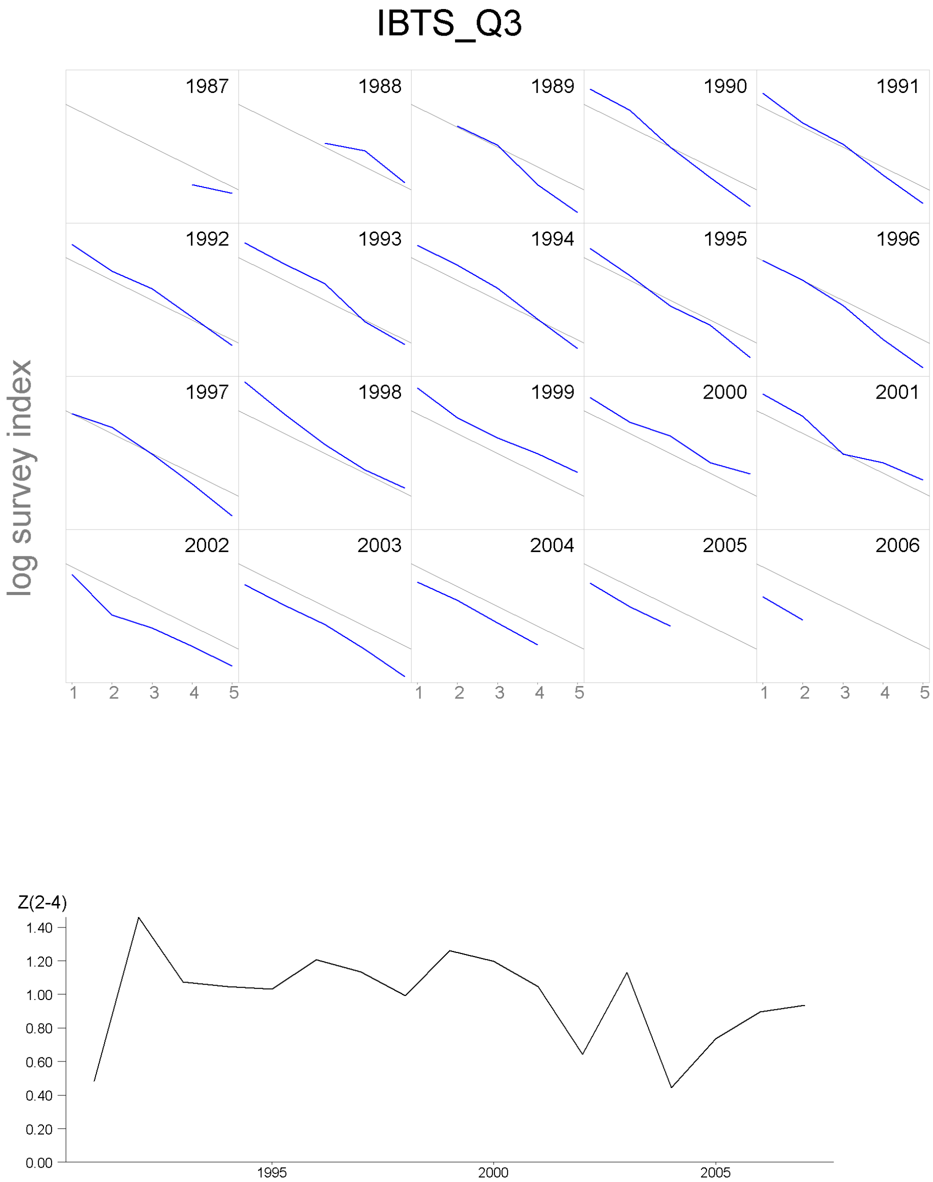


Figure 12.3.5 **Whiting in IV and VIId. Top panel: Log indices by cohort for the IBTS Quarter 3 survey (ages 1 to 5). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 4, Z at age was estimated as log index (y, a) – log index (y+1, a+1).**

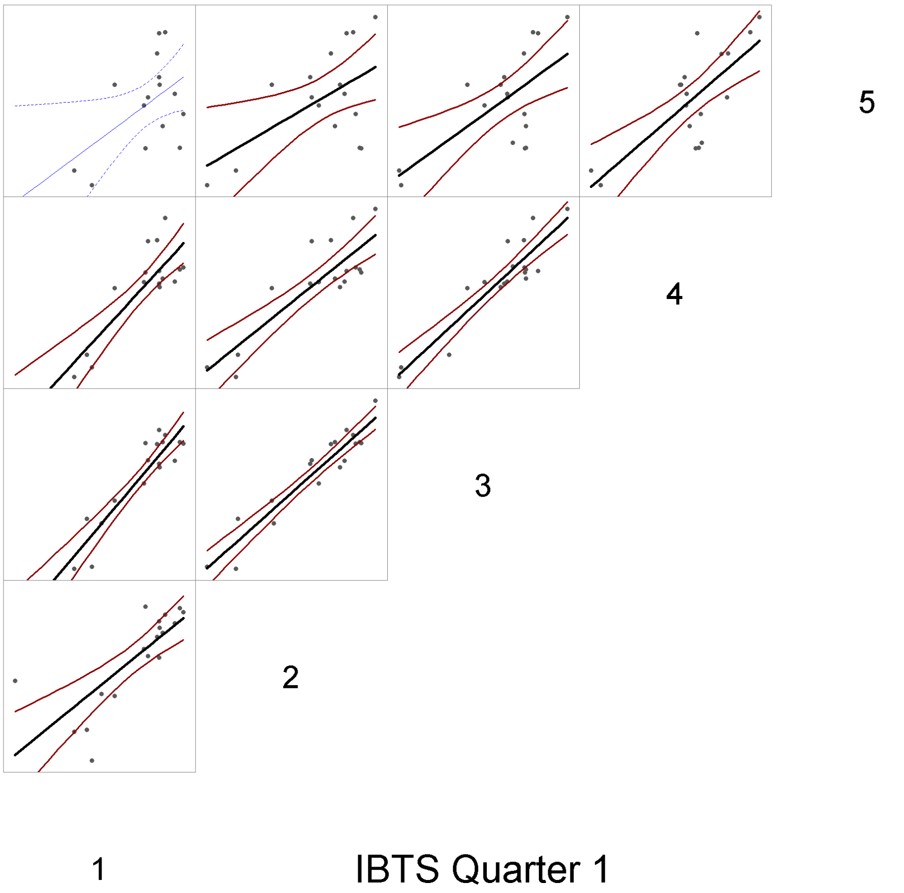


Figure 12.3.6 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 1 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

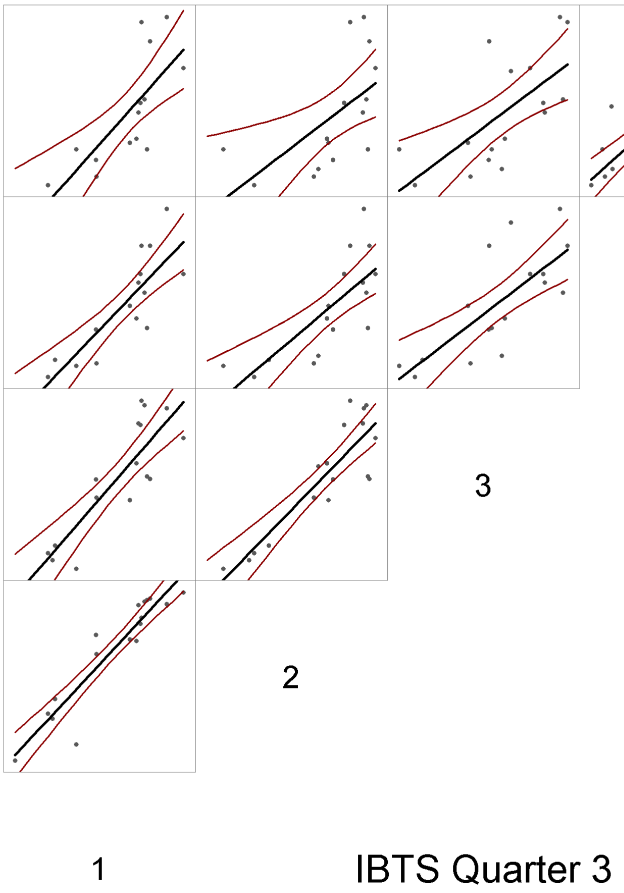


Figure 12.3.7 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 3 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

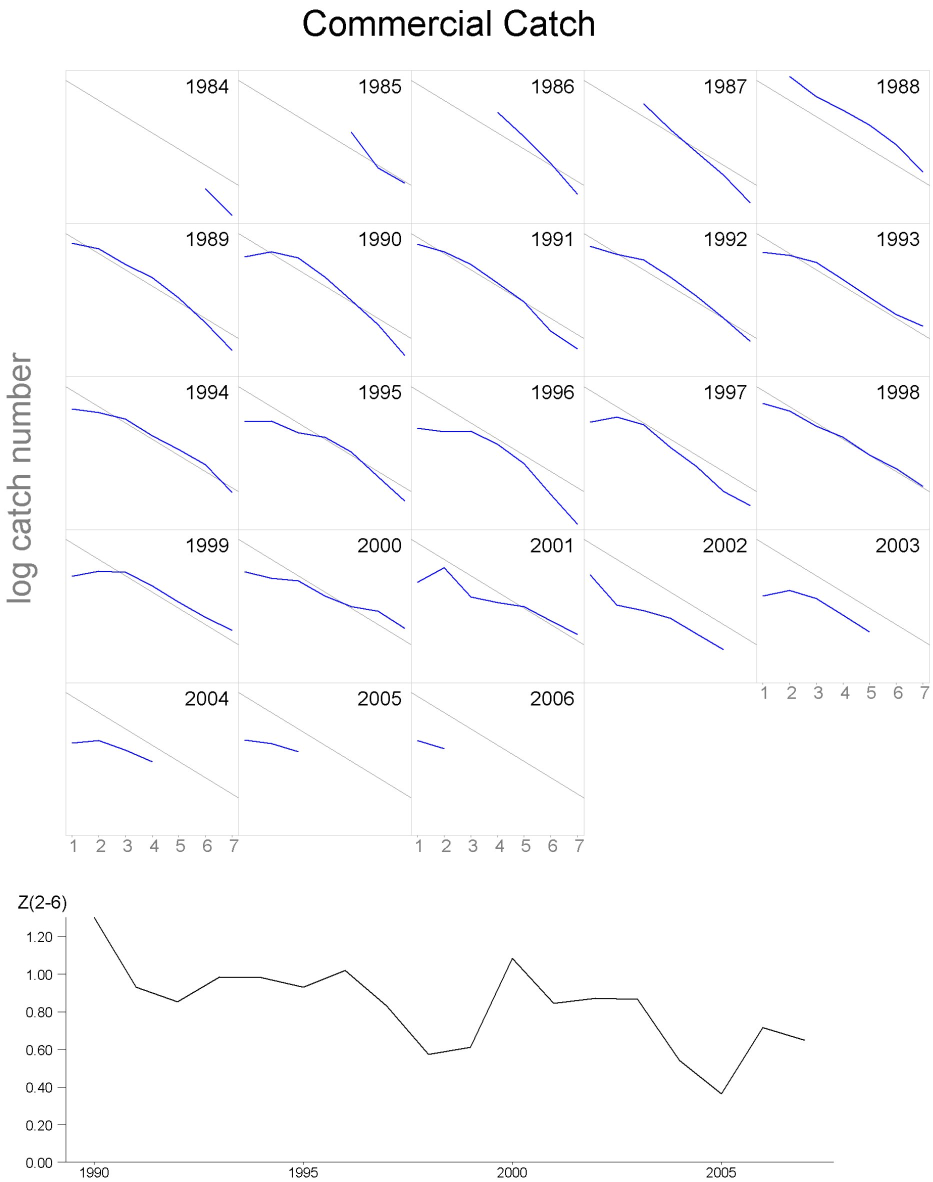


Figure 12.3.8 Whiting in IV and VIId. Top panel: Log catch number by cohort (ages 1 to 7). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 6, Z at age was estimated as log catch (y, a) – log catch (y+1, a+1).

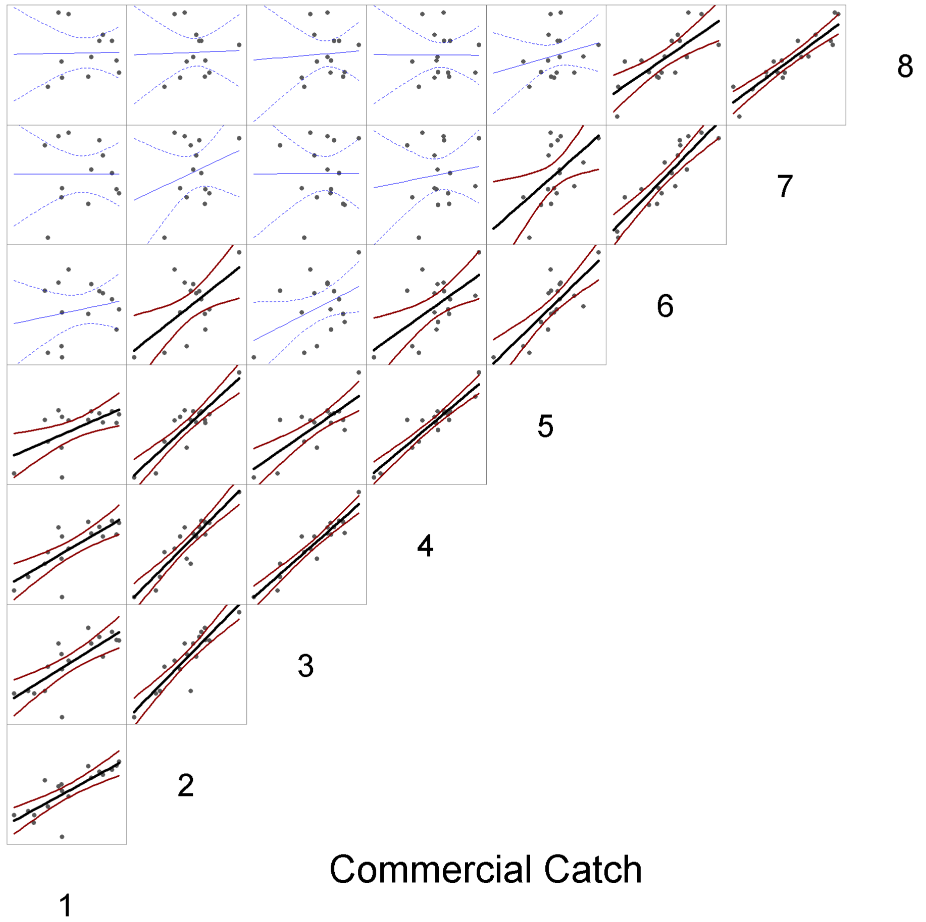


Figure 12.3.9 Whiting in IV and VIId. Correlations in the catch at age matrix (log numbers). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression.

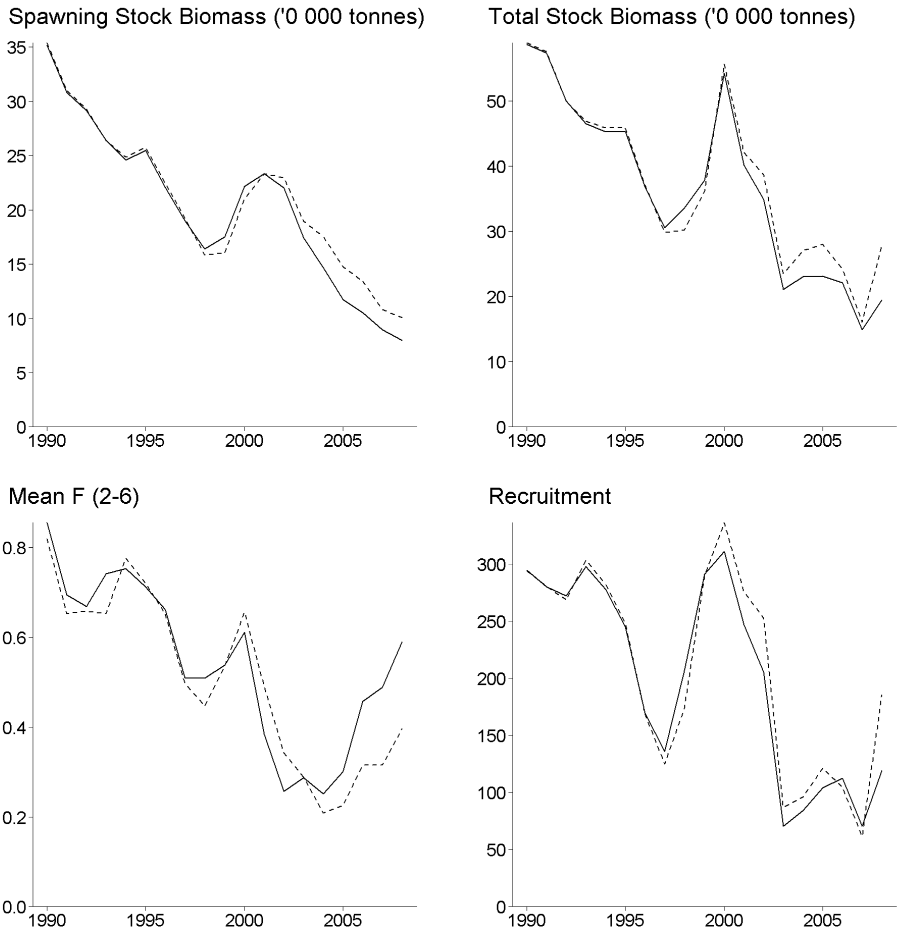


Figure 12.3.10 Whiting in IV and VIId. Comparison of spawning stock biomass, total stock biomass, mean F(2-6) and recruitment for individual tuning fleet XSA runs (with the settings used in the final assessment).

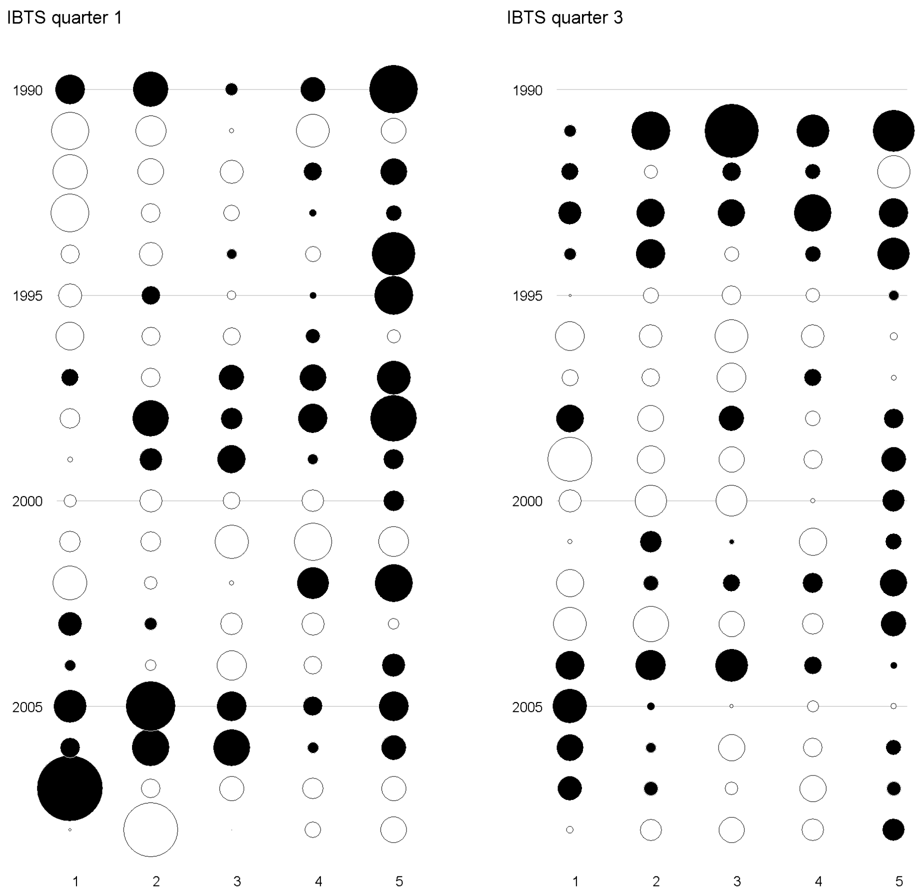


Figure 12.3.11 Whiting in IV and VIId. Residuals from single fleet XSA runs. Black signifies a negative residual and white signifies a positive residual.

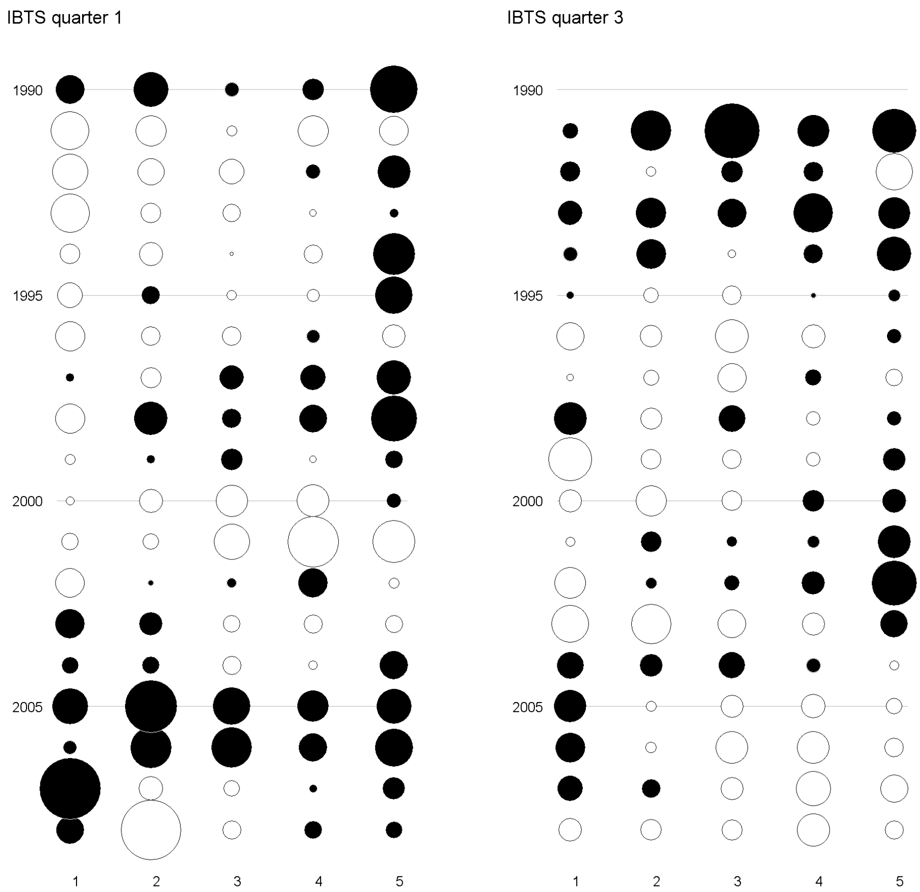


Figure 12.3.12 Whiting in IV and VIId. XSA final run: log catchability residuals. Black signifies a negative residual and white signifies a positive residual.

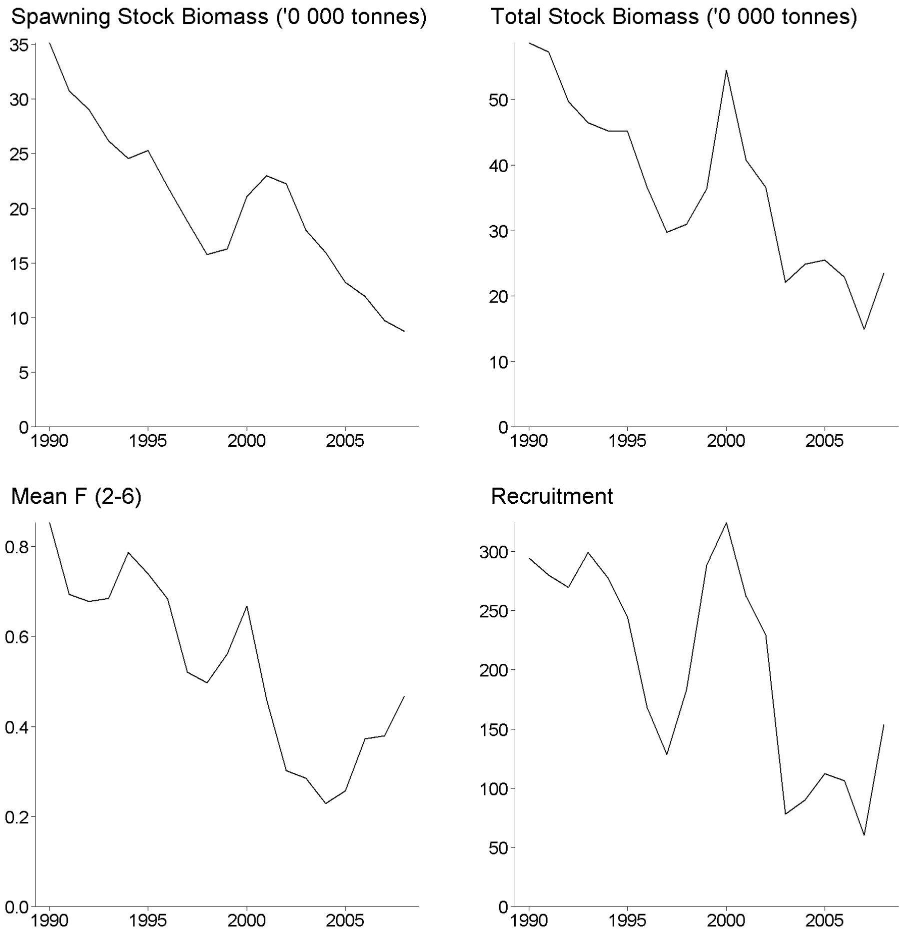


Figure 12.3.13 Whiting in IV and VIId. XSA final run: Summary plots.

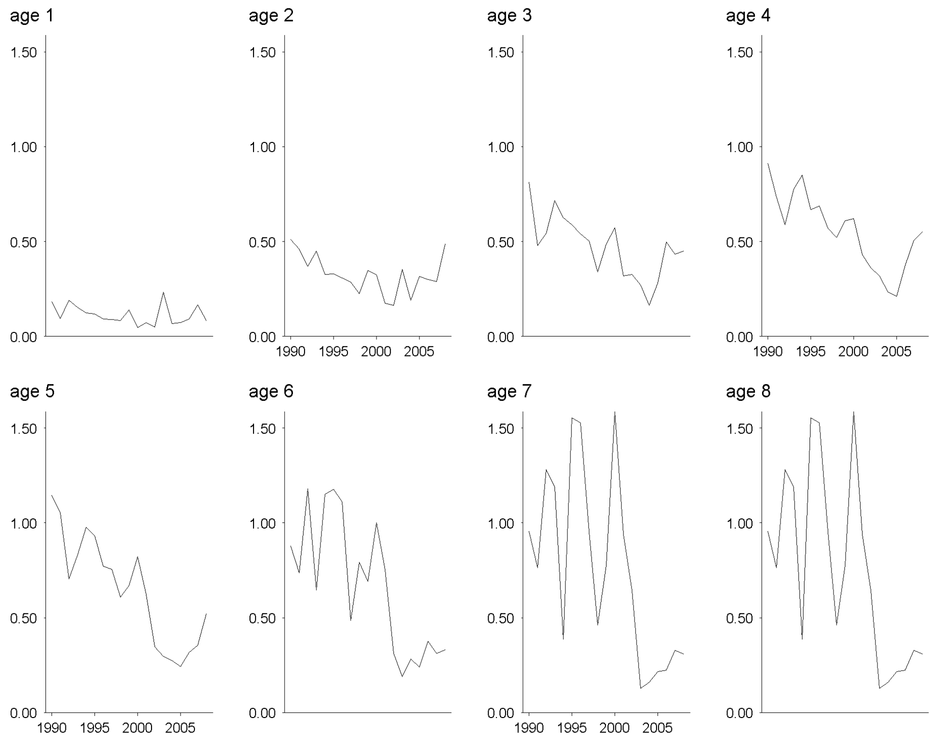


Figure 12.3.14 Whiting in IV and VIId. XSA fishing mortality at age.

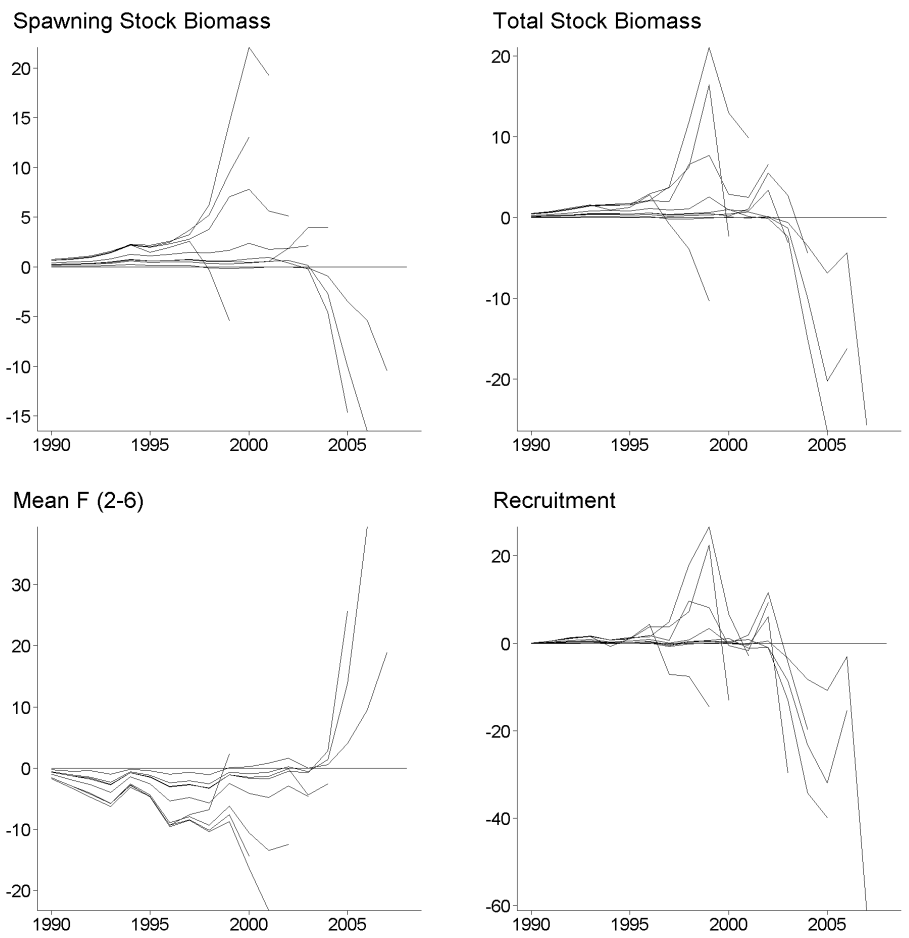


Figure 12.3.15 Whiting in IV and VIId. XSA spaly run: retrospective patterns. The y axis represents the percentage difference from the most recent assessment.

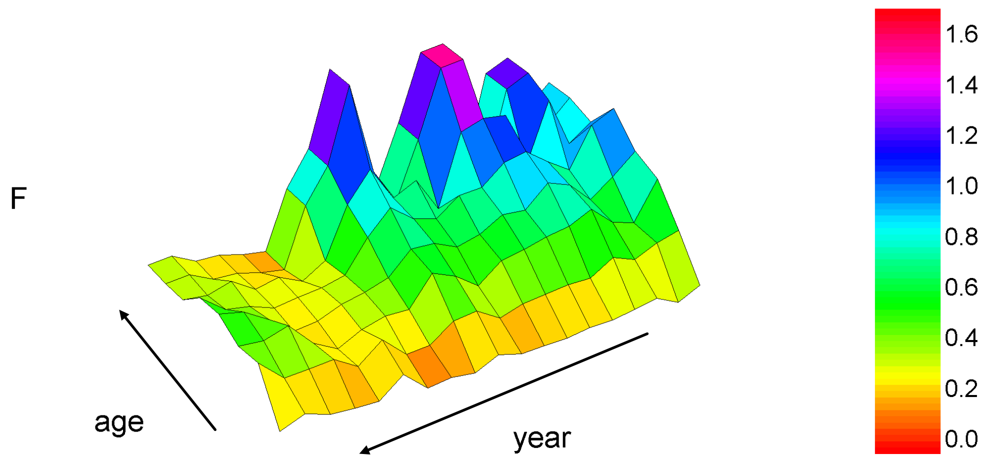


Figure 12.4.1 Whiting in IV and VIId. Changes in estimated exploitation pattern. The height of the plot denotes F at age, year is from 1990 to 2008, and ages 1 to 8+.

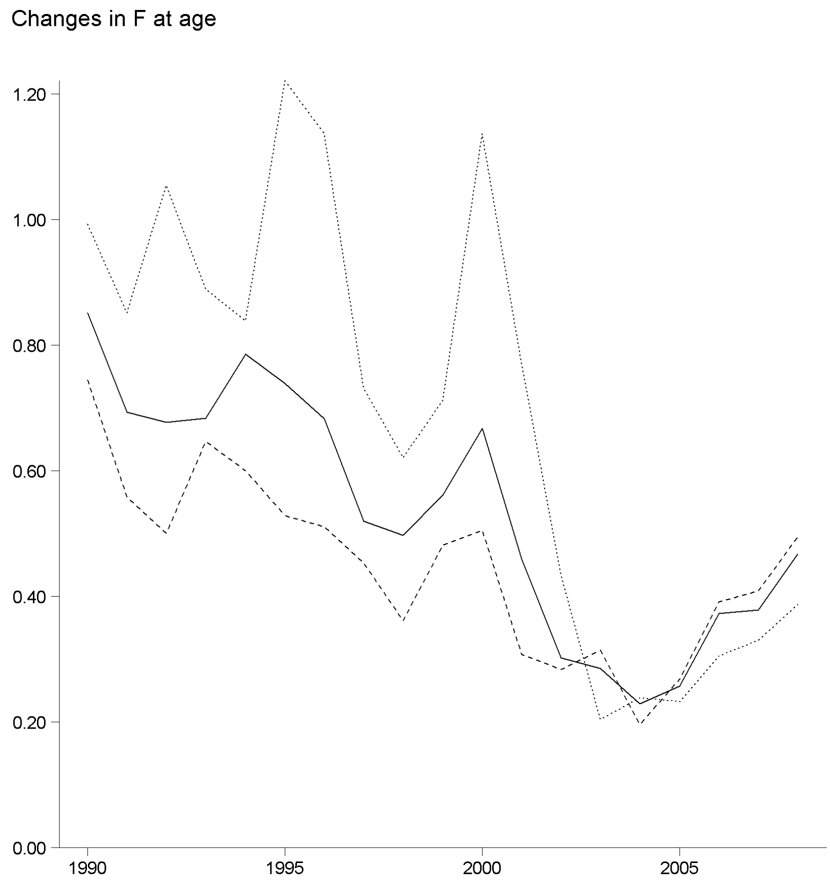


Figure 12.4.2 Whiting in IV and VIId Whiting in IV and VIId. Changes in exploitation pattern. Solid line : F(2-6), dashed line : F(2-4), dotted line : F(5:7). Historically, F has increased with age, since 2004 exploitation is greater on younger ages than older.

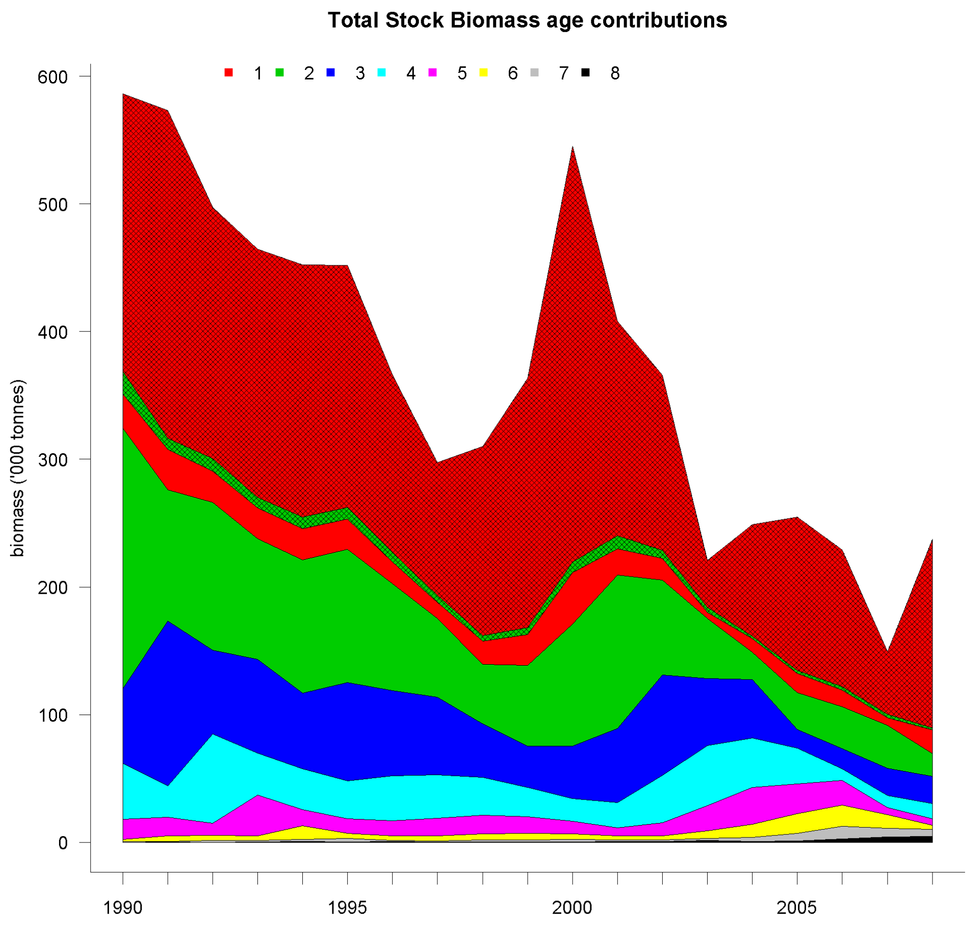


Figure 12.4.3 Whiting in IV and VIId. Age contributions to the SSB and TSB. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.

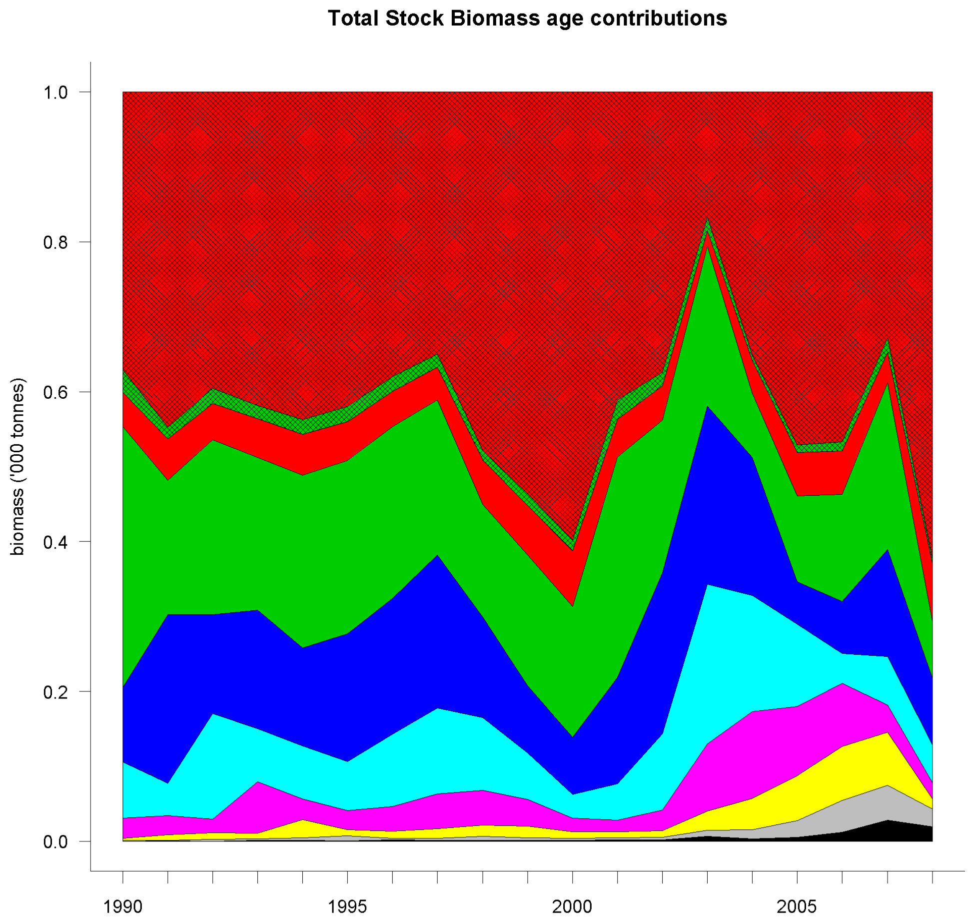
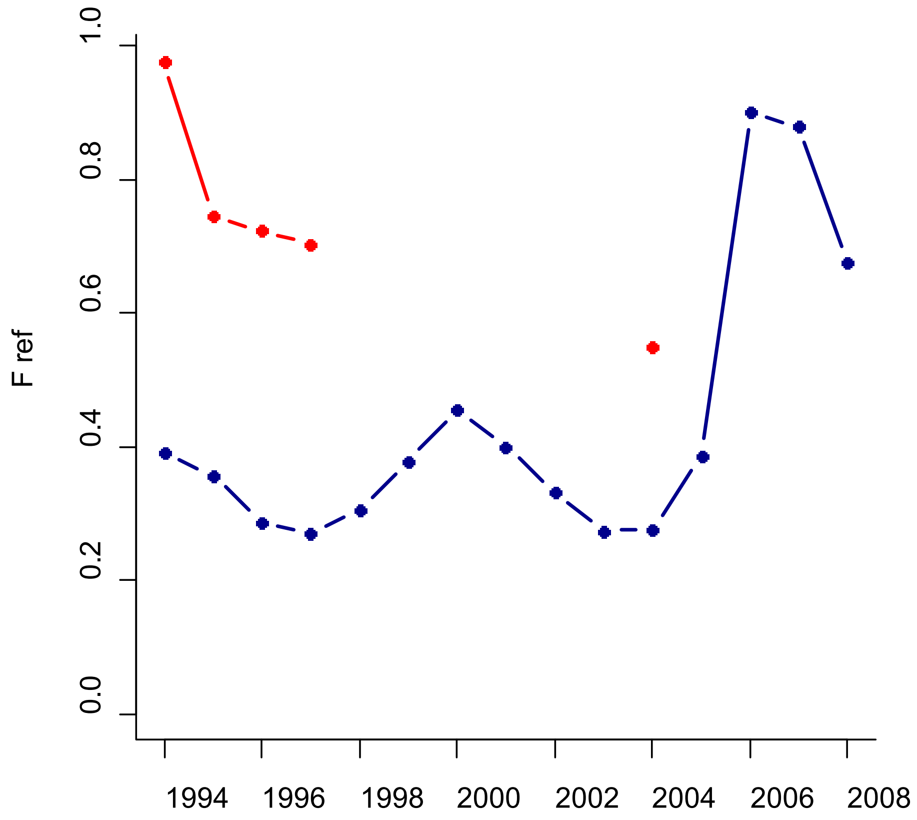


Figure 12.4.4 **Whiting in IV and VIId. Age contributions to the SSB and TSB shown as proportions of the total stock biomass. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.**


F ref
0.0
0.2
0.4
0.6
0.8
1.0
1994
1996
1998
2000
2002
2004
2006
2008

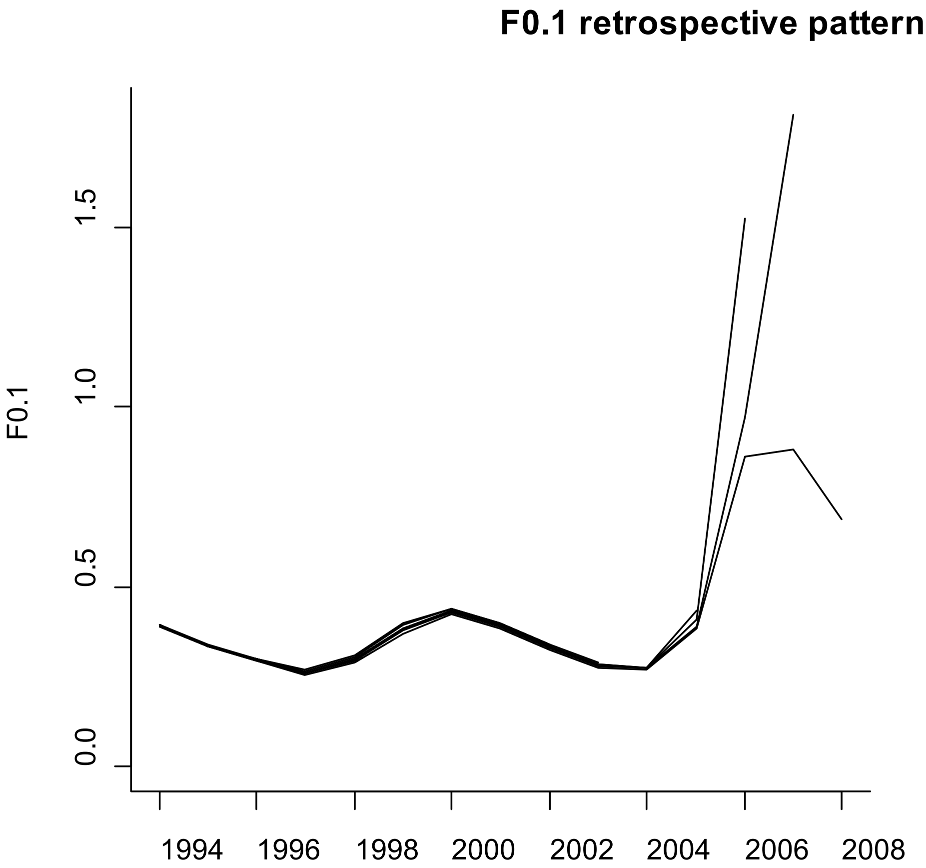


Figure 12.8.2 Whiting in IV and VIId. Retrospective pattern of F0.1 as estimated from rerospective runs of XSA.

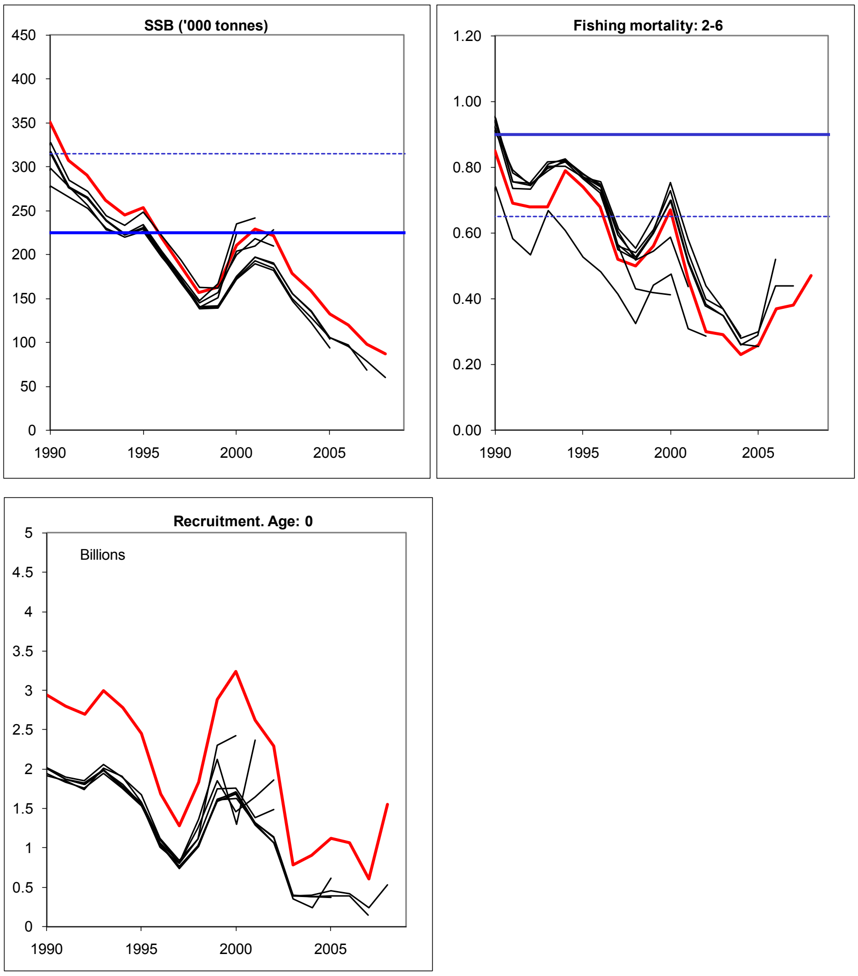


Figure 12.9.1 Whiting in IV and VIId. Historical performance of the assessment.

13 Haddock in Subarea IV and Division IIIa (N)

The assessment of haddock presented in this section is an update assessment. No changes have been made to the run settings and model configurations used in last year's assessment. Recommendations for issues to be considered at the forthcoming benchmark meetings are given in Section 13.9.

13.1 General

13.1.1 Ecosystem aspects

Ecosystem aspects are summarised in the Stock Annex.

13.1.2 Fisheries

A general description of the fishery (along with its historical development) is presented in the Stock Annex. Most of the information presented below and in the Stock Annex pertains to the Scottish fleet, which takes the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland) and VIb (Rockall).

Changes in fleet dynamics

There have been no decommissioning schemes affecting haddock fisheries since the major rounds in 2002 and 2004. Scottish vessels have been taking up opportunities for oil support work during 2006-2009 with a view to saving quota and days at sea.

With the reduced cod quota in recent years, many vessels have tended to concentrate more on the haddock fishery, with others taking the opportunity to move between the *Nephrops* and demersal fisheries (particularly during 2006 and 2007 – there may have been fewer boats changing focus in this way in 2008 and 2009). Accompanying the change in emphasis towards the haddock fishery, there has also been a tendency to target smaller fish in response to market demand. Some trawlers operating in the east of the North Sea are using 130 mm mesh (to ensure they meet regulations), and this is likely to improve selectivity for haddock. Fish from the moderate 2005 year-class now form the bulk of haddock catches, and discarding rates for these fish declined during 2008 as they grew beyond the minimum landings size.

A more complete history of the North Sea haddock fishery is given in the Stock Annex. It is difficult to conclude what will be the likely effect of the recent fishery changes on haddock mortality. Changes in gear that are required to qualify for the Scottish Conservation Credits Scheme (CCS; see Section 13.1.4) are likely to reduce bycatch (and therefore) discards of haddock in the *Nephrops* fishery in particular. In 2008, Scottish vessels were included in the CCS unless they opt outed of it, and as only one or two vessels chose to do so, compliance was close to 100%. Cod avoidance under the real-time closures scheme (which is a component of the CCS) could also have moved vessels away from haddock concentrations, but the extent of this depends on how closely cod and haddock distributions are linked, and on how successful the avoidance strategies have been. On the other hand, vessels catching fewer cod may increase their exploitation of haddock in order to maintain economic viability. In 2009, the CCS is the only option available to Scottish skippers.

Additional information provided by the fishing industry

Haddock are still the mainstay of the Scottish whitefish fleet. Quota uptake for 2008 was around 61%, in line with recent years (range 53% to 76% since 1999). However, the projected UK quota uptake for 2009 is thought to be higher, partly because whiting quota are likely to be exhausted rapidly. UK uptake (as of 6th May) was 21.2% in 2008, and 27.4% in 2009.

13.1.3 ICES advice

ICES advice for 2008

In June 2007, ICES concluded the following:

> *Based on the most recent estimate of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2006 is estimated at 238 000 t. SSB is above the B_{pa}. The stock is still dominated by the strong 1999 year class and the 2005 year class is also estimated to be above average. Fishing mortality in 2006 is estimated at 0.49, which is below F_{pa}.*

The Q3 North Sea surveys for haddock (EngGFS and ScoGFS) did not change the perception of recruitment significantly compared to the estimates available in June. Therefore, ICES did not change its advice in October 2007.

ICES advice for 2009

In June 2008, ICES concluded the following:

> *Based on the most recent estimate of SSB (in 2008) and fishing mortality (in 2007), ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2008 is estimated to be above B_{pa}. Fishing mortality in 2007 is estimated to be below F_{pa}, but above the target F_{HCR} (0.3) specified in the EU–Norway management plan. The influence of the strong 1999 year class on the stock is diminishing. The 2005 year class is estimated to be above average.*

As in 2007, the 2008 Q3 North Sea surveys for haddock (EngGFS and ScoGFS) did not change the perception of recruitment significantly compared to the estimates available in June. Therefore, ICES did not change its advice in October 2008.

13.1.4 Management

North Sea haddock are jointly managed by the EU and Norway under an agreed management plan, the details of which are given in the Stock Annex. The plan was modified during 2008 to allow for limited interannual quota flexibility, following the meeting in June of the Norway-EC Working Group on Interannual Quota Flexibility and subsequent simulation analysis (Needle 2008a). The review and potential revision planned for 2009 has been postponed until 2010.

Annual management of the fishery operates through TACs for two discrete areas. The first is Subarea IV and Division IIIa (EC waters), which are considered jointly. The 2008 and 2009 TACs for haddock in this area were 46 444 t and 42 110 t respectively. At most 24 863 t of the 2009 TAC was to be taken in Norwegian waters of Subarea IV by EC vessels. The second area is Divisions IIIa-d, for which the TACs for 2008 and 2009 were 2 856 t and 2 590 t respectively.

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS). At the time of writing in 2009, 46 further RTCs have been implemented (with a target of 150 for the year), and the CCS been adopted by 439 Scottish and around 30 English and Welsh vessels. It has two central themes aimed at reducing the capture of cod through:

1) avoiding areas with elevated abundances of cod through the use of compulsory Real Time Closures (RTCs) and voluntary “amber zones”; and
2) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally.

Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock. Whether this effect is positive (e.g. moving vessels away for areas inhabited by both cod and haddock) or negative (e.g. increasing targeting on haddock to compensate for forgone cod catches) remains to be seen (see also Section 13.1.2). However, early indications suggest that improved gear selectivity is likely to contribute to reductions in fishing mortality and discard levels, particularly of haddock and whiting, and there is evidence that the exploitation patterns for haddock and whiting across all participating vessels have improved since the introduction of the CCS scheme (see, for example, Section 13.4 below).

In early 2008, a one-net rule was introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

The remaining technical conservation measures in place for the haddock fisheries are summarised in the Stock Annex. New EU effort regulations for 2009 are listed in Section 14.1.3.

13.2 Data available

Collation issues for catch data

Due to problems in InterCatch with the raising of discard estimates from unsampled fleets (see Section 1.XXX), the international catch data for haddock have been aggregated using a spreadsheet approach (as has been the case for the previous two years). Some brief notes are provided here which are intended to clarify issues that have arisen with this process. Further information on the data collation method used can be found in the Stock Annex.

Discard data from UK (England and Wales)

Discards data (total tonnes discarded for the years 2002-2008, numbers at age and mean weights at age) were provided by UK (E&W). These data had not been available at the time of data collation for previous WGs.

Previously, UK(E&W) have provided their discard data for Subarea IV and Division VIId aggregated as a single area. Since there are very few haddock caught in Division VIId this means that the E&W discards for haddock were effectively for Subarea IV. In order to improve the situation for whiting in Division VIId, the data submitter was asked whether discard data could be provided separately for ICES Subarea IV and Division VIId. These data were available for cod, haddock and whiting. The received UK (E&W) discards data were for 2002 onwards.

The earlier data could be incorporated as part of a benchmark assessment workshop for North Sea haddock. The 2007 spreadsheet for aggregation of international catch data was updated with the E&W discards data, and these data were also used in the 2008 data collation for raising purposes.

Revisions to catch data for 2007

UK (England & Wales)

There was a small reduction (2.089 tonnes) in the UK (E&W) landings of haddock from Subarea IV.

Norway

Norwegian data revisions for 2007 landings were received for human consumption only. No industrial bycatch data revisions were received. Norwegian data revisions were provided for Division IIIa (including both IIIaN and IIIaS). The 2007 spreadsheet has been updated with these most recent data revisions from Norway.

Sweden

Contrary to what was reported to the 2008 WG, there was no industrial bycatch (i.e. a zero observation) of haddock by Sweden in 2007.

Catch data for 2008

The approach to the raising of discards was essentially the same as for 2007, since the data that were provided by respective nations were broadly of the same format in terms of the fishing areas for which age distributions were available. Some minor changes to the data available were noted for 2008, as follows.

Denmark

Age distributions for industrial bycatch in Subarea IV and Division IIIa(N) (numbers at age and mean weights at age) were provided by Denmark. Concerns were raised about these data, as the mean weights-at-age seemed implausible for Subarea IV. The available age distribution for industrial bycatch in Division IIIa(N) also seemed incongruous when compared with those for the human consumption and discarded components of the catch. No other age distributions are available for the industrial catch. Danish discard age compositions were used as a proxy for the missing industrial bycatch age compositions.

Norway

Norwegian landings were provided covering the fishery for human consumption only. In addition, it appears that the Norwegian data for Division IIIa may include both IIIa(N) and IIIa(S). The data were requested for just Division IIIa(N) but a clear resolution to this had not been reached by the time of the WG meeting.

Due to these data issues, it has not been possible to estimate industrial bycatch for Division IIIa and these data are missing from the current assessment.

Faroes

Preliminary Faroese landings of haddock for Subarea IV were provided. These data are not yet available from the official statistics.

Germany

The sum of products of landings numbers at age and mean weights at age gave an SOP check of 0.67 for German landings data. Although the data for discards were incorporated into the spreadsheet, German discards and landings data were not used for raising because of this SOP discrepancy.

Sweden

Swedish discards sampling is carried out in the fisheries that discard the most. The data submitted for Sweden noted that the shrimp fishery is not well covered by sampling and that this may present a problem. The Swedish haddock discards data Division IIIa(N) have been included in the collation, but not used for raising purposes – this follows the same procedure as last year.

13.2.1 Catch

Official landings data for each country participating in the fishery are presented in Table 13.2.1.1, together with the corresponding WG estimates and Total Allowable Catch (TAC). The full time series of landings, discards and industrial by-catch (IBC) is presented in Table 13.2.1.2. These data are illustrated further in Figure 13.2.1.1. The total landed yield of the international fishery changed little between 2007 and 2008. The WG estimates (Table 13.2.1.2) suggest that discarding decreased substantially during 2008, which may be due in part to the growth beyond the minimum landing size of the moderate 2005 year-class. Subarea IV discard estimates are derived from data submitted by several countries. As Scotland is the principal haddock fishery in that area, Scottish discard practices dominate the overall estimates. Industrial by-catch (IBC) has declined considerably from the high levels observed until the late 1990s.

13.2.2 Age compositions

Total catch-at-age data are given in Table 13.2.2.1, while catch-at-age data for each catch component are given in Tables 13.2.2–4. The fishery in 2008 (landings for human consumption) was strongly reliant on the moderate 2005 year-class, although the strong 1999 year-class is still present in the plus-group. It is interesting to note that the plus-group in 2007 and 2008 is larger than at any time since the mid-1970s: this is the result of the combination of the large 1999 year-class and low fishing mortality in recent years. Discards predominantly consist of medium-sized fish aged 2 and 3 (from the 2006 and 2005 year-classes respectively). Vessels seldom exhaust their quota in this fishery, and discarding behaviour is thought to be driven by a complicated mix of economic and other market-driven factors.

13.2.3 Weight at age

Weight-at-age for the total catch in the North Sea is given in Table 13.2.3.1. Weight-at-age in the total catch is a number-weighted average of weight-at-age in the human consumption landings, discards and industrial bycatch components. Weight-at-age in the stock is assumed to be the same as weight-at-age in the total catch. The mean weights-at-age for the separate catch components are given in Tables 13.2.3.2-4 and are illustrated in Figure 13.2.3.1: this shows the declining trend in weights-at–age for older ages, as well as evidence for reduced growth rates for large year classes.

13.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed to be fixed over time and are given below. The basis for these estimates is described in the Stock Annex.

Age	0	1	2	3	4	5	6	7+
Natural mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20
Proportion mature	0.00	0.01	0.32	0.71	0.87	0.95	1.00	1.00

13.2.5 Catch, effort and research vessel data

Survey distribution and annual density at age for recent years is given in Figure 13.2.5.1 for the IBTS Q1 survey. Figure 13.2.5.2 gives the equivalent survey distribution for the ScoGFS Q3 survey alone. All plots show a north to north-westerly distribution of haddock. The strong 1999 year class and (to a lesser extent) the moderate 2000 and 2005 year classes can also be identified and tracked through time.

Data available for calibration of the assessment are presented in Table 13.2.5.1, including commercial data from Scottish fleets which are not currently used in the assessment (see below). The IBTS Q1 data are shown as collated, including the plus-group (ages 6 and older) which cannot be used in standard XSA tuning. XSA also cannot use data from the current year (2009). For this reason, the IBTS Q1 data are backshifted before being used in XSA – that is, all ages and years are reduced by one, and the survey is considered to have taken place at the very end of the previous year.

Trends in survey indices are shown in Figure 13.2.5.3. These indicate reasonably good consistency in stock signals from different surveys. Commercial data on landings per unit effort (LPUE) from two Scottish fleets are summarised in Figure 13.2.5.4, from which the influence of the strong 1999 year-class is again apparent. Figure 13.2.5.5 shows recorded (nominal) effort for these fleets. However, it must be remembered that effort recording is not mandatory in the EU, and these data must be viewed with caution (see also ICES-WGNSSK, 2000).

The data available are summarised in the following table: data used in the final assessment are highlighted in bold.

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	Seine	All	ScoSei	1978-2008	1-13+	-
	Light trawl	All	ScoLTR	1978-2008	1-13+	-
	Groundfish survey	Q3	ScoGFS_ABDN	1982-1997	0-8	0-7
	Groundfish survey	Q3	ScoGFS_GOV	1998-2008	0-8	0-7
England	Groundfish survey	Q3	EngGFS_GRT	1977-1991	0-10+	0-7
	Groundfish survey	Q3	EngGFS_GOV	1992-2008	0-10+	0-7
International	Groundfish survey	Q1	IBTS	1983-2009	1-6+	1-5
	Groundfish survey	Q1	IBTS (backshifted)	1982-2008	0-5+	0-4

13.3 Data analyses

The intention for this year was to perform an update assessment; that is, to carry out the same procedure as last year. This has been done using FLXSA (the FLR implementation of XSA) as the main assessment method. Separable VPA results are presented along with catch curves and intra-series correlations to check for data consistency and validity. The results of a SURBA analysis are also shown, to corroborate the update assessment.

13.3.1 Reviews of last year's assessment

At its meeting in May 2008, RGNSSK raised a number of issues. These are listed below, along with the WG response and actions taken (if applicable).

3) *It seems that a reduction of effort has been produced in recent years. If an effective reduction of effort occurred, this could be help in order to obtain some external information to elucidate the differences obtained in recent trends of Fs estimates from different models applied*

- A full analysis of effort trends in the relevant fisheries has not yet been undertaken by the WG.

4) *One of the main concerns of the RG is still the mean weight at age as it was pointed out by the RG in 2007. This in combination with plus group problems (mainly for large year-classes) and doubts on goodness of fit affecting to SSB estimates can be producing certain instability to the system in terms of perception of the stock and forecasts. The EG is conscious about this problems and propose alternatives, as it was done last year (in coherence with update status), to reduce the possible impact in terms of assessment and advice. However, it seems that is accepted by the EG the influence of dependent effects of large year-classes on growth and maturity (e.g. 1999 YCs) when in fact is just a plausible possibility. It also happens the same for the moderate 2000 YC. This is not so clear for the highest 1967 and high 1974 YCs. It should be preferable first to check if this growth pattern is more a sampling effect than a population effect. It should be desirable to screen the length and/or weight distributions at age in AL(W)K and/or AL(W)Ds mainly for years effects observed in older ages for 1999 and 2007 (and adjacent years) considering weight at age as a quality control tool about: reading problems, weights' parameters used, sampling coverage, raising procedures etc.*

- The WG welcomes these comments and suggestions, and is similarly keen to improve growth modelling for haddock and other stocks. One of several initiatives in this area is a PhD studentship at the University of Aberdeen in Scotland, co-supervised by the WG member responsible for the haddock assessment. However, suitable methods are not yet available to allow the WG to build such growth modeling into forecast considerations.

The points which have not been addressed here need to be considered during the forthcoming benchmark meeting for North Sea haddock, a date for which has not yet been set (see Section 13.9).

13.3.2 Exploratory catch-at-age-based analyses

The catch-at-age data, in the form of log-catch curves linked by cohort (Figure 13.3.2.1), indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort from ages 2 to 7 have reduced for recent cohorts, reflecting a reduction in fishing mortality. Recent catch curves have also lost much of the regularity of more historical catch curves, which may reflect the lower sample size available from reduced landings. Figure 13.3.2.2 plots the negative gradient of straight lines fitted to each cohort over the age range 2–4, which can be viewed as a rough proxy for average total mortality for ages 2–4 in the cohort. These negative gradients are also lower in recent cohorts except for an apparent rise in the 2004 cohort.

Cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 13.3.2.3. These correlations show good consistency within cohorts up to the plus-group, verifying the ability of the catch-at-age data to track relative cohort strengths (although data for ages 0 and 1 are slightly more variable).

Residuals from a separable VPA carried out on the catch data (Figure 13.3.2.4) show very few outliers, and none greater than ±3. This supports the conclusion that catch data are reasonably consistent.

Single-fleet XSAs for the final assessment were produced to investigate the sensitivity of XSA to the effects of tuning by individual fleets. Results are shown in Figure 13.3.2.5 for the latter halves of the EngGFS Q3 and ScoGFS Q3 series, as well as for the IBTS Q1 series, with corresponding log-catchability residual plots shown in Figure 13.3.2.6. Overall trends are similar for the three tuning fleets, but absolute levels differ towards the end of the time series with the ScoGFS series producing higher estimates of F and lower estimates of SSB.

13.3.3 Exploratory survey-based analyses

A SURBA run was carried out using the same combination of tuning indices as in the update XSA assessments, except that the IBTS Q1 survey was not backshifted. The summary plot from this run is given is Figure 13.3.3.1. The stock trends are in broad agreement with those from the XSA assessment. The main exceptions are total mortality, which is estimated to have risen much more quickly during 2003-2006 before falling in 2007 (the rise in the very last year is an artefact of the model); and SSB which appears to have recovered considerably in 2007 and 2008 with the growth of the moderate 2005 year-class. The SURBA estimates of recruitment confirm that year-classes since 2005 have been poor. The IBTS Q1 indices from 2009 are available, but cannot be used directly to indicate recruitment for the 2009 year-class as the survey takes place too early for these juveniles to be caught.

Log catch curves for the survey indices are given in Figure 13.3.3.2. Overall, these show good tracking of cohort strength, although there is a tendency for reduced survey catchability on younger ages (shown by the "hooks" at the start of many of the curves). Cohort correlations in the index-at-age matrices (plotted as log-numbers) are shown in Figure 13.3.3.3. These correlations show good consistency for nearly all of the cohorts and ages used in the final assessment (with a few minor exceptions).

13.3.4 Conclusions drawn from exploratory analyses

Exploratory analyses using survey and catch data do not indicate any serious problems with these data for North Sea haddock. One main methodological issue remains which has not yet been addressed. The update assessment sets the maximum iterations for the FLXSA algorithm to a high value (200), so that the iteration process continues until the algorithm has converged. However, doing this also increases the final-year SSB considerably (see, for example, Figure 13.3.3.4). FLXSA (and XSA) has no goodness-of-fit criteria, and it is not clear what the correct approach should be in this situation. In this year's assessment the previous method has been retained, but the WG has concerns about its validity which need to be addressed in any subsequent benchmark (Section 13.9).

13.3.5 Final assessment

The final XSA assessment uses the following settings, which are the same as those used last year (except for the addition of another year of data). XSA settings from a number of recent years are compared in the Stock Annex.

Assessment year		2009
q plateau		6
Tuning fleet year ranges	EngGFS Q3	77-91; 92-08
	ScoGFS Q3	82-97; 98-08
	IBTS Q1*	82-08
Tuning fleet age ranges	EngGFS Q3	0-7
	ScoGFS Q3	0-7
	IBTS Q1*	0-4
*Backshifted		

The final XSA assessment tuning diagnostics are presented in Table 13.3.5.1, with log-catchability residuals given in Figure 13.3.5.1, and a comparison of fleet-based contributions to survivors in Figure 13.3.5.2. Fishing mortality estimates for the final XSA assessment are presented in Table 13.3.5.2, the stock numbers in Table 13.3.5.3, and the assessment summary in Table 13.3.5.4 and Figure 13.3.5.3. A retrospective analysis, shown in Figure 13.3.5.4, indicates little retrospective bias in the assessment.

13.4 Historical Stock Trends

The historical stock and fishery trends are presented in Figure 13.3.5.3.

Landings yield has stabilised since 2000, partly due (in the most recent years) to the limitation of inter-annual TAC variation to ±15% in the EU-Norway management plan. Discards have fluctuated considerably in the same period due to the appearance and subsequent growth of the 1999 and 2005 year-classes, while industrial by-catch (IBC) is now at a very low level for haddock (see also Figure 13.2.1.1).

The estimated fishing mortality for 2008 has continued the reduction seen in 2007, and is now estimated to be below the management plan target of 0.3. Fluctuations around the target F rate of the management plan are an expected consequence of the lag between data collection and management action, and should not be taken to indicate that the plan is not working. The 2006-2008 year-classes have been weak, and the fishery is likely to be sustained (over the short term at least) by the 2005 year-class. The final XSA assessment indicates a reduction in the rate of decline of SSB as the 2005 year-class starts to make an impact on spawning biomass.

13.5 Recruitment estimates

There are no indications of incoming year-class strength available to the WG. The ScoGFS and EngGFS Q3 survey indices are not yet available. The IBTS Q1 indices are available, but do not include age-0 recruiting fish as these are too small to be caught (or are not yet hatched) when the survey takes place. For this reason, recruitment estimates of the 2009 year-class are based on a mean of previous recruitment.

In the past, a strong year-class has generally been followed by a sequence of low recruitments (Figure 13.5.1.1). In order to take this feature into account, the geometric mean of the five lowest recruitment values over the period 1994–2006 (4067 million) has been assumed for recruitment in 2009-2011. Recruitment estimates for 2007 and 2008 are not included in this calculation, because the two most recent XSA estimates of recruitment are thought to be relatively uncertain. The following table summarises the recruitment, age 1 and age 2 assumptions for the short term forecast.

Year class	Age in 2009	XSA estimate (millions)	Geometric mean of 5 lowest recruitments 1994–2006
2007	2	170	
2008	1	588	
2009	0		4067
2010	Age 0 in 2010		4067
2011	Age 0 in 2011		4067

13.6 Short-term forecasts

Weights-at-age

The perceived slow growth of the above-average 1999 and 2000 year-classes continues to pose a problem for the short-term forecast. Mean stock weights for these year classes were calculated using proportional increments. That is: growth from age *a* to *a*+1 for these year-classes was estimated using the mean proportional increment (*a*+1)/*a* calculated over all other year classes for which this information is available. This method was approved by RGNSSK in 2006 as being appropriate to project weights at age, although alternatives are being explored and the issue needs to be considered at a forthcoming benchmark. Mean stock weights for other ages (except the plus-group) in the forecast where taken as a 5-year average (2004–2008), omitting the 1999 and 2000 year classes from the calculation where appropriate. For the plus-group weights, an alternative XSA assessment was run using a plus-group at age 13. The abundances and fishing mortality estimates from this were then used as the basis for a simple deterministic 3-year forecast to give abundances from ages 0-13+ for 2009-2011. These were then used in turn in weighted-average calculations to generate the required forecast mean weights for the plus-group at age 8. The outcome is summarized in Figure 13.6.1.

The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age (see Figure 13.6.2). However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2004–2008 for these components.

Fishing mortality

The 2007 and 2008 WG reports contained extensive analyses and discussion on the exploitation pattern to be used in the forecasts, exploring the hypothesis that moderate-to-large cohorts would experience a different pattern to small cohorts. In both reports, the WG concluded that there was only weak evidence for using anything other than the exploitation pattern from the final historical year in the assessment. In the spirit of the update process, the 2008 fishing mortality-at-age pattern is used for all years in the forecast in the current report. However, this conclusion may not hold for future cohorts, and the WG recommends that a forthcoming benchmark process explores this issue further. Status quo F is assumed to be the mean F(2–4) for 2008 only.

Given the choice of fishing-mortality rates discussed above, partial fishing mortality values were obtained for each catch component (human consumption, discards and bycatch) by using the relative contribution (averaged over 2006-2008) of each component to the total catch.

Forecast results

The inputs to the short-term forecast are presented in Table 13.6.1. Results for the short-term forecasts are presented in Table 13.6.2. The forecast has been run subject to a TAC constraint in 2009 (so that landings yield is restricted to the agreed quota of 44700 t). Running the forecast assuming status quo F in the intermediate year leads to landings in 2009 that are greater than the quota. Recent experience (see Table 13.2.1.1), and reports from the fishing industry, indicate that full uptake of the quota in 2009 is unlikely. While it is difficult to predict the extent of the undershoot, it would certainly be an error to forecast an overshoot, so a TAC-constrained forecast is a compromise.

Assuming a TAC constraint in 2009 and status quo F in 2010, SSB is expected to fall to 171 kt in 2010, and again in 2011 to 167 kt. In this case, human consumption yield will be around 27 kt in 2010, with associated discards of 6 kt. The continued decline in SSB, which will occur despite a fall in 2008 in both F and discard rates, is the result of low recruitment in recent years – the 2005 year-class is the only reasonably strong cohort out of the last eight.

Two alternative options have been highlighted in Table 13.6.2: a forecast allowing for a 15% decrease in the 2009 TAC (which is the maximum decrease allowed under the management plan when SSB > B_{pa}), and a forecast with total fishing mortality fixed to the level specified in the EU-Norway management plan (F = 0.3). Under the first of these options, 2010 landings yield of 38 kt and discards of 9 kt lead to SSB in 2011 of 154 kt. Under the second, 2010 landings yield of around 32 kt and discards of 7 kt lead to SSB in 2011 of 161 kt. All of these SSB forecasts for 2011 are above B_{pa} (140 kt), but the trend in SSB is downwards and this will continue unless a strong year-class appears.

The following table compares the intermediate-year (2008) forecast from the 2008 WG with the 2008 observations and assessment results from the 2009 WG:

WG	Landings 2008	F(landings) 2008	Discards 2008	F(discards) 2008	SSB 2009
2008 forecast	49300	0.20	17173	0.10	211522
2009 assessment	30248	0.16	13194	0.09	194861

All these values have been assessed to be less than previously predicted. SSB in 2009 could be less because a) the mean weight-at-age of fish in the forecast was greater than subsequently observed, or b) the numbers of fish in the forecast were overestimated. Figure 13.6.1 shows that forecast weights were actually less than subsequently observed weights. Therefore the forecast numbers must have been too high. While the difference is relatively small, the reason for it is presently unclear, and will need to be addressed at a forthcoming benchmark.

13.7 Medium-term forecasts and yield-per-recruit analyses

No medium-term forecasts have been carried out for this stock. However, management simulations over the medium-term period have been performed for haddock (most recently by Needle 2008a,b), as discussed briefly in Section 13.1.4 above.

The results of a yield-per-recruit analysis (run using MFYPR) are shown in Figure 13.7.1 and Table 13.7.1. There is no maximum in the yield-per-recruit curve over the specified range of mean F_{2-4}, so F_{max} is undefined. An equilibrium analysis such an yield-per-recruit can be difficult to interpret for a stock like haddock with sporadic large recruitments.

13.8 Biological reference points

Biological reference points for this stock are given in the Stock Annex.

13.9 Quality of the assessment

Survey data are consistent both within and between surveys, and the catch data are internally consistent. Trends in mortality from catch data and survey indices are quite similar, although surveys do indicate higher mortality in recent years. Only minor changes were made to the data collation or assessment methodology from last year's assessment. There is very little retrospective bias. The stock estimates from the current and previous assessments are compared in Figure 13.9.1.

Several issues remain of some concern with the assessment, and will need to be addressed during the forthcoming benchmark process:-

1) Haddock growth appears to vary by cohort, with large cohorts in particular growing more slowly than small cohorts. The pragmatic solution of applying proportional increments as a basis for predicting the weight at age for the 1999 and 2000 year classes incorporates the history of growth in the stock, while recognising the slow growth rate of these cohorts. However, intersessional work (not presented here) has suggested that alternative growth models may be more appropriate, and these need to be explored further.

2) In a similar vein, the proportion of mature individuals in each age-class is likely to vary by year and cohort. The effect of using year specific maturity data obtained from surveys should be considered, as well as methods by which this can be modeled in forecasts. The same consideration applies to estimates of natural mortality (M); biannually-updated values of M are now used in the assessment for North Sea cod, for example (see Section 14).

3) Exploitation rates also vary by cohort. The implications of this for forecasting should be addressed.

4) It is likely that haddock will continue to experience sporadic large year-classes. The problem of how to accommodate these year-classes in the plus-group structure of the assessment will therefore not go away, and a robust approach is needed that will remove the requirement to change the plus-group whenever a large year-class enters it.

5) The SSB estimates generated by the XSA/FLXSA model is strongly dependent (for haddock) on the number of algorithm iterations permitted. Interim results suggest that changes of ±40% or more are possible. There is no

goodness-of-fit statistic in XSA which would help in the determination of the most suitable number of iterations, so the choice becomes essentially *ad hoc*. This is not a satisfactory situation and will have to be remedied. Alternative models should be explored.

6) Survey indices from the IBTS Q1 series have traditionally been supplied by ICES using a 6+ age group. Information on large year-classes at ages older than 5 is therefore lost from the tuning process. The WG recommends that ICES supply these data for a greater true age range, and that the implications of this be explored in the benchmark assessment.

7) The haddock assessment uses separate Scottish and English Q3 groundfish survey series, rather than the combined IBTS Q3 series. The former are longer, but the latter has more sample points and should there be less variable. This choice should be considered in detail.

8) The relationship between forecasts produced by the WG in one year and assessments generated in the next year needs to be checked. The brief analysis carried out above suggests that there may be a degree of inconsistency, and this issue needs to be explored.

9) A longer time-series of discard data from UK(E&W) was made available this year (see Section 13.2). Its inclusion in the overall discard estimation procedure is a question that should be resolved.

13.10 Status of the Stock

The historical perception of the haddock stock remains unchanged from last year's assessment. Fishing mortality is now estimated to have fallen further (from 0.41 in 2007 to 0.25 in 2008) and is now close to the historical minimum. This is well below F_{pa} (0.7), and is also lower than the mortality rate recommended in the management plan (0.3). Discards have also decreased in 2008, possibly due to the growth past the MLS of fish of the 2005 year-class. Spawning stock biomass (203 kt in 2008) is predicted to have continued in its decline from its peak in 2002–3, but remains above B_{pa} (140 kt). SSB is forecast to fall further to 195 kt in 2009 despite low F and reduced discards: this is due to the appearance of only one moderate year-class in the last eight years. At current levels of fishing mortality, SSB is likely to continue to decline from 2010 onwards unless a moderate-to-strong year-class appears. The 2006-2008 year-classes are estimated to be weak, and there is no information yet on the 2009 year-class.

Figure 13.10.1 gives the results of the North Sea stock survey from 2008. The industry perception of haddock abundance in the main haddock fishing areas (1 and 2) is of stabilization, which concurs with the indications from the assessment of a temporary slowing of the rate of decline in SSB with the growth of the 2005 year-class.

13.11 Management Considerations

In 2006 the EU and Norway agreed a revised management plan for this stock, which states that every effort will be made to maintain a minimum level of SSB greater than 100 000 t (B_{lim}). Furthermore, fishing will be restricted on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups, along with a limitation on interannual TAC variability of ±15%. Following a minor revision in 2008, interannual quota flexibility ("banking and borrowing") of up to ±10% is permitted (although this facility has not yet been used).

The stipulations of the management plan have been adhered to by the EU and Norway since its implementation in 2001. Fishing mortality fell while the 1999 year-class dominated the fishery, and this year-class was allowed to contribute to the fishery and the stock for much longer than if the plan had not been in place. SSB has declined as the 1999 year-class has passed out of the stock, although the rate of the decline has been slowed by low fishing mortality rates and the appearance of the moderate 2005 year-class. F now appears to fluctuating around the target level (0.3) as predicted by management evaluations. Adherence to the EU–Norway management plan has contributed to increased yield and greatly improved stability of yield, along with a much lower average fishing mortality level.

The decline in SSB has been slowed temporarily by the growth of the moderately-sized 2005 year class, but this year-class is smaller than the 1999 year-class and is unlikely to contribute very strongly to SSB for many years to come. Short-term forecasts indicate a continued decline in SSB in the future until the next significant recruitment event.

Keeping fishing mortality close to the target level would be preferable to encourage the sustainable exploitation of the 2005 year-class. As this year-class entered the fishery, discards were fairly substantial in 2006 and 2007, although they were considerably lower in 2008. Further improvements to gear selectivity measures, allowing for the release of small fish, would be highly beneficial not only for the haddock stock, but also for the survival of juveniles of other species that occur in mixed fisheries along with haddock. Similar considerations also apply to spatial management approaches (such as real-time closures), and other measures intended to reduce unwanted bycatch and discarding of various species (such as the Scottish Conservation Credits scheme).

Short-term forecasts indicate a continued decline in SSB in the future until the next significant recruitment event. However, SSB is predicted to remain above B_{pa} until 2011 at fishing mortality levels below F_{pa}, and for even longer under the agreed management plan.

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery catching cod, whiting and Nephrops. It is important to consider both the species-specific assessments of these species for effective management, as well as the latest developments in the mixed fisheries approach. This is not straightforward when stocks are managed via a series of single-species management plans that do not incorporate mixed-stocks considerations. However, a reduction in effort on one stock may lead to a reduction or an increase in effort on another, and the implications of any change need to be considered carefully.

Estimates of the catch of haddock as a bycatch in the industrial fisheries have been included in the short-term forecast option table. They indicate that industrial bycatch will be negligible. These estimates are more unreliable than would have been the case in the past and it is likely that they underestimate the likely level in 2009 and 20q0. This is because they are based on average exploitation over the previous three years. During this period industrial fisheries with bycatches of haddock have been either closed or operating at a much reduced level, and this may no longer be the case.

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Table 13.2.1.1. Haddock in Subarea IV and Division IIIa. Nominal landings (000 t) during 2001–2008, as officially reported to, and estimated by, ICES, along with WG estimates of catch components, and TACs. Landings estimates for 2008 are preliminary.

Sum of Landings		Year								
ICES area	Country	2001	2002	2003	2004	2005	2006	2007	2008	2009
Division IIIa	Belgium	0	0	0	0	0	0	0		
	Denmark	1590	3791	1741	1116	615	1001	1054	1053	
	Faeroe Islands	0	0	0	0	0	0	0		
	Germany	128	239	113	69	69	186	206	87	
	Netherlands	0	0	6	1	0	0	0		
	Norway	149	149	211	154	93	113	152	170	
	Portugal	0	0	0	0	0	30	37		
	Sweden	283	393	165	158	180	246	278	274	
	UK - Eng+Wales+N.Irl.	0	0	0	0	0	0	0		
	UK - Scotland	7	0	0	0	0	0	0		
Division IIIa Total		2157	4572	2236	1498	957	1576	1727	1584	
WG Division IIIa	WG estimates of discards	0	0	195	112	217	970	816	646	
	WG estimates of IBC	0	0	0	0	0	0	0	0	
	WG estimates of landings	1903	4137	1808	1443	764	1537	1515	1374	
	WG estimates of total catch	1903	4137	2003	1555	981	2507	2332	2020	
WG Division IIIa Total		3806	8273	4007	3110	1963	5014	4663	4041	
Subarea IV	Belgium	606	559	374	373	190	105	179	112	
	Denmark	2407	5123	3035	2075	1274	759	645	501	
	Faeroe Islands	1	25	12	22	22	4	0	3	
	France	485	914	1108	552	439	444	498	302	
	Germany	681	852	1562	1241	733	725	727	393	
	Greenland	0	0	149	686	18	5	0		
	Ireland	0	0	1	0	0	0	0		
	Netherlands	274	359	187	104	64	33	55	29	
	Norway	1902	2404	2196	2258	2089	1798	1706	1478	
	Poland	12	17	16	0	0	8	8	16	
	Portugal	0	0	0	0	0	76	0		
	Sweden	804	572	477	188	135	100	130	85	
	UK - Eng+Wales+N.Irl.	3334	3647	1561	1159	651	477	1799		
	UK - Scotland	29263	39624	31527	39339	25319	31905	24919		
	UK - all								27341	
Subarea IV Total		39769	54096	42205	47997	30934	36439	30666	30260	
WG Subarea IV	WG estimates of discards	118320	45892	23499	15439	8416	16943	27805	12532	
	WG estimates of IBC	7879	3717	1150	554	168	535	48	199	
	WG estimates of landings	38958	54171	40140	47253	47616	36074	29418	28893	
	WG estimates of total catch	167060	107917	66792	64800	57181	56058	59603	43644	
WG Subarea IV Total		332217	211697	131580	128046	113380	109610	116874	85268	
TAC	TAC IIIa	4000	6300	3150	4940	4018	3189	3360	2856	2590
	TAC IV	61000	104000	51735	77000	66000	51850	54640	46444	42110
TAC Total		65000	110300	54885	81940	70018	55039	58000	49300	44700

Table 13.2.1.2. Haddock in Subarea IV and Division IIIa. Working Group estimates of catch components by weight (000 tonnes).

Year	Subarea IV				Division IIIa(N)				Combined			
	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total
1963	68.4	189.3	13.7	271.4	0.4	-	-	0.4	68.8	189.3	13.7	271.8
1964	130.6	160.3	88.6	379.5	0.4	-	-	0.4	131.0	160.3	88.6	379.9
1965	161.7	62.3	74.6	298.6	0.7	-	-	0.7	162.4	62.3	74.6	299.3
1966	225.6	73.5	46.7	345.8	0.6	-	-	0.6	226.2	73.5	46.7	346.3
1967	147.4	78.2	20.7	246.3	0.4	-	-	0.4	147.7	78.2	20.7	246.7
1968	105.4	161.8	34.2	301.4	0.4	-	-	0.4	105.8	161.8	34.2	301.8
1969	331.1	260.1	338.4	929.5	0.5	-	-	0.5	331.6	260.1	338.4	930.0
1970	524.1	101.3	179.7	805.1	0.7	-	-	0.7	524.8	101.3	179.7	805.8
1971	235.5	177.8	31.5	444.8	2.0	-	-	2.0	237.5	177.8	31.5	446.8
1972	193.0	128.0	29.6	350.5	2.6	-	-	2.6	195.5	128.0	29.6	353.1
1973	178.7	114.7	11.3	304.7	2.9	-	-	2.9	181.6	114.7	11.3	307.6
1974	149.6	166.4	47.5	363.5	3.5	-	-	3.5	153.1	166.4	47.5	367.0
1975	146.6	260.4	41.5	448.4	4.8	-	-	4.8	151.3	260.4	41.5	453.2
1976	165.7	154.5	48.2	368.3	7.0	-	-	7.0	172.7	154.5	48.2	375.3
1977	137.3	44.4	35.0	216.7	7.8	-	-	7.8	145.1	44.4	35.0	224.5
1978	85.8	76.8	10.9	173.5	5.9	-	-	5.9	91.7	76.8	10.9	179.4
1979	83.1	41.7	16.2	141.0	4.0	-	-	4.0	87.1	41.7	16.2	145.0
1980	98.6	94.6	22.5	215.7	6.4	-	-	6.4	105.0	94.6	22.5	222.1
1981	129.6	60.1	17.0	206.7	6.6	-	-	6.6	136.1	60.1	17.0	213.2
1982	165.8	40.6	19.4	225.8	7.5	-	-	7.5	173.3	40.6	19.4	233.3
1983	159.3	66.0	12.9	238.2	6.0	-	-	6.0	165.3	66.0	12.9	244.2
1984	128.2	75.3	10.1	213.6	5.4	-	-	5.4	133.6	75.3	10.1	218.9
1985	158.6	85.2	6.0	249.8	5.6	-	-	5.6	164.1	85.2	6.0	255.4
1986	165.6	52.2	2.6	220.4	2.7	-	-	2.7	168.2	52.2	2.6	223.1
1987	108.0	59.1	4.4	171.6	2.3	-	-	2.3	110.3	59.1	4.4	173.9
1988	105.1	62.1	4.0	171.2	1.9	-	-	1.9	107.0	62.1	4.0	173.1
1989	76.2	25.7	2.4	104.2	2.3	-	-	2.3	78.4	25.7	2.4	106.5
1990	51.5	32.6	2.6	86.6	2.3	-	-	2.3	53.8	32.6	2.6	88.9
1991	44.7	40.2	5.4	90.2	3.1	-	-	3.1	47.7	40.2	5.4	93.3
1992	70.2	47.9	10.9	129.1	2.6	-	-	2.6	72.8	47.9	10.9	131.7
1993	79.6	79.6	10.8	169.9	2.6	-	-	2.6	82.2	79.6	10.8	172.5
1994	80.9	65.4	3.6	149.8	1.2	-	-	1.2	82.1	65.4	3.6	151.0
1995	75.3	57.4	7.7	140.4	2.2	-	-	2.2	77.5	57.4	7.7	142.6
1996	76.0	72.5	5.0	153.5	3.1	-	-	3.1	79.2	72.5	5.0	156.6
1997	79.1	52.1	6.7	137.9	3.4	-	-	3.4	82.5	52.1	6.7	141.3
1998	77.3	45.2	5.1	127.6	3.8	-	-	3.8	81.1	45.2	5.1	131.3
1999	64.2	42.6	3.8	110.7	1.4	-	-	1.4	65.6	42.6	3.8	112.0
2000	46.1	48.8	8.1	103.0	1.5	-	-	1.5	47.6	48.8	8.1	104.5
2001	39.0	118.3	7.9	165.2	1.9	-	-	1.9	40.9	118.3	7.9	167.1
2002	54.2	45.9	3.7	103.8	4.1	-	-	4.1	58.3	45.9	3.7	107.9
2003	40.1	23.5	1.1	64.8	1.8	0.2	-	2.0	41.9	23.7	1.1	66.8
2004	47.3	15.4	0.6	63.2	1.4	0.1	-	1.6	48.7	15.6	0.6	64.8
2005	47.6	8.4	0.2	56.2	0.8	0.2	-	1.0	48.4	8.6	0.2	57.2
2006	36.1	16.9	0.5	53.6	1.5	1.0	-	2.5	37.6	17.9	0.5	56.1
2007	29.4	27.8	0.0	57.3	1.5	0.8	-	2.3	30.9	28.6	0.0	59.6
2008	28.9	12.5	0.2	41.6	1.4	0.6	-	2.0	30.3	13.2	0.2	43.6
Min	28.9	8.4	0.0	41.6	0.4	0.1	-	0.4	30.3	8.6	0.0	43.6
Mean	118.1	81.0	27.3	226.3	2.9	0.5	-	2.9	121.0	81.1	27.3	229.3
Max	524.1	260.4	338.4	929.5	7.8	1.0	-	7.8	524.8	260.4	338.4	930.0

- denotes missing data.

Table 13.2.2.1. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**1359**	**1305780**	**334952**	**20958**	**13026**	**5780**	**502**	**653**	566	59	18	0	0	0	0	0	**643**
1964	**139777**	**7425**	**1295363**	**135110**	**9066**	**5348**	**2405**	**287**	236	231	25	0	0	0	0	0	**492**
1965	**649768**	**367500**	**15151**	**649052**	**29485**	**4659**	**1972**	**452**	107	90	41	0	0	0	0	0	**238**
1966	**1666973**	**1005922**	**25658**	**6423**	**412510**	**9978**	**1045**	**601**	165	90	23	2	0	0	0	0	**280**
1967	**305249**	**837155**	**89068**	**4863**	**3585**	**177851**	**2443**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**11105**	**1097030**	**439209**	**19592**	**1947**	**2528**	**45971**	**325**	40	13	5	0	0	0	0	0	**58**
1969	**72559**	**20469**	**3575922**	**303333**	**7594**	**2410**	**2515**	**19128**	200	24	7	0	0	0	0	0	**231**
1970	**924601**	**266151**	**218362**	**1908087**	**57430**	**1178**	**1196**	**256**	5954	67	11	19	0	0	0	0	**6051**
1971	**330673**	**1810248**	**70951**	**47518**	**400415**	**10371**	**462**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**240896**	**676001**	**586824**	**40591**	**21211**	**157994**	**3563**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**59872**	**364918**	**570428**	**240603**	**6192**	**4467**	**39459**	**1257**	108	29	109	49	5	0	0	0	**300**
1974	**601412**	**1214416**	**175587**	**331870**	**54206**	**1873**	**1348**	**10917**	242	23	32	4	5	0	0	0	**306**
1975	**44946**	**2097588**	**639003**	**58837**	**108892**	**15808**	**983**	**620**	2714	266	63	11	0	8	0	0	**3062**
1976	**167173**	**167693**	**1055191**	**210308**	**9950**	**31186**	**4995**	**206**	76	759	60	3	0	0	0	0	**898**
1977	**114954**	**250593**	**106012**	**390344**	**40051**	**4304**	**6261**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**285842**	**454920**	**146179**	**30321**	**113601**	**8704**	**1264**	**2075**	402	116	15	64	13	2	0	0	**612**
1979	**841439**	**345398**	**203196**	**41225**	**7402**	**28006**	**2235**	**262**	483	152	54	12	11	1	0	0	**713**
1980	**374959**	**660144**	**331838**	**72505**	**10392**	**1897**	**8061**	**598**	121	162	75	31	9	3	1	0	**402**
1981	**646419**	**134440**	**421348**	**142948**	**15205**	**2034**	**457**	**2498**	125	64	23	30	4	1	3	0	**250**
1982	**278705**	**275385**	**85474**	**299211**	**41382**	**3377**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**639814**	**156256**	**251703**	**73666**	**127173**	**16480**	**1708**	**297**	61	190	53	6	4	4	0	0	**318**
1984	**95502**	**432178**	**167411**	**122784**	**22067**	**32649**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**139579**	**178878**	**533698**	**78633**	**37430**	**5303**	**7354**	**965**	212	52	21	88	4	0	0	0	**377**
1986	**56503**	**160359**	**178798**	**323638**	**27682**	**9690**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**9419**	**277705**	**250003**	**47378**	**67865**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**10808**	**29420**	**484481**	**89071**	**13432**	**18579**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**10704**	**47271**	**35097**	**182331**	**18037**	**2631**	**4044**	**508**	199	83	30	13	6	2	2	1	**337**
1990	**55473**	**81336**	**101513**	**18674**	**56696**	**3731**	**878**	**1320**	206	78	41	11	11	1	4	2	**354**
1991	**123910**	**224136**	**78092**	**23167**	**3882**	**12525**	**976**	**401**	614	148	54	6	5	1	2	1	**831**
1992	**270758**	**194249**	**252884**	**32482**	**6550**	**1250**	**4861**	**454**	300	293	124	22	6	2	0	0	**747**
1993	**141209**	**345275**	**261834**	**108395**	**7105**	**1697**	**450**	**1138**	146	103	144	59	3	2	0	0	**457**
1994	**85966**	**96850**	**296528**	**100465**	**29608**	**1919**	**573**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**201260**	**296237**	**85826**	**167801**	**25875**	**7644**	**511**	**127**	45	62	19	8	6	2	1	0	**143**
1996	**148437**	**46689**	**357942**	**56894**	**55147**	**7503**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**28855**	**132262**	**85854**	**213293**	**15273**	**15407**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**22115**	**82770**	**166732**	**49550**	**107995**	**5741**	**3561**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**84408**	**80970**	**121249**	**87242**	**24740**	**39860**	**2338**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**6632**	**349063**	**88623**	**43352**	**26357**	**6026**	**8708**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**2531**	**85436**	**632880**	**32344**	**8886**	**4123**	**1561**	**1305**	195	64	17	3	1	0	0	0	**280**
2002	**50754**	**18400**	**66343**	**242196**	**6547**	**2039**	**1066**	**549**	458	265	15	8	5	0	0	0	**751**
2003	**9072**	**19548**	**14261**	**44747**	**109063**	**1969**	**602**	**271**	109	89	38	5	1	0	0	0	**243**
2004	**1030**	**10538**	**18122**	**6573**	**34945**	**91121**	**724**	**147**	56	35	35	10	1	0	0	0	**137**
2005	**4814**	**10505**	**18394**	**11385**	**3329**	**25077**	**58753**	**314**	89	34	10	7	4	1	0	0	**145**
2006	**2412**	**106506**	**26164**	**16813**	**7482**	**2970**	**13685**	**30229**	123	29	16	6	3	0	0	0	**177**
2007	**1788**	**18788**	**155749**	**13899**	**6463**	**2353**	**1426**	**5973**	6776	69	7	14	3	1	0	0	**6870**
2008	**1940**	**12595**	**29534**	**70919**	**4169**	**1440**	**648**	**311**	1247	2448	5	8	1	1	0	0	**3710**

Table 13.2.2.2. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	**653**	566	59	18	0	0	0	0	0	**643**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	**286**	236	231	25	0	0	0	0	0	**492**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	**446**	107	90	41	0	0	0	0	0	**238**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	**599**	165	90	23	2	0	0	0	0	**280**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	**324**	40	13	5	0	0	0	0	0	**58**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	**18876**	200	24	7	0	0	0	0	0	**231**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	**254**	5954	67	11	19	0	0	0	0	**6051**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	**1257**	108	29	109	49	5	0	0	0	**300**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	**10693**	242	23	32	4	5	0	0	0	**306**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	**620**	2709	266	63	11	0	8	0	0	**3057**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	**206**	76	759	60	3	0	0	0	0	**898**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	**2070**	402	116	15	64	13	2	0	0	**612**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	**262**	483	152	54	12	11	1	0	0	**713**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	**591**	121	161	75	31	9	3	1	0	**401**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	**2498**	125	64	23	30	4	1	3	0	**250**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	**297**	61	190	53	6	4	4	0	0	**318**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	**965**	212	52	21	88	4	0	0	0	**377**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	**498**	199	83	30	13	6	2	2	1	**336**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	**1242**	202	78	41	11	11	1	4	2	**350**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	**401**	614	148	54	6	5	1	2	1	**831**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	**454**	300	293	124	22	6	2	0	0	**747**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	**1119**	146	103	144	59	3	2	0	0	**457**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	**127**	45	62	19	8	6	2	1	0	**143**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	**1295**	191	64	17	3	1	0	0	0	**276**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	**419**	458	265	15	8	5	0	0	0	**751**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	**270**	109	89	38	5	1	0	0	0	**242**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	**139**	56	35	35	10	1	0	0	0	**137**
2005	**0**	**782**	**5490**	**8086**	**2926**	**21703**	**54742**	**313**	89	34	10	7	4	1	0	0	**145**
2006	**0**	**2062**	**9849**	**10267**	**6302**	**2705**	**12486**	**28158**	116	28	15	6	3	0	0	0	**168**
2007	**0**	**1111**	**28030**	**10083**	**5932**	**2290**	**1422**	**5918**	6705	69	7	14	3	1	0	0	**6799**
2008	**0**	**278**	**6176**	**48247**	**3915**	**1401**	**625**	**309**	1241	2444	5	8	1	1	0	0	**3700**

Table 13.2.2.3. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**42**	**1047925**	**193718**	**3476**	**708**	**51**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**2395**	**4182**	**623111**	**13597**	**262**	**21**	**10**	**0**	0	0	0	0	0	0	0	0	**0**
1965	**5307**	**110628**	**4020**	**130369**	**3641**	**4**	**1**	**0**	0	0	0	0	0	0	0	0	**0**
1966	**7880**	**444111**	**12388**	**1166**	**24114**	**35**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1967	**6250**	**389691**	**49635**	**863**	**216**	**1576**	**9**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**39**	**615649**	**219022**	**3006**	**94**	**15**	**186**	**0**	0	0	0	0	0	0	0	0	**0**
1969	**1732**	**5152**	**1158445**	**37686**	**420**	**16**	**8**	**0**	0	0	0	0	0	0	0	0	**0**
1970	**51717**	**92978**	**77992**	**289679**	**2640**	**13**	**4**	**0**	0	0	0	0	0	0	0	0	**0**
1971	**7586**	**1205838**	**35117**	**8960**	**24590**	**66**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**4231**	**424657**	**322547**	**6353**	**1212**	**1212**	**13**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**18540**	**241423**	**352310**	**46740**	**352**	**33**	**123**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**24758**	**915157**	**90904**	**57011**	**2814**	**6**	**4**	**0**	0	0	0	0	0	0	0	0	**0**
1975	**630**	**1478590**	**353422**	**15781**	**13388**	**143**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1976	**2191**	**98420**	**648662**	**38317**	**183**	**137**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**11812**	**95090**	**44918**	**73431**	**605**	**9**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1978	**5250**	**316339**	**80219**	**4207**	**12085**	**72**	**106**	**0**	0	0	0	0	0	0	0	0	**0**
1979	**1824**	**205555**	**75517**	**3232**	**34**	**84**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1980	**644**	**369727**	**168124**	**2346**	**39**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1981	**1509**	**33434**	**237524**	**25928**	**86**	**3**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1982	**3703**	**93865**	**31915**	**49462**	**1845**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	**151108**	**85338**	**128171**	**15966**	**7112**	**717**	**105**	**0**	0	0	0	0	0	0	0	0	**0**
1984	**2915**	**314421**	**80803**	**13430**	**327**	**240**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	**17501**	**165086**	**267747**	**6088**	**149**	**4**	**8**	**0**	0	0	0	0	0	0	0	0	**0**
1986	**23807**	**108204**	**114606**	**61612**	**31**	**12**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	**1166**	**188582**	**133010**	**9320**	**1506**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	**1528**	**24588**	**325259**	**9684**	**788**	**67**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	**1790**	**40211**	**16959**	**51491**	**814**	**20**	**42**	**0**	0	0	0	0	0	0	0	0	**1**
1990	**52477**	**68625**	**56359**	**3977**	**10190**	**235**	**77**	**0**	0	0	0	0	0	0	0	0	**0**
1991	**7001**	**182162**	**27942**	**725**	**27**	**145**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	**29056**	**110995**	**123961**	**3298**	**38**	**0**	**65**	**0**	0	0	0	0	0	0	0	0	**0**
1993	**16715**	**235123**	**170794**	**18375**	**48**	**3**	**0**	**1**	0	0	0	0	0	0	0	0	**0**
1994	**16059**	**82033**	**217538**	**29100**	**1862**	**53**	**48**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**3228**	**191807**	**54448**	**65250**	**1095**	**79**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**3968**	**35340**	**275597**	**16870**	**7872**	**2**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**7162**	**85588**	**50976**	**85664**	**1061**	**182**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**3132**	**72793**	**112075**	**10165**	**13766**	**71**	**18**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**14588**	**69196**	**90861**	**31119**	**1094**	**2064**	**180**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**2474**	**272894**	**36568**	**12614**	**2764**	**148**	**64**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**545**	**61878**	**529908**	**6100**	**1446**	**186**	**0**	**10**	4	0	0	0	0	0	0	0	**4**
2002	**946**	**3872**	**48189**	**127212**	**403**	**8**	**0**	**130**	0	0	0	0	0	0	0	0	**0**
2003	**4927**	**13533**	**11069**	**29537**	**34480**	**37**	**31**	**1**	0	0	0	0	0	0	0	0	**1**
2004	**1030**	**9467**	**14960**	**2388**	**12528**	**17177**	**5**	**3**	0	0	0	0	0	0	0	0	**0**
2005	**4814**	**9546**	**12807**	**3273**	**394**	**3369**	**3810**	**0**	0	0	0	0	0	0	0	0	**0**
2006	**2412**	**102672**	**15599**	**6304**	**1133**	**219**	**1125**	**1963**	6	1	1	0	0	0	0	0	**8**
2007	**1788**	**17650**	**127501**	**3810**	**530**	**63**	**4**	**55**	71	0	0	0	0	0	0	0	**71**
2008	**1928**	**12235**	**23078**	**22492**	**202**	**22**	**18**	**1**	6	4	0	0	0	0	0	0	**10**

Table 13.2.2.4. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**1317**	**230502**	**23050**	**791**	**105**	**85**	**3**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**137382**	**3195**	**421729**	**35144**	**638**	**638**	**112**	**1**	0	0	0	0	0	0	0	0	**0**
1965	**644461**	**254237**	**7686**	**183288**	**2365**	**592**	**118**	**6**	0	0	0	0	0	0	0	0	**0**
1966	**1659093**	**548835**	**6546**	**1007**	**15861**	**755**	**25**	**2**	0	0	0	0	0	0	0	0	**0**
1967	**298999**	**392510**	**5539**	**155**	**24**	**2264**	**12**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**11066**	**462938**	**81153**	**2029**	**46**	**19**	**738**	**1**	0	0	0	0	0	0	0	0	**0**
1969	**70826**	**15178**	**1703617**	**98650**	**632**	**380**	**126**	**252**	0	0	0	0	0	0	0	0	**0**
1970	**872884**	**170914**	**88509**	**485274**	**3967**	**153**	**61**	**2**	0	0	0	0	0	0	0	0	**0**
1971	**323088**	**570391**	**9972**	**3390**	**6381**	**299**	**6**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**236664**	**238566**	**57010**	**1023**	**146**	**439**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**41332**	**117470**	**12402**	**11**	**11**	**196**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**576654**	**275266**	**32266**	**46862**	**4600**	**82**	**112**	**224**	0	0	0	0	0	0	0	0	**0**
1975	**44317**	**594854**	**84620**	**4761**	**5203**	**141**	**5**	**0**	5	0	0	0	0	0	0	0	**5**
1976	**164982**	**66973**	**183064**	**29188**	**46**	**2946**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**103142**	**147019**	**29352**	**67628**	**2355**	**238**	**240**	**0**	0	0	0	0	0	0	0	0	**0**
1978	**280592**	**125698**	**11330**	**809**	**1480**	**64**	**6**	**5**	0	0	0	0	0	0	0	0	**0**
1979	**839615**	**125834**	**17671**	**1507**	**84**	**379**	**16**	**0**	0	0	0	0	0	0	0	0	**0**
1980	**374315**	**281436**	**21820**	**8258**	**1291**	**54**	**86**	**7**	0	1	0	0	0	0	0	0	**1**
1981	**644910**	**99247**	**30358**	**4613**	**440**	**6**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1982	**275002**	**174147**	**14740**	**13540**	**1810**	**464**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	**488707**	**63818**	**14331**	**5134**	**2242**	**3**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1984	**92587**	**98257**	**10644**	**4702**	**368**	**535**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	**122078**	**11672**	**17826**	**1739**	**547**	**223**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1986	**32696**	**40023**	**1831**	**802**	**103**	**7**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	**8253**	**82226**	**3797**	**295**	**138**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	**9280**	**3309**	**12819**	**2462**	**620**	**202**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	**8914**	**2541**	**1751**	**2789**	**460**	**37**	**86**	**10**	0	0	0	0	0	0	0	0	**0**
1990	**2996**	**7218**	**1986**	**359**	**1491**	**227**	**25**	**78**	4	0	0	0	0	0	0	0	**4**
1991	**116909**	**22493**	**3248**	**601**	**43**	**43**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	**241702**	**80402**	**10971**	**356**	**27**	**3**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1993	**124495**	**107664**	**13220**	**3214**	**82**	**9**	**0**	**18**	0	0	0	0	0	0	0	0	**0**
1994	**69907**	**14349**	**9534**	**1011**	**160**	**7**	**1**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**198032**	**102560**	**2201**	**888**	**65**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**144469**	**10608**	**7453**	**3338**	**107**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**21694**	**45264**	**10935**	**4451**	**184**	**17**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**18983**	**9155**	**16337**	**2649**	**1490**	**63**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**69820**	**10780**	**4531**	**2932**	**344**	**166**	**3**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**4158**	**71419**	**21740**	**2085**	**186**	**5**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**1987**	**22946**	**35776**	**10127**	**35**	**8**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2002	**49807**	**13889**	**4489**	**3638**	**504**	**27**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2003	**4145**	**5983**	**2101**	**1285**	**1524**	**12**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2004	**0**	**590**	**265**	**84**	**258**	**753**	**8**	**4**	0	0	0	0	0	0	0	0	**0**
2005	**0**	**176**	**97**	**26**	**9**	**5**	**201**	**1**	0	0	0	0	0	0	0	0	**0**
2006	**0**	**1772**	**716**	**241**	**47**	**46**	**74**	**108**	1	0	0	0	0	0	0	0	**1**
2007	**1**	**27**	**218**	**6**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2008	**12**	**82**	**280**	**180**	**52**	**18**	**4**	**1**	0	0	0	0	0	0	0	0	**0**

Table 13.2.3.1. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.012**	**0.123**	**0.253**	**0.473**	**0.695**	**0.807**	**1.004**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.011**	**0.118**	**0.239**	**0.403**	**0.664**	**0.814**	**0.909**	**1.382**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.010**	**0.069**	**0.226**	**0.366**	**0.648**	**0.845**	**1.193**	**1.173**	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.697**
1966	**0.010**	**0.088**	**0.247**	**0.367**	**0.533**	**0.949**	**1.266**	**1.525**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.011**	**0.115**	**0.281**	**0.461**	**0.594**	**0.639**	**1.057**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.010**	**0.126**	**0.253**	**0.510**	**0.731**	**0.857**	**0.837**	**1.606**	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**2.343**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	**1.094**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.180**
1970	**0.013**	**0.073**	**0.222**	**0.352**	**0.735**	**0.874**	**1.191**	**1.362**	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.462**
1971	**0.011**	**0.107**	**0.247**	**0.362**	**0.506**	**0.887**	**1.267**	**1.534**	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.349**
1972	**0.024**	**0.116**	**0.243**	**0.388**	**0.506**	**0.606**	**1.000**	**1.366**	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.741**
1973	**0.044**	**0.112**	**0.241**	**0.373**	**0.586**	**0.649**	**0.725**	**1.044**	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.732**
1974	**0.024**	**0.128**	**0.227**	**0.344**	**0.549**	**0.892**	**0.896**	**0.952**	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**1.724**
1975	**0.020**	**0.101**	**0.242**	**0.357**	**0.450**	**0.680**	**1.245**	**1.124**	1.093	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.183**
1976	**0.013**	**0.125**	**0.225**	**0.402**	**0.512**	**0.589**	**0.922**	**1.933**	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.425**
1977	**0.019**	**0.109**	**0.243**	**0.347**	**0.602**	**0.614**	**0.803**	**1.181**	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.900**
1978	**0.011**	**0.144**	**0.256**	**0.420**	**0.443**	**0.719**	**0.745**	**0.955**	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.652**
1979	**0.009**	**0.096**	**0.292**	**0.444**	**0.637**	**0.664**	**0.934**	**1.187**	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.377**
1980	**0.012**	**0.104**	**0.286**	**0.488**	**0.733**	**1.046**	**0.936**	**1.394**	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0.000	**1.758**
1981	**0.009**	**0.074**	**0.265**	**0.477**	**0.745**	**1.148**	**1.480**	**1.180**	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.686**
1982	**0.011**	**0.100**	**0.293**	**0.462**	**0.785**	**1.170**	**1.441**	**1.672**	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.520**
1983	**0.022**	**0.136**	**0.298**	**0.449**	**0.651**	**0.916**	**1.215**	**1.162**	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.554**
1984	**0.010**	**0.141**	**0.302**	**0.489**	**0.671**	**0.805**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.050**
1985	**0.013**	**0.149**	**0.280**	**0.481**	**0.668**	**0.858**	**1.049**	**1.459**	1.833	2.124	2.145	2.003	2.387	0.000	0.000	0.000	**1.936**
1986	**0.025**	**0.124**	**0.242**	**0.397**	**0.613**	**0.863**	**1.257**	**1.195**	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.916**
1987	**0.008**	**0.126**	**0.267**	**0.406**	**0.615**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.673**
1988	**0.024**	**0.166**	**0.217**	**0.418**	**0.590**	**0.748**	**1.284**	**1.424**	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.784**
1989	**0.027**	**0.198**	**0.304**	**0.372**	**0.606**	**0.811**	**0.982**	**1.364**	1.655	1.684	2.248	2.166	2.364	2.389	2.307	1.146	**1.755**
1990	**0.044**	**0.195**	**0.293**	**0.434**	**0.474**	**0.772**	**0.971**	**1.168**	1.530	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.857**
1991	**0.029**	**0.179**	**0.322**	**0.473**	**0.640**	**0.651**	**1.042**	**1.232**	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.584**
1992	**0.018**	**0.108**	**0.307**	**0.486**	**0.748**	**1.016**	**0.896**	**1.395**	1.537	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.784**
1993	**0.010**	**0.116**	**0.282**	**0.447**	**0.680**	**0.894**	**1.173**	**1.102**	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.753**
1994	**0.017**	**0.116**	**0.251**	**0.420**	**0.597**	**0.943**	**1.208**	**1.570**	1.469	1.620	2.418	2.108	2.849	2.403	0.000	0.000	**1.615**
1995	**0.013**	**0.102**	**0.301**	**0.366**	**0.597**	**0.768**	**1.118**	**1.444**	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.866**
1996	**0.019**	**0.128**	**0.248**	**0.399**	**0.490**	**0.795**	**0.879**	**0.855**	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0.000	**1.925**
1997	**0.021**	**0.134**	**0.286**	**0.362**	**0.591**	**0.621**	**0.921**	**0.974**	1.647	2.209	2.146	2.032	2.757	2.262	2.867	0.000	**1.893**
1998	**0.023**	**0.154**	**0.258**	**0.405**	**0.442**	**0.660**	**0.769**	**1.113**	1.200	1.834	2.340	2.150	1.115	2.423	2.085	2.509	**1.346**
1999	**0.023**	**0.168**	**0.244**	**0.365**	**0.480**	**0.499**	**0.691**	**0.785**	0.758	1.258	1.559	1.913	2.232	2.392	0.000	0.000	**0.836**
2000	**0.048**	**0.120**	**0.256**	**0.370**	**0.501**	**0.619**	**0.653**	**1.104**	1.100	1.757	1.963	2.323	2.385	2.315	0.000	0.000	**1.229**
2001	**0.021**	**0.110**	**0.217**	**0.315**	**0.472**	**0.706**	**0.762**	**0.975**	1.893	1.216	2.144	2.891	3.237	0.000	0.000	0.000	**1.769**
2002	**0.016**	**0.100**	**0.271**	**0.328**	**0.541**	**0.744**	**0.931**	**0.848**	1.426	1.942	2.346	1.840	2.349	0.000	0.000	0.000	**1.637**
2003	**0.030**	**0.097**	**0.214**	**0.330**	**0.406**	**0.682**	**0.791**	**1.158**	1.384	1.658	2.181	2.209	2.506	0.000	0.000	0.000	**1.631**
2004	**0.053**	**0.177**	**0.256**	**0.410**	**0.404**	**0.445**	**0.744**	**1.071**	1.372	1.741	1.777	2.355	2.172	0.000	0.000	0.000	**1.647**
2005	**0.055**	**0.200**	**0.295**	**0.387**	**0.522**	**0.484**	**0.521**	**0.882**	1.119	1.360	1.835	2.682	2.553	2.319	0.000	0.000	**1.348**
2006	**0.048**	**0.122**	**0.289**	**0.358**	**0.470**	**0.545**	**0.546**	**0.549**	0.996	1.584	2.129	2.513	1.823	0.000	0.000	0.000	**1.263**
2007	**0.039**	**0.163**	**0.228**	**0.423**	**0.499**	**0.624**	**0.717**	**0.716**	0.749	0.909	2.278	0.954	1.712	2.348	0.000	0.000	**0.753**
2008	**0.038**	**0.181**	**0.257**	**0.365**	**0.607**	**0.700**	**0.842**	**1.109**	0.947	0.877	1.680	1.969	0.914	0.224	0.000	0.000	**0.903**

Table 13.2.3.2. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.000**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.000**	**0.221**	**0.313**	**0.459**	**0.695**	**0.870**	**0.934**	**1.386**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.000**	**0.310**	**0.357**	**0.410**	**0.679**	**0.907**	**1.242**	**1.182**	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.697**
1966	**0.000**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	**1.529**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.000**	**0.260**	**0.404**	**0.510**	**0.614**	**0.645**	**1.063**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.000**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	**1.610**	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**2.343**
1969	**0.000**	**0.178**	**0.302**	**0.506**	**0.870**	**0.984**	**1.065**	**1.102**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.180**
1970	**0.000**	**0.242**	**0.310**	**0.403**	**0.786**	**0.949**	**1.235**	**1.370**	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.462**
1971	**0.000**	**0.256**	**0.335**	**0.399**	**0.524**	**0.905**	**1.281**	**1.534**	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.349**
1972	**0.000**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	**1.366**	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.741**
1973	**0.000**	**0.225**	**0.315**	**0.406**	**0.606**	**0.663**	**0.726**	**1.044**	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.732**
1974	**0.000**	**0.275**	**0.320**	**0.389**	**0.585**	**0.908**	**0.954**	**0.963**	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**1.724**
1975	**0.000**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	**1.124**	1.094	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.184**
1976	**0.000**	**0.250**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	**1.933**	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.425**
1977	**0.000**	**0.286**	**0.362**	**0.396**	**0.614**	**0.630**	**0.817**	**1.181**	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.900**
1978	**0.000**	**0.275**	**0.356**	**0.457**	**0.470**	**0.725**	**0.789**	**0.956**	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.652**
1979	**0.000**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	**1.187**	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.377**
1980	**0.000**	**0.299**	**0.367**	**0.526**	**0.750**	**1.056**	**0.934**	**1.392**	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0.000	**1.758**
1981	**0.000**	**0.339**	**0.385**	**0.525**	**0.754**	**1.149**	**1.481**	**1.180**	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.686**
1982	**0.000**	**0.300**	**0.364**	**0.507**	**0.818**	**1.237**	**1.441**	**1.672**	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.520**
1983	**0.000**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	**1.162**	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.554**
1984	**0.000**	**0.281**	**0.376**	**0.515**	**0.677**	**0.810**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.050**
1985	**0.000**	**0.277**	**0.359**	**0.502**	**0.671**	**0.871**	**1.051**	**1.459**	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.936**
1986	**0.000**	**0.276**	**0.351**	**0.433**	**0.613**	**0.863**	**1.257**	**1.195**	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.916**
1987	**0.000**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.673**
1988	**0.000**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	**1.424**	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.784**
1989	**0.000**	**0.310**	**0.388**	**0.415**	**0.617**	**0.810**	**0.982**	**1.361**	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	**1.752**
1990	**0.000**	**0.308**	**0.379**	**0.484**	**0.516**	**0.802**	**1.039**	**1.191**	1.543	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.868**
1991	**0.000**	**0.319**	**0.377**	**0.480**	**0.643**	**0.653**	**1.042**	**1.232**	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.584**
1992	**0.000**	**0.336**	**0.379**	**0.510**	**0.751**	**1.017**	**0.904**	**1.395**	1.538	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.784**
1993	**0.000**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	**1.111**	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.753**
1994	**0.000**	**0.288**	**0.390**	**0.482**	**0.617**	**0.962**	**1.296**	**1.570**	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.615**
1995	**0.000**	**0.323**	**0.403**	**0.425**	**0.608**	**0.772**	**1.118**	**1.444**	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.866**
1996	**0.000**	**0.351**	**0.364**	**0.475**	**0.523**	**0.795**	**0.879**	**0.855**	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0.000	**1.925**
1997	**0.000**	**0.388**	**0.416**	**0.417**	**0.614**	**0.624**	**0.921**	**0.974**	1.647	2.209	2.146	2.032	2.757	2.262	2.867	2.782	**1.893**
1998	**0.000**	**0.280**	**0.377**	**0.444**	**0.462**	**0.666**	**0.771**	**1.113**	1.200	1.834	2.340	2.150	1.115	2.423	2.085	2.509	**1.346**
1999	**0.000**	**0.291**	**0.349**	**0.423**	**0.489**	**0.511**	**0.729**	**0.785**	0.758	1.258	1.559	1.913	2.232	2.392	2.912	2.225	**0.836**
2000	**0.000**	**0.345**	**0.370**	**0.423**	**0.524**	**0.626**	**0.656**	**1.104**	1.100	1.757	1.963	2.323	2.385	2.315	3.595	1.843	**1.229**
2001	**0.000**	**0.433**	**0.355**	**0.447**	**0.505**	**0.723**	**0.762**	**0.980**	1.922	1.216	2.144	2.891	3.237	2.534	1.239	3.425	**1.787**
2002	**0.000**	**0.475**	**0.458**	**0.399**	**0.570**	**0.750**	**0.931**	**1.000**	1.426	1.942	2.346	1.840	2.349	2.762	0.000	0.000	**1.637**
2003	**0.000**	**0.311**	**0.438**	**0.476**	**0.443**	**0.687**	**0.798**	**1.159**	1.386	1.659	2.181	2.209	2.506	2.606	1.981	3.092	**1.633**
2004	**0.000**	**0.369**	**0.388**	**0.489**	**0.460**	**0.469**	**0.747**	**1.086**	1.372	1.741	1.777	2.355	2.172	0.000	0.000	0.000	**1.647**
2005	**0.000**	**0.400**	**0.401**	**0.429**	**0.551**	**0.512**	**0.533**	**0.883**	1.119	1.360	1.835	2.682	2.553	2.319	3.431	0.000	**1.348**
2006	**0.000**	**0.396**	**0.389**	**0.422**	**0.514**	**0.581**	**0.582**	**0.580**	1.051	1.663	2.236	2.641	1.926	3.022	2.901	2.709	**1.331**
2007	**0.000**	**0.383**	**0.386**	**0.473**	**0.515**	**0.631**	**0.718**	**0.719**	0.753	0.909	2.278	0.954	1.712	2.348	4.244	0.000	**0.757**
2008	**0.000**	**0.364**	**0.409**	**0.414**	**0.621**	**0.705**	**0.859**	**1.113**	0.949	0.877	1.695	1.969	0.914	0.224	3.792	3.024	**0.904**

Table 13.2.3.3. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.064**	**0.139**	**0.218**	**0.327**	**0.397**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.065**	**0.177**	**0.249**	**0.306**	**0.337**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1965	**0.064**	**0.131**	**0.200**	**0.341**	**0.613**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1966	**0.063**	**0.141**	**0.208**	**0.244**	**0.310**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1967	**0.064**	**0.171**	**0.209**	**0.274**	**0.306**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.063**	**0.186**	**0.212**	**0.256**	**0.318**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1969	**0.064**	**0.129**	**0.216**	**0.237**	**0.301**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1970	**0.063**	**0.129**	**0.210**	**0.238**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1971	**0.063**	**0.134**	**0.201**	**0.242**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.063**	**0.139**	**0.206**	**0.237**	**0.261**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.063**	**0.131**	**0.201**	**0.235**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.062**	**0.145**	**0.200**	**0.233**	**0.259**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1975	**0.050**	**0.123**	**0.200**	**0.257**	**0.275**	**0.348**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1976	**0.079**	**0.176**	**0.197**	**0.237**	**0.292**	**0.337**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.071**	**0.196**	**0.197**	**0.216**	**0.309**	**0.347**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1978	**0.037**	**0.180**	**0.199**	**0.222**	**0.224**	**0.265**	**0.284**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1979	**0.053**	**0.118**	**0.219**	**0.242**	**0.259**	**0.340**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1980	**0.051**	**0.149**	**0.231**	**0.274**	**0.324**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1981	**0.073**	**0.160**	**0.198**	**0.290**	**0.650**	**0.727**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1982	**0.072**	**0.197**	**0.248**	**0.271**	**0.264**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1983	**0.067**	**0.187**	**0.237**	**0.347**	**0.476**	**0.711**	**0.792**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1984	**0.046**	**0.162**	**0.245**	**0.317**	**0.300**	**0.314**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1985	**0.040**	**0.155**	**0.214**	**0.264**	**0.336**	**0.423**	**0.421**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1986	**0.045**	**0.138**	**0.184**	**0.245**	**0.408**	**0.329**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1987	**0.023**	**0.159**	**0.200**	**0.225**	**0.287**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1988	**0.063**	**0.172**	**0.170**	**0.238**	**0.254**	**0.360**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1989	**0.085**	**0.187**	**0.229**	**0.268**	**0.335**	**0.708**	**0.844**	**0.000**	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	**2.810**
1990	**0.046**	**0.196**	**0.229**	**0.249**	**0.266**	**0.290**	**0.333**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1991	**0.065**	**0.179**	**0.243**	**0.344**	**0.464**	**0.493**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1992	**0.043**	**0.137**	**0.246**	**0.286**	**0.347**	**0.000**	**0.415**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1993	**0.027**	**0.142**	**0.237**	**0.287**	**0.344**	**0.369**	**0.000**	**0.369**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1994	**0.044**	**0.126**	**0.211**	**0.269**	**0.306**	**0.304**	**0.270**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.064**	**0.131**	**0.251**	**0.275**	**0.363**	**0.384**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.046**	**0.138**	**0.219**	**0.279**	**0.297**	**0.358**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.063**	**0.161**	**0.254**	**0.286**	**0.321**	**0.385**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.041**	**0.162**	**0.231**	**0.293**	**0.315**	**0.391**	**0.428**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.049**	**0.183**	**0.217**	**0.273**	**0.307**	**0.304**	**0.250**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.030**	**0.129**	**0.246**	**0.281**	**0.319**	**0.355**	**0.287**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.045**	**0.116**	**0.205**	**0.307**	**0.308**	**0.364**	**0.000**	**0.411**	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.416**
2002	**0.042**	**0.166**	**0.226**	**0.268**	**0.352**	**0.378**	**0.000**	**0.357**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.046**	**0.125**	**0.222**	**0.265**	**0.332**	**0.536**	**0.654**	**0.951**	0.946	1.154	0.000	0.000	0.000	0.000	0.000	0.000	**1.015**
2004	**0.053**	**0.171**	**0.232**	**0.280**	**0.308**	**0.342**	**0.639**	**0.716**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2005	**0.055**	**0.185**	**0.251**	**0.283**	**0.313**	**0.305**	**0.345**	**0.621**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2006	**0.048**	**0.116**	**0.228**	**0.257**	**0.233**	**0.152**	**0.162**	**0.115**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2007	**0.039**	**0.149**	**0.193**	**0.292**	**0.315**	**0.370**	**0.427**	**0.342**	0.368	0.400	0.000	0.000	0.000	0.000	0.000	0.000	**0.368**
2008	**0.038**	**0.177**	**0.216**	**0.261**	**0.374**	**0.531**	**0.353**	**0.449**	0.463	0.596	0.321	0.000	0.000	0.000	0.000	0.000	**0.520**

Table 13.2.3.4. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1965	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1966	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1967	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1969	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1970	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1971	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.023**	**0.067**	**0.136**	**0.255**	**0.288**	**0.231**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.035**	**0.068**	**0.141**	**0.246**	**0.327**	**0.396**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.022**	**0.058**	**0.150**	**0.260**	**0.359**	**0.579**	**0.277**	**0.447**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1975	**0.020**	**0.039**	**0.173**	**0.275**	**0.267**	**0.413**	**0.585**	**0.000**	0.585	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.585**
1976	**0.012**	**0.046**	**0.181**	**0.304**	**0.473**	**0.360**	**0.725**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.013**	**0.042**	**0.184**	**0.307**	**0.490**	**0.352**	**0.442**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.317**
1978	**0.011**	**0.040**	**0.174**	**0.286**	**0.372**	**0.473**	**0.411**	**0.456**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.345**
1979	**0.009**	**0.039**	**0.177**	**0.285**	**0.384**	**0.461**	**0.735**	**1.234**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.333**
1980	**0.012**	**0.039**	**0.176**	**0.268**	**0.623**	**0.722**	**1.102**	**1.591**	0.000	1.796	0.000	0.000	0.000	0.000	0.000	0.000	**1.796**
1981	**0.009**	**0.040**	**0.176**	**0.371**	**0.467**	**0.858**	**1.200**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.346**
1982	**0.010**	**0.040**	**0.206**	**0.379**	**0.636**	**0.751**	**1.225**	**1.233**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1983	**0.008**	**0.047**	**0.173**	**0.428**	**0.584**	**1.006**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.318**
1984	**0.009**	**0.045**	**0.211**	**0.414**	**0.626**	**0.751**	**1.225**	**1.234**	1.315	1.319	1.400	1.400	0.000	0.000	0.000	0.000	**1.356**
1985	**0.009**	**0.043**	**0.186**	**0.371**	**0.550**	**0.563**	**0.565**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.319**
1986	**0.010**	**0.040**	**0.186**	**0.375**	**0.626**	**1.259**	**1.225**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.328**
1987	**0.006**	**0.038**	**0.258**	**0.442**	**0.908**	**1.171**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1988	**0.018**	**0.077**	**0.196**	**0.274**	**0.455**	**0.549**	**1.225**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.330**
1989	**0.015**	**0.165**	**0.251**	**0.347**	**0.670**	**0.923**	**1.065**	**1.492**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.329**
1990	**0.005**	**0.104**	**0.229**	**0.506**	**0.609**	**0.842**	**0.829**	**0.796**	0.956	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**0.956**
1991	**0.027**	**0.058**	**0.206**	**0.357**	**0.472**	**0.477**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1992	**0.015**	**0.059**	**0.217**	**0.422**	**0.552**	**0.615**	**0.548**	**1.234**	0.621	0.820	0.000	0.000	0.000	0.000	0.000	0.000	**0.659**
1993	**0.008**	**0.053**	**0.206**	**0.399**	**0.521**	**0.578**	**1.225**	**0.582**	1.315	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.315**
1994	**0.011**	**0.055**	**0.155**	**0.435**	**0.595**	**0.698**	**0.490**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.012**	**0.045**	**0.193**	**0.285**	**0.387**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.018**	**0.077**	**0.136**	**0.162**	**0.264**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.007**	**0.076**	**0.149**	**0.309**	**0.419**	**0.601**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.020**	**0.075**	**0.166**	**0.291**	**0.351**	**0.453**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.018**	**0.064**	**0.177**	**0.304**	**0.416**	**0.309**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.058**	**0.070**	**0.113**	**0.176**	**0.370**	**0.203**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.014**	**0.086**	**0.133**	**0.110**	**0.353**	**0.431**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2002	**0.016**	**0.064**	**0.178**	**0.283**	**0.374**	**0.431**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.012**	**0.031**	**0.056**	**0.231**	**0.326**	**0.339**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2004	**0.000**	**0.116**	**0.183**	**0.255**	**0.276**	**0.446**	**0.539**	**0.840**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2005	**0.000**	**0.107**	**0.187**	**0.239**	**0.268**	**0.287**	**0.598**	**0.619**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2006	**0.000**	**0.127**	**0.232**	**0.273**	**0.273**	**0.280**	**0.283**	**0.286**	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.287**
2007	**0.035**	**0.141**	**0.192**	**0.290**	**0.315**	**0.370**	**0.427**	**0.342**	0.368	0.400	0.000	0.000	0.000	0.000	0.000	0.000	**0.368**
2008	**0.042**	**0.146**	**0.291**	**0.388**	**0.454**	**0.526**	**0.414**	**0.406**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

EngGFS Q3 GRT. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7
1977	100	**53.48**	**6.681**	**3.206**	**6.163**	**0.925**	**0.073**	**0.091**	0.013
1978	100	**35.827**	**13.688**	**2.618**	**0.239**	**2.22**	**0.214**	**0.005**	0.074
1979	100	**87.551**	**29.555**	**5.461**	**0.872**	**0.108**	**0.438**	**0.035**	0.005
1980	100	**37.403**	**62.331**	**16.732**	**2.57**	**0.273**	**0.042**	**0.142**	0.022
1981	100	**153.746**	**17.318**	**43.91**	**7.557**	**0.742**	**0.064**	**0.003**	0.061
1982	100	**28.134**	**31.546**	**7.98**	**11.8**	**1.025**	**0.237**	**0.098**	0.015
1983	100	**83.193**	**21.82**	**10.952**	**2.143**	**2.174**	**0.265**	**0.04**	0.013
1984	100	**22.847**	**59.933**	**6.159**	**3.078**	**0.418**	**0.478**	**0.103**	0.013
1985	100	**24.587**	**18.656**	**23.819**	**2.111**	**0.698**	**0.196**	**0.128**	0.041
1986	100	**26.6**	**14.974**	**4.472**	**3.382**	**0.277**	**0.175**	**0.038**	0.036
1987	100	**2.241**	**28.194**	**4.31**	**0.532**	**0.686**	**0.048**	**0.033**	0.003
1988	100	**6.073**	**2.856**	**18.352**	**1.549**	**0.16**	**0.279**	**0.041**	0.012
1989	100	**9.428**	**8.168**	**1.447**	**3.968**	**0.253**	**0.031**	**0.061**	0.014
1990	100	**28.188**	**6.645**	**1.983**	**0.287**	**0.878**	**0.048**	**0.026**	0.012
1991	100	**26.333**	**11.505**	**0.961**	**0.231**	**0.048**	**0.219**	**0.005**	0.007

EngGFS Q3 GOV. Period: 0.5 - 0.75.

	Effort	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1992	100	**246.059**	**58.746**	**29.133**	**1.742**	**0.146**	**0.037**	**0.251**	0.010	0.135	0.000	0.016	0.000	0.000	0.000	0.000
1993	100	**40.336**	**73.145**	**17.435**	**4.951**	**0.176**	**0.048**	**0.000**	0.026	0.003	0.000	0.000	0.000	0.000	0.000	0.000
1994	100	**279.344**	**23.990**	**26.992**	**2.511**	**0.894**	**0.058**	**0.003**	0.003	0.000	0.003	0.000	0.000	0.000	0.000	0.000
1995	100	**53.435**	**113.775**	**13.223**	**11.032**	**0.827**	**0.275**	**0.021**	0.000	0.000	0.008	0.000	0.000	0.000	0.003	0.000
1996	100	**61.301**	**26.747**	**43.044**	**3.603**	**2.052**	**0.207**	**0.088**	0.006	0.000	0.003	0.000	0.000	0.000	0.000	0.000
1997	100	**40.653**	**45.346**	**12.608**	**19.968**	**0.719**	**0.718**	**0.067**	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	100	**15.747**	**26.497**	**16.778**	**4.079**	**4.141**	**0.226**	**0.141**	0.009	0.021	0.000	0.000	0.000	0.000	0.000	0.000
1999	100	**626.610**	**16.551**	**8.404**	**3.663**	**1.258**	**1.201**	**0.040**	0.036	0.011	0.000	0.000	0.000	0.000	0.000	0.000
2000	100	**92.139**	**249.813**	**4.528**	**1.634**	**0.740**	**0.336**	**0.350**	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000
2001	100	**1.097**	**28.622**	**96.498**	**3.039**	**0.828**	**0.350**	**0.135**	0.058	0.177	0.003	0.000	0.000	0.000	0.000	0.000
2002	100	**2.721**	**3.954**	**22.559**	**60.583**	**0.542**	**0.097**	**0.153**	0.096	0.034	0.007	0.000	0.000	0.000	0.000	0.000
2003	100	**3.199**	**6.015**	**1.247**	**13.967**	**45.079**	**0.719**	**0.026**	0.221	0.082	0.014	0.000	0.000	0.000	0.000	0.003
2004	100	**3.398**	**6.599**	**3.864**	**0.448**	**6.836**	**17.406**	**0.217**	0.093	0.089	0.083	0.082	0.000	0.000	0.000	0.000
2005	100	**122.383**	**9.740**	**5.992**	**2.584**	**1.249**	**6.617**	**3.654**	0.021	0.007	0.000	0.000	0.000	0.000	0.000	0.000
2006	100	**12.838**	**54.403**	**3.226**	**1.137**	**0.426**	**0.148**	**0.861**	1.547	0.027	0.011	0.003	0.000	0.000	0.000	0.000
2007	100	**8.463**	**10.628**	**43.401**	**1.402**	**0.624**	**0.092**	**0.078**	0.315	0.559	0.046	0.015	0.000	0.000	0.000	0.000
2008	100	**2.613**	**6.494**	**5.801**	**18.534**	**0.727**	**0.266**	**0.137**	0.024	0.099	0.183	0.000	0.000	0.000	0.000	0.000

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoGFS Aberdeen Q3. Period: 0.5 - 0.75.

	Effort	0	1	2	3	4	5	6	7
1982	100	**1235**	**2488**	**996**	**1336**	**115**	**7**	**2**	1
1983	100	**2203**	**1813**	**1611**	**372**	**455**	**53**	**12**	1
1984	100	**873**	**4367**	**788**	**336**	**55**	**65**	**9**	5
1985	100	**818**	**1976**	**2981**	**232**	**103**	**14**	**22**	4
1986	100	**1747**	**2329**	**574**	**598**	**36**	**27**	**4**	3
1987	100	**277**	**2393**	**704**	**106**	**128**	**8**	**5**	1
1988	100	**406**	**467**	**1982**	**170**	**27**	**23**	**2**	1
1989	100	**432**	**886**	**214**	**574**	**31**	**4**	**7**	1
1990	100	**3163**	**1002**	**240**	**32**	**103**	**7**	**1**	3
1991	100	**3471**	**1705**	**178**	**21**	**5**	**16**	**2**	0
1992	100	**8270**	**3832**	**963**	**48**	**8**	**3**	**8**	0
1993	100	**859**	**5836**	**1380**	**269**	**6**	**4**	**1**	3
1994	100	**13762**	**1265**	**2080**	**210**	**53**	**2**	**0**	0
1995	100	**1566**	**8153**	**734**	**926**	**74**	**28**	**2**	0
1996	100	**1980**	**2231**	**4705**	**231**	**206**	**22**	**6**	0
1997	100	**972**	**2779**	**849**	**1397**	**66**	**56**	**6**	0

ScoGFS Q3 GOV. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7	8
1998	100	**3280**	**6349**	**1924**	**490**	**511**	**24**	**18**	2	1
1999	100	**66067**	**1907**	**1141**	**688**	**197**	**164**	**6**	7	1
2000	100	**11902**	**30611**	**460**	**221**	**130**	**73**	**27**	4	3
2001	100	**79**	**3790**	**11352**	**179**	**65**	**40**	**18**	14	1
2002	100	**2149**	**675**	**2632**	**6931**	**70**	**37**	**18**	3	3
2003	100	**2159**	**1172**	**307**	**2092**	**4344**	**22**	**17**	8	2
2004	100	**1729**	**1198**	**547**	**101**	**819**	**1420**	**9**	1	1
2005	100	**19708**	**761**	**657**	**153**	**112**	**347**	**483**	4	3
2006	100	**2280**	**7275**	**272**	**158**	**33**	**14**	**73**	227	2
2007	100	**1119**	**1810**	**5527**	**117**	**57**	**11**	**5**	38	36
2008	100	**1885**	**733**	**1002**	**2424**	**28**	**24**	**6**	2	8

IBTS Q1. Period 0.0 - 0.25

	Effort	1	2	3	4	5	6
1983	100	**302.278**	**403.079**	**89.463**	**116.447**	**13.182**	2.046
1984	100	**1072.285**	**221.275**	**127.77**	**20.41**	**20.9**	4.608
1985	100	**230.968**	**833.257**	**107.598**	**32.317**	**3.575**	6.567
1986	100	**573.023**	**266.912**	**303.546**	**17.888**	**6.49**	2.15
1987	100	**912.559**	**328.062**	**45.201**	**58.262**	**4.345**	2.434
1988	100	**101.691**	**677.641**	**97.149**	**12.684**	**13.965**	2.072
1989	100	**219.705**	**98.091**	**274.788**	**16.653**	**2.113**	4.697
1990	100	**217.448**	**139.114**	**32.997**	**50.367**	**3.163**	1.801
1991	100	**680.231**	**134.076**	**25.032**	**4.26**	**8.476**	2.43
1992	100	**1141.396**	**331.044**	**17.035**	**3.026**	**0.664**	2.202
1993	100	**1242.121**	**519.521**	**152.384**	**8.848**	**1.076**	0.953
1994	100	**227.919**	**491.051**	**97.656**	**23.308**	**1.566**	0.788
1995	100	**1355.485**	**201.069**	**176.165**	**24.354**	**5.286**	0.816
1996	100	**267.411**	**813.268**	**65.869**	**46.691**	**7.734**	3.061
1997	100	**849.943**	**353.882**	**466.731**	**24.987**	**15.238**	3.429
1998	100	**357.597**	**420.926**	**103.531**	**112.632**	**8.758**	5.412
1999	100	**211.139**	**222.907**	**127.064**	**48.217**	**36.65**	4.35
2000	100	**3734.185**	**107.06**	**48.638**	**24.549**	**15.589**	10.052
2001	100	**894.651**	**2255.213**	**47.899**	**10.962**	**7.218**	5.76
2002	100	**58.211**	**492.299**	**1387.877**	**10.01**	**7.457**	4.344
2003	100	**89.958**	**38.585**	**251.271**	**524.144**	**4.275**	2.364
2004	100	**71.875**	**79.622**	**35.473**	**173.589**	**330.011**	1.065
2005	100	**69.976**	**60.993**	**32.625**	**10.997**	**61.287**	95.689
2006	100	**1212.163**	**47.784**	**28.576**	**8.977**	**4.404**	53.175
2007	100	**109.096**	**963.325**	**36.609**	**15.483**	**3.374**	21.385
2008	100	**60.115**	**106.489**	**239.315**	**14.783**	**1.554**	6.332
2009	100	**74.75**	**139.871**	**102.968**	**135.748**	**2.523**	2.26

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoLTR_IV. Period: 0 - 1

	Effort	1	2	3	4	5	6	7	8	9	10	11	12	13+
1978	236929	45733	11471	2914	12279	774	110	167	24	4	0	5	1	0
1979	287494	44562	23135	4109	714	3644	203	20	57	20	0	0	1	0
1980	333197	92519	46282	8062	755	197	1015	61	18	8	5	0	0	0
1981	251504	7979	58146	13653	1518	161	20	320	12	6	7	6	0	0
1982	250870	24575	10170	33463	3937	133	67	7	58	0	0	2	0	0
1983	244349	19635	48680	6955	11807	1258	124	27	4	25	7	0	0	2
1984	240725	56769	22191	13375	2074	3392	402	98	15	7	14	1	0	0
1985	268136	38850	57422	4913	2787	414	872	128	27	2	0	18	0	0
1986	279767	26322	26549	32339	2797	1014	124	307	43	37	2	2	2	3
1987	351128	26220	33648	6464	7197	496	377	72	119	27	2	4	3	4
1988	391988	2931	57589	14075	2367	2924	167	84	28	21	6	0	0	0
1989	405883	10415	2919	24895	2754	541	627	109	30	21	7	4	1	1
1990	441084	11886	19205	2665	10237	669	168	264	45	14	5	2	1	0
1991	408056	44141	12394	3356	564	2213	226	80	146	38	16	2	1	0
1992	473955	20443	31073	3889	757	144	766	98	52	58	17	3	1	0
1993	447064	39863	39176	20213	1527	362	84	274	29	27	26	8	2	1
1994	480400	8267	49047	23557	6304	474	128	42	64	13	7	7	2	2
1995	442010	22874	13762	32063	5821	1658	97	15	13	17	3	2	1	1
1996	445995	14281	72692	9860	13959	2041	955	304	10	14	7	1	2	1
1997	479449	15907	13451	49548	3537	4511	553	163	13	2	2	1	1	1
1998	427868	27498	33166	9597	29614	1666	1228	173	46	4	1	1	0	1
1999	329750	24475	36849	24426	5531	11752	841	579	94	9	2	0	0	0
2000	280938	64710	15038	11707	7061	1300	2593	174	83	8	2	1	0	0
2001	245489	15567	173376	6323	2897	1253	365	444	62	17	9	0	0	0
2002	184096	982	11514	53313	1738	664	395	165	218	94	5	4	2	0
2003	98723	2804	3186	10931	30249	601	235	123	56	35	15	2	1	0
2004	63953	1114	3797	1602	6436	18851	243	68	26	17	11	3	0	0
2005	54905	1571	4512	2971	760	5634	11540	42	30	11	2	2	1	0
2006	51816	154	1583	2445	1042	492	2412	5486	32	10	7	2	3	0
2007	50035	13	4240	1359	1104	385	225	697	1062	3	1	0	0	0
2008	56311	7	537	8424	764	289	121	59	206	341	3	1	0	0

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoSEI_IV. Period: 0 - 1

	Effort	1	2	3	4	5	6	7	8	9	10	11	12	13+
1978	325246	160843	69033	14340	44152	2366	482	673	86	29	3	16	6	0
1979	316419	83631	78815	17215	3040	8073	648	70	113	24	4	1	1	0
1980	297227	131314	128306	26205	3393	501	2415	123	20	56	23	13	1	1
1981	289672	10367	134260	55726	5181	702	102	579	15	22	1	10	2	0
1982	297730	31143	30969	118898	14297	682	145	39	230	1	9	1	0	0
1983	333168	29021	77289	30414	50115	6394	583	119	15	69	26	1	2	0
1984	388085	120868	63391	49286	9426	14977	1594	254	18	8	38	3	2	0
1985	382910	29239	164839	33203	15993	2293	2846	308	47	19	9	28	2	0
1986	425017	33999	72604	155836	12895	4169	490	620	58	11	20	15	11	3
1987	418734	43646	97731	19731	28883	1989	1174	199	285	31	16	15	12	7
1988	377132	11576	201533	37421	4736	7415	718	290	80	70	27	6	6	7
1989	355735	19004	19274	91070	8389	1091	1611	223	89	40	13	6	4	1
1990	300076	35844	46489	9055	26705	1434	302	408	67	29	5	3	0	0
1991	336675	66144	30755	9531	1485	5028	308	122	183	42	11	1	1	0
1992	300217	30384	64733	8588	1512	290	1180	79	57	53	18	4	0	1
1993	268413	74523	88375	34997	2349	446	100	314	29	15	14	3	0	1
1994	264738	26626	125357	34127	10522	415	138	42	95	9	7	7	2	1
1995	204545	67772	32301	70290	8734	2181	117	39	13	9	4	2	3	1
1996	177092	9192	123829	18532	17077	2161	707	84	12	8	11	3	2	1
1997	166817	30046	19165	59309	3918	4083	495	195	10	7	2	0	0	2
1998	150361	12692	36813	12003	26564	1659	856	69	22	4	2	2	0	0
1999	93796	23253	35102	21991	6628	11164	690	456	56	12	0	1	0	0
2000	69505	46422	13650	8497	5610	1761	2357	110	41	4	1	0	0	0
2001	36135	3973	91165	4469	1720	799	273	263	27	18	1	1	0	0
2002	21817	708	10089	45219	1177	400	169	61	45	15	1	1	0	0
2003	15374	395	1312	8571	23778	346	80	32	11	4	5	2	0	0
2004	15674	3711	6459	868	9719	24783	125	19	4	4	3	1	0	0
2005	16149	1841	3189	3210	491	5839	14660	26	2	6	1	1	0	0
2006	13539	206	1348	2163	1119	433	2336	6209	20	1	0	0	0	0
2007	20241	45	4796	1765	1281	468	136	878	977	9	1	1	0	0
2008	11838	7	1051	10501	561	210	69	19	182	201	0	0	0	0

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

FLR XSA Diagnostics 2009-05-03 23:11:25

CPUE data from x.idx

Catch data for 46 years. 1963 to 2008. Ages 0 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	EngGFS Q3 GRT	0	6	1977	1991	0.5	0.75
2	EngGFS Q3 GOV	0	6	1992	2008	0.5	0.75
3	ScoGFS Aberdeen Q3	0	6	1982	1997	0.5	0.75
4	ScoGFS Q3 GOV	0	6	1998	2008	0.5	0.75
5	IBTS Q1 (backshifted)	0	4	1982	2008	0.99	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 0

Catchability independent of age for ages > 6

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 = 2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.002	0.001	0.002	0.038	0.007	0.001	0.000	0.001	0.001	0.001
1	0.156	0.047	0.059	0.123	0.101	0.050	0.051	0.050	0.047	0.050
2	0.757	0.727	0.277	0.141	0.331	0.321	0.284	0.454	0.235	0.239
3	0.838	0.822	0.776	0.185	0.152	0.288	0.399	0.536	0.549	0.183
4	0.511	0.712	0.409	0.364	0.125	0.180	0.244	0.533	0.431	0.331
5	0.677	0.227	0.227	0.157	0.181	0.151	0.195	0.370	0.325	0.163
6	0.404	0.299	0.084	0.084	0.063	0.093	0.137	0.155	0.305	0.138
7	0.145	0.157	0.066	0.038	0.028	0.020	0.053	0.097	0.093	0.100
8	0.145	0.157	0.066	0.038	0.028	0.020	0.053	0.097	0.093	0.100

XSA population number (thousands)

year \ age	0	1	2	3	4	5	6	7	8
1999	135516779	1275645	278849	174157	70082	89520	7780	13046	3201
2000	26511570	17415454	209504	87648	58643	32747	37226	4255	2133
2001	2835366	3410585	3191665	67876	30003	22411	21358	22599	4831
2002	3750722	364102	617562	1621278	24319	15524	14618	16074	21957
2003	3891493	464639	61862	359647	1048915	13161	10865	11004	9837
2004	3731671	497716	80667	29791	240604	720648	8994	8351	7789
2005	38595613	480027	90968	39236	17401	156544	507568	6709	3088
2006	7205011	4966875	87585	45918	20510	10614	105477	362399	2118
2007	4572803	926671	907213	37289	20924	9370	6003	73975	84811
2008	3735922	588038	169734	480606	16775	10592	5542	3624	43117

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Estimated population abundance at 1st Jan 2009

year \ age	0	1	2	3	4	5	6	7	8
2009	8906	480257	107415	89598	311723	9386	7370	3952	2686

Fleet: EngGFS Q3 GRT

Log catchability residuals.

age \ year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.379	-0.271	-0.123	0.575	0.989	0.130	-0.093	0.117	-0.112	-0.676	-0.379
1	-0.502	-0.242	-0.007	0.157	0.434	0.295	0.360	0.159	0.392	-0.207	-0.319
2	0.225	-0.305	-0.109	0.312	0.544	0.381	0.104	-0.036	0.060	0.076	-0.444
3	-0.243	-0.813	0.124	0.561	0.818	0.364	0.304	0.169	0.231	-0.408	-0.510
4	0.363	0.177	-0.136	0.378	0.490	0.034	0.002	0.030	0.089	-0.211	-0.468
5	0.227	0.186	-0.084	0.284	0.036	0.168	-0.082	-0.178	0.466	0.047	-0.480
6	0.257	-0.659	-0.420	0.206	-1.014	1.528	-0.722	0.254	-0.225	-0.074	-0.199

age \ year	1988	1989	1990	1991
0	-0.244	0.053	-0.163	-0.183
1	-0.120	0.214	0.024	-0.637
2	0.176	0.054	-0.076	-0.961
3	0.173	0.031	-0.124	-0.678
4	-0.151	0.009	-0.046	-0.560
5	0.129	-0.377	-0.192	-0.147
6	0.963	0.142	0.962	-0.999

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-15.5122	-15.0316	-15.2082	-15.3519	-15.5353	-15.9771
S.E_Logq	0.3307	0.3661	0.4596	0.2899	0.2547	0.7385

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8580509	16.9644

Fleet: EngGFS Q3 GOV

Log catchability residuals.

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.121	0.153	-0.013	0.204	0.006	0.166	-0.039	-0.250	0.027	-0.275
1	0.242	0.059	0.106	0.157	0.079	0.224	0.193	-0.005	0.028	-0.501
2	0.468	0.017	-0.092	0.314	-0.062	0.043	0.082	0.010	-0.342	-0.285
3	0.391	0.077	-0.503	0.216	0.210	0.181	-0.150	-0.213	-0.344	0.504
4	-0.231	-0.349	-0.115	-0.114	-0.101	-0.130	-0.152	-0.257	-0.484	0.110
5	0.072	0.325	-0.057	0.118	-0.075	0.121	-0.090	-0.048	-0.596	-0.176
6	1.296	NA	-0.505	0.242	0.453	0.139	-0.338	-0.547	-0.008	-0.539

age \ year	2002	2003	2004	2005	2006	2007	2008
0	-0.095	-0.063	-0.016	-0.096	0.083	0.205	-0.116
1	-0.204	-0.041	-0.049	0.378	-0.240	-0.195	-0.231
2	-0.181	-0.657	0.202	0.498	0.022	0.148	-0.186
3	-0.044	-0.026	-0.891	0.655	-0.238	0.188	-0.014
4	-0.132	0.377	-0.003	0.964	-0.097	0.201	0.513
5	-1.136	1.048	0.213	0.800	-0.200	-0.579	0.259
6	-0.035	-1.524	0.806	-0.376	-0.240	0.319	0.858

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-14.7323	-14.3047	-14.4841	-14.8024	-15.2301	-15.8602
S.E_Logq	0.2208	0.2902	0.3786	0.3504	0.5036	0.6797

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.6155408	16.40579

Fleet: ScoGFS Aberdeen Q3

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.135	-0.732	-0.252	-0.586	-0.646	0.113	-0.205	-0.186	0.270	0.370
1	-0.216	-0.099	-0.432	0.175	-0.039	-0.757	0.098	0.021	0.161	-0.518
2	0.291	0.179	-0.100	-0.027	0.014	-0.265	-0.059	0.134	-0.197	-0.656
3	0.237	0.605	0.006	0.075	-0.088	-0.071	0.016	0.150	-0.265	-1.023
4	0.029	0.620	0.185	0.358	-0.069	0.036	0.252	0.092	-0.006	-0.639
5	-1.088	0.575	0.093	0.093	0.444	-0.005	-0.100	-0.158	0.149	-0.497
6	-0.276	0.162	-0.095	0.102	-0.237	0.002	0.032	0.066	-0.208	0.173

age \ year	1992	1993	1994	1995	1996	1997
0	0.654	-0.027	0.776	0.344	0.166	0.076
1	0.321	0.339	-0.028	0.330	0.404	0.240
2	-0.223	0.199	0.063	0.141	0.442	0.063
3	-0.425	-0.059	-0.208	0.515	0.239	0.298
4	-0.403	-0.995	-0.209	0.205	0.332	0.214
5	0.131	0.412	-0.852	0.405	0.255	0.142
6	0.055	0.224	NA	0.096	-0.028	-0.068

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-10.6331	-10.1152	-10.3524	-10.6267	-10.8942	-11.1578
S.E_Logq	0.3366	0.2584	0.3847	0.4025	0.4616	0.1521

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8634553	13.39096

Fleet: ScoGFS Q3 GOV

Log catchability residuals.

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-0.029	-0.159	0.030	-1.488	0.501	0.461	0.344	0.059	-0.008	-0.112
1	0.782	-0.147	-0.053	-0.504	0.047	0.341	0.263	-0.154	-0.233	0.053
2	0.033	0.130	-0.512	-0.308	-0.212	0.058	0.364	0.404	-0.334	0.204
3	-0.081	0.303	-0.156	-0.140	-0.024	0.263	-0.192	0.017	-0.023	-0.107
4	-0.034	0.100	-0.013	-0.224	0.032	0.248	0.086	0.763	-0.444	0.019
5	-0.039	0.254	0.171	-0.051	0.194	-0.146	0.000	0.145	-0.265	-0.409
6	-0.009	-0.056	-0.182	-0.166	0.213	0.440	0.011	-0.012	-0.319	-0.040

age \ year	2008
0	0.401
1	-0.395
2	0.174
3	0.140
4	-0.533
5	0.147
6	0.118

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	1	2	3	4	5	6
Mean_Logq	-9.8428	-9.5136	-9.7646	-10.1054	-10.6156	-11.3407
S.E_Logq	0.3627	0.3004	0.1676	0.3456	0.2092	0.2050

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.816643	12.18883

Fleet: IBTS Q1 (backshifted)

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-0.351	-0.380	-0.435	0.028	-0.250	0.169	0.176	0.139	0.007	0.478	0.166
1	-0.154	-0.328	-0.224	0.069	-0.134	-0.162	0.405	0.027	0.036	-0.283	0.190
2	-0.046	-0.195	0.075	-0.165	-0.225	0.012	0.176	0.426	-0.123	-0.795	0.121
3	0.015	-0.012	-0.045	-0.199	-0.026	0.136	0.110	0.008	0.073	-0.647	0.235
4	0.127	-0.098	-0.210	-0.045	0.293	0.201	0.138	0.242	-0.125	-0.367	-0.031

age \ year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-0.189	-0.040	-0.132	0.461	0.194	-0.019	0.003	0.296	0.046	0.187
1	-0.258	0.004	-0.121	0.402	0.214	0.087	-0.361	-0.036	0.084	-0.162
2	-0.237	-0.287	-0.172	0.209	0.022	0.050	-0.224	0.016	0.212	0.009
3	-0.205	-0.055	-0.238	0.258	-0.076	0.296	-0.203	-0.339	-0.219	-0.022
4	-0.029	-0.194	0.250	-0.005	0.400	0.099	0.251	-0.141	0.261	-0.130

age \ year	2003	2004	2005	2006	2007	2008
0	-0.063	-0.052	0.207	-0.282	-0.367	0.003
1	0.298	-0.089	-0.295	0.371	-0.155	0.575
2	0.541	0.182	-0.107	0.348	-0.330	0.506
3	0.345	0.212	-0.156	0.369	0.543	-0.160
4	0.214	0.057	0.115	-0.028	-0.926	-0.319

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

	1	2	3	4
Mean_Logq	-11.8323	-11.8835	-12.1866	-12.5100
S.E_Logq	0.2519	0.2864	0.2529	0.2694

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.9182171	13.52970

Terminal year survivor and F summaries:

Age 0 Year class = 2008

source	survivors	N	scaledWts
EngGFS Q3 GOV	397672	1	0.444
ScoGFS Q3 GOV	785124	1	0.073
IBTS Q1 (backshifted)	481796	1	0.444
fshk	303687	1	0.010
nshk	2753479	1	0.029

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Age 1 Year class = 2007

source	survivors	N	scaledWts
EngGFS Q3 GOV	112959	2	0.416
ScoGFS Q3 GOV	76284	2	0.164
IBTS Q1 (backshifted)	117299	2	0.416
fshk	79477	1	0.005

Age 2 Year class = 2006

source	survivors	N	scaledWts
EngGFS Q3 GOV	82366	3	0.387
ScoGFS Q3 GOV	100363	3	0.222
IBTS Q1 (backshifted)	91650	3	0.387
fshk	61909	1	0.004

Age 3 Year class = 2005

source	survivors	N	scaledWts
EngGFS Q3 GOV	291938	4	0.339
ScoGFS Q3 GOV	337788	4	0.271
IBTS Q1 (backshifted)	314324	4	0.387
fshk	132022	1	0.003

Age 4 Year class = 2004

source	survivors	N	scaledWts
EngGFS Q3 GOV	12197	5	0.316
ScoGFS Q3 GOV	6997	5	0.283
IBTS Q1 (backshifted)	9382	5	0.397
fshk	10315	1	0.005

Age 5 Year class = 2003

source	survivors	N	scaledWts
EngGFS Q3 GOV	8328	6	0.305
ScoGFS Q3 GOV	8475	6	0.382
IBTS Q1 (backshifted)	5527	5	0.308
fshk	4684	1	0.004

Age 6 Year class = 2002

source	survivors	N	scaledWts
EngGFS Q3 GOV	4248	7	0.270
ScoGFS Q3 GOV	3696	7	0.488
IBTS Q1 (backshifted)	4184	5	0.237
fshk	3593	1	0.005

Age 7 Year class = 2001

source	survivors	N	scaledWts
EngGFS Q3 GOV	2408	7	0.280
ScoGFS Q3 GOV	2642	7	0.447
IBTS Q1 (backshifted)	3146	5	0.268
fshk	1193	1	0.005

Table 13.3.5.2. Haddock in Subarea IV and Division IIIa. Estimates of fishing mortality at age from the final XSA assessment. Estimates refer to the full year (January – December) except for age 0, for which the mortality rate given refers to the second half-year only (July – December).

Year	Age								
	0	1	2	3	4	5	6	7	8+
1963	0.002	0.125	0.805	0.668	0.762	0.902	0.648	0.778	0.778
1964	0.043	0.059	0.457	1.174	0.751	0.886	1.365	1.012	1.012
1965	0.071	1.359	0.421	0.513	0.984	1.275	1.026	1.108	1.108
1966	0.070	1.304	0.828	0.367	0.792	1.237	1.225	1.098	1.098
1967	0.002	0.262	1.085	0.412	0.382	1.057	1.313	0.927	0.927
1968	0.002	0.051	0.578	0.908	0.304	0.528	0.900	0.582	0.582
1969	0.017	0.021	0.654	1.377	1.333	0.801	1.871	1.352	1.352
1970	0.030	0.503	1.036	1.145	1.274	0.781	1.364	1.153	1.153
1971	0.012	0.474	0.665	0.793	0.860	0.873	0.838	0.866	0.866
1972	0.032	0.168	0.793	1.380	1.183	1.121	0.880	1.074	1.074
1973	0.002	0.373	0.565	1.161	0.873	0.910	0.995	0.936	0.936
1974	0.013	0.351	0.934	0.945	1.006	0.751	0.791	0.859	0.859
1975	0.011	0.333	0.957	1.261	1.086	1.005	1.264	1.132	1.132
1976	0.029	0.306	0.809	1.310	0.797	1.215	1.104	1.051	1.051
1977	0.012	0.327	0.995	1.014	1.085	1.081	0.871	1.024	1.024
1978	0.020	0.373	0.990	1.123	1.068	0.761	1.199	0.827	0.827
1979	0.033	0.171	0.827	1.078	1.050	0.891	0.443	0.882	0.882
1980	0.068	0.182	0.689	1.010	0.988	0.908	0.705	0.201	0.201
1981	0.057	0.176	0.439	0.896	0.635	0.533	0.571	0.490	0.490
1982	0.039	0.172	0.417	0.779	0.773	0.283	0.358	0.853	0.853
1983	0.027	0.151	0.653	0.961	1.032	0.872	0.226	0.248	0.248
1984	0.016	0.125	0.670	0.973	0.970	0.870	0.496	0.114	0.114
1985	0.016	0.208	0.613	0.967	1.032	0.680	0.481	0.223	0.223
1986	0.003	0.129	1.029	1.239	1.335	0.882	0.325	0.205	0.205
1987	0.006	0.106	0.909	1.078	1.081	0.925	0.719	0.231	0.231
1988	0.004	0.135	0.787	1.311	1.222	1.101	0.981	0.337	0.337
1989	0.003	0.106	0.655	0.975	1.218	0.884	0.764	1.040	1.040
1990	0.005	0.184	1.112	1.143	1.077	0.960	0.865	0.610	0.610
1991	0.013	0.152	0.778	1.035	0.844	0.767	0.723	1.460	1.460
1992	0.018	0.136	0.725	1.133	1.077	0.765	0.790	0.923	0.923
1993	0.030	0.161	0.790	0.999	0.894	0.988	0.704	0.422	0.422
1994	0.004	0.144	0.541	1.018	0.921	0.670	1.189	0.754	0.754
1995	0.040	0.099	0.484	0.825	0.878	0.671	0.372	0.963	0.963
1996	0.019	0.061	0.429	0.847	0.779	0.715	0.627	1.680	1.680
1997	0.006	0.118	0.393	0.584	0.615	0.532	0.388	0.271	0.271
1998	0.006	0.122	0.579	0.485	0.725	0.511	0.221	0.156	0.156
1999	0.002	0.156	0.757	0.838	0.511	0.677	0.404	0.145	0.145
2000	0.001	0.047	0.727	0.822	0.712	0.227	0.299	0.157	0.157
2001	0.002	0.059	0.277	0.776	0.409	0.227	0.084	0.066	0.066
2002	0.038	0.123	0.141	0.185	0.364	0.157	0.084	0.038	0.038
2003	0.007	0.101	0.331	0.152	0.125	0.181	0.063	0.028	0.028
2004	0.001	0.050	0.321	0.288	0.180	0.151	0.093	0.020	0.020
2005	0.000	0.051	0.284	0.399	0.244	0.195	0.137	0.053	0.053
2006	0.001	0.050	0.454	0.536	0.533	0.370	0.155	0.097	0.097
2007	0.001	0.047	0.235	0.549	0.431	0.325	0.305	0.093	0.093
2008	0.001	0.050	0.239	0.183	0.331	0.163	0.138	0.100	0.100

Table 13.3.5.3. Haddock in Subarea IV and Division IIIa. Estimates of stock numbers at age from the final XSA assessment. Estimates refer to January 1st, except for age 0 for estimates refer to July 1st. *Estimated survivors.

Year	Age								
	0	1	2	3	4	5	6	7	8+
1963	2315029	25450196	739728	48724	27677	10747	1164	1334	1295
1964	9155436	297538	4315469	221619	19450	10060	3569	499	839
1965	26286793	1128473	53888	1832192	53363	7147	3397	746	385
1966	68923260	3150893	55672	23718	854126	15539	1635	997	455
1967	3.88E+08	8274725	164299	16311	12803	301155	3694	393	552
1968	17114876	49884880	1222290	37210	8411	6807	85639	814	144
1969	12133821	2199297	9099630	459731	11689	4833	3285	28519	336
1970	87606750	1536012	413405	3171947	90348	2402	1776	414	9575
1971	78211007	10946303	178355	98334	786434	19681	901	372	3580
1972	21426954	9949842	1308923	61465	34648	259111	6729	319	791
1973	72953038	2671964	1614619	396946	12048	8265	69183	2285	536
1974	1.33E+08	9370120	353231	615284	96810	3918	2725	20938	578
1975	11407700	16889101	1267331	93019	186309	27559	1513	1011	4895
1976	16402039	1452443	2324314	326346	20520	49001	8259	350	1498
1977	26219907	2051534	205452	694117	68562	7200	11900	2242	623
1978	39832982	3334172	284178	50924	196102	18051	2001	4078	1184
1979	72661935	5025336	440965	70809	12901	52472	6904	494	1323
1980	15806947	9052222	813750	129225	18765	3516	17619	3630	2430
1981	32617680	1900372	1449180	273786	36655	5443	1162	7131	707
1982	20491370	3967101	306050	626444	87074	15129	2616	537	1592
1983	66956253	2537956	641198	135171	223823	31293	9331	1497	1594
1984	17181331	8390044	418937	223731	40262	62083	10709	6094	2649
1985	23920805	2177571	1421911	143758	65886	11882	21288	5340	2075
1986	49030758	3029362	339812	516181	42565	18280	4929	10774	2896
1987	4156240	6291697	511514	81395	116392	8720	6198	2917	5684
1988	8339335	531674	1086620	138193	21579	30756	2832	2471	1582
1989	8606296	1069686	89215	331724	29020	4953	8370	869	565
1990	28351635	1104090	184717	31068	97440	6683	1675	3193	847
1991	27479298	3629942	176396	40708	7716	25852	2096	577	1167
1992	41947282	3493086	598906	54306	11259	2584	9833	833	1348
1993	13157783	5302932	585720	194414	13628	2988	984	3652	1454
1994	56144741	1643201	867116	178248	55752	4343	910	399	1467
1995	14447705	7196943	273134	338469	50160	17290	1819	227	251
1996	21503804	1787712	1252351	112818	115516	16230	7239	1027	165
1997	12826240	2715032	322869	546418	37654	41296	6499	3166	477
1998	9970725	1640832	463460	146134	237320	15847	19870	3609	1302
1999	1.36E+08	1275645	278849	174157	70082	89520	7780	13046	3201
2000	26511570	17415454	209504	87648	58643	32747	37226	4255	2133
2001	2835366	3410585	3191665	67876	30003	22411	21358	22599	4831
2002	3750722	364102	617562	1621278	24319	15524	14618	16074	21957
2003	3891493	464639	61862	359647	1048915	13161	10865	11004	9837
2004	3731671	497716	80667	29791	240604	720648	8994	8351	7789
2005	38595613	480027	90968	39236	17401	156544	507568	6709	3088
2006	7205011	4966875	87585	45918	20510	10614	105477	362399	2118
2007	4572803	926671	907213	37289	20924	9370	6003	73975	84811
2008	3735922	588038	169734	480606	16775	10592	5542	3624	43117
2009*		480257	107415	89598	311723	9386	7370	3952	2686

Table 13.3.5.4. Haddock in Subarea IV and Division IIIa. Stock summary table.

	Recruitment	TSB	SSB	Catch	Landings	Discards	IBC	Yield/SSB	Mean F(2–4)
1963	2315029	3412701	137055	271851	68821	189329	13700	0.502	0.745
1964	9155436	1281826	417718	379915	131006	160309	88600	0.314	0.794
1965	26286793	1081002	521742	299344	162418	62326	74600	0.311	0.639
1966	68923260	1480501	427843	346349	226184	73465	46700	0.529	0.662
1967	388351571	5527477	224795	246664	147742	78222	20700	0.657	0.626
1968	17114876	6852043	259402	301821	105811	161810	34200	0.408	0.597
1969	12133821	2477692	810551	930043	331625	260065	338353	0.409	1.121
1970	87606750	2541782	900223	805776	524773	101274	179729	0.583	1.152
1971	78211007	2546502	420405	446824	237502	177776	31546	0.565	0.773
1972	21426954	2182328	302982	353084	195545	127954	29585	0.645	1.119
1973	72953038	4088546	297169	307595	181592	114736	11267	0.611	0.866
1974	132869060	4711585	260797	366992	153057	166429	47505	0.587	0.962
1975	11407700	2385624	238364	453205	151349	260369	41487	0.635	1.101
1976	16402039	1097845	309660	375305	172680	154462	48163	0.558	0.972
1977	26219907	1069750	242563	224516	145118	44376	35022	0.598	1.031
1978	39832982	1138494	138416	179376	91683	76789	10903	0.662	1.06
1979	72661935	1353240	117454	145020	87069	41710	16240	0.741	0.985
1980	15806947	1472212	169873	222126	105041	94614	22472	0.618	0.896
1981	32617680	997530	257894	213240	136132	60067	17041	0.528	0.656
1982	20491370	1092906	321698	233283	173335	40564	19383	0.539	0.657
1983	66956253	2254533	277335	244212	165337	65977	12898	0.596	0.882
1984	17181331	1692122	224959	218946	133568	75298	10080	0.594	0.871
1985	23920805	1189276	262039	255366	164119	85249	5998	0.626	0.871
1986	49030758	1942695	237914	223081	168236	52202	2643	0.707	1.201
1987	4156240	1098211	167460	173852	110299	59143	4410	0.659	1.022
1988	8339335	630796	160326	173123	106973	62148	4002	0.667	1.106
1989	8606296	623884	128027	106529	78439	25680	2410	0.613	0.949
1990	28351635	1582939	81017	88934	53780	32565	2589	0.664	1.111
1991	27479298	1553319	63345	93286	47715	40185	5386	0.753	0.886
1992	41947282	1364802	103501	131650	72790	47934	10927	0.703	0.978
1993	13157783	1019411	139012	172550	82176	79608	10766	0.591	0.894
1994	56144741	1488820	161684	151020	82074	65370	3576	0.508	0.826
1995	14447705	1174840	163135	142524	77458	57372	7695	0.475	0.729
1996	21503804	1063289	202515	156609	79148	72461	5000	0.391	0.685
1997	12826240	980803	227379	141347	82574	52089	6684	0.363	0.531
1998	9970725	796184	205012	131316	81054	45160	5101	0.395	0.596
1999	135516779	3608494	159117	112021	65588	42598	3835	0.412	0.702
2000	26511570	3515647	137513	104457	47553	48770	8134	0.346	0.754
2001	2835366	1224874	314654	166960	40856	118225	7879	0.13	0.488
2002	3750722	885642	517532	107922	58348	45857	3717	0.113	0.23
2003	3891493	767729	505527	66806	41964	23692	1150	0.083	0.203
2004	3731671	765036	433795	64839	48734	15551	554	0.112	0.263
2005	38595613	2620075	374772	57162	48357	8637	168	0.129	0.309
2006	7205011	1266096	298800	56056	37613	17908	535	0.126	0.508
2007	4572803	688998	214574	59643	30939	28657	48	0.144	0.405
2008	3735922	532933	203254	43640	30248	13194	199	0.149	0.251
Units	Thousands	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes		

Table 13.6.1. Haddock in Subarea IV and Division IIIa. Short-term forecast input.

MFDP version 1a
Run: had01
Time and date: 13:14 10/05/2009
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2009

Age	N	M	Mat	PF	PM	SWt
0	4067014	2.05	0.00	0	0	0.047
1	480257	1.65	0.01	0	0	0.168
2	107415	0.40	0.32	0	0	0.265
3	89598	0.25	0.71	0	0	0.389
4	311723	0.25	0.87	0	0	0.524
5	9386	0.20	0.95	0	0	0.617
6	7370	0.20	1.00	0	0	0.768
7	3952	0.20	1.00	0	0	1.020
8	2686	0.20	1.00	0	0	1.079

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.047
1	0.001	0.382	0.048	0.160
2	0.050	0.394	0.188	0.224
3	0.124	0.446	0.059	0.274
4	0.295	0.550	0.034	0.309
5	0.154	0.633	0.007	0.340
6	0.127	0.775	0.010	0.385
7	0.094	1.027	0.006	0.449
8	0.099	1.080	0.001	0.444

IBC

Age	Sel	CWt
0	0.000	0.015
1	0.001	0.127
2	0.001	0.217
3	0.001	0.289
4	0.002	0.317
5	0.002	0.382
6	0.001	0.452
7	0.000	0.499
8	0.000	0.328

2010

Age	N	M	Mat	PF	PM	SWt
0	4067014	2.05	0.00	0	0	0.047
1	.	1.65	0.01	0	0	0.168
2	.	0.40	0.32	0	0	0.265
3	.	0.25	0.71	0	0	0.389
4	.	0.25	0.87	0	0	0.524
5	.	0.20	0.95	0	0	0.617
6	.	0.20	1.00	0	0	0.768
7	.	0.20	1.00	0	0	1.020
8	.	0.20	1.00	0	0	1.265

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.047
1	0.001	0.382	0.048	0.160
2	0.050	0.394	0.188	0.224
3	0.124	0.446	0.059	0.274
4	0.295	0.550	0.034	0.309
5	0.154	0.633	0.007	0.340
6	0.127	0.775	0.010	0.385
7	0.094	1.027	0.006	0.449
8	0.099	1.269	0.001	0.444

IBC

Age	Sel	CWt
0	0.000	0.015
1	0.001	0.127
2	0.001	0.217
3	0.001	0.289
4	0.002	0.317
5	0.002	0.382
6	0.001	0.452
7	0.000	0.499
8	0.000	0.328

2011

Age	N	M	Mat	PF	PM	SWt
0	4067014	2.05	0.00	0	0	0.047
1	.	1.65	0.01	0	0	0.168
2	.	0.40	0.32	0	0	0.265
3	.	0.25	0.71	0	0	0.389
4	.	0.25	0.87	0	0	0.524
5	.	0.20	0.95	0	0	0.617
6	.	0.20	1.00	0	0	0.768
7	.	0.20	1.00	0	0	1.020
8	.	0.20	1.00	0	0	1.375

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.047
1	0.001	0.382	0.048	0.160
2	0.050	0.394	0.188	0.224
3	0.124	0.446	0.059	0.274
4	0.295	0.550	0.034	0.309
5	0.154	0.633	0.007	0.340
6	0.127	0.775	0.010	0.385
7	0.094	1.027	0.006	0.449
8	0.099	1.380	0.001	0.444

IBC

Age	Sel	CWt
0	0.000	0.015
1	0.001	0.127
2	0.001	0.217
3	0.001	0.289
4	0.002	0.317
5	0.002	0.382
6	0.001	0.452
7	0.000	0.499
8	0.000	0.328

Input units are thousands and kg - output in tonnes

Table 13.6.2. Haddock in Subarea IV and Division IIIa. Short-term forecast output. The MP target F, a 15% TAC decrease, and the status quo F forecast are highlighted.

MFDP version 1a
Run: had01
Time and date: 13:14 10/05/2009
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2009

Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield
516875	194861	0.97	0.243	0.151	44700	0.091	8647	1	0.001	227

2010											2011		
Biomass	SSB	Catch FMult	Fbar	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	Landings FBar	Yield	Biomass	SSB	
480537	170697	0.00	0.001	0.000	0	0.000	0	1	0.001	220	507454	200074	
.	170697	0.10	0.026	0.016	2956	0.009	682	1	0.001	218	503493	196466	
.	170697	0.20	0.051	0.031	5853	0.019	1352	1	0.001	217	499612	192933	
.	170697	0.30	0.076	0.047	8692	0.028	2012	1	0.001	215	495811	189472	
.	170697	0.40	0.101	0.063	11474	0.038	2662	1	0.001	213	492086	186081	
.	170697	0.50	0.126	0.078	14202	0.047	3301	1	0.001	211	488436	182760	
.	170697	0.60	0.151	0.094	16875	0.056	3930	1	0.001	210	484860	179506	
.	170697	0.70	0.176	0.109	19496	0.066	4549	1	0.001	208	481356	176318	
.	170697	0.80	0.201	0.125	22066	0.075	5158	1	0.001	206	477922	173195	
.	170697	0.90	0.226	0.141	24585	0.084	5758	1	0.001	205	474557	170134	
.	170697	1.00	0.251	0.156	27056	0.094	6349	1	0.001	203	471258	167135	(status quo)
.	170697	1.10	0.276	0.172	29478	0.103	6931	1	0.001	201	468025	164197	
	170697	1.19	0.300	0.187	31730	0.112	7474	1	0.001	200	465021	161467	(plan target)
.	170697	1.20	0.301	0.188	31853	0.112	7504	1	0.001	200	464856	161317	
.	170697	1.30	0.326	0.203	34182	0.122	8068	1	0.001	198	461750	158494	
.	170697	1.40	0.351	0.219	36467	0.131	8624	1	0.001	197	458705	155728	
.	170697	1.47	0.368	0.230	37995	0.138	8997	1	0.001	196	456668	153879	(15% quota decrease)
.	170697	1.50	0.376	0.235	38707	0.141	9171	1	0.001	195	455719	153017	
.	170697	1.60	0.401	0.250	40905	0.150	9710	1	0.001	194	452792	150359	
.	170697	1.70	0.426	0.266	43061	0.159	10242	1	0.001	192	449922	147754	
.	170697	1.80	0.451	0.281	45175	0.169	10765	1	0.001	191	447108	145201	
.	170697	1.90	0.476	0.297	47250	0.178	11281	1	0.001	189	444349	142697	
.	170697	2.00	0.501	0.313	49285	0.187	11790	1	0.001	188	441643	140243	

Input units are thousands and kg - output in tonnes

Table 13.7.1. Haddock in Subarea IV and Division IIIa. Summary of yield-per-recruit analysis.

MFYPR version 2a
Run: had01
Time and date: 14:34 10/05/2009
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	pwnNosSpwn	SSBSpwn
0	0.0000	0.0000	0.0000	1.2384	0.1258	0.0871	0.0570	0.0871	0.0570
0.1	0.0251	0.0017	0.0008	1.2310	0.1201	0.0800	0.0514	0.0800	0.0514
0.2	0.0502	0.0033	0.0014	1.2244	0.1151	0.0737	0.0465	0.0737	0.0465
0.3	0.0753	0.0047	0.0020	1.2185	0.1106	0.0681	0.0421	0.0681	0.0421
0.4	0.1004	0.0060	0.0025	1.2132	0.1066	0.0631	0.0383	0.0631	0.0383
0.5	0.1255	0.0072	0.0029	1.2085	0.1031	0.0586	0.0349	0.0586	0.0349
0.6	0.1506	0.0083	0.0033	1.2042	0.1000	0.0546	0.0318	0.0546	0.0318
0.7	0.1757	0.0093	0.0036	1.2004	0.0972	0.0510	0.0291	0.0510	0.0291
0.8	0.2008	0.0103	0.0039	1.1969	0.0947	0.0478	0.0267	0.0478	0.0267
0.9	0.2259	0.0111	0.0041	1.1938	0.0925	0.0449	0.0246	0.0449	0.0246
1	0.2510	0.0119	0.0043	1.1909	0.0905	0.0422	0.0227	0.0422	0.0227
1.1	0.2761	0.0127	0.0045	1.1883	0.0887	0.0399	0.0210	0.0399	0.0210
1.2	0.3012	0.0134	0.0047	1.1860	0.0870	0.0377	0.0194	0.0377	0.0194
1.3	0.3263	0.0140	0.0049	1.1838	0.0856	0.0357	0.0180	0.0357	0.0180
1.4	0.3514	0.0146	0.0050	1.1818	0.0843	0.0340	0.0168	0.0340	0.0168
1.5	0.3765	0.0152	0.0051	1.1800	0.0831	0.0323	0.0157	0.0323	0.0157
1.6	0.4016	0.0157	0.0052	1.1783	0.0820	0.0308	0.0147	0.0308	0.0147
1.7	0.4267	0.0163	0.0053	1.1768	0.0810	0.0295	0.0138	0.0295	0.0138
1.8	0.4518	0.0168	0.0054	1.1754	0.0801	0.0282	0.0129	0.0282	0.0129
1.9	0.4769	0.0172	0.0054	1.1740	0.0793	0.0271	0.0122	0.0271	0.0122
2	0.5020	0.0177	0.0055	1.1728	0.0785	0.0260	0.0115	0.0260	0.0115

Reference point	F multiplier	Absolute F
Fbar(2-4)	1	0.251
FMax	>=1000000	
F0.1	1.7387	0.436
F35%SPR	1.1646	0.292

Weights in kilograms

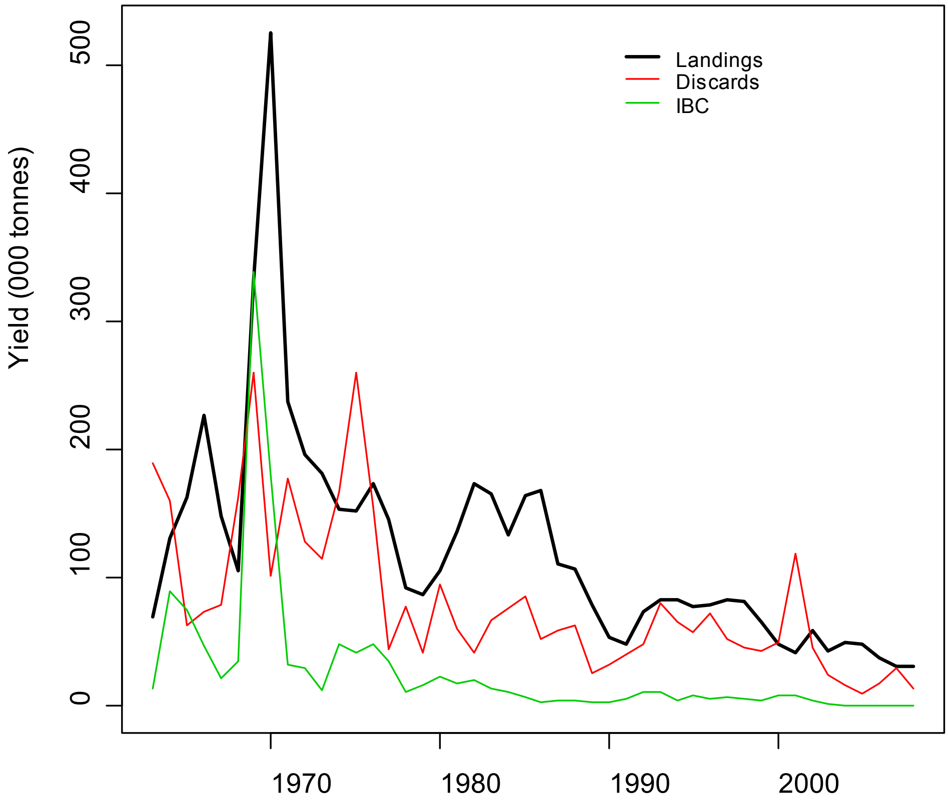


Figure 13.2.1.1. Haddock in Subarea IV and Division IIIa. Yield by catch component.

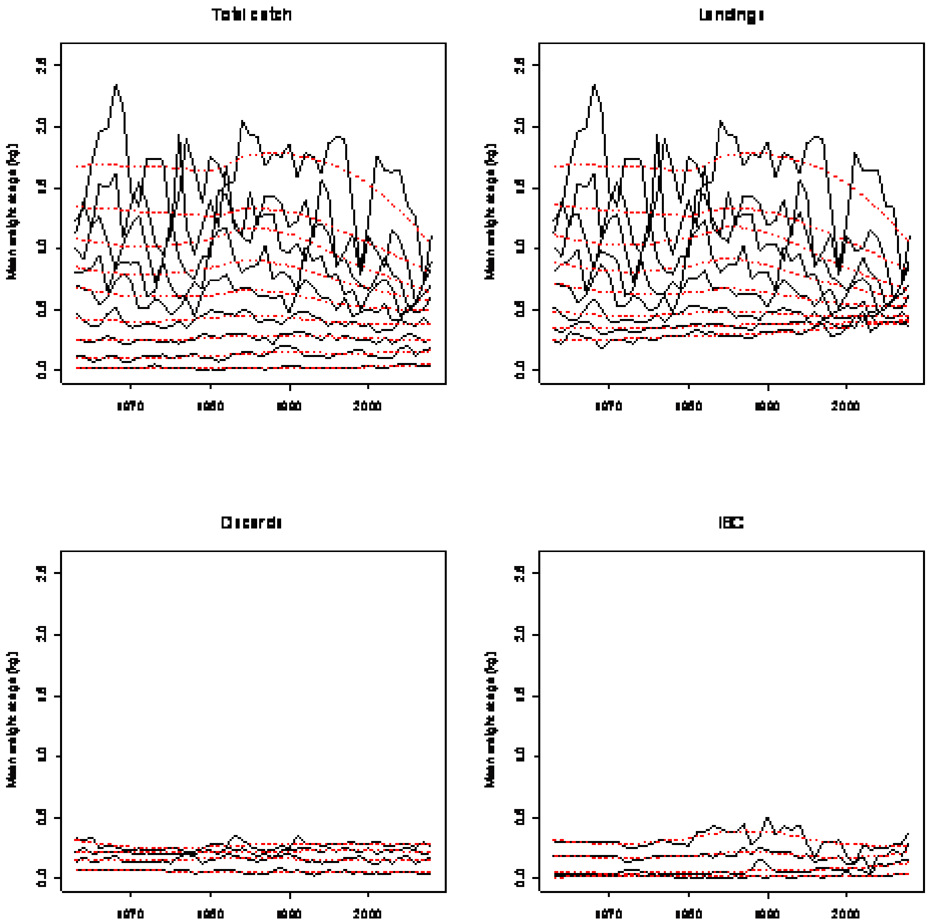


Figure 13.2.3.1. Haddock in Subarea IV and Division IIIa. Mean weights-at-age (kg) by catch component. Catch mean weights are also used as stock mean weights. Red dotted line give loess smoothers through each time-series of mean weights-at-age.

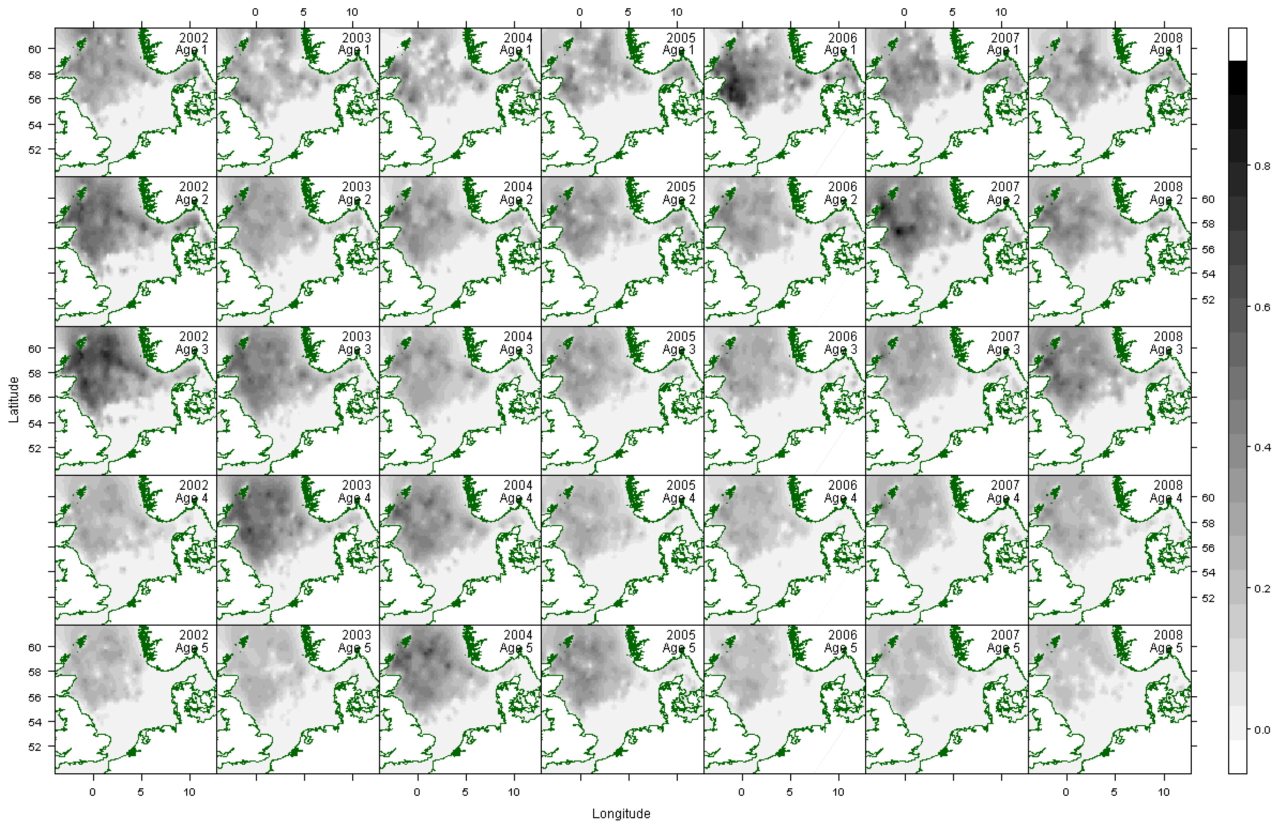


Figure 13.2.5.1. Haddock in Subarea IV and Division IIIa. Spatial distribution from the IBTS Q1 survey. Contour scale (given in the bar to the right) is the square root of survey CPUE, rescaled to lie between 0 and 1.

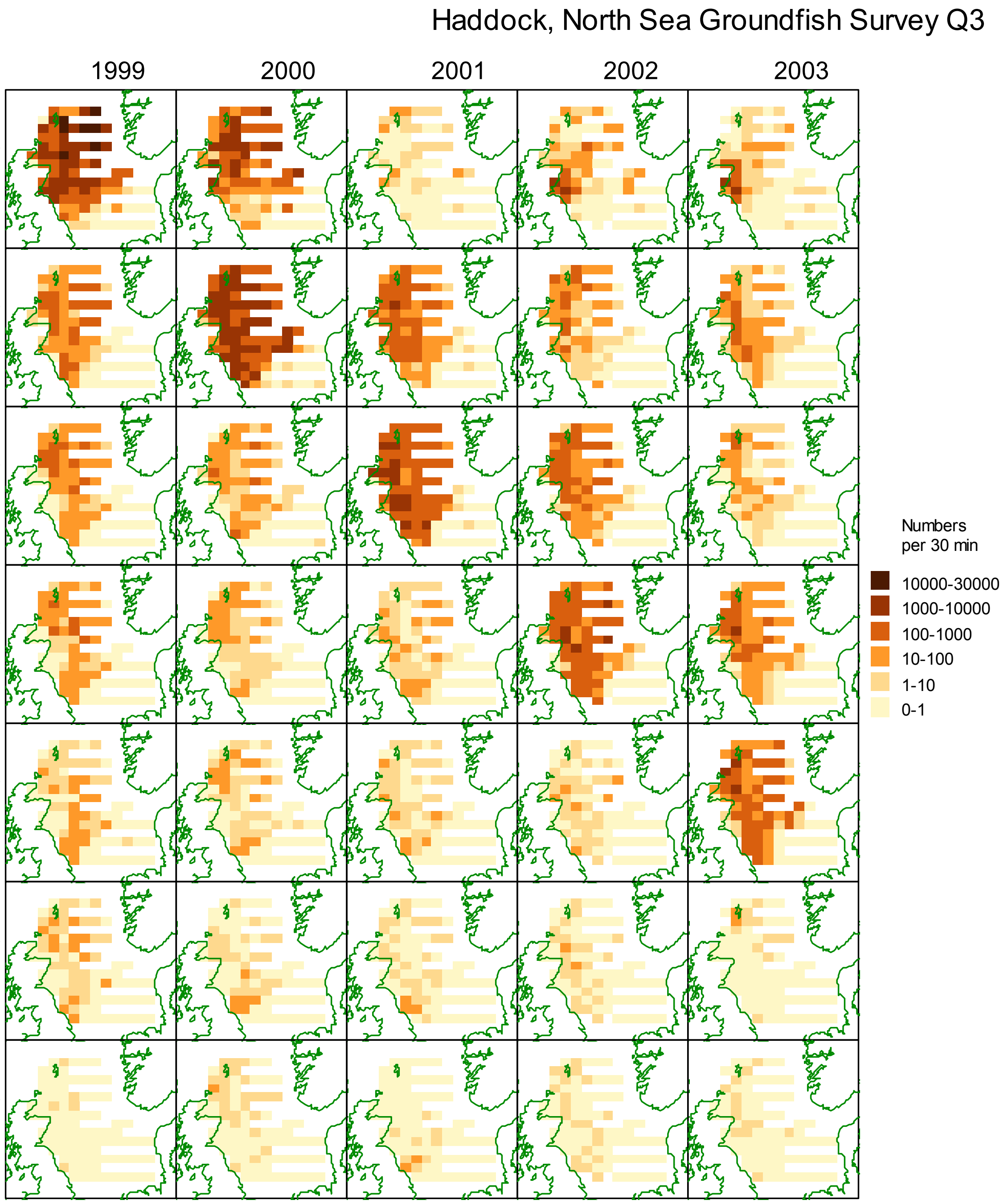


Figure 13.2.5.2. Haddock in Subarea IV and Division IIIa. Spatial distribution from the ScoGFS Q3 survey.

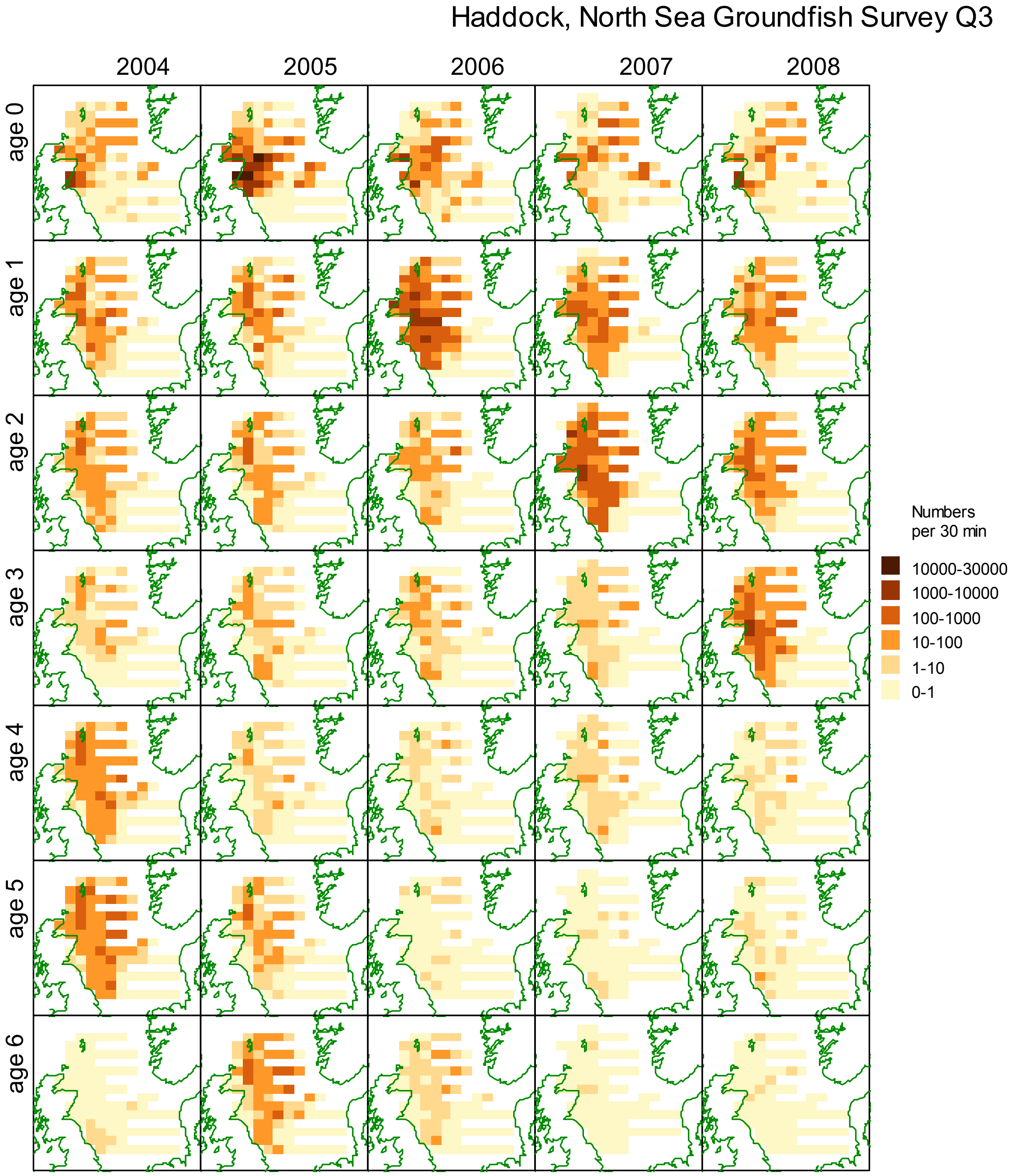


Figure 13.2.5.2. Haddock in Subarea IV and Division IIIa. Spatial distribution from the ScoGFS Q3 survey. (cont.)

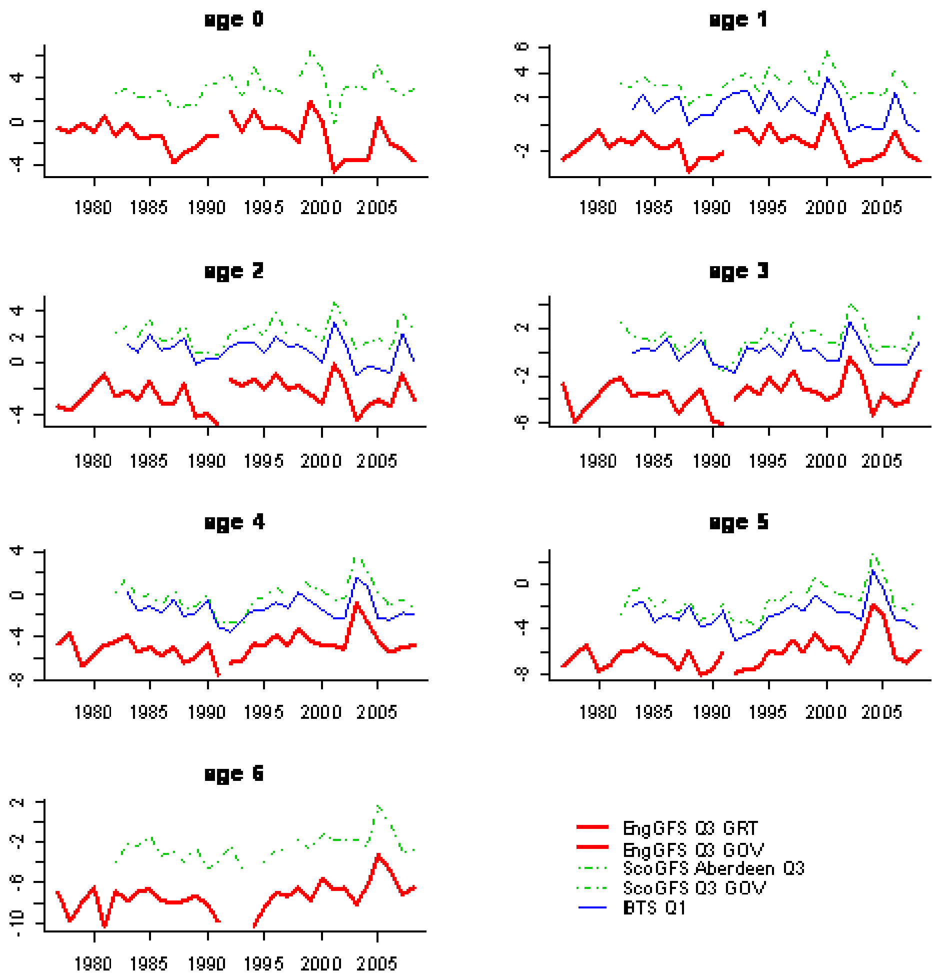


Figure 13.2.5.3. Haddock in Subarea IV and Division IIIa. Survey log CPUE (catch per unit effort) at age.

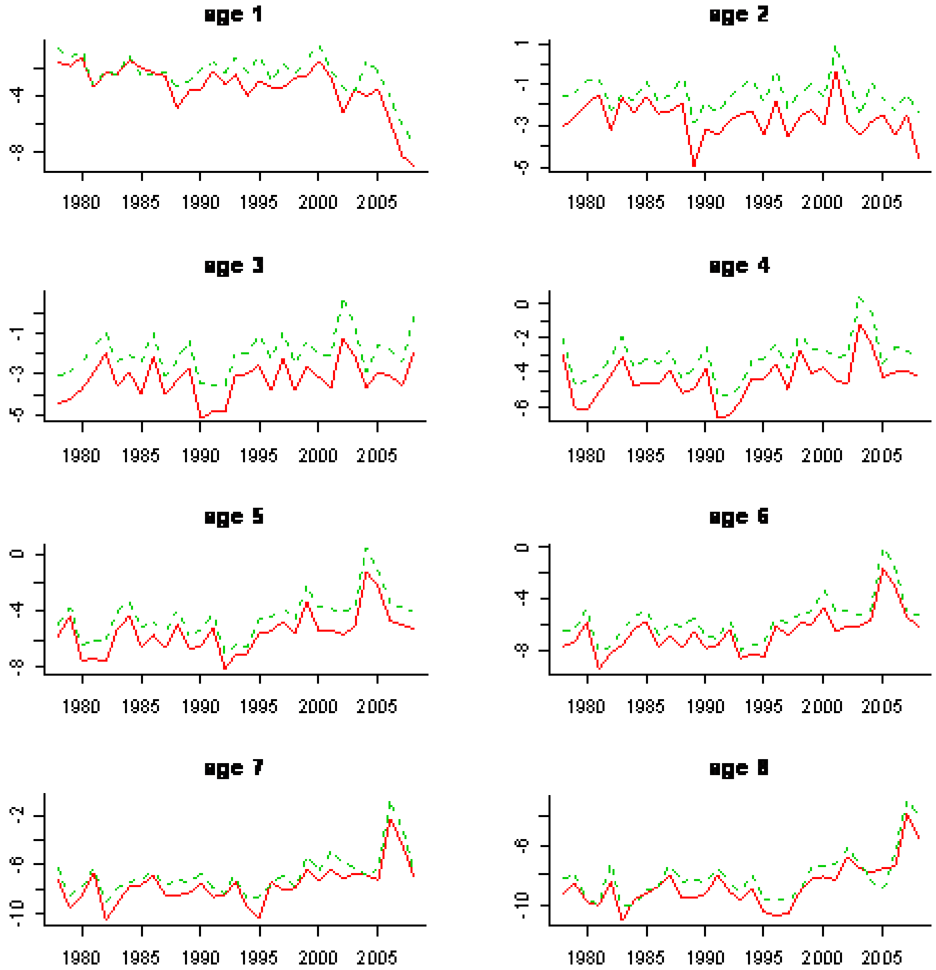


Figure 13.2.5.4. Haddock in Subarea IV and Division IIIa. Commercial log LPUE (landings per unit effort) at age. Red lines: Scottish light trawl. Green lines: Scottish seine.

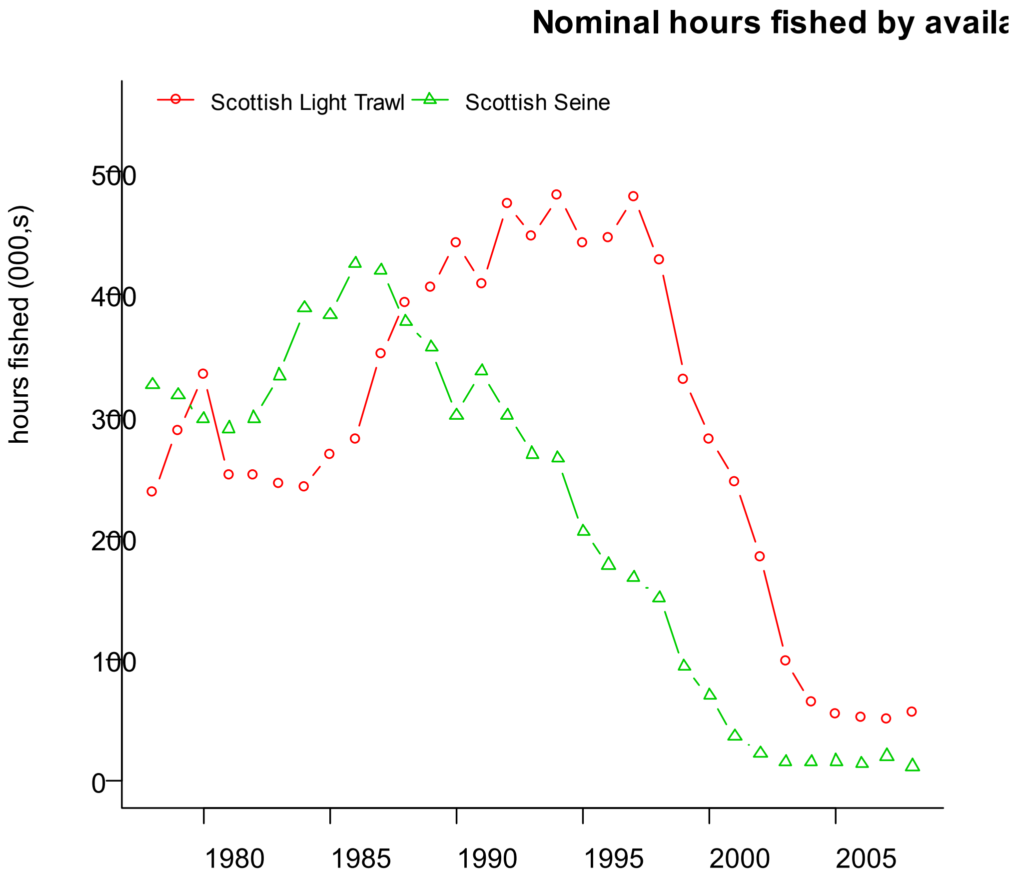


Figure 13.2.5.5. Haddock in Subarea IV and Division IIIa. Nominal hours fished by Scottish fleets, as provided to the WG. Recording of hours fished is not mandatory in European logbooks and is not considered to be a reliable indicator of deployed fishing effort.

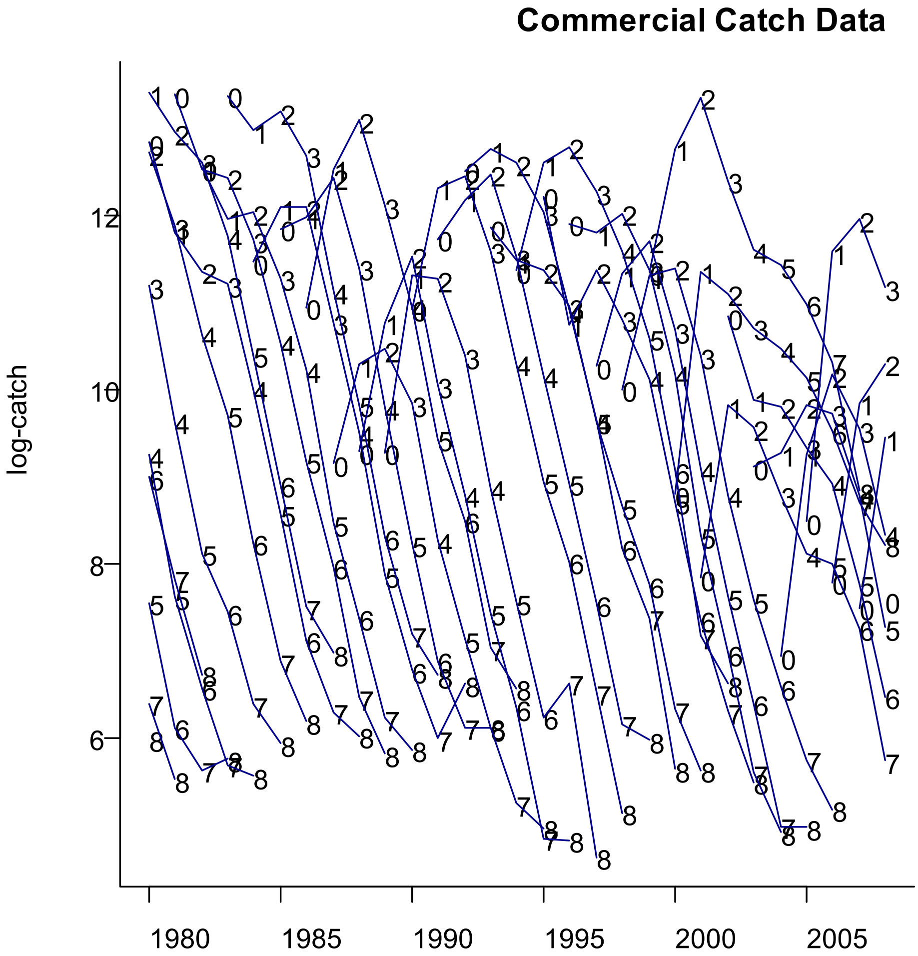


Figure 13.3.2.1. Haddock in Subarea IV and Division IIIa. Log catch curves by cohort for total catches.

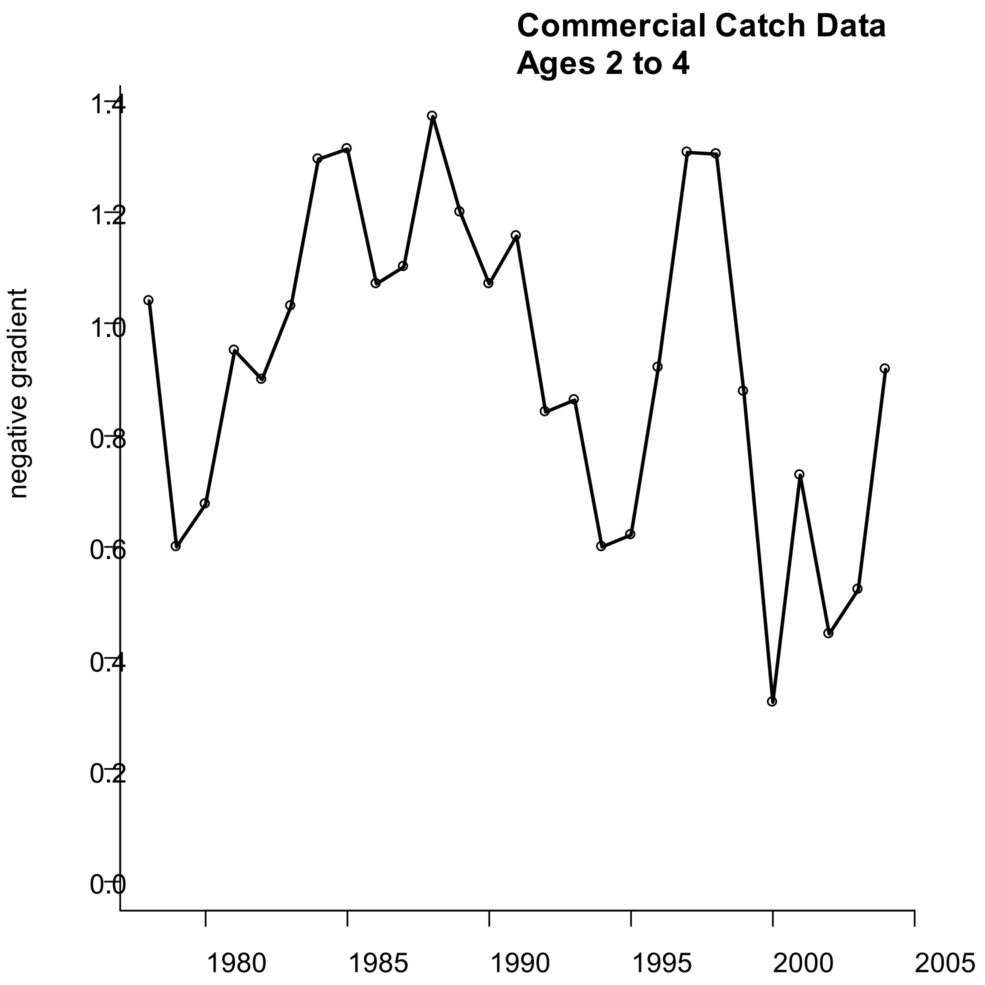


Figure 13.3.2.2. Haddock in Subarea IV and Division IIIa. Negative gradients of log catches per cohort, averaged over ages 2-4. The x-axis represents spawning year of cohort.

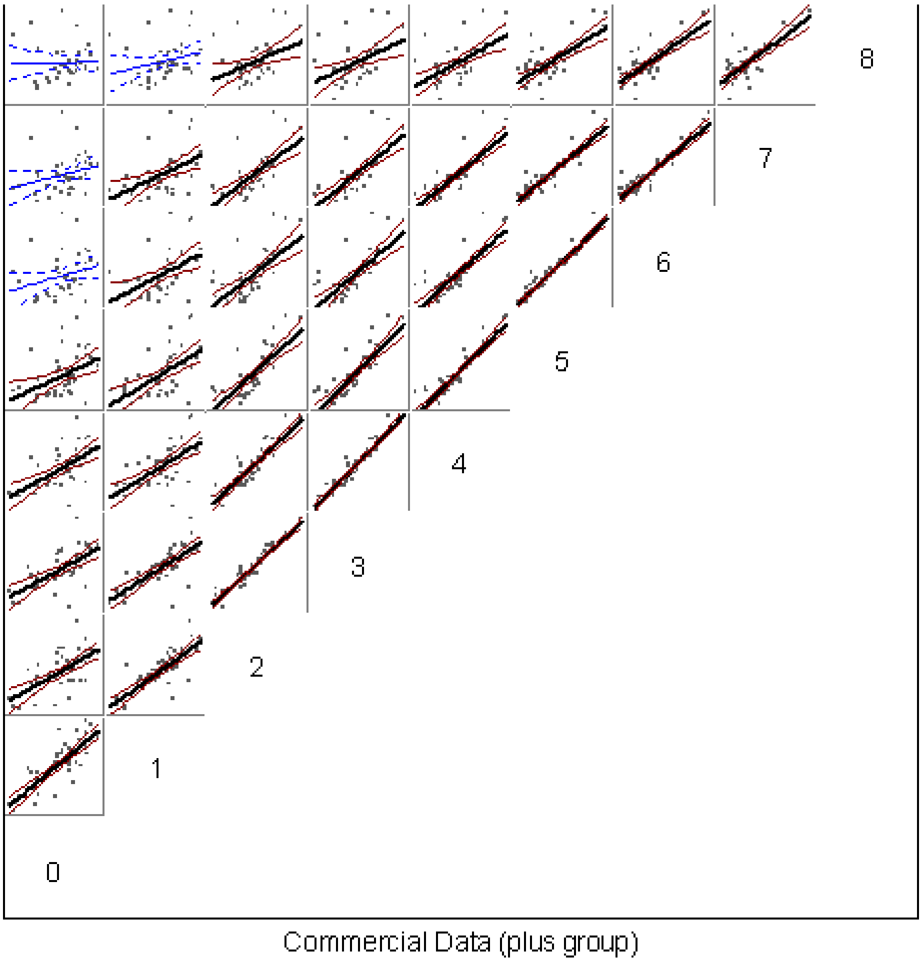
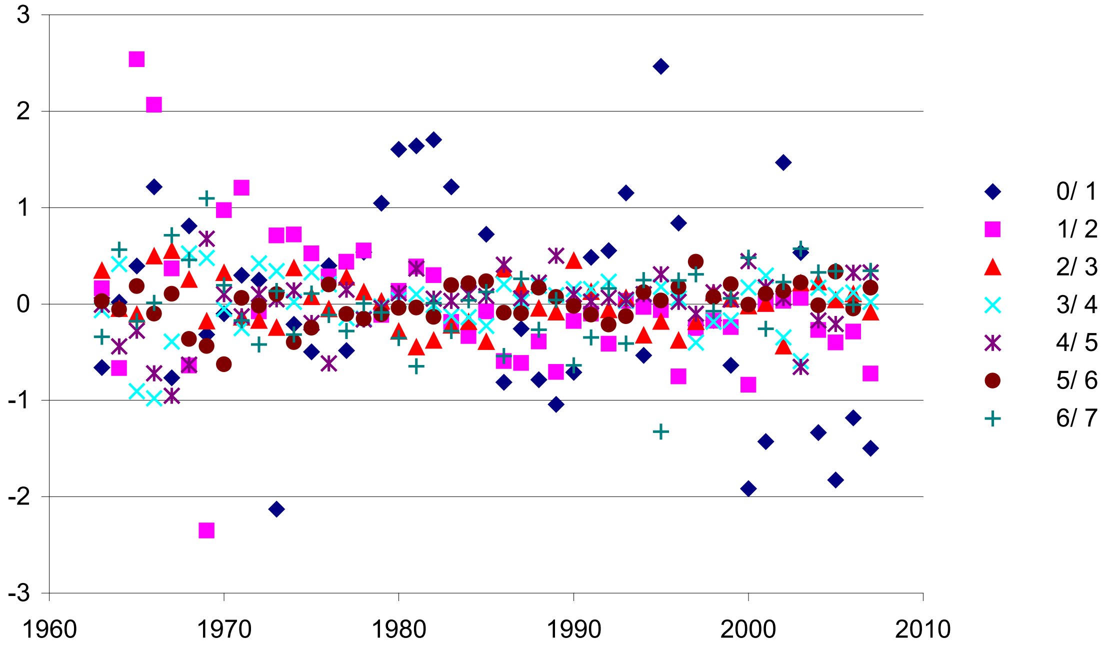


Figure 13.3.2.3. Haddock in Subarea IV and Division IIIa. Correlations in the catch-at-age matrix (including the plus-group for ages 8 and older), comparing estimates at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.



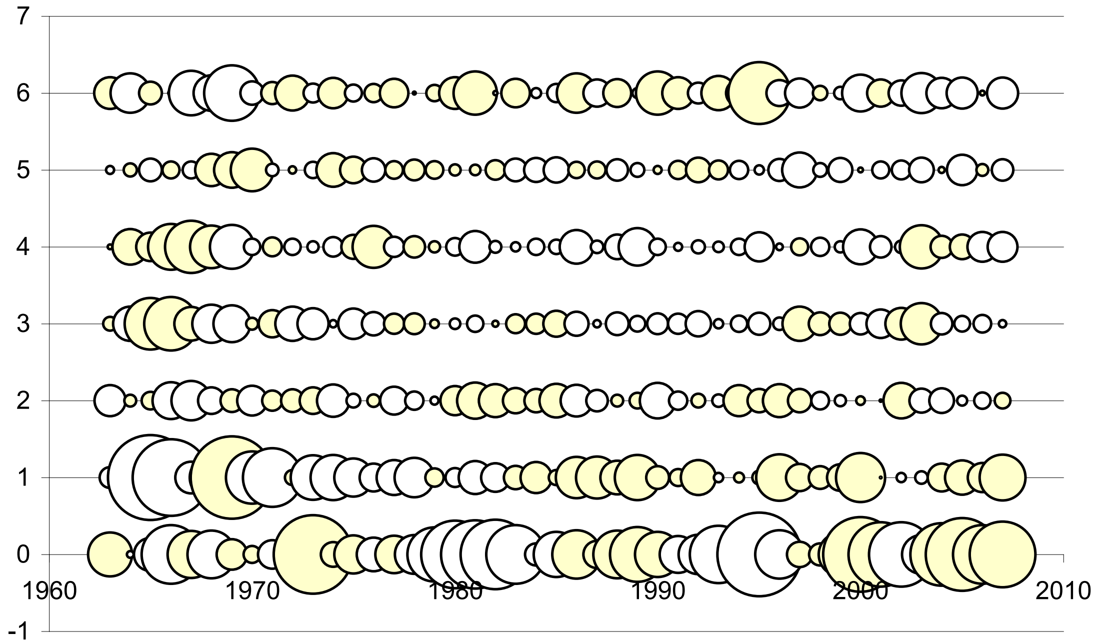


Figure 13.3.2.4. Haddock in Subarea IV and Division IIIa. Residuals from separable VPA analysis. The x-axis labels give the first year only of the actual year ratio used (so "1970" denotes 1970/1971). The y-axis labels for the lower plot give the first age only of the actual age ratio used (so "1" denotes 1/2). The area of the bubbles in the lower plot is proportional to the size of the residual.

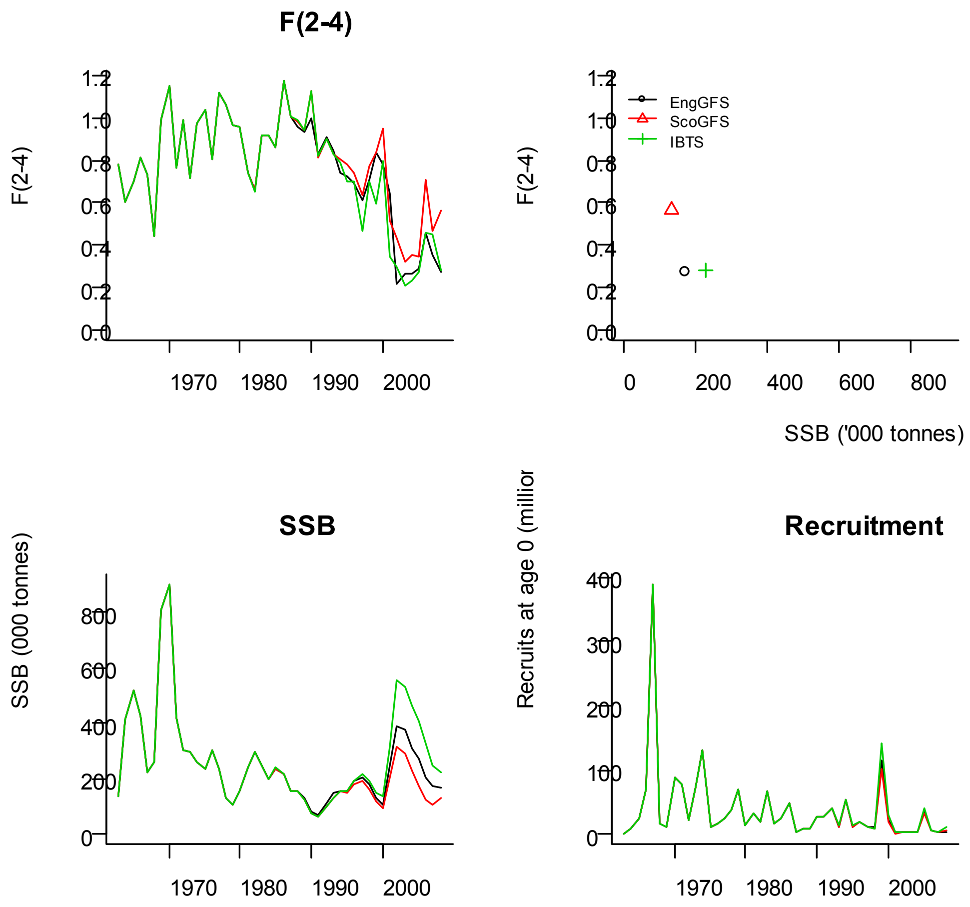


Figure 13.3.2.5. Haddock in Subarea IV and Division IIIa. Stock summary plots for single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here. Final year (2008) values of SSB and mean F(2-4) are plotted against each other in the upper right plot.

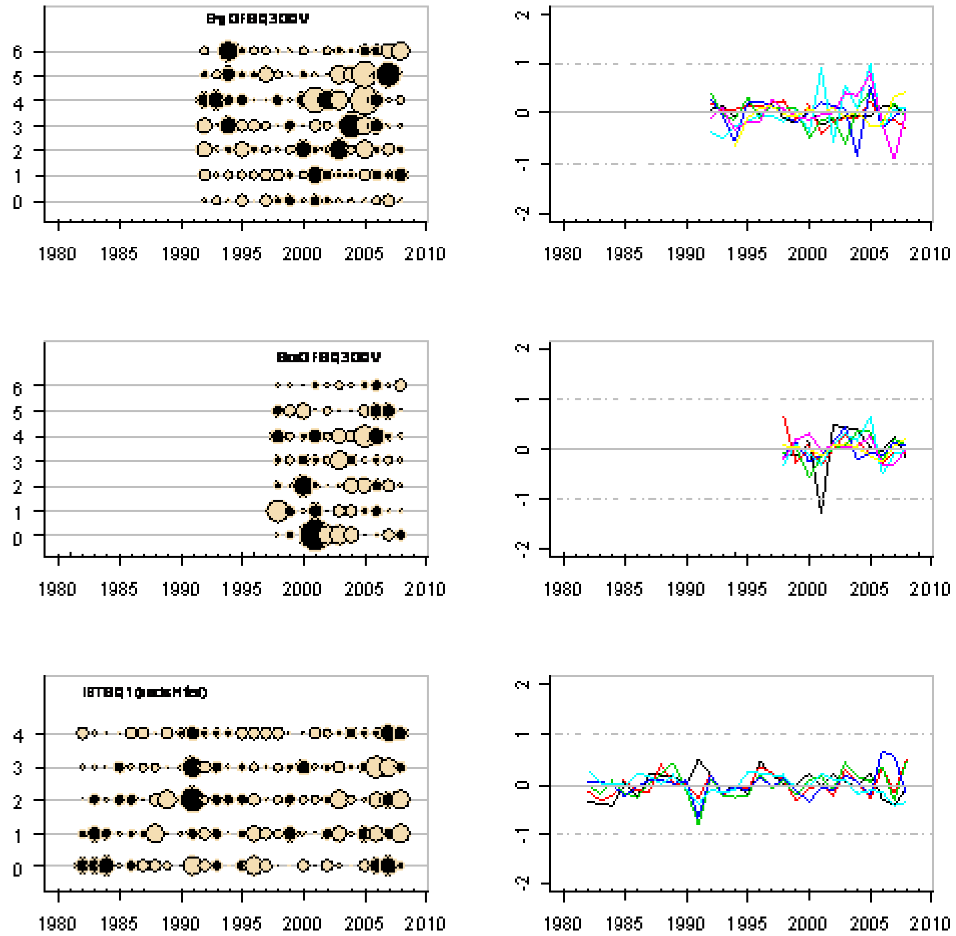


Figure 13.3.2.6. Haddock in Subarea IV and Division IIIa. Log catchability residuals from single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here.

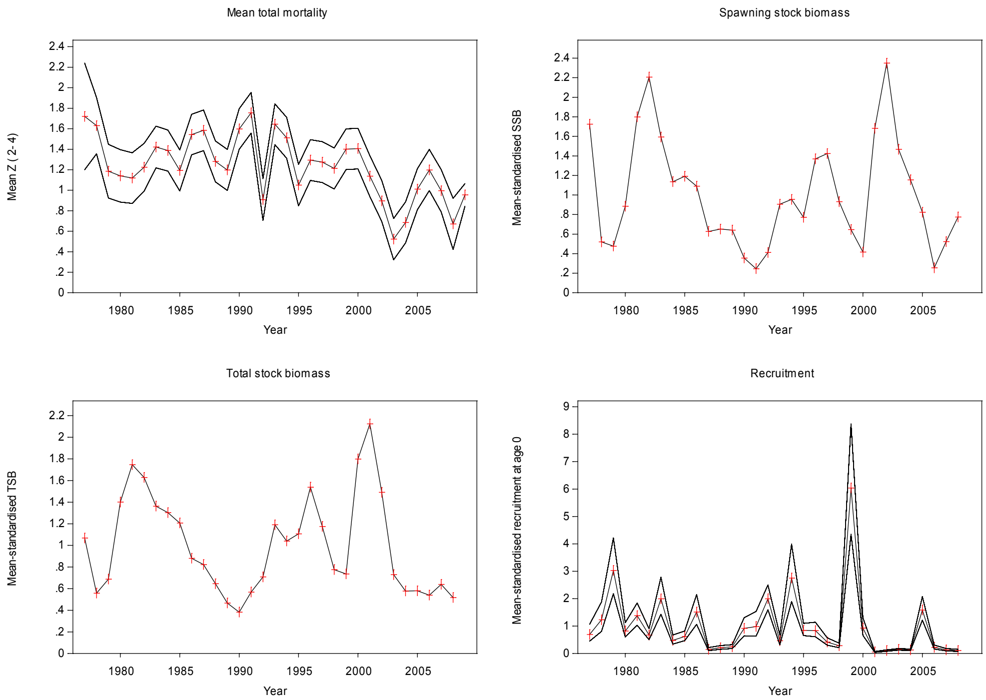
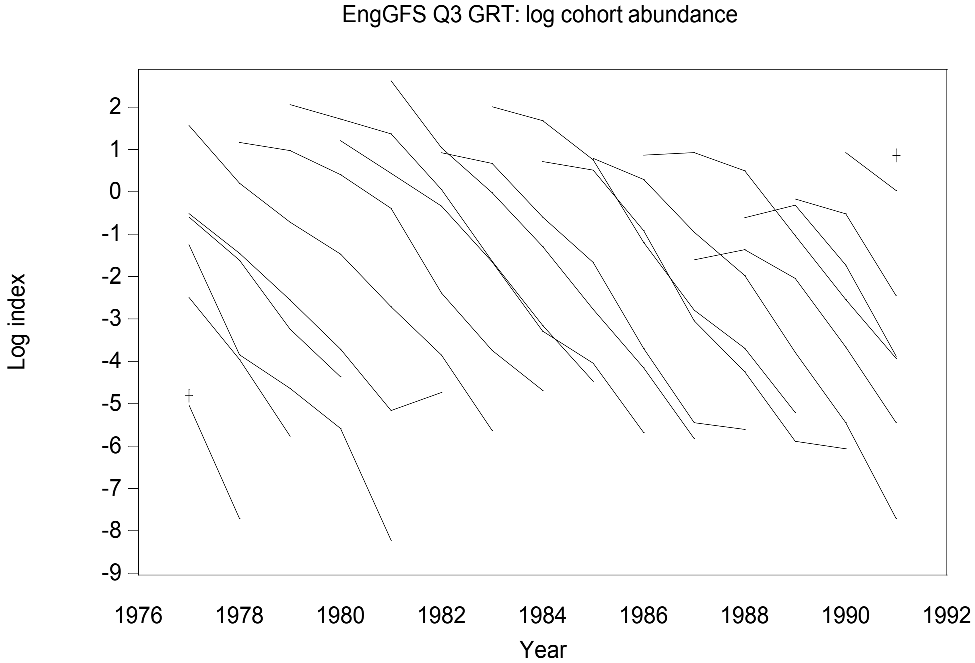


Figure 13.3.3.1. Haddock in Subarea IV and Division IIIa. Summary plots from an exploratory SURBA assessment, using all available surveys (EngGFS Q3, ScoGFS Q3, IBTS Q1). Solid lines give median estimates, dotted lines give approximate 95% confidence bounds for mean Z and recruitment.



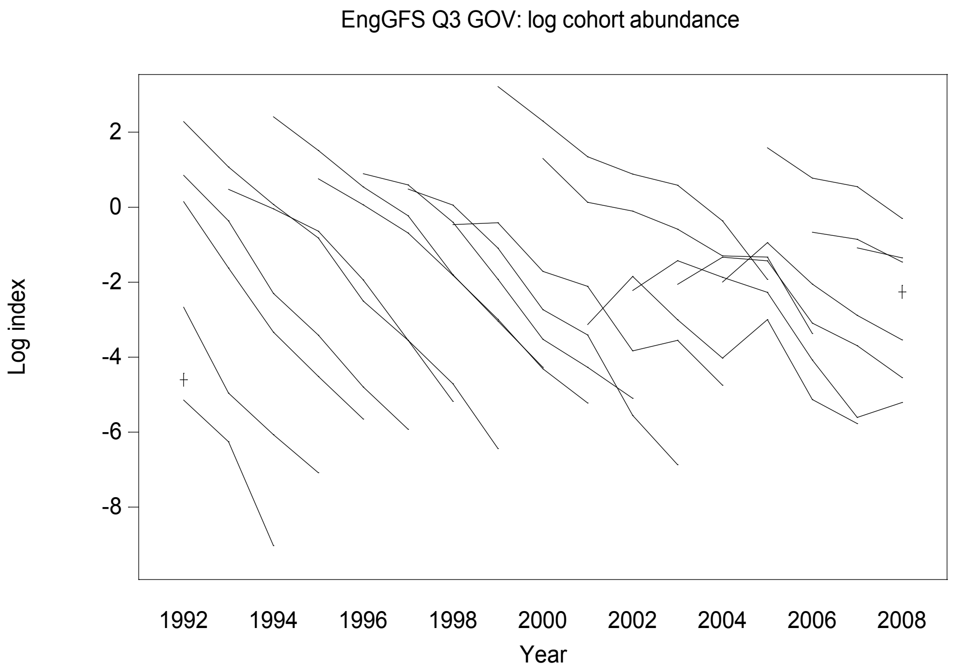
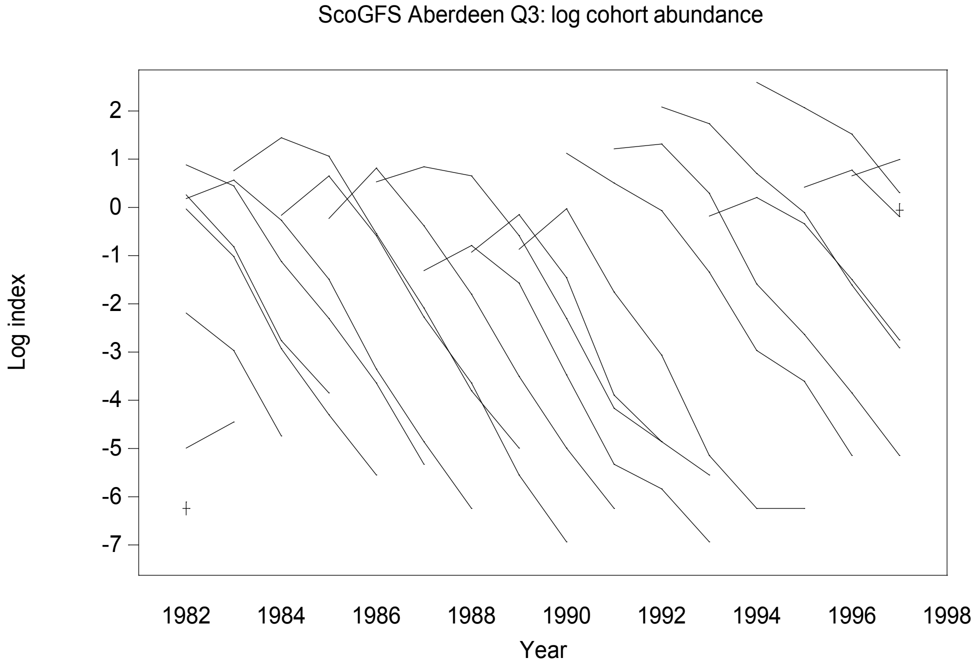


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices.



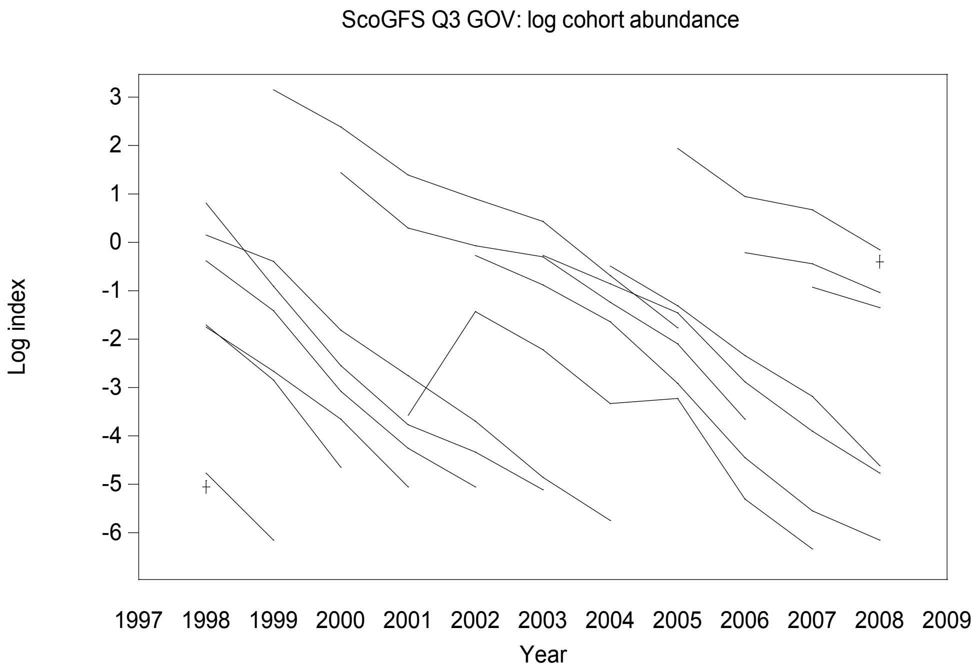


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.)

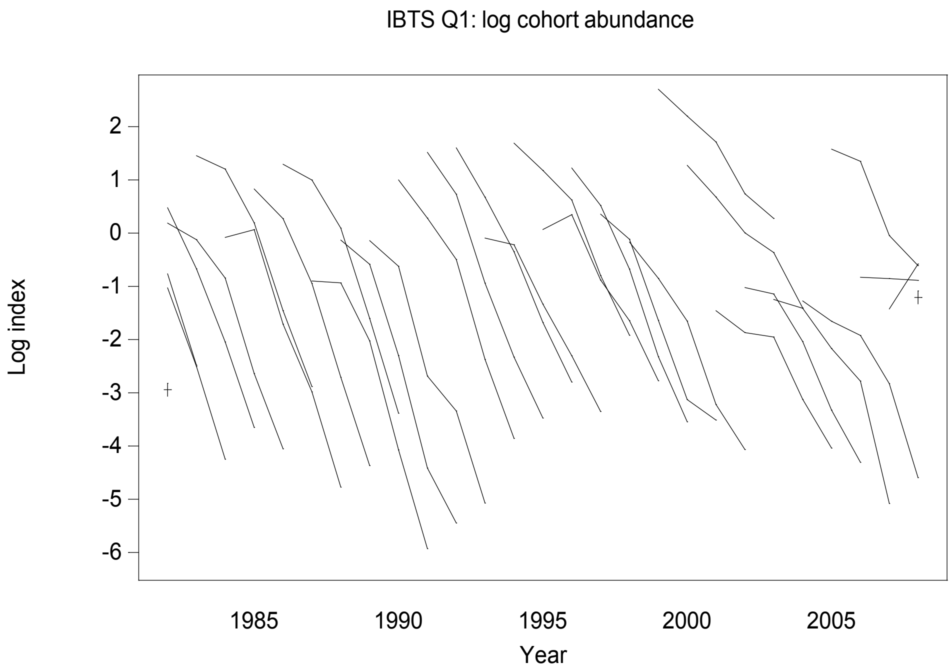


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.).

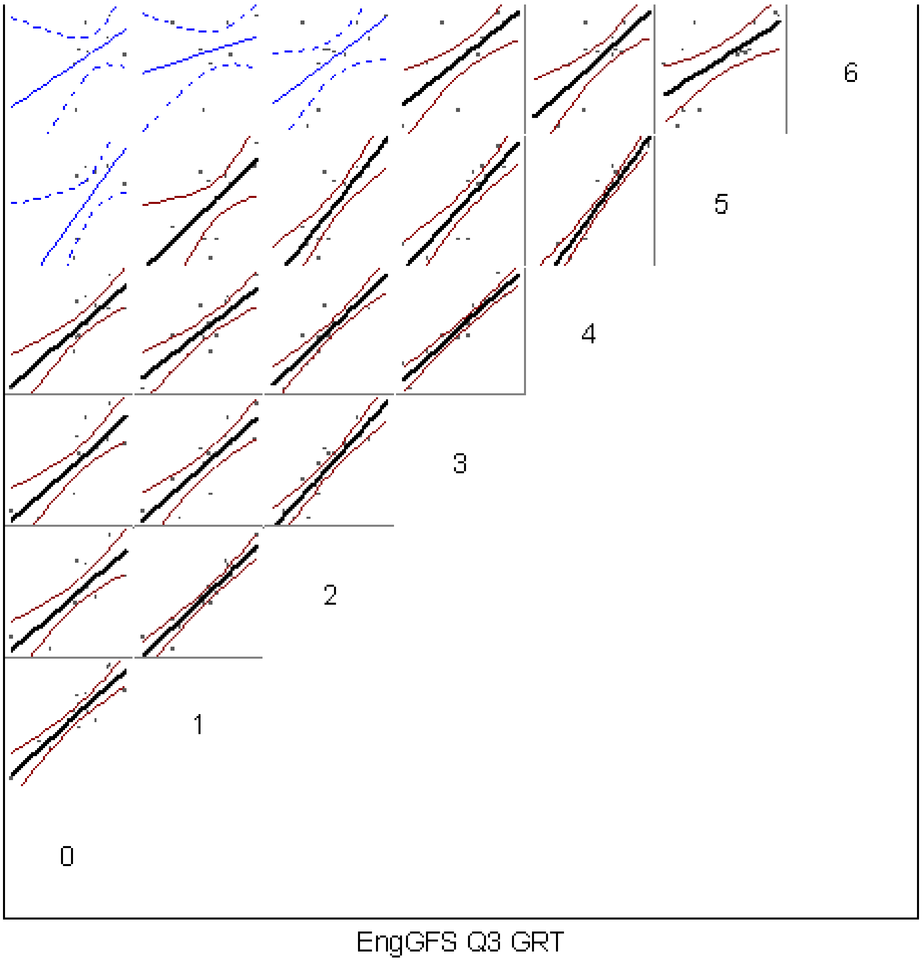


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GRT) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

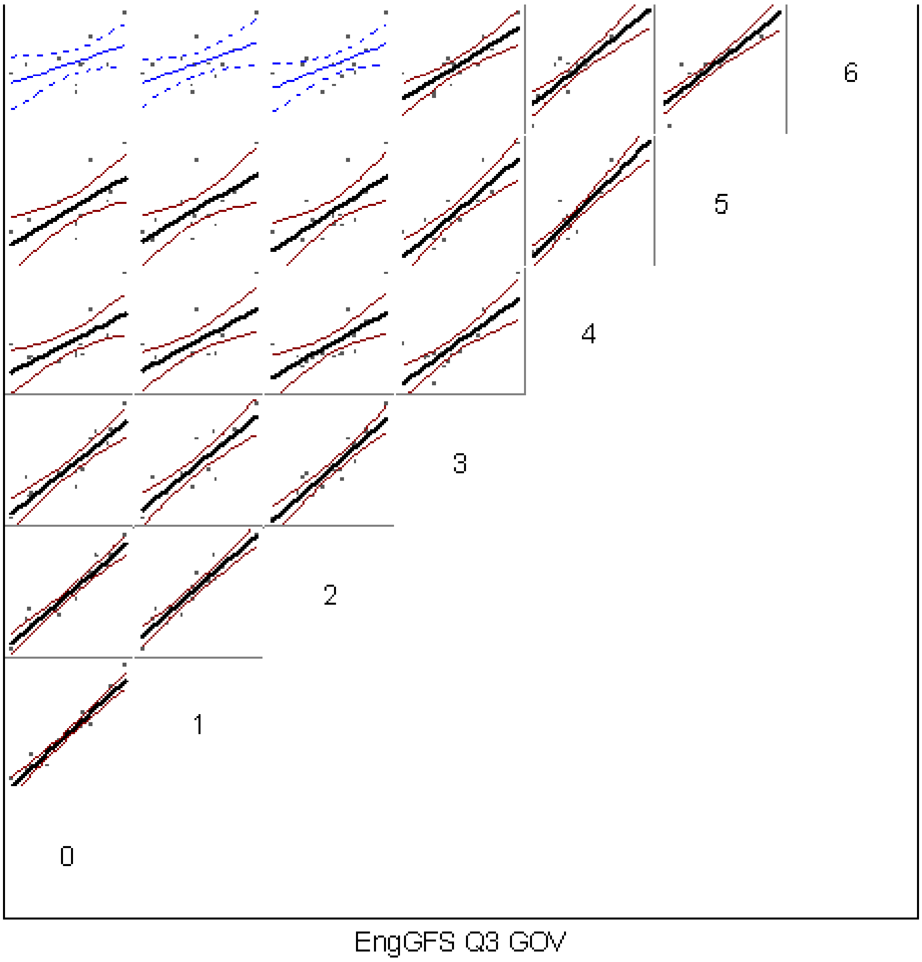


Figure 13.3.3.3. cont. **Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

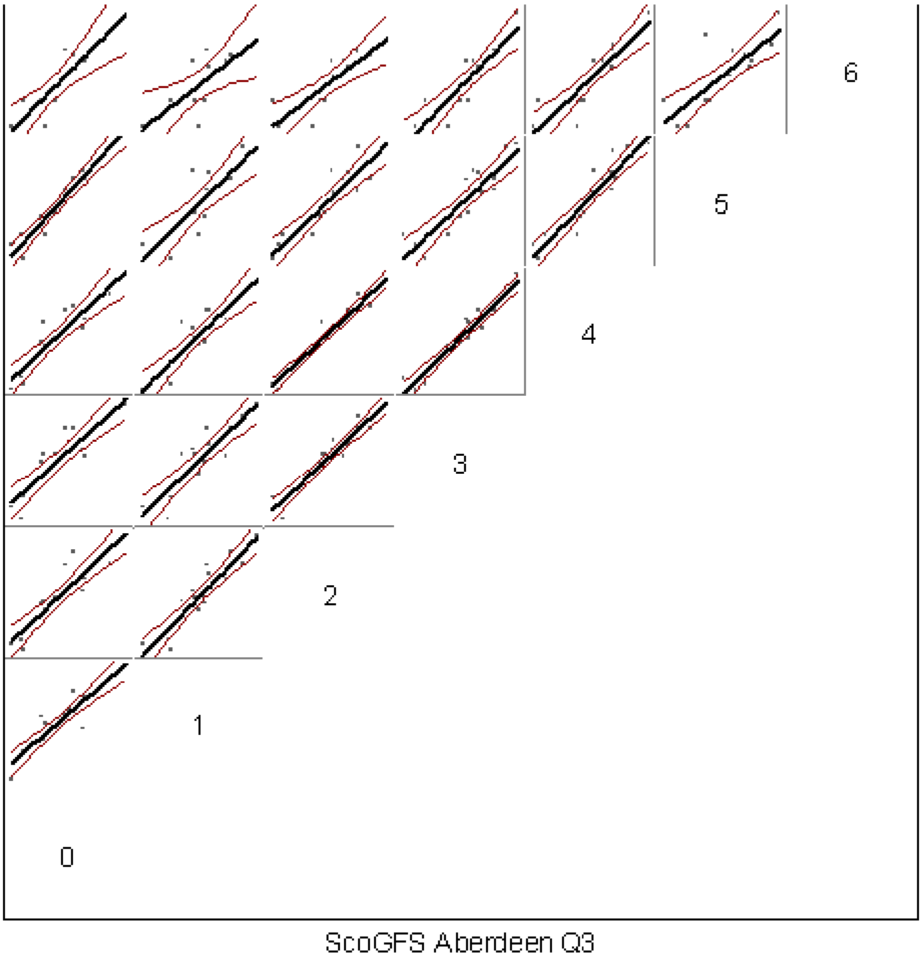


Figure 13.3.3.3. cont. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (Aberdeen) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

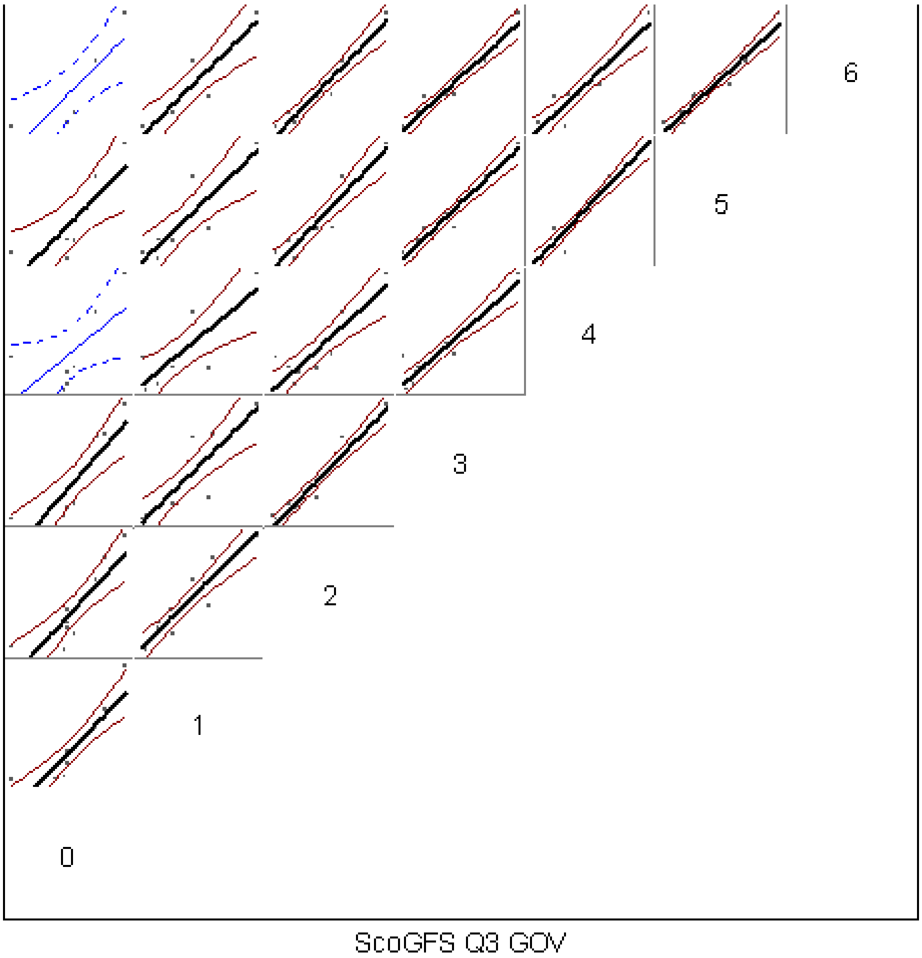


Figure 13.3.3.3. cont. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

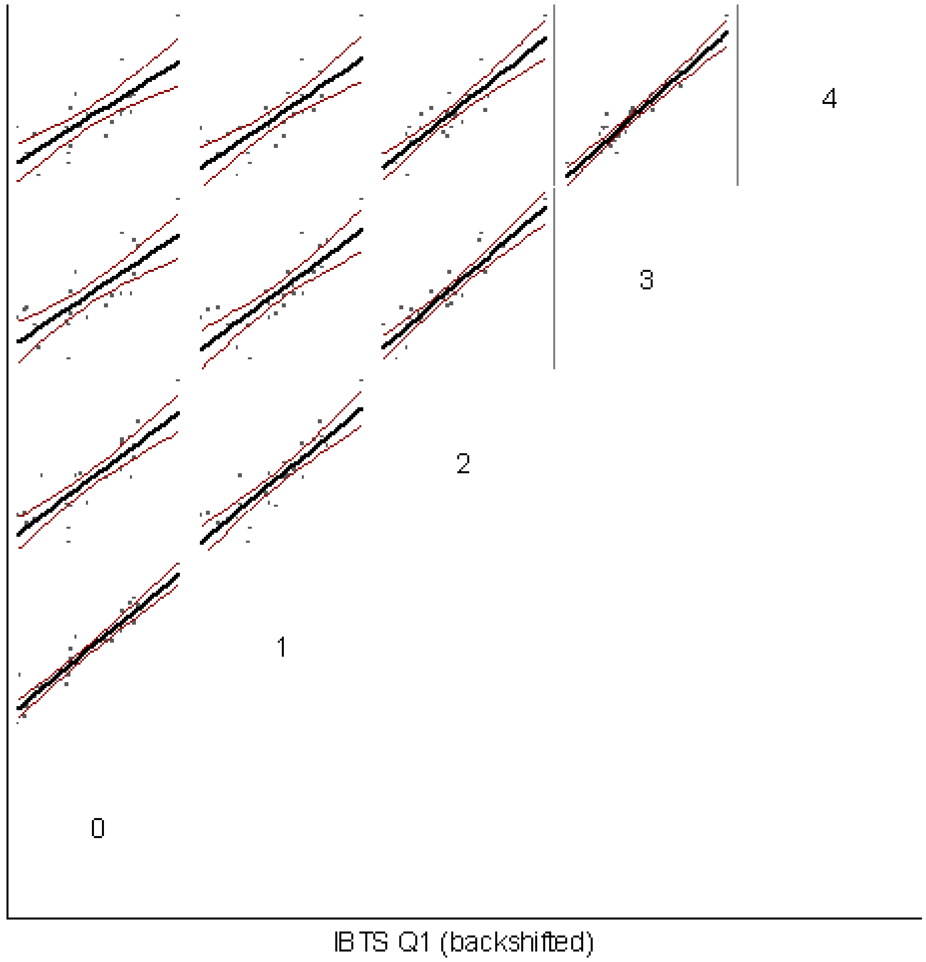


Figure 13.3.3.3. cont. **Haddock in Subarea IV and Division IIIa. Within-survey correlations for the IBTS Q1 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

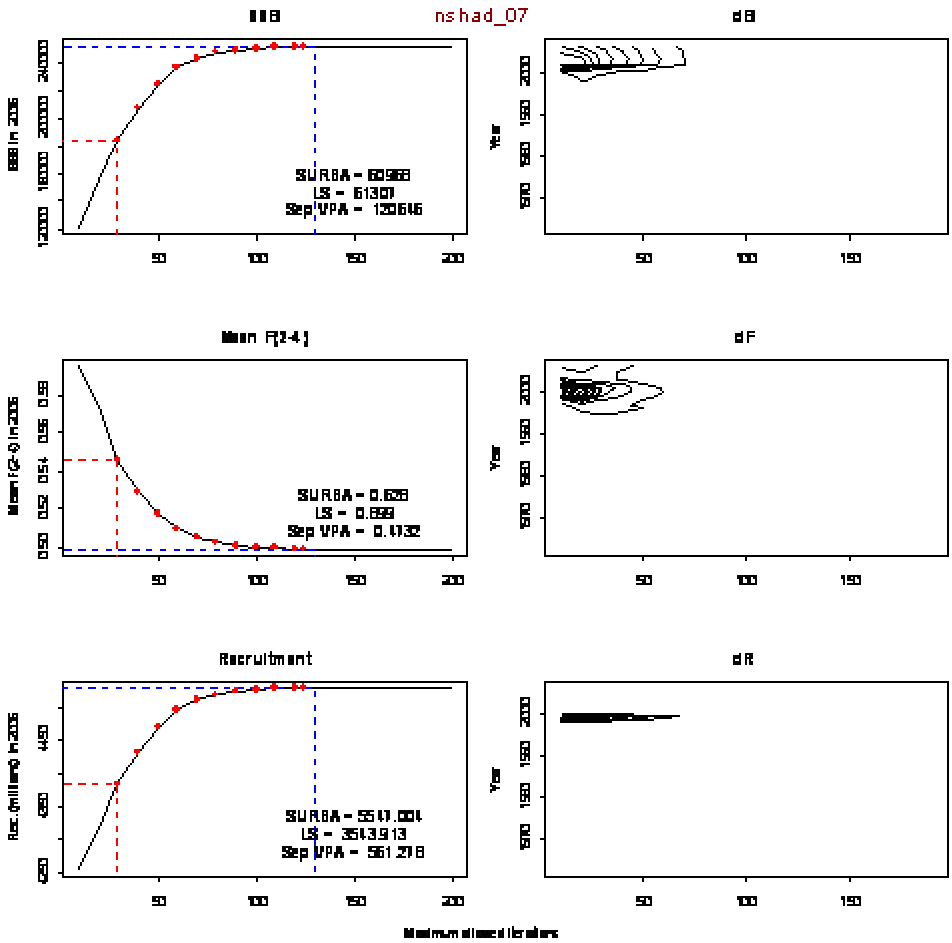


Figure 13.3.3.4. Haddock in Subarea IV and Division IIIa. The effect of the number of XSA iterations carried out on final year population estimates (left-hand plots). The solid lines show results from FLXSA, while the red dots give results from a series of comparative XSA runs. The point of convergence is shown by blue dashed lines, while the red dashed lines show 30 iterations (which for many years was the standard stopping point for this assessment). The legends give equivalent estimates from SURBA, Laurec-Shepherd and separable VPA models. The right-hand contour plots show differences over the full assessment time-series in biomass (dB), fishing mortality (dF) and recruitment (dR) between subsequent iterations. For this example, all the differences occur towards the end of the time-series. Note that this analysis has been carried out using the assessment from the 2008 WG report.

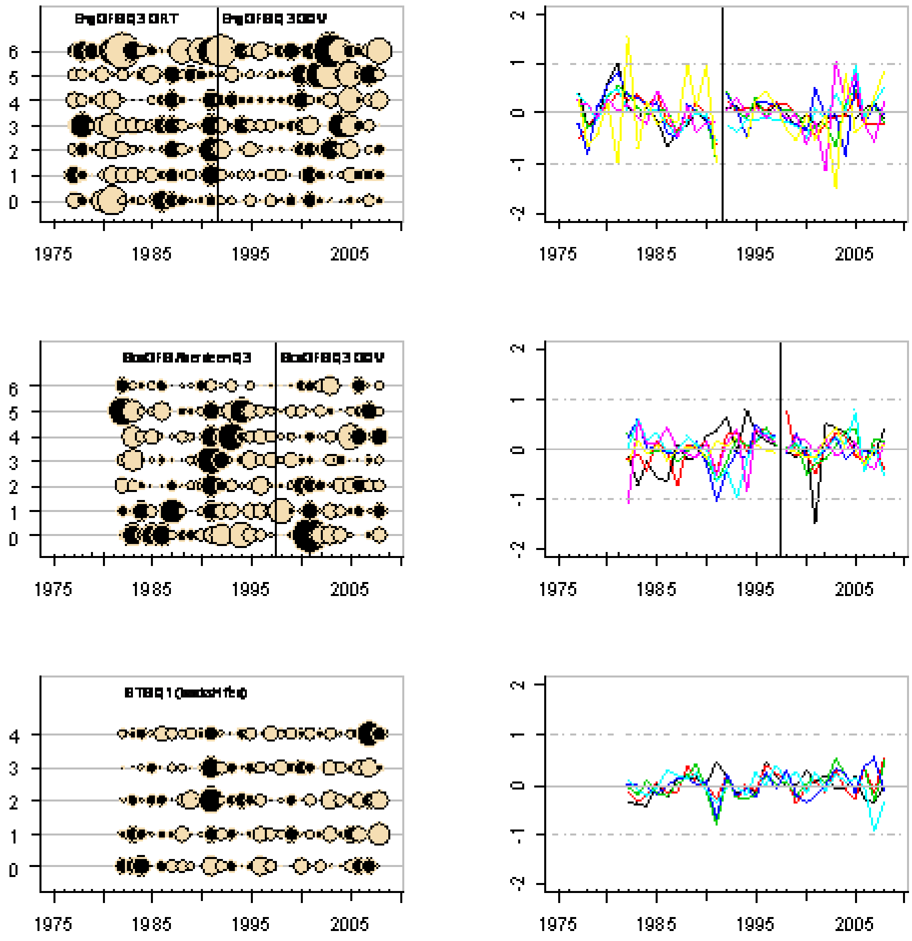


Figure 13.3.5.1 Haddock in Subarea IV and Division IIIa. Log catchability residuals for final XSA assessment. Both EngGFS and ScoGFS are split when used as tuning indices, and this split is shown by vertical lines on the relevant plots.

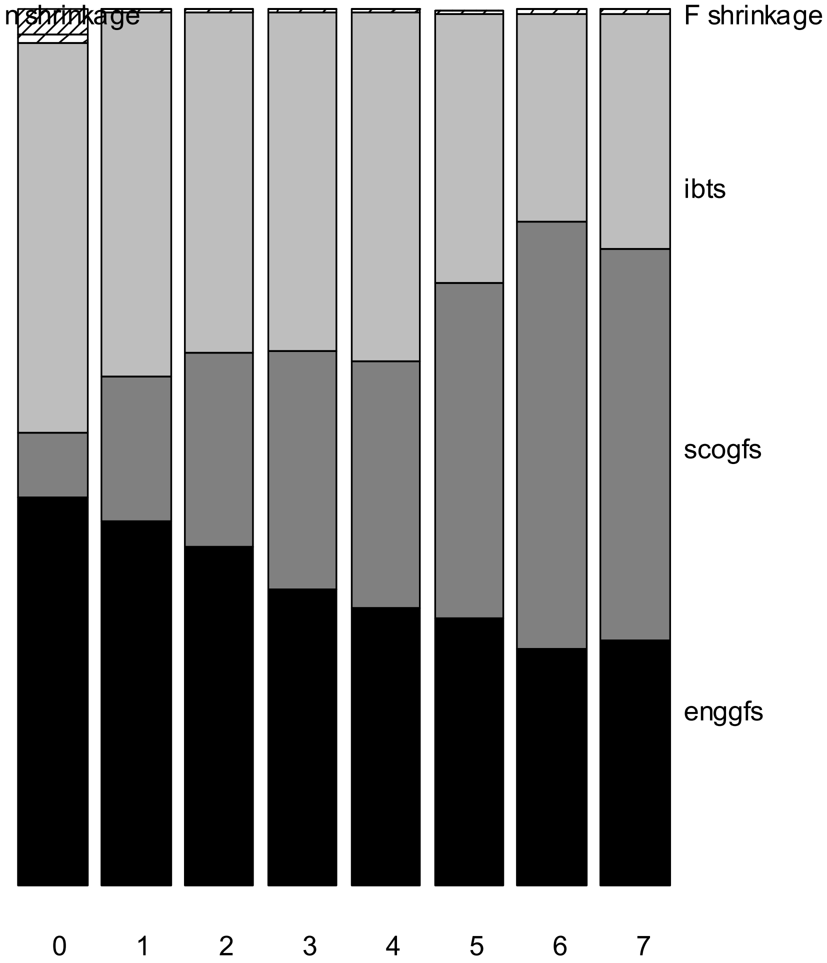


Figure 13.3.5.2. Haddock in Subarea IV and Division IIIa. Contribution to survivors' estimates in final XSA assessment.

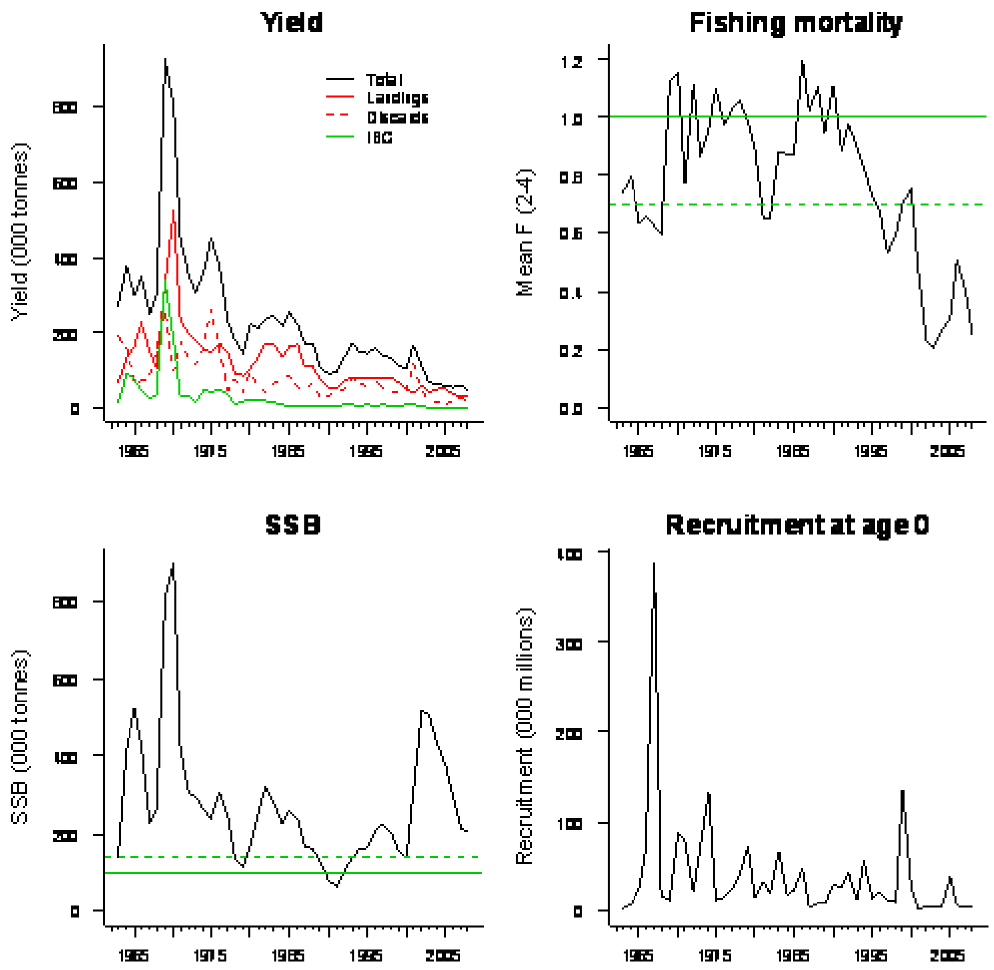


Figure 13.3.5.3. Haddock in Subarea IV and Division IIIa. Summary plots for final XSA assessment. Dotted horizontal lines indicate F_{pa} (top right plot) and B_{pa} (bottom left plot), while solid horizontal lines indicate F_{lim} and B_{lim} in the same plots.

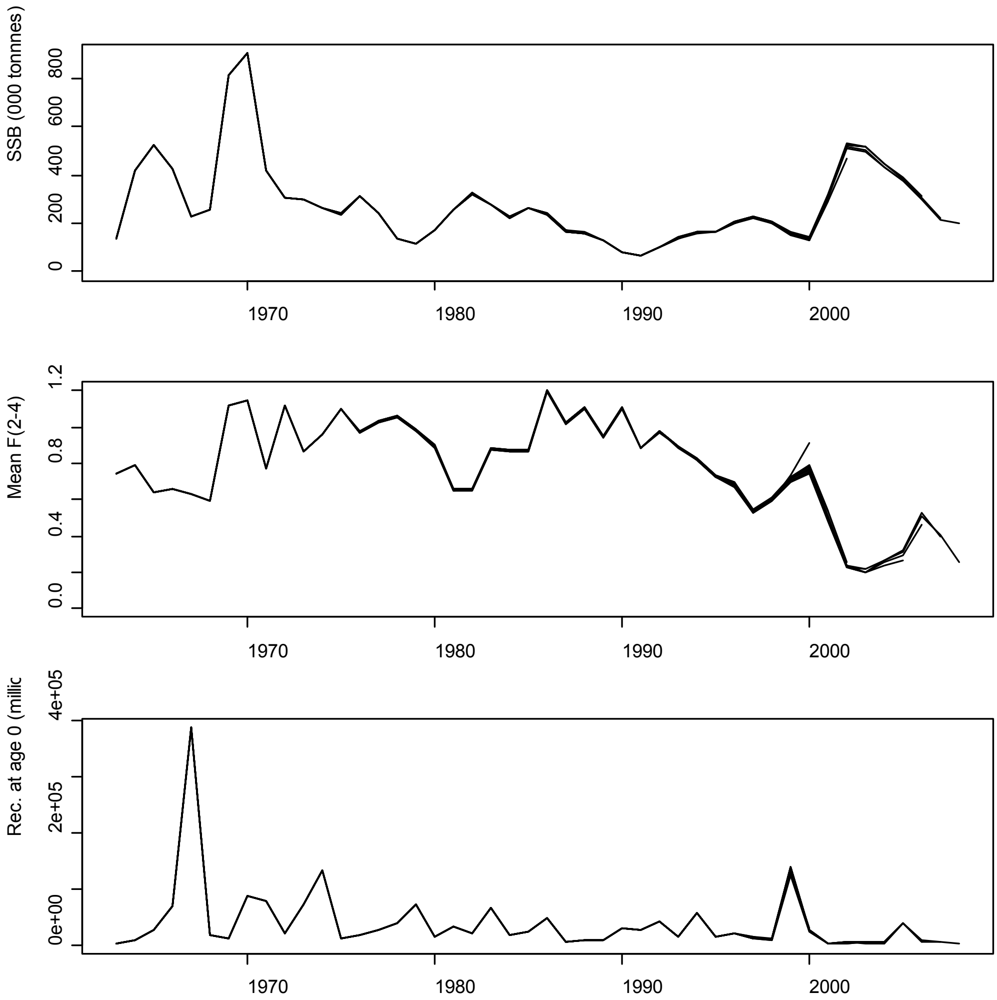


Figure 13.3.5.4. Haddock in Subarea IV and Division IIIa. Eight-year retrospective plots for final XSA assessment.

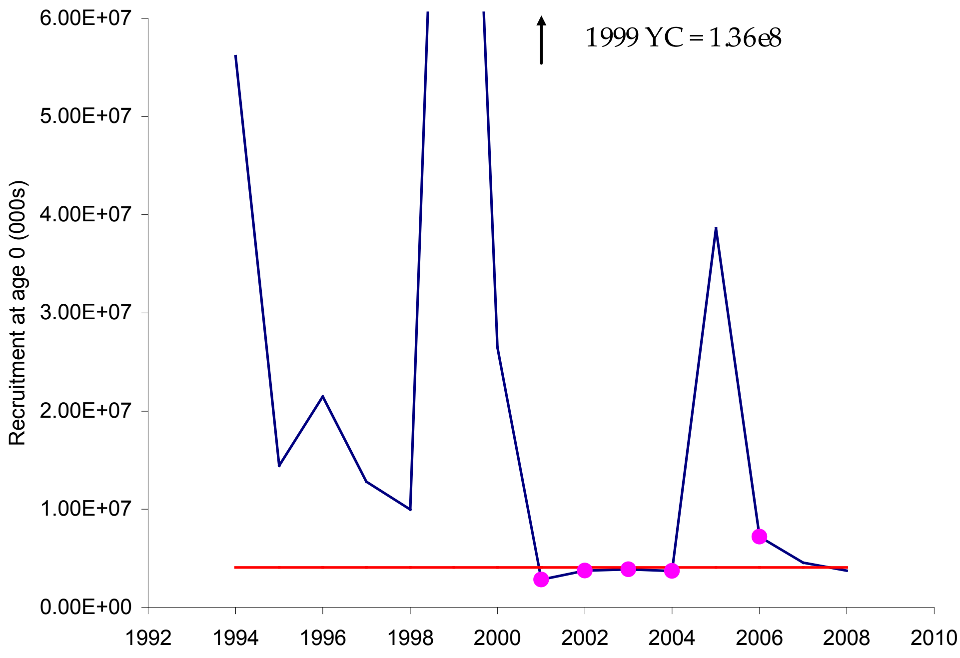


Figure 13.5.1.1. Haddock in Subarea IV and Division IIIa. Estimated recruitment from the final XSA assessment for 1994-2008 (black line), with 5 lowest values (pink dots) and geometric mean of these (red line).

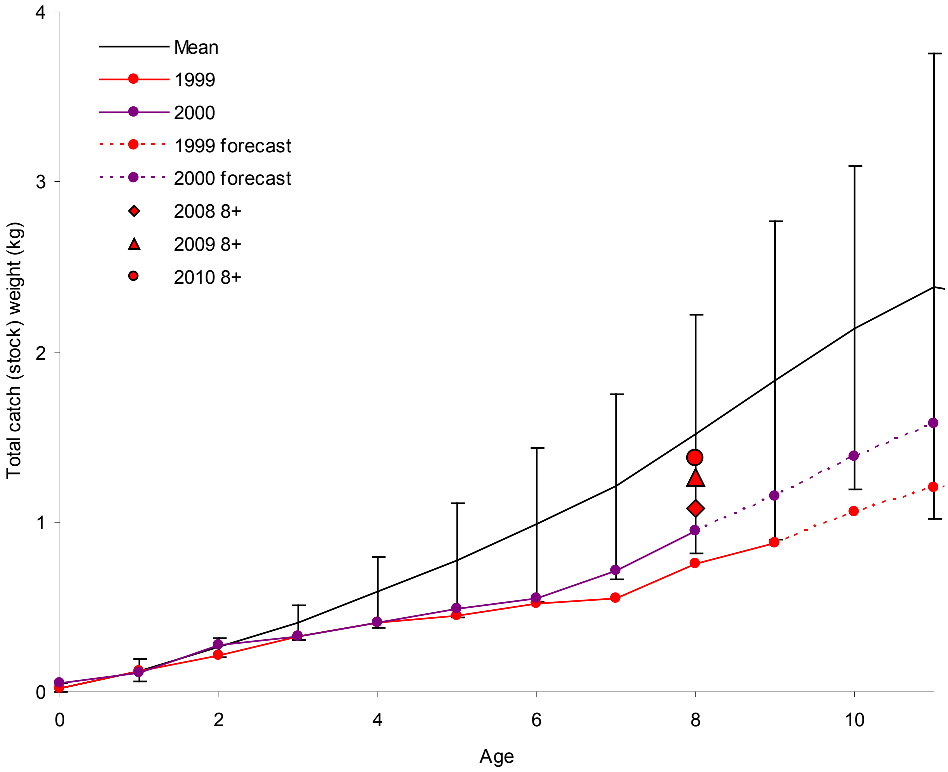


Figure 13.6.1. Haddock in Subarea IV and Division IIIa. Results of growth modelling for total catch weights (also used as stock weights) using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2008 cohorts (error bars give ±2 standard deviations). Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast). Large red symbols indicate forecast weight for the 8+ group in 2009 (diamond), 2010 (triangle) and 2011 (circle).

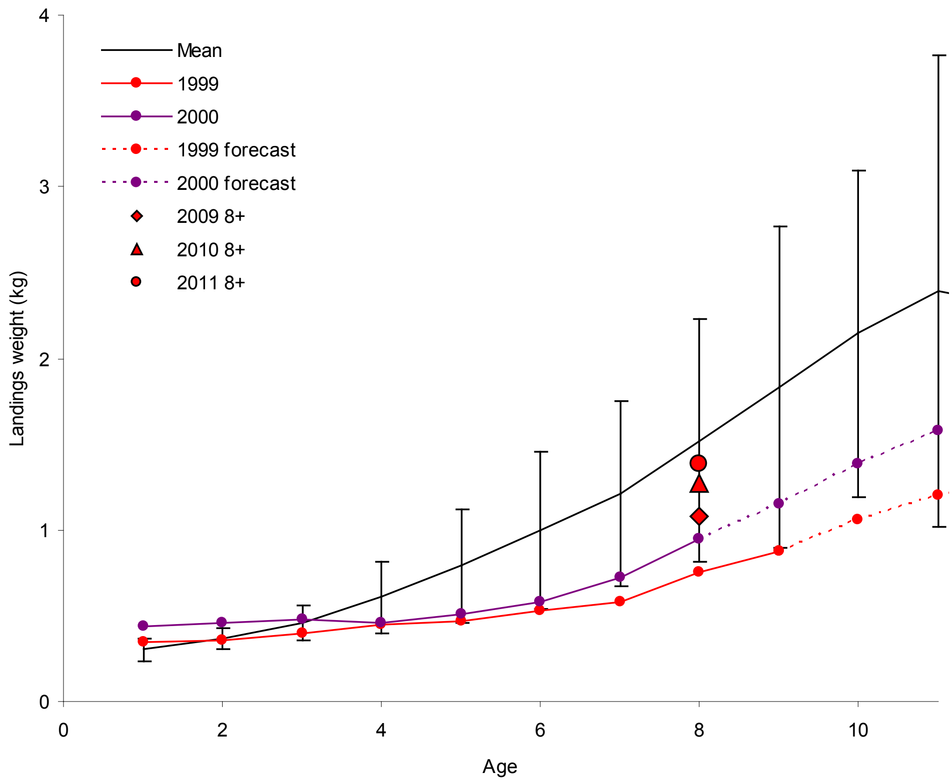


Figure 13.6.2. Haddock in Subarea IV and Division IIIa. Results of growth modelling for human consumption landings using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2008 cohorts (error bars give ±2 standard deviations). Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast). Large red symbols indicate forecast weight for the 8+ group in 2009 (diamond), 2010 (triangle) and 2011 (circle).

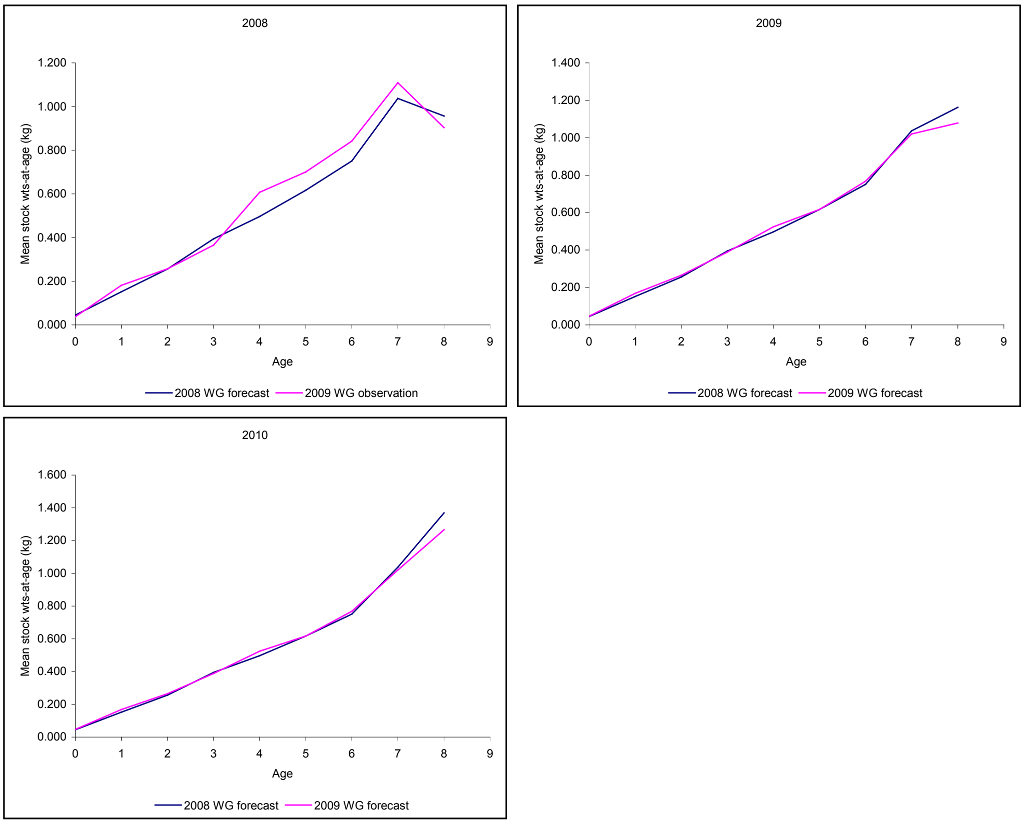


Figure 13.6.1. Haddock in Subarea IV and Division IIIa. Comparison of weights-at-age for 2008-10 from the 2008 WG, with the weights-at-age for 2008-10 from the 2009 WG.

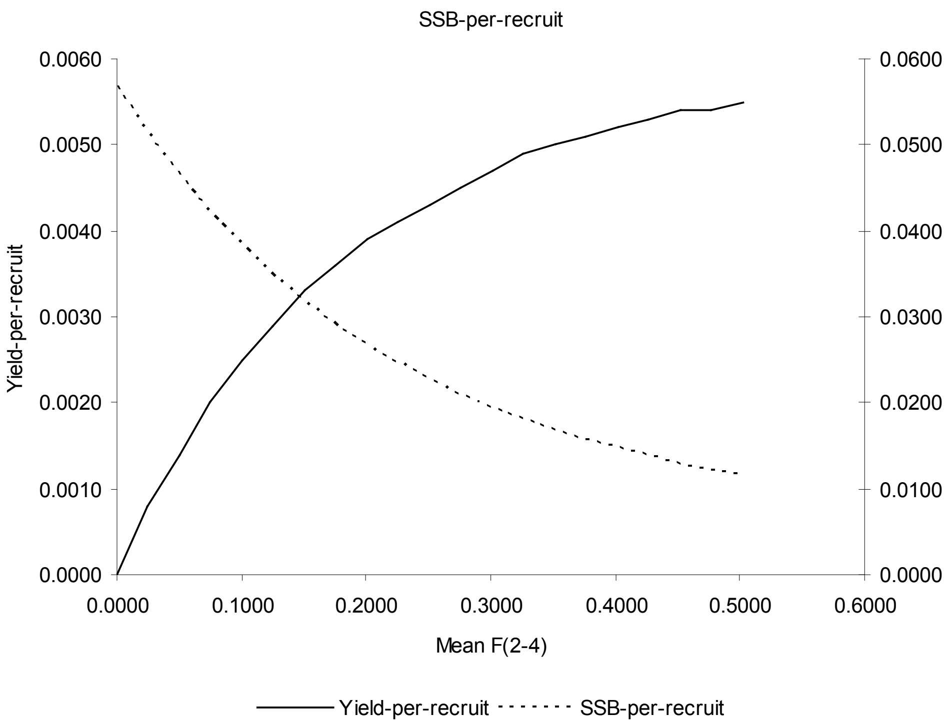


Figure 13.7.1. Haddock in Subarea IV and Division IIIa. Summary of yield-per-recruit analysis.

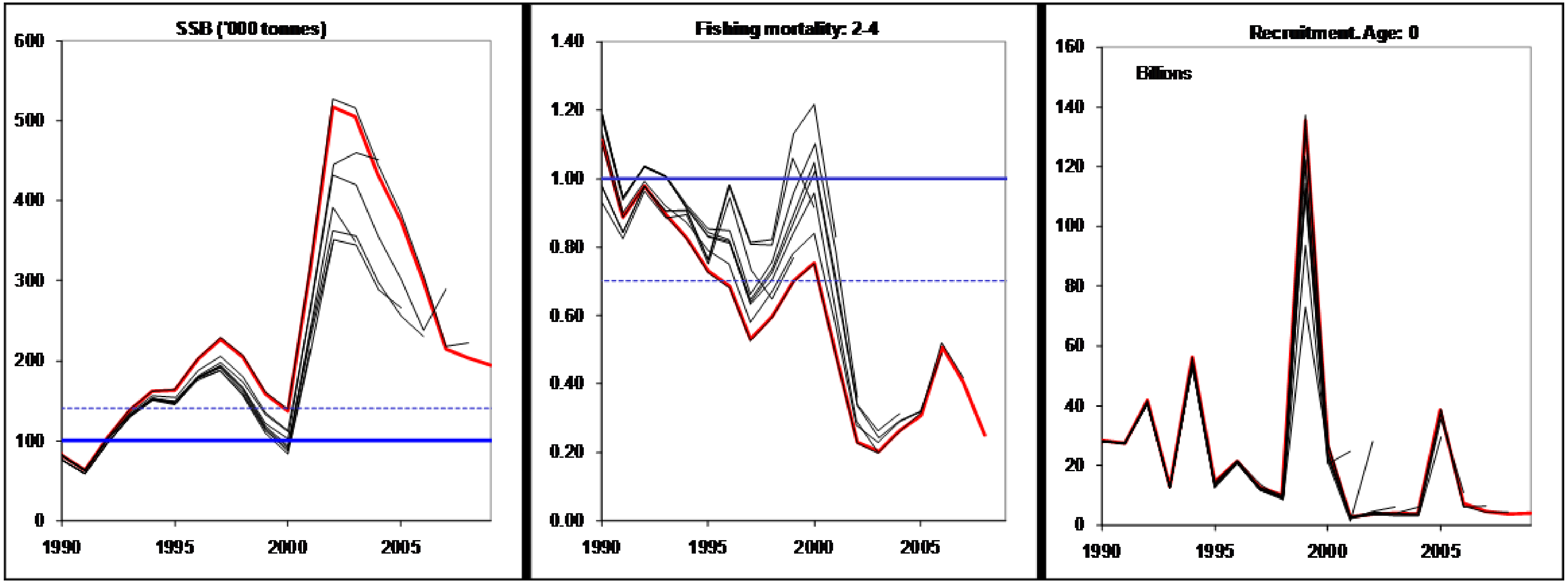


Figure 13.9.1. Haddock in Subarea IV and Division IIIa. Historical assessment quality plot.

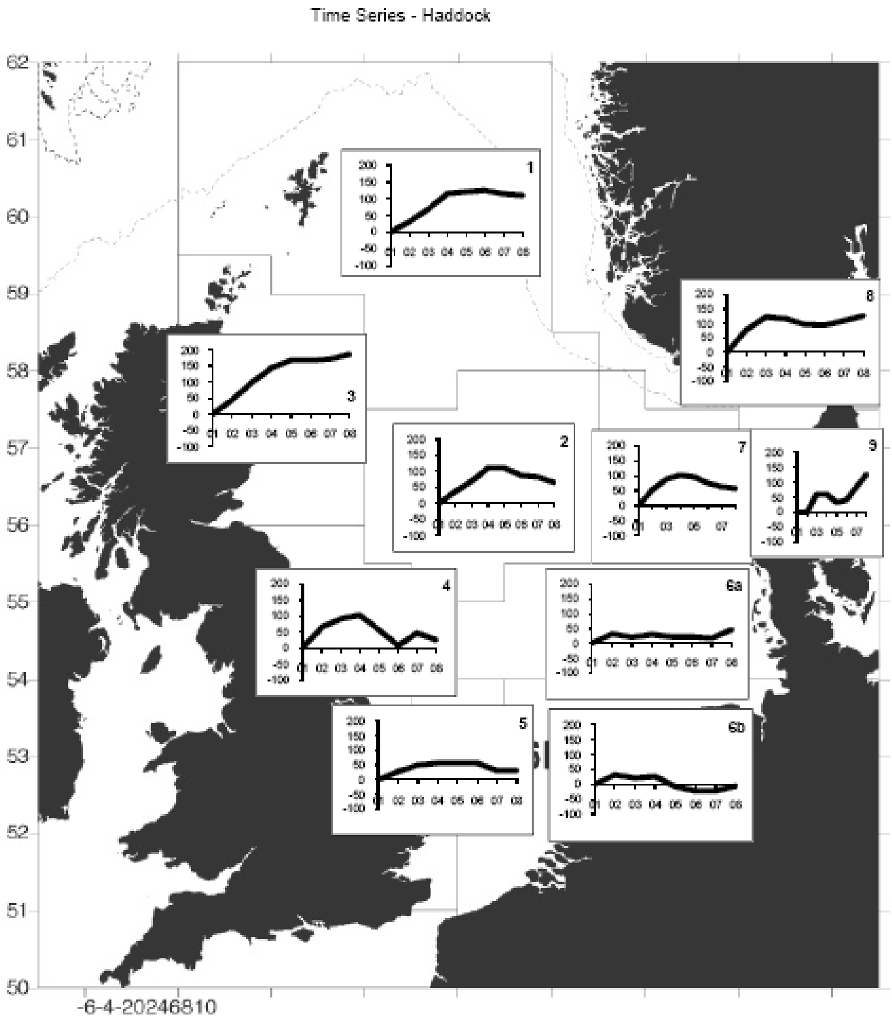


Figure 13.10.1. **Haddock in Subarea IV and Division IIIa. Results of 2008 North Sea Stock Survey.**

14 Cod

This assessment relates to the cod stock in the North Sea (Subarea IV), the Skagerrak (the northern section of Division IIIa) and the eastern Channel (Division VIId). This assessment is presented as an update assessment based on the revised assessment protocol specified by the 2009 meeting of WKROUND (ICES-WKROUND 2009).

A stock annex (within Annex 3 to this report) records more detail and references historic information on the stock definition, ecosystem aspects and the fisheries. This report section records only recent developments and new information presented to WGNSSK.

14.1 General

14.1.1 Stock definition

No new information was presented at the EG. A summary of available information on stock definition can be found in the Stock Annex.

14.1.2 Ecosystem aspects

No new information was presented at the EG. A summary of available information on ecosystem aspects is presented in the Stock Annex.

14.1.3 Fisheries

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species. In some of them, cod are considered to be a by-catch (for example in beam trawls targeting flatfish), and in others the fisheries are directed mainly towards cod (for example, some of the fixed gear fisheries). A summary of historic information on the directed and by-catch cod fisheries and past and current technical measures used for the management of cod is presented in the Stock Annex**.**

Technical Conservation Measures

In 2009 a new system of effort management, by setting effort ceilings (kilowatt-days), has been introduced in accordance with the new cod management plan (EC 1342/2008). The number of kw-days utilized was estimated for the different metiers of the national fleets during a reference period selected by each nation (2004-2006 or 2005-2007). From these reference values, the effort in the primary metiers catching cod (with discard and bycatch taken into account) will be reduced in direct proportion to reductions in fishing mortality until the new cod management plan target fishing mortality of 0.4 is achieved. EC 1342/2008 specifies that for 2009 a 25% reduction in effort shall be applied to metiers using Otter Trawls, Danish Seines or similar gears with mesh size 80 mm and larger and Gill Nets. However, if certain national fleet segments can provide proof that they use highly selective gears and/or that their catches per fishing trip comprise less than 5% cod, the 25% reductions will not pertain. National fleet segments with less than 1.5% cod catches can apply to be excluded from the effort management regime completely.

Changes in national fleet dynamics

The ICES WGFTFB meeting, which provides information on developments of fleets and gear impacting on the North Sea fisheries, was scheduled to meet after the WGNSSK 2009; a summary of information on fleet dynamics for all countries will be available in the ICES WGFTFB 2009 report.

Scotland

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS), and Scottish vessels were included in the CCS unless they opted out of it: as only one or two vessels opted out, compliance was close to 100%. In 2009, the CCS has been adopted by 439 Scottish and around 30 English and Welsh vessels: indeed, the CCS is now the only option available to Scottish skippers. At the time of writing (May 2009), 46 further RTCs have been implemented (with a target of 150 for the year). The CCS has two central themes aimed at reducing the capture of cod, namely through:

1) avoiding areas with elevated abundances of cod through the use of compulsory Real Time Closures (RTCs) and voluntary "amber zones"; and
2) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally.

In early 2008, a one-net rule was also introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

Cod avoidance under the real-time closures scheme is a key component of the CCS, but it is not yet clear how successful the avoidance strategies have been. Therefore, it is difficult to conclude what will be the likely effect of the recent fishery changes on cod mortality. Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock. Its success depends on the reaction of skippers to closures. If they move away to areas with few cod, then mortality should be reduced by the scheme. On the other hand, if they move to cod-rich areas and fish there until these areas are in turn closed, the impact on mortality may not be as significant as hoped. Changes in gear that are required to qualify for the Scottish Conservation Credits Scheme (CCS) are also likely to reduce bycatch (and therefore) discards of cod in the Nephrops fishery in particular.

Fisheries Science Partnerships

A series of new and ongoing collaborative studies were presented to WGNSSK providing information on a number of species; details are listed below. The WG welcomes FSP studies of this format, particularly on a regional basis as they enhance the ability of the group to interpret information and analyses, and enhance the quality of management advice that the group can provide.

UK - North East Coast Cod Survey

The NE Coast cod survey (De Oliveira *et al.*, WD 1) is a designated time-series survey conducted since 2003 as part of the UK Fisheries Science Partnership (FSP). The objective of the survey series is to provide year-on-year comparative information on distribution, relative abundance and size/age composition of cod and whiting off the NE coast of England. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock. In 2008 the population of cod in the survey area primarily comprised 1- and 2-year-olds, with some 3- and 4-year-olds. Older fish have generally been scarce throughout the time series. The relative strength of recent year classes of cod, as indicated by the time-series of FSP catch rates of 1-year-olds, has been similar to the trends given by the most recent ICES assessments (ICES-WGNSSK 2008). The FSP survey index appeared to follow the overall ICES assessment result more closely than the 1-group indices for the whole North Sea from the ICES International Bottom Trawl Survey (IBTS) programme (ICES-WGNSSK 2008). The FSP series indicated that the 2006 year class is about half as abundant as the relatively strong 2005 year class and that the 2006 and 2007 year classes are about the same magnitude.

UK - Codwatch

A second UK FSP project initiated in 2007 (the "North Sea Codwatch" project, Large et al., WD ??) has been mapping the distribution of young cod of the 2005 and 2006 year classes in the North Sea using a fisher self-sampling scheme (www.cefas.co.uk/fsp). The project involves 12 Eastern England Fish Producer Organisation (EEFPO) vessels, representing a wide range of fishing gears and target species, and operating throughout the North Sea. These vessels observed and recorded the incidence, fine-scale distribution and abundance of the 2005 - 2008 year classes of cod, and of cod in general in the North Sea from commercial catches made between April 2007 and March 2009.

Based on fishers' perception of current year class strength relative to previous year classes (participants have an average of 30 years fishing experience), the 2007 North Sea Codwatch results suggested that the 2005 year class was widely distributed throughout the North Sea (appearing in most sampled areas), with the highest levels of abundance occurring in the western-central North Sea in Q3, and in the western central and southern North Sea in Q4. Of all rectangles sampled (153 in total), only 19% recorded perceptions of "high" or "very high" abundance of the 2005 year class relative to historical abundance (the remainder recording perceptions of "zero", "low" or "moderate" abundance), but the proportion of rectangles recording "high" or "very high" increased with time (from 10% in Q2 to 26% in Q4).

In contrast, the 2006 year class was present in relatively few of the sampled rectangles, with 80% of sampled rectangles recording perceptions of "zero" or "low", but skippers noted that this may be a consequence of the low selectivity for young fish by the gear used. This year class was indicated to be more abundant at age 2 in the first two quarters of 2008, particularly in the southern North Sea in Q1 and in the central and southern North Sea (western part) in Q2. This trend is likely be largely driven by higher selectivity as the fish grow and recruit to the fishery. Data for Q3 2008 are at present incomplete and are unlikely to reliably indicate spatial patterns in and levels of relative abundance.

Spatial distribution maps of the modal index of relative abundance of the 2007 year class in catches sampled in each ICES rectangle for the first 3 quarters in 2008 suggest that this year class was again present in relatively few of the rectangles sampled. Comparison of the Q2 abundance data for the 2006 and 2007 year classes as 1-year-olds in 2007 and 2008 respectively suggest that these year classes may be of broadly similar strengths. These perceptions are consistent with WG estimates of these two year classes, both relative to each other and in the historical context.

Industry contributors commented that, in their opinion, the low estimates of relative abundance for all cod year classes observed during this project could be attributed to the use of larger mesh codends than used five years ago, and the transfer of effort to areas with few cod in order to eke out quotas and to minimise discards. In their opinion, low absolute abundance should not be interpreted solely as poor recruitment. Fishers independently have also reported greater abundance of cod in areas where historical abundance was low, despite this feature not showing clearly in the results of Codwatch thus far.

Denmark - REX

A collaborative biologist-fishermen project on North Sea cod (REX) was initiated by DTU-Aqua (Institute for Aquatic Resources at the Technical University of Denmark) and the Danish Fishermen Association in summer 2006 (Wieland et al., WD ?? revised). Three commercial vessels representing different fishing methods participated in the study. These were a trawler, a flyshooter and a gillnetter. The original survey area consisted of 7 ICES statistical rectangles in the north-eastern central North Sea.

During the first two surveys in June and August 2006 the fishermen were free to select the fishing positions that tended to be mainly located on rough bottom, which is usually not covered by scientific bottom trawl surveys. In order to allow the investigation of a potential effect of bottom type, the fishermen were subsequently requested to select paired stations within 10x10 nmi^2 with one station on sand bottom and the other on different bottom types (gravel and stone bottom, as well as ship wrecks in the case of the gillnetter) during the next two surveys in January/February and June 2007. In order to obtain a better impression of the spatial distribution, a higher degree of randomisation in the survey design was used in surveys conducted in August 2007, in February and August/September 2008, and in January/February 2009 (survey area divided into 5x5 nmi^2; randomly selected fishing position with the square chosen by the fishermen; at least 25 % of the stations on sand bottom; number of squares covered in an ICES rectangles differed between the vessels).

The first three surveys resulted in sampling of a few clusters of stations in favourite spots of fishermen, yielding considerable catch rates of cod. In the later surveys a much wider extension of areas with high densities of cod were recorded (e.g. catch rates of more than 1 ton of cod per nmi2 were found in 25 % of the stations in the August 2007 survey). In general, catch rates were lower in spring than in summer, and catches were considerably higher on rough bottom than on sand in the summer surveys. For the most recent surveys, the results suggest an increase in cod biomass density from the 3rd quarter 2007 to the 3rd quarter 2008 and from the 1st quarter 2008 to the 1st quarter 2009. The length frequencies ranged from 20 to 129 cm with a peak between 30and 40 cm for the trawler and flyshooter (105 and 100 mm meshsize in the codends). The length frequencies for the gillnetter started at larger sizes due to meshsize selection whereas the maximum length of the cod observed did not differ much between the three fishing methods.

Cod between 60 and 80 cm was well represented in the length frequencies for all vessels, and larger (> 100 cm) cod was caught regularly. CPUE in numbers at age 2 from the trawler indicates that the 2007 year class is about two times stronger than the 2006 year class and that also the abundance of the older age have increased in the study area. A comparison with the IBTS indices suggests a moderate decline of the efficiency of the IBTS for cod older than age 2 in the 3rd quarter and a decrease in the catchability from age 2 to 3 followed by an increase in catchabilibity beyond age 4 in the 1st quarter 2008.

UK - SiSP

As part of the SiSP collaborative research intiative in May 2008, Scotland ran comparative trials of the GOV gear (as used in IBTS) and a standard commercial gear (Reid et al. 2009). These were conducted using 66 twin-trawl hauls on the commercial vessel *MFV* Russa Taign, at a number of locations between Aberdeen and Shetland. In general, the results of the trials show that the catch rates for most key species is quite similar in both nets. The catch rate for cod in the GOV was slightly, but significantly, greater than for the commercial net. There was no length dependency in relative catch rates for cod (see Figure 14.17). These results need to be treated with a degree of caution, as neither gear was used in exactly the same way as the would be in survey or commercial operations, but the study does provide evidence against the common assumption that the GOV is a "bad cod net".

France - Fisher self sampling

In 2008 France initiated a collaborative Industry Science partnership with the help of a European financial income (EFF) to extend the DCR sampling scheme and to give more information about the situation of the French cod fishery in the Eastern channel and the Southern North Sea. The study, called "cod study in 7d/4c", was established with the industry and study was planned for 7 months, from mid October 2008 to mid May 2009 (Léonardi *et al*. 2008 WD ??).

Based on the Ifremer fishing activity census (conducted each year to provide information on the different metier for all boats each month) and also logbook information, a monthly scheme was developed to sample 3 % of the fishing activity targeting demersal species and having cod as by catch in 7d and 4. The principle is to sample normal fishing practice as usual in observation at sea.

These data are preliminary but show clearly that all of the catch was above the minimum landing size (35 cm) with the discarded component corresponding mainly to Boulogne vessels (cod quota entirely closed) and the retained sizes to Port-en-Bessin. The difference in the length structure is certainly linked to different fishing areas for these two fleets. High rates of discards were recorded for lengths between 37 and 48cm (ages 2 and 3) confirming the information provided by French fisherman and the WGNSSK in 2007 (ICES WGNSSK 2008) of recent improved recruitment in the southern North Sea and VIId.

The North Sea Stock Survey

The North Sea Stock Survey (Laurenson 2008, WD ??) was submitted to WGNSSK in order for the fishers perception of the state of the stock to be considered as part of the assessment process.

Abundance

The spatial distribution of the change in the abundance since 2003 is recorded by survey area in Figure 14.18. The perceptions of cod abundance remain positive with the majority of respondents (67 – 91% per area) reporting "more" or "much more" cod. No respondents perceived there to be "much less" cod. The modal response from respondents in each of the vessel size groups was that cod were "more" abundant. Compared to 2007, a similar percentage of the respondents from vessels <15m (82%) believe there are "more" or "much more" cod and in the 15 – 24m and >24m groups 84% and 92% respectively, indicated that there were "more" or "much more" cod, higher percentages than recorded in 2007. By fishing gear type the vast majority of respondents gave a positive view of cod abundance, the modal response being "more" for each gear type.

Size Range

As in previous surveys the modal response in all areas was for "all sizes" of cod being caught. Strong modal responses of "all sizes" were also observed by vessel size and gear type. In each area, the percentages of respondents reporting "mostly small" cod were lower than in 2007. As in 2007, the highest percentage of respondents reporting "mostly small" cod referred to area 6b, but the percentage of responses in this category had decreased from 33% to 17%. Except in area 3, where the number of responses for cod size only numbered seven, "mostly large" cod were reported for all areas with the highest percentage response occurring for area 7 (26%). As in 2007, the gear type in which the highest proportion of "mostly small" cod was reported was the beam trawl (13% of respondents); while less than 10% of respondents in each of the other groups reported "mostly small" cod. The highest percentage of "mostly large" responses was received from the gill net group (22%).

Discards

In this survey between 50 and 77% of responses for areas 1 – 5 and 9 indicated that there were "more" or "much more" discarding. Except for area 4, these percentages were higher than recorded in 2007. As in 2007, the modal response for areas 6a, 6b, 7 and 8 was that "no change" in discarding had occurred. Only the <15m group showed a strong modal response for "no change" in cod discards. Opinions of the respondents from the larger vessel size groups were mainly split between "no change"; "more" or "much more". By gear type the pattern of responses is more complex and although the distributions of responses are generally different to those of 2007, there has been a decrease in the percentages of respondents indicating "much less" or "less" discards. Beam trawl, *Nephrops* trawl and gill net respondents gave modal responses of "same" while respondents using trawl or seine were more evenly split between "same", "more" and "much more".

Recruits

As in 2007, up to 46% of respondents for each area reported "don't know" for recruitment. As in 2007, excluding the "don't know" responses, the modal responses from five of the ten areas was "high". By vessel size, of those who expressed an opinion, the modal response of respondents in each size group was for "high" recruitment. This is more positive than in 2007, where the modal responses for both the 15 – 24m and >24m groups were "moderate".

Comparison between the fishers survey and the IBTS survey data has been shown in previous years the time series are broadly in agreement in recording a stable overall stock abundance in until 2003 - 2005 followed by an increase more recently, especially in the north-western North Sea. The IBTS survey (Figure 14.3a,b) has more variability, due to the inherent spatial variation, but exhibits similar trends in the same areas as the fishers survey, with significant increases in the north and west.

14.1.4 Management

Management of cod is by TAC and technical measures. The agreed TACs for Cod in Division IIIa (Skagerrak), VIId and Sub-area IV were as follows:

TAC(000T)	2005	2006	2007	2008	2009
IIIa (Skagerrak)	3.9	3.3	2.9	3.2	4.1
IIa + IV	27.3	23.2	20.0	22.2	28.8
VIId					1.7

There was no TAC for cod set for Division VIId alone until 2009. Landings from Division VIId were counted against the overall TAC agreed for ICES Divisions VII b-k.

EU Cod Recovery plans

A Cod Recovery Plan which detailed the process of setting TACs for the North Sea cod was in place until 2008. Details of it are given in EC 423/2004 and previous working group reports. ICES considered the recovery plan as not consistent with the precautionary approach because it did not result in a closure of the fisheries for cod at a time of very low stock abundance and until an initial recovery of the cod SSB had been proven.

In April 2008, the European Commission adopted a proposal to amend the cod recovery plan, based on input from stakeholders, and on scientific advice from both ICES and STECF that current measures have been inadequate to reduce fishing pressure on cod to enable stock recovery. The main changes proposed were replacing targets in terms of biomass levels with new targets expressed as optimum fishing rates intended to provide high sustainable yield, and introducing a new system of effort management by setting effort ceilings (kilowatt-days) for groups of vessels or fleet segments to be managed at a national level by Member States. The new system is intended to be simpler, more flexible and more efficient than the previous one, allowing effort reductions to be proportionate to targeted reductions in fishing mortality for the segments that contribute the most to cod mortality, while for other segments effort will be frozen at the average level for 2005-2007.

In December 2008 the European Commission and Norway agreed on a new cod management plan implementing the new system of effort management and a target fishing mortality of 0.4. The recovery plan is evaluated against the precautionary approach reference points in Section 15 of this report. Details of it are given in EC 1342/2008. The HCR for setting TAC for the North Sea cod stock are as follows:

Article 7: Procedure for setting TACs for cod stocks in the Kattegat the west of Scotland and the Irish Sea

1. Each year, the Council shall decide on the TAC for the following year for each of the cod stocks in the Kattegat, the west of Scotland and the Irish Sea. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are forecast by STECF as corresponding to the fishing mortality rates referred to in paragraphs 2 and 3:

(a) a quantity of fish equivalent to the expected discards of cod from the stock concerned;

(b) as appropriate a quantity corresponding to other sources of cod mortality caused by fishing to be fixed on the basis of a proposal from the Commission.

Article 8: Procedure for setting TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).

2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.

3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75 % for the TACs in 2009, 65 % for the TACs in 2010, and applying successive decrements of 10 % for the following years.

4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:

(a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;

*(b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: 0,4 – (0,2 * (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))*

(c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.

5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20 % below or above the TACs established in the previous year.

6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.

Article 9: Procedure for setting TACs in poor data conditions

Where, due to lack of sufficiently accurate and representative information, STECF is not able to give advice allowing the Council to set the TACs in accordance with Articles 7 or 8, the Council shall decide as follows:

(a) where STECF advises that the catches of cod should be reduced to the lowest possible level, the TACs shall be set according to a 25 % reduction compared to the TAC in the previous year;

(b) in all other cases the TACs shall be set according to a 15 % reduction compared to the TAC in the previous year, unless STECF advises that this is not appropriate.

Article 10: Adaptation of measures

1. When the target fishing mortality rate in Article 5(2) has been reached or in the event that STECF advises that this target, or the minimum and precautionary spawning biomass levels in Article 6 or the levels of fishing mortality rates given in Article 7(2) are no longer appropriate in order to maintain a low risk of stock depletion and a maximum sustainable yield, the Council shall decide on new values for these levels.

2. In the event that STECF advises that any of the cod stocks is failing to recover properly, the Council shall take a decision which:

(a) sets the TAC for the relevant stock at a level lower than that provided for in Articles 7, 8 and 9;

(b) sets the maximum allowable fishing effort at a level lower than that provided for in Article 12;

(c) establishes associated conditions as appropriate.

14.2 Data available

14.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 14.1. The WG estimate for landings from the three areas (IV, IIIa-Skagerrak and VIId) in 2006 - 2008 were based on annual data, as opposed to quarterly data in the past, because of ongoing difficulties with international data aggregation procedures, particularly with regard to discard raising.

The Netherlands, France, Belgium and Sweden, who respectively landed 8%,7%, 4% and 2% of all cod for combined area IV and VIId in 2008, do not provide discard estimates for this combined area. Similarly, Germany, the Netherlands and Belgium, who respectively landed 2%, 1% and 1% of all cod in area IIIa, do not provide discard estimates for this area. Norwegian discarding is illegal, so although this nation landed in 2008 18% and 9% of all cod in combined area IV and VIId, and area IIIa respectively, it does not provide discard estimates.

The landings estimate for 2008 is 27.2 thousand tonnes, split as follows for the separate areas (thousand tonnes):

<table>
<tr><th></th><th>Landings</th><th>TAC</th><th>Discards</th></tr>
<tr><td>IIIa-Skagerrak</td><td>3.3</td><td>3.2</td><td>2.2</td></tr>
<tr><td>IV</td><td>22.2</td><td>22.2</td><td rowspan="2">19.6</td></tr>
<tr><td>VIId</td><td>1.4</td><td>Comb VIIb-k*</td></tr>
<tr><td>Total</td><td>26.8</td><td></td><td>21.8</td></tr>
</table>

*Division VIId is included in the TAC relevant to Divisions VIIb-k

WG estimates of discards are also shown in the above table.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age. For 2006, Denmark was excluded from this calculation as they provided their own discard estimates. For 2007 and 2008, Scottish, Danish, German and England & Wales discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in sub-area IV to account for missing discards. Discard numbers-at-age for IIIa-Skagerrak were based on observer sampling estimates. For 2006 to 2008, Danish and Swedish discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in Division IIIa-Skagerrak to account for missing discards. Although in some cases other nations' discard proportions are available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset. Because of the data co-ordination difficulties in 2006, which have continued to 2008, it was not possible to consistently apply Danish (and now also England and Wales) discard age compositions to other years, even though these are now available. Figure 14.1a plots reported landings and estimated discards used in the assessment.

For cod in IV, IIIa-Skagerrak and VIId, ICES first raised concerns about the misreporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG believes that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for 1998 were adjusted to include an estimated 3 000t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no *a priori* reason to believe that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicated that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, it has no alternative than to use its best estimates of landings, which in general are in line with the officially reported landings. An attempt is made to incorporate a statistical correction to the sum of reported landings and discards data in the assessment of this stock, but the figures shown in Table 14.1 and Figure 14.1a nevertheless comprise the input values to the assessment. Buyers and Sellers legislation introduced in the UK towards the end of 2005 is expected to have improved the accuracy of reported cod landings for the UK. This has brought the UK in line with existing EU legislation.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2008 was ??? tonnes (Table 2.1.3##).

Age compositions

Age compositions were provided by Denmark, England, Germany, the Netherlands, Scotland and Sweden (see Section 1.2.4##).

Landings in numbers at age for age groups 1-11+ and 1963-2008 are given in Table 14.2. SOP values are shown. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV (Tables 2.1.3 to 2.1.5##) and separately for the Skagerrak (Table 14.1). During the last five years an average of 82% (80% in 2008) of the international landings in number were accounted for by juvenile cod aged 1-3. In 2008, age 1 cod comprised 25% of the total catch by number, age 2, 35% and age 3 (the 2005 year class), 33%.

Discard numbers-at-age are shown in Table 14.3. The proportions of the estimated total numbers discarded are plotted in Figure 14.1b and the proportion of the estimated discards for ages 1-3, in Figure 14.1c. Estimated total numbers discarded have varied between 35 and 55% since 1995, but have shown an increase to above 70% since 2006, due to the stronger 2005 year class entering the fishery (estimated to be almost the size of the 1999 year class), and a mismatch between the TAC and effort. Historically, the proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. During the last six years, it is estimated to be at around 90%. At ages 2 to 4 discard proportions have been increasing steadily and are currently estimated to be 73% at age 2, 64% of age 3 (the 2005 year class) and 12% of 4 year old cod in 2008. Note that these observations refer to numbers discarded, not weight.

14.2.2 Weight at age

Mean weight at age data for landings, discards and catch, are given in Tables 14.4-6. Total catch mean weight values were also used as stock mean weights. Long-term trends in mean catch weight at age for ages 1-9 are plotted in Figure 14.2, which indicates that there have been short-term trends in mean weight at age and that the decline noted during the 90's at ages 3-5 now seems to have been reversed, most likely as a result of high-grading. Ages 1 and 2 show little absolute variation over the long-term.

14.2.3 Maturity and natural mortality

In the historic assessments natural mortality for cod is assumed to be constant in time. However, calculations with the SMS key run (Stochastic Multi Species Model; Lewy and Vinther, 2004), carried out by the Working Group on Multi Species Assessment Methods (ICES WGSAM 2008), indicate that predation mortalities (M2) declined substantially over the last 30 years for age 1 and age 2 cod. In addition, calculations with the latest 4M key run (Vinther et al., 2002), carried out during the EU project BECAUSE (contract number SSP8 CT 2003 502482) in 2007, indicate a systematic increasing trend for older ages (3–6) of cod due to seal predation. A review of the WGSAM estimates was carried out at the 2009 WKROUND benchmark assessment of the North Sea cod (ICES-WKROUND 2009), and the variable time series of M, which include the major sources of predation on North Sea cod, was considered appropriate for use in future assessments. Table 14.7b shows estimates of M, based on multi species considerations adopted for the revised assessment. For 2008 the same natural mortalities were applied as for 2007 since no new estimates are available. WKROUND also concluded that as new stomach data (e.g. on seal predation) become available, a revision of more recent M2 values to reflect the current status of the food web, should be considered.

Values for maturity are given in Table 14.7a, they are applied to all years and are unchanged from those used in recent assessments. ICES-WKROUND (2009) also examined systematic changes in age at maturation which has increased in a number of cod stocks. In recent years, North Sea cod has shown changes in maturity with fish maturing at a younger age and smaller size. The variable maturity data leads to a substantial deterioration in model fit, and therefore does not help explain the relationship between SSB and recruitment. ICES-WKROUND (2009) concluded that until further investigations are carried on issues linked to earlier maturity, for example relating the quality of reproductive output of young first time spawners to recruitment success, the constant maturity ogive should be used for future assessments.

14.2.4 Catch, effort and research vessel data

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the method of recording data means that individual trip data are now more accessible than before; however, the recording of fishing effort as hours fished has become less reliable as it is not a mandatory field in the logbook data. Consequently, the effort data, as hours fished, are not considered to be representative of the fishing effort actually deployed. The WG has previously argued that, although they are in general agreement with the survey information, commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK 2001), and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006, 2007). Therefore, although the commercial fleet series are available, only survey and commercial landings and discard information are analysed within the assessment presented.

Two survey series are used within this assessment:

- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2009. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.
- Quarter 3 international bottom-trawl survey (IBTSQ3): ages 0–6+, covering the period 1991–2008. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. The Scottish and English third quarter surveys described above contribute to this index.

The data used for calibrating the catch-at-age analysis are shown in Table 14.9.

Maps showing the IBTS distribution of cod are presented in Figures 14.3a-b (ages 1-3+). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 and 2005 year-classes are clearly apparent from these charts. Fish of older ages continued to decline until 2006 due to the very weak 2000, 2002 and 2004 year classes, but have subsequently begun to increase, especially in the north and west. The abundance of 3+ fish is still at a low level compared to historic levels but is increasing.

An analysis of IBTSQ1 data by Rindorf and Vinther (WD 4 in ICES-WGNSSK, 2007) illustrated the increased importance of recruitment from the Skagerrak. The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. WKROUND (2009) compared the standard and an extended area IBTS index for IBTS Q1 and Q3. The indices show minor changes for the ages used in the assessment (1–5 for IBTSQ1 and 1–4 for IBTSQ3) when the index is extended. The largest changes occur at the younger ages, particularly for age 0 in IBTSQ3, which is not used in the assessment. Residuals for B-Adapt runs including the standard and extended indices indicate a slight improvement in fit for the extended indices run compared to the standard indices run. Given the improved fit for the extended indices and other benefits of using these indices (such as better coverage of the stock distribution area), WKROUND concluded that it would be beneficial for the North Sea cod assessment to use the extended indices in future analyses.

Correspondence between WGNSSK and the IBTSWG during spring 2009 discussed the addition of the suggested areas to the calculation of the extended index. Some of the rectangles were not covered by surveys each year and a modified list was agreed. Unfortunately, after calculation of the extended area and standard indices using the IBTS Q1 2009 values, large differences between the indices were noted at the older ages, that did not occur in previous years. There was insufficient time before the WGNSSK meeting to investigate the reason for the differences and therefore a decision was made to continue with the standard indices for a further year before the transition to the extended area surveys was undertaken.

14.3 Data analyses

14.3.1 Reviews of last year's assessment

In 2008 the ACFM review group raised the following issues (given in italics in quotes), and the WG responds as follows (given in normal text):

The WG are encouraged to contrast the two methods using the 2007 data and if differences are noted, to consider methods to correct the time series with the 'new' approach. This was partially addressed during the 2008 EG in which it was observed that the data raising procedure resulted in no major change to the assessment results. The problems will be addressed in more detail when new data raising procedure is available which avoids the complexity of the spreadsheets currently used.

The WG should note that in other fisheries, discarding of cod across all age groups is evident (West of Scotland and Celtic Sea), largely as a consequence of the buyers and sellers regulations. Therefore, in time, any biases may affect the estimate of SSB, this may become important in the short term given the strength of the 2005 year class. Agreed the EG has noted this development for a number of years and has noted the high discard 2008 rate for the 2005 year class and increasing discards of 4 year old fish.

Lack of discard data from Belgium, Sweden and France with unreliable (low sample size) data from the Netherlands is concerning, given that the WG note that concentrations of small cod are typically found in the southern North Sea, it is therefore unfortunate that discard data is not available form the 'small' meshed fisheries that occur in VIc and VIb. The application of a discard correction factor from other (more northern, larger mesh fisheries) may significantly underestimate discards in this area. The lack of catch numbers at age from France are of concern given the importance of the French fishery in VIId / IVc and the fact that the industry themselves have raised the issue of elevated discarding in certain areas. The WG are encouraged to make every effort to rectify this. Data from the French Industry/Science partnership have highlighted the high rate of discards in VIId and the southern North Sea. The industry paper has noted that the increased effort put into sampling of the French fisheries is aimed at providing information for the WGNSSK.

14.3.2 Exploratory survey-based analyses

Survey abundance indices are plotted in log-mean standardised form by year and cohort in Figure 14.4a for the IBTSQ1 survey, together with log-abundance curves and associated negative gradients for the age range 2-4. Similar plots are shown for the IBTSQ3 survey in Figure 14.4b. The log-mean standardised curves indicate no obvious year effects (top-left plots), and tracks cohort signals well (top right) The log abundance curves for each survey series indicate consistent gradients (bottom left), with less steep gradients in recent years (bottom right).

Figures 14.5a and b show within-survey consistency (in cohort strength) for the IBTSQ1 and Q3 surveys, while Figure 14.5c shows between-survey consistency (for each age) for the two surveys. These show generally good consistency, justifying their use for survey tuning. Correlations deteriorate for age 5 for the IBTSQ3 survey, and this age is not used for tuning.

The SURBA survey analysis model was fitted to the survey data for the IBTSQ1 and IBTSQ3. The summary plots are presented in Figures 14.6a-b.

Biomass - Both time series estimated in SURBA indicate that spawning stock biomass reached the lowest level in the time series in 2005-6 caused by a series of poor recruitments coupled with high fishing mortality and discard rates at the youngest ages, but that it is now increasing again because the stronger 2005 year class is starting to mature. This increase can also be seen in the time series for total stock biomass.

Total mortality – In all SURBA model fits, there is a high level of uncertainty in the model estimates, and trends in mean Z cannot be determined with any confidence.

Recruitment – SURBA estimates of recruitment appear to have very wide confidence intervals for the IBTSQ3 survey, the reason for which is not immediately clear. The IBTSQ1 survey indicates that the recruiting years classes since 1996 have been relatively weak, but that the 2005 year class is one of the highest of the recent low values. The variation recorded in year class strength at age 1 is substantially higher than that recorded subsequently at ages 2 and 3, indicating that the high rates of discarding (90%) and high mortality rates at this age are resulting in reduced contributions from one year old fish to the stock and catches. **The 2009 data from IBTSQ1 indicate that the 2008 year class may be one of the lowest recorded in the survey series.**

14.3.3 Exploratory catch-at-age-based analyses

Catch-at-age matrix and Separable VPA

The total catch-at-age matrix (combination of landings and discards shown in Tables 14.2 and 14.3) is expressed as proportions-at-age, standardised over time in Figure 14.7. It shows clearly the contribution of the 1996 and 1999 year classes to catches in recent years, with the larger 1996 year class disappearing more rapidly from the catches compared to the 1999 year class. It also shows the greater proportion of older fish in the catches at the start of the time series relative to recent years. The 2005 year class is starting to feature strongly in the catch.

As in previous years, a separable VPA model was used to examine the structure of the catch numbers at age data before its use in a catch at age analysis. The fitted model indicates that the age structure of the recorded landings may have changed in the last two years, positive residuals at the youngest ages in the most recent year and negative at the oldest. This may be an effect of the high grading, discarding noted earlier. The catch data are not subject to large random or process errors that would lead to concerns as to the way in which the recorded catch has been processed.

Catch curve cohort trends

The top panel of Figure 14.8 presents the log catch curve plot for the catch at age data. Through time there is an increase in the slope of the cohort plots indicating faster removal rates or high total mortality. In the most recent years there has been a gradual decrease in the slope at the youngest ages – a sign of decreased mortality rates. The bottom panel plots the negative slope of a regression fitted to the ages 2-4, the age range used as the reference for mortality trends. The decrease in the negative slope indicates that total mortality rates at the ages comprising the dominant ages within the fishery are declining.

State-Space Model

Nielsen (ICES WGNSSK 2008 WD) presented state-space model (SAM) estimates applied to the North Sea cod data. The model was evaluated for the cod assessment at WKROUND (2009) at which it was agreed that B-Adapt continue to be used as the main assessment model for North Sea cod until an appropriate formulation of the SAM model can be found that deals with the issues of retrospective bias and trends in F that appear to diverge across ages in recent years.

The WG therefore fitted the SAM model in parallel to the B-ADAPT assessment in order to continue the comparative series alternative model analyses. SAM showed the same pattern in SSB (Figure 14.9) and recruitment as B-ADAPT. The overall development in Fbar is also the same in the estimates from SSASS and B-ADAPT, but the decrease in the SAM Fbar estimates in the most recent years are less steep and the overestimation retrospective pattern noted before is still present. The B-ADAPT estimates are more fluctuating, which is a consequence of B-ADAPT assuming reported catches and age compositions known without error (Figure 14.10). The estimated catch multiplier (Figure 14.11) is similar to that estimated by B-ADAPT.

B-ADAPT

The following table presents a selection of the runs considered, comprising single fleet B-ADAPT runs fitted to the IBTSQ1 and IBTSQ3 groundfish surveys respectively, and the update assessment (using the same settings as last year).

Description	Period for catch multiplier
Single Fleet Runs	
1. IBTSQ1	1998-2008
2. IBTSQ3	1998-2008
Candidate Assessments	
3. Update assessment	1993-2008

Single fleet runs of the B-ADAPT model were fitted to the IBTSQ1 (run 1) and IBTSQ3 (run 2) groundfish surveys in order to examine the time series of estimates derived from independent survey data sets. Because B-ADAPT requires a reasonable period of overlap (at least 5 years) between the survey data and the period for which a catch multiplier is not estimated, and because the base run estimated catch multipliers close to 1 for 1997, the IBTSQ3 run only estimated the catch multiplier for the period 1998-2007, with the values used for the period 1993-1997 taken from the updated assessment (run 3). To ensure consistency between the single fleet runs, the same procedure was used for IBTSQ1 (setting multipliers for 1993-1997 equal to base run values, and estimating those from 1998 on), despite enough data being available for estimating catch multpliers from 1993.

Figure 14.12 plots trajectories of SSB, recruitment (age 1), mean F(2-4) and the catch multiplier for the two single fleet runs, together with the update assessment, which combines the two surveys. The single fleet runs indicate that the estimated removals since 1998 are higher than indicated by the catch data, but that they are still lower than the values from the update assessment in the most recent two years, reasons for which are not entirely understood at this stage (further investigation is needed, but this is beyond the terms of reference for this WG). Furthermore, SSB is now no longer in decline having attained the lowest level in the time series in 2006, and that fishing mortality is generally on the decline (but note the final year increase for the IBTSQ1 run and update assessment).

Residual plots are shown in Figure 14.13 for the update assessment, indicating no obvious model misspecification, apart from the most recent years showing generally negative residuals for IBTSQ1, and positive ones for IBTSQ3. Retrospective plots for the base run are shown in Figure 14.14. These show a slight under-estimation of fishing mortality prior to 2007, but a relatively large change in 2007 for F(2-4) and the catch multiplier.

14.3.4 Final assessment

This being an update assessment, run 3 was accepted as the final assessment. B-ADAPT was fitted to landings data for the years 1963-2008 and ages 1-7+, adjusted for discarding as described in Section 14.2. Survey data used for tuning are the International Bottom Trawl Survey Q1 (1983-2009, ages 1-5) and Q3 (1991-2008, ages 1-4). Surviving population numbers at ages 1-5 were estimated in 2009 with fishing mortality at age 6 in all years calculated as the average of ages 3-5. Bias parameters (catch multipliers) were estimated in the years 1993-2008. A smoothing weight of 0.5 was applied to between-year residuals of the log-total catch in tonnes. No time series weighting was applied and survey residuals were given equal weight in the analysis. Survey catchability was assumed to be constant in time and independent of age for ages 1-5 for the IBTSQ1 survey, and 1-3 for the IBTSQ3 survey. These run settings are the same as for last year's assessment.

This being an update assessment, the WG considered the smoothed B-ADAPT to be an appropriate model for estimating the dynamics of the fishery and stock.

The diagnostics and stock estimates of the fitted model expected values are presented in Tables 14.9-14.12. Median values from the bootstrapped estimates for fishing mortality are presented in Table 14.10, stock numbers in Table 14.11, and the median of the assessment summary time series in Table 14.12a, while Table 14.12b summarises landings, discards and bootstrap median estimates of total removals. Figure 14.13 presents the time series of log catchability residuals from the fitted smoothed B-ADAPT model. Figure 14.15 presents the time series of B-ADAPT derived assessment estimates of the stock, recruitment, exploitation trends, catch, and the catch multipliers, together with estimates of precision represented by bootstrap percentiles. Figure 14.16 presents the mean F(2-4) shown in Figure 14.15, but split into landings and discards components using reported catch data.

Retrospective estimates of median fishing mortality, SSB, recruitment and the catch multiplier from the B-ADAPT bootstrap model are presented in Figure 14.14.

14.4 Historic Stock Trends

The historic stock and fishery trends are presented in Figures 14.15 and Table 14.12a.

Recruitment has fluctuated at a relatively low level since 1998. The 1996 year class was the last large year class that contributed to the fishery, and subsequent year classes have been the lowest in the time series apart from the 1999 and 2005 year classes. The addition of discards to the assessment has raised the overall level of recruitment abundance but not the trend in recent year class strengths. The 2006 and 2007 year classes are estimated to be weak.

Fishing mortality increased until the early 1980's remained high until 2000 after which it has decreased. Median fishing mortality (human consumption and discard mortality) at ages 2-4 in 2008 is estimated to be 0.79, up from 0.62 in 2007.

SSB declined steadily during the 1970's and 80's. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes, but with low recruitment abundance since 1998 and continued high mortality rates, SSB continued to decline. SSB is estimated to have increased from the lowest level in the time series of 34 000t in 2006 to 42 000t in 2007 and 57 000t in 2008. TSB estimates have been increasing for longer than SSB because of the 2005 year class, but this year class is now starting to mature and contribute to SSB.

The North Sea Fishers' Survey indicates that perceptions of cod abundance in recent years has been of a general increase throughout the North Sea, which is consistent with the stronger 2005 year class entering the fishery.

14.5 Recruitment estimates

Estimates of recruitment were sampled from the 1997-2007 year classes, reflecting recent low levels of recruitment, but including the stronger 1999 and 2005 year classes. These are only used for B-ADAPT medium term forecasts in order to evaluate future stock dynamics.

14.6 Short-term forecasts

Due to the uncertainty in the final year estimates of fishing mortality the WG agreed that a standard (deterministic) short-term forecast was not appropriate for this stock.

14.7 Medium-term forecasts

Stochastic projections were carried out using each of 1000 non-parametric bootstrap iterations. Starting populations were taken from each bootstrap iteration, fishing mortalities were taken as a three year average scaled to the final year. Mean weights and mortalities were taken from the average of the final three years of assessment data. Recruitment was re-sampled from the 1997-2007 year-classes, eight years with low recruitment and two with the slightly higher levels (1999 and 2005 year classes). This is a conservative estimate to account for the possibility that the low levels estimated in the last few years may continue.

For the purposes of the forecast, the WG assumes that future removals due to fishing comprise only landings and discards. Landings and discards in the forecasts were estimated by applying the landings- and discard-at-age ratios for 2008 to total fishing mortility-at-age for the projection period.

All the scenarios assume a 25% reduction in fishing mortality in 2009 relative to 2008 to account for a 25% reduction in effort for the main cod gears, as stipulated in EC 1342/2008. The scenarios explored were:

1. a reduction in fishing mortality by 25% in 2009, followed by constant fishing mortality at the 2009 level for 2010 onwards;
2. a reduction in1 fishing mortality by 25% in 2009, followed by further reductions in 2010 (relative to 2009) of:

a. 10%,
b. 15%,
c. 20%,
d. 25%,
e. 30%;

in each of these scenarios, fishing mortality is held constant at the 2010 level for 2011 onwards;

3. a reduction in fishing mortality by 25% in 2009, followed by a further reduction to the target fishing mortality of 0.4 for 2010 onwards;
4. a reduction in fishing mortality by 25% in 2008, followed by a closure of the fishery from 2010 onwards;
5. a reduction in fishing mortality by 25% in 2009, followed by a further reduction in F of 35% in 2010, 45% in 2011, 55% in 2012, etc relative to the 2008 level (a combination of Options 5 and 6 mimic the European Commission's cod management plan given in EC 1342/2008, at least until SSB>Blim);
6. reduction in fishing mortality by 25% in 2009, followed by a further reduction to the target fishing mortality of 0.2 for 2010 onwards (a combination of Options 5 and 6 mimic the European Commission's cod management plan given in EC 1342/2008, at least until SSB>Blim).

Tables 14.13-14.18 present the results of the stochastic projections, while Table 14.19 summarises outcomes for all options in a single table for ease of comparison. For each scenario, the associated figures present fishing mortality, catch, SSB and recruitment. The 5th, 25th, median, 75th and 95th percentiles from the bootstrap distributions are plotted. Percentiles of fishing mortality, SSB and catch in 2008, 2009, 2010 and 2011 are tabulated with the probability that SSB in a year exceeds the SSB estimated for 2008 and the ratio of median SSB at the start of the year to the end of the year in order to quantify stock rebuilding.

In each of the stock projections SSB starts to increase following a historic low in 2006, due to a combination of lower fishing mortality and the 2005 year class starting to mature. Subsequent increases in SSB rely on the scale of the reduction in fishing mortality.

All options considered result in return of SSB to levels above B_{lim} (70 000t) from 2011 onwards, assuming discard practices are similar to those in 2008.

14.8 Biological reference points

The Precautionary Approach reference points for cod in IV, IIIa (Skagerrak) and VIId have been unchanged since 1998. They are:

	Type	Value	Technical basis
Precautionary approach	B_{lim}	70 000 t	B_{loss} (~1995)
	B_{pa}	150 000 t	B_{pa} = Previous MBAL and signs of impaired recruitment below 150 000 t.
	F_{lim}	0.86	F_{lim} = F_{loss} (~1995)
	F_{pa}	0.65	F_{pa} = Approx. 5th percentile of F_{loss}, implying an equilibrium biomass > B_{pa}.
Targets	F_y	0.4	EU/Norway agreement December 2009

Unchanged since 1998

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 2-4	Yield/R	SSB/R
F_{max}	0.25	0.69	2.1
$F_{0.1}$	0.16	0.69	3.2
F_{med}	0.81	0.51	0.3

Estimated by ICES in 2009, assuming constant maturity and variable M, with M and stock weights averaged over the period 2000-2007. Selectivity is averaged over 2005-2007, and scaled to 2007.

14.9 Quality of the assessment

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 WG considers the international landings figures from 1993 onwards to have inaccuracies that lead to retrospective underestimation of fishing mortality and over estimation of spawning stock biomass and other problems with an analytical assessment. The mismatch between reported and actual landings is now estimated to be decreasing.

Prior to 2006 estimates of discards for areas IV and VIId are taken from the Scottish discard sampling program and the average proportions across gears applied to raise the landings data from other areas. If the gear and fishery characteristics differ this could introduce bias. This bias is likely to introduce sensitivity to the estimates of the youngest age classes (1 and 2) and will not affect estimates of SSB. For 2006, Scottish discard sampling was used to raise all landings data apart from Danish landings, because Danish discard data were provided. For 2007 and 2008, a combination of Scottish, Danish, German and England and Wales discard estimates was used to raise landings from countries that did not provide discard estimates. Although discard estimates were provided by Denmark for years prior to 2006, and by Germany and England and Wales for years prior to 2007, these have not been used as it was not possible to re-work earlier discard estimates.

The North Sea surveys have good consistency within and between the indices. The indication that SSB in 2006 was at or around a historical low, and is now increasing, is supported by SURBA analyses and single survey assessment model fits. The low level of recent recruitments is consistent between model fits and within and between survey indices, which also confirm a higher 2005 year class compared to recent years. This year, comparative single survey assessments have resulted in substantial differences in the estimates for the recent time series of SSB and fishing mortality. The underlying causes are unknown, but the difference is not caused by the model applied, and due to the update assessment status could not be evaluated at the meeting. They will be explored in detail during the year.

The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. A series of investigations at WKNSSK and WKROUND have established that more of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices. The data sets were prepared for the meeting but significant differences in the values calculated for the standard area and the extended area were recorded for 2009. Until this is examined in detail the new indices coud not be applied.

The B-ADAPT model was developed to correct for retrospective bias by estimating the quantity of additional “unallocated removals” that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings.

The estimates of bias can also be influenced by any trends in survey catchability or outlying values, particularly where the calibration period surveys are noisy at the oldest and youngest ages. For this reason, the bootstrap percentiles are used to provide stock and exploitation trends and the estimated values should not be over-interpreted.

Until this year, retrospective plots (Figure 14.14) had shown a slight under-estimation of fishing mortality. However, a strong retrospective difference has occurred between the estimates of fishing mortality and catch multiplier for the last two years. The perception of a decrease in mortality rates for the stock is robust to the period over which the model is fitted.

Values for natural mortality have been updated this year; they are smoothed annual model estimates from a multi-species VPA fitted by the Multi-species WG in 2007. The maturity at age values are constant by year and were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea.

The historical performance of the assessment is summarised in Figure 14.19. The plot illustrates the rescaling of SSB, recruitment and fishing mortality following the change to the natural mortality values used in the assessment; but no change to the trends.

14.10 Status of the Stock

The perception of an increase in the cod abundance remains unchanged, although the 2008 estimate of SSB is showing a slower rate of increase than forecast previously due to an increase in the rate of discarding.

Survey indices and results from models fitted to the commercial catch at age data indicate that in 2008 the spawning stock biomass was at about 30 - 40% of the level it was in the early 1980's and that it is likely to continue increasing in 2009 at the relatively lower fishing mortality levels observed recently and as the more abundant 2005 year class (relative to recent year classes) matures.

The assessment models indicate that, since 2000, the fishing mortality rate has begun to decline towards the lower levels required to allow the stock to rebuild, but the most recent values are uncertain. In 2008 total mortality increased due to higher rates of discarding both observed and reported by the industry. In 2008, discard mortality now exceeded human consumption mortality.

The proportion of older individuals in the estimated stock remains very low. In recent years, around 1.5% of individuals at age 1 survive to age 5; this contrasts with over 2.5% of individuals surviving to age 5 at the beginning of the time series (mid-1960s).

Recruitment of 1 year old cod has varied considerably since the 1960s, but since 1998, average recruitment has been lower than any other time. The 2005 year class is of higher abundance than the recent low levels, especially in the central and northern north sea (Figures 14.3a and b); however the subsequent year classes have also been low. The 2009 data from IBTSQ1 indicate that the 2008 year class may be one of the lowest recorded in the survey series.

Although the UK-FSP surveys (NE coast cod, and North Sea Codwatch), the IBTS surveys and the assessment all indicate a poorer 2006 year class relative to the one in 2005 in the northern North Sea, there have been indications of relatively large numbers of the 2006 year class in the southern North Sea and eastern Channel. These indications initially came from observations of substantial amounts of this year class as 0-group fish in the English Channel beam trawl survey (ICES WGNSSK 2008), reinforced by the Belgian beam trawl survey fishing in the same area, and in both the English Thames herring and bass surveys (ICES WGNSSK 2008). Subsequent indications have come from French Channel groundfish survey (ICES WGNSSK 2008), where the 2006 year class has been observed as large numbers of age 1 fish, and from French fishers, who have encountered large numbers of this year class in 2008 and again in 2009.

High rates of discarding in 2006-2008 have reduced the contribution that the 2005 year class has made to the catches and the stock in recent years. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery (Figure 14.7).

14.11 Management Considerations

Although the current SSB and fishing mortality are uncertain, it is clear that the stock has begun to recover from the low level to which it was reduced in early 2000, at which recruitment has been impaired and the biological dynamics of the stock are difficult to predict.

Emergency measures have been taken and a recovery plan has been implemented with the aim of reversing the declining trend in SSB and increasing the spawning stock above Blim. These measures have contributed to a reduction in fishing mortality and a rebuilding of SSB.

There is a need to reduce fishing induced mortality on North Sea cod further, particularly for younger ages, in order to allow more fish to reach maturity and increase the probability of good recruitment. This could be achieved by reducing discarding which in 2008 was estimated to be at the same level as or exceeding landings mortality. In the last three years high-grading of cod has increased substantially. In 2008, 94% of 1 year old, 73% of 2 year old, 64% of 3 year old (the abundant 2005 year class) and 12% of 4 year old cod were discarded.

Because the fishery is at present so dependent on incoming year classes, fishing mortalities on these year classes are high. At the same time, the unbalanced age structure of the stock reduces its reproductive capacity even if a sufficient SSB were reached, as first-time spawners reproduce less successfully than older fish. Both factors are believed to have contributed to the reduction in recruitment of cod.

The recruitment of the relatively more abundant 2005 year class to the fishery may have no beneficial effect on the stock if it is caught and heavily discarded. In 2006, the 2005 year class comprised 62% of the total catch by number, in 2007 it comprised 55%, and in 2008 it comprised 33%. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery.

French fishers have been reporting substantial discards of undersize cod in the eastern Channel (VIId) in 2007 and early 2008. Relatively large numbers of the 2006 year class were first observed as 0-group fish in several surveys in the eastern Channel and southern North Sea. This year class has been observed again in large numbers as age 2 fish in the French groundfish survey in eastern Channel, and by French fishers targeting cuttlefish in this area. This appears to be a localised phenomenon, since this 2006 year class is estimated to be poor, based on the North Sea IBTS Q1 and Q3 surveys.

Several nations who make substantial landings of cod do not supply the WG with estimates of discards, despite the requirement to do so according to EU data collection regulations. In order to improve the quality of the assessment, and hence management advice, these nations should be encouraged to do so.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear such as the Eliminator Trawl, should be encouraged.

The reported landings in 2008 were 26 800 t and the estimated discards in 2008 were 21 800 t, giving a total of 48 600 t. Surveys indicate that the year classes are depleting faster than one would expect from these catches and point to unaccounted removals. There is no documented information on the source of these unaccounted removals; while it is assumed that these removals originate mostly from fishing activities, changes in natural mortality may also have an influence. Their magnitude is difficult to predict in the future. Plausible fishery-based contributions to these unaccounted removals are discards that do not count against quota, and the mis- and under-reporting of catches. The recent recorded landings (2005-2008) have fluctuated between 30% and 55% of the total removals. This indicates that the management system does not control the catches effectively.

Cod are taken by towed gears in mixed demersal fisheries, which include haddock, whiting, Nephrops, plaice, and sole. They are also taken in directed fisheries using fixed gears.

Cod catch in Division VIId is managed by a TAC for Divisions VIIb-k,VIII, IX, X, and CECAF 34.1.1, (i.e. the TAC covers a small proportion of the North Sea cod stock together with cod in Divisions VIIe-k). Division VIId was allocated a separate TAC for 2009 which was adjusted inline with the revision to the North Sea TAC.

It is considered that conclusions drawn from the trends in the historic stock dynamics are robust to the uncertainty in the level of recent recorded catches.

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Table 14.1 Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1989-2008 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	3,398	2,934	2,331	3,356	3,374	2,648	4,827	3,458	4,642	5,799
Denmark	25,782	21,601	18,997	18,479	19,547	19,243	24,067	23,573	21,870	23,002
Faroe Islands	35	96	23	109	46	80	219	44	40	102
France	2,578	1,641	975	2,146	1,868	1,868	3,040	1,934	3,451	2,934
Germany	11,430	11,725	7,278	8,446	6,800	5,974	9,457	8,344	5,179	8,045
Greenland	-	-	-	-	-	-	-	-	-	-
Netherlands	12,028	8,441	6,831	11,133	10,220	6,512	11,199	9,271	11,807	14,676
Norway	4,813	5,168	6,022	10,476	8,742	7,707	7,111	5,869	5,814	5,823
Poland	24	53	15	-	-	-	-	18	31	25
Sweden	501	620	784	823	646	630	709	617	832	540
UK (E/W/NI)	18,035	15,593	14,249	14,462	14,940	13,941	14,991	15,930	13,413	17,745
UK (Scotland)	31,828	31,187	29,060	28,677	28,197	28,854	35,848	35,349	32,344	35,633
Total Nominal Catch	110,452	99,059	86,565	98,107	94,380	87,457	111,468	104,407	99,423	114,324
Unallocated landings	5,248	5,692	1,968	-758	10,200	7,066	8,555	2,161	2,746	7,779
WG estimate of total landings	**115,700**	**104,751**	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**
Agreed TAC	**124,000**	**105,000**	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**	**130,000**	**115,000**	**140,000**

Division VIId										
Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	173	237	182	187	157	228	377	321	310	239
Denmark	<0.5	-	-	1	-	9	-	-	-	-
France	.	.	.	2,079	1,771	2,338	3,261	2,808	6,387	7,788
Netherlands	1	-	-	2	-	-	-	-	-	19
UK (E/W/NI)	563	422	341	443	530	312	336	414	478	618
UK (Scotland)	-	7	2	22	2	<0.5	<0.5	4	3	1
Total Nominal Catch	737	666	525	2,734	2,460	2,887	3,974	3,547	7,178	8,665
Unallocated landings	4,801	2,097	1,361	-65	-28	-37	-10	-44	-135	-85
WG estimate of total landings	**5,538**	**2,763**	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**

Division IIIa (Skagerrak)**										
Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	16,634	15,819	10,294	11,187	11,994	11,921	15,888	14,573	12,159	12,339
Germany	-	58	3	-	530	399	285	259	81	54
Norway	1,003	1,061	924	1,208	1,043	850	1,039	1,046	1,323	1,293
Sweden	1,805	1,136	3,846	2,523	2,575	1,834	2,483	1,986	2,173	1,900
Others	34	76	38	102	88	71	134	-	-	-
Norwegian coast *	888	846	854	923	909	760	846	748	911	976
Danish industrial by-catch *	428	687	953	1,360	511	666	749	676	205	97
Total Nominal Catch	19,476	18,150	15,105	15,020	16,230	15,075	19,829	17,864	15,736	15,586
Unallocated landings	-779	-350	-3,046	-1,018	-1,493	-1,814	-7,720	-1,615	-790	-255
WG estimate of total landings	**18,697**	**17,800**	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**
Agreed TAC	**20,500**	**21,000**	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**	**23,000**	**16,100**	**20,000**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total Nominal Catch	130,665	117,875	102,195	115,861	113,070	105,419	135,271	125,818	122,337	138,575
Unallocated landings	9,271	7,439	283	-1,841	8,679	5,215	825	502	1,821	7,439
WG estimate of total landings	**139,936**	**125,314**	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**

** Skaggerak/Kattegat split derived from national statistics

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa

. Magnitude not available - Magnitude known to be nil <0.5 Magnitude less than half the unit used in the table n/a Not applicable

Division IIIa (Skagerrak) landings not included in the assessment										
Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Norwegian coast *	888	846	854	923	909	760	846	748	911	976
Danish industrial by-catch *	428	687	953	1,360	511	666	749	676	205	97
Total	**1,316**	**1,533**	**1,807**	**2,283**	**1,420**	**1,426**	**1,595**	**1,424**	**1,116**	**1,073**

Table 14.1 cont. Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1988-2008 as officially reported to ICES, and as used by the Working Group.

Sub-area IV										
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	3,882	3,304	2,470	2,616	1,482	1,627	1,722	1,309	1,009	890
Denmark	19,697	14,000	8,358	9,022	4,676	5,889	6,291	5,105	3,430	3,828
Faroe Islands	96	.	9	34	36	37	34	3	-	-
France	.	1,222	717	1,777	620	294	664	354	659	631
Germany	3,386	1,740	1,810	2,018	2,048	2,213	2,648	2,537	1,899	1,736
Greenland	-	-	-	-	-	-	35	23	.	.
Netherlands	9,068	5,995	3,574	4,707	2,305	1,726	1,660	1,585	1,523	1,896
Norway	7,432	6,410	4,369	5,217	4,417	3,223	2,900	2,749	3,057	4,128
Poland	19	18	18	39	35	-	-	-	1	2
Sweden	625	640	661	463	252	240	319	309	387	435
UK (E/W/NI)	10,344	6,543	4,087	3,112	2,213	1,890	1,270	1,491	1,587	n/a
UK (Scotland)	23,017	21,009	15,640	15,416	7,852	6,650	4,936	6,857	6,511	n/a
UK (combined)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8,727
Others	-	-	-	-	-	-	-	786	.	.
Norwegian indust by-catch *	.	.	.	.	.	.	.	48	101	22
Danish industrial by-catch *	.	.	.	.	.	.	.	34	18	46
Total Nominal Catch	77,566	60,881	41,713	44,421	25,936	23,789	22,479	23,108	20,063	22,272
Unallocated landings	826	-1,114	-740	-121	-89	-240	1,391	-915	-380	-78
WG estimate of total landings	**78,392**	**59,767**	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**	**22,193**	**19,683**	**22,195**
Agreed TAC	**132,400**	**81,000**	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**	**23,205**	**19,957**	**22,152**
Division VIId										
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	172	110	93	51	54	47	51	80	84	155
Denmark	-	-	-	-	-	-	-	-	-	-
France	.	3,084	1,677	1,361	1,730	810	986	1,124	1,735	760
Netherlands	3	4	17	6	36	14	9	9	59	30
UK (E/W/NI)	454	385	249	145	121	103	184	270	175	n/a
UK (Scotland)	-	-	-	-	-	-	-	2	12	n/a
UK (conbined)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	151
Total Nominal Catch	629	3,583	2,036	1,563	1,941	974	1,230	1,485	2,065	1,096
Unallocated landings	6,229	-1,258	-463	1,534	-707	-167	-197	-358	-325	258
WG estimate of total landings	**6,858**	**2,325**	**1,573**	**3,097**	**1,234**	**807**	**1,033**	**1,127**	**1,740**	**1,354**
Division IIIa (Skagerrak)**										
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	8,682	7,656	5,870	5,511	3,054	3,009	2,984	2,478	2,228	2,534
Germany	54	54	32	83	49	99	86	84	67	52
Norway	1,146	926	762	645	825	856	759	628	681	779
Sweden	1,909	1,293	1,035	897	510	495	488	372	370	365
Others	-	-	-	-	27	24	21	373	385	13
Norwegian coast *	788	624	846	.	.	720	759	524	494	499
Danish industrial by-catch *	62	99	687	.	.	10	18	9	.	.
Total Nominal Catch	11,791	9,929	7,699	7,136	4,465	4,483	4,338	3,935	3,731	3,743
Unallocated landings	-817	-652	-613	332	-674	-696	-533	-569	-785	-445
WG estimate of total landings	**10,974**	**9,277**	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**	**3,366**	**2,946**	**3,298**
Agreed TAC	**19,000**	**11,600**	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**	**3,315**	**2,851**	**3,165**
Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Nominal Catch	89,986	74,393	51,448	53,120	32,342	29,246	28,047	28,528	25,859	27,112
Unallocated landings	6,239	-3,024	-1,816	1,745	-1,470	-1,103	661	-1,842	-1,490	-264
WG estimate of total landings	**96,225**	**71,369**	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**	**26,686**	**24,369**	**26,847**

** Skaggerak/Kattegat split derived from national statistics

* The Danish and Norwegian industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings

. Magnitude not available - Magnitude known to be nil <0.5 Magnitude less than half the unit used in the table n/a Not applicable

Division IV and IIIa (Skagerrak) landings not included in the assessment										
Country	1999	2000	2001	2002	2002	2004	2003	2006	2007	2008
Norwegian coast *	788	624	846	.	.	720	759	524	494	499
Norwegian indust by-catch *	.	.	.	.	.	.	.	48	101	22
Danish industrial by-catch *	62	99	687	.	.	10	18	43	18	46
Total	**850**	**723**	**1,533**	**.**	**.**	**730**	**777**	**615**	**613**	**567**

Table 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings numbers at age (Thousands).

Landings numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5029	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22486	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20104	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4306	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1917	2387	3379	3271	6076	4565	6297	7101	2726	2206
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201	1109
7	81	599	658	477	888	870	588	961	893	1680	1060
8	492	118	298	370	355	309	422	209	458	612	489
9	14	94	51	126	138	151	147	186	228	390	80
10	6	12	75	56	40	111	46	98	77	113	58
+gp	0	4	8	83	17	24	78	40	94	18	162
TOTALNUM	60965	56486	98957	122538	132335	153600	79651	129791	235691	254064	131888
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976	239051
SOPCOF %	100	100	100	100	100	100	100	100	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	15562	33378	5724	75413	29731	34837	62605	20279	66777	25733	64751
2	58920	47143	100283	51118	175727	91697	104708	189007	65299	129632	66428
3	11404	18944	18574	25621	17258	44653	35056	34821	60411	21662	31276
4	15824	4663	6741	4615	9440	4035	12316	9019	9567	11900	4264
5	4624	7563	1741	2294	3003	3395	1965	4118	3476	2830	3436
6	961	2067	3071	836	1108	712	1273	785	2065	1258	1019
7	438	449	924	1144	410	398	495	604	428	595	437
8	395	196	131	371	405	140	197	134	236	181	244
9	332	229	67	263	153	158	74	65	78	90	60
10	81	95	63	26	36	42	55	37	27	28	45
+gp	189	63	43	96	44	17	25	21	16	23	20
TOTALNUM	108729	114791	137361	161797	237314	180085	218770	258889	208380	193932	171978
TONSLAND	214279	205245	234169	209154	297022	269973	293644	335497	303251	259287	228286
SOPCOF %	100	100	100	100	100	101	100	100	99	100	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	8845	100239	24915	21480	22239	11738	13466	27668	4783	15557	15717
2	118047	32437	128282	55330	36358	54290	23456	32059	55272	25279	63586
3	18995	34109	9800	43955	18193	11906	16776	8682	11360	21144	12943
4	7823	5814	8723	3134	9866	4339	3310	5007	3190	3083	5301
5	1377	2993	1534	2557	1002	2468	1390	1060	1577	870	802
6	1265	604	1075	655	1036	310	1053	491	435	519	286
7	373	556	235	295	251	310	225	329	204	142	151
8	173	171	215	66	140	54	139	52	108	58	42
9	79	69	55	63	27	60	28	40	18	32	15
10	16	44	48	23	31	12	4	17	10	7	13
+gp	31	23	12	18	10	9	10	9	13	16	5
TOTALNUM	157022	177058	174895	127577	89153	85496	59857	75415	76970	66706	98861
TONSLAND	214629	204053	216212	184240	139936	125314	102478	114020	121749	110634	136096
SOPCOF %	100	101	100	100	100	99	100	99	99	99	98

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	4938	23769	1255	5941	8294	2220	7192	400	1589	1502	1906
2	36805	29194	81737	9731	23033	20832	7870	9615	4083	8210	4931
3	23364	18646	16958	32224	6472	6200	13252	3511	4949	2865	4447
4	3169	6499	5967	4034	6697	1142	2519	2660	1965	1628	1015
5	1860	1238	2402	1446	1021	1080	366	449	988	474	471
6	399	700	509	626	385	144	349	66	150	392	151
7	162	153	236	223	139	84	51	49	43	44	116
8	88	47	41	91	40	27	31	13	23	11	22
9	43	14	16	14	18	14	13	7	8	8	4
10	4	15	4	10	5	6	5	3	3	2	2
+gp	8	10	12	2	1	1	0	1	0	0	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13800	15135	13064
TONSLAND	126320	124158	146014	96225	71371	49694	54865	30872	28188	28708	26590
SOPCOF %	100	100	100	100	100	100	100	102	100	100	103

AGE/YEAR	2007	2008
1	1241	556
2	6852	3400
3	2443	4292
4	1532	1063
5	307	697
6	114	170
7	39	70
8	36	30
9	6	21
10	1	4
+gp	0	3
TOTALNUM	12573	10306
TONSLAND	24433	26847
SOPCOF %	100	99

Table 14.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard numbers at age (Thousands).

Discards numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	16231	8089	98414	108921	50467	31272	2515	53225	260226	38442	86349
2	20003	6199	6632	22236	24861	23073	10331	8700	37412	59641	17475
3	33	116	90	71	160	198	113	153	47	178	247
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	36267	14404	105136	131229	75489	54542	12959	62078	297686	98261	104071
TONSDISC	12247	4731	29251	38109	23438	17575	4816	17928	84392	33848	30190
SOPCOF %	100	101	100	100	100	100	101	101	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	124777	137341	227925	474377	29043	584603	1189692	156878	183476	55478	540795
2	15958	16296	83630	48189	78477	5302	17751	34559	8448	11237	12594
3	71	0	193	466	0	0	0	80	99	25	5
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	140807	153637	311747	523032	107520	589904	1207444	191516	192022	66740	553394
TONSDISC	39807	37060	72840	139820	32583	163279	295449	57897	54501	22101	151923
SOPCOF %	100	100	100	100	100	100	100	101	100	102	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	63659	565753	24732	15461	178265	34194	48110	104321	34112	324703	45425
2	36780	5784	62194	17179	8751	48699	8495	10065	29119	17012	44083
3	115	305	0	218	492	79	454	2	12	162	30
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	100555	571842	86927	32858	187508	82972	57059	114388	63242	341877	89539
TONSDISC	31503	139081	27839	10714	62119	27022	18552	36920	21860	99578	32188
SOPCOF %	100	100	100	101	100	100	101	100	100	100	100

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	14451	87308	15608	31550	37981	5600	13373	8511	11865	11290	26690
2	23376	13892	91140	5737	5650	33946	2622	9976	4661	5673	5563
3	774	41	1514	8437	0	773	1972	1118	1158	108	804
4	0	0	0	0	0	0	0	69	0	19	53
5	0	0	0	0	0	0	0	11	0	4	12
6	0	0	0	0	0	0	0	2	0	3	2
7	0	0	0	0	0	0	0	1	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	38601	101241	108262	45725	43631	40319	17967	19688	17684	17097	33126
TONSDISC	14255	33616	40480	14180	13713	13871	5706	6372	5849	6272	8050
SOPCOF %	100	100	100	102	100	100	100	101	102	103	102

AGE/YEAR	2007	2008
1	14622	8384
2	20183	9165
3	1506	7474
4	371	149
5	49	21
6	25	13
7	0	0
8	2	3
9	0	0
10	0	0
+gp	0	0
TOTALNUM	36757	25209
TONSDISC	23636	21814
SOPCOF %	100	100

Table 14.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings weights at age (kg).

Landings weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.590	0.640	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.541	0.573	0.550	0.550	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.470	2.160	2.001	2.411	1.948	2.190	1.858	1.835	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.590	0.583	0.635	0.585	0.673	0.737	0.670	0.699	0.699	0.677	0.721
2	0.932	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.021
3	2.141	1.834	1.955	1.982	1.846	2.176	2.038	2.546	2.479	2.201	2.210
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.699	0.656	0.542	0.640	0.611	0.725	0.758	0.608	0.700	0.828	0.750
2	1.117	0.960	0.922	0.935	1.021	1.004	1.082	1.174	0.997	1.190	1.161
3	2.147	2.120	1.724	1.663	1.747	2.303	1.916	1.849	2.014	1.978	2.192
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.256	3.096	3.690	3.731
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.186	5.172	5.060	5.660
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.395	7.426	7.551	6.882
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.703	8.675	9.607	8.896
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.178	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.494	14.140	15.340	10.773

AGE/YEAR	2007	2008
1	0.805	0.801
2	1.161	1.503
3	2.376	2.511
4	4.046	4.026
5	5.523	5.777
6	8.197	7.164
7	8.986	9.358
8	9.777	10.909
9	12.358	11.596
10	13.725	15.278
+gp	9.482	13.653

Table 14.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard weights at age (kg).

Discards weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.270	0.270	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	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

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.268	0.227	0.189	0.255	0.287	0.276	0.242	0.279	0.274	0.297	0.270
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0.000	0.412	0.376	0.000	0.000	0.000	0.517	0.593	0.534	0.509
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	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

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.300	0.326	0.260	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0.000	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	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

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.293	0.284	0.179
2	0.380	0.453	0.375	0.389	0.422	0.361	0.420	0.344	0.384	0.468	0.426
3	0.515	0.616	0.481	0.422	0.000	0.406	0.340	0.540	0.427	1.084	0.751
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.675	0.000	4.099	1.300
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.272	0.000	4.501	2.862
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.849	0.000	8.197	4.663
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.585	0.000	0.000	10.895
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.033	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	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	5.771	0.000	0.000	0.000

AGE/YEAR	2007	2008
1	0.231	0.299
2	0.762	0.683
3	1.881	1.660
4	4.136	2.459
5	6.141	2.848
6	9.724	8.051
7	1.735	1.239
8	12.032	0.576
9	0.000	0.000
10	0.000	0.000
+gp	0.500	0.500

Table 14.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Catch and stock weights at age (kg).

Catch weights at age (kg)

AGE/YEAF	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.314	0.357	0.313	0.314	0.326	0.328	0.416	0.449	0.313	0.300	0.335
2	0.808	0.762	0.900	0.836	0.868	0.847	0.755	0.845	0.834	0.729	0.700
3	2.647	2.367	2.295	2.437	2.395	2.215	2.127	2.028	2.188	2.080	1.912
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.304	0.304	0.199	0.295	0.432	0.291	0.258	0.329	0.358	0.403	0.304
2	0.901	0.760	0.722	0.673	0.743	0.905	0.917	0.769	0.908	0.882	0.921
3	2.206	2.348	2.449	2.128	2.001	2.411	1.948	2.186	1.856	1.833	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAF	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.314	0.293	0.437	0.466	0.364	0.382	0.392	0.395	0.327	0.305	0.420
2	0.800	0.782	0.773	0.753	0.931	0.690	0.889	0.970	0.845	0.788	0.768
3	2.132	1.822	1.955	1.974	1.810	2.165	1.994	2.545	2.478	2.188	2.207
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.433	0.386	0.372	0.317	0.354	0.372	0.456	0.275	0.341	0.348	0.217
2	0.831	0.797	0.633	0.732	0.903	0.605	0.916	0.752	0.671	0.895	0.771
3	2.095	2.117	1.622	1.405	1.747	2.093	1.712	1.533	1.713	1.945	1.972
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.191	3.096	3.695	3.610
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.113	5.172	5.055	5.590
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.270	7.426	7.555	6.848
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.630	8.675	9.607	8.911
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.056	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.351	14.140	15.340	10.773

AGE/YEAF	2007	2008
1	0.276	0.33
2	0.863	0.904
3	2.187	1.971
4	4.064	3.834
5	5.607	5.692
6	8.467	7.228
7	8.917	9.321
8	9.902	9.879
9	12.358	11.596
10	13.725	15.278
+gp	8.154	13.295

Table 14.7a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Proportion mature by age-group.

Age group	Proportion mature
1	0.01
2	0.05
3	0.23
4	0.62
5	0.86
6	1.0
7+	1.0

Table 14.7b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Natural mortality by age-group.

	Age						
Year	1	2	3	4	5	6	7+
1963	0.78	0.42	0.33	0.22	0.21	0.22	0.2
1964	0.82	0.43	0.34	0.22	0.21	0.22	0.2
1965	0.85	0.44	0.35	0.22	0.21	0.22	0.2
1966	0.87	0.45	0.36	0.22	0.21	0.22	0.2
1967	0.89	0.46	0.37	0.22	0.21	0.22	0.2
1968	0.91	0.46	0.37	0.22	0.21	0.22	0.2
1969	0.92	0.47	0.38	0.22	0.21	0.22	0.2
1970	0.92	0.47	0.38	0.22	0.21	0.22	0.2
1971	0.92	0.47	0.38	0.22	0.21	0.23	0.2
1972	0.93	0.47	0.38	0.22	0.21	0.23	0.2
1973	0.92	0.46	0.38	0.22	0.21	0.23	0.2
1974	0.92	0.46	0.37	0.22	0.21	0.23	0.2
1975	0.92	0.45	0.37	0.22	0.21	0.23	0.2
1976	0.92	0.45	0.37	0.22	0.21	0.23	0.2
1977	0.92	0.44	0.36	0.22	0.22	0.23	0.2
1978	0.92	0.43	0.36	0.23	0.22	0.23	0.2
1979	0.92	0.43	0.36	0.23	0.22	0.24	0.2
1980	0.91	0.42	0.36	0.23	0.22	0.24	0.2
1981	0.9	0.41	0.36	0.23	0.22	0.24	0.2
1982	0.89	0.41	0.36	0.23	0.22	0.24	0.2
1983	0.87	0.4	0.36	0.23	0.22	0.25	0.2
1984	0.85	0.39	0.36	0.23	0.22	0.25	0.2
1985	0.83	0.38	0.36	0.23	0.23	0.25	0.2
1986	0.81	0.38	0.36	0.23	0.23	0.26	0.2
1987	0.79	0.37	0.36	0.24	0.23	0.26	0.2
1988	0.77	0.36	0.37	0.24	0.23	0.27	0.2
1989	0.75	0.35	0.37	0.24	0.24	0.28	0.2
1990	0.73	0.35	0.38	0.24	0.24	0.28	0.2
1991	0.72	0.34	0.39	0.25	0.24	0.29	0.2
1992	0.7	0.34	0.4	0.25	0.25	0.3	0.2
1993	0.7	0.34	0.41	0.26	0.25	0.31	0.2
1994	0.69	0.33	0.42	0.26	0.25	0.31	0.2
1995	0.68	0.33	0.43	0.26	0.26	0.32	0.2
1996	0.67	0.32	0.44	0.27	0.26	0.33	0.2
1997	0.65	0.31	0.44	0.27	0.26	0.34	0.2
1998	0.63	0.31	0.45	0.27	0.27	0.34	0.2
1999	0.61	0.3	0.45	0.27	0.27	0.34	0.2
2000	0.58	0.29	0.44	0.27	0.27	0.35	0.2
2001	0.56	0.29	0.44	0.27	0.27	0.35	0.2
2002	0.53	0.28	0.43	0.27	0.27	0.35	0.2
2003	0.51	0.28	0.42	0.27	0.27	0.34	0.2
2004	0.5	0.27	0.41	0.27	0.27	0.34	0.2
2005	0.49	0.27	0.4	0.26	0.26	0.34	0.2
2006	0.47	0.27	0.39	0.26	0.26	0.33	0.2
2007	0.46	0.26	0.38	0.26	0.26	0.33	0.2
2008	0.46	0.26	0.38	0.26	0.26	0.33	0.2

Table 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Survey tuning CPUE. Data used in the assessment are highlighted in bold text

North Sea/Skagerrak/Eastern Channel Cod, Tuning data for standard survey. Updated 29 Apr 09
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IBTS_Q1, 6 is a plusgroup

1983	2009					
1	1	0	0.25			
1	5					
1	**4.734**	**16.699**	**2.749**	**1.932**	**0.798**	1.357
1	**15.856**	**8.958**	**4.059**	**0.905**	**0.976**	0.875
1	**0.928**	**18.782**	**3.217**	**1.744**	**0.476**	0.930
1	**16.785**	**3.627**	**7.079**	**2.242**	**1.280**	0.967
1	**9.425**	**28.833**	**1.515**	**1.789**	**0.636**	0.819
1	**5.638**	**6.334**	**6.204**	**0.658**	**0.860**	1.127
1	**15.117**	**6.328**	**5.044**	**2.345**	**0.394**	0.992
1	**3.953**	**15.665**	**1.885**	**1.034**	**0.967**	0.619
1	**2.481**	**4.714**	**4.254**	**0.861**	**0.420**	0.771
1	**13.129**	**4.346**	**1.183**	**0.996**	**0.288**	0.483
1	**13.088**	**19.521**	**2.025**	**0.688**	**0.565**	0.377
1	**14.660**	**4.387**	**2.876**	**0.815**	**0.483**	0.521
1	**9.832**	**22.062**	**2.731**	**1.105**	**0.276**	0.335
1	**3.441**	**7.970**	**5.922**	**0.679**	**0.639**	0.384
1	**39.951**	**6.897**	**2.247**	**1.069**	**0.458**	0.417
1	**2.672**	**26.368**	**2.003**	**0.884**	**0.505**	0.392
1	**2.112**	**1.583**	**8.078**	**0.764**	**0.439**	0.495
1	**6.563**	**3.767**	**0.738**	**2.050**	**0.387**	0.504
1	**2.786**	**8.647**	**1.659**	**0.231**	**0.394**	0.262
1	**7.755**	**3.380**	**4.278**	**0.496**	**0.119**	0.218
1	**0.584**	**2.860**	**1.144**	**1.361**	**0.514**	0.192
1	**6.740**	**1.985**	**1.288**	**0.347**	**0.432**	0.224
1	**2.272**	**2.197**	**0.629**	**0.551**	**0.227**	0.424
1	**6.642**	**1.644**	**0.994**	**0.293**	**0.152**	0.270
1	**3.091**	**5.830**	**1.222**	**0.423**	**0.261**	0.286
1	**2.694**	**1.261**	**2.498**	**0.579**	**0.400**	0.164
1	**1.230**	**2.772**	**0.928**	**0.925**	**0.301**	0.254

IBTS_Q3, 6 is a plusgroup

1991	2008						
1	1	0.5	0.75				
0	4						
1	29.207	**8.170**	**2.438**	**1.164**	**0.164**	0.066	0.069
1	19.591	**43.487**	**3.596**	**0.737**	**0.457**	0.153	0.136
1	16.288	**10.473**	**7.903**	**0.861**	**0.183**	0.136	0.061
1	16.112	**42.737**	**6.155**	**2.389**	**0.213**	0.082	0.073
1	10.864	**22.282**	**17.419**	**1.468**	**0.762**	0.068	0.070
1	68.916	**10.283**	**5.327**	**1.833**	**0.390**	0.183	0.036
1	0.130	**60.518**	**5.471**	**1.659**	**0.636**	0.130	0.125
1	91.708	**2.397**	**20.057**	**1.294**	**0.386**	0.235	0.117
1	9.543	**11.952**	**0.961**	**3.863**	**0.291**	0.089	0.037
1	1.845	**10.689**	**2.294**	**0.205**	**0.523**	0.075	0.090
1	4.669	**4.723**	**5.533**	**0.792**	**0.150**	0.153	0.145
1	0.767	**11.334**	**2.117**	**1.557**	**0.439**	0.100	0.046
1	12.854	**1.735**	**2.475**	**0.516**	**0.483**	0.401	0.504
1	2.287	**12.178**	**1.703**	**1.088**	**0.202**	0.143	0.046
1	13.755	**4.745**	**2.062**	**0.622**	**0.218**	0.049	0.124
1	7.329	**15.215**	**1.890**	**1.252**	**0.219**	0.044	0.059
1	8.135	**9.079**	**6.154**	**0.975**	**0.344**	0.137	0.122
1	1.384	**9.989**	**2.518**	**3.000**	**0.516**	0.249	0.116

Table 14.9a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run tuning model specification

Lowestoft VPA Program

30/04/2009 10:26

Adapt Analysis

North Sea/Skagerrak Tuning data. INCLUDES DISCARDS

CPUE data from file Cod347_2009_std.tun

Catch data for 46 years : 1963 to 2008. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1_std	1983	2009	1	5	0	0.25
IBTS_Q3_std	1991	2008	1	4	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1_std	1	5
IBTS_Q3_std	1	3

Catchability independent of stock size for all ages

Bias estimation : Bias estimated for the final 16 years.
Oldest age F estimates in 1963 to 2009 calculated as 1.000 * the mean F of ages 3- 5
Total catch penalty: lambda = 0.500

Individual fleet weighting not applied

INITIAL SSQ =	42.12556	SSQ =	27.53499	IFAIL =	0
PARAMETERS =	21	QSSQ =	26.71884	IFAILCV = 0	
OBSERVATIONS =	223	CSSQ =	0.81615		

Table 14.9b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ1 tuning diagnostics

Fleet : IBTS_Q1_std

Log index residuals

Age	1983	1984	1985	1986	1987	1988	1989
1	-0.69	-0.57	-1.76	-0.64	0.24	0.15	0.20
2	0.12	0.03	0.16	-0.19	0.39	-0.22	0.21
3	0.00	-0.11	0.12	0.39	-0.01	0.07	0.68
4	-0.14	0.05	0.05	0.75	0.08	0.09	0.26
5	-0.11	-0.13	0.01	0.29	0.20	0.03	0.26

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.02	-0.75	0.17	0.92	-0.24	0.14	-0.33	0.93	0.28	-0.52
2	0.48	0.17	-0.17	0.59	-0.29	0.38	-0.13	0.13	0.34	-0.41
3	0.03	0.45	-0.30	0.02	-0.23	0.05	0.26	-0.29	-0.29	0.38
4	0.17	0.21	-0.05	0.00	0.16	-0.30	-0.24	-0.23	-0.21	0.00
5	0.08	-0.11	-0.31	0.00	0.41	-0.43	-0.18	0.08	-0.32	-0.01

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.08	0.41	0.83	-0.94	1.11	0.21	0.36	0.36	0.05	99.99
2	0.00	0.13	0.20	-0.41	0.12	-0.34	-0.37	-0.13	-0.79	-0.31
3	-0.25	0.13	0.27	-0.29	-0.02	-0.35	-0.35	-0.04	-0.33	-0.08
4	0.58	-0.15	-0.23	0.19	-0.37	0.09	-0.27	-0.41	-0.11	-0.30
5	0.39	-0.02	-0.22	0.66	-0.19	-0.09	-0.43	0.03	0.14	-0.27

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	-10.6751	-9.5681	-9.3245	-9.0576	-8.6149
S.E(Log q)	0.6489	0.3242	0.2803	0.273	0.2618

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	-1.02	10.35	0.58	26	0.76421	-10.68
2	0.79	3.617	9.99	0.92	26	0.20917	-9.57
3	0.82	2.379	9.51	0.88	26	0.21015	-9.32
4	0.88	1.33	9.06	0.83	26	0.23548	-9.06
5	1.05	-0.427	8.65	0.78	26	0.27867	-8.61

Table 14.9c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ3 tuning diagnostics

Fleet : IBTS_Q3_std

Log index residuals

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	99.99	-0.41	0.51	-0.22	0.07	0.05	-0.22	0.37	-0.78	0.31
2	99.99	-0.20	-0.07	0.08	0.26	0.56	-0.14	0.10	0.48	-0.65
3	99.99	-0.26	-0.27	-0.19	0.13	0.08	-0.18	0.00	-0.01	0.54
4	99.99	-0.71	-0.08	-0.48	-0.49	0.10	0.02	0.01	-0.15	0.01
5	No data for this fleet at this age									

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	-0.41	-0.13	0.19	-0.78	0.66	-0.04	0.15	0.43	0.29	99.99
2	-0.18	-0.08	-0.18	-0.12	0.12	-0.18	-0.09	0.04	0.26	99.99
3	-0.77	-0.11	-0.12	-0.42	0.38	0.17	0.37	0.17	0.50	99.99
4	0.22	0.15	0.51	0.00	-0.11	0.01	0.10	0.09	0.45	99.99
5	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
Mean Log	-9.2619	-9.2752	-9.2814	-9.2814
S.E(Log q)	0.416	0.2794	0.3355	0.3043

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	0.88	1.038	9.61	0.83	18	0.36552	-9.26
2	0.81	2.864	9.67	0.93	18	0.18894	-9.28
3	0.85	1.205	9.42	0.8	18	0.28165	-9.28
4	1.04	-0.21	9.32	0.67	18	0.32395	-9.3

Table 14.9d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run parameter estimates

Parameters			Variance covariance matrix																			
Age	Survivors	s.e log est	0.06	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	60978	0.24	0.00	0.08	0.01	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
2	12739	0.28	0.00	0.01	0.08	0.01	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	11602	0.28	0.00	0.01	0.01	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	2519	0.25	0.00	0.04	0.05	0.02	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04
5	489	0.92	0.01	0.01	0.01	0.01	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
			0.00	0.00	0.00	0.00	0.00	0.00	0.06	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year	Multiplier	s.e log est	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	1.21	0.21	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	0.96	0.24	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	1.40	0.21	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996	1.44	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.99	0.23	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1.08	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	-0.01	0.00	0.00	0.00	0.00	0.00
1999	1.24	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01	0.00	0.00	0.00	0.00
2000	1.15	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00
2001	1.06	0.24	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.06	-0.01	0.00	0.00
2002	1.42	0.22	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01	0.00
2003	2.33	0.19	0.00	0.01	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.06	0.00
2004	1.30	0.24	0.00	0.00	0.00	0.00	-0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
2005	1.72	0.21	0.00	-0.01	-0.02	-0.01	-0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
2006	1.42	0.24																				
2007	1.49	0.25																				
2008	2.13	0.25																				

Table 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median fishing mortality at age.

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Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.1180	0.0423	0.2771	0.2534	0.1305	0.1851	0.0286	0.1536	0.3147	0.2157
2	0.6451	0.4183	0.4529	0.6199	0.5633	0.6578	0.4593	0.6087	0.9088	0.9396
3	0.3690	0.5654	0.6420	0.5759	0.7007	0.7197	0.5520	0.6996	0.7367	0.8541
4	0.4839	0.4459	0.6163	0.5487	0.5045	0.7347	0.6164	0.5504	0.6972	0.6751
5	0.4063	0.5417	0.4880	0.4941	0.6517	0.5774	0.6857	0.6641	0.6613	0.7030
6	0.4197	0.5177	0.5821	0.5396	0.6189	0.6772	0.6180	0.6380	0.6984	0.7441
+gp	0.4197	0.5177	0.5821	0.5396	0.6189	0.6772	0.6180	0.6380	0.6984	0.7441
FBAR 2- 4	0.4993	0.4765	0.5704	0.5815	0.5895	0.7041	0.5426	0.6196	0.7809	0.8229

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.3538	0.4723	0.2849	0.5882	0.5534	0.1499	0.8930	1.0001	0.5506	0.4646
2	0.8401	0.8581	0.8182	1.2282	1.1762	1.1723	0.7565	0.8993	1.0053	0.9407
3	0.7763	0.6385	0.7488	0.8409	0.7481	0.8960	0.8941	0.9352	0.9583	1.1707
4	0.7752	0.6199	0.6792	0.7749	0.5862	0.7909	0.6225	0.7836	0.7838	0.9166
5	0.6252	0.6509	0.7101	0.5996	0.6874	1.0254	0.7840	0.7461	0.6916	0.8533
6	0.7256	0.6364	0.7127	0.7385	0.6739	0.9041	0.7669	0.8216	0.8112	0.9802
+gp	0.7256	0.6364	0.7127	0.7385	0.6739	0.9041	0.7669	0.8216	0.8112	0.9802
FBAR 2- 4	0.7972	0.7055	0.7487	0.9480	0.8368	0.9531	0.7577	0.8727	0.9158	1.0094

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.2916	0.8466	0.4774	0.8044	0.2170	0.2472	0.5731	0.3814	0.3923	0.3975
2	1.0524	0.9879	1.0817	0.9318	1.0910	1.0005	0.9283	1.2110	0.8233	0.8386
3	1.1244	0.9420	0.9075	0.9954	0.8528	1.0903	1.0145	0.8787	0.8536	0.6971
4	0.9148	0.8212	0.7644	0.9450	0.8969	0.8852	0.9391	0.8290	0.7780	0.7928
5	0.8154	0.7825	0.7304	0.8034	0.7430	0.7768	0.8644	0.6885	0.7479	0.6640
6	0.9515	0.8486	0.8008	0.9146	0.8309	0.9174	0.9393	0.7988	0.7932	0.7180
+gp	0.9515	0.8486	0.8008	0.9146	0.8309	0.9174	0.9393	0.7988	0.7932	0.7180
FBAR 2- 4	1.0305	0.9171	0.9179	0.9574	0.9469	0.9920	0.9606	0.9729	0.8183	0.7761

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.2917	0.6339	0.3066	0.1739	0.2531	0.2546	0.4294	0.2568	0.1513	0.2577
2	1.0291	0.6957	1.0559	1.0037	0.7753	1.0128	0.8174	0.8768	0.8497	0.4751
3	0.9601	0.7597	0.9301	1.0741	0.9309	0.9951	1.4477	1.1115	0.7297	0.8977
4	0.9857	0.6966	0.7970	0.8826	0.8949	0.9771	1.2378	1.2347	0.8251	1.0000
5	0.8942	0.6520	0.6232	0.9126	0.8301	0.9502	1.1580	1.2941	0.8071	0.9318
6	0.9464	0.7025	0.7833	0.9562	0.8850	0.9738	1.2814	1.2136	0.7874	0.9422
+gp	0.9464	0.7025	0.7833	0.9562	0.8850	0.9738	1.2814	1.2136	0.7874	0.9422
FBAR 2- 4	0.9920	0.7177	0.9274	0.9861	0.8667	0.9951	1.1674	1.0740	0.8014	0.7902

AGE\YEAR	2003	2004	2005	2006	2007	2008
1	0.3813	0.2894	0.3151	0.2981	0.3417	0.1859
2	1.0465	0.7327	0.6599	0.6516	0.5753	0.9052
3	0.8672	0.9536	0.6541	0.7380	0.5747	0.8895
4	0.8771	1.0208	0.8633	0.6912	0.7169	0.5568
5	1.0159	0.7177	0.7638	0.8199	0.5009	1.0513
6	0.9196	0.8979	0.7600	0.7501	0.5970	0.8372
+gp	0.9196	0.8979	0.7600	0.7501	0.5970	0.8372
FBAR 2- 4	0.9299	0.9026	0.7247	0.6944	0.6189	0.7882

Table 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median population numbers at age.

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Table 10 Stock number at age (start of year) Numbers*10**-3

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	249718	462750	687286	835166	748976	329855	295479	1143743	1687701	329293
2	157713	101732	195367	222662	271562	269935	110340	114432	390898	490970
3	26607	54365	43557	79995	76384	97605	88266	43564	38910	98457
4	10179	13227	21985	16153	31378	26182	32826	34758	14799	12738
5	9194	5035	6796	9526	7489	15205	10079	14222	16087	5914
6	3912	4964	2374	3381	4711	3164	6919	4115	5934	6731
+gp	1892	2236	2700	2916	3403	3250	3035	3459	3796	5839
TOTAL	459217	644308	960065	1169799	1143902	745195	546944	1358293	2158126	949942

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	561402	550554	1030925	769399	1898803	638410	1502822	2807522	609627	983478
2	104719	157056	136821	308981	170280	435083	218995	245208	415711	142910
3	119921	28535	42037	38492	57688	33825	87639	66859	65553	100962
4	28661	37733	10409	13732	11468	19047	9633	25006	18309	17541
5	5204	10595	16292	4235	5078	5121	6862	4107	9075	6643
6	2373	2258	4480	6492	1885	2049	1474	2514	1563	3647
+gp	3907	3326	2209	2563	4231	1914	1535	1646	1686	1364
TOTAL	826187	790057	1243172	1143896	2149432	1135451	1828960	3152863	1121523	1256545

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	470856	1485856	272216	1668788	363026	238092	630938	199511	260092	546894
2	253796	147368	272357	73644	332123	132620	86093	168028	65660	85515
3	37021	59388	37151	63141	19836	77051	34021	23978	35274	20515
4	21846	8391	16152	10459	16281	5898	17889	8521	6810	10171
5	5573	6953	2933	5975	3230	5223	1915	5502	2926	2436
6	2271	1979	2552	1122	2126	1221	1909	635	2174	1089
+gp	1622	1530	1326	1565	1090	842	819	882	807	952
TOTAL	792985	1711465	604686	1824696	737712	460948	773583	407055	373742	667573

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	254721	939238	413639	233277	734266	96659	177838	299673	86372	155474
2	182494	94232	247940	153497	100368	296961	40074	62528	129470	42355
3	26313	46279	33525	61951	40666	33852	79805	12951	19400	41400
4	6849	6663	14181	8578	13563	10310	8037	11867	2730	6014
5	3585	1965	2555	4906	2698	4223	2987	1766	2618	912
6	977	1138	794	1050	1512	906	1257	709	367	891
+gp	758	532	595	761	490	520	647	354	317	244
TOTAL	475696	1090048	713228	464020	893562	443431	310645	389848	241273	247289

AGE\YEAR	2003	2004	2005	2006	2007	2008
1	73605	106661	88393	218422	98279	120160
2	70763	30073	48317	39294	101674	43852
3	19867	18606	11029	18881	15605	43863
4	10921	5448	4755	3813	6120	5968
5	1685	3446	1498	1533	1478	2275
6	273	462	1282	533	520	679
+gp	279	224	201	475	302	462
TOTAL	177393	164919	155474	282951	223977	217259

Table 14.12a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median stock and management metrics.

Run title: North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
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B-ADAPT median values

	RECRUITS Age 1 ('000)	TSB (tons)	SSB (tons)	CATCH (tons)	YIELD/SSB	FBAR 2-4
1963	249718	443856	164821	128686	0.781	0.499
1964	462750	530389	166809	130740	0.784	0.477
1965	687286	695016	193421	210237	1.087	0.570
1966	835166	846628	225100	259416	1.152	0.581
1967	748976	900304	249059	276387	1.110	0.589
1968	329855	797607	254722	305911	1.201	0.704
1969	295479	654250	252744	205510	0.813	0.543
1970	1143743	993899	260553	243867	0.936	0.620
1971	1687701	1201678	264800	412264	1.557	0.781
1972	329293	863226	243532	387737	1.592	0.823
1973	561402	683266	205762	269139	1.308	0.797
1974	550554	650496	233150	253989	1.089	0.705
1975	1030925	728266	211890	242349	1.144	0.749
1976	769399	644409	180579	307102	1.701	0.948
1977	1898803	946599	163815	349038	2.131	0.837
1978	638410	817810	150864	328585	2.178	0.953
1979	1502822	964889	158450	430688	2.718	0.758
1980	2807522	1255362	179034	590678	3.299	0.873
1981	609627	844173	190515	393451	2.065	0.916
1982	983478	834918	184954	359372	1.943	1.009
1983	470856	638926	148887	281696	1.892	1.031
1984	1485856	825394	131990	379974	2.879	0.917
1985	272216	505132	124377	247031	1.986	0.918
1986	1668788	761628	115131	341047	2.962	0.957
1987	363026	563625	107496	244809	2.277	0.947
1988	238092	432243	98890	194798	1.970	0.992
1989	630938	469625	92913	202639	2.181	0.961
1990	199511	323769	81361	153021	1.881	0.973
1991	260092	301415	78090	121204	1.552	0.818
1992	546894	428548	77338	151755	1.962	0.776
1993	254721	372630	78810	173978	2.208	0.992
1994	939238	520934	75503	203158	2.691	0.718
1995	413639	531888	95546	223243	2.336	0.927
1996	233277	443080	103589	199412	1.925	0.986
1997	734266	537068	91120	173408	1.903	0.867
1998	96659	349928	76426	179324	2.346	0.995
1999	177838	256969	74317	138457	1.863	1.167
2000	299673	241222	49052	96179	1.961	1.074
2001	86372	182425	38830	75895	1.955	0.801
2002	155474	217959	47150	81559	1.730	0.790
2003	73605	152148	43644	76695	1.757	0.930
2004	106661	128590	40050	53925	1.346	0.903
2005	88393	132469	36564	51858	1.418	0.725
2006	218422	145291	34475	53268	1.545	0.694
2007	98279	189117	42313	70102	1.657	0.619
2008	120160	212026	57282	90687	1.583	0.788
2009			60139			

Table 14.12b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings, discards and estimated total removals, based on the B-Adapt base run.

	Landings	Discards	Catch (L+D)	Total estimated removals
1985	214.6	31.5	246.1	247.0
1986	204.1	139.1	343.1	341.0
1987	216.2	27.8	244.1	244.8
1988	184.2	10.7	195.0	194.8
1989	139.9	62.1	202.1	202.6
1990	125.3	27.0	152.3	153.0
1991	102.5	18.6	121.0	121.2
1992	114.0	36.9	150.9	151.8
1993	121.7	21.9	143.6	174.0
1994	110.6	99.6	210.2	203.2
1995	136.1	32.2	168.3	223.2
1996	126.3	14.3	140.6	199.4
1997	124.2	33.6	157.8	173.4
1998	146.0	40.5	186.5	179.3
1999	96.2	14.2	110.4	138.5
2000	71.4	13.7	85.1	96.2
2001	49.7	13.9	63.6	75.9
2002	54.9	5.7	60.6	81.6
2003	30.9	6.4	37.2	76.7
2004	28.2	5.8	34.0	53.9
2005	28.7	6.3	35.0	51.9
2006	26.6	8.1	34.6	53.3
2007	24.4	23.6	48.1	70.1
2008	26.8	21.8	48.7	90.7

Table 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 1: reduction in fishing mortality by 25% in 2009, followed by constant fishing mortality at the 2009 level for 2010 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.750	0.750

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.41	0.41
0.25	0.69	0.51	0.51	0.51
0.5	0.79	0.59	0.59	0.59
0.75	0.88	0.66	0.66	0.66
0.95	1.03	0.77	0.77	0.77

SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	44378
0.25	53641	54778	57815	60238
0.5	57282	60139	65950	73667
0.75	61654	66376	76485	88363
0.95	67418	77475	94615	118660

Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	36108	36757
0.25	42931	38274	40941	42012
0.5	50430	41915	45008	47419
0.75	58251	45579	49805	54257
0.95	69507	50777	60179	66118

Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	19396	20237
0.25	34271	21205	24690	24691
0.5	40257	24771	29254	30340
0.75	46500	28339	35683	37899
0.95	55485	33932	47145	50351

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.78	0.82	0.83

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.12
P25/P75	0.89	0.87	0.79

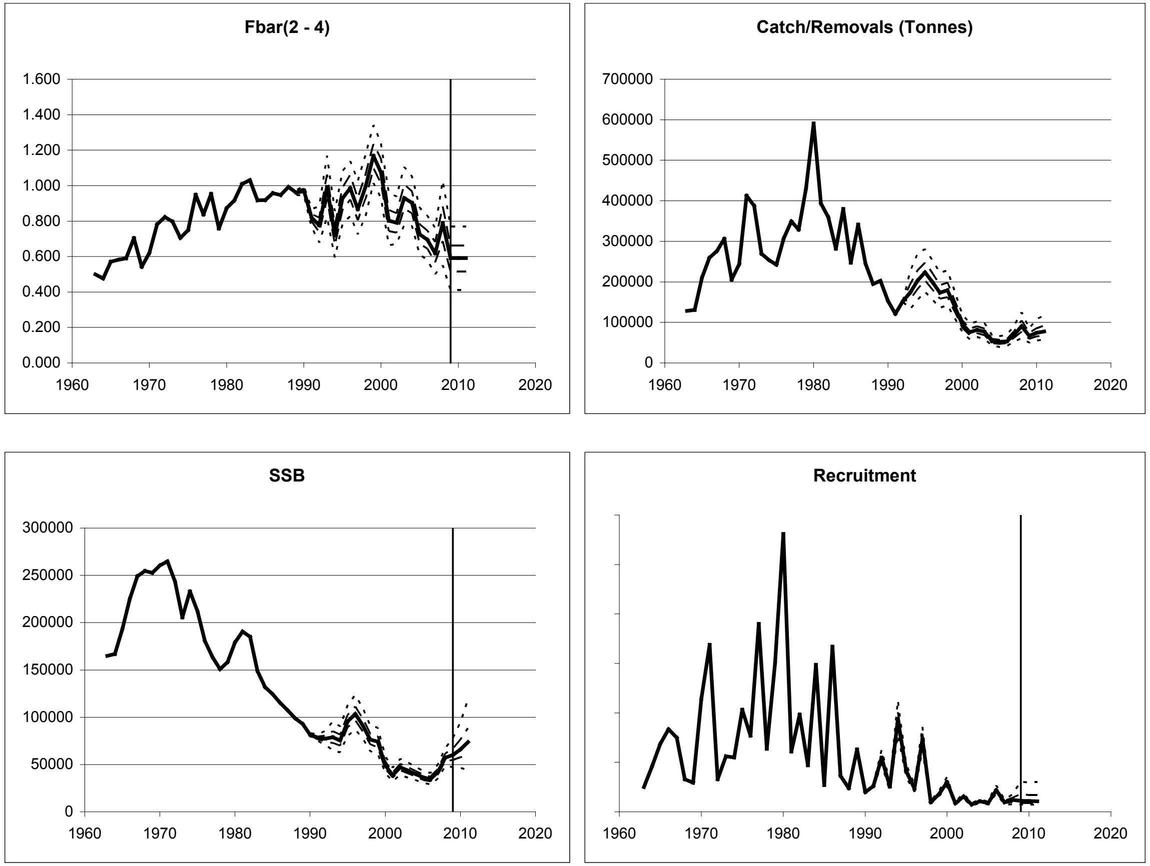


Table 14.14a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2a: reduction in fishing mortality by 25% in 2009, followed by a further reduction of 10% in 2010 (relative to 2009), then held constant for at the 2010 level for 2011 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.675	0.675

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.37	0.37
0.25	0.69	0.51	0.46	0.46
0.5	0.79	0.59	0.53	0.53
0.75	0.88	0.66	0.60	0.60
0.95	1.03	0.77	0.69	0.69

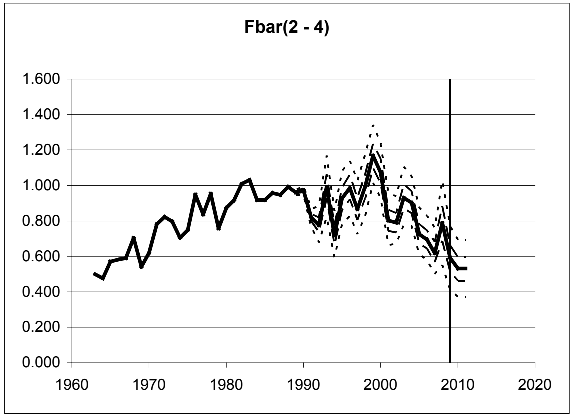
SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	48329
0.25	53641	54778	57815	64371
0.5	57282	60139	65950	78064
0.75	61654	66376	76485	93363
0.95	67418	77475	94615	123546

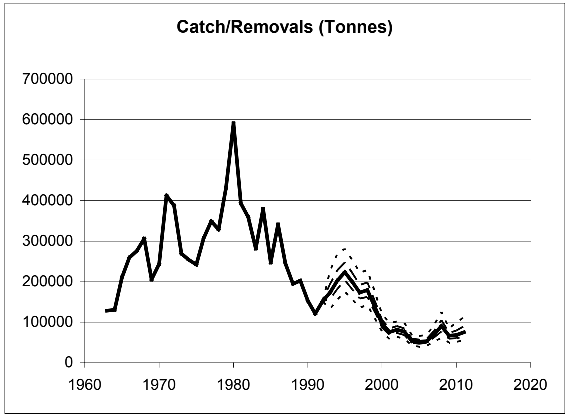
Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	33378	35995
0.25	42931	38274	37859	41057
0.5	50430	41915	41551	46200
0.75	58251	45579	46112	52755
0.95	69507	50777	55716	64316

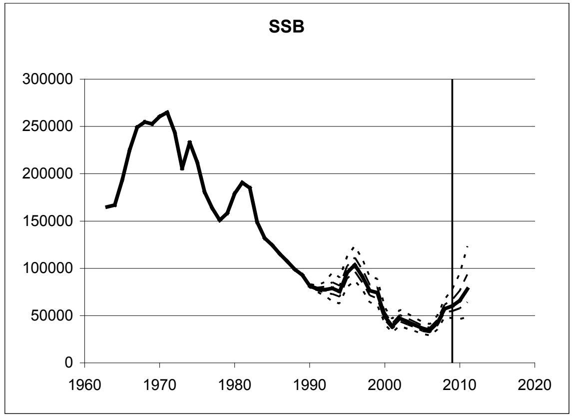
Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	17835	19177
0.25	34271	21205	22759	23509
0.5	40257	24771	26948	28934
0.75	46500	28339	32867	36420
0.95	55485	33932	43528	48114

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.84	0.89	0.91

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.18
P25/P75	0.89	0.87	0.84







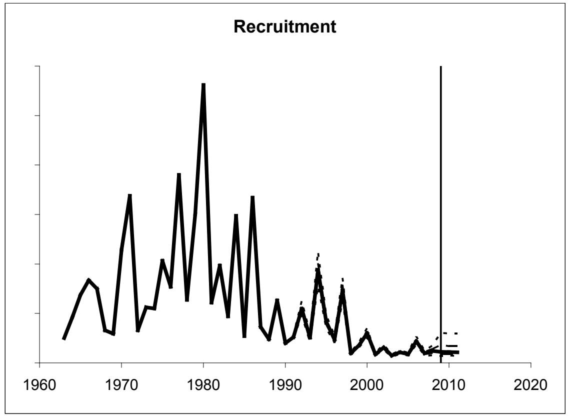


Table 14.14b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2b: reduction in fishing mortality by 25% in 2009, followed by a further reduction of 15% in 2010 (relative to 2009), then held constant for at the 2010 level for 2011 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.637	0.637

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.35	0.35
0.25	0.69	0.51	0.44	0.44
0.5	0.79	0.59	0.50	0.50
0.75	0.88	0.66	0.56	0.56
0.95	1.03	0.77	0.65	0.65

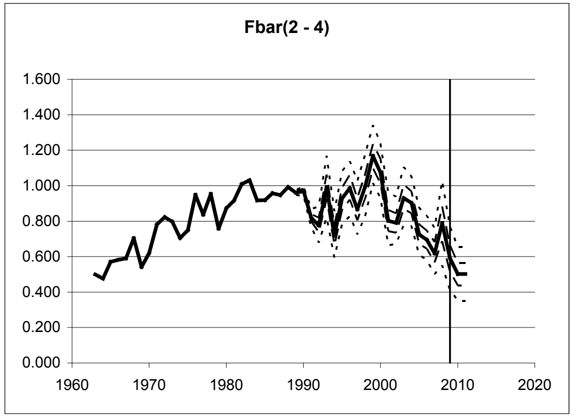
SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	50217
0.25	53641	54778	57815	66540
0.5	57282	60139	65950	80474
0.75	61654	66376	76485	95896
0.95	67418	77475	94615	126002

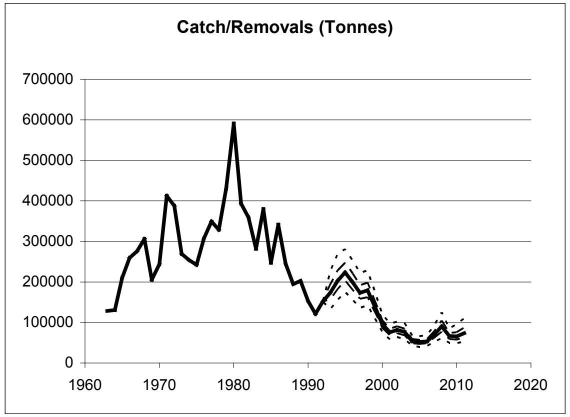
Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	31858	35264
0.25	42931	38274	36265	40380
0.5	50430	41915	39699	45359
0.75	58251	45579	44216	51724
0.95	69507	50777	53416	63290

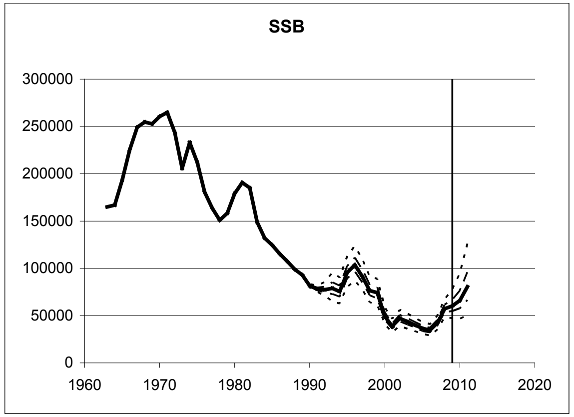
Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	17014	18534
0.25	34271	21205	21727	22844
0.5	40257	24771	25717	28122
0.75	46500	28339	31450	35417
0.95	55485	33932	41678	47183

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.86	0.92	0.94

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.22
P25/P75	0.89	0.87	0.87







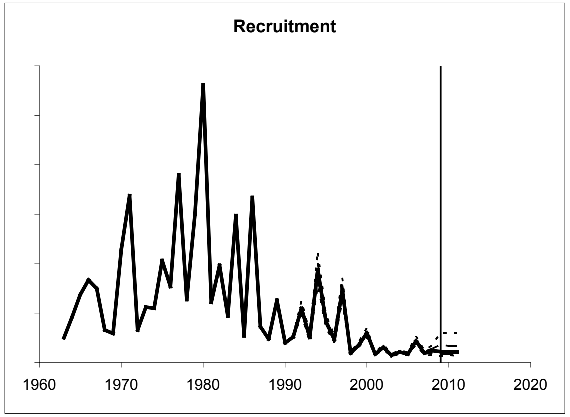


Table 14.14c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2c: reduction in fishing mortality by 25% in 2009, followed by a further reduction of 20% in 2010 (relative to 2009), then held constant for at the 2010 level for 2011 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.600	0.600

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.33	0.33
0.25	0.69	0.51	0.41	0.41
0.5	0.79	0.59	0.47	0.47
0.75	0.88	0.66	0.53	0.53
0.95	1.03	0.77	0.62	0.62

SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	52140
0.25	53641	54778	57815	68880
0.5	57282	60139	65950	82854
0.75	61654	66376	76485	98602
0.95	67418	77475	94615	128533

Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	30350	34556
0.25	42931	38274	34606	39510
0.5	50430	41915	37907	44364
0.75	58251	45579	42177	50612
0.95	69507	50777	50955	61782

Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	16146	17882
0.25	34271	21205	20702	22030
0.5	40257	24771	24490	27159
0.75	46500	28339	29997	34430
0.95	55485	33932	39849	45935

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.89	0.94	0.96

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.26
P25/P75	0.89	0.87	0.90

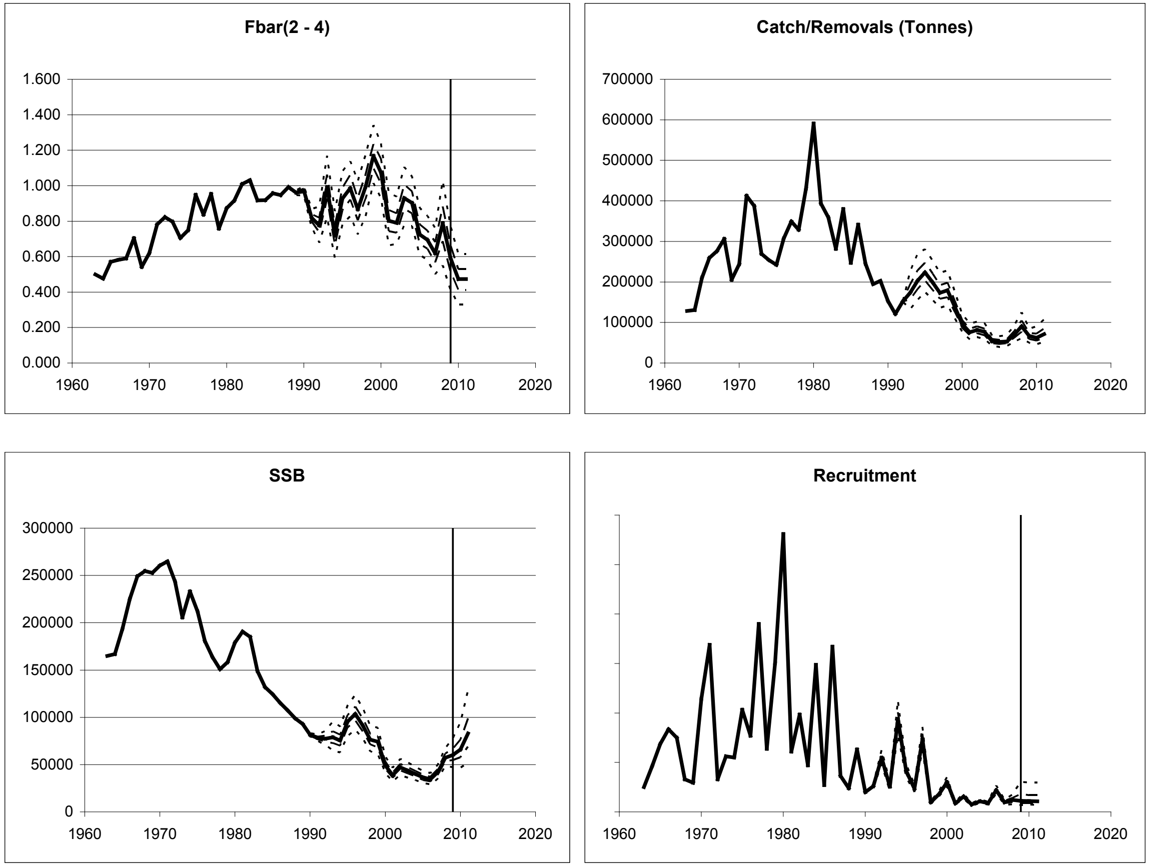


Table 14.14d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2d: reduction in fishing mortality by 25% in 2009, followed by a further reduction of 25% in 2010 (relative to 2009), then held constant for at the 2010 level for 2011 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.562	0.562

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.31	0.31
0.25	0.69	0.51	0.39	0.39
0.5	0.79	0.59	0.44	0.44
0.75	0.88	0.66	0.50	0.50
0.95	1.03	0.77	0.58	0.58

SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	54057
0.25	53641	54778	57815	70924
0.5	57282	60139	65950	85359
0.75	61654	66376	76485	101519
0.95	67418	77475	94615	131413

Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	28769	33559
0.25	42931	38274	32829	38537
0.5	50430	41915	36086	43190
0.75	58251	45579	40105	49290
0.95	69507	50777	48347	60431

Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	15296	17161
0.25	34271	21205	19611	21335
0.5	40257	24771	23274	26243
0.75	46500	28339	28456	33340
0.95	55485	33932	37843	44552

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.91	0.95	0.97

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.29
P25/P75	0.89	0.87	0.93

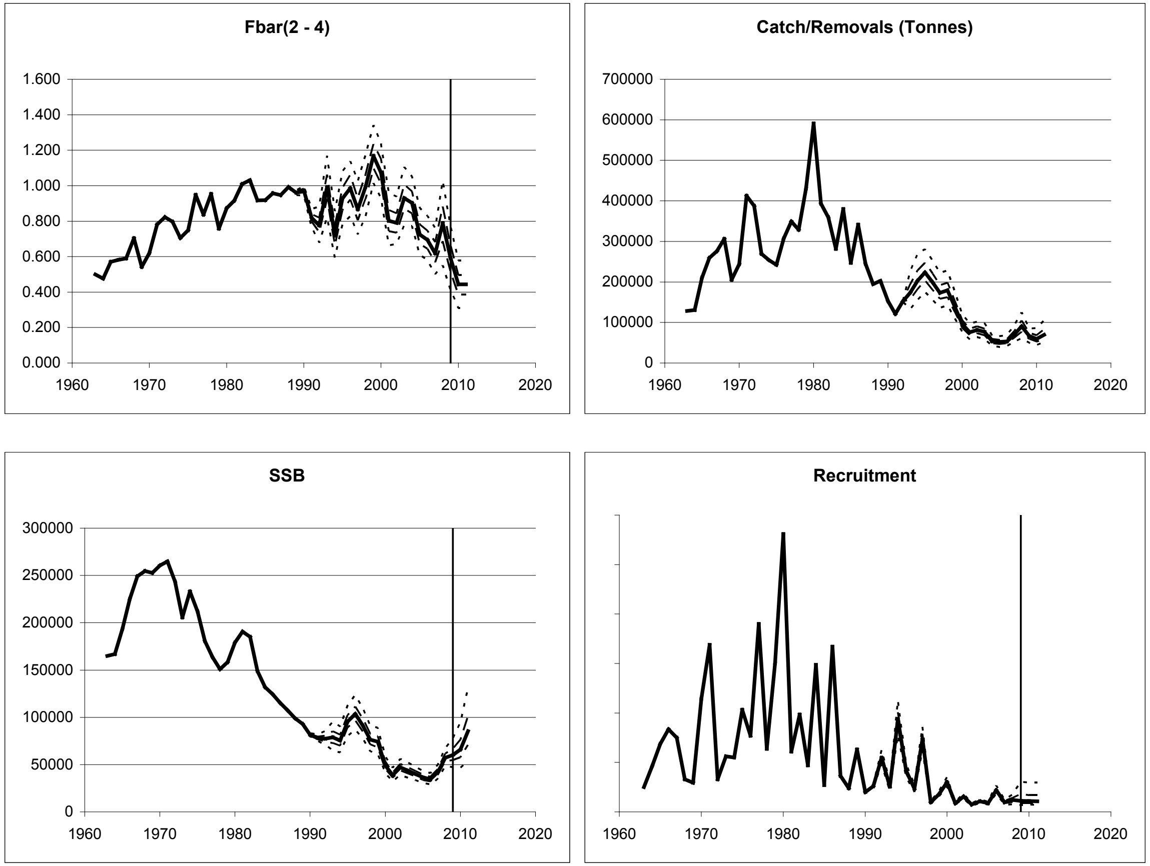


Table 14.14e Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 2e: reduction in fishing mortality by 25% in 2009, followed by a further reduction of 30% in 2010 (relative to 2009), then held constant for at the 2010 level for 2011 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.525	0.525

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.29	0.29
0.25	0.69	0.51	0.36	0.36
0.5	0.79	0.59	0.41	0.41
0.75	0.88	0.66	0.46	0.46
0.95	1.03	0.77	0.54	0.54

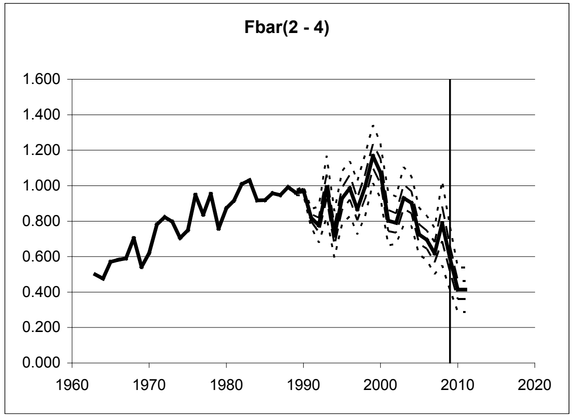
SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	56300
0.25	53641	54778	57815	73248
0.5	57282	60139	65950	87931
0.75	61654	66376	76485	104321
0.95	67418	77475	94615	134758

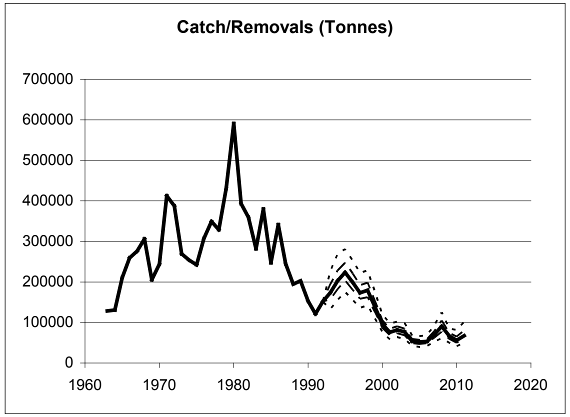
Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	27151	32562
0.25	42931	38274	31027	37319
0.5	50430	41915	34136	42088
0.75	58251	45579	37942	47963
0.95	69507	50777	45856	58636

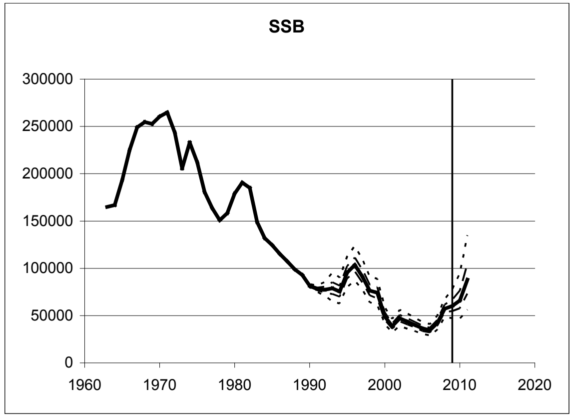
Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	14432	16461
0.25	34271	21205	18526	20446
0.5	40257	24771	21983	25302
0.75	46500	28339	26916	32106
0.95	55485	33932	35717	43246

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.93	0.96	0.99

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.33
P25/P75	0.89	0.87	0.96







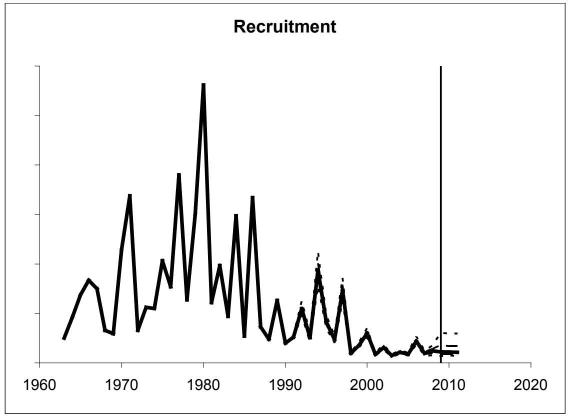


Table 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 3: reduction in fishing mortality by 25% in 2009, followed by a further reduction to the target fishing mortality of 0.4 for 2010 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.508	0.508

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.28	0.28
0.25	0.69	0.51	0.35	0.35
0.5	0.79	0.59	0.40	0.40
0.75	0.88	0.66	0.45	0.45
0.95	1.03	0.77	0.52	0.52

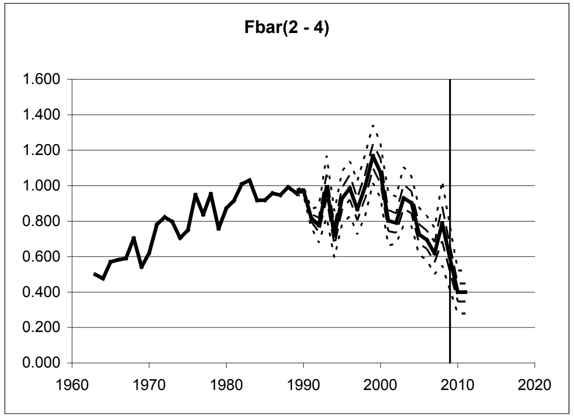
SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	57403
0.25	53641	54778	57815	74469
0.5	57282	60139	65950	89188
0.75	61654	66376	76485	105480
0.95	67418	77475	94615	136348

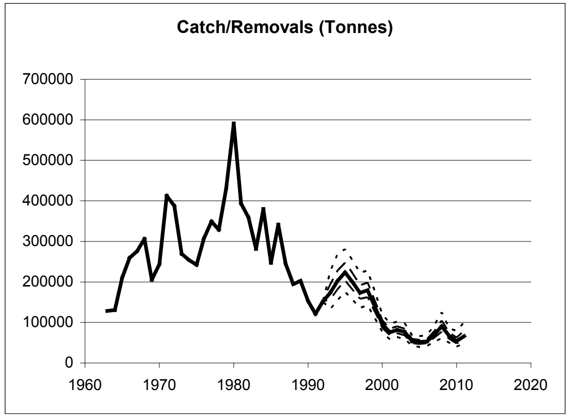
Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	26389	32060
0.25	42931	38274	30170	36722
0.5	50430	41915	33213	41398
0.75	58251	45579	36913	47274
0.95	69507	50777	44620	57695

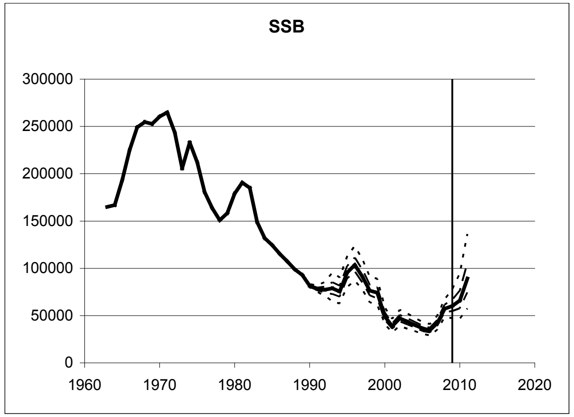
Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	14017	16116
0.25	34271	21205	17998	20074
0.5	40257	24771	21367	24750
0.75	46500	28339	26157	31499
0.95	55485	33932	34733	42478

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.93	0.97	0.99

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.35
P25/P75	0.89	0.87	0.97







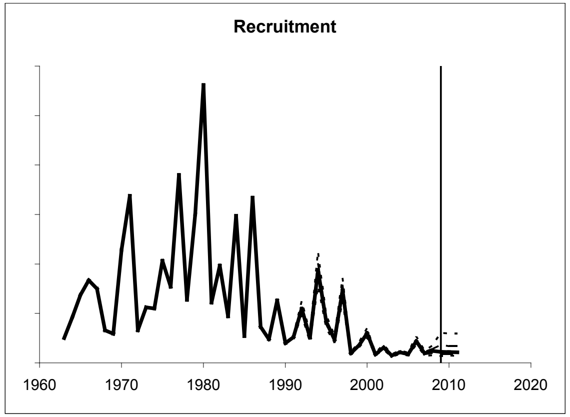


Table 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 4: reduction in fishing mortality by 25% in 2009, followed by a closure of the fishery from 2010 onwards.

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.000	0.000

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.00	0.00
0.25	0.69	0.51	0.00	0.00
0.5	0.79	0.59	0.00	0.00
0.75	0.88	0.66	0.00	0.00
0.95	1.03	0.77	0.00	0.00

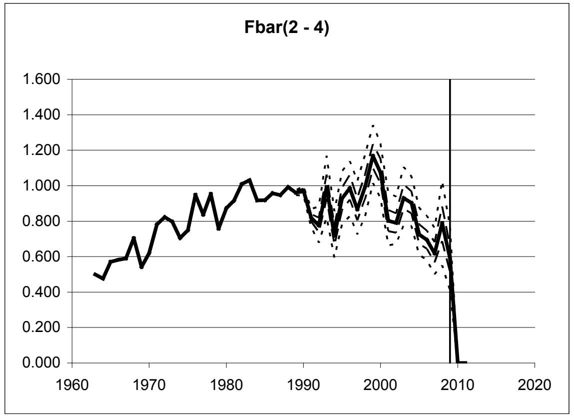
SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	96942
0.25	53641	54778	57815	116264
0.5	57282	60139	65950	134045
0.75	61654	66376	76485	151987
0.95	67418	77475	94615	187910

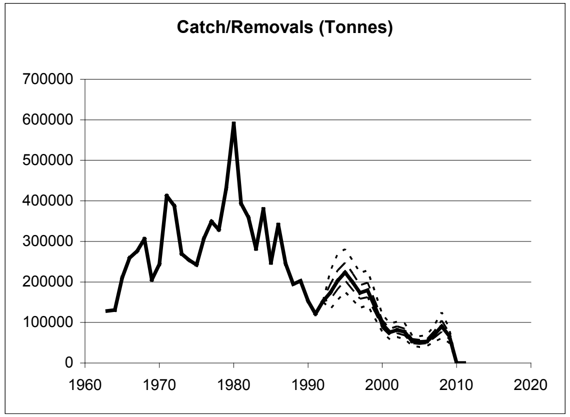
Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	0	0
0.25	42931	38274	0	0
0.5	50430	41915	0	0
0.75	58251	45579	0	0
0.95	69507	50777	0	0

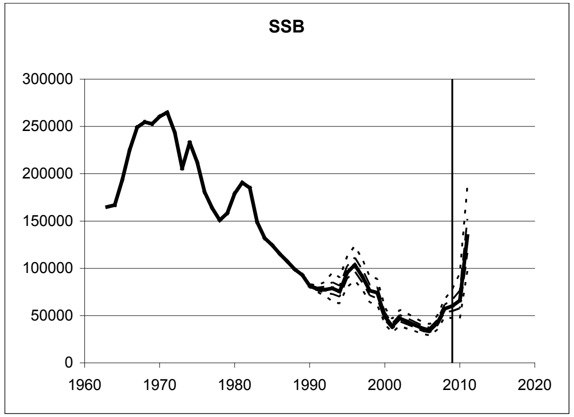
Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	0	0
0.25	34271	21205	0	0
0.5	40257	24771	0	0
0.75	46500	28339	0	0
0.95	55485	33932	0	0

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	1.00	1.00	1.00

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	2.03
P25/P75	0.89	0.87	1.52







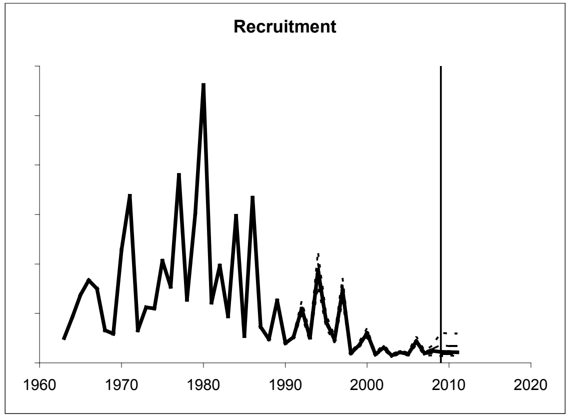


Table 14.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 5: reduction in fishing mortality by 25% in 2009, followed by a further reduction in F of 35% in 2010, 45% in 2011, 55% in 2012, etc relative to the 2008 level (a combination of Options 5 and 6 mimic the European Commission's cod management plan given in EC 1342/2008, at least until SSB>Blim).

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.650	0.550

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.36	0.30
0.25	0.69	0.51	0.45	0.38
0.5	0.79	0.59	0.51	0.43
0.75	0.88	0.66	0.57	0.49
0.95	1.03	0.77	0.67	0.56

SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	49579
0.25	53641	54778	57815	65826
0.5	57282	60139	65950	79644
0.75	61654	66376	76485	95070
0.95	67418	77475	94615	125061

Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	32375	31054
0.25	42931	38274	36824	35596
0.5	50430	41915	40335	39972
0.75	58251	45579	44898	45614
0.95	69507	50777	54175	55736

Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	17299	16280
0.25	34271	21205	22065	20055
0.5	40257	24771	26129	24710
0.75	46500	28339	31937	31321
0.95	55485	33932	42282	41663

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.85	0.94	0.98

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.21
P25/P75	0.89	0.87	0.86

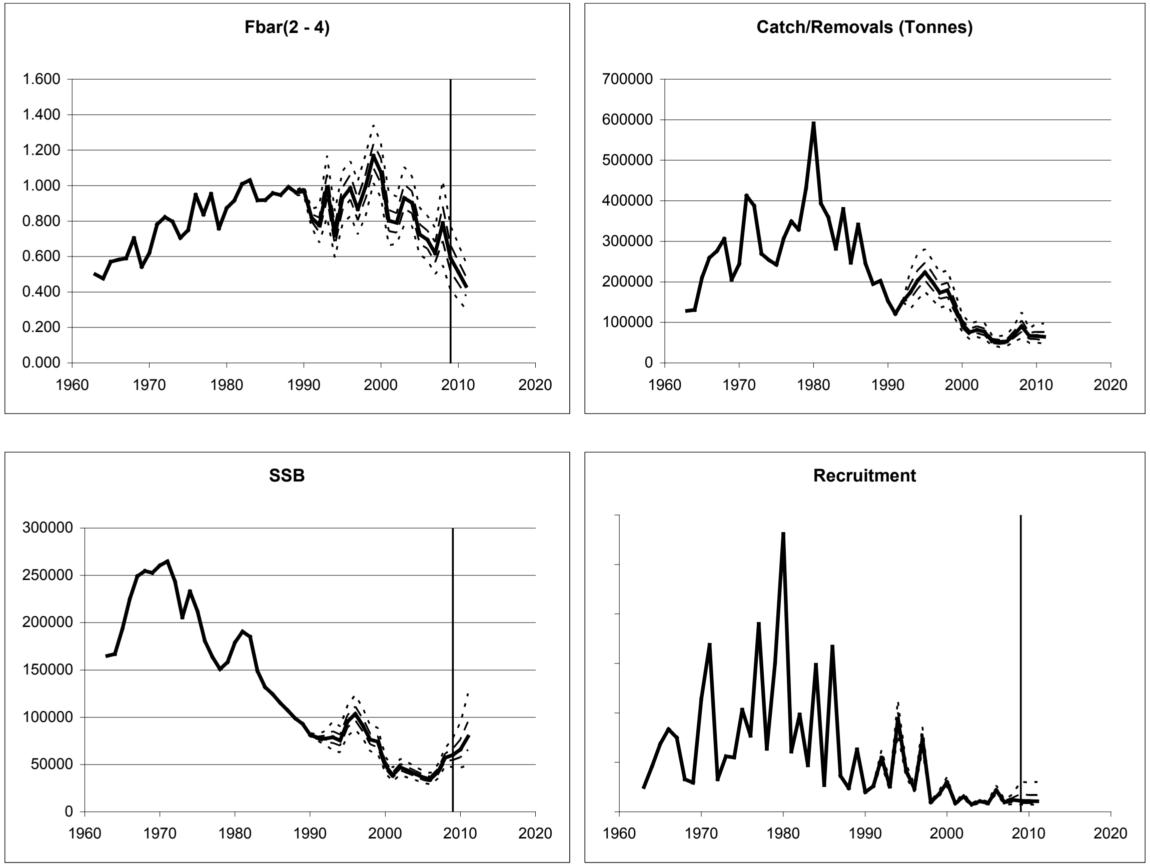


Table 14.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast Option 6: reduction in fishing mortality by 25% in 2009, followed by a further reduction to the target fishing mortality of 0.2 for 2010 onwards (a combination of Options 5 and 6 mimic the European Commission's cod management plan given in EC 1342/2008, at least until SSB>Blim).

	2008	2009	2010	2011
F2008 mult	1.000	0.750	0.254	0.254

Fbar(2-4)	Year			
Percentile	2008	2009	2010	2011
0.05	0.55	0.41	0.14	0.14
0.25	0.69	0.51	0.17	0.17
0.5	0.79	0.59	0.20	0.20
0.75	0.88	0.66	0.22	0.22
0.95	1.03	0.77	0.26	0.26

SSB	Year			
Percentile	2008	2009	2010	2011
0.05	48379	47381	46642	75587
0.25	53641	54778	57815	92829
0.5	57282	60139	65950	109243
0.75	61654	66376	76485	126163
0.95	67418	77475	94615	160670

Landings	Year			
Percentile	2008	2009	2010	2011
0.05	33996	33045	14294	20196
0.25	42931	38274	16537	24179
0.5	50430	41915	18375	27274
0.75	58251	45579	20441	31327
0.95	69507	50777	24808	38446

Discards	Year			
Percentile	2008	2009	2010	2011
0.05	27138	17016	7558	9594
0.25	34271	21205	9786	12382
0.5	40257	24771	11673	15419
0.75	46500	28339	14188	19754
0.95	55485	33932	18937	27068

P(SSBYear > SSB 2008)				
2009	2010	2011	2012	2013
0.62	0.74	0.99	1.00	1.00

In year SSB change			
	2008	2009	2010
Median	1.05	1.10	1.66
P25/P75	0.89	0.87	1.21

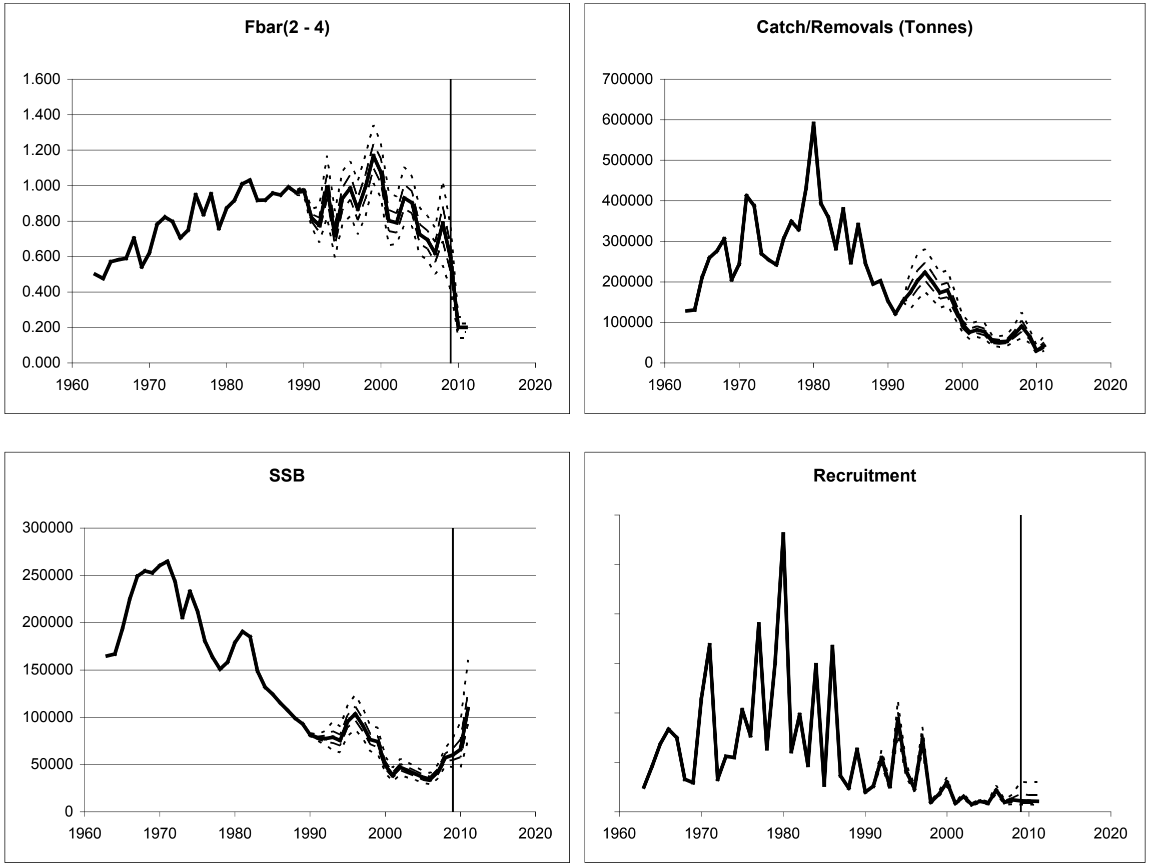


Table 14.19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median term forecast summary of options 1-6, ordered by size of F-multiplier assumed for 2010-11 for options 1-4, with options 5 and 6 given in the final columns.

			Option 1		Option 2a		Option 2b		Option 2c		Option 2d		Option 2e		Option 3		Option 4		Option 5		Option 6	
	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
F2008 mult	1.000	0.750	0.750	0.750	0.675	0.675	0.637	0.637	0.600	0.600	0.562	0.562	0.525	0.525	0.508	0.508	0.000	0.000	0.650	0.550	0.254	0.254
			cut in F = 0%		cut in F = 10%		cut in F = 15%		cut in F = 20%		cut in F = 25%		cut in F = 30%		F = 0.4		F = 0		Recov: 10% F cuts		F = 0.2	

Fbar(2-4)		Year																				
Percentile	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0.05	0.55	0.41	0.41	0.41	0.37	0.37	0.35	0.35	0.33	0.33	0.31	0.31	0.29	0.29	0.28	0.28	0.00	0.00	0.36	0.30	0.14	0.14
0.25	0.69	0.51	0.51	0.51	0.46	0.46	0.44	0.44	0.41	0.41	0.39	0.39	0.36	0.36	0.35	0.35	0.00	0.00	0.45	0.38	0.17	0.17
0.5	0.79	0.59	0.59	0.59	0.53	0.53	0.50	0.50	0.47	0.47	0.44	0.44	0.41	0.41	0.40	0.40	0.00	0.00	0.51	0.43	0.20	0.20
0.75	0.88	0.66	0.66	0.66	0.60	0.60	0.56	0.56	0.53	0.53	0.50	0.50	0.46	0.46	0.45	0.45	0.00	0.00	0.57	0.49	0.22	0.22
0.95	1.03	0.77	0.77	0.77	0.69	0.69	0.65	0.65	0.62	0.62	0.58	0.58	0.54	0.54	0.52	0.52	0.00	0.00	0.67	0.56	0.26	0.26

SSB		Year																				
Percentile	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0.05	48379	47381	46642	44378	46642	48329	46642	50217	46642	52140	46642	54057	46642	56300	46642	57403	46642	96942	46642	49579	46642	75587
0.25	53641	54778	57815	60238	57815	64371	57815	66540	57815	68880	57815	70924	57815	73248	57815	74469	57815	116264	57815	65826	57815	92829
0.5	57282	60139	65950	73667	65950	78064	65950	80474	65950	82854	65950	85359	65950	87931	65950	89188	65950	134045	65950	79644	65950	109243
0.75	61654	66376	76485	88363	76485	93363	76485	95896	76485	98602	76485	101519	76485	104321	76485	105480	76485	151987	76485	95070	76485	126163
0.95	67418	77475	94615	118660	94615	123546	94615	126002	94615	128533	94615	131413	94615	134758	94615	136348	94615	187910	94615	125061	94615	160670

Landings		Year																				
Percentile	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0.05	33996	33045	36108	36757	33378	35995	31858	35264	30350	34556	28769	33559	27151	32562	26389	32060	0	0	32375	31054	14294	20196
0.25	42931	38274	40941	42012	37859	41057	36265	40380	34606	39510	32829	38537	31027	37319	30170	36722	0	0	36824	35596	16537	24179
0.5	50430	41915	45008	47419	41551	46200	39699	45359	37907	44364	36086	43190	34136	42088	33213	41398	0	0	40335	39972	18375	27274
0.75	58251	45579	49805	54257	46112	52755	44216	51724	42177	50612	40105	49290	37942	47963	36913	47274	0	0	44898	45614	20441	31327
0.95	69507	50777	60179	66118	55716	64316	53416	63290	50955	61782	48347	60431	45856	58636	44620	57695	0	0	54175	55736	24808	38446

Discards		Year																				
Percentile	2008	2009	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
0.05	27138	17016	19396	20237	17835	19177	17014	18534	16146	17882	15296	17161	14432	16461	14017	16116	0	0	17299	16280	7558.3	9594.3
0.25	34271	21205	24690	24691	22759	23509	21727	22844	20702	22030	19611	21335	18526	20446	17998	20074	0	0	22065	20055	9785.6	12382
0.5	40257	24771	29254	30340	26948	28934	25717	28122	24490	27159	23274	26243	21983	25302	21367	24750	0	0	26129	24710	11673	15419
0.75	46500	28339	35683	37899	32867	36420	31450	35417	29997	34430	28456	33340	26916	32106	26157	31499	0	0	31937	31321	14188	19754
0.95	55485	33932	47145	50351	43528	48114	41678	47183	39849	45935	37843	44552	35717	43246	34733	42478	0	0	42282	41663	18937	27068

P(SSBYear > SSB 2008)																						
2009	2010	2011	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
0.62	0.74	0.78	0.82	0.83	0.89	0.91	0.92	0.94	0.94	0.96	0.95	0.97	0.96	0.99	0.97	0.99	1.00	1.00	0.94	0.98	1.00	1.00

In year SSB change												
	2008	2009	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
Median	1.05	1.10	1.12	1.18	1.22	1.26	1.29	1.33	1.35	2.03	1.21	1.66
P25/P75	0.89	0.87	0.79	0.84	0.87	0.90	0.93	0.96	0.97	1.52	0.86	1.21

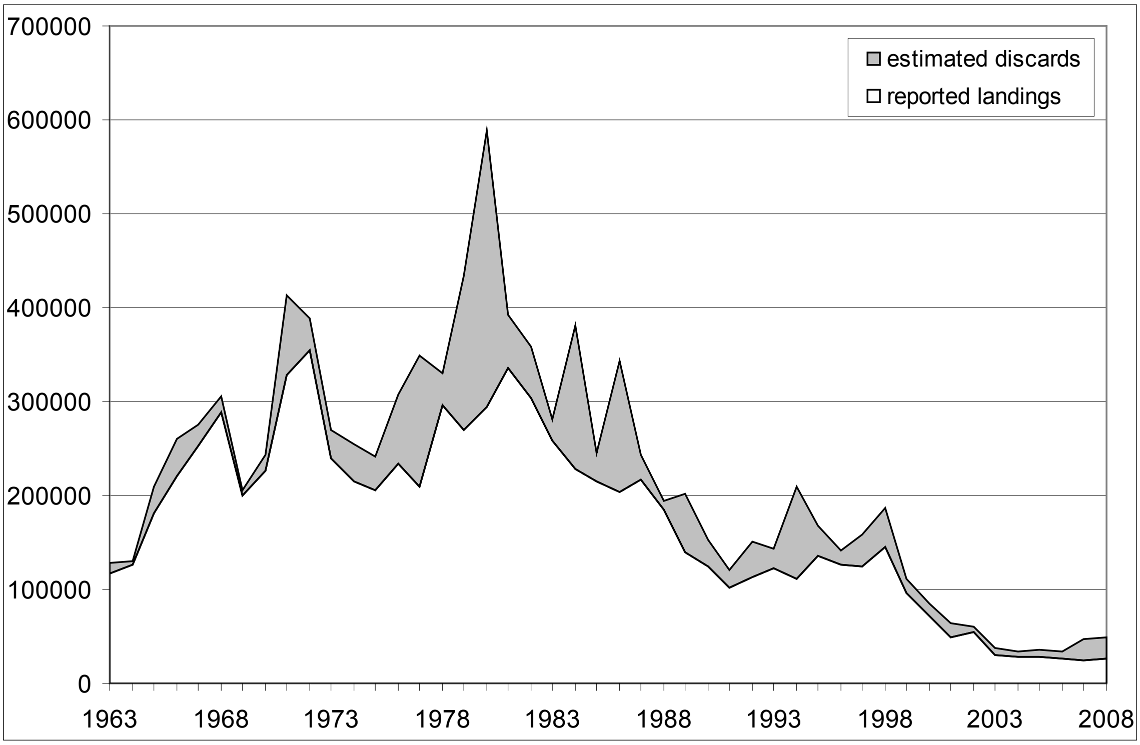


Figure 14.1a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Stacked area plot of reported landings and estimated discards (in tons).

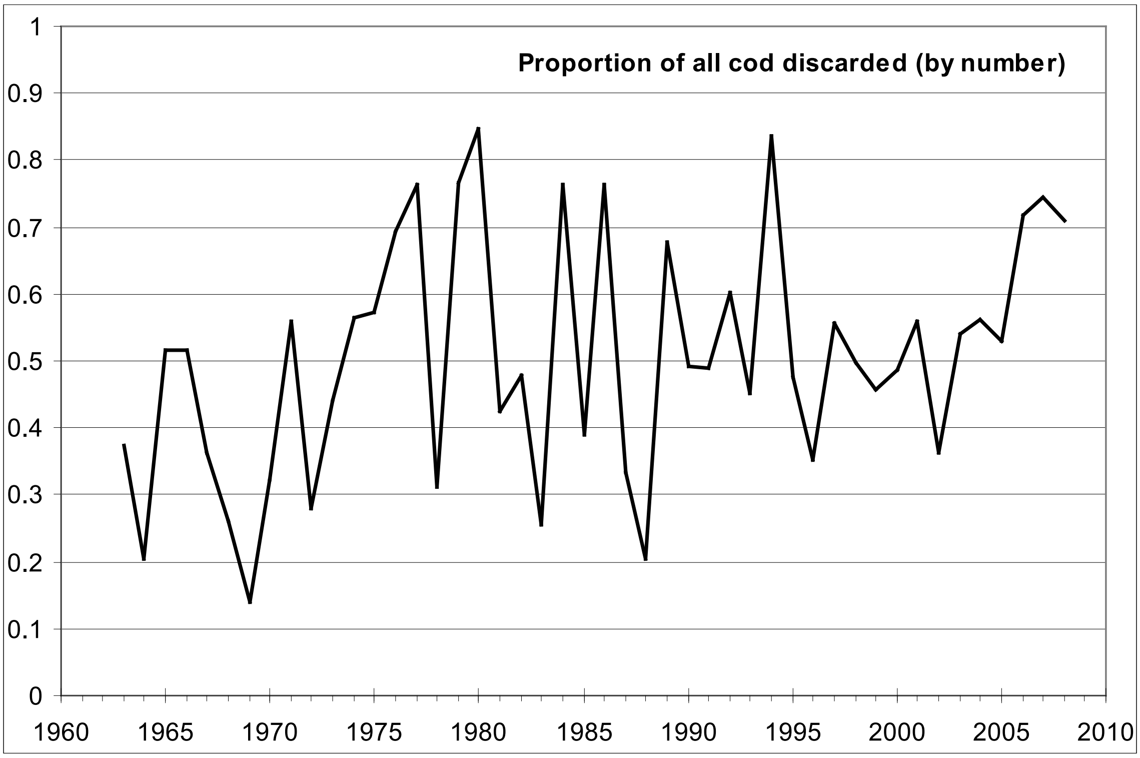


Figure 14.1b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught that are discarded.

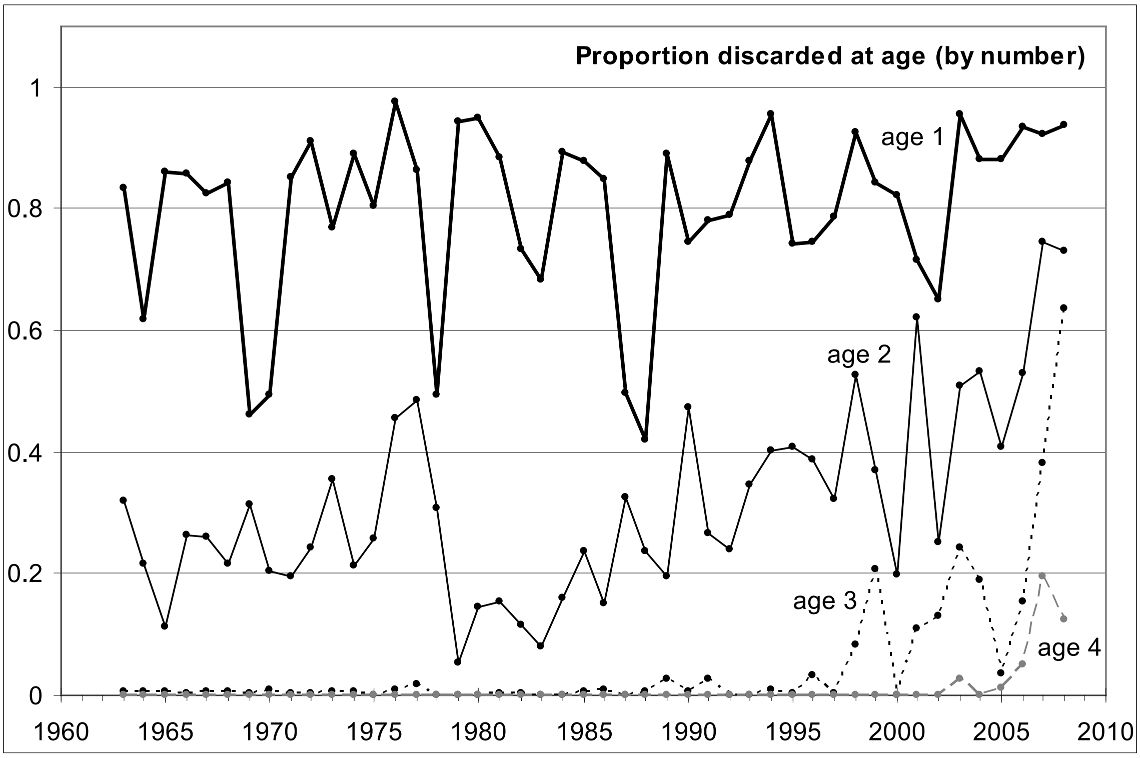


Figure 14.1c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Proportion of total numbers caught at age that are discarded.

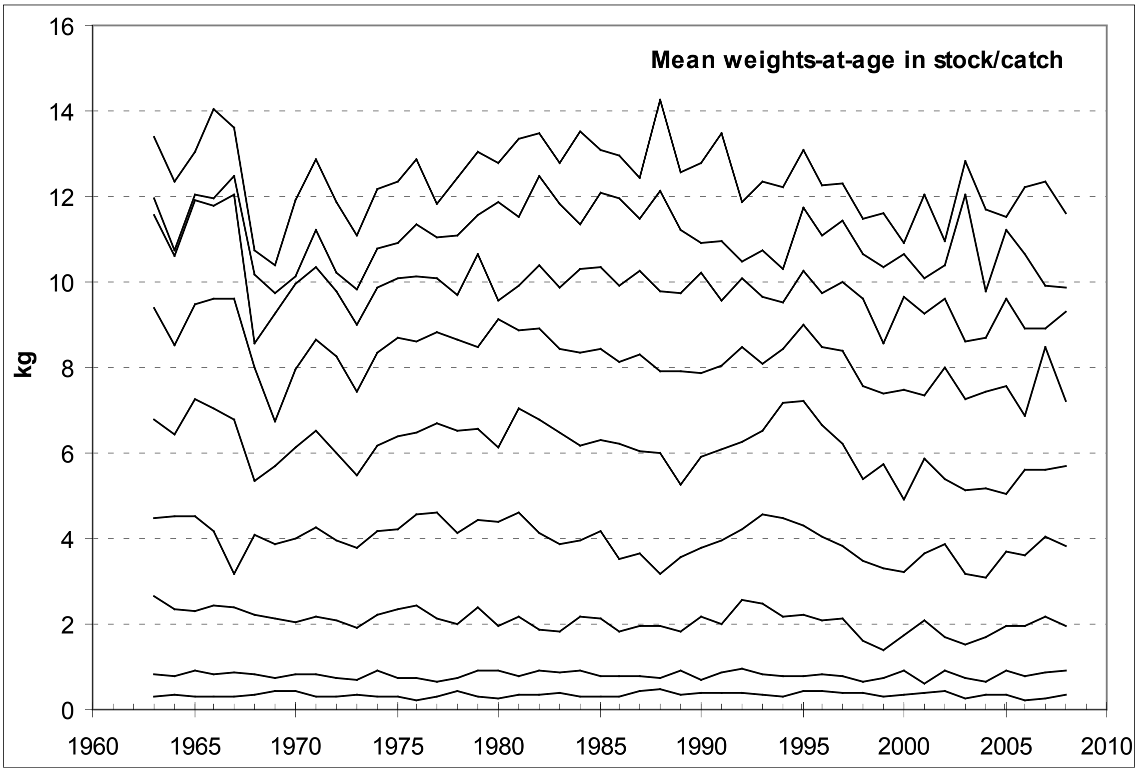


Figure 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the catch for ages 1-9.

Figure 14.3(a) Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1995-2009 in the North Sea.

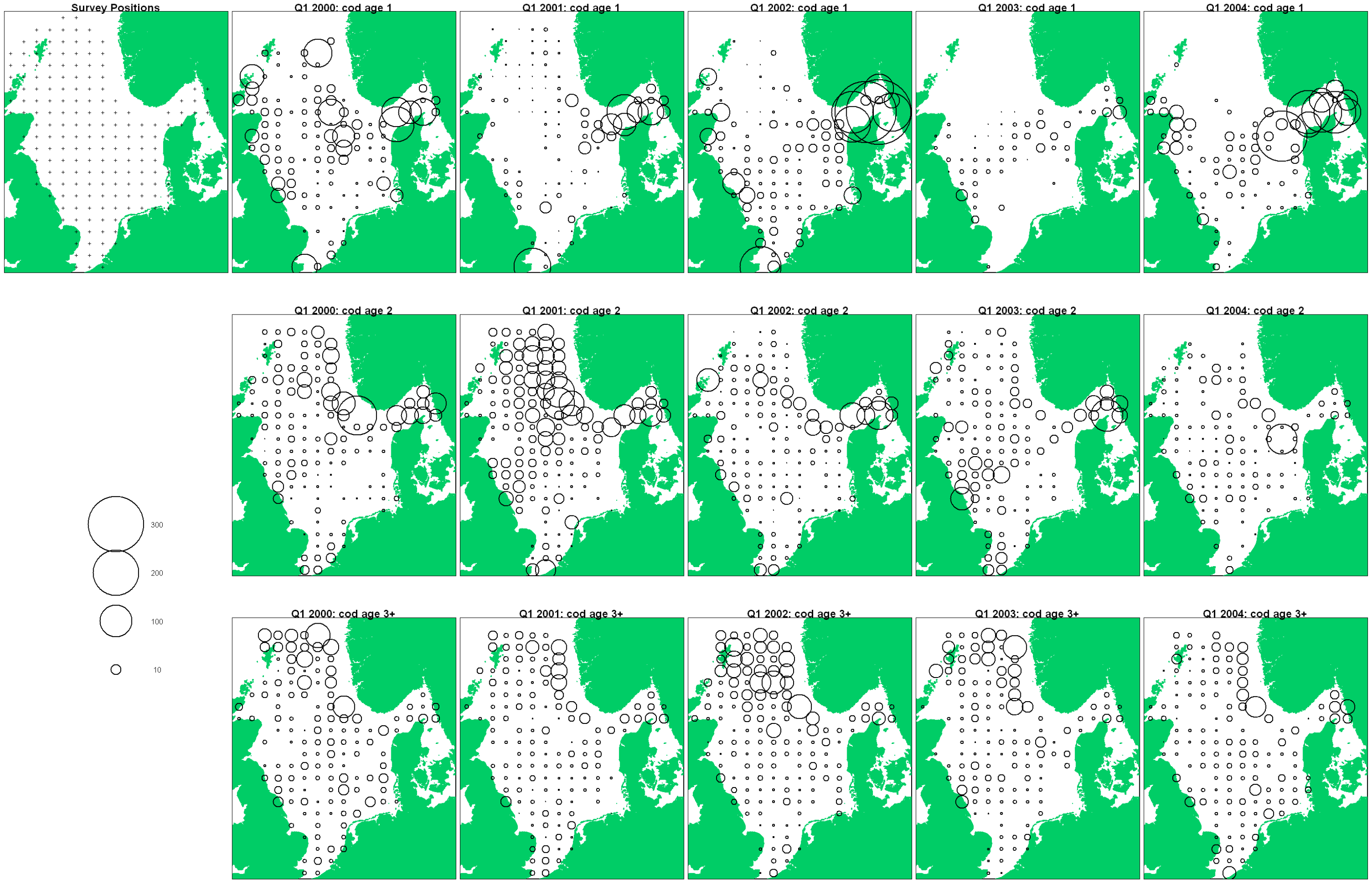


Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1995-2009 in the North Sea.

Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1995-2009 in the North Sea.

Figure 14.3(b). Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1994-2008 in the North Sea.

Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1994-2008 in the North Sea.

Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1994-2008 in the North Sea.

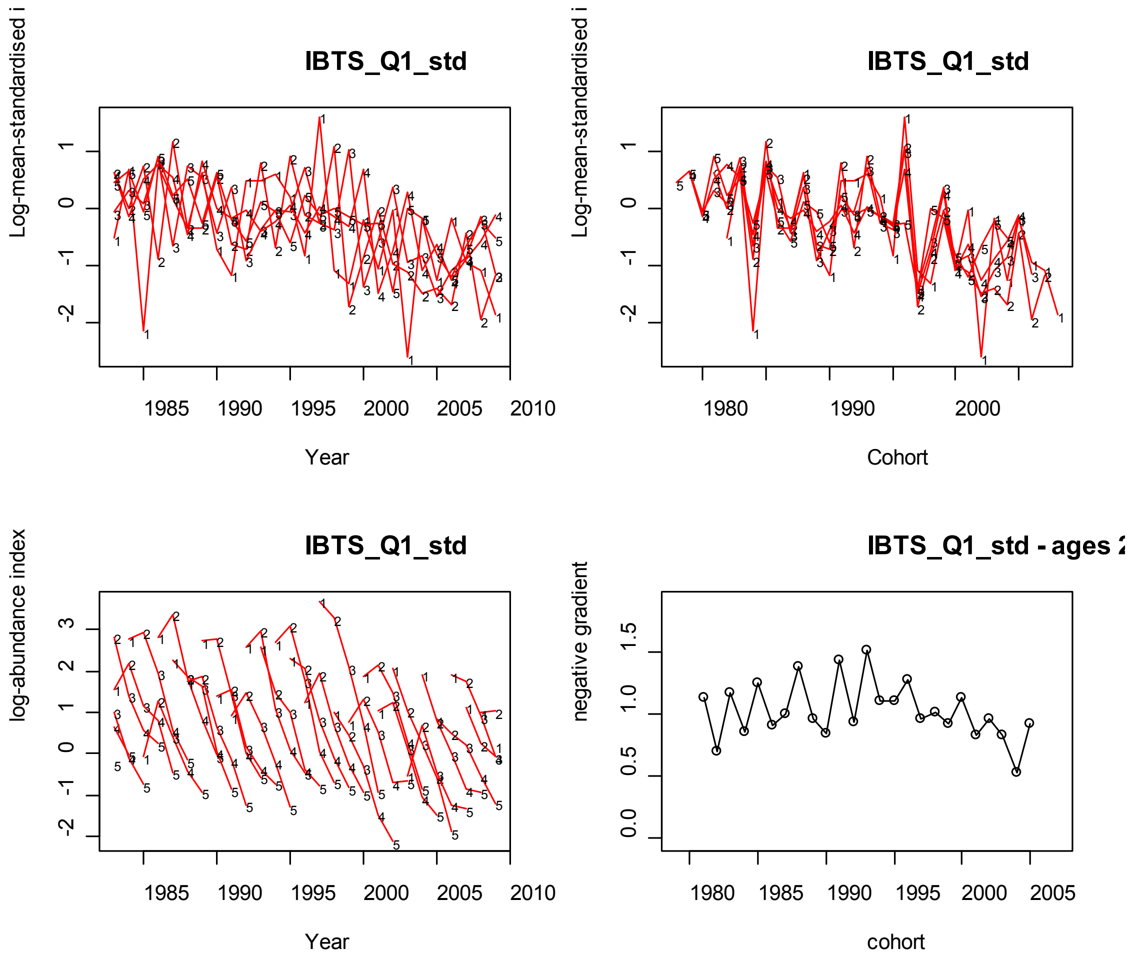


Figure 14.4a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ1 standard area groundfish survey.

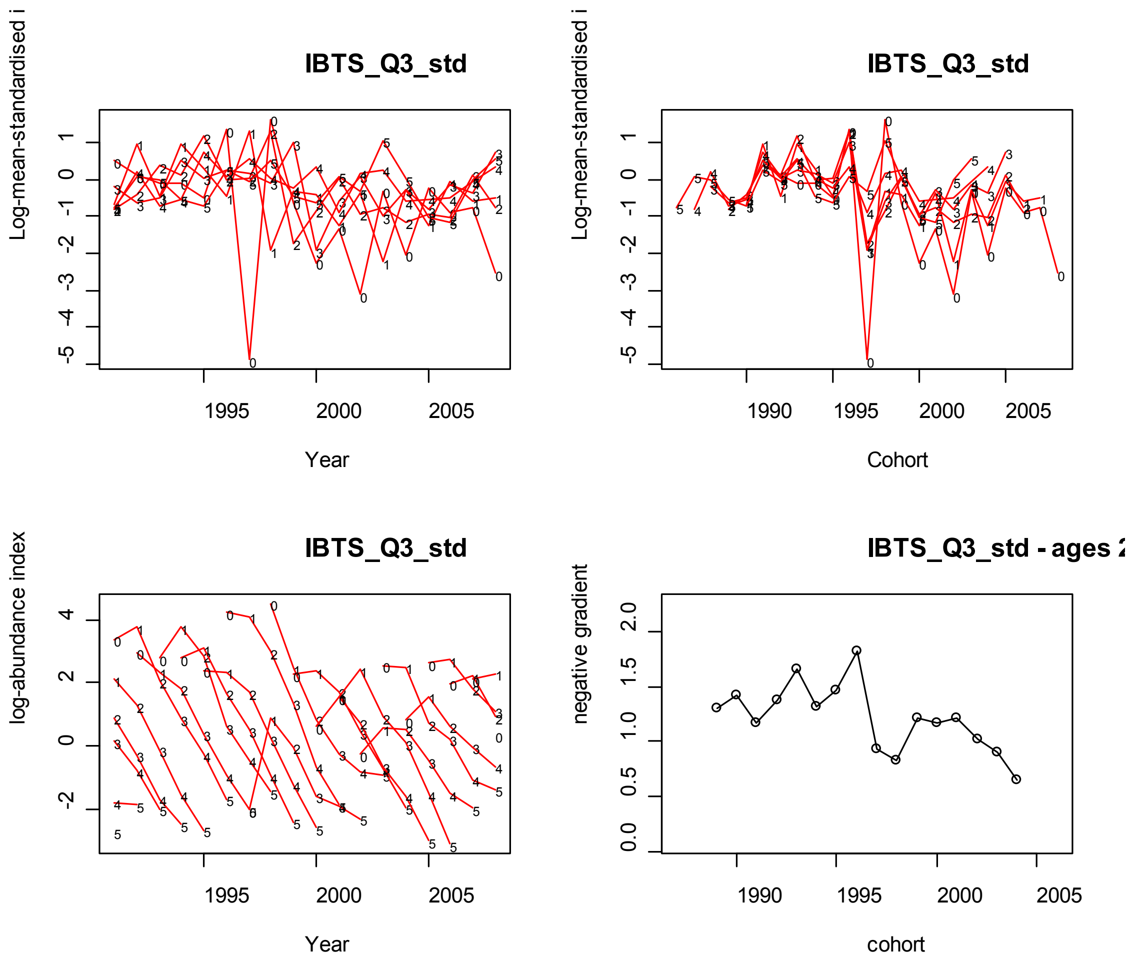


Figure 14.4b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ3 standard area groundfish survey.

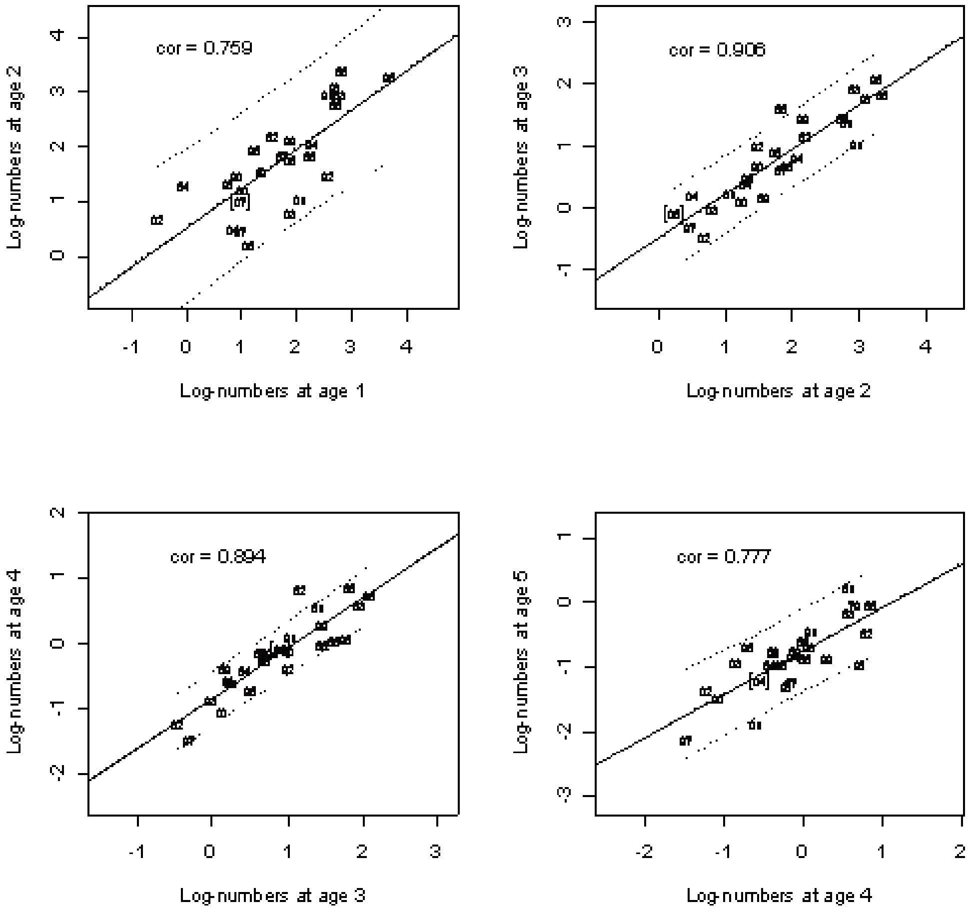
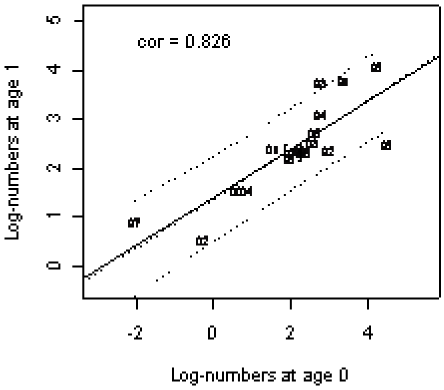
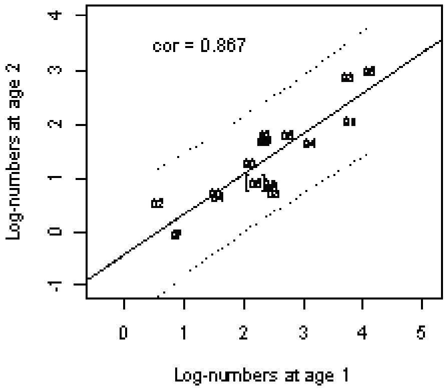
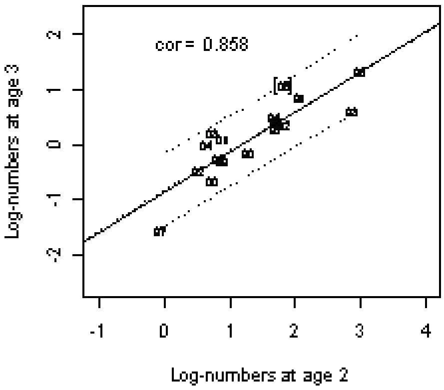
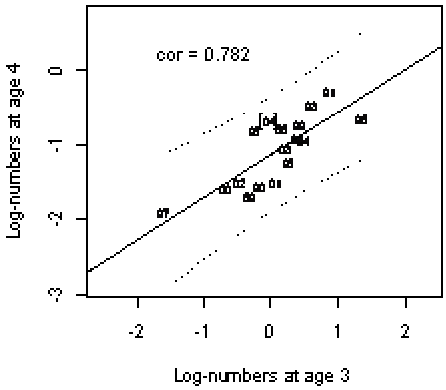


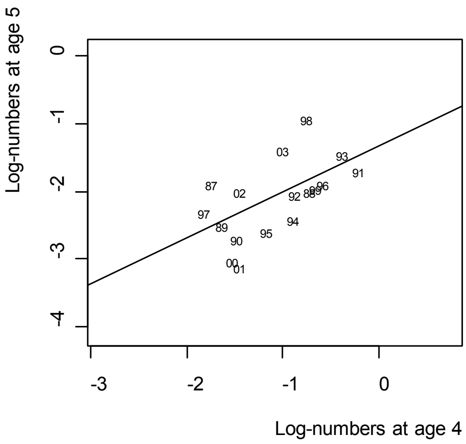
Figure 14.5a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Within-survey correlations for IBTSQ1 for the period 1983-2009. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, the broken line nearest to it a robust linear regression line, and "cor" denotes the correlation coefficient. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data point appears in square brackets.


cor = 0.826
Log-numbers at age 1
Log-numbers at age 0


cor = 0.867
Log-numbers at age 2
Log-numbers at age 1


cor = 0.858
Log-numbers at age 3
Log-numbers at age 2


cor = 0.782
Log-numbers at age 4
Log-numbers at age 3


Log-numbers at age 5
Log-numbers at age 4

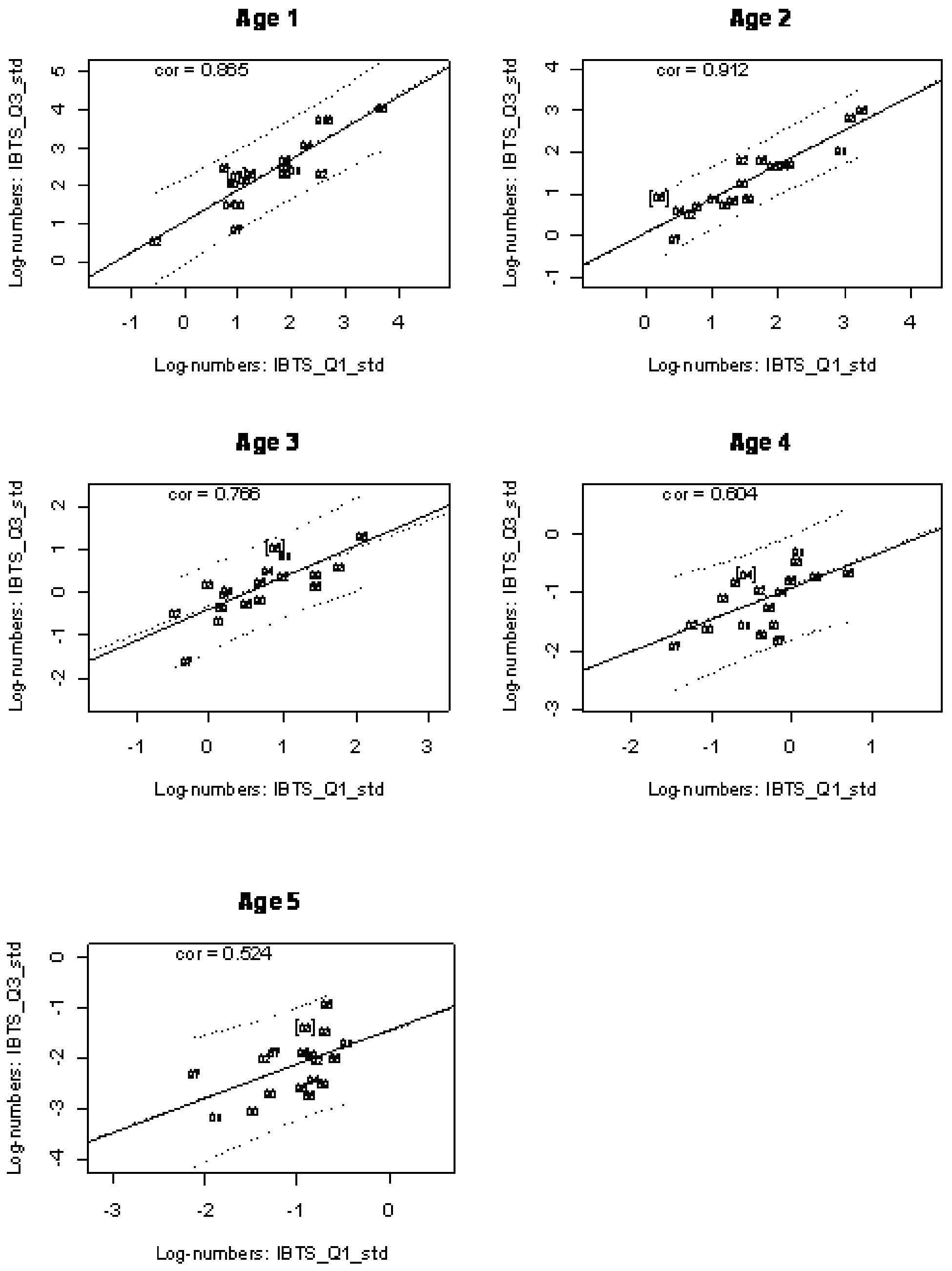


Figure 14.5c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Between-survey correlations for IBTSQ1 and Q3 surveys for the period 1991-2008. Individual points are given by cohort (year-class), the solid line is a standard linear regression line, and the broken line nearest to it a robust linear regression line. The pair of broken lines on either side of the solid line indicate prediction intervals. The most recent data appear in square brackets.

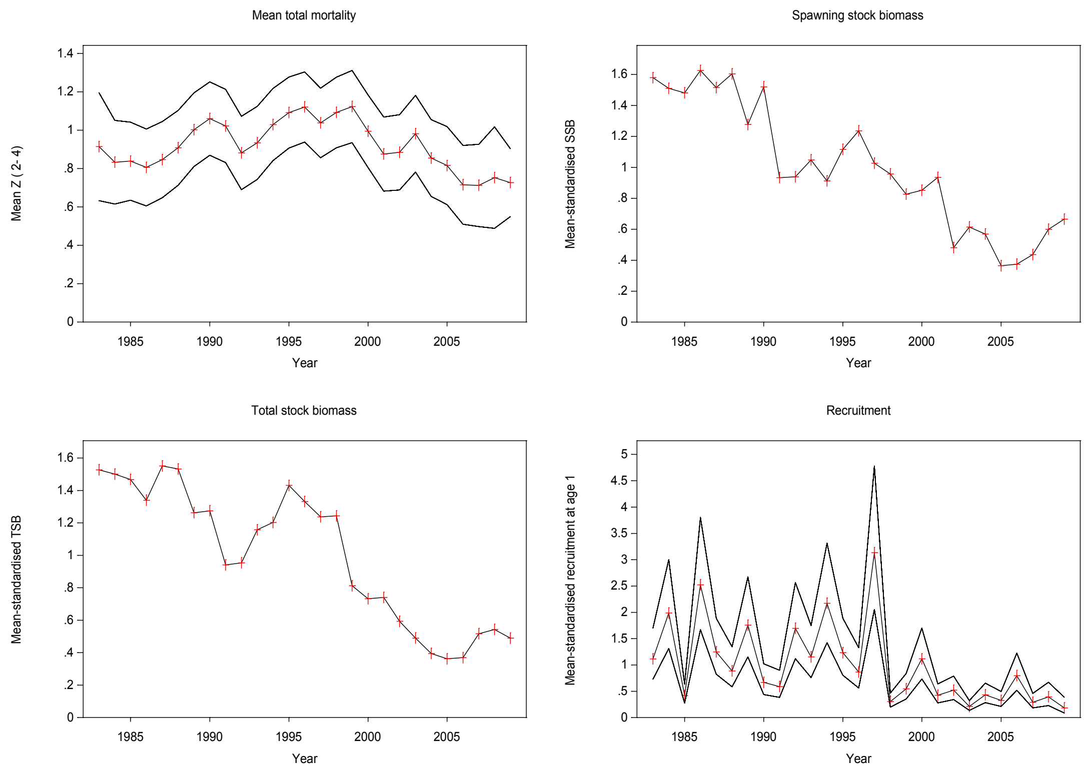


Figure 14.6a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ1 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

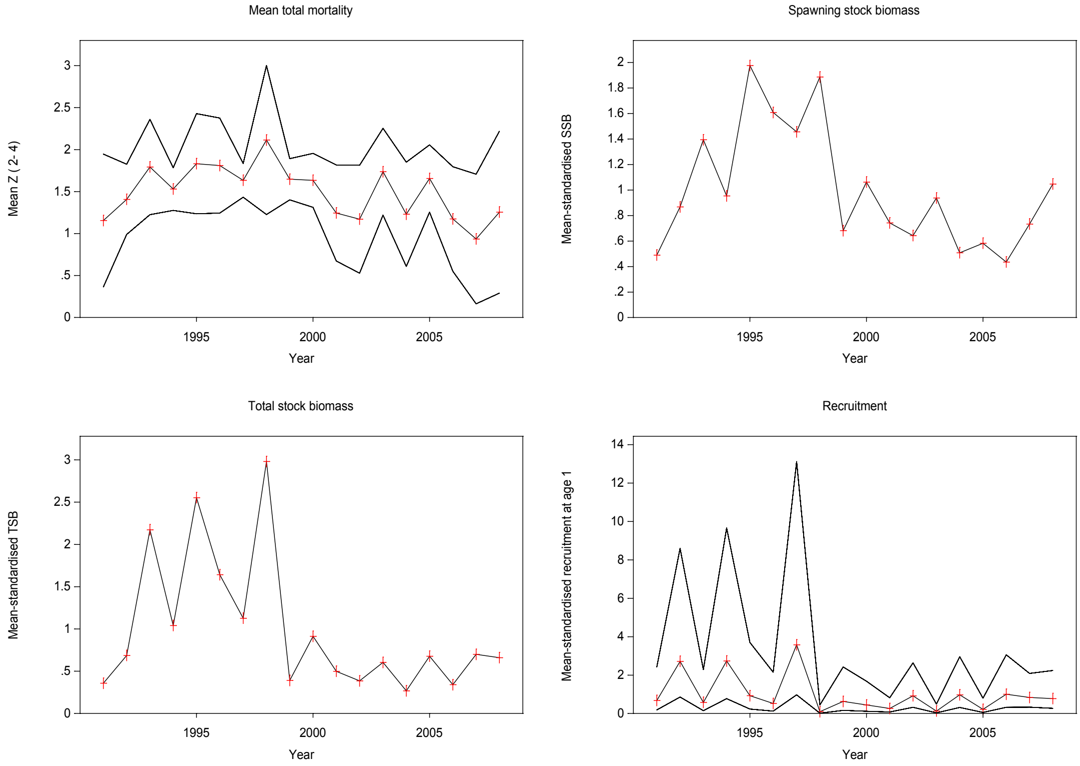


Figure 14.6b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ3 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

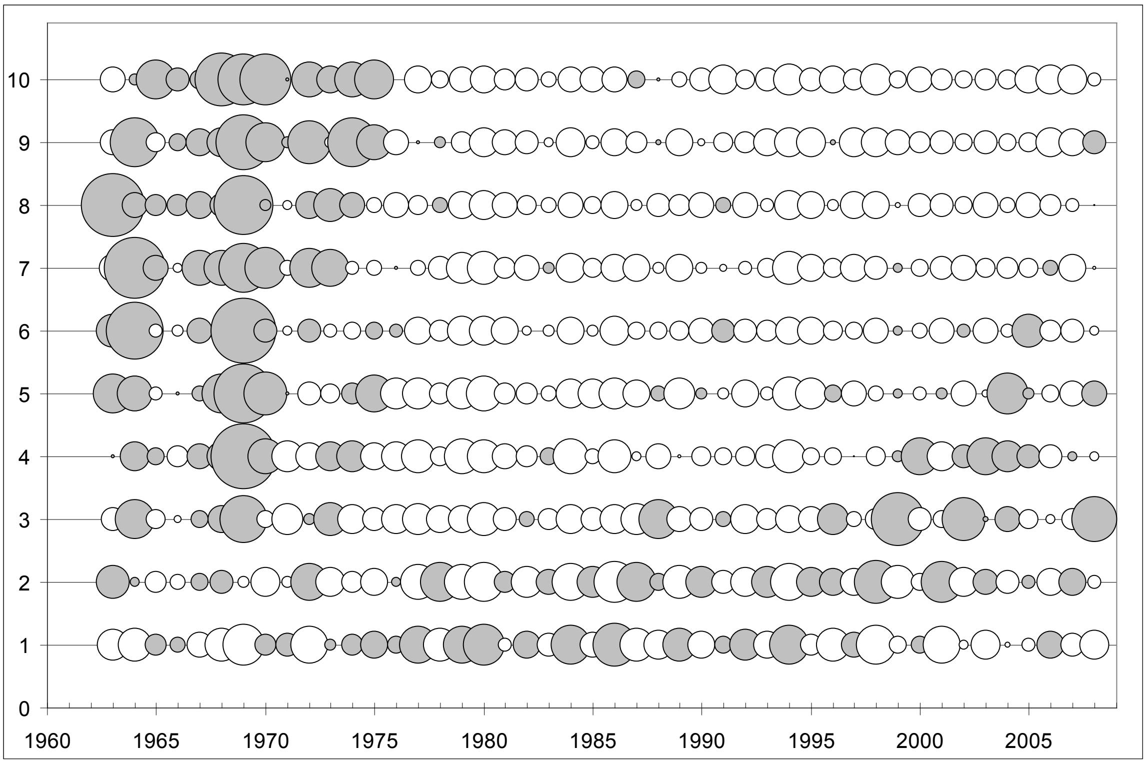


Figure 14.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Total catch-at-age matrix expressed as proportions-at-age which have been standardised over time (for each age, this is achieved by subtracting the mean proportion-at-age over the time series, and dividing by the corresponding variance). Grey bubbles indicate proportions above the mean over the time series at each age.

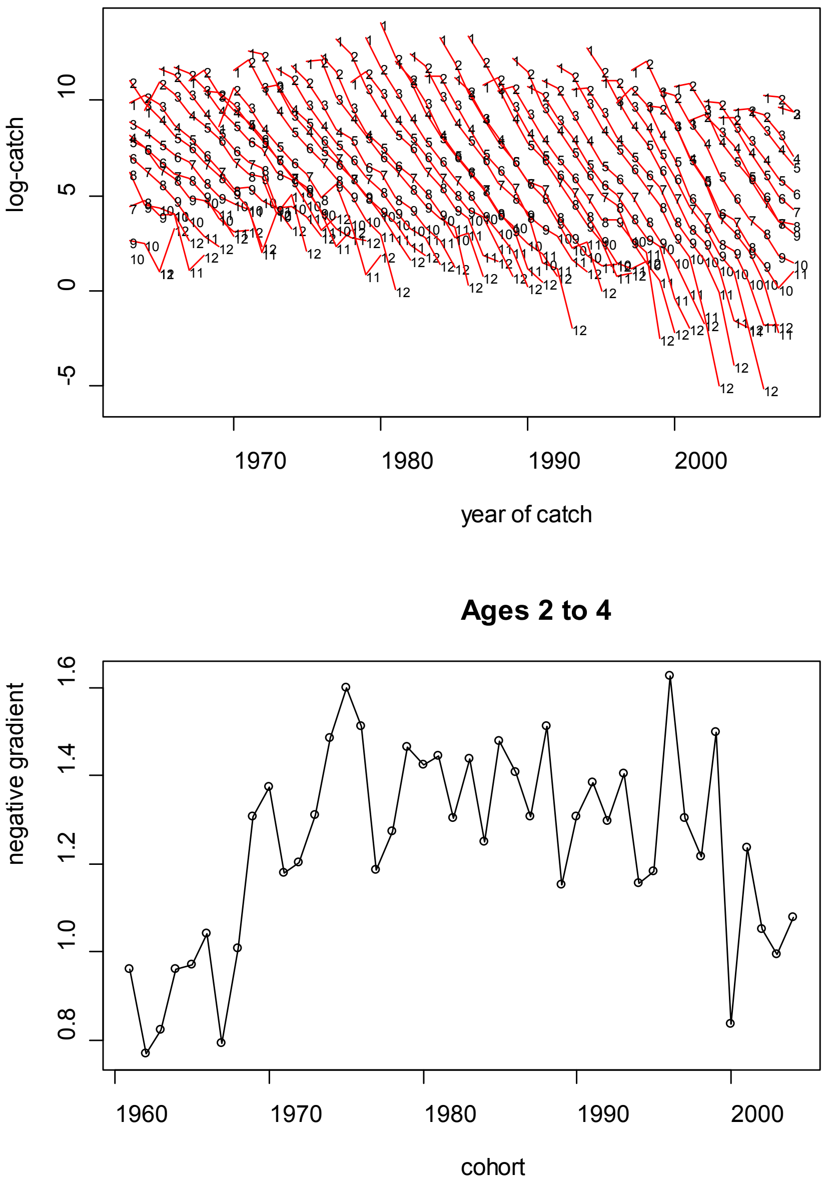


Figure 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log-catch cohort curves (top panel) and the associated negative gradients for each cohort across the reference fishing mortality of age 2-4.

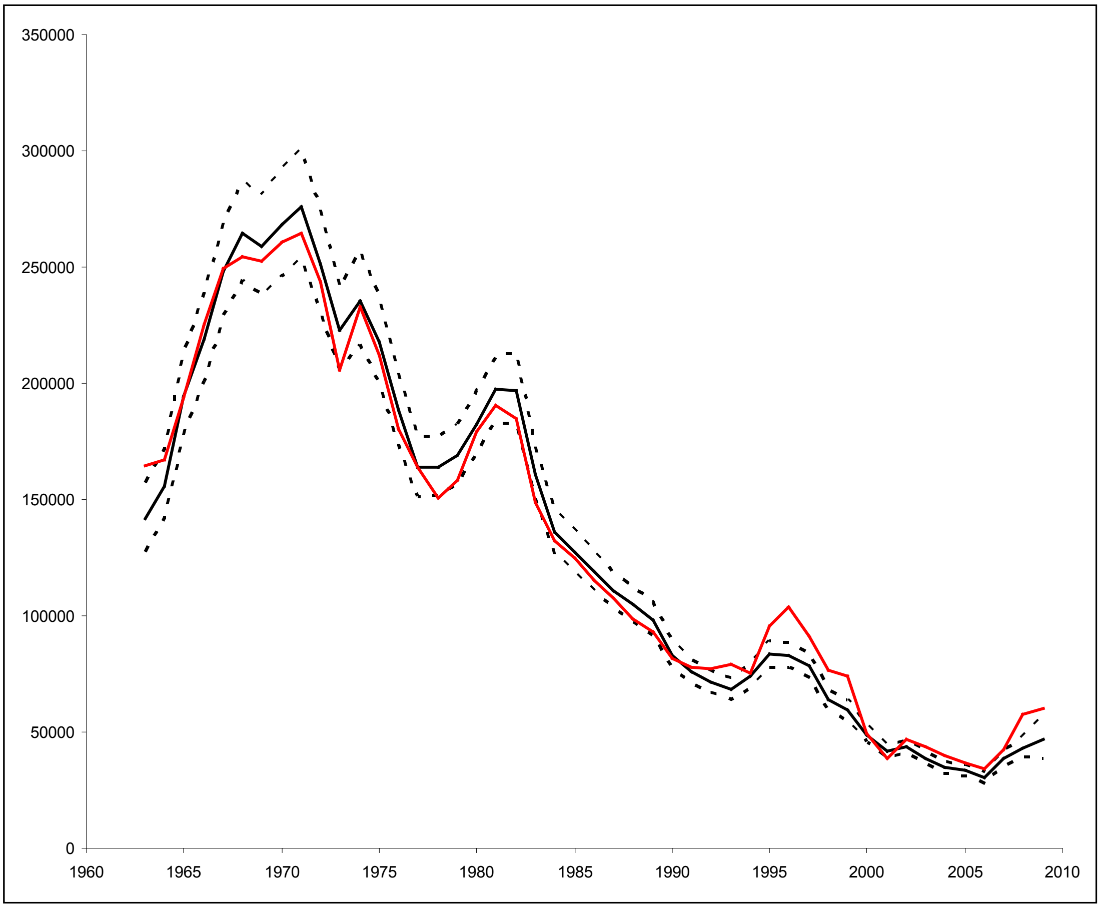


Figure 14.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated SSB from the SAM model. Solid black and hatched lines are results from a model with year specific scaling. Red line is B-ADAPT result.

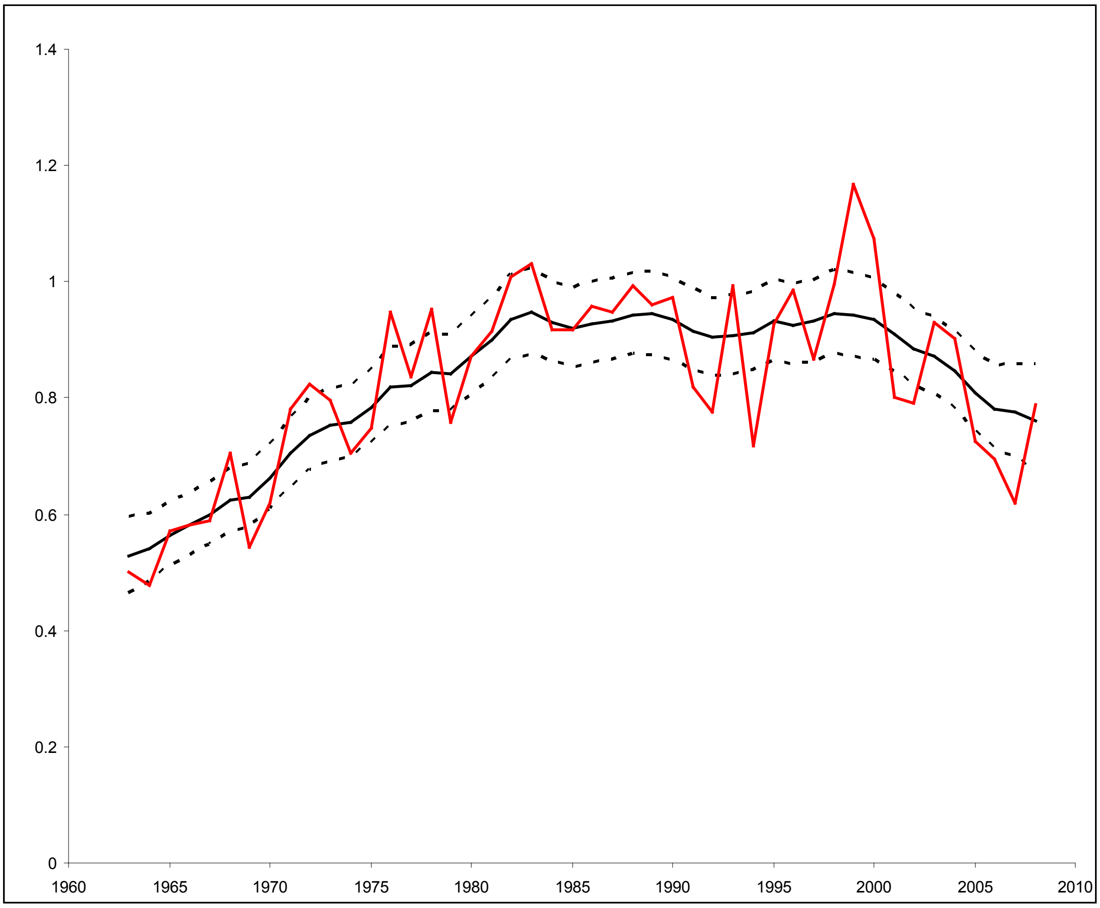


Figure 14.10a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated F(2-4) from the SAM model. Solid black and hatched lines are results from a model with year specific scaling. Red line is B-ADAPT result.

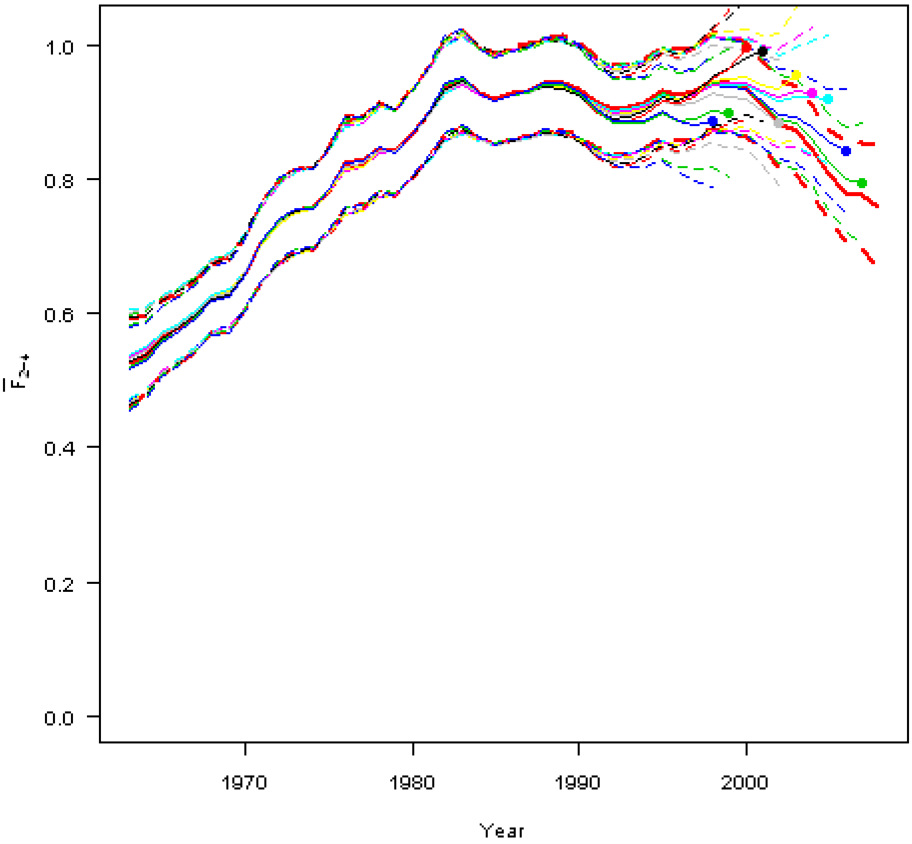


Figure 14.10b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated yearly average fishing motality (solid line), and corresponding 95% confidence intervals retrospective estimates from the SAM model where catch scaling was estimated.

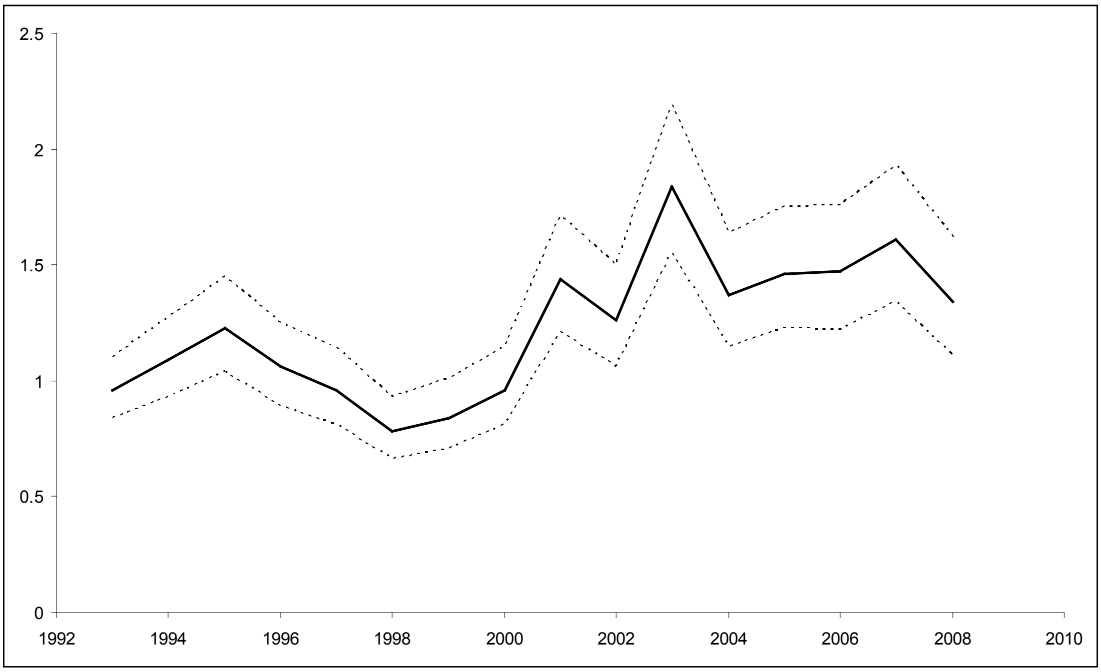


Figure 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated yearly catch multiplier (solid line), and corresponding 95% confidence intervals from the SAM model where catch scaling was estimated.

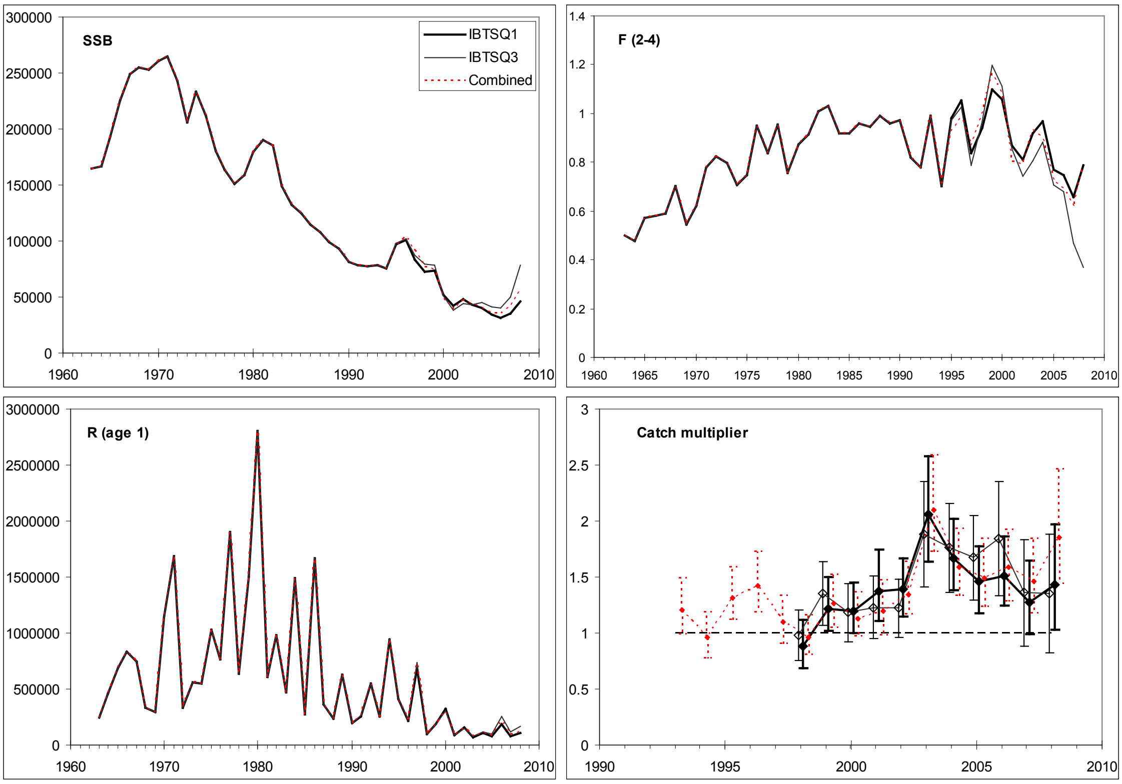


Figure 14.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Median of bootstrap estimates of spawning stock biomass (SSB), recruitment (R (age 1)), average fishing mortality (F (2-4)) and the catch multiplier for B-ADAPT single fleet runs for the IBTSQ1 and Q3 groundfish surveys. The error bars in the catch multiplier plot indicate 5th and 95th percentiles. The base run (see Figure 14.16), which combines both surveys, is also shown as a broken red line.

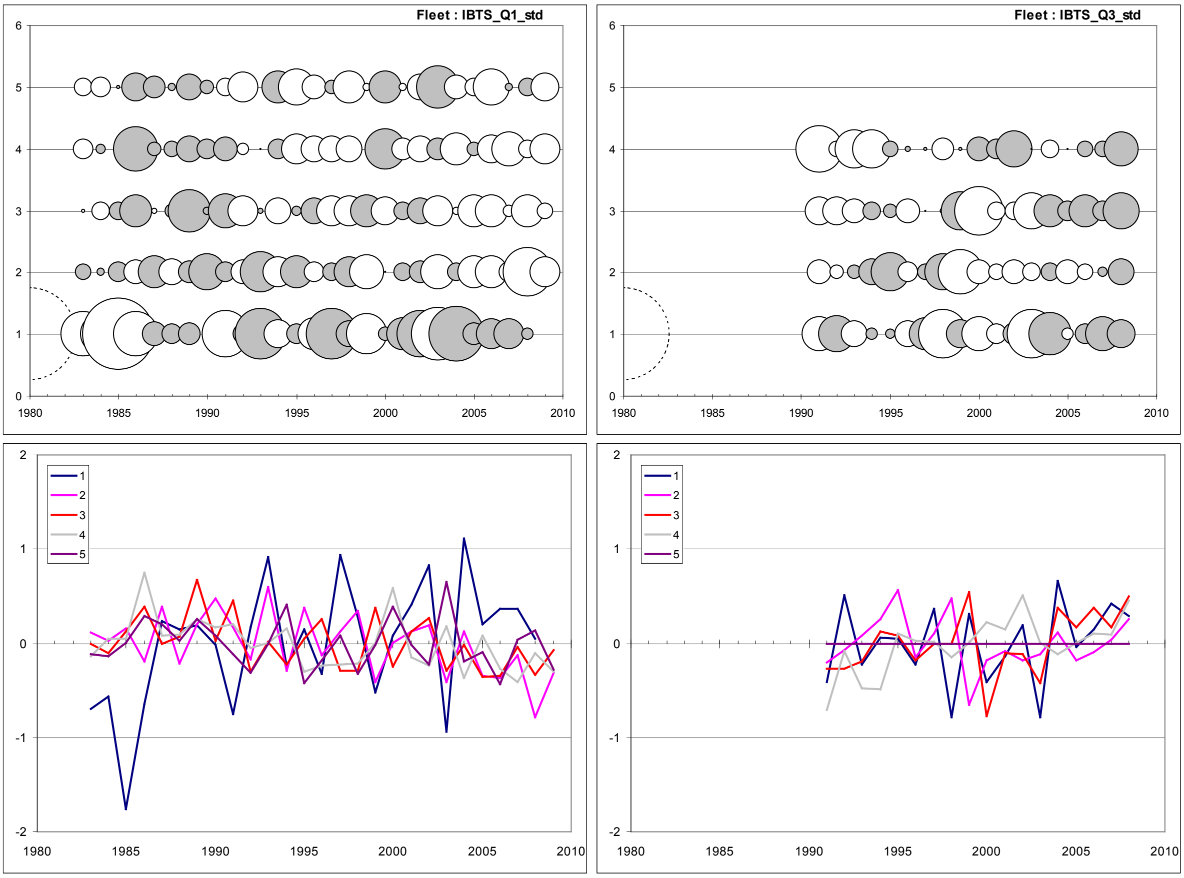


Figure 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Residual plots for the B-Adapt base run. In the top row grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

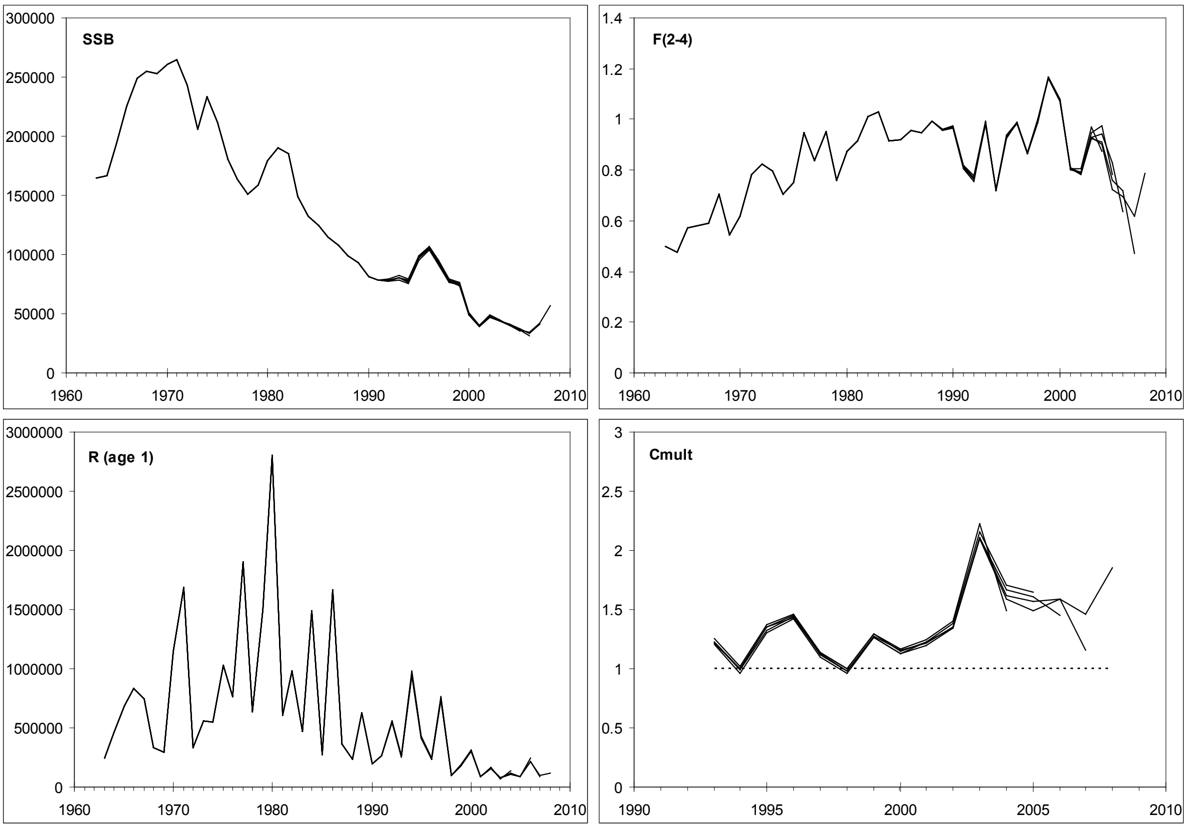


Figure 14.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. 5-year retrospective plots of median bootstrap values for SSB, Recruitment (age 1), F(2-4) and the catch multiplier for B-Adapt base run.

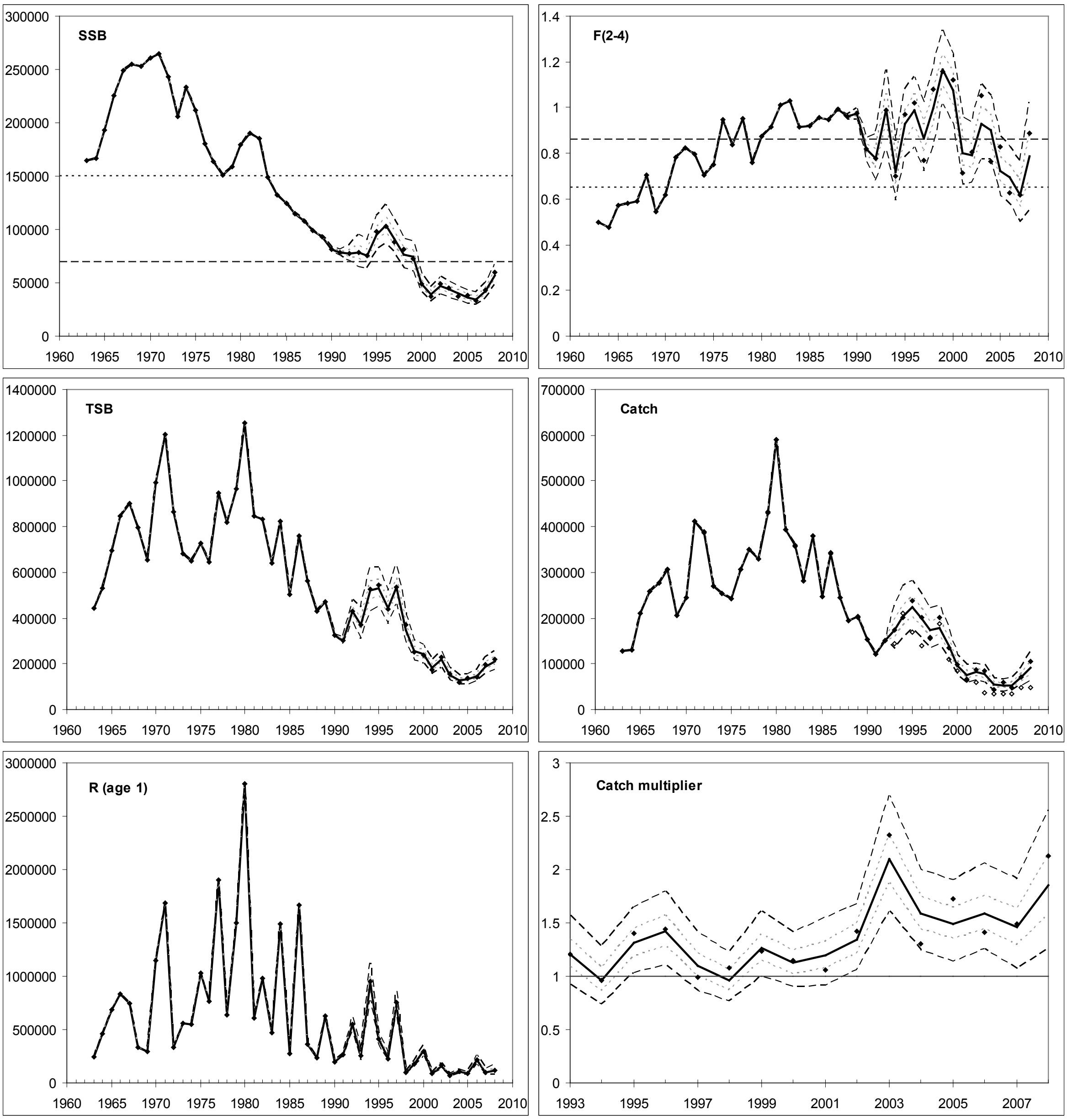


Figure 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)), from the B-ADAPT base run. The heavy lines represent the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates, and the open diamonds given in the catch plot the recorded total catch. The horizontal broken lines in the SSB plot indicate Blim=70 000t and Bpa=150 000t, and those in the F(2-4) plot Fpa=0.65 and Flim=0.86. The horizontal solid line in the catch multiplier plot indicates a multiplier of 1. Catch, SSB and TSB are in tons, and R in thousands.

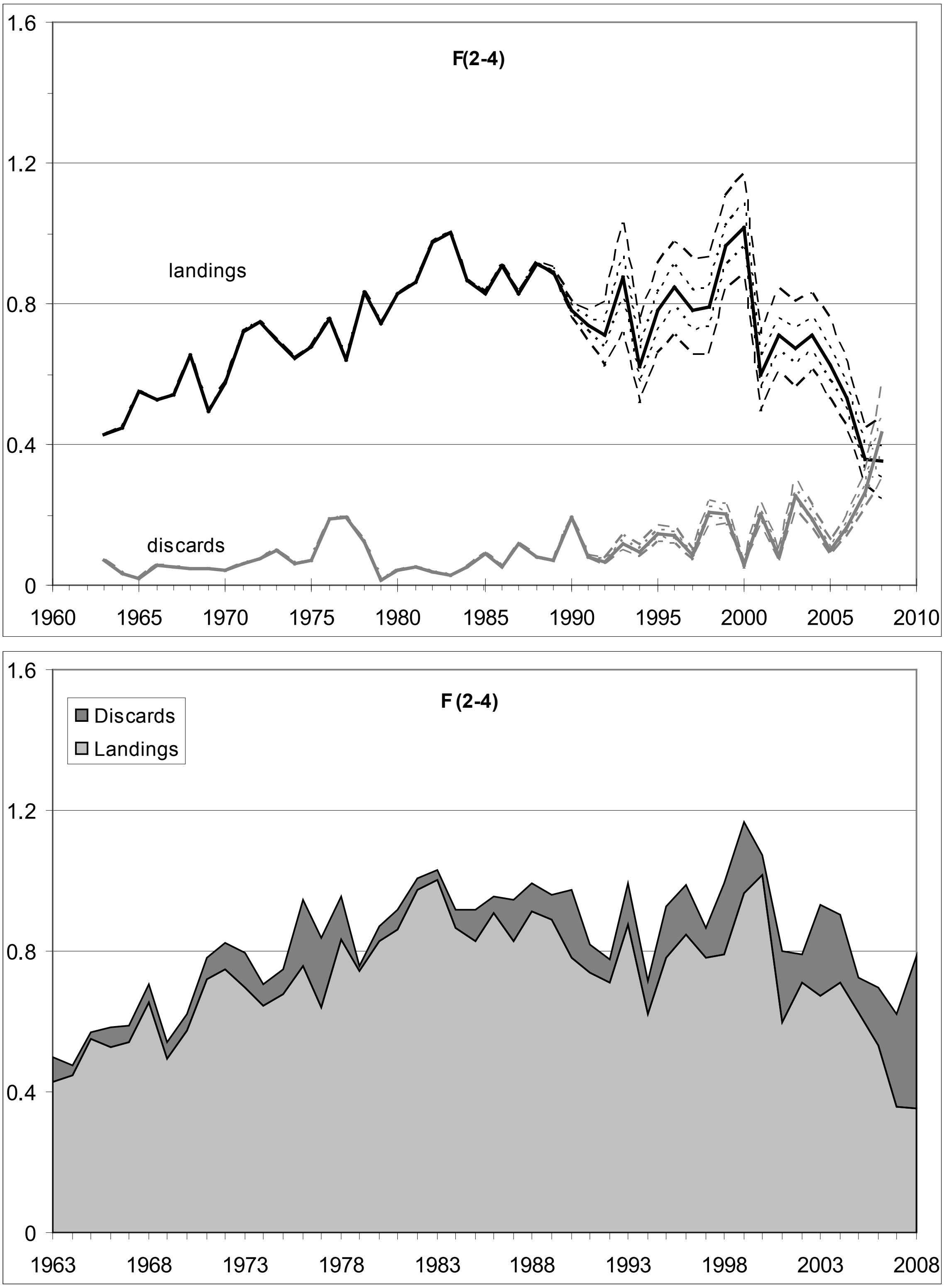


Figure 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The mean fishing mortality for ages 2-4 (F(2-4)) shown in Figure 14.15, but split into landings and discards components by using ratios calculated from the landings and discards numbers at age from the reported catch data. The top panel shows bootstrap medians (heavy lines) with 25th and 75th percentiles (light broken lines), and 5th and 95th percentiles (heavy broken lines), while the bottom panel shows a stacked-area plot of the bootstrap medians.

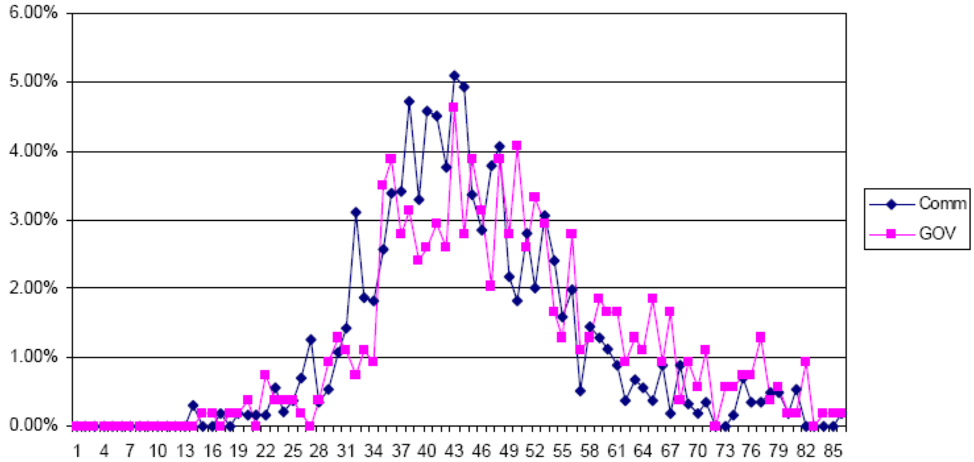


Figure 14.17. Pooled cod length frequencies from twin-trawl hauls in May 2008, using a commercial ("Comm") net and a GOV net. Source: Reid et al (2009)

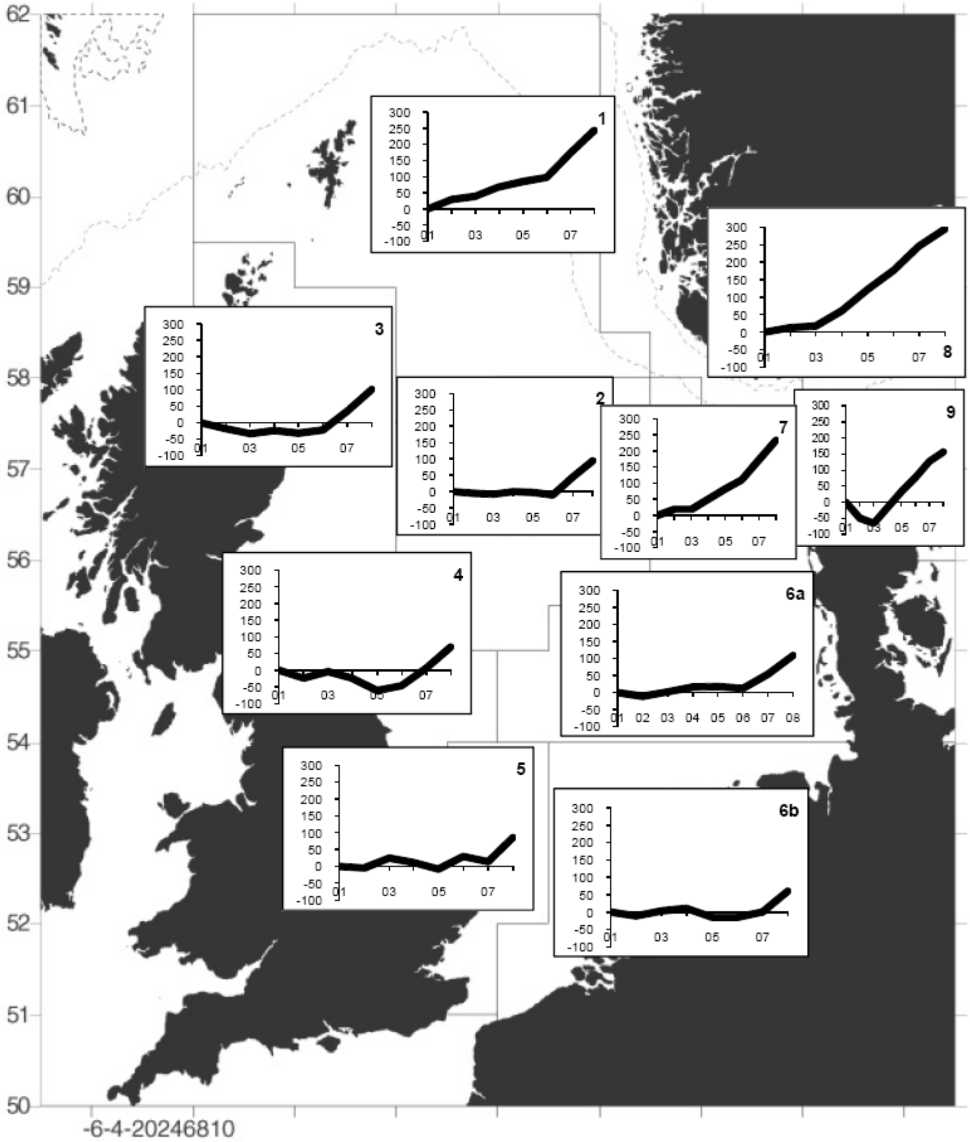


Figure 14.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The North Sea Stock Survey fishers perception of the change abundance of North Sea cod since 2003 (Laurenson 2008).

15 Cod management plan evaluations

15.1 Background

EC (DG MARE) requested ICES in 2008 to evaluate an EC proposal for cod recovery plans (EC 2008a). The main feature of the proposed management plans was the intended harvest of all stocks covered by the plan (North Sea cod, Kattegat, West of Scotland, Irish Sea, Celtic Sea Cod) at a fishing mortality of 0.4 in the long-term. Therefore, HCRs were suggested to achieve a stepwise reduction in fishing mortalities towards 0.4. The request was extended to include a proposed management plan by the Norwegian authorities for North Sea cod. The main differences between the two management plans can be summarized as follows:

	Norwegian proposal	EC proposal
15% TAC constraint	When the stock is above Bpa	When the stock is above Blim
Recovery phase	Target fishing mortality is the only constraint.	Only one phase
Long-term phase	This phase starts when the TAC following from the recovery phase is lower than the TAC following the long-term criteria. Once the long-term phase is applied, it continues to apply.	Starts immediately
F targets when the Plan is initiated	Pre-specified targets, defined as % reductions from the 2008 assessment outcomes. F 2008 is multiplied by following series of factors for setting F in 2009 and subsequent years: 0.75, 0.75×0.85, 0.75×0.85^2, 0.75×0.85^3,	Specifies reductions relative to the most recent assessment. There is a reduction of 25% when B<Blim, of 15% when Blim<B<Bpa and 10% when B>Bpa (25/15/10) until F=0.4 is reached
F targets if stock size declines while in the long-term phase	If stock size is below Bpa, the plan specifies reductions in F below 0.4. There is a proportional linear reduction of F towards 0.2 if the stock declines towards Blim.	F is maintained at or above 0.4 during the long-term phase. If the stock falls below Blim it is considered in need of recovery again, but reductions in F below 0.4 are not specified.

An ICES Adhoc Working Group (AGCREMP) was formed to evaluate objectives foreseen in the long-term management plans and to analyse if a target fishing mortality rate of 0.4 will appear well defined for all cod stocks covered by such a plan (ICES-AGCREMP 2008). The group was asked to analyse both the Commission proposal and the Norwegian lawful Authorities proposal in the light of objectives set out for such a long-term plan with the purpose to appreciate if they will be suitable for matching targets that will be suggested in terms of fishing mortality rates.

In particular, the group had to evaluate the consequences of the plans in terms of:

- biological risks, in particular in relation to the ICES interpretation of the precautionary approach;
- yields, especially in the longer term;
- stability of catches.

For practical reasons, AGCREMP could only respond to these issues for the North Sea cod stock.

Management Strategy Evaluation (MSE) was done by AGCREMP using the simulation tool FLR (Fisheries Library for R, http://www.flr-project.org, Kell *et al.*, 2007). The model included a dynamic feedback between the operating model, the observation-error model and the management procedure. The assessment process was dynamically included in the management procedure. Several sources of uncertainty have been included in the modelling (e.g. bias in natural mortality or catch, different recruitment regimes). Therefore, conclusions on the MSE could be given for different assumptions on the operating model and observation-error model. Several different scenarios were considered to address sources of uncertainty in assessments. In addition, the performance of the plans was evaluated for a "standard" recruitment model that reflects the long-term relationship between spawning stock size and recruitment, and for a "low" recruitment model that reduces recruitment by 50%.

The simulation results for the AGCREMP scenarios that correspond to the way the stock is currently assessed, and for the two recruitment models, were summarized as follows:

Recruitment Model	Prob(SSB>Blim) In 2015		Prob(SSB>Bpa) in 2015		Avg. Yield (tonnes) in 2015	
	EC	Norway	EC	Norway	EC	Norway
Standard	0.84	0.96	0.77	0.90	96.4	128.5
Low	0.61	0.81	0.54	0.66	76.1	88.9

The probabilities of recovery varied in both directions (i.e. both higher and lower) for the other scenarios representing different sources of uncertainty and recruitment regimes. For the worst case scenarios, the probabilities of recovery above B_{lim} by 2015 were 0.42 and 0.56 for the EC and Norwegian Plans, respectively. ICES also considered the performance of alternative versions of the EC and Norwegian Plans where constraints on the annual change in TAC were eliminated. The probabilities of recovery were almost unaffected, but the average yields in 2015 were much higher. The potential for growth of the North Sea cod stock at low fishing mortality rates is greater than 15%. The 15% constraint on TAC change during stock recovery therefore results in a strong reduction in fishing mortality to very low levels as rebuilding outstrips the increase in quota. In addition, a TAC constraint could also promote a collapse of the stock towards B_{lim} if the decline in the stock is faster than 15% per year.

The final ICES advice (ICES ACOM 2008) on the two management plan proposals based on the AGCREMP simulations includes that:

- **both the EC and the Norwegian proposed Recovery/Management Plans are likely to recover the North Sea cod stock.**
- ICES does not advise on the suitability of the Plans in relation to the precautionary approach because generally agreed criteria are lacking for Recovery Plans. ICES recommends that future plans state their objective in terms of the

target date for recovery and the acceptable level of risk that recovery does not occur by that date.

A subgroup of the WGNSSK reviewed and modified the AGCREMP code and ran simulations required to respond to an additional request from France during the 3–7 November 2008. France has requested ICES to evaluate a further set of scenarios for the EC proposal. The proposal of the European Commission considered a reduction of 25% when B<Blim, of 15% when Blim<B<Bpa and 10% when B>Bpa (25/15/10) until the target fishing mortality of 0.4 has been reached. The request asked for an evaluation of 25/10/5 and 15/10/5. The alternative sets of fishing mortality reductions and runs with the modified code did not alter the main conclusion about the EC proposal (i.e., that recovery is likely), although the probabilities of recovery changed to a small extent.

In December 2008 the European Commission and Norway agreed on a new cod management plan implementing a new system of effort management and a target fishing mortality of 0.4. Details of it are given in EC 1342/2008. The HCR for setting TACs for North Sea cod are as follows:

Article 7: Procedure for setting TACs for cod stocks in the Kattegat the west of Scotland and the Irish Sea

1. Each year, the Council shall decide on the TAC for the following year for each of the cod stocks in the Kattegat, the west of Scotland and the Irish Sea. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are forecast by STECF as corresponding to the fishing mortality rates referred to in paragraphs 2 and 3:

(a) a quantity of fish equivalent to the expected discards of cod from the stock con cerned;

(b) as appropriate a quantity corresponding to other sources of cod mortality caused by fishing to be fixed on the basis of a proposal from the Commission.

Article 8: Procedure for setting TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).

2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.

3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75 % for the TACs in 2009, 65 % for the TACs in 2010, and applying successive decrements of 10 % for the following years.

4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:

(a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;

*(b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: 0,4 – (0,2 * (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))*

(c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.

5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20 % below or above the TACs established in the previous year.

6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.

Article 9: Procedure for setting TACs in poor data conditions

Where, due to lack of sufficiently accurate and representative information, STECF is not able to give advice allowing the Council to set the TACs in accordance with Articles 7 or 8, the Council shall decide as follows:

(a) where STECF advises that the catches of cod should be reduced to the lowest possible level, the TACs shall be set according to a 25 % reduction compared to the TAC in the previous year;

(b) in all other cases the TACs shall be set according to a 15 % reduction compared to the TAC in the previous year, unless STECF advises that this is not appropriate.

Article 10: Adaptation of measures

1. When the target fishing mortality rate in Article 5(2) has been reached or in the event that STECF advises that this target, or the minimum and precautionary spawning biomass levels in Article 6 or the levels of fishing mortality rates given in Article 7(2) are no longer appropriate in order to maintain a low risk of stock depletion and a maximum sustainable yield, the Council shall decide on new values for these levels.

2. In the event that STECF advises that any of the cod stocks is failing to recover properly, the Council shall take a decision which:

(a) sets the TAC for the relevant stock at a level lower than that provided for in Articles 7, 8 and 9;

(b) sets the maximum allowable fishing effort at a level lower than that provided for in Article 12;

(c) establishes associated conditions as appropriate.

Therefore, the procedure of setting TACs in the agreed plan was based on the Norwegian proposal, however, with some modifications. Especially the TAC constrained was increased to +/- 20% and is now applied in all circumstances (i.e., also during the recovery phase) despite in 2009. Also the reductions in fishing mortalities during the recovery phase were slightly altered. The differences between the HCRs of both management plans can be summarized as follows:

	[Norway Rule, AGCREMP 2008]	[Council Regulation (EC) 1342/2008 plan]
1	TAC constraint = ±15%	TAC constraint = ±20%
2	TAC constraint not applied in Recovery Phase, and not applied when SSB≤B_{pa}	TAC constraint applied in all circumstances, but not in 2009
3	Recovery Phase F2007 = 0.64, and F2008 = 0.9 F2007	Transition Phase F2007 = 0.64, and F2008 = 0.9 F2007
4	F 2008 multiplied by following series of factors for setting F in 2009 and subsequent years: 0.75, 0.75×0.85, 0.75×0.85^2, 0.75×0.85^3, …	F2008 multiplied by following series of factors for setting F in 2009 and subsequent years relative to F2008: 0.75, 0.65, 0.55, 0.45, …

The final agreed cod management plan (EC 2008b) was evaluated for North Sea cod with the same methods as applied for the proposals (WD xxx). In addition, sensitivity analyses were carried out with the operating model conditioned on the basis of different assessments (WGNSSK 2008 assessment vs. Benchmark assessment 2009 (most recent assessment at the time simulations were carried out)) and with alternative interpretations of the Transition Phase value for F2007. Following conclusions were drawn from the simulations by the authors:

- For the scenarios that correspond to bias due to unreported catch, and to the way the North Sea cod stock is currently assessed (bias due to unreported catch is taken into account in the assessment process) recovery of SSB to above Blim by 2015 is achieved with more than 95% probability for both the "standard" and "low" recruitment models.
- The imposition of TAC constraints of ± 20% leads to values of F by 2012 that are much lower than ever seen before. This occurs because TAC constraints prevent TAC increases from keeping pace with the rapid recovery that occurs as a result of the relatively low target F (0.4) of the management plan.
- When TAC constraints are removed, probability of recovery remains high, much larger yields are obtained, and F values are closer to 0.4 from 2012 than when TAC constraints are kept. However, the target F is not reached by 2015 because the short-term forecast recruitment assumption (average of last 10 years of recruitment) causes a bias when there is a rapid recovery in recruitment.
- As expected, probability of recovery by 2015 and yield is lower for the "low" recruitment model than for the "standard" recruitment model.
- Generally, there is a trade-off between recovery probabilities and yield, such that when comparing scenarios with a common operating model (OM and SR), scenarios that have higher recovery probabilities tend to have lower yields, and *vice versa*.

15.2 Review of the North Sea Cod Management Evaluation

WGNSSK 2009 was kindly asked to review the latest evaluations of the final agreed management plan and to evaluate whether the management plan can be considered to be precautionary or not. Based on the reviews of the ACOM Review Group on Cod Management Plans that were made available to WGNSSK (WD xxx) following conclusions were made:

- The approach used to evaluate the final agreed cod management plan is based on state-of-the-art and is widely applied to the evaluation of management plans, although technical details vary between applications. However, the approach cannot explicitly predict changes in the biology of the stock (e.g., changes in future predation mortalities if the stock recovers to levels not observed in the past) or changes in fleet dynamics caused by technical conservation measures introduced with the new management plan. Therefore, conclusions from the simulations are only valid under the assumption that historically observed dynamics in stock biology and fleet behaviour will not change substantially in future years.
- Strict application of the HCR reduces fishing mortality (landings and discards) to very low levels (0.1-0.2) by 2012 at which they remain until, at least, 2015 in scenarios that correspond to bias due to unreported catch, and to the way the North Sea cod stock is currently assessed (bias due to unreported catch is taken into account in the assessment process). Such low levels of fishing mortality have not been recorded previously and would almost certainly imply a by-catch only fishery during the rebuilding of the stock. The low level of fishing mortality results from the constraint on the change in TAC. As the stock recovers following the reduction in mortality to very low levels the increase in the stock biomass is considerably greater than that of the TAC and therefore the proportional removals remain very low. Constraints on inter-annual TAC changes could result in unintended increases in uncertainty associated with the monitoring of the fishery.
- Constraints stabilise TAC variation from year to year but also ensure that the change in TAC does not match the change in stock abundance. The potential for growth of the cod stock at low fishing mortality rates is greater than the 20% constraint on the TAC. Consequently strong reductions in fishing mortality result as rebuilding rapidly outstrips the increases in quota. The simulation approach assumes that discard mortality is a constant fraction of the stock caught and that as fishing mortality rates are reduced the discard mortality is also proportionately reduced. In recent years as tighter restrictions have been imposed, discarding rates have been increasing. At the low fishing mortality rates generated by the simulations, the relationship between discard and fishing mortalities is likely to breakdown because the scale of the required cod avoidance and effort restrictions is almost certainly impractical. An inverse relationship between discard and fishing mortality rates is likely to arise unless severe restrictions on effort are imposed. Therefore, the validity of the model at such low fishing mortality rates is a concern
- The management plan is suitable to recover North Sea cod above B_{lim} with a high probability until 2015 according to the scenarios that correspond to bias due to unreported catch, and to the way the North Sea cod stock is currently assessed (bias due to unreported catch is taken into account in the assessment process). The probabilities are equal or above 90% for all tested combinations representing different recruitment regimes, conditionings of the operational model on the basis of different assessments (WGNSSK 2008 assessment vs. Benchmark assessment 2009 (most recent assessment at the time simulations were carried out) and alternative interpretations of the Transition Phase value for F2007. However, the constraints on inter-annual TAC changes could induce unintended

consequences as already discussed above. Instead of stabilizing TACs, they could induce long-term fluctuations because the change in TAC does not match the change in stock abundance. The resulting low fishing mortality rates may lead to substantial forgone yield for the fishing industry and could result in increased rates of discards unless effort is strongly reduced or cod avoidance measures are enforced. In addition, the TAC constraint could also promote a collapse of the stock if the decline in the stock is more than 20% per year. Without TAC constraints the fluctuations in the cod SSB and fishing mortality rates are still induced by the management system, but to a lesser extent. Removing the constraint on TAC change would reduce the level of discards and lead to more appropriate management and fishing practices but would also result in longer times required for recovery.

15.3 Conclusions from WGNSSK 2009 for ACOM Advice

- The conclusion whether the plan can be considered to be precautionary or not was based on the ICES criteria that management plans must lead to stocks above B_{lim} with more than 95% probability in 2015 (Table 1). This criteria is fulfilled for all scenarios that correspond to bias due to unreported catch, and to the way the North Sea cod stock is currently assessed (bias due to unreported catch is taken into account in the assessment process) despite for one. Under the assumption of a low recruitment scenario and an increase of future natural mortalities due to increasing cannibalism if the stock recovers (WD xxx, Table 1, Scenario 7b), the probability to be above B_{lim} was estimated to be 90%.
- In addition, probabilities are below 95% in various scenarios representing errors in the perception of stock status during the assessment process, i.e. if unallocated removals are assumed to be caused by natural mortality in the operational model but are assumed to stem from unallocated catches in the assessment process (WD xxx, Table 1, Scenarios 4a, 4b, 10a, 10b).
- The application of the 20% TAC Constraint results in levels of fishing mortality that are so low that it is impractical for effort to be reduced to the levels required, possibly even for by-catch fisheries. At such low levels of fishing behaviour of the fishery is considered highly uncertain and the model assumptions will break down, especially with respect to discard practices.
- Therefore, the plan cannot be considered to be precautionary under all circumstances based on the simulations carried out. In general, a certain statement on the precautionary nature of management plans based on MSE simulations alone is hardly possible, since in no way all potential uncertainties can be fully reflected in MSE simulations.

15.4 References:

EC 2008a. Proposal for a Council Regulation amending Regulation (EC) No 423/2004 as regards the recovery of cod stocks and amending Regulation (EEC) No 2847/93. {SEC. 2008. 386, SEC(2008) 389} Brussels, 2.4.2008, COM(2008) 162 final, 2008/0063 (CNS).

EC 2008b. Council Regulation establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No. 423/2004. (EC) No. 1342/08.

ICES-AGCREMP 2008. Report of the Ad hoc Group on Cod Recovery Management Plan (AG-CREMP). ICES CM 2008/ACOM: 61.

ICES_WKOMSE 2009. Report of the ICES-STECF Workshop on Fish-ery Management Plan Development and Evaluation (WKOMSE). ICES CM 2009/ACOM: 27.

ICES ACOM 2008 Section 6.3.3.7 Request on Cod Recovery Management Plans

Kell, L.T., Mosqueira, I., Grosjean, P., Fromentin, J-M., Garcia, D., Hillary, R., Jardim, E., Mardle, S., Pastoors, M.A., Poos, J.J., Scott, F. and R.D. Scott. 2007. FLR: an open-source framework for the evaluation and development of management strategies. ICES Journal of Marine Science 64: 640–646.

Table 15.1 Criteria agreed during WKOMSE to be applied in the evaluation of Harvest Control Rules – Management Plans, HCR (MP) in relation to precautionary reference points (Taken from ICES WKOMSE 2009).

Element	Criterion	Notes
Time frame	**2015**: The performance of the HCR (MP) will be evaluated using as time horizon the year 2015 (in agreement with the Johannesburg Declaration)	The simulations will use as starting year the population parameter estimates from the most recent assessment (e.g. from WG or benchmark).
Biological Reference Points	**Limit reference points**: Evaluate the HCR (MP) based on Blim and Flim	If new limit reference points have been accepted (ACOM) these should be used in the evaluation; In the absence of defined limit reference points such as Blim, use proxies (e.g. xlim derived from %SPR, or 0.5Bmsy, or 20%Bo, ….)
Risk	**5%**: The HCR (MP) is considered to be precautionary if the probability of SSB<Blim (or x<xlim) is less than 5%	Criteria for management plan of stocks within safe biological limits to be precautionary: no more than 5% of 10 year simulation runs having one or more years outside of safe biological limits. Criteria for recovery plan qualifying as precautionary: at least 95% of simulation runs recovering by 2015 (the year WSSD committed for rebuilding fish stocks). The 5% will be used unless managers specify another percentage.

16 Mixed fisheries

In 2006, the WG dedicated significant amount of time dealing with mixed-fisheries issues in the North Sea. This has not been repeated since 2007, due to changes in the WG period and duration, as well as changes in the general ICES structure. Mixed-fisheries issues have been dealt with independently from the assessment Working Groups, through two initiatives, the ICES SGMixMan and the EU FP6 research project AFRAME. The latest outcomes were presented to WGNSSK but no further work was conducted.

ICES SGMixMan (Study Group on Mixed-Fisheries Management Models) has met three times, first in January 2006 as a workshop (WKMixMan) then in January 2007 and 2008. In 2006, this Study Group reviewed potential alternatives to mixed-fisheries models and identified the Fcube model (Fleet and Fisheries Forecast, Ulrich et al., 2006, 2008) as an appropriate framework in relation to fleet and fishery-based management advice. This approach was further tested in the 2007 meeting, and was finally used as for real advice situation in 2008. The outcomes were also presented every year to Working Groups Chairs meetings.

EU FP6 AFRAME is a two years research project aiming at further developing the Fcube approach through its application to three contrasting case studies, the North Sea demersal fisheries, the Western Waters demersal fisheries and the Greek demersal fisheries. This project terminated by 1st april 2009, and final results were being processed at the time of the WGNSSK.

Both initiatives gathered a number of common participants, and worked as complementary forces. Most of the methodological development and testing was done within the research project, while ICES SGMixMan acted as a milestone ensuring that the work was being made fully operational for the purpose of mixed-fisheries advice.

On the basis of the work achieved in AFRAME and ICES SGMixMan, the work on mixed-fisheries issues will be moved from a Study Group to an Advisory Workshop.

The Workshop on Mixed Fisheries Advice for the North Sea [WKMIXFISH] (Chair: Clara Ulrich Rescan*, Denmark) will meet at ICES Headquarters 26–28 August 2009 to:

a) Compile and review available fleet and fisheries data for North Sea fisheries

b) Carry out mixed fisheries forecast taking into account the draft advice that is produced by WGNSSK 2009 and the management measures currently in place for 2009

c) Develop a draft overview section for the advisory report 2009 that includes a dissemination of the fleet and fisheries data and forecast

The outcomes of this workshop will be reported to WGNSSK in 2010.

References :

Ulrich, C., Reeves, S.A., and Kraak, S.B.M., 2008. Mixed Fisheries and the Ecosystem Approach. ICES Insight 45:36-39

Ulrich,C., Andersen B.S., Hovgård H., Sparre P., Murta A., Garcia D., Castro J..2006. Fleet-based short-term advice in mixed-fisheries – the F[3] approach. ICES Symposium on Fisheries Management Strategies, June 2006, Galway. http://www.ices06sfms.com/presentations/index.shtml

ICES, 2006. Report of the Working Group on Workshop on Simple Mixed Fisheries Management Models. ICES CM 2006/ACFM:14

ICES, 2007. Report Of The Study Group On Mixed Fisheries Management. ICES CM 2007/ACFM:02.

ICES, 2008. Report Of The Study Group On Mixed Fisheries Management. ICES CM 2008/ACOM:23. 65 pp.

Annex 1 – List of Participants

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6 - 12 May 2009**

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**Warning may contain nuts

Annex 2 – Update forecasts and assessments

2.1 Summary

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: Chris Darby*, UK) met by correspondence at the beginning of October 2009 to evaluate new information from the fisheries independent surveys carried out during 2009 subsequent to the meeting of the group in May.

The WGNSSK followed the protocol defined by the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60) in its evaluation of the survey information - fitting the RCT3 regression model to data that included the 2009 survey information to estimate the 2009 recruitment abundance and then comparing the prediction and its associated uncertainty with the estimate from previous surveys used as the basis for the ACOM spring advice.

The comparisons indicated that there was potential for re-opening of the advice for sole a 3% decrease in the TAC would result. The estimates of recruitment for cod, whiting and saithe are unchanged from the values used in the spring; the new information is either too uncertain to provide a change to the advice (saithe) or indicates that the estimate from the new information does not differ from the assumptions used in the spring forecast (cod, whiting). For haddock and plaice there are indications of improved recruitment in 2009 which will increase future catches and SSB, however in both cases, the constraint which restricts changes in the TAC to +/-15% is applicable for both stocks, as it was in May and the advice is unchanged.

2.2 Cod in Sub-Area IV, VIID and IIIa

2.2.1 New survey information

Research surveys were conducted as part of the IBTS 3rd quarter survey of 2009. This survey, in conjunction with the IBTS quarter 1 survey, provides information on year-class strength for the incoming year-class (2008 year-class) that could potentially be used in a TAC forecast. However, these surveys are not considered to provide reliable enough information on the incoming year-class to be used in the TAC forecast, and the approach for North Sea cod has been to replace estimates of the incoming 2008 year-class, and subsequent year-classes, with re-sampled values from the 1997-2007 year-classes. Nevertheless, an RCT3 analysis was conducted to see if the information on the 2008 year-class provided by these surveys is significantly different to the median implied by the forecast re-sampling.

2.2.2 RCT3 Analysis

RCT3 was run using the new information from the surveys to predict recruitment at age 1 in 2009. The input data are presented in Table 2.2.1 and the output in Table 2.2.2.

2.2.3 Update protocol calculations

The recruitment value for 2008 used in the forecast was 110222. This was based on values sampled from the 1997-2007 year-classes, and was a median from the 1000 B-Adapt bootstraps. According to the protocol (AGCREFA), this is compared with the output from RCT3 as follows:

Log WAP = 11.53, internal s.e. = 0.4, D = -0.2

2.2.4 Forecast

The absolute value of D is less than 1, so it is not appropriate to consider re-opening the advice for North Sea cod. It should be noted, however, that this would have been the case, regardless of the value of D, because the most recent survey estimate of age 1 receives no weight in the assessment, and does not feature in the TAC forecast.

2.2.5 Conclusions

Based on considering only the most recent estimate of age 1 in the surveys as a criteria for re-opening advice, it is not appropriate to re-open advice for North Sea cod because the absolute value of D is less than 1, and because the most recent survey estimates of age 1 do not feature in either the assessment or the TAC forecast.

Table 2.2.1 The RCT3 input data file updated with the North Sea cod CPUE from the third quarter IBTS surveys.

Cod NS & Skag. Age 1

2	26	2	
'Year'	'Badapt'	'Q1_1'	'Q3_1'
1982	470856	4.734	-11
1983	1485856	15.856	-11
1984	272216	0.928	-11
1985	1668788	16.785	-11
1986	363026	9.425	-11
1987	238092	5.638	-11
1988	630938	15.117	-11
1989	199511	3.953	-11
1990	260092	2.481	8.17
1991	546894	13.129	43.487
1992	254721	13.088	10.473
1993	939238	14.66	42.737
1994	413639	9.832	22.282
1995	233277	3.441	10.283
1996	734266	39.951	60.518
1997	96659	2.672	2.397
1998	177838	2.112	11.952
1999	299673	6.563	10.689
2000	86372	2.786	4.723
2001	155474	7.755	11.334
2002	73605	0.584	1.735
2003	106661	6.74	12.178
2004	88393	2.272	4.745
2005	218422	6.642	15.215
2006	98279	3.091	9.079
2007	120160	2.694	9.989
2008	-11	1.23	6.926

Table 2.2.2 The RCT3 output file for North Sea cod.

```
Analysis by RCT3 ver3.1 of data from file :
 nscod2.txt
 Cod NS & Skag. Age 1
 Data for    2 surveys over   27 years :  1982 - 2008
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                    included
 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/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 Q1_1      1.49   9.63    .76   .577     26    .80   10.82     .842     .229
 Q3_1      1.05   9.56    .42   .783     18   2.07   11.75     .459     .771

                                        VPA Mean =   12.49     .873     .000
 Year     Weighted      Log      Int      Ext      Var      VPA      Log
 Class     Average      WAP      Std      Std     Ratio              VPA
          Prediction            Error    Error
 2008      102108     11.53      .40      .39      .93
```

2.3 Haddock in Sub-Area IV and Division IIIa

2.3.1 New survey information

The new data available for a potential autumn forecast are the third-quarter groundfish surveys carried out by Scotland (ScoGFS) and England (EngGFS), and the international third-quarter IBTS survey (IBTS Q3). The latter is not used in the haddock assessment or forecast, and is not considered further here. The full available dataset for the ScoGFS and EngGFS series is given in Table 2.3.1. Note that the following analysis compares the effect of the new survey data with the revised forecast carried out in September (Darby, Millar and Needle 2009), *not* the forecast provided by the Working Group (ICES-WGNSSK 2009): the latter was found to be incorrect due to software problems.

2.3.2 RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2009) year-class at age 0. The RCT3 input and output files are given in Tables 2.3.2 and 2.3.3.

Update protocol calculations

The outcome of the application of the protocol was as follows:

Calculations for 2009 year-class	
Log WAP from RCT3	9.50
Log of recruitment assumed in spring	8.31
Int SE of log WAP	0.21
Distance D	**5.66**

2.3.3 Conclusions from protocol

As the distance D > 1.0, the protocol concludes that the advisory process for North Sea haddock should be **reopened**.

2.3.4 Updated forecast

The RCT3 analysis indicates that the recruitment of the 2009 year class at age 0 in 2009 should be exp(9.50) = 13359.727 millions. This value was included in the MFDP input file given in Table 2.3.4. The remaining forecast assumptions (regarding growth, exploitation and so on) were unchanged from the revised September forecast (ICES-WGNSSK 2009; Darby, Millar and Needle 2009).

The results of the MFDP run are given in Table 2.3.5. The following text table summarises the differences in forecast **landings yield in 2010** at key *F*-multipliers:

	15% TAC decrease	Plan target	Status quo
September	35619	35343	30112
October	35619	35605	30331
Difference	0.000%	+0.741%	+0.727%

The following summarises the differences in forecast **SSB in 2011**:

	15% TAC decrease	Plan target	Status quo
September	187665	187994	194224
October	208323	208340	214748
Difference	+11.008%	+10.823%	+10.567%

The autumn survey indices result in a significant increase (>10%) in the forecast SSB in 2011. However, the difference between the September and October forecast landings under the target or status quo *F* values is less than 1.0%, and when the TAC constraint is applied there is no difference between the forecasts. On this basis, the advisory process should not be taken further for North Sea haddock.

Table 2.3.1. Haddock in Sub-Area IV and Division IIIa. Indices from the third-quarter English (EngGFS) and Scottish (ScoGFS) groundfish survey series. New data from autumn 2009 are highlighted in bold.

Survey data							
EngGFS Q3 GOV							
1992	2009						
1	1	0.5	0.75				
0	6						
100	246.021	58.746	29.133	1.742	0.146	0.037	0.251
100	40.336	73.145	17.435	4.951	0.176	0.048	0
100	279.344	23.99	26.992	2.511	0.894	0.058	0.003
100	53.435	113.775	13.223	11.032	0.827	0.275	0.021
100	61.301	26.747	43.044	3.603	2.052	0.207	0.088
100	40.653	45.346	12.608	19.968	0.719	0.718	0.067
100	15.747	26.497	16.778	4.079	4.141	0.226	0.141
100	626.1	16.551	8.404	3.663	1.258	1.201	0.04
100	92.139	249.813	4.528	1.634	0.74	0.336	0.35
100	1.097	28.622	96.498	3.039	0.828	0.35	0.135
100	2.721	3.954	22.559	60.583	0.542	0.097	0.153
100	3.199	6.015	1.247	13.967	45.079	0.719	0.026
100	3.398	6.599	3.864	0.448	6.836	17.406	0.217
100	122.383	9.74	5.992	2.584	1.249	6.617	3.654
100	11.825	54.816	3.27	1.14	0.433	0.15	0.859
100	8.463	10.628	43.401	1.402	0.624	0.092	0.078
100	2.613	6.494	5.801	18.534	0.727	0.266	0.137
100	**28.978**	**5.532**	**6.781**	**4.636**	**7.147**	**0.108**	**0.099**
ScoGFS Q3 GOV							
1998	2009						
1	1	0.5	0.75				
0	6						
100	3280	6349	1924	490	511	24	18
100	66067	1907	1141	688	197	164	6
100	11902	30611	460	221	130	73	27
100	79	3790	11352	179	65	40	18
100	2149	675	2632	6931	70	37	18
100	2159	1172	307	2092	4344	22	17
100	1729	1198	547	101	819	1420	9
100	19708	761	657	153	112	347	483
100	2280	7275	272	158	33	14	73
100	1119	1810	5527	117	57	11	5
100	1885	733	1002	2424	28	24	6
100	**9015**	**877**	**547**	**469**	**1185**	**37**	**8**

Table 2.3.2. Haddock in Sub-Area IV and Division IIIa. RCT3 input file. Data from surveys in autumn 2009 are highlighted in bold.

HADDOCK IN IV, RCT3 INPUT VALUES									
8	29	2							
'YEARCLASS'	'VPA'	'IBTS1'	'IBTS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'
1981	32617680	-1	403.079	-1	-1	-1	-1	-1	-1
1982	20491370	302.278	221.275	-1	-1	-1	-1	-1	-1
1983	66956253	1072.285	833.257	-1	-1	-1	-1	-1	-1
1984	17181331	230.968	266.912	-1	-1	-1	-1	-1	-1
1985	23920805	573.023	328.062	-1	-1	-1	-1	-1	-1
1986	49030758	912.559	677.641	-1	-1	-1	-1	-1	-1
1987	4156240	101.691	98.091	-1	-1	-1	-1	-1	-1
1988	8339335	219.705	139.114	-1	-1	-1	-1	-1	-1
1989	8606296	217.448	134.076	-1	-1	-1	-1	-1	-1
1990	28351635	680.231	331.044	-1	-1	29.133	-1	-1	-1
1991	27479298	1141.396	519.521	-1	58.746	17.435	-1	-1	-1
1992	41947282	1242.121	491.051	246.021	73.145	26.992	-1	-1	-1
1993	13157783	227.919	201.069	40.336	23.990	13.223	-1	-1	-1
1994	56144741	1355.485	813.268	279.344	113.775	43.044	-1	-1	-1
1995	14447705	267.411	353.882	53.435	26.747	12.608	-1	-1	-1
1996	21503804	849.943	420.926	61.301	45.346	16.778	-1	-1	1924
1997	12826240	357.597	222.907	40.653	26.497	8.404	-1	6349	1141
1998	9970725	211.139	107.06	15.747	16.551	4.528	3280	1907	460
1999	135516779	3734.185	2255.213	626.100	249.813	96.498	66067	30611	11352
2000	26511570	894.651	492.299	92.139	28.622	22.559	11902	3790	2632
2001	2835366	58.211	38.585	1.097	3.954	1.247	79	675	307
2002	3750722	89.958	79.622	2.721	6.015	3.864	2149	1172	547
2003	3891493	71.875	60.993	3.199	6.599	5.992	2159	1198	657
2004	3731671	69.976	47.784	3.398	9.740	3.270	1729	761	272
2005	38595613	1212.163	963.325	122.383	54.816	43.401	19708	7275	5527
2006	7205011	109.096	106.489	11.825	10.628	5.801	2280	1810	1002
2007	4572803	60.115	139.871	8.463	6.494	**6.781**	1119	733	**547**
2008	3735922	74.75	-1	2.613	**5.532**	-1	1885	**877**	-1
2009	-1	-1	-1	**28.978**	-1	-1	**9015**	-1	-1

Table 2.3.3. Haddock in Sub-Area IV and Division IIIa. RCT3 output file.

```
Analysis by RCT3 ver3.1 of data from file :
 hadivrct.in
 HADDOCK IN IV, RCT3 INPUT VALUES
 Data for    8 surveys over   29 years :  1981 - 2009
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass =   2009
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 IBTS1
 IBTS2
 EGFS0      .66   7.22    .19   .974     17   3.40    9.47     .213     .938
 EGFS1
 EGFS2
 SGFS0      .82   2.56    .70   .777     11   9.11   10.00     .826     .062
 SGFS1
 SGFS2

                                        VPA Mean =    9.61    1.040     .000
 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio              VPA
         Prediction            Error   Error

 2009       13403      9.50     .21     .13      .38
```

Table 2.3.4. Haddock in Sub-Area IV and Division IIIa. MFDP output table (October revision). Options are highlighted for the management plan target F (0.3), a 15% TAC decrease, and the status quo F forecast.

MFDP version 1a
Run: 100
Time and date: 16:23 08/10/2009
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2009

		Catch		Landings		Discards		IBC	Landings	
Biomass	SSB	FMult	Fbar	FBar	Yield	FBar	Yield	FMult	FBar	Yield
988097	229325	0.9014	0.2266	0.1409	44700	0.0844	8286	1	0.0013	229

2010											2011		
		Catch		Landings		Discards		IBC	Landings				
Biomass	SSB	FMult	Fbar	FBar	Yield	FBar	Yield	FMult	FBar	Yield	Biomass	SSB	
1151663	205949	0.00	0.001	0.000	0	0.000	0	1	0.001	298	1236227	251712	
.	205949	0.10	0.026	0.016	3299	0.009	1154	1	0.001	296	1231621	247683	
.	205949	0.20	0.051	0.031	6536	0.019	2294	1	0.001	294	1227101	243733	
.	205949	0.30	0.076	0.047	9711	0.028	3423	1	0.001	292	1222665	239859	
.	205949	0.40	0.101	0.063	12826	0.038	4539	1	0.001	290	1218311	236060	
.	205949	0.50	0.126	0.078	15883	0.047	5643	1	0.001	288	1214038	232335	
.	205949	0.60	0.151	0.094	18882	0.056	6735	1	0.001	286	1209843	228680	
.	205949	0.70	0.176	0.109	21825	0.066	7816	1	0.001	285	1205724	225096	
.	205949	0.80	0.201	0.125	24714	0.075	8886	1	0.001	283	1201681	221580	
.	205949	0.90	0.226	0.141	27549	0.084	9944	1	0.001	281	1197712	218131	
.	205949	1.00	0.251	0.156	30331	0.094	10992	1	0.001	279	1193814	214748	status quo
.	205949	1.10	0.276	0.172	33063	0.103	12028	1	0.001	277	1189986	211428	
	205949	1.19	0.300	0.187	35605	0.112	13002	1	0.001	276	1186422	208340	target F
	205949	1.20	0.300	0.187	35619	0.112	13007	1	0.001	276	1186402	208323	15% TAC decrease
.	205949	1.20	0.301	0.188	35744	0.112	13055	1	0.001	276	1186227	208171	
.	205949	1.30	0.326	0.203	38376	0.122	14071	1	0.001	274	1182536	204975	
.	205949	1.40	0.351	0.219	40960	0.131	15077	1	0.001	272	1178910	201839	
.	205949	1.50	0.376	0.235	43497	0.141	16073	1	0.001	271	1175349	198762	
.	205949	1.60	0.401	0.250	45988	0.150	17060	1	0.001	269	1171850	195742	
.	205949	1.70	0.426	0.266	48434	0.159	18036	1	0.001	267	1168413	192778	
.	205949	1.80	0.451	0.281	50837	0.169	19004	1	0.001	266	1165037	189869	
.	205949	1.90	0.476	0.297	53196	0.178	19962	1	0.001	264	1161719	187013	
.	205949	2.00	0.501	0.313	55513	0.187	20912	1	0.001	263	1158459	184210	

Input units are thousands and kg - output in tonnes

2.4 Saithe in Subarea IV, VI and Division IIIa

2.4.1 New survey information

Several research vessel surveys were conducted in the third quarter of 2009 to produce the 2009 Q3 IBTS indices. Additionally, 2008 indices for the Q3 IBTS index had small revisions compared to the values used in May. The new information that is utilized is the age 3 in the IBTS Q3 index for 2009, and revisions to the IBTS Q3 age 3 for 2008. The full survey series are given in Table 2.4.1.

2.4.2 RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2006) year class at age 3. The RCT3 input and output files are given in Tables 2.4.2 and 2.4.3.

The outcome of the application of the protocol was as follows:

Calculations for 2006 year-class	
Log WAP from RCT3	10.76
Log of recruitment assumed in spring	11.71
Int SE of log WAP	0.81
Distance D	**-1.17**

2.4.3 Update protocol calculations

The value of D is less than -1, so the most recent information is sufficiently different from that available in May, 2009. However, the protocol emphasises that a reopening of the advice depends on new reliable survey information. The IBTSq3 estimates of age 3 are very noisy with poor correlation with the VPA population estimates (0.3) and consequently high prediction coefficients of variation (~80% and progressively worse).

Previous saithe forecasts have used the geometric mean recruitment and as seen in Table 2.4.3 this has a lower standard error than the prediction estimates. Consequently the new information for saithe is too noisy to use and the advisory process for saithe should not be reopened.

Table 2.4.1. Saithe in Sub-Area IV, VI and Division IIIa. Indices from the 1st and 3rd quarter IBTS survey series. New data for autumn 2009 are highlighted in bold.

IBTS q3

1991 2009

1 1 0.5 0.75

3 5

1	1.946	0.402	0.064
1	1.077	2.76	0.516
1	7.965	2.781	1.129
1	1.117	1.615	0.893
1	13.959	2.501	1.559
1	3.825	6.533	1.112
1	3.756	3.351	7.461
1	1.027	3.921	1.333
1	2.1 2.019	2.949	
1	3.479	8.836	1.081
1	21.496	6.173	3.937
1	10.748	18.974	1.327
1	19.272	23.802	13.402
1	4.979	6.896	3.158
1	8.893	6.87	4.994
1	10.636	29.82	2.934
1	34.018	5.594	11.763
1	**3.467**	**5.86**	**1.122**
1	**1.346**	**1.703**	**0.568**

Table 2.4.2. Saithe in Sub-area IV, VI and Division IIIa RCT3 input file

```
NORTH SEA SAITHE AS 3 YEAR OLD
1 19 2 (No. Surveys, No.Yearclasses, VPA Column)
'YEAR' 'VPA' 'IBTSQ3'
1991 138452  1.946
1992  92781  1.077
1993 151493  7.965
1994 102360  1.117
1995 224246 13.959
1996 110295  3.825
1997 162820  3.756
1998  71182  1.027
1999 139349  2.1
2000  94158  3.479
2001 221180 21.496
2002 186590 10.748
2003 123594 19.272
2004  86544  4.979
2005 211248  8.893
2006  56975 10.636
2007 173990 34.018
2008 72416 3.467
2009  -11 1.346
```

Table 2.4.3. Whiting in Sub-Area IV and Division VIId. RCT3 output file.

```
Analysis by RCT3 ver3.1 of data from file :
 c:\ices\ina3fin.txt

 NORTH SEA SAITHE AS 3 YEAR OLD
 Data for    1 surveys over   19 years :  1991 - 2009
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                     included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression
 Forecast/Hindcast variance correction used.
 Yearclass =   2006
          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 IBTSQ3     .63  10.68     .38   .494    15   2.45   12.23     .434    1.000

                                        VPA Mean =   11.80     .364     .000
 Year class =   2007
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 IBTSQ3    1.05   9.83     .77   .231    16   3.56   13.57     .969    1.000
                                        VPA Mean =   11.74     .410     .000
 Yearclass =   2008
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 IBTSQ3     .90  10.04     .71   .257    17   1.50   11.38     .784    1.000
                                        VPA Mean =   11.76     .405     .000
 Yearclass =   2009
          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights
 IBTSQ3     .93   9.97     .72   .264    18    .85   10.76     .810    1.000

                                        VPA Mean =   11.73     .415     .000
 Year     Weighted      Log     Int     Ext     Var      VPA       Log
 Class     Average      WAP     Std     Std    Ratio               VPA
          Prediction           Error   Error

 2006      203952      12.23     .43     .00      .00  56975     10.95
 2007      785282      13.57     .97     .00      .00 173991     12.07
 2008       87988      11.38     .78     .00      .00  72416     11.19
 2009       47230      10.76     .81     .00      .00
```

2.5 Whiting in Sub-Area IV and VIID

2.5.1 Whiting in Sub-Area IV and Division IIIa

New survey information

Several research vessel surveys were conducted in the third quarter of 2009 combining to produce the 2009 Quarter 3 IBTS indices. Additionally, 2009 indices for the Quarter 1 IBTS index had small revisions compared to values used in May. The new information that is utilized is the age 1 IBTS Q3 index for 2009, and revisions to the IBTS Q1 age 1 and 2 for 2009. The full survey series are given in Table 2.5.1. Note that the following analysis considers the reopening of the revised forecast carried out in September (Darby, Millar and Needle 2009), *not* the forecast provided by the Working Group (ICES-WGNSSK 2009): the latter was found to be incorrect due to software problems.

RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2008) year-class at age 1. The RCT3 input and output files are given in Tables 2.5.2 and 2.5.3.

Update protocol calculations

The outcome of the application of the protocol was as follows:

Calculations for 2009 year-class	
Log WAP from RCT3	17.44
Log of recruitment assumed in spring	17.17
Int SE of log WAP	0.42
Distance D	**0.64**

Conclusions from protocol

The value of D is not less than -1 and not greater than 1, so the most recent information is not sufficiently different from that available in May, 2009. Therefore the forecast from September still stands and the advice will not be reopened.

Table 2.5.1. Whiting in Sub-Area IV and Division VIId. Indices from the 1st and 3rd-quarter IBTS survey series. New data for autumn 2009 are highlighted in bold.

IBTS Q1							
	1	2	3	4	5	6	
1990	518.94	862.35	198.16	91.61	16.94	3.67	
1991	1007.62	686.45	479.62	70.95	37.64	7.59	
1992	907.30	665.71	240.16	150.83	12.67	13.93	
1993	1075.62	522.81	244.59	65.49	59.02	11.44	
1994	721.71	627.41	181.02	68.08	11.86	9.11	
1995	678.59	448.48	239.45	58.07	11.87	5.58	
1996	502.36	485.97	244.70	69.74	23.09	9.85	
1997	287.73	342.21	162.52	60.43	18.01	9.18	
1998	543.12	160.70	125.38	54.05	15.50	9.26	
1999	676.27	305.45	94.68	57.45	25.83	11.08	
2000	756.87	537.86	182.22	53.07	20.02	14.74	
2001	648.65	598.39	299.18	98.32	25.72	26.16	
2002	670.59	416.82	275.25	66.63	22.11	10.41	
2003	131.60	298.87	237.01	133.36	48.37	12.63	
2004	184.61	89.73	173.00	100.03	48.97	22.17	
2005	167.63	55.97	31.48	56.39	37.85	29.36	
2006	223.01	92.38	32.56	16.54	28.25	27.14	
2007	42.19	166.13	71.07	18.78	8.99	25.26	
2008	267.75	205.56	65.61	22.11	7.52	15.23	
2009	**210.05**	**226.60**	**74.46**	**24.85**	**10.47**	**11.22**	
IBTS Q3							
	0	1	2	3	4	5	6
1991	536.99	703.37	158.59	79.02	14.57	5.18	1.02
1992	1379.46	600.87	296.10	72.45	57.50	10.27	6.21
1993	919.19	638.72	177.38	66.12	14.71	15.90	3.04
1994	610.74	677.65	219.54	74.71	19.51	4.72	3.16
1995	729.25	619.79	291.18	107.20	21.51	6.01	3.46
1996	316.50	545.71	278.22	129.36	34.00	6.89	4.10
1997	2062.67	332.97	180.68	108.99	28.01	10.71	4.25
1998	2631.69	330.60	150.21	52.77	31.01	11.18	4.70
1999	2498.55	1203.50	190.65	53.93	24.45	9.53	4.18
2000	1968.07	941.66	326.94	64.11	13.63	6.53	4.87
2001	3031.44	645.00	282.32	94.85	19.28	4.32	7.51
2002	264.06	732.14	237.37	125.15	33.96	5.28	2.76
2003	363.41	246.16	302.05	134.82	66.06	16.45	4.66
2004	711.28	161.56	47.78	64.42	45.24	31.04	11.94
2005	162.59	179.50	70.53	27.61	45.39	29.21	33.93
2006	202.83	172.79	85.14	31.97	13.24	22.92	25.46
2007	819.06	99.48	66.18	34.47	11.83	6.04	23.22
2008	769.57	389.38	38.90	29.94	14.09	3.87	14.60
2009	**595.99**	**580.50**	**380.56**	**37.20**	**11.21**	**7.74**	**6.49**

Table 2.5.2. Whiting in Sub-Area IV and Division VIId. RCT3 input file. New or revised values are highlighted in bold.

Whi4&7d (age 1)

4	19	2			
1990	2942	1007.62	665.71	-11	703.37
1991	2798	907.3	522.81	536.99	600.87
1992	2694	1075.62	627.41	1379.46	638.72
1993	2991	721.71	448.48	919.19	677.65
1994	2778	678.59	485.97	610.74	619.79
1995	2449	502.36	342.21	729.25	545.71
1996	1680	287.73	160.7	316.5	332.97
1997	1284	543.12	305.45	2062.67	330.6
1998	1832	676.27	537.86	2631.69	1203.5
1999	2883	756.87	598.39	2498.55	941.66
2000	3239	648.65	416.82	1968.07	645
2001	2617	670.59	298.87	3031.44	732.14
2002	2295	131.6	89.73	264.06	246.16
2003	783	184.61	55.97	363.41	161.56
2004	901	167.63	92.38	711.28	179.5
2005	1124	223.01	166.13	162.59	172.79
2006	1063	42.19	205.56	202.83	99.48
2007	605	267.75	**226.6**	819.06	389.38
2008	-11	**210.05**	-11	769.57	**580.503**

ibtsq1age1
ibtsq1age2
ibtsq3age0
ibtsq3age1

Table 2.5.3. Whiting in Sub-Area IV and Division VIId. RCT3 output file.

```
Analysis by RCT3 ver3.1 of data from file :
 rct3-oct.csv
 Whi4&7d (age 1),,,,,
 Data for    4 surveys over   19 years :  1990 - 2008
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                   included
 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/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error           Pts  Value   Value    Error   Weights

 ibtsq1     .91   2.05    .59   .469     18   5.35    6.91     .650     .408
 ibtsq1
 ibtsq3    1.45  -2.16   1.28   .160     17   6.65    7.46    1.397     .088
 ibtsq3    1.08   1.00    .53   .517     18   6.37    7.85     .585     .504
                                         VPA Mean =    7.51     .535     .000
 Year     Weighted      Log     Int      Ext     Var      VPA      Log
 Class     Average      WAP     Std      Std    Ratio              VPA
          Prediction            Error   Error
2008        1697       7.44     .42      .32      .58
```

2.6 North Sea plaice

2.6.1 New survey information

The new survey information that is available comes from the Beam Trawl Survey RV Isis (BTS-Isis) that was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). It uses an 8-m beam trawl with 40 mm stretched mesh codend.

2.6.2 RCT3 Analysis

The RCT3 analysis on the BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in Table 2.6.1. In 2009, the new data comprises age 1 of year class 2008 and age 2 of year class 2007. The last 4 years from the assessment estimates were removed from the time series.

2.6.3 Update protocol calculations

The outcomes from the RCT3 analyses for the two ages are presented in table 2.6.2. For age 1, the D value for this age indicates a positive revision to the estimate and following the protocol the forecast should be recalculated. For age 2 the D value indicates a positive index. The full RCT3 analysis table is given in Table 2.6.3 and the revised recruitment estimates in Table 2.6.4.

The input to the North Sea plaice forecast is provided in Tables 2.6.5, the detailed output in Table 2.6.6 and the short term management summary table in Table 2.6.7.

2.6.4 Conclusions from protocol

If the TAC is advised according to the management plan, then the new option table results in a TAC advice that is equal to the advice of June 2009 (63 825 t). The rationale behind this is that The TAC is bound by the upper 15% TAC change constraint, at 63 825 t.

Following the AGCREFA protocol, the new available survey indices for North Sea plaice ages 1 and 2 do indicate an increase in abundance but the revised level of catch is constrained by the limitation on TAC change and there is no requirement to reopen the advice.

Table 2.6.1 North Sea plaice RCT3 input data

```
North Sea Plaice Age 1
1      25     2
1984   1846346       115.58
1985   4750659       667.44
1986   1950224       225.82
1987   1769839       680.17
1988   1187325       467.88
1989   1036310       115.31
1990   913820 185.45
1991   776857 176.97
1992   531067 124.76
1993   442720 145.21
1994   1162817       252.16
1995   1290188       218.28
1996   2148532       -11
1997   776201 342.51
1998   844549 305.9
1999   983135 277.61
2000   540793 222.71
2001   1712546       541.25
2002   546025 126.11
2003   1261256       226.2
2004   789082 158.45
2005   -11           135.11
2006   -11           329.34
2007   -11           235.37
2008   -11           408.99
BTS1

North Sea Plaice Age 2
1      25     2
1983   843201 179.9
1984   1284914       131.77
1985   3234130       764.29
1986   1420748       146.99
1987   1269821       319.27
1988   870248 102.64
1989   797991 122.05
1990   651274 125.93
1991   567698 179.1
1992   385566 64.22
1993   340171 43.55
1994   931722 212.32
1995   1060536       -11
1996   1820845       431.9
1997   602709 130
1998   642546 74.4
1999   788694 78.44
2000   456223 47.74
2001   1253741       170.08
2002   429086 41.75
2003   919217 69.6
2004   622218 38.99
2005   -11           72.29
2006   -11           130.6
2007   -11           105.22
BTS2
```

Table 2.6.2 North Sea plaice RCT3 output for age 1 and D calculation

D calculation North Sea plaice age 1

RCT3 ver3.1 file: ple_iv1.txt, NS Plaice Age 1, 1 survey over 1984 - 2008

Regression type = C, Tapered time weighting not applied, Survey weighting not applied

Final estimates not shrunk towards mean

Estimates with S.E.'S greater than that of mean

+ included

Minimum S.E. for any survey taken as .03, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

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
BTS1	1.71	4.52	.79	.348	20	6.02	14.79	.874	1.000
						VPA Mean =	13.90	.569	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2008	2659228	14.79	.87	.00	.00

Plaice age 1 **D= (14.79 - log(912907))/0.87 = 1.22**

D calculation North Sea plaice age 2

RCT3 ver3.1 file : ple_iv2.txt, NS Plaice Age 1, 1 survey over 1983 - 2007

Regression type = C, Tapered time weighting not applied, No Survey weighting

Final estimates not shrunk towards mean

Estimates with S.E.'S greater than that of mean

+ included

Minimum S.E. for any survey taken as .03, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2007 I-----------Regression----------I I-----------Prediction—---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BTS2	.84	9.59	.36	.703	21	4.67	13.51	.392	1.000
						VPA Mean =	13.63	.535	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2007	735532	13.51	.39	.00	.00		

Plaice age 2 **D= (13.51 - log(676656))/0.39 = 0.218**

Table 2.6.3 Full RCT3 calculation North Sea plaice age 1 all survey data

```
RCT3 ver3.1 file : ple_iv1.txt, NS Plaice Age 1, 6 surveys over1969 -
2008

Regression type = C, Tapered time weighting not applied, No survey
weighting

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.


Yc 2008  I-----------Regression-----------I I-----------Prediction----
-------I

Survey/  Slope  Inter-   Std  Rsquare  No.   Index Predicted     Std       WAP
Series          cept   Error           Pts   Value     Value    Error  Weights
SNS0       .96   4.72    .89   .271     34   10.82     15.14     .948     .158
BTS1      1.71   4.52    .79   .348     20    6.02     14.79     .874     .186
DFS0      2.36    .13    .90   .292     22    5.24     12.51    1.012     .138

                                    VPA Mean =   13.83     .523     .519

Year      Weighted      Log      Int      Ext       Var
Class     Average       WAP      Std      Std     Ratio
          Prediction            Error    Error
2008      1239014      14.03      .38      .46      1.52
```

Table 2.6.4 Updated North Sea Plaice recruitment table

Recruitment table

Year class	At age in 2009	XSA Survivors	RCT3	GM 1957 – 2006	Accepted estimate
2007	**2**	**676 656**	645 091	673 614.4	XSA survivors
2008	1		**1 239 014**	912 907	RCT3 estimates
2009	0			**912 907**	GM 1957 – 2006

Table 2.6.5 Updated North Sea plaice STF results: Input

age	year	f	f.disc	f.land	stock.n	catch wt	land wt	disc wt	stock wt	mat	M
1	2009	0.141	0.14	0.00	1239014	0.06	0.26	0.06	0.05	0.0	0.1
2	2009	0.359	0.33	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1
3	2009	0.296	0.17	0.12	526211	0.22	0.30	0.17	0.21	0.5	0.1
4	2009	0.232	0.05	0.18	260705	0.31	0.34	0.19	0.28	1.0	0.1
5	2009	0.187	0.01	0.17	137053	0.38	0.39	0.19	0.35	1.0	0.1
6	2009	0.156	0.02	0.13	156361	0.40	0.44	0.21	0.42	1.0	0.1
7	2009	0.116	0.03	0.09	39583	0.44	0.52	0.22	0.46	1.0	0.1
8	2009	0.150	0.05	0.10	79483	0.42	0.57	0.20	0.52	1.0	0.1
9	2009	0.088	0.00	0.09	14367	0.59	0.59	0.00	0.57	1.0	0.1
10	2009	0.088	0.00	0.09	61988	0.67	0.67	0.00	0.67	1.0	0.1
1	2010	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1
2	2010	0.359	0.33	0.02		0.12	0.27	0.11	0.11	0.5	0.1
3	2010	0.296	0.17	0.12		0.22	0.30	0.17	0.21	0.5	0.1
4	2010	0.232	0.05	0.18		0.31	0.34	0.19	0.28	1.0	0.1
5	2010	0.187	0.01	0.17		0.38	0.39	0.19	0.35	1.0	0.1
6	2010	0.156	0.02	0.13		0.40	0.44	0.21	0.42	1.0	0.1
7	2010	0.116	0.03	0.09		0.44	0.52	0.22	0.46	1.0	0.1
8	2010	0.150	0.05	0.10		0.42	0.57	0.20	0.52	1.0	0.1
9	2010	0.088	0.00	0.09		0.59	0.59	0.00	0.57	1.0	0.1
10	2010	0.088	0.00	0.09		0.67	0.67	0.00	0.67	1.0	0.1
1	2011	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1
2	2011	0.359	0.33	0.02		0.12	0.27	0.11	0.11	0.5	0.1
3	2011	0.296	0.17	0.12		0.22	0.30	0.17	0.21	0.5	0.1
4	2011	0.232	0.05	0.18		0.31	0.34	0.19	0.28	1.0	0.1
5	2011	0.187	0.01	0.17		0.38	0.39	0.19	0.35	1.0	0.1
6	2011	0.156	0.02	0.13		0.40	0.44	0.21	0.42	1.0	0.1
7	2011	0.116	0.03	0.09		0.44	0.52	0.22	0.46	1.0	0.1
8	2011	0.150	0.05	0.10		0.42	0.57	0.20	0.52	1.0	0.1
9	2011	0.088	0.00	0.09		0.59	0.59	0.00	0.57	1.0	0.1
10	2011	0.088	0.00	0.09		0.67	0.67	0.00	0.67	1.0	0.1

Table 2.6.6 Updated North Sea plaice STF results: Detailed output

age	year	F	Fdisc	Fland	stock n	catch wt	land wt	disc wt	stock wt	mat	M	catch n	catch	land n	land	disc n	disc	SSB	TSB
1	2009	0.141	0.14	0.00	1239014	0.06	0.26	0.06	0.05	0.0	0.1	155109	9368	1074	274	154036	9088	0	62364
2	2009	0.359	0.33	0.02	676656	0.12	0.27	0.11	0.11	0.5	0.1	194833	24218	13315	3566	181519	20633	37893	75786
3	2009	0.296	0.17	0.12	526211	0.22	0.30	0.17	0.21	0.5	0.1	128479	28761	54120	16199	74359	12492	55603	111206
4	2009	0.232	0.05	0.18	260705	0.31	0.34	0.19	0.28	1.0	0.1	51501	15962	40796	13950	10705	1991	72997	72997
5	2009	0.187	0.01	0.17	137053	0.38	0.39	0.19	0.35	1.0	0.1	22264	8422	20592	8098	1672	322	47786	47786
6	2009	0.156	0.02	0.13	156361	0.40	0.44	0.21	0.42	1.0	0.1	21555	8678	18419	8066	3135	655	64994	64994
7	2009	0.116	0.03	0.09	39583	0.44	0.52	0.22	0.46	1.0	0.1	4114	1799	3049	1577	1065	231	18221	18221
8	2009	0.150	0.05	0.10	79483	0.42	0.57	0.20	0.52	1.0	0.1	10534	4471	6844	3868	3690	736	40934	40934
9	2009	0.088	0.00	0.09	14367	0.59	0.59	0.00	0.57	1.0	0.1	1158	681	1158	681	0	0	8175	8175
10	2009	0.088	0.00	0.09	61988	0.67	0.67	0.00	0.67	1.0	0.1	4999	3350	4999	3350	0	0	41529	41529
1	2010	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	2010	0.359	0.33	0.02	973796	0.12	0.27	0.11	0.11	0.5	0.1	280390	34853	19162	5132	261229	29693	54533	109065
3	2010	0.296	0.17	0.12	427562	0.22	0.30	0.17	0.21	0.5	0.1	104393	23369	43974	13163	60419	10150	45179	90358
4	2010	0.232	0.05	0.18	354273	0.31	0.34	0.19	0.28	1.0	0.1	69985	21691	55438	18957	14547	2706	99196	99196
5	2010	0.187	0.01	0.17	187021	0.38	0.39	0.19	0.35	1.0	0.1	30381	11492	28099	11051	2282	439	65208	65208
6	2010	0.156	0.02	0.13	102874	0.40	0.44	0.21	0.42	1.0	0.1	14181	5709	12119	5307	2063	431	42761	42761
7	2010	0.116	0.03	0.09	121013	0.44	0.52	0.22	0.46	1.0	0.1	12576	5499	9321	4822	3255	705	55706	55706
8	2010	0.150	0.05	0.10	31908	0.42	0.57	0.20	0.52	1.0	0.1	4229	1795	2747	1553	1481	295	16433	16433
9	2010	0.088	0.00	0.09	61916	0.59	0.59	0.00	0.57	1.0	0.1	4993	2935	4993	2935	0	0	35230	35230
10	2010	0.088	0.00	0.09	63239	0.67	0.67	0.00	0.67	1.0	0.1	5099	3417	5099	3417	0	0	42366	42366
1	2011	0.141	0.14	0.00	912907	0.06	0.26	0.06	0.05	0.0	0.1	114285	6902	791	202	113494	6696	0	45950
2	2011	0.359	0.33	0.02	717494	0.12	0.27	0.11	0.11	0.5	0.1	206592	25680	14118	3781	192474	21878	40180	80359
3	2011	0.296	0.17	0.12	615316	0.22	0.30	0.17	0.21	0.5	0.1	150235	33631	63285	18943	86950	14608	65018	130037
4	2011	0.232	0.05	0.18	287857	0.31	0.34	0.19	0.28	1.0	0.1	56865	17625	45045	15403	11820	2199	80600	80600
5	2011	0.187	0.01	0.17	254143	0.38	0.39	0.19	0.35	1.0	0.1	41285	15617	38184	15017	3101	596	88611	88611
6	2011	0.156	0.02	0.13	140381	0.40	0.44	0.21	0.42	1.0	0.1	19352	7791	16537	7241	2815	588	58352	58352
7	2011	0.116	0.03	0.09	79617	0.44	0.52	0.22	0.46	1.0	0.1	8274	3618	6132	3172	2142	464	36651	36651
8	2011	0.150	0.05	0.10	97551	0.42	0.57	0.20	0.52	1.0	0.1	12928	5487	8399	4747	4529	903	50239	50239
9	2011	0.088	0.00	0.09	24856	0.59	0.59	0.00	0.57	1.0	0.1	2004	1178	2004	1178	0	0	14143	14143
10	2011	0.088	0.00	0.09	103656	0.67	0.67	0.00	0.67	1.0	0.1	8358	5602	8358	5602	0	0	69444	69444

Table 2.6.7 Updated North Sea plaice STF results: Management summary table

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2009
2009	1	0.246	0.25	0.25	59629	46147	105710	388131

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2011
2010	0.2	0.049	0.05	0.05	14466	11479	25949	456613	595304
2010	0.3	0.074	0.08	0.07	21470	16965	38440	456613	582771
2010	0.4	0.098	0.10	0.10	28325	22290	50621	456613	570547
2010	0.5	0.123	0.13	0.12	35036	27457	62501	456613	558623
2010	0.6	0.148	0.15	0.15	41605	32474	74087	456613	546993
2010	0.7	0.172	0.18	0.17	48037	37343	85389	456613	535646
2010	0.8	0.197	0.20	0.20	54334	42070	96414	456613	524576
2010	0.9	0.221	0.23	0.22	60500	46660	107170	456613	513776
2010	1.0	0.246	0.25	0.25	66537	51116	117664	456613	503237
2010	1.1	0.271	0.28	0.27	72450	55443	127903	456613	492953
2010	1.2	0.295	0.30	0.30	78239	59645	137895	456613	482916
2010	1.3	0.320	0.33	0.32	83910	63725	147646	456613	473121
2010	1.4	0.344	0.35	0.34	89464	67689	157163	456613	463560
2010	1.5	0.369	0.38	0.37	94904	71538	166452	456613	454227
2010	1.6	0.394	0.40	0.39	100232	75278	175519	456613	445117
2010	1.7	0.418	0.43	0.42	105452	78910	184371	456613	436222
2010	1.8	0.443	0.46	0.44	110566	82440	193014	456613	427538
2010	1.9	0.467	0.48	0.47	115576	85869	201452	456613	419059
2010	2.0	0.492	0.51	0.49	120485	89201	209692	456613	410779

2.7 North Sea sole

2.7.1 New survey information

The new survey information that is available comes from the Beam Trawl Survey RV Isis (BTS-Isis) that was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea (RV Isis). It uses an 8-m beam trawl with 40 mm stretched mesh codend.

2.7.2 RCT3 Analysis

The RCT3 analysis on the BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in Table 2.7.1. In 2009, the new data comprises age 1 of year class 2008 and age 2 of year class 2007. The last 4 years from the assessment estimates were removed from the time series.

2.7.3 Update protocol calculations

The outcomes from the RCT3 analyses for the two ages are presented in table 2.7.2. For age 1, the D value for this age indicates a positive signal and following the protocol the forecast would not be recalculated. For age 2 the D value indicates a large negative index. The full RCT3 analysis table is given in Table 2.7.3 and the revised recruitment estimates in Table 2.7.4.

The input to the North Sea plaice forecast is provided in Tables 2.7.5, the detailed output in Table 2.7.6 and the short term management summary table in Table 2.7.7.

2.7.4 Conclusions from protocol

Following the AGCREFA protocol, the new available survey indices for North Sea sole age 2 indicate a decrease in estimated abundance using the new information and the forecast should be recalculated.

If the TAC is advised according to the management plan, then the new option table results in a decrease in the TAC advice of 14100 - 13645= 455 tonnes, compared to the advice of June 2009. This is a decrease in TAC of 3.2%. This is within the 15% TAC change boundaries, which are 11 900 – 16 100 t.

Table 2.7.1 North Sea sole RCT3 input data

Sole North Sea age 1

1	25	2	
1984	80833		2.65
1985	159654	7.88	
1986	72553		6.97
1987	454627	83.11	
1988	108296	9.02	
1989	177757	22.60	
1990	70476		3.71
1991	354171	74.44	
1992	69289		4.99
1993	57057		5.88
1994	96104		27.86
1995	49508		3.51
1996	271749	173.94	
1997	114161	14.12	
1998	82581		11.41
1999	123824	14.46	
2000	63480		8.17
2001	187821	21.90	
2002	85663		10.76
2003	46679		3.65
2004	49955		3.14
2005	-11		16.82
2006	-11		5.81
2007	-11		15.04
2008	-11		15.95

BTS1

Sole North Sea age 2

1	25	2	
1983	63873		7.89
1984	72984		4.49
1985	144105	12.55	
1986	65559		12.51
1987	411354	68.08	
1988	97879		22.36
1989	160020	23.19	
1990	63655		23.2
1991	319535	27.36	
1992	62644		4.99
1993	50944		8.46
1994	82392		6.17
1995	44633		5.37
1996	244377	29.21	
1997	103065	19.26	
1998	74450		6.53
1999	109804	10.71	
2000	56599		4.17
2001	168944	10.55	
2002	76515		4.4
2003	41746		3.3
2004	44101		2.44
2005	-11		19.97
2006	-11		8.87
2007	-11		5.00

BTS2

Table 2.7.2 North Sea sole RCT3 output for age 1

D calculation North Sea sole age 1

```
Analysis by RCT3 ver3.1 of data from file: altin_1.txt, NS Sole Age 1, 1 sur-
veys over 1984 - 2008


Regression type = C, Tapered time weighting not applied, No survey weighting

Final estimates not shrunk towards mean

Estimates with S.E.'S greater than that of mean

+                                                    included

Minimum S.E. for any survey taken as    .03

Minimum of   3 points used for regression


Forecast/Hindcast variance correction used.

2008     I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP

Series           cept   Error           Pts  Value   Value    Error   Weights

BTS1      .69   9.79    .35   .778     21   2.83   11.75     .382    1.000

                                      VPA Mean =   11.56     .648     .000

Year     Weighted      Log      Int      Ext      Var

Class     Average      WAP      Std      Std    Ratio

        Prediction            Error    Error

2008      126663     11.75     .38      .00      .00
```

Sole age 1 **D = (11.75 - log(93800))/0.38 = 0.79**

D calculation North Sea sole age 2

```
Analysis by RCT3 ver3.1 of data from file : altin_2.txt, NS Sole Age 2, 1 sur-
veys over 1983 - 2007

Regression type = C, Tapered time weighting not applied, No survey weighting

Final estimates not shrunk towards mean

Estimates with S.E.'S greater than that of mean

+                                                    included

Minimum S.E. for any survey taken as    .03

Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

2007     I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP

Series           cept   Error           Pts  Value   Value    Error   Weights

BTS2     1.02   8.95    .47   .663     22   1.79   10.78     .510    1.000

                                       VPA Mean =   11.44     .641     .000

Year     Weighted      Log      Int      Ext      Var      VPA       Log

Class     Average      WAP      Std      Std    Ratio                VPA

       Prediction             Error    Error

2007       48286     10.78     .51      .00      .00
```

Sole age 2 **D= (10.78 - log(80500))/0.51= -1.01**

Table 2.7.3 North Sea sole RCT3 output for age 1

Full RCT3 calculation North Sea sole age 2 all survey data

Analysis by RCT3 ver3.1 of data from file : altin_2.txt, North Sea Sole-Age 2, 5 surveys over 1969 - 2008

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 = 2007

	I---------Regression--------------------------I					I---------Prediction---------------------------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
DFS0	1.16	6.24	1.02	.348	28	3.20	9.95	1.102	.039
SNS1	.73	5.79	.34	.809	35	7.14	11.00	.357	.371
BTS1	.70	9.66	.36	.770	21	2.78	11.60	.393	.306
BTS2	1.02	8.95	.47	.663	22	1.79	10.78	.510	.182
						VPA Mean =	11.36	.680	.102

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2007	**68897**	11.14	.22	.20	.82

Table 2.7.4 Updated North Sea sole recruitment table

Recruitment table

Year Class	Age in 2009	XSA thousands	RCT3 thousands	GM(1957 – 2006) thousands
2007	2	80 500	**68 900**	83 800
2008	1		67 300	**93 800**
2009	Recruit			**93 800**

Table 2.7.5 North Sea sole STF Input table

age	year	f	stock.n	stock wt	land wt	mat	M
1	2009	0.018	93786	0.05	0.16	0	0.1
2	2009	0.184	68900	0.15	0.19	0	0.1
3	2009	0.352	43345	0.19	0.22	1	0.1
4	2009	0.374	90880	0.23	0.25	1	0.1
5	2009	0.408	10752	0.25	0.27	1	0.1
6	2009	0.370	5763	0.28	0.31	1	0.1
7	2009	0.352	5701	0.28	0.30	1	0.1
8	2009	0.428	7286	0.28	0.32	1	0.1
9	2009	0.531	685	0.31	0.32	1	0.1
10	2009	0.531	1228	0.39	0.37	1	0.1
1	2010	0.018	93786	0.05	0.16	0	0.1
2	2010	0.184		0.15	0.19	0	0.1
3	2010	0.352		0.19	0.22	1	0.1
4	2010	0.374		0.23	0.25	1	0.1
5	2010	0.408		0.25	0.27	1	0.1
6	2010	0.370		0.28	0.31	1	0.1
7	2010	0.352		0.28	0.30	1	0.1
8	2010	0.428		0.28	0.32	1	0.1
9	2010	0.531		0.31	0.32	1	0.1
10	2010	0.531		0.39	0.37	1	0.1
1	2011	0.018	93786	0.05	0.16	0	0.1
2	2011	0.184		0.15	0.19	0	0.1
3	2011	0.352		0.19	0.22	1	0.1
4	2011	0.374		0.23	0.25	1	0.1
5	2011	0.408		0.25	0.27	1	0.1
6	2011	0.370		0.28	0.31	1	0.1
7	2011	0.352		0.28	0.30	1	0.1
8	2011	0.428		0.28	0.32	1	0.1
9	2011	0.531		0.31	0.32	1	0.1
10	2011	0.531		0.39	0.37	1	0.1

Table 2.7.6 North Sea sole Detailed STF table

age	year	f	st.n	st.wt	land.wt	mat	M	land.n	land	SSB	TSB
1	2009	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2009	0.184	68900	0.15	0.19	0	0.1	11037	2057	0	10427
3	2009	0.352	43345	0.19	0.22	1	0.1	12263	2692	8322	8322
4	2009	0.374	90880	0.23	0.25	1	0.1	27079	6814	20690	20690
5	2009	0.408	10752	0.25	0.27	1	0.1	3441	935	2692	2692
6	2009	0.370	5763	0.28	0.31	1	0.1	1702	521	1639	1639
7	2009	0.352	5701	0.28	0.30	1	0.1	1616	492	1604	1604
8	2009	0.428	7286	0.28	0.32	1	0.1	2422	769	2030	2030
9	2009	0.531	685	0.31	0.32	1	0.1	270	87	212	212
10	2009	0.531	1228	0.39	0.37	1	0.1	484	181	481	481
1	2010	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2010	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2010	0.352	51865	0.19	0.22	1	0.1	14673	3221	9958	9958
4	2010	0.374	27595	0.23	0.25	1	0.1	8222	2069	6282	6282
5	2010	0.408	56564	0.25	0.27	1	0.1	18103	4917	14160	14160
6	2010	0.370	6468	0.28	0.31	1	0.1	1910	585	1839	1839
7	2010	0.352	3601	0.28	0.30	1	0.1	1021	311	1013	1013
8	2010	0.428	3627	0.28	0.32	1	0.1	1206	383	1011	1011
9	2010	0.531	4298	0.31	0.32	1	0.1	1693	549	1330	1330
10	2010	0.531	1018	0.39	0.37	1	0.1	401	150	399	399
1	2011	0.018	93786	0.05	0.16	0	0.1	1566	243	0	4689
2	2011	0.184	83372	0.15	0.19	0	0.1	13355	2489	0	12617
3	2011	0.352	62759	0.19	0.22	1	0.1	17755	3898	12050	12050
4	2011	0.374	33018	0.23	0.25	1	0.1	9838	2476	7517	7517
5	2011	0.408	17175	0.25	0.27	1	0.1	5497	1493	4299	4299
6	2011	0.370	34027	0.28	0.31	1	0.1	10050	3077	9675	9675
7	2011	0.352	4042	0.28	0.30	1	0.1	1145	349	1137	1137
8	2011	0.428	2291	0.28	0.32	1	0.1	761	242	638	638
9	2011	0.531	2140	0.31	0.32	1	0.1	843	273	662	662
10	2011	0.531	2828	0.39	0.37	1	0.1	1114	417	1108	1108

Table 2.7.7 North Sea sole STF results: Management summary table

fmult	year	ssb	f2-6	recruit	landings
1	2009	37670	0.338	93786	14792

year	fmult	f2-6	landings	ssb	ssb2011
2010	0.0	0.000	0	35992	51426
2010	0.2	0.068	3409	35992	48133
2010	0.4	0.135	6590	35992	45069
2010	0.5	0.169	8099	35992	43617
2010	0.6	0.203	9558	35992	42216
2010	0.7	0.236	10967	35992	40865
2010	0.8	0.270	12329	35992	39560
2010	0.9	0.304	13645	35992	38302
2010	1.0	0.338	14917	35992	37087
2010	1.1	0.371	16147	35992	35914
2010	1.2	0.405	17335	35992	34782
2010	1.4	0.473	19596	35992	32634
2010	1.6	0.540	21710	35992	30631
2010	1.8	0.608	23689	35992	28763
2010	2.0	0.675	25540	35992	27020

2.8 References

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ICES-IBTSWG (2009) Report of the international Bottom Trawl Survey Working group (IBTSWG). ICES CM 2009/RMC:04

ICES (2008). Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA). ICES CM 2008/ACOM:60

Annex 3 – Stock Annexes

Stock Annex– Cod in Subarea IV, Division VIId and Division IIIa West (Skagerrak)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Cod in Subarea IV, Divison VIId & Division IIIa West (Skagerrak)
Working Group:	Working Group North Sea, Skagerrak and Kattegat
Date:	January 2009
By:	José De Oliveira

A. General

A.1. Stock definition

Cod are widely distributed throughout the North Sea. Scientific survey data indicate that historically, young fish (ages 1 and 2) have been found in large numbers in the southern part of the North Sea. Adult fish have in the past been located in concentrations of distribution in the Southern Bight, the north east coast of England, in the German Bight, the east coast of Scotland and in the north-eastern North Sea. As stock abundance fluctuates, these groupings appear to be relatively discrete but the area occupied has contracted. During recent years, the highest densities of 3+ cod have been observed in the deeper waters of the central to northern North Sea.

North Sea cod is really a meta-population of sub-populations with differential rates of mixing among them (Horwood *et al*. 2006, Metcalfe 2006, Heath *et al*. 2008). A genetic survey of cod in European continental shelf waters using micro-satellite DNA detected significant fine scale differentiation suggesting the existence of at least 4 genetically divergent cod populations, resident in the northern North Sea off Bergen Bank, within the Moray Firth, off Flamborough Head and within the Southern Bight (Hutchinson *et al*. 2001). The differentiation was weak (typical of marine fishes with large population sizes and high dispersal potentials), but significant, with the degree of genetic isolation weakly correlated with geographical separation distance. This recent genetic evidence is largely consistent with the limited movements suggested by earlier tagging studies (ICES-NSRWG 1971, Metcalfe 2006, Righton *et al*. 2007). Furthermore, Holmes *et al*. (2008) found significant differences in SSB trends between spawning areas in the North Sea, consistent with asynchronous population dynamics across spawning areas and providing support for the concept of meta-population structure.

Available information indicates that the majority of spawning takes place from the beginning of January through to April offshore in waters of salinity 34-35% (Brander 1994, Riley and Parnell 1984). Around the British Isles there is a tendency towards later timing with increasing latitude (ICES 2005). Cod spawn throughout much of the North Sea but spawning adult and egg survey data and fishermen's observations indicate a number of spawning aggregations. Results from the first ichthyoplankton survey to cover the whole of the North Sea, conducted in 2004 to map spawning grounds of North Sea cod, are reported in Fox *et al*. (2008). This study compared the results from the plankton survey with estimates of egg production inferred from the distribution of mature cod in contemporaneous trawl surveys. The comparison found general agreement of hot spots of egg production around the southern and eastern edge of the Dogger Bank, in the German Bights, the Moray Firth and to the east of the Shetlands, which mapped broadly into known spawning areas from the period 1940-1970, but was unable to detect any significant spawning activity off Flamborough (a historic spawning ground off the northeast coast of England). The study showed that most of the major cod spawning grounds in the North Sea are still active, but that the depletion of some localised populations may have made the detection of spawning activity in the corresponding areas difficult (Fox *et al*. 2008).

At the North Sea scale, there has been a northerly shift in the mean latitudinal distribution of the stock (Hedger *et al*. 2004, Perry *et al*. 2005). However the evidence for this being a migratory response is slight or non-existent. More likely, cod in the North Sea are composed of a complex of more or less isolated sub-stocks (as indicated above) and the southern units have been subjected to disproportionately high rates of fishing mortality (STECF-SGRST-07-01). Blanchard *et al*. (2005) demonstrated that the contraction in range of juvenile North Sea cod stock could be linked to reduced abundance as well as increased temperature, and further noted that the combined negative effects of increased temperature on recruitment rates and the reduced availability of optimal habitat may have increased the vulnerability of the cod population to fishing mortality. Rindorf and Lewy (2006) linked the northward shift in distribution to the effect of a series of warm, windy winters on larvae and the resultant distribution of recently settled cod, followed by a northwards shift in the distribution of older age groups (because of the tendency for northerly distributed juveniles to remain northerly throughout their life). They noted further that this effect is intensified by the low abundance of older age cod due to heavy fishing pressure. In contrast, Neat and Righton (2007) analysed the temperature experienced by 129 individual adult cod throughout the North Sea, and found that the majority experienced a warmer fraction of the sea than was potentially available to them (even though they had the capacity to find cooler water), with individuals in the south in summer experiencing temperatures considered superoptimal for growth. This suggests that the thermal regime of the North Sea is not yet causing adult cod to move to cooler waters.

Several tagging studies have been conducted on cod in the North Sea since the mid 1950s in order to investigate the migratory movements and geographical range of cod populations (Bedford 1966, ICES-NSRWG 1971, Daan 1978, Righton *et al*. 2007). These studies support the existence of regional populations of cod that separate during the spawning season and, in some cases, intermix during the feeding season (Metcalfe 2006). Righton *et al*. (2007) re-analysed some of the historical datasets of conventional tags and used recent data from electronic tags to investigate movement and distribution of cod in the southern North Sea and English Channel. Their re-analysis of conventional tags showed that, although most cod remained within their release areas, a larger proportion of cod were recaptured outside their release area in the feeding season than the spawning season, and a larger proportion of adults were recaptured outside their release area than juveniles, with the displacement (release to recapture) occurring mostly to the southern North Sea for fish released in the English Channel, and to areas further north for fish released in the southern North Sea (see Table 5 in Righton *et al*. 2007). This suggests a limited net influx of cod from the English Channel to the southern North Sea, but no significant movement in the other direction (Metcalfe 2006).

The lack of obvious physical barriers to mixing between different sub-populations in the North Sea suggests that behavioural and/or environmental factors are responsible for maintaining the relative discreteness of these populations (Metcalfe 2006). For example, Righton *et al*. (2007) conclude that behavioural differences between cod in the southern North Sea and English Channels (such as tidal stream transport being used by fish tagged and released in the southern North Sea to migrate, but rarely being used by those tagged and released in the English Channel) may limit mixing of cod from these two areas during feeding and spawning season. Robichaud and Rose (2004) describe four behavioural categories for cod populations: "sedentary residents" exhibiting year-round site fidelity, "accurate homers" that return to spawn in specific locations, "inaccurate homers" that return to spawn in a broader area around the original site, and "dispersers" that move and spawn in a haphazard fashion within a large geographical area. These categories are not necessarily mutually exclusive and behaviours in different regions may be best described by differing degrees of each category (Heath *et al*. 2008).

Evidence from electronic tags suggest that cod populations have a strong tendency for site attachment (even in migratory individuals), rapid and long-distance migrations, the use of deeper channels as migratory "highways" and, in some cases, clearly defined feeding and spawning "hot spots" (Righton *et al*. 2008). Andrews *et al*. (2006) used a spatially and physiologically explicit model describing the demography and distribution of cod on the European shelf in order to explore a variety of hypotheses about the movements of settled cod. They fitted the model to spatial data derived from International Bottom Trawl Surveys, and found that structural variants of the model that did not recognise an active seasonal migration by adults to a set of spatially stable spawning sites, followed by a dispersal phase, could not explain both the abundance and distribution of the spawning stock. Heath *et al*. (2008) investigated different hypotheses about natal fidelity, and their consequence for regional dynamics and population structuring, by developing a model representing multiple demes, with the spawning locations of fish in each deme governed by a variety of rules concerning oceanographic dispersal, migration behaviour and straying. They used an age-based discrete time methodology, with a spatial representation of physical oceanographic patterns, fish behaviour patterns, recruitment, growth and mortality (both natural and fishing). They found that active homing is not necessary to explain some of the population structures of cod (with separation possible through distance and oceanographic processes affecting the dispersal of eggs and larvae, such is in the Southern Bight), but that homing behaviour may be necessary to explain the structure of other sub-populations.

A.2. Fishery

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species. In some of them cod are considered to be a by-catch (for example in beam trawls targeting flatfish), and in others the fisheries are directed mainly towards cod (for example, some of the fixed gear fisheries).

An analysis of landings and estimated discards of cod by gear category (excluding Norwegian data) highlighted the following fleets as the most important in terms of cod for 2003-5 (accounting for close to 88% of the EU landings), listed with the main use of each gear (STECF SGRST-07-01):

- Otter trawl, ≥ 120mm, a directed roundfish fishery by UK, Danish and German vessels.
- Otter trawl, 70-89mm, comprising a 70-79mm French whiting trawl fishery centered in the Eastern Channel, but extending into the North Sea, and an 80-89mm UK *Nephrops* fishery (with smaller landings of roundfish and anglerfish) occurring entirely in the North Sea.
- Otter trawl, 90-99mm, a Danish and Swedish mixed demersal fishery centered in the Skagerrak, but extending into the Eastern North Sea.
- Beam trawl, 80-89mm, a directed Dutch and Belgian flatfish fishery.
- Gillnets, 110-219mm, a targeted cod and plaice fishery.

For Norway in 2007, trawls (mainly bycatch in the saithe fishery) and gillnets account for around 60% (by weight) of cod catches, with the remainder taken by other gears mainly in the fjords and on the coast, whereas in the Skagerrak, trawls and gillnets account for up to 90% of cod catches.

With regard to trends in effort for these major cod fisheries since 2000, the largest changes to have happened in North Sea fisheries have involved an overall reduction in trawl effort and changes in the mesh sizes in use, due to a combination of decommissioning and days-at-sea regulations. In particular 100-119mm meshes have now virtually disappeared, and instead vessels are using either 120mm+ (in the directed whitefish fishery) or 80-99mm (primarily in the *Nephrops* fisheries and in a variety of mixed fisheries). The use of other mesh sizes largely occurs in the adjacent areas, with the 70-79mm gear being used in the Eastern Channel/Southern North Sea Whiting fishery, and the majority of the landings by 90-99mm trawlers coming from the Skagerrak. Higher discards are associated with these smaller mesh trawl fisheries, but even when these are taken into account, the directed roundfish fishery (trawls with ≥ 120mm mesh) still has the largest impact of any single fleet on the cod stock, followed by the mixed demersal fishery (90-99mm trawls) in the Skagerrak.

1. Technical Conservation Measures

The present technical regulations for EU waters came into force on 1 January 2000 (EC 850/98 and its amendments). The regulations prescribe the minimum target species' composition for different mesh size ranges. Additional measures were introduced in Community waters from 1 January 2002 (EC 2056/2001).

In 2001, the European Commission implemented an emergency closure of a large area of the North Sea from 14 February to 30 April (EC 259/2001). An EU-Norway expert group in 2003 concluded that the emergency closure had an insignificant effect upon the spawning potential for cod in 2001. There were several reasons for the lack of impact. The redistribution of the fishery, especially along the edges of the box, coupled to the increases in proportional landings from January and February appear to have been able to negate the potential benefits of the box. The conclusion from this study was that the box would have to be extended in both space and time to be more effective. This emergency measure has not been adopted after 2001. A cod protection area was implemented in 2004 (EC 2287/2003 and its amendments), which defined conditions under which certain stocks, including haddock, could be caught in Community waters, but this was only in force in 2004.

Apart from the technical measures set by the Commission, additional unilateral measures are in force in the UK, Denmark and Belgium. The EU minimum landing size (mls) is 35cm, but Belgium operate a 40cm mls, while Denmark operate a 35cm mls in the North Sea and 30cm in the Skagerrak. Additional measures in the UK relate to the use of square mesh panels and multiple rigs, restrictions on twine size in both whitefish and *Nephrops* gears, limits on extension length for whitefish gear, and a ban on lifting bags. In 2001, vessels fishing in the Norwegian sector of the North Sea had to comply with Norwegian regulations setting the minimum mesh size at 120mm. Since 2003, the basic minimum mesh size for towed gears targeting cod is 120mm.

Effort regulations in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2008 compared to 2007 (2006 is included for comparison). The changes (2007-2008) were intended to generate a cut in effort of 10% for the main gears catching cod.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see EC 40/2008 for more details). The table only shows changes in 2008 compared to 2007, but 2006 is also included for comparison.

Description of gear and special condition (if applicable)	Area			Max days at sea		
	IV,II	Skag	VIId	2006	2007	2008**
Trawls or Danish seines with mesh size ≥120mm	x	x	x	103	96	86
Trawls or Danish seines with mesh size ≥100mm and < 120mm	x	x	x	103	95	86
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm	x		x	227	209	188
Trawls or Danish seines with mesh size ≥90mm and < 100mm		x		103	95	86
Trawls or Danish seines with mesh size ≥70mm and < 90mm	x			227	204	184
Trawls or Danish seines with mesh size ≥70mm and < 90mm			x	227	221	199
Beam trawls with mesh size ≥120mm	x	x		143	143	129
Beam trawls with mesh size ≥100mm and < 120mm	x	x		143	143	129
Beam trawls with mesh size ≥80mm and < 90mm	x	x		143	132	119
Gillnets and entangling nets with mesh sizes ≥ 150mm and < 220mm	x	x	x	140	130	117
Gillnets and entangling nets with mesh sizes ≥ 110mm and < 150mm	x	x	x	140	140	126
Trammel nets with mesh size < 110mm. The vessel shall be absent from port no more than 24h.	x		x	205	205	185*

* For member states whose quotas less than 5% of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205

** If member states opt for an overall kilowatt-days regime, then the maximum number of days at sea per vessel could be different to that set out for 2008 (see text below and EC 40/2008 for details).

Additional provisions were introduced for 2008 (points 8.5-7, Annex IIa, EC 40/2008) to provide Member States greater flexibility in managing their fleets, in order to encourage a more efficient use of fishing opportunities and stimulate fishing practices that lead to reduced discards and lower fishing mortality of both juvenile and adult fish. This measure allowed a Member State that fulfilled the requirements laid out in EC 40/2008 to manage a fleet (i.e. group of vessels with a specific combination of geographical area, grouping of fishing gear and special condition) to an overall kilowatt-days limit for that fleet, instead of managing each individual vessel in the fleet to its own days-at-sea limit. The overall kilowatt-days limit for a fleet is initially calculated as the sum of all individual fishing efforts for vessels in that fleet, where an individual fishing effort is the product of the number of days-at-sea and engine power for the vessel concerned. This provision allowed Member States to draw up fishing plans in collaboration with the Fishing Industry, which could, for example, specify a target to reduce cod discards to below 10% of the cod catch, allow real-time closures for juveniles and spawners, implement cod avoidance measures, trial new selective devices, etc.

Incentives of up to 12 additional days at sea per vessel were in place for 2008 to encourage vessels to sign up to a Discard Reduction Plan (points 12.9-10, Annex IIa, EC 40/2008). The plan focused on discarding of cod or other species with discard problems for which a management/recovery plan is adopted, and was to include measures to avoid juvenile and spawning fish, to trial and implement technical measures for improving selectivity, to increase observer coverage, and to provide data for monitoring outcomes. For vessels participating in a Cod Avoidance Reference Fleet Programme in 2008 (points 12.11-14, Annex IIa, EC 40/2008), a further 10-12 additional days at sea was possible (over and above that for the Discard Reduction Plan). Vessels participating in this program were to meet a specific target to reduce cod discards to below 10% of cod catches, and be subject to observer coverage of at least 10%.

Under the provisions laid down in point 8.5 of Annex IIa (EC 40/2008), Scotland implemented a national kilowatt-days scheme known as the 'Conservation Credits Scheme'. The principle of this two-part scheme involved credits (in terms of additional time at sea) in return for the adoption of and adherence to measures that reduce mortality on cod and lead to a reduction in discard numbers. The initial, basic scheme was implemented from the beginning of February 2008 and essentially granted vessels their 2007 allocation of days (operated as hours at sea) in return for: observance of Real Time Closures (RTC), observance of a one net rule, adoption of more selective gears (110mm square meshed panels in 80mm gears or 90mm square meshed panels in 95mm gear), agreeing to participate in additional gear trials, and participation in an enhanced observer scheme.

For the first part of 2008, the RTC system was designed to protect aggregations of larger, spawning cod (>50cm length). Commercial catch rates of cod observed on board vessels was used to inform trigger levels leading to closures. Ten closures occurred to the beginning of May and protection agency monitoring suggested good observance. The scheme was extended for the remainder of the year to protect aggregations of all sizes of cod. A joint industry/science partnership (SISP) had a number of gear trials programmed for 2008 examining methods to improve selectivity and reduce discards, and an enhanced observer scheme was announced by the Scottish Government.

Observance of the above conditions also gave eligibility for vessels to participate in the second, enhanced, part of the Conservation Credits scheme.

2. Changes in fleet dynamics

The introduction of the one-net rule as part of the Scottish Conservation Credit Scheme and new Scottish legislation implemented in January 2008 were both likely to improve the accuracy of reporting of Scottish landings to the correct mesh size range, although some sectors of the Scottish industry have been granted derogations to continue carrying two nets (seiners until the end of January 2009, and others until the end of April 2008). The concerted effort to reduce cod mortality, through implementation of the Conservation Credit Scheme from February 2008, could have lead to greater effort being exerted on haddock, whiting, monk, flatfish and *Nephrops*.

Shifts in the UK fleet in 2007/8 included: (a) a move of Scottish vessels using 100-110mm for whitefish on west coast ground (sub-area VI) to the North Sea using 80mm prawn codends (motivated by fuel costs, and could increase effort on North Sea stocks; the simultaneous requirement to use 110 square mesh panels may mitigate unwanted selectivity implications – see below); (b) a move away from the Farne Deeps *Nephrops* fishery into other fisheries for whitefish because of poor *Nephrops* catch rates (implying increased effort in whitefish fisheries); and (c) a move of Scottish vessels from twin trawls to single rig, and increased use of pair trawls, seines and double bag trawls (motivated by fuel costs). For 2008 in the Scottish fleet, all twin-rig gear in the 80-99mm category have to use a 110mm square mesh panel, but this also applied to single-rig gears from July 2008 onwards, which was likely to have improved whitefish selection. A large number of 110mm square mesh panels have been bought by Scottish fishers at the beginning of 2008 in order to qualify for the Conservation Credit Scheme, which dramatically improved the uptake of selective gear. The ban on the use of multi-rigs in Scotland, implemented in January 2008, may have limited the potential for an uncontrolled increase in effective effort.

The Dutch fleet was reduced, through decommissioning, by 23 vessels from the beginning of 2008, while 5 Belgian beam trawlers (approximately 5% of the Belgian fleet) left the fishery in 2007, both changes implying reductions in effort in the beam trawl sector. The introduction of an ITQ regulation system in Denmark in 2007 might have influenced the effort distribution over the year, but this should not have affected the total Danish effort deployed or the size distribution of catches.

Dutch beam trawlers have gradually shifted to other techniques such as twin trawling, outrigging and fly-shooting, as well as opting for smaller, multi-purpose vessels, implying a shift in effort away from flatfish to other sectors. These changes were likely caused by TAC limitations on plaice and sole, and rising fuel costs. Belgian and UK vessels have also experimented with outrigger trawls as an alternative to beam trawling, motivated by more fuel efficient and environmentally friendly fishing methods.

The increased effort costs in the Kattegat (2.5 days at sea per effort day deployed) in 2008 has led to a shift in effort by Swedish vessels to the Skagerrak and Baltic Sea. There has also been an increase in the number of Swedish *Nephrops* vessels in recent years, attributed to the input of new capital transferred from pelagic fleets following the introduction of an ITQ-system for pelagic species, and leading to further increases in effort. The Swedish trawler fleet operating in IIIa has had a steady increase in the uptake of the *Nephrops* grid since the introduction of legislation in 2004 (use of the grid is mandatory in coastal waters), and given the strong incentives to use the grid (unlimited days at sea). Uptake of the *Nephrops* grid should have resulted in improved selection.

A squid fishery in the Moray Firth has continued to develop using very unselective 40mm mesh when squid species are available on the grounds. Although the uptake was poor in 2007 due to the lack of squid, the potential for high bycatches of young gadoids in future, including those of cod and haddock, remains. This fishery may provide an alternative outlet for the Scottish *Nephrops* fleet seasonally, and hence reduce effort in the *Nephrops* sector.

A.3. Ecosystem aspects

Cod are predated upon by a variety of species through their life history. The Working Group on Multi-species Assessment Methods (ICES-WGSAM 2008) estimated predation mortalities using SMS (Stochastic Multi Species Model) with diet information largely derived from the Years of the Stomach databases (stomachs sampled in the years 1981-1991). Long-term trends have been observed in several partial predation mortalities with significant increases for grey gurnard preying on 0-group cod. In contrast, predation mortalities on age 1 and age 2 cod decreased over the last 30 years due to lower cannibalism. Predation on older cod (age 3-6) increased due to increasing numbers of grey seals in the North Sea. .

SMS identified grey gurnard as a significant predator of 0-group cod. The abundance of grey gurnard (as monitored by IBTS) is estimated to have increased in recent years resulting in a rise in estimated predation mortality from 1.08 to 1.76 between 1991 and 2003. A degree of caution is required with these estimates as they assume that the spatial overlap and stomach contents of the species has remained unchanged since 1991. Given the change in abundance of both species this assumption is unlikely to hold and new diet information is required before 0-group predation mortalities can be relied upon.

Several other predators contribute to predation mortality upon 0-group cod, whiting and seabirds being the next largest components.

The consumption of cod in the North Sea in 2002 by grey seals (*Halichoerus grypus*) has recently been estimated (Hammond and Grellier 2006). For the North Sea it was estimated that in 1985 grey seals consumed 4150 tonnes of cod (95% confidence intervals: 2484-5760 tonnes), and in 2002 the population tripled in size (21-68 000) and consumed 8344 tonnes (95% confidence intervals: 5028-14941 tonnes). These consumption estimates were compared to the Total Stock Biomass (TSB) for cod of 475 000 tonnes and 225 000 tonnes for 1985 and 2002 respectively. The mean length of cod in the seal diet was estimated as 37.1 cm and 35.4 cm in 1985 and 2002 respectively. It should be noted, however, that seal diet analysis must be treated with a degree of caution because of the uncertainties related to modelling complex processes (e.g. using scat analysis to estimate diet composition involves complex parameters, and can overestimate species with more robust hard parts), and the uncertainties related to estimating seal population size from pup production estimates (involving assumptions about the form of density-dependent dynamics). The analysis may also be subject to bias because scat data from haul-out sites may reflect the composition of prey close to the sites rather than further offshore.

The effect of seal predation on cod mortality rates has been estimated for the North Sea within a multi-species assessment model (MSVPA), which was last run in 2007 during the EU project BECAUSE (contract number SSP8-CT-2003-502482) using revised estimates of seal consumption rates . The grey seal population size was obtained from WGMME (ICES-WGMME 2005) and was assumed to be 68,000 in 2002 and 2003 respectively. Estimates of cod consumption were 9657 tonnes in 2002 and 5124 tonnes in 2003, which is similar to the values estimated by Hammond and Grellier (2006). Sensitivity analysis of the North Sea cod stock assessment estimates to the inclusion of the revised multi-species mortality rates were carried out at the 2009 meeting of the WKROUND. Inclusion of the multi-species mortality rates for older ages of cod had a relatively minor effect on the high levels of estimated fishing mortality rates and low levels of spawning stock biomass abundance. This suggests that the estimates of seal predation will not alter the current perception of North Sea cod stock dynamics (also stated by STECF-SGRST-07-01).

A recent meeting (2007) of the STECF reviewed the broad scale environmental changes in the north-eastern Atlantic that has influenced all areas under the cod recovery plan (STECF-SGRST-07-01), and concluded that:

- Warming has occurred in all areas of the NW European shelf seas, and is predicted to continue.
- A regime shift in the North Sea ecosystem occurred in the mid-1980s.
- These ecological changes have, in addition to the decline in spawning stock size, negatively affected cod recruitment in all areas.
- Biological parameters and reference points are dependent on the time-period over which they are estimated. For example, for North Sea cod FMSY, MSY and BMSY are lower when calculated for the recent warm period (after 1988) compared to values derived for the earlier cooler period.
- The decline in FMSY, MSY and BMSY can be expected to continue due to the predicted warming, and possible future change should be accounted for in stock assessment and management regimes.
- Modelling shows that under a changing climate, reference points based on fishing mortality are more robust to uncertainty than those based on biomass.
- Despite poor recruitment, modelling suggests that cod recovery is possible, but ecological change may affect the rate of recovery, and the magnitude of achievable stock sizes.
- Recovery of cod populations may have implications to their prey species, including *Nephrops*.

With the exception of the general effects noted above, the overall conclusion from the STECF meeting (STECF-SGRST-07-01) for the North Sea was that there is no specific significant environmental or ecosystem change in the Skagerrak, North Sea and eastern Channel (e.g. the effects of gravel extraction, etc.) affecting potential cod recovery. The conclusions from the STECF meeting merit further discussion within ICES, which is ongoing (e.g. ICES-WKREF 2007).

B. Data

B.1. Commercial catch

The WG estimate for landings from the three areas (IV, IIIa-Skagerrak and VIId) in 2006 and 2007 were based on annual data, as opposed to quarterly data prior to 2006, because of ongoing difficulties with international data aggregation procedures, particularly with regard to discard raising.

France, Belgium and Sweden, who respectively landed 9%, 5% and 2% of all cod for combined area IV and VIId, do not provide discard estimates for this combined area. Similarly, Belgium and Germany, who each land 2% of all cod in area IIIa, do not provide discard estimates for this area. Norwegian discarding is illegal, so although this nation landed 14% and 6% of all cod in combined area IV and VIId, and area IIIa respectively, it does not provide discard estimates. Although the Netherlands (7% of all cod landed in IV and VIId, 1% in IIIa) does provide discard data for area IV, these are based on very low sample sizes for cod, and are therefore not reliable enough to be raised to fleet level. All percentages quoted in this paragraph refer to landings in 2007.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age for years prior to 2006. For 2006, Denmark was excluded from this calculation as they provided their own discard estimates. For 2007, Scottish, Danish, German and England & Wales discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in sub-area IV to account for missing discards. Discard numbers-at-age for IIIa-Skagerrak were based on observer sampling estimates. For 2006 and 2007, Danish and Swedish discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in Division IIIa-Skagerrak to account for missing discards. Although in some cases other nations' discard proportions were available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset.

For cod in IV, IIIa-Skagerrak and VIId, ICES first raised concerns about the mis-reporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG believes that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for 1998 were adjusted to include an estimated 3000t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no *a priori* reason to believe that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicated that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, it has no alternative than to use its best estimates of landings, which in general are in line with the officially reported landings. An attempt is made to incorporate a statistical correction to the sum of reported landings and discards data in the assessment of this stock. Buyers and Sellers legislation introduced in the UK towards the end of 2005 is expected to have improved the accuracy of reported cod landings for the UK. This has brought the UK in line with existing EU legislation.

1 Age compositions

Age compositions are currently provided by Denmark, England, Germany, the Netherlands, Scotland and Sweden.

Landings in numbers at age for age groups 1-11+ and 1963-present form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in Sub-area IV and separately for the Skagerrak.

During the five years 2003-2007, an average of 82% (84% in 2007) of the international landings in number were accounted for by juvenile cod aged 1-3. In 2007, age 1 cod comprised 32% of the total catch by number, and age 2 (the 2005 year class), 55%.

Estimated total numbers discarded have varied between 35 and 55% of the total catch numbers since 1995, but have shown an increase to above 70% in 2006 and 2007, due to the stronger 2005 year class entering the fishery (estimated to be almost the size of the 1999 year class), and a mismatch between the TAC and effort. Historically, the proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. For 2004-2007, it is estimated to be at around 90%. At ages 2 and 3 discard proportions have been increasing steadily and are currently estimated to be 75% and 38% respectively in 2007. Note that these observations refer to numbers discarded, not weight.

2 Data exploration

Data exploration for commercial catch data for North Sea cod currently involves:

(a) expressing the total catch-at-age matrix as proportions-at-age, normalised over time, so that year classes making above-average contributions to the catches are shown as large positive residuals (and vice-versa for below-average contributions);

(b) applying a separable VPA model in order to examine the structure of the catch 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;

(c) performing log-catch-curve analyses to examine data consistency, fishery selectivity and mortality trends over time – the negative slope of a regression fitted to ages down a cohort (e.g. ages 2-4) can be used as a proxy for total mortality.

B.2. Biological Information

1 Weight at age

Mean catch weight-at-age is a catch-number weighted average of individual catch weight-at-age, available by country, area and type (i.e. landings and discards). For ages 1-9 there have been short-term trends in mean weight at age throughout the time series with a decline over the recent decade at ages 3-5 that recently seems to have been reversed. The data also indicate a slight downward trend in mean weight for ages 3-6 during the 1980s and 1990s. Ages 1 and 2 show little absolute variation over the long-term.

Using weight-at-age from annual ICES assessments and International Bottom Trawl Surveys, Cook *et al*. (1999) developed a model that explained weight-at-age in terms of a von Bertalanffy growth curve and a year-class effect. They found that the year-class effect was correlated with total and spawning stock biomass, indicating density-dependent growth, possibly through competition. Further evidence for density-dependent growth had previously been found by others (Houghton and Flatman 1981, Macer 1983 and Alphen and Heessen 1984), although they pointed to different mechanisms (Rijnsdorp *et al*. 1991, ICES 2005). Results from Macer (1983) imply that juvenile cod compete strongly with adults, while the data from Alphen and Heessen (1984) suggest strong within-year-class competition during the first three years of life.

Growth rate can be linked to temperature and prey availability (Hughes and Grand 2000, Blanchard *et al*. 2005). Growth parameters of North Sea cod given in ICES (1994) demonstrate that cod in the southern North Sea grow faster than those in the north, but reach a smaller maximum length (Oosthuizen and Daan 1974, ICES 2005). Furthermore, older and larger cod have lower optimal temperatures for growth (Björnsson and Steinarsson 2002), and distributions of cod are known to depend on the local depth and temperature (Ottersen *et al*. 1998, Swain 1999, Blanchard *et al*. 2005)

Differences in mean length by age and sex can also be found for mature vs. immature cod (ICES 2005). For example, Hislop (1984) found that within an age group, mature cod of each sex are, on average, larger than immature cod.

2 Maturity and natural mortality

Values for natural mortality are assumed to be variable in time. The natural mortality values are model estimates from multi-species models (SMS and 4M) fitted by the Working Group on Multi Species Assessment Methods (ICES-WGSAM 2008, see Table XXX.1).

The maturity values are applied to all years and are left unchanged from year to year. They were estimated using the International Bottom trawl Survey series for 1981-1985. These values were derived for the North Sea.

Age group	Proportion mature
1	0.01
2	0.05
3	0.23
4	0.62
5	0.86
6	1.0
7+	1.0

Relative fecundity appears to have changed over time, with values in the late 1980s being approximately 20% higher than those in the early 1970s, an increase that coincided with a 4-fold decline in spawning stock biomass (Rijnsdorp *et al*. 1991, ICES 2005).

In an analysis of International Bottom Trawl Survey maturity data, Cook *et al*. (1999) found that proportion of fish mature at age is a function of both weight and age. They used a descriptive model based on both age and weight to reconstruct the historical series of maturity ogives where no observations existed, and calculated new spawning stock sizes that could be compared to those estimated by the conventional assessment. They found that, although accounting for changes in growth and maturity for North Sea cod altered the scale of SSB values, it did not make substantial changes to trajectories over time, and did not substantially alter the estimates of sustainable exploitation rates for the stock.

3 Recruitment

Recruitment has been linked not only to SSB, but also to temperature (Dickson and Brander 1993, Myers *et al*. 1995, Planque and Fredou 1999, O'Brien *et al*. 2000) plankton production timing and mean prey size (Beaugrand *et al*. 2003), and the NAO (Brander and Mohn 2004, ICES 2005).

B.3. Surveys

Four survey series are available for this assessment:

- English third-quarter groundfish survey (EngGFS), ages 0-7, which covers the whole of the North Sea in August-September each year to about 200m depth using a fixed station design of 75 standard tows. The survey was conducted using the Granton trawl from 1977-1991 and with the GOV trawl from 1992-present. Only ages 1–6 should be used for calibration, as catch rates for older ages are very low.

- Scottish third-quarter groundfish survey (ScoGFS): ages 1–8. This survey covers the period 1982–present. This survey is undertaken during August each year using a fixed station design and the GOV trawl. Coverage was restricted to the northern part of the North Sea until 1998, corresponding to only the northernmost distribution of cod in the North Sea. Since 1999, it has been extended into the central North Sea and made use of a new vessel and gear. Only ages 1–6 should be used for calibration, as catch rates for older ages are very low.
- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–present (usually data are available up to the year of the assessment for this survey, whereas it is only available up to the year prior to the assessment year for the other surveys). This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.
- Quarter 3 international bottom-trawl survey (IBTSQ3): ages 0–6+, covering the period 1991–present. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl. The Scottish and English third quarter surveys described above contribute to this index.

The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 and 2005 year classes are clearly apparent from maps of the IBTS distribution of cod (ages 1-3+). However, fish of older ages have continued to decline due to the very weak 2000, 2002 and 2004 year-classes. The abundance of 3+ fish is at a low level in recent years.

An analysis of the third quarter Scottish and English survey data by Parker-Humphries and Darby (WD 24 in ICES-WGNSSK 2006) showed that the extremely high catch rates estimated for ages 2-4 in a single station in the third quarter Scottish survey in 2004 resulted in the estimation of a strong reduction in mortality in 2004 followed by high mortality in 2005. When the station with high catch rates was removed, total mortality was then consistent with values obtained in previous years. The WG agreed that it would be *ad hoc* and statistically inappropriate to remove the station from the calculation of the Scottish index. After reviewing the information available on survey catch rates and spatial distribution, the WG decided to discontinue the use of the English and Scottish surveys on their own in the cod assessment because of the current low catch rates recorded by these surveys and the potential for noise at the oldest ages due to low sampling levels. Instead, the WG decided to use the IBTSQ3 survey, which incorporates both the Scottish and English surveys, together with the IBTSQ1 survey.

An analysis of IBTSQ1 data by Rindorf and Vinther (WD 4 in ICES-WGNSSK 2007) illustrated the increased importance of recruitment from the Skagerrak. Up until 2008 (ICES-WGNSSK 2008) the survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. More of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices, in order to produce an unbiased abundance index for the management unit (IV, IIIa-Skagerrak and VIId) of cod. Furthermore, the Skagerrak is almost entirely covered by a single vessel in both the IBTSQ1 and Q3 surveys. This is not advantageous as it does not allow for a comparison of cod catchability between vessels, which is essential for comparison of catch rates between roundfish areas. In the North Sea, each rectangle is covered by at least 2 nations to reduce bias in indices.

WKROUND (2009) compared the standard and extended IBTS index for ages 1-5 for IBTSQ1 and 1-4 for IBTSQ3 with an extended are index. The largest changes in abundance were observed at the younger ages, particularly for age 0 in IBTSQ3 (not used in the assessment). Residual plots indicated a slight improvement in fit for the extended indices run compared to the standard indices run. Given the improved fit for the extended indices and other benefits of using these indices (such as better coverage of the stock distribution area) the group recommended that it would be beneficial for North Sea cod to use the extended indices in future assessments.

1 Data exploration

Data exploration for survey data for North Sea cod currently involves:

(a) expressing the survey abundance indices (IBTSQ1 and IBTSQ3) in log-mean standardised form, both by year and cohort, to investigate whether there are any year effects, and the extent to which the surveys are able to track cohort signals;

(b) performing log-catch-curve analyses on the abundance indices to examine data consistency and mortality trends over time – the negative slope of a regression fitted to ages down a cohort (e.g. ages 2-4) can be used as a proxy for total mortality;

(c) performing within-survey consistency plots (correlation plots of a cohort at a given age against the same cohort one or more years later) to investigate self-consistency of a survey;

(d) performing between-survey consistency plots (correlation plots of a given age for IBTSQ1 against the same age for IBTSQ3) to investigate the consistency between surveys;

(e) applying a SURBA analysis to the survey data for comparison with models that include fishery-dependent data.

B.4. Commercial CPUE

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the method of recording data means that individual trip data are now more accessible than before; however, the recording of fishing effort as hours fished has become less reliable because it is not a mandatory field in the logbook data. Consequently, the effort data, as hours fished, are not considered to be representative of the fishing effort actually deployed.

The WG has previously argued that, although they are in general agreement with the survey information, commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK 2001), and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006, 2007). Therefore, although the commercial fleet series are available, only survey and commercial landings and discard information are analysed within the assessment presented.

B.5. Other relevant data

The annual North Sea Fishers' Survey presents fishers' perceptions of the state of several species including cod; the survey covers the years 2003-2008, (Laurenson, 2008). In addition, a number of collaborative research projects are reported to the WGNSSK each year. To date the studies providing time series of quantitative information have been relatively local, whereas those with wider coverage have been qualitative. The studies have therefore been used to corroborate assessment results and highlight differences in perception. The studies have proven useful in examining the dynamics of sub-stocks within the North Sea, for instance local recruitment, and thereby in the provision of advice to managers.

C. Historical Stock Development

1 Available stock assessment models

There are currently two models that could be used to provide an assessment of North Sea cod, namely B-Adapt and SAM. Both models estimate an annual catch multiplier, which appears to be necessary for any assessment of this stock (ICES-WGNSSK 2008). B-Adapt is currently used as a basis for ICES advice for North Sea cod (ICES-WGNSSK 2008). Further details about B-ADAPT can be found in Darby (WD15 in ICES-WGNSSK 2004), and about SAM in ICES-WKROUND (2009) Annex 5, which discusses general aspects and in Nielsen (WD14 in ICES-WKROUND 2009). A comparison of these two methods appears in ICES-WGNSSK (2008).

2 Model used as a basis for advice

The North Sea cod assessment is based on B-ADAPT (Darby, WD15 in ICES-WGNSSK 2004), a variation of ADAPT-VPA (Gavaris 1988), developed specifically to handle the problem of mis-reported catch (ICES-WGNSSK 2008). B-ADAPT corrects for retrospective bias by estimating the quantity of additional "unallocated removals" that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The model therefore uses survey information to estimate additional mortality not represented by recorded landings, estimated discards and the assumed levels of natural mortality.

Model used: B-ADAPT

Software used: ADAPT_16_04_07.exe

Model Options chosen:

Settings used at the 2008 WGNSSK meeting (ICES-WGNSSK 2008):

[Note "→" on a new numbered line with no text indicates pressing the return button with NO input (i.e. accepting the default). Thus in the second line below, "→ → →" implies accepting the default three consecutive times. Furthermore an asterisk "*" next to an input indicates that that input will change from year to year, accounting for an additional year of data, or an appropriate assumption about the intermediate-year F-multiplier.]

1. Please input [path]name of stock index file → cod347.idx
2. → → →
3. Please give last age: <default=15> → 7
4. →
5. Your choice? <default=1> → 2
6. → →
7. Please give lower age limit for the mean: <default=3> → 2
8. →

[Central Menu appears]

9. Please select one of the options → 3
10. →
11. Enter report name (LPT1 for line printer) → codrep.csv
12. →
13. Do you wish to use the survey data for the year after the final catch at age year? Y/<N> → Y
14. F multiplier <1.0> → 0.9*
15. Exact VPA (V) or Cohort analysis <C> → V
16. Fleet 1

First age of constant catchability (Fleet range: 1-4) <Default: 3> → 1

Age for the catchability plateau (Fleet range: 1-4) <Default: 4> → 5

17. Fleet 2

First age of constant catchability (Fleet range: 0-3) <Default: 3> → 1

Age for the catchability plateau (Fleet range: 0-3) <Default: 4> → 3

18. →
19. Estimate missing year catch multipliers? <N>/Y → Y
20. Enter the number of years for catch multiplier Maximum: 45 <Default 1> → 15*
21. → → → →
22. Use inverse variance weighting? <Y>/N → N
23. →
24. Constrain Catch? Y/<N> → Y
25. → →

[Program will run and Central Menu will re-appear. If bootstraps required, continue to 26, else go to next comment after 66.]

26. Please select one of the options: → 5
27. Please give [path]name of fleet effort and catch data file → cod347_2008.tun*
28. →

29-41. {Repeat 13-25}

42. Do you run predictions? Y/<N> → Y
43. First year with SSB: <default = 1964> → 1998
44. Last year <default = 2004> → 2007*
45. Model type:
    Shepherd - S
    Beverton Holt - B
    Ricker - R

```
    Geometric                    mean                     -                 G
    Bootstrap      - P → P

46. →

47.                           Prediction                              type:
    TAC           constraint                                  -          T
    F        multiplier                                          -       M
    Target      F                                                   -    F
    TAC            option              range              -             C
    F option range    - R → M

48. F multiplier → 0.9*

49-66. {Repeat 47-48 nine times}
```

[If requested, program runs bootstraps. Central Menu re-appears. Save output files.]

```
67. Please select one of the options: → 9

68. Please select required tables → 16

69. Enter report filename

    (LPT1 for line printer) → codout.csv
```

[End program]

```
70. Please select one of the options: → 0
```

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1963-present	-	Y
Canum	Catch at age in numbers	1963-present	1-7+	Y
Weca	Weight at age in the commercial catch	1963-present	1-7+	Y
West	Weight at age of the spawning stock at spawning time.	Weca used for West	Weca used for West	Weca used for West
Mprop	Proportion of natural mortality before spawning	1963-present	1-7+	N
Fprop	Proportion of fishing mortality before spawning	1963-present	1-7+-	N
Matprop	Proportion mature at age	1963-present	1-7+	N
Natmor	Natural mortality	1963-2007*	1-7+	Y

*Updated values for natural mortality will only be provided every 2 years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	IBTS-Q1	1983-final year of catch data + 1	1-5
Tuning fleet 2	IBTS-Q3	1991-final year of catch data	1-4

3 Recruitment estimation;

Estimation of recruitment relies on the age-structure in the catch and survey data, but stock-recruit parameters are not estimated internally in the B-Adapt assessment model. Furthermore, when performing short-term projections in order to evaluate future stock dynamics, estimates of recruitment are not based on a stock-recruit function, but instead are sampled from the year-classes 1997-most recently estimated year-class, reflecting recent low levels of recruitment, but including the stronger 1999 and 2005 year classes.

D. Short-Term Projection

Due to the uncertainty in the final year estimates of fishing mortality, the WG agrees that a standard (deterministic) short-term forecast is not appropriate for this stock. Therefore, stochastic projections are performed, from which short-term projections are extracted. The stochastic projections are carried out using each of 1000 non-parametric bootstrap iterations. These projections are an extension of the program that provides the final B-Adapt assessment, and therefore the assessment and stochastic projections are self-consistent.

Model used: B-ADAPT

Software used: ADAPT_16_04_07.exe

Initial stock size:

Starting populations taken from each bootstrap iteration.

Maturity:

Average of final three years of assessment data (constant for North Sea cod).

Natural mortality:

Average of final three years of assessment data.

F and M before spawning:

Both taken as zero.

Weight at age in the catch:

Average of final three years of assessment data.

Weight at age in the stock:

Same as weight at age in the catch.

Exploitation pattern:

Fishing mortalities taken as a three year average scaled to the final year.

Intermediate year assumptions:

Multiplier reflecting intended changes in effort (and therefore F) relative to the final year of the assessment

Stock recruitment model used:

Recruitment is re-sampled from the year classes 1997-most recently estimated year-class; for ICES-WGNSSK (2008), these comprised eight years with low recruitment and two with the slightly higher levels (1999 and 2005 year classes). This is a conservative estimate to account for the possibility that the low levels estimated in the last few years may continue.

Procedures used for splitting projected catches:

For the purposes of the forecast, the WG assumes that future removals due to fishing comprise only landings and discards. Landings and discards in the forecasts were estimated by applying the landings- and discard-at-age ratios for 2007 to total fishing mortality-at-age for the projection period.

E. Medium-Term Projections

Medium-term projections are not carried out for this stock.

F. Long-Term Projections

Long-term projections are not carried out for this stock.

G. Biological Reference Points

The Precautionary Approach reference points for cod in IV, IIIa (Skagerrak) and VIId have been unchanged since 1998. They are:

	Type	Value	Technical basis
Precautionary approach	B_{lim}	70 000 t	B_{loss} (~1995)
	B_{pa}	150 000 t	B_{pa} = Previous MBAL and signs of impaired recruitment below 150 000 t.
	F_{lim}	0.86	F_{lim} = F_{loss} (~1995)
	F_{pa}	0.65	F_{pa} = Approx. 5th percentile of F_{loss}, implying an equilibrium biomass > B_{pa}.
Targets	F_y	0.4	EU/Norway agreement December 2009

Unchanged since 1998

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 2-4	Yield/R	SSB/R
F_{max}	0.25	0.69	2.1
$F_{0.1}$	0.16	0.69	3.2
F_{med}	0.81	0.51	0.3

Estimated by ICES in 2009, assuming constant maturity and variable M, with M and stock weights averaged over the period 2000-2007. Selectivity is averaged over 2005-2007, and scaled to 2007.

H. Other Issues

No other issues.

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Table XXX.1 Variable natural mortality (M) values for North Sea cod, based on multi-species considerations. The seal diet data were originally collated from information sampled over a period of years (ICES 1997). Data were then transformed to diet by age using age-length keys. Finally this set of data was allocated to one year (1985). Due to the stock structure of cod in this particular year, with a relatively low abundance of age 6, the M2 for this age becomes higher than for both younger and older cod. It is considered that, for assessment purposes, the M2 values for age 6 should be replaced by the M2 values for age 5, as reflected here.

	1	2	3	4	5	6	7+
1963	0.78	0.42	0.33	0.22	0.21	0.21	0.20
1964	0.82	0.43	0.34	0.22	0.21	0.21	0.20
1965	0.85	0.44	0.35	0.22	0.21	0.21	0.20
1966	0.87	0.45	0.36	0.22	0.21	0.21	0.20
1967	0.89	0.46	0.37	0.22	0.21	0.21	0.20
1968	0.91	0.46	0.37	0.22	0.21	0.21	0.20
1969	0.92	0.47	0.38	0.22	0.21	0.21	0.20
1970	0.92	0.47	0.38	0.22	0.21	0.21	0.20
1971	0.92	0.47	0.38	0.22	0.21	0.21	0.20
1972	0.93	0.47	0.38	0.22	0.21	0.21	0.20
1973	0.92	0.46	0.38	0.22	0.21	0.21	0.20
1974	0.92	0.46	0.37	0.22	0.21	0.21	0.20
1975	0.92	0.45	0.37	0.22	0.21	0.21	0.20
1976	0.92	0.45	0.37	0.22	0.21	0.21	0.20
1977	0.92	0.44	0.36	0.22	0.22	0.22	0.20
1978	0.92	0.43	0.36	0.23	0.22	0.22	0.20
1979	0.92	0.43	0.36	0.23	0.22	0.22	0.20
1980	0.91	0.42	0.36	0.23	0.22	0.22	0.20
1981	0.90	0.41	0.36	0.23	0.22	0.22	0.20
1982	0.89	0.41	0.36	0.23	0.22	0.22	0.20
1983	0.87	0.40	0.36	0.23	0.22	0.22	0.20
1984	0.85	0.39	0.36	0.23	0.22	0.22	0.20
1985	0.83	0.38	0.36	0.23	0.23	0.23	0.20
1986	0.81	0.38	0.36	0.23	0.23	0.23	0.20
1987	0.79	0.37	0.36	0.24	0.23	0.23	0.20
1988	0.77	0.36	0.37	0.24	0.23	0.23	0.20
1989	0.75	0.35	0.37	0.24	0.24	0.24	0.20
1990	0.73	0.35	0.38	0.24	0.24	0.24	0.20
1991	0.72	0.34	0.39	0.25	0.24	0.24	0.20
1992	0.70	0.34	0.40	0.25	0.25	0.25	0.20
1993	0.70	0.34	0.41	0.26	0.25	0.25	0.20
1994	0.69	0.33	0.42	0.26	0.25	0.25	0.20
1995	0.68	0.33	0.43	0.26	0.26	0.26	0.20
1996	0.67	0.32	0.44	0.27	0.26	0.26	0.20
1997	0.65	0.31	0.44	0.27	0.26	0.26	0.20
1998	0.63	0.31	0.45	0.27	0.27	0.27	0.20
1999	0.61	0.30	0.45	0.27	0.27	0.27	0.20
2000	0.58	0.29	0.44	0.27	0.27	0.27	0.20
2001	0.56	0.29	0.44	0.27	0.27	0.27	0.20
2002	0.53	0.28	0.43	0.27	0.27	0.27	0.20
2003	0.51	0.28	0.42	0.27	0.27	0.27	0.20
2004	0.50	0.27	0.41	0.27	0.27	0.27	0.20
2005	0.49	0.27	0.40	0.26	0.26	0.26	0.20
2006	0.47	0.27	0.39	0.26	0.26	0.26	0.20
2007	0.46	0.26	0.38	0.26	0.26	0.26	0.20

Stock annex: Haddock in Subarea IV and Division IIIa(N)

Stock specific documentation of the standard assessment procedures used by ICES.

Stock:	Haddock in Subarea IV and Division IIIa(N) (Skagerrak)
Working Group:	ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)
Date:	May 2009
Author:	Coby Needle

A. General

A.1. Stock definition

Haddock in Subarea IV and Division IIIa (N) occupy the northern and central North Sea and Skagerrak and are possibly linked to the Division VIa stock on the West of Scotland. Haddock are seldom found below 300 m, and prefer depths between 50 m and 200 m. They are found as juvenile fish in coastal areas in particular in the Moray Firth, around Orkney and Shetland, along the continental shelf at around 200 m and continuing round to the Skagerrak. Adult fish are predominantly found around Shetland and in the northern North Sea near the continental shelf edge.

A.2. Fishery

Most of the information presented below pertains to the Scottish demersal whitefish fleet, which takes the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland) and VIb (Rockall): it is also a multi-species fishery that lands a number of species other than haddock.

A.2.1. Management plans

In 1999 the EU and Norway "agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield." This plan was implemented in January 2005, updated in December 2006, and implemented in revised form in January 2007. It consists of the following elements:

1) *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass greater than 100,000 tonnes (Blim).*
2) *For 2007 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140,000 tonnes (Bpa).*
3) *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*

4) *Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to 0.3-0.2*(Bpa-SSB)/(Bpa-Blim). This consideration overrides paragraph 3.*

5) *Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.*

6) *In order to reduce discarding and to increase the spawning stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*

7) *In the event that ICES advices that changes are required to the precautionary reference points Bpa (140 000 t) or Blim (100 000 t) the parties shall meet to review paragraphs 1-5.*

8) *No later than 31 December 2009, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.*

In October 2007, ICES evaluated this plan and concluded that it could "*provisionally be accepted as precautionary and be used as the basis for advice*." The methods used to reach this conclusion (along with illustrative results) are given in Needle (2008). ICES considers that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as lower boundaries on SSB, and not as targets.

The plan was modified during 2008 to allow for limited interannual quota flexibility, following the meeting in June of the Norway-EC Working Group on Interannual Quota Flexibility and subsequent simulation analysis (Needle 2008).

Further technical conservation measures

EU technical regulations in force are contained in Council Regulation (EC) 850/98 and its amendments. This regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement running until 31 December 2002 vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm.

At the December Council 2006 (EC 41/2006), additional derogations were introduced to allow additional days fishing in the smaller mesh (90 mm) trawl fishery where vessels fitted a square mesh window close to the cod end to allow for improved selectivity of these gears (and hence the possibility of lower haddock discards). The change in mesh size was expected to shift exploitation patterns to older ages and increase the weight-at-age for retained fish from younger age classes. Improvements in the exploitation pattern were not immediately observed, however, and it was not possible to determine if this was due to confounding effects from other fleet segments.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2005 (EC 27/2005, Annex IV). Effort regulations for 2008 in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2008 compared to 2007 (2006 is included for comparison). The changes (2007-2008) are intended to lead to a cut in effort of 10% for the main gears catching cod.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see EC 40/2008 for more details). The table only shows changes in 2008 compared to 2007, but 2006 is also included for comparison.

Description of gear and special condition (if applicable)	Area			Max days at sea		
	IV,II	Skag	VIId	2006	2007	2008
Trawls or Danish seines with mesh size ≥120mm	x	x	x	103	96	86
Trawls or Danish seines with mesh size ≥100mm and < 120mm	x	x	x	103	95	86
Trawls or Danish seines with mesh size ≥90mm and < 100mm	x		x	227	209	188
Trawls or Danish seines with mesh size ≥90mm and < 100mm		x		103	95	86
Trawls or Danish seines with mesh size ≥70mm and < 90mm	x			227	204	184
Trawls or Danish seines with mesh size ≥70mm and < 90mm			x	227	221	199
Beam trawls with mesh size ≥120mm	x	x		143	143	129
Beam trawls with mesh size ≥100mm and < 120mm	x	x		143	143	129
Beam trawls with mesh size ≥80mm and < 90mm	x	x		143	132	119
Gillnets and entangling nets with mesh sizes ≥ 150mm and < 220mm	x	x	x	140	130	117
Gillnets and entangling nets with mesh sizes ≥ 110mm and < 150mm	x	x	x	140	140	126
Trammel nets with mesh size < 110mm. The vessel shall be absent from port no more than 24h.	x		x	205	205	185*

*** For member states whose quotas less than 5% of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205**

In early 2008, a one-net rule was introduced in Scotland as part of the new conservation credits scheme (Section 13.1.4). This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

Under the provisions laid down in point 8.5 of Annex IIa to the 2008 year's EU TAC and Quota Regulation, Scotland implemented in 2008 a national KWdays scheme known as the **Conservation Credits Scheme** (CCS). The principle of this two-part scheme involves credits (in terms of additional time at sea) in return for the adoption of and adherence to measures which reduce mortality on cod and lead to a reduction in discard numbers. The initial scheme was implemented from the beginning of February 2008 and granted vessels their 2007 allocation of days (operated as hours at sea) in return for observance of Real Time Closures (RTC) and a one-net rule, adoption of more selective gears (110mm square meshed panels in 80mm gears or 90mm SMP in 95mm gear), agreeing to participate in additional gear trials and participation in an enhanced observer scheme.

For the first part of 2008 the RTC system was designed to protect aggregations of larger, spawning cod (>50cm length). Trigger levels leading to closures were informed by commercial catch rates of cod observed by FRS on board vessels. During 2008, there were 15 such closures. Protection agency monitoring suggested good observance.

A joint industry/science partnership (SISP) undertook a number of gear trials in 2008 examining methods to improve selectivity and reduce discards and an enhanced observer scheme has been announced by the Scottish Government. Results and citation? Conservation credits and EU regs 2009.

Fleet changes and development

The number of Scottish-based vessels (over 10 m) in the demersal sector was reduced by approximately one third (98 vessels) during 2002, the bulk of this being due to vessels accepting decommissioning. Although the decommissioning scheme encompassed all vessel types and sizes, the vessels eventually decommissioned included a significant number of older boats and those with track record of catching cod. Amongst the remaining vessels there has been a reduction in the segment operating seine net or pair seine. The observed shift towards pair trawling from single-vessel seine and trawls in the early 2000’s may have implied an increase in catchability, but the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers, resulting in no real overall change in fleet composition.

The number of Scottish based vessels (over 10 m) in the demersal sector was reduced by 67 in a further decommissioning round in 2004. More recently, increased fuel prices have resulted in a shift from twin trawl to single trawl and pair seine/trawl by many boats in the Scottish demersal mixed fishery sector (ICES-WGFTFB 2006). The observed shift towards pair trawling from single seine may be explained by a standardization of reporting and recording of gear types. Vessels previously participating in the seine net class may have included vessels operating pair seine whereas this classification is now recorded as pair trawl.

In 2005, there was an expansion in the squid fishery in the Moray Firth area resulting from increased effort from smaller (<10m) vessels, and from a number of larger vessels that had switched from demersal fisheries for haddock and cod, to squid fisheries, in order to avoid days-at-sea restrictions (ICES-WGFTFB 2006). The mesh regulation for squid fishing is 40 mm codend, which could lead to bycatch/discard of young haddock and cod. In 2006 and 2007, the squid fishery declined: vessels that shifted away from squid targeted *Nephrops* instead. However, the potential remains for high bycatches of young gadoids in the future, given the small mesh size used.

During 2008, a number of Scottish vessels switched focus to the Rockall area to take advantage of the increased quota there. The economic benefit of being able to land more haddock outweighed the costs involved in steaming to Rockall in a climate of increased fuel prices. This fishery is very dependent on good weather, however, and is not a consistent feature. At the same time, several vessels switched from whitefish fishing in Division VIa to *Nephrops* exploitation in Subarea IV using 80-mm gear (ICES-WGFTFB 2008). This may have implications for haddock bycatch in the *Nephrops* fishery, although (under the stipulations of the Scottish conservations credits scheme; see above), nets in the 80mm range will had to have a 110mm square mesh panel installed from July 2008. Compliance was close to 100% during 2008. Trials suggested that this square-mesh panel increased the 50% selection length (L_{50}) for haddock by around 30%, which implied increased escapement of young haddock from the *Nephrops* fishery.

Also during 2008, a number of Scottish vessels moved from twin to single trawls, and there was also an increase in the use of pair trawl/seine. Some high-powered white-fish vessels switched to *Nephrops* and were targeting North Sea grounds with double bag trawls. This was very much driven by fuel costs, and may have had implications for reduced LPUE and increases in discarding.

Analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations (STECF-SGRST-05-01 & 04, 2005). The decrease in effort is most pronounced in the years 2002 and beyond.

Information presented to ICES in 2008 noted that the UK large mesh demersal trawl fleet category (>100 mm, 4A) has been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70–90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004. The effort of the combined trawl gears has shown a continued decrease of 36% overall, from the EU reference year of 2001 (STECF-SGRST-05-01 & 04, 2005).

A.3. Ecosystem aspects

The North Sea haddock stock is characterised by sporadically high recruitment leading to dominant year-classes in the fishery. These large year-classes may grow more slowly than less abundant year-classes, possibly due to density dependent effects. Haddock primarily prey on benthic and epibenthic invertebrates, sandeels and demersal herring egg deposits. They are an important prey species, mainly for saithe and other gadoids

B. Data

B.1. Commercial catch

Age compositions

To be written.

Data exploration

To be written.

B.2. Biological Information

Weight at age

To be written.

Maturity and natural mortality

To be written.

Recruitment

To be written.

B.3. Surveys

To be written.

Data exploration

To be written.

B.4. Commercial CPUE

B.5. Other relevant data

C. Historical stock development

Model used as a basis for advice

The advice is based on assessments carried out using the XSA model (Shepherd, Darby and Flatman) implemented as the FLXSA module of the FLR library (FLR) of the R statistical package.

Model Options chosen

XSA model settings used in the WGs from 2004 to 2007 were as follows:

Assessment year		2004	2005	2006	2007
q plateau		2	3	3	6
Tuning fleet year ranges	EngGFS Q3	92-03	77-91; 92-04	77-91; 92-05	77-91; 92-06
	ScoGFS Q3	82-03	82-97; 98-04	82-97; 98-05	82-97; 98-06
	IBTS Q1*	82-03	82-04	82-05	82-06
Tuning fleet age ranges	EngGFS Q3	0-5	0-5	0-5	0-7
	ScoGFS Q3	0-5	0-5	0-5	0-7
	IBTS Q1*	0-4	0-4	0-4	0-4

*Backshifted

The default update setting is that used in the 2007 WG, with the addition of extra years as required.

Input data types and characteristics:

Tuning data:

See table above.

Recruitment estimation

Recruits at age 0 are generated by FLXSA.

D. Short-term projection

Initial stock size

Deterministic starting populations taken from VPA survivors.

Maturity

Average of final three years of assessment data (constant for North Sea haddock).

Natural mortality

Average of final three years of assessment data (constant for North Sea haddock).

F and M before spawning

Both taken as zero.

Weight-at-age in the catch

The perceived slow growth of the above-average 1999 and 2000 year-classes pose a problem for the short-term forecast. Mean stock weights for these year classes were calculated using proportional increments. That is: growth from age *a* to *a*+1 for these year-classes was estimated using the mean proportional increment (*a*+1)/*a* calculated over all other year classes for which this information is available. This method was approved by RGNSSK in 2006 as being appropriate to project weights at age, although alternatives are being explored and the issue needs to be considered at a forthcoming benchmark. Mean stock weights for other ages (except the plus-group) in the forecast where taken as a 5-year average, omitting the 1999 and 2000 year classes from the calculation where appropriate. For the plus-group weights, an alternative XSA assessment was run using a plus-group at age 13. The abundances and fishing mortality estimates from this were then used as the basis for a simple deterministic 3-year forecast to give abundances from ages 0-13+ for the forecast years. These were then used in turn in weighted-average calculations to generate the required forecast mean weights for the plus-group at age 8.

The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average of the last five assessment years.

Weight-at-age in the stock

Same as weight-at-age in the catch.

Exploitation pattern

Fishing mortalities in the forecast are taken to be the same as in the final assessment year.

Intermediate year assumptions

Running the haddock forecast assuming status quo F in the intermediate year can lead to landings that are greater than the available quota. In recent years, a combination of low F, TAC constraints limiting the decline of quota, and market forces has meant that full uptake of the quota is unlikely. While it is difficult to predict the extent of the undershoot, it would certainly be an error to forecast an overshoot, and a TAC-constrained forecast is a compromise. If the status quo forecast indicates an undershoot of quota, then no TAC constraint is used.

Stock recruitment model used

North Sea haddock shows no detectable influence of stock size on subsequent recruitment. In addition, there are no observed indications of incoming year-class strength available to the WG. The ScoGFS and EngGFS Q3 survey indices are not yet available. The IBTS Q1 indices are available, but do not include age-0 recruiting fish as these are too small to be caught (or are not yet hatched) when the survey takes place. For this reason, recruitment estimates of the incoming year-class are based on a mean of previous recruitment.

In the past, a strong haddock year-class has generally been followed by a sequence of low recruitments. In order to take this feature into account, the geometric mean of the five lowest recruitment values over the period from 1994 to *y* – 3 (where *y* is the year of the assessment WG) has been assumed for recruitment in the years *y*, *y* + 1 and *y* + 2. Recruitment estimates for years *y* – 2 and *y* - 1 are not included in this calculation, because the most recent two XSA estimates of recruitment are thought to be relatively uncertain.

Procedures used for splitting projected catches

Three-year average of catch component ratios.

E. Medium-term projections

Medium-term projections, in the sense of biological simulations assuming fixed mortality, are no longer carried out for this stock on an annual basis. However, management simulations are regularly performed to evaluate management plan proposals, and these are similar in some ways to medium-term projections (see Section A2.1 above).

F. Long-term projections

Yield and spawning-stock-biomass per recruit analyses are carried out for this stock as part of the annual assessment process. The MFYPR software is used for this purpose.

G. Biological reference points

The Precautionary Approach reference points for cod in IV, IIIa (Skagerrak) and VIId have been unchanged since 2007. They are:

	Type	Value	Technical basis
Precautionary approach	B(lim)	100 000 tonnes	Smoothed B(loss)
	B(pa)	140 000 tonnes	B(pa) = 1.4 * B(lim) (*)
	F(lim)	1.0	F(lim) = 1.4 * F(pa) (*)
	F(pa)	0.7	10% probability that SSB(MT) < B(pa)
Targets	F(HCR)	0.3	Based on HCR simulations and agreed in the management plan

***The multiplier of 1.4 is derived from exp(σ^2), where σ^2 ~ 0.34 is intended to reflect the variability of the time-series concerned (B or F).**

Yield and spawning biomass per recruit reference points

Include summaries from recent MSY work.

H. Other issues

No other issues.

I. References

To be completed.

Stock Annex: WGNSSK – Norway pout

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Norway pout in the North Sea and Skagerrak (ICES Area IV and IIIa)
Working Group:	WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak
Date:	12.5.09

A. General

A.1. Stock definition

Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Lambert, Nielsen, Larsen and Sparholt, 2009).

It is distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea. The distribution for this stock is in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b; (Lambert, Nielsen, Larsen and Sparholt, 2009). Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway (Lambert, Nielsen, Larsen and Sparholt, 2009). Figures 1 and 2 show geographical distribution of the stock obtained from the ICES IBTS surveys. The IBTS Surveys only cover areas within the 200 m depth zone. However, very few Norway pout are caught at depths greater than 200 m in the North Sea and Skagerrak on shrimp trawl survey (Sparholt et al. 2002b). For the Norwegian Trench, Albert (1994) found Norway pout at depths greater than 200 m, but very few deeper than 300 m.

At present, there is no evidence for separating the North Sea component into smaller stock units (Lambert, Nielsen, Larsen and Sparholt (2009). Norway pout in the eastern Skagerrak is only to a very small degree a self-contained stock. The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). ICES ACFM (October 2001) asked the ICES WGNSSK to verify the justification of treating ICES Division VIa as a management area for Norway pout (and sandeel) separately from ICES areas IV and IIIa. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in a Working Document to the 2000 meeting of the ICES WGNSSK Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07), gave no evidence for a stock separation in the whole northern area. This conclusion is supported by the results in Lambert, Nielsen, Larsen and Sparholt (2009).

Spawning distribution: So far it has been evaluated that around 10 % of the Norway pout reach maturity already at age 1, and that most individuals reach maturity at age 2 on which the maturity ogive in the assessment has been based. Results in a recent paper (Lambert, Nielsen, Larsen and Sparholt (2009) indicate that the maturity rate for the 1-group is close to 20% on average (varying between years and sex) with an increasing tendency over the last 20 years. Furthermore, the average maturity rate for

2 and 3 groups in 1st quarter of the year was observed to be only around 90% and 95%, respectively, as compared to 100% used in the assessment. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Sparholt and Nielsen (2001), gave no evidence for a stock separation in the whole northern area. Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway in coastal waters (along the 120 m iso-cline) (Lambert, Nielsen, Larsen and Sparholt (2009).

Larvae and juvenile distribution: The species is not generally considered to have specific nursery grounds, but pelagic 0-group fish remain widely dispersed in the northern North Sea close to spawning grounds (Lambert, Nielsen, Larsen and Sparholt (2009). The main bulk drifts as larvae from more western areas to which they return mainly during the latter part of their second year of life before becoming mature (Poulsen 1968). The IBTS CPUE map (Figure 2) shows, however, a relative high CPUE in the Skagerrak area in the third quarter, where the 0-group dominates the catches.

Adult migration: There is an adult spawning migration out of Skagerrak and Kattegat as no spawning occurs in this area. Otherwise there is no indication of adult migration. Based on IBTS data, the main aggregations of settled fish are distributed around the 150 m contour, with a slight preference for deeper water for the older fish.

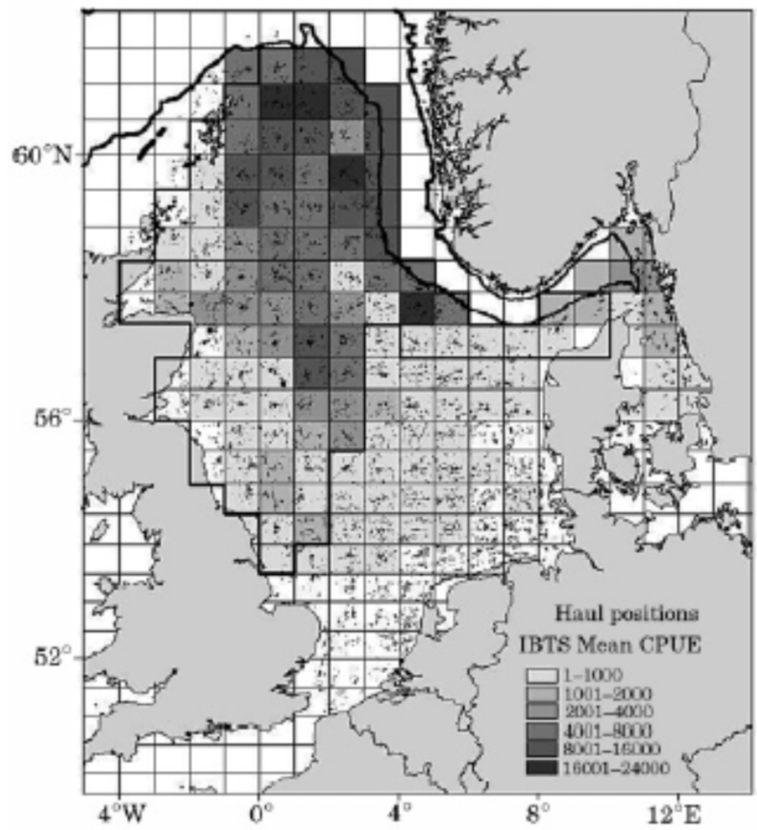


Figure 1 Positions fished at the International Bottom Trawl Survey (IBTS) first quarter and mean CPUE (numbers) of Norway pout by rectangle, 1981–1999. The standard area used to calculate abundance indices and the 200 m depth contour is also shown [from Sparholt et al., 2002b].

A.2. Fishery

The fishery is mainly carried out by Danish and Norwegian (large) vessels using small-mesh trawls in the north-western North Sea especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. Norway pout is caught in small meshed trawls (16-31 mm) in a mixed fishery with blue whiting, i.e. in addition to the directed Norway pout fishery, the species is also taken as by-catch in the blue whiting fishery. The fishery in more recent times is mainly carried out by Denmark (~70-80%) and Norway (~20-30%) at fishing grounds in the northern North Sea especially at Fladen Ground and along the edge of the Norwegian Trench. Norway pout is landed for reduction purposes (fish meal and fish oil). In recent years Denmark has performed the main Norway pout landings compared to Norway, while the long term average show more equal catches between the countries. There is a tendency towards the more recent Danish landings mainly originates from the Fladen Ground area compared to the Norwegian Trench area.

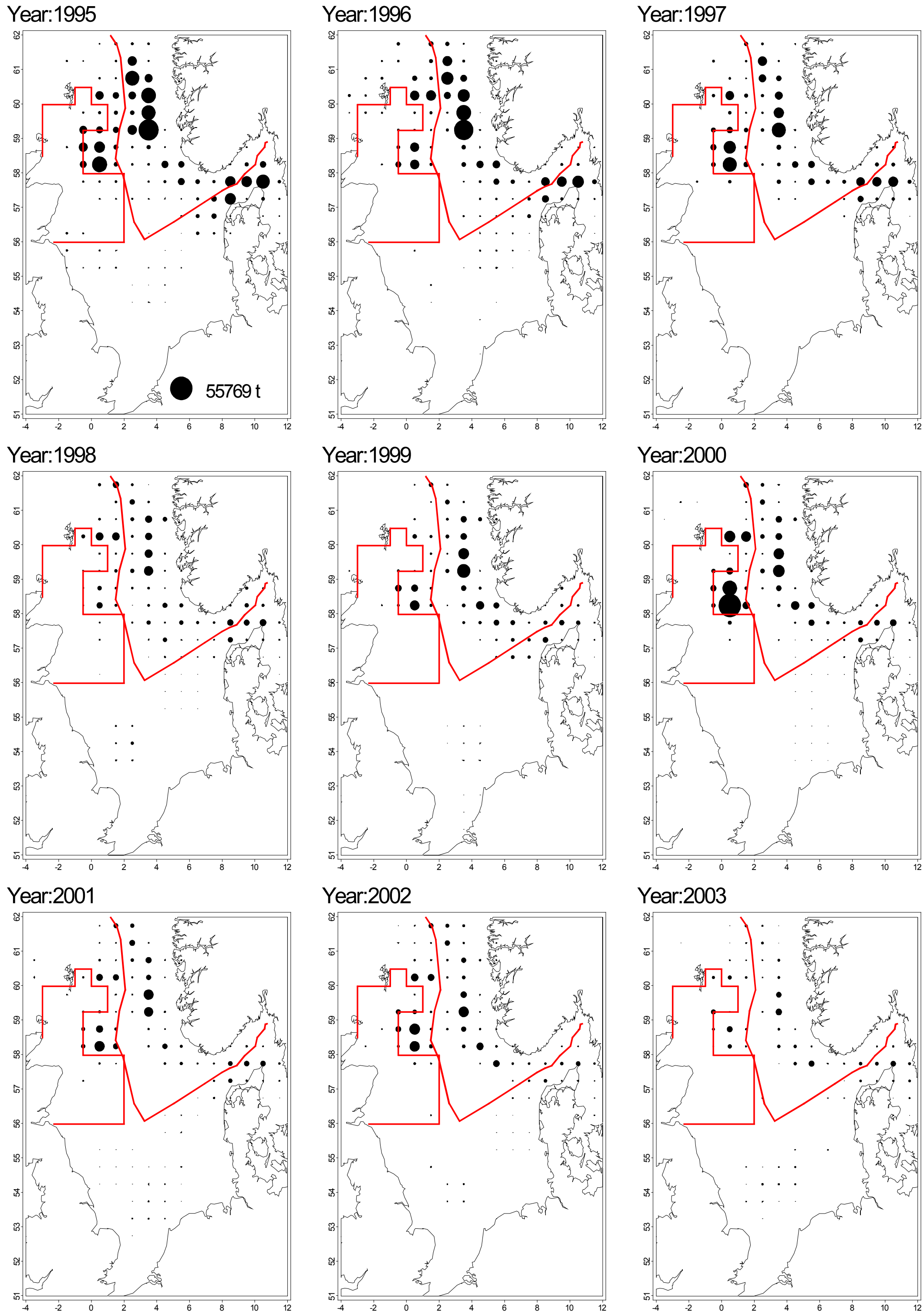


Figure 2. Landings of Norway pout by year and ICES rectangles for the period 1995-2003. Landings include Danish and Norwegian landing for the whole period. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the 1995 map. The "Norway pout box" and the boundary between the EU and the Norwegian EEZ are shown on the map.

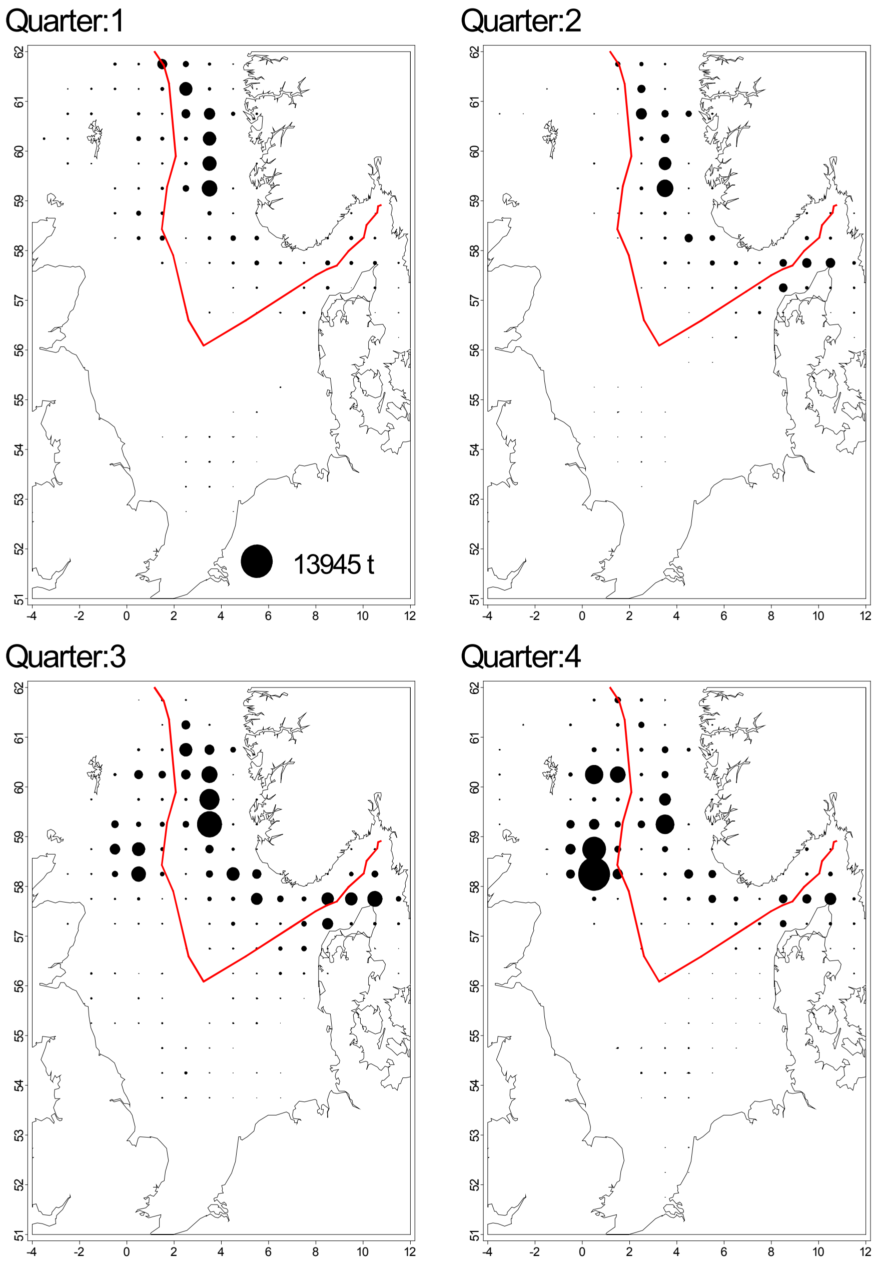


Figure 3. Average Danish and Norwegian landings of Norway pout by quarter of the year and ICES rectangles for the period 1994-2003. The area of the circles represents landings by rectangle. All rectangle landings are scaled to the largest rectangle landings shown at the quarter 1 map

Landings have been low since 2001, and the 2003-2004 landings were the lowest on record. Effort in 2003 and 2004 has been historically low and well below the average of the 5 previous years. The effort in the Norway pout fishery was in 2002 at the same level as in the previous eight years before 2001. The targeted Norway pout fishery was closed for 2005, in the first half year of 2006, as well as in all of 2007, but Norway pout were in the periods of closure taken as a by-catch in the Norwegian mixed blue whiting and Norway pout fishery, as well as in a small experimental fishery in 2007. The fishery was open for the second half year of 2006 and in all of 2008 based on the 2005 and 2007 year classes, respectively, both being on the long term average level. However, the Norwegian part of the Norway pout fishery was only open from May to August in 2008. Despite opening of the fishery by 1st January 2008 (with an preliminary EU quota of 36 500 t and a Norwegian quota of 4 750 t as well as a final EU quota of 110 000 t set late in 2008) only 30.4 kt was taken by Denmark, and the Norwegian catches were 5.7 kt, i.e. 36.1 kt in total. According to information from the fishery associations this is due mainly to high fuel prices and only to a minor extent late setting of the final quota affecting the trade of individual Danish vessel quotas, and less due to the by-catch percentages of other species in the fishery.

By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degel *et al*., 2006, ICES CM 2007/ACFM:35, (WD 22 and section 16.5.2.2)), and recent by-catch numbers are given in section 2 of this report. In general, the by-catch levels of these gadoids have decreased in the Norway pout fishery over the years. Review of scientific documentation reveals that by-catch reduction gear selective devices can be used in the Norway pout fishery, significantly reducing by-catches of juvenile gadoids, larger gadoids, and other non-target species (Nielsen and Madsen, 2006, ICES CM 2007/ACFM:35, WD 23 and section 16.5.2.2). By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. A detailed description of the regulations and their background can be found further below in this Stock Annex.

With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The Norway pout fishery is regulated by technical measures such as minimum mesh size in the trawls, fishing area closure in the Norway pout box in the North-Western part of the North Sea, and by-catch regulations to protect other species. An overview of relevant technical regulations for the Norway pout fishery and stock is given below in section f. By-catch in the fishery is described in detail in Annex 1.

A.3. Ecosystem aspects

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by high recruitment variation and variation in predation mortality (or other natural mortality causes) due to the short life span of the species (Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt (2009). With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery, and in general the fishing mortality on 0-group Norway pout is low (ICES WGNSSK Reports). However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is among other important as food source for other species (e.g. saithe, haddock, cod and mackerel) (ICES-SGMSNS 2006). Natural mortality levels by age and season used in the stock assessment do include the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

Natural mortality varies between age groups, and natural mortality at age varies over different time periods. Even though different sources of information (surveys, MSVPA) give slightly different perception of natural mortality at age (see below), the natural mortalities obtained from the most recent run with the North Sea MSVPA model (presented and used in the ICES SGMSNS (2006)) indicate high predation mortality on Norway pout. Especially the more recent high abundance of saithe predators and the more constant high stock level of western mackerel as likely predators on smaller Norway pout are likely to significantly affect the Norway pout population dynamics. However, interspecific density dependent patterns in Norway pout growth and maturity were not found in relation to stock abundance of those predators but rather in relation to North Sea cod and whiting stock abundance (Lambert, Nielsen, Larsen and Sparholt, 2009).

The Review Group (2007) asked the WG to provide guidance on how to deal with the objective of keeping a certain amount of biomass for predators. If a minimum biomass is found to be required, then natural mortality could not be kept constant in the prediction (if it does during the assessment period). It was suggested that variable M be examined to determine the amount of biomass removed via predation, to serve as a baseline biomass requirement for predators.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment do reflect the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006). Growth and mean weight-at-age for the above mentioned predators seems independent of the stock size of Norway pout.

In order to protect other species (cod, haddock, saithe and herring as well as mackerel, squids, flatfish, gurnards, *Nephrops*) there is a row of technical management measures in force for the small meshed fishery in the North Sea such as the closed Norway pout box, by-catch regulations, minimum mesh size, and minimum landing size.

B. Data

B.1. Commercial catch and effort data

The assessment uses the combined catch and effort data from the commercial Danish and Norwegian small meshed trawler fleets fishing mainly in the northern North Sea.

For the Danish and Norwegian commercial landings sampling procedures of the commercial landings, which vary between the countries, were described in detail in the report of the WGNSSK meeting in September 2004 (ICES WGNSSK (2005) ICES C.M. 2005/ACFM: xx).

From 2002 onwards, an EU regulation (1639/2001) was endorsed which affects the market sampling procedures. First, each country is obliged to sample all fleet segments, including foreign vessels landing in their country. Second, a minimum number of market samples per tonnes of landing are required. The national market sampling programmes have been adjusted accordingly. In general there is set a level of minimum 2 samples pr. tonnes landed for Norway pout in the North Sea and Skagerak

Method of effort standardization of the commercial fishery tuning fleet

Results and parameter estimates by period from the yearly regression analysis on CPUE versus GRT for the different Danish vessel size categories are used in the effort standardization of both the Norwegian and Danish commercial fishery vessels included in the assessment tuning fleet.

Background descriptions of the commercial fishery tuning series used and methods of effort standardization of the commercial fishery between different vessel size categories and national commercial fleets are given in the 2004 working group report (ICES WGNSSK (2005) ICES CM 2005/ACFM: xx) and the 1996 working group report (ICES CM 1997/Assess:6). Previous to the 2001 assessment the effort has been standardized by vessel category (to a standard 175 GRT vessel) only using the catch rate proportions between vessel size categories within the actual year. In 2002, a new regression standardization method was introduced (see methodological description below), and the assessment was run both with and without the new standardization method (regression). The differences in results of output SSB, TSB and F between the two assessment runs were small.

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to this in the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to and discussed by the working group in 2004 and presented in the 2004 report of this working group in section 12 (ICES CM 2005/ACFM: xx).

Since 2002, the assessments have used output of the regression analyses using time series from 1987(1994)-most recent assessment year, where the regressions have been applied to the Danish and Norwegian commercial fishery. Effort standardization of both the Danish and the Norwegian part of the commercial fishery tuning series is performed by applying standardization factors to reported catch and effort data for the different vessel size categories. The standardization factors are obtained from regression of CPUE indices by vessel size category over years of the Danish commercial fishery tuning fleet. The number of small vessels in the Danish Norway pout fishing fleet has decreased significantly and the relative number of large vessels has increased in the more recent years. Furthermore, there were found no trends in CPUE between vessel categories over time. For these reasons the CPUE indices used in the regression has been obtained from pooled catch and effort data over the years 1994-present assessment year by vessel category in order to obtain and include estimates for all vessel categories also for the latest years where no observations exists for the smallest vessels groups.

The conclusion of the discussion in the working group of these analysis results was that further analysis and exploration of data is necessary before suggesting an alternative standardization method and alternative division of commercial fishery tuning fleets to be used in the assessment. This should be done in a coming benchmark assessment of the stock. Among other it should be further investigated whether it is possible to split the Danish and Norwegian commercial tuning fleet, and also effects of excluding the commercial tuning fleets from the assessment should be further exploited.

Parameter estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is shown for the period 1994-2006 in this quality control handbook below.

The regression model used in effort standardisation is the following:

Regression models: $CPUE=b*GRT^{a} \Rightarrow \ln(CPUE)=\ln(b)+a*\ln((GRT-50))$

estimates from regressions of ln(CPUE) versus ln(average GRT) by period together with estimates of standardized CPUE to the group of Danish 175 GRT industrial fishery trawlers is used to standardize effort in the commercial fishery tuning fleet used in the Norway pout assessment. Parameter estimates for the period 1994-2004 is the following:

Year	Slope	Intercept	R-Square	CPUE(175 tonnes)
1994-2006	0.18	14.05	0.77	32.76

Norwegian effort data

In 1997, Norwegian effort data were revised as described in sections 13.1.3.1 and 1.3.2 of the 1997 working group report (ICES CM 1998/Assess:7). Furthermore, in the 2000 assessment Norwegian average GRT and Effort data for 1998-99 were corrected because data from ICES area IIa were included for these years in the 1998-99 assessments. Observed average GRT and effort for the Norwegian commercial fleets are given in the input data to the yearly performed assessment. This information has been put together in the report of the ICES WGNSSK meeting in 2004 (ICES WGNSSK (2005), ICES CM2005/ACFM:xx).

Danish effort data

In each yearly assessment the input data as CPUE data by vessel size category and year for the Danish commercial fishery in area IVa is given. This is based on fishing trips where total catch included at least 70 % Norway pout and blue whiting per trip, and where Norway pout was reported as main species in catch in the logbook per fishing day and fishing trip. There has been a relative reduction in the number and effort of small vessels and an increase for the larger vessels in the fleet in the latest years. Furthermore, it appears clearly that there is big difference in CPUE (as an indicator of fishing power) between different vessel size categories (BRT). Accordingly, standardization of effort is necessary when using a combined commercial fishery tuning fleet in the assessment including several vessel categories. Minor revisions (updating) of the Danish effort and catch data used in the effort standardization and as input to the tuning fleets have been made for the 2001 assessment.

Exploration of methods for effort standardization

With respect to further exploration of the effect of using effort standardization and using a combined Danish and Norwegian commercial fishery tuning fleet in the Norway pout assessment different analyses have been made in relation to the benchmark assessment in 2004. This was done to investigate alternative standardization methods and alternative division of the commercial fishery assessment tuning fleet used in the assessment. The results of these analyses were presented to the working group and were discussed here in 2004 (ICES CM 2005/ACFM:xx).

Analysis of variance (GLM-analyses) of catch, effort and log transformed CPUE data on trip basis for the Danish commercial fishery for Norway pout during the period 1986 to 2004 showed statistical significant differences in catch rates between different GT-groups, years, quarters of years (seasons), and fishing areas, as well as statistical significant first order interaction effects between all of these variables. The detailed patterns in this variation are not clear and straight forward to conclude on.

It has not yet been possible to obtain disaggregated effort and catch data by area and vessel size (GT-group) from the Norwegian Norway pout fishery to perform similar analyses for the Norwegian fishery.

Also it is not possible to regenerate the historical time series (before 1996) of catch numbers at age in the commercial fishery tuning fleet by nation which is only available for the combined Danish and Norwegian commercial tuning fleet. The reason for this is partly that there is no documentation of historical allocation of biological samples (mean weight at age data) to catch data (catch in weight) in the tuning fleet in order to calculate catch number at age for the period previous to 1996 for both nations, and partly because it seems impossible to obtain historical biological data for Norway pout (previous to 1996) from Norway. Alternative division of the commercial fishery tuning fleet would, thus, need new allocation of biological data to catch data for both the Danish and Norwegian fleet, and result in a significantly shorter Norwegian commercial fishery tuning fleet time series, and a historically revised Danish commercial fishery tuning fleet with new allocation of biological data to catch data. Revision of the tuning fleet would, furthermore, need analyses of possible variation in biological mean weight at age data to be applied to different fleets, as well as of the background for and effect of this possible variation.

Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in the input data to the yearly performed assessment, as well as the combined CPUE indices by age and quarter for the commercial fishery tuning fleet.

The seasonal variation in effort data is one reason for performing a seasonal VPA.

B.2. Biological data

Age reading

There are no reports of age reading problems of Norway pout otoliths, and no indications of low quality of the age length keys used in the assessment of this stock.

Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Historical levels and variation in mean weight at age in catch by quarter of year is shown in Figure 12.2.1 in the 2004 benchmark assessment in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005), ICES CM 2005/ACFM:xx). In general, the mean weights at age in the catches are variable between seasons of year. The same mean weight at age in the stock is used for all years. Mean weight in catch is not used as estimator of weight in the stock partly because the smallest 0-group fish are not fully recruited to the fishery in 3rd quarter of the year.

Maturity and natural mortality

Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway. Around 10 % (varying between years and sex – see below) of the Norway pout reach maturity already at age 1, however, most individuals reach maturity at age 2. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen *et al*. (2001), indicated variation in maturity between years and sexes, especially for the 1-group.

The same proportion mature and natural mortality are used for all years in the assessment. The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex.

In the 2001 and 2002 assessment exploratory runs were made with revised input data for natural mortality based on the results from two papers presented to the working group in 2001, (*both papers published in ICES J. Mar. Sci. in 2002, Sparholt, Larsen and Nielsen 2002a,b).* This was not explored further in the 2003 up-date assessment but the

2004 benchmark assessment of the stock includes an exploratory run with revised natural mortalities. These revised natural mortalities are given in Table 12.2.3 in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005); ICES CM2005/ACFM:xx).

The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appears that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the Working Group again in the 2004 benchmark assessment where an exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout the 3 years of exploratory runs.

Research results on population dynamics parameters (e.g. natural mortality and maturity)

Investigations on population dynamics (natural mortality, distribution, and spawning and maturity as well as growth patterns) of Norway pout in the North Sea are ongoing.

Studies presented to the working group in 2001 and published in 2002 indicate that natural mortality may be significantly different between age groups compared to constant as currently assumed in the assessment model Sparholt, Larsen and Nielsen (2002a,b).

Exploratory runs of the SXSA model was presented in the 2001 and 2002 assessment reports as well as in the 2004 and 2006 assessments (Norway pout benchmark assessments) with revised input data for natural mortality by age based on the results from two papers presented to the working group in 2001, (later published in *Sparholt, Larsen and Nielsen, 2002a,b*) as well as natural mortality estimates from the North Sea MSVPA model in the 2006 assessment (ICES CM 2006/ACFM:35).

The resulting SSB, TSB (3rd quarter of year), TSB (1st quarter of year) and F for the final exploratory run was compared to those for the accepted run with standard settings. It appeared that the implications of these revised input data are very significant. The working group in 2002 suggested that an assessment with partly the traditional settings (constant M) and a new assessment with the revised values for M were made for at least a 3 year period in order to compare the output and the performance of the assessments before the working group decided on final adoption of the revised values for M to be used in the assessment. This attitude was adopted by the working group again in the 2004 benchmark assessment where an exploratory run with revised values for M was performed as well. The results of the exploratory runs have been consistent throughout all years of exploratory runs.

The working group recommended in 2005 that there was made a limited benchmark assessment for Norway pout in the 2006 assessment (ICES CM 2006/ACFM:35) with specific reference to evaluation of effects of using revised natural mortalities, and that the WG on this basis decides on which natural mortalities to use in the assessment. Here three data time series for natural mortality was considered and compared through exploratory assessment runs:

1. Constant natural mortalities by age, quarter and year as used in previous years standard (baseline) assessment
2. Revised natural mortalities obtained from and based on the results from Sparholt *et al* (2002a,b)
3. Revised natural mortalities obtained from the most recent run with the North Sea MSVPA model (presented and used in the ICES SGMSNS (2006).

The estimates of natural mortality by Sparholt *et al* (2002a,b) indicate age and periodical tendencies and differences in natural mortality with higher M for age 2 and 3 compared to age 1 (and 0). The proportion of the natural mortality due to predation was found highest at age 1. Non-predation mortality on Norway pout increases with age and is very high for age 2 and older fish resulting in relatively higher overall M values for age 2 and 3 compared to age 1. The estimates are based on analysis of IBTS quarter 1 survey time series in two periods from 1977-1981 and 1987-1991. The results also revealed high variation in total mortality (Z) by age and period using different survey time series (IBTS Q1 1977-81, 1987-1991, 1979-1999, SGFS Q3 1987-1991, 1980-1997, and EGFS Q3 1982-1992) as well as other source time series (commercial catch data time series 1977-1981, 1987-1991, and numbers consumed by year class 1977-1981, 1987-1991). Even though the results using different sources and surveys confirmed overall age specific tendencies in Z there were high variability and some inconsistency in the estimates from different sources in different periods.

The estimated M and Z values by age based on the 1987-1991 IBTS Q1 data from this study are shown in ICES CM 2006/ACFM:35, Figures 5.2.3-4 as well as in Table 5.2.6. The M values from 1987-1991 were extrapolated and used as constant values by age and quarter for all years for the period 1983-2006 in exploratory SMS assessment runs comparing use of baseline M and M from Sparholt *et al* (2002a,b) (Figure 5.2.3-4). The results showed different levels of SSB, F, recruitment and TSB but the same perception of stock dynamics in accordance with previous years results (Figure 5.3.10).

Estimates of total mortality based on the SURBA assessment model estimates (2005 SURBA run for Norway pout, ICES C.M. 2006/ACFM:35) using all survey time series included in the baseline assessment (as given in Table 5.3.2 of ICES CM 2007/ACFM:18 and 30) covering the period 1983-2005 was also presented in Figure 5.2.3. It appeared that for the period up to 1990-1995 Z estimated from SURBA and Sparholt, Larsen and Nielsen (2002a,b) is on the same level for both the 1-2 group and 2-3 group, and there also seems to be age specific differences in Z. In the period from 1995 and onwards the Z-estimates from SURBA are lower compared to the constant M values obtained from Sparholt, Larsen and Nielsen (2002a,b). In recent years from 2002-03 SURBA estimates of Z increases again compared to the period 1995-2001.

In conclusion, the survey based mortality estimates indicate age specific differences in Z and M. However, different survey time series indicate high variability in the mortality with somewhat contradicting tendencies between periods. Sparholt, Larsen and Nielsen (2002a,b) discussed their results in context of changed catchability in the surveys, migration out of the area, or age specific distribution patterns of Norway pout and concluded that the mortality patterns were not caused by this.

The MSVPA estimates of Z in the period 1983-2003 also shown in Figure 5.2.3-4 of ICES CM 2007/ACFM: 18 and 30 and obtained from ICES SGMSNS (2006) are higher than the survey based estimates from Sparholt, Larsen and Nielsen (2002a,b) and from SURBA for the 1-2 age groups, but on the same level for the 2-3 age groups indicating relatively high difference for the 1-group. Higher natural mortality (M) values for the 1-group from MSVPA compared to those from Sparholt, Larsen and Nielsen

(2002a,b) are evident from Figure 5.2.4. The MSVPA indicate that M by quarter of year is on the same level for all three age groups (1-3) by year during the whole assessment period.

MSVPA M increase in 2002 and 2003 for both age 1, 2 and 3 (as was also observed in SURBA estimated Z). Whether this tendency of change in level of MSVPA M for in recent years has continued is unknown because MSVPA M estimates in 2004 and 2005 are not available (ICES-SGMSNS 2006). The SURBA estimates for 2003-2005 might indicate that the increasing tendency in Z (and accordingly M as F is 0) is not continuing from 2003 to 2004-05 (Figure 5.2.3). Accordingly, when using the MSVPA natural mortalities it is necessary to make assumptions about natural mortality for the years 2004 and 2005. The rather constant level of natural mortality for all age groups in the MSVPA in previous years might be changing (increasing) in recent years from 2002 and onwards as indicated on Figure 5.2.3-4, but this cannot be finally documented. When up-date estimates of MSVPA M-values are available it should again be considered whether to use MSVPA estimates of M in the assessment. In the exploratory runs with SMS using MSVPA values, the M for 2004 and 2005 was assumed to be equal to the 2003 values. The results of this exploratory run revealed that there was no difference in perception of the stock compared to the baseline assessment with constant M (Figure 5.3.11). This should be seen in context of the constant M by age and quarter chosen in the baseline assessment at 0.4 by quarter and age is based on the rather constant level of M estimates from MSVPA in the period 1983-2001.

Consequently, the MSVPA estimates indicate rather constant M between age groups (and years), and do not provide the most recent estimates of M.

Overall, the independent sources of information on mortality are contradicting between age groups and inconclusive between periods (variable). Consequently, it has been chosen to continue using the baseline assessment constant values for M at age and quarter as in previous years assessment.

Conclusions of the explorative comparison runs:

The exploratory runs give very much similar results and showed no differences in the perception of the stock status and dynamics. With respect to the exploratory runs using different natural mortalities no conclusions could be reached as the different sources showed different trends with no obvious biological explanation. On that basis it was decided that the final assessment in the September 2006 benchmark assessment continues to use the standard constant natural mortality values by age, year and season. The exploratory comparisons between assessment using the traditional SXSA assessment model and the SMS model give comparable results and the same perception of the Norway pout stock dynamics.

Preliminary results from an analysis of regionalized survey data on Norway pout maturity is presented in a Working Document to the 2000 meeting of the Working Group (*Larsen, Lassen, Nielsen and Sparholt,2001* in ICES C.M.2001/ACFM:07).

B.3. Assessment tuning fleet data and indices (general)

<u>Revision of assessment tuning fleets (survey CPUE data and commercial fishery CPUE data) in the 2004 benchmark assessment</u>:

Revision of the Norway pout assessment tuning fleets was performed during the 2004 benchmark assessment. The background for this, the results, and the conclusions from the analyses in relation to this are described here in the stock quality handbook as well as in the benchmark assessment in the working group report from 2004.

Revision of the Norway pout assessment tuning fleets during benchmark assessment have been based partly on cohorte analyses and analyses of correlations within and between the different tuning fleet indices by age group, as well as on the results from a row of exploratory assessment runs described under section 12.3 of the 2004 benchmark assessment (ICES WGNSSK (2005)) which analyses the performance of the different tuning fleets in the assessment. The exploratory assessment runs also give indications of possible catchability patterns and trends in the fishery over time within the assessment period. The analyses of the tuning fleet indices are presented in the benchmark assessment 2004 (ICES WGNSSK (2005)) Figures 12.2.3-12.2.8 and Tables 12.2.9-12.2.12.

An overview over the resulting tuning data and fleets used in the assessment during different time periods are shown in the table over tuning data in section C below.

B.4. Survey data

Survey index series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (Q1 and Q3) and the EGFS (Q3) and the SGFS (Q3). The SGFS data from 1998 onwards should be used with caution due to new survey design (new vessel from 1998 and new gear and extended survey area from 1999). The 0-group indices from this survey have accordingly not been used in the assessment tuning fleet for this survey previous to the 2004 benchmark assessment. The index for the 0-group from SGFS changed with an order of magnitude in the years after the change in survey design compared to previous years (Table 12.2.8, ICES WGNSSK (2005)). The EGFS data from previous to 1992 should be used with caution as the survey design shifted in 1992. This change in survey design has until 2004 been accounted for by simply multiplying all indices with a factor 3.5 for all age groups in the years previous to 1992 in order to standardize it to the later indices. The EGFS survey indices for Norway pout has been revised in the 2004 assessment compared to the previous years assessment for the 1996, 2001, 2002, and 2003 indices. In previous years assessments (before 2004) the full EGFS survey time series for all age groups have been included as an assessment tuning fleet. Time series for IBTS Q3 are only available from 1991 and onwards. The 3rd quarter IBTS and the EFGS and SGFS are not independent of each other as the two latter is a part of the first. Accordingly, the following changes have been made for the survey tuning index series in the 2004 benchmark assessment (also shown in the tuning series overview table in section C):

1) The IBTS Q3 for the period 1991-2003 has been included in the assessment. This survey has a broader coverage of the Norway pout distribution area compared to the EGFS and SGFS isolated. However, as this survey index is not available for the most recent year to be used in the seasonal assessment it has been chosen to exclude the 0- and 1-group indices from the IBTS Q3 in order to allow inclusion of the 0- and 1-group indices from the SGFS and EGFS which are available for the most recent year in the assessment. (Not relevant in relation to spring assessments) Accordingly, the IBTS Q3 tuning fleet for age 2 and age 3 has been included in the assessment as a new tuning fleet. The SXSA demands at least two age groups in order to run which is the reason for including both age 0 and age 1 under the EGFS and SGFS tuning fleets and not including age 1 in the IBTS Q3 tuning fleet.

2) The SGFS for age group 0 and 1 for the period 1998 and onwards has been used as tuning fleet in the assessment. The short time series is due to the change in survey design for SGFS as explained above. The quarter 3 0-group survey index for SGFS is back-shifted to the final season of the as-

sessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

3) The EGFS for age group 0 and 1 for the period 1992 and onwards has been used as tuning fleet in the assessment. The shorter time series is due to the change in survey design for EGFS as explained above. Furthermore, there is a good argument for excluding the age 2-3 of the EGFS as the within survey correlation between the age groups 1-2 and 2-3 is very poor while the within correlation between age groups 0-1 is good. The quarter 3 0-group survey index for EGFS is back-shifted to the final season of the assessment in the terminal year, i.e. to quarter 2 of the assessment year in order to include the most recent 0-group estimate in the assessment.

4) The IBTS Q1 tuning fleet has remained unchanged compared to previous years assessment.

IBTS Quarter 1 IBTS Quarter 3

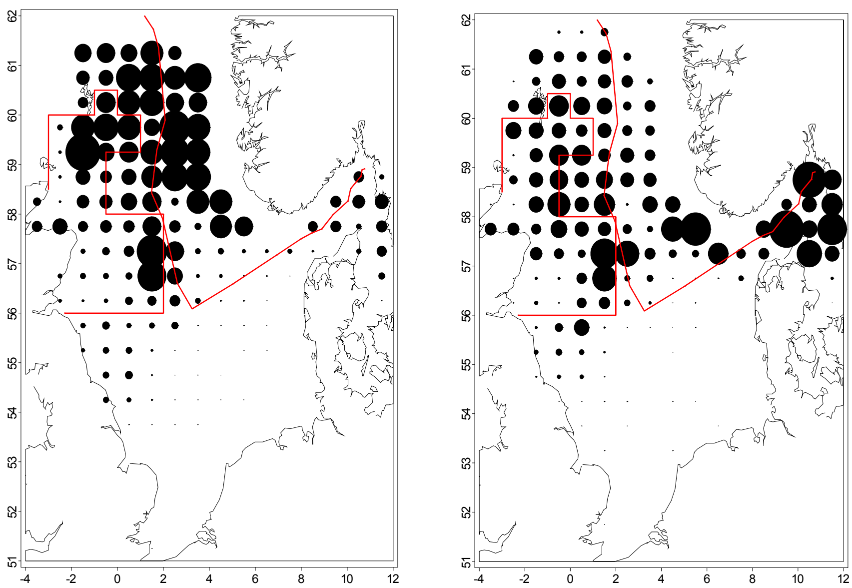


Figure 4 IBTS mean CPUE (numbers per hour) by quarter during the period 1991-2004. The area of the circles is proportional to CPUE. The IBTS surveys do only cover areas within the 200 m depth zone. The "Norway pout box" and the boundary between the EU and the Norwegian EEZ are shown on the map. The maps are scaled individually.

B.5. Commercial CPUE data

Combined CPUE indices by age and quarter for the Danish and Norwegian commercial fishery tuning fleet is calculated from effort data obtained from the method of effort standardization of the commercial fishery tuning fleet described under section B.1 and vessel category specific catches by area. CPUE is estimated on a quarterly basis for the Danish and Norwegian commercial fleets.

The resulting combined, commercial fishery CPUE data by age and quarter is presented in the input data to the yearly performed assessment. The commercial fleet data are used in tuning of the assessment based on the combined and standardized Danish and Norwegian effort data and on the catch data for the commercial fishery

Commercial fishery tuning fleets:

In addition to the analyses of the commercial fishery assessment tuning fleet as described above (effort standardization) the quarterly CPUE indices of the commercial fishery tuning fleet were analyzed during the 2004 benchmark assessment:

1) The indices for the 0-group in 3rd quarter of the year have been excluded from the commercial fishery tuning fleet. The main argumentation for doing that is that this age group indicate clear patterns in trends in catchability over the assessment period as shown in the single fleet/quarter assessment runs in section 12.3 (Figure 12.3.7), ICES WGNSSK (2005). Secondly, there is no correlation between the commercial fishery 3rd quarter 0-group index and the commercial fishery 4th quarter 0-group index, and no correlation between the 3rd quarter commercial fishery 0-group index in a given year with the 1-group index of the 3rd quarter commercial fishery the following year.

2) The 2nd quarter indices for all age groups have been excluded from the commercial fishery tuning fleet. This is mainly because of indications of strong trends in catchability over time in the assessment period for this part of the tuning fleet for all age groups as indicated by single fleet tuning runs in the section 12.3 (Figure 12.3.7), ICES WGNSSK (2005). Also, the within quarter and between quarter correlation indices are in general relatively poor. The cohorte analyses of the 2nd quarter commercial fishery indices indicate as well relative changes over time.

C. Historical Stock Development

The SXSA (Seasonal Extended Survivors Analysis: Skagen (1993)) has been used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak as the standard assessment method. The catch at age analysis was carried out according to the specifications given in the present stock quality handbook.

The assessment is analytical using catch-at-age analysis based on quarterly catch and CPUE data. The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery. The seasonal model makes it possible to include and use the most recent information from the fishery and from the surveys at the assessment in , and provides a gives at the assessment time an The seasonal variation in effort data is one reason for performing a seasonal VPA.

In the options chosen in the SXSA for the Norway pout assessment the catchability, r, per age and quarter and fleet is assumed to be constant within the period 1983-2005 where the estimated catchability, rhat, is a geometric mean over years by age, quarter and tuning fleet. In the 2004 benchmark assessment exploration of trends in tuning fleet catchabilities was investigated by single fleet runs with the SXSA. The accepted assessment with revised tuning fleets in the 2004 benchmark assessment assume constant catchability.

Tuning is performed over the period 1983 to present producing log residual (log(Nhat/N)) stock numbers and survivor estimates by year, quarter, age and tuning fleet. The contributions from the various age groups to the survivor estimates by year and quarter and fleet are in the SXSA combined to an overall survivors estimate, shat, estimated as the geometric mean over years of log(shat) weighted by the exponential of the inverse cumulated fishing mortality as described in Skagen (1993).

In exploratory and comparison runs especially the SMS model has been used during the period 2005-2007:

SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) is an age-structured multi-species assessment model which includes biological interactions. However, the model can be used with one species only. In "single species mode" the model can be fitted to observations of catch-at-age and survey CPUE. SMS uses maximum likelihood to weight the various data sources assuming a log-normal error distribution for both data sources. The likelihood for the catch observation is then as defined below:

$$L_C = \prod_{a,y,q} \frac{1}{\sigma_{catch}(aa)\sqrt{2\pi}} \exp(-(\ln(C(a,y,q)) - \ln(\hat{C}(a,y,q)))^2 / (2\sigma^2_{catch}(aa)))$$

where C is the observed catch-at-age number, $\hat{C}$ is expected catch-at-age number, y is year, q is quarter, a is age group, and aa is one or more age groups.

SMS is a "traditional" forward running assessment model where the expected catch is calculated from the catch equation and F-at-age, which is assumed to be separable into an age selection, a year effect and a season (year, half-year, quarter) effect.

As an example, the F model configuration is shown below for a species where the assessment includes ages 0–3+ and quarterly catch data and quarterly time step are used:

$$F = F(a_a) \times F(y_y) \times F(q_q),$$

with F-components defined as follows:

$F(a)$:

Age 0	Fa_0
Age 1	Fa_1
Age 2	Fa_2
Age 3	Fa_3

$F(q)$:

	q1	q2	q3	q4
Age 0	0.0	0.0	Fq	0.25
Age 1	$Fq_{1,1}$	$Fq_{1,2}$	$Fq_{1,3}$	0.25
Age 2	$Fq_{2,1}$	$Fq_{2,2}$	$Fq_{1,3}$	0.25
Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

$F(y)$:

Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	…
1	Fy_2	Fy_3	Fy_4	Fy_5	Fy_6	Fy_7	Fy_8	Fy_9	….

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ Fy in the first year are set to constants to obtain a unique solution. For annual data, the $F(q_q)$ is set to a constant 1and the model uses annual time steps.

One $F(a)$ vector can be estimated for the whole assessment period, or alternatively, individual $F(a)$ vectors can be estimated for subsets of the assessment periods. A separate $F(q)$ matrix is estimated for each $F(a)$ vector.

For the CPUE time series the expected CPUE numbers are calculated as the product of an assumed age (or age group) dependent catchability and the mean stock number in the survey period.

The likelihood for CPUE observations, L_S, is similar to L_C, as both are assumed log-normal distributed. The total likelihood is the product of the likelihood of the catch and the likelihood for CPUE ($L = L_C * L_{CPUE}$,). Parameters are estimated from a minimisation of -log(L).

The estimated model parameters include stock numbers the first year, recruitment in the remaining years, age selection pattern, and the year and season effect for the separable F model, and catchability at age for CPUE time series.

SMS is implemented using ADmodel builder (Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but has extensively been tested in the last year on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average F or SSB from the Hessian matrix. Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (Gilks *et al*. 1996), MCMC, to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation including CV can be used.

Comparison of SXSA and SMS model output and assessment model evaluation:

The September 2006 limited benchmarking considered the most appropriate assessment model to be used and considered in order to describe the dynamics of the stock.

Previously, the SXSA (Seasonal Extended Survivors Analysis) model has been used in the assessment of Norway pout. The method is described in the quality control handbook.

The SMS is like the SXSA a seasonal based model being able to deal with assessment of a short lived species (where there are only few age groups in the VPA) and seasonality in fishing patterns.

The SMS (Stochastic Multi Species model; see section 1.3.3 and the stock quality handbook) objective functions (in "single species mode") for catch at age numbers and survey indices at age time series are minimized assuming a log-normal error distribution for both data sources. The expected catch is calculated from the catch equation and F at age, which is assumed to be separable into a year effect, an age selection, and an age-season selection. The SMS assumes constant seasonal and age-dependent F-pattern. SMS uses maximum likelihood to weight the various data sources. For years with no fishery (here 2005 and 2006 in this assessment) SMS simply set F to zero and exclude catch observations from the objective function. In such case only the survey indices are used in the model. The SXSA needs catch input for all quarters, all years, and in years with no catch infinitive small catch values have to be put into the model as an approximation. SXSA handles catch at age observation as exact, i.e. the SXSA does not rely on the assumption of constant exploitation pattern in catch at age data as for example the SMS does. As a stochastic model, SMS uses catch observations as observed with noise, but assumes a separable F. Both assumptions are violated to a certain degree.

SMS being a stochastic model can estimate the variance of parameters and derived values like average F and SSB. The SXSA is a deterministic model.

The Norway pout assessment includes normally catches from the first and second quarter of the assessment year. SMS uses survey indices from the third quarter of the assessment year under the assumption that the survey is conducted the very beginning of the third quarter. SXSA model has not that option and data from the third quarter of the assessment year can only be used by "back-shifting" the survey one quarter back in time.

The SMS model has so far assumed recruitment in 3rd quarter of the year and not in the start of the 2nd quarter of the year which the SXSA use. Actual recruitment is in the 2nd quarter of the year. Consequently, the assumed natural mortality of 0.4 for the 0-group in first and second quarter of the year is not included in the SMS compared to use of this in 2nd quarter of the year for the SXSA for the 0-group.

The diagnostics and results of the exploratory runs for comparison between SXSA and SMS assessment are shown in the WGNSSK September 2006 report (ICES WGNSSK, 2007). The models give comparable results and the same perception of the Norway pout stock dynamics, which have been documented in the 2004 benchmark assessment, the September 2005 and April 2006 update assessments (see above), as well as in the September 2006 exploratory runs. However, as SMS is a stochastic model it also provides uncertainties of the results. Accordingly, SMS was in September 2006 chosen as the new standard assessment model for Norway pout. However, it was decided that near future assessments should also include a comparative, exploratory SXSA assessment.

Comparison of output from a seasonal based assessment model (the SXSA model) and a annual based (the XSA model):

In the 2004 benchmark assessment of the Norway pout stock a comparison of the output, performance and weighting of tuning tuning fleets of the seasonal based SXSA model and the annual based XSA model was performed. The results are in detail presented in the 2004 ICES WGNSSK Report (ICES WGNSSK (2005)). The differences in results of output SSB, TSB and F between the two assessment runs were small. Both model runs gave in general similar weighting to the different tuning fleets used. This was based on comparison of runs of the accepted assessment (by the WG and ACFM) in 2003.

Summary of conclusions from the exploratory catch at age analyses in the 2004 benchmark assessments:

A number of exploratory runs were carried out as part of the benchmark assessment in 2004 in order to evaluate performance of stock indices as tuning fleets and also to compare performance of the seasonal XSA (SXSA) to the 'conventional' XSA. The exploratory runs are described in the 2004 working group report. The conclusions of the explorative runs in the 2004 benchmark assessment were the following:

1. *Catch and CPUE data for the assessment of Norway pout are very noisy, but internally consistent. The assessment, using SMS, gave very similar results irrespective of the CPUE time series used. Four of the seven CPUE series are data from the commercial fishery and these data are already included in the catch data. Therefore, these*

commercial fleets will not give a signal very different from the catch data. None of the scientific surveys had a clear signal different form the signal in the catch data.

2. *A comparison of the revised 2004 assessment with new tuning fleets compared to the previous 2003 assessment showed that the estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group for the revised, accepted assessment were in general consistent with the estimates of previous years assessment. Only historical F seemed to slightly deviate from the previous years assessment.*
3. *The overall performance and output for the XSA model was similar to the SXSA model, so the working group in 2004 decided to continue using SXSA. Both methods did overall not show insensible to the tuning fleet indices used in the assessment.*

In the up-date assessment in 2005 output of the SXSA model was compared to output from the SMS and SURBA model to evaluate the use of the SXSA model in a situation with having zero catches in the terminal year of the assessment. The results showed similar output of the different models and the same perception of the stock. The results are in detail presented in the 2005 ICES WGNSSK Report (ICES WGNSSK (2006)).

Analysis of output from SXSA and SMS and to evaluate the effect on the assessment of no catches in 2005 and 2006:

Due to closure of the Norway pout fishery and no catches in 2005 and in the first part of 2006 there has been made exploratory and comparative assessment runs using different assessment models (SXSA, SMS) to evaluate the effect on the assessment of this situation during the April 2006 assessment. This has been considered necessary to evaluate the effect of the absolute value of the artificial catch numbers on the on the SXSA output and to use a modified version of SMS that allows for no fishing in the end of the assessment period, where the SMS assessment uses identical input data as the SXSA assessment. Also the aim has been to evaluate how the SMS reacts to a situation with several years of no catches.

In the April 2006 assessments exploratory runs of SXSA was made where the artificial catch numbers in 2005 and 2006 was 4-doubled (but still low, from 400 t per quarter of year to 1600 t per quarter) compared to the very low catch levels used in the accepted assessment. The results of these comparative runs are not shown, however, the resulting output of the assessments were identical giving the same perception of the stock status and dynamics. Furthermore, in the September 2005 up-date assessment a SXSA assessment was performed with the change of using catch numbers in the first and second quarter of 2005 corresponding to 50% of the 2004 quarter 1 and 2 catch numbers (instead of 10% of the catches in the accepted assessment). The results of these comparative runs are shown in Figure 5.3.8 of the September 2005 report (ICES-WGNSSK 2006). The resulting outputs of these assessments were identical giving the same perception of the stock status and dynamics. From these SXSA runs it can be concluded that the absolute values of the artificial (small) catches does not practically affect the assessment output.

In April 2006 a SMS run was made with an assumption of no catches in 2005-2006. SMS was modified to exclude the likelihood of catch observation for 2005-2006 (and 2007) from the objective function. CPUE observations for 2005 and 2006 were, however, used in the model and objective function. By letting the model include 2007 as terminal year it is possible to forecast stock status under the assumption of no fishery in 2006-2007, and recruitments that follows the SMS recruitment function (geometric mean).

It appeared that the diagnostics of the SMS looked very similar to the one produced for the 2005 assessment As it was also shown in the 2004 benchmark assessment, the SMS model results in a rather similar weighting of the catch at age data as well as the tuning fleets as the SXSA model does. As seen in the previous years assessments, the SMS model tends to estimate lower SSB and higher F compared to results of the SXSA model, however, the perception of the stock status and dynamics are very much similar from the results of both model runs. Recruitment estimates of the two models cannot be directly compared as the SMS gives recruitment in third quarter of the year while the SXSA gives recruitment in the second quarter of the year.

Software used:

SXSA program available from ICES. Used for the final assessment as standard software.

SMS program available from Morten Vinther, DIFRES, Copenhagen (Exploratory run, 2004 and 2005, April 2006 and September 2006).

(SURBA program available from Coby Needle, MARLAB, Aberdeen; Exploratory run, 2005)

The XSA and SURBA cannot perform quarterly based assessment.

Model Options chosen:

The parameter settings and options of the SXSA and SMS have been the same in all recent years assessments, except that recruitment season to the fishery has been backshifted from 3rd quarter of the year to 2nd quarter of the year when running SXSA in the autumn in order to gain benefit from the most recent 0-group indices from the 3rd quarter surveys (SGFS and EGFS as explained above) in the assessment. This has not been necessary in the SMS assessment. In the May 2007 assessment with SXSA this backshifting has not been performed.

No time taper or shrinkage is used in the catch at age analysis. The three surveys and the seasonally (by quarter) divided commercial fleets are all used in the tuning.

The following parameters were used:

```
Year range:
       1983 - 2007
Seasons per year:                                                    4
The last season in the last year is season:                3
Youngest age:                                                        0
Oldest true age:
       3
Plus group:                                                          No
plus group in SMS (4+-group in SXSA)
Recruitment in season:                                               3
Spawning in season:                                                  1
Single species mode:                                                 Yes,
number of species = 1
```

The following fleets were included:

```
Fleet  1: (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4: Age 0-2) commercial
q134
Fleet  2:                                                   ibtsq1
       (Age 1-3)
Fleet  3:                                                   egfsq2
       (Age 0-1)
Fleet  4:                                                   sgfsq2
       (Age 0-1)
Fleet  5:                                                   ibtsq3
       (Age 2-3)
```

Data were input from the following files:

```
Catch in numbers:                                          canum.qrt
Weight in catch:                                           weca.qrt
Weight in stock:                                           west.qrt
Natural mortalities:                                       natmor.qrt
Maturity ogive:                                            propmat.qrt
Tuning data (CPUE):                                        tun2007.xsa
Weighting for rhats:                                       rweigh.xsa
```

In the SXSA the following options were used:

```
The following options were used:
1: Inv. catchability:                                              2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:                                                   2
  (1: Direct; 2: Using z)
3: Comb. shats:                                                    2
  (1: Linear; 2: Log.)
4: Fit catches:                                                    0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:                                           0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:                                             0
  (0: Manual)
7: Weighting of shats:                                             2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:                                     1
  (1: Dynamic; 2: Extra age group)

Factor (between 0 and 1) for weighting the inverse catchabilities
at the oldest age versus the second oldest age (factor 1 means that
the catchabilities for the oldest age are used as they are):       0

Specification of minimum value for the survivor number (this is
Used instead of the estimate if the estimate becomes very low):    0

Iteration until convergence (setting 0):                           0
```

The following tuning fleet options were used in the SMS model

(summary from fleet_info.dat):

```
Minimum CV of CPUE observations:            0.2

Fleet specific options:
1-2, First year last year,
3-4. Alpha and beta - the start and end of the fishing period for the fleet
given as
     fractions of the season (or year if annual data are used)
5-6  First and last age,
7.   last age with age dependent catchability,
8.   last age for stock size dependent catchability (power model), -1 indicated
no
     ages uses power model
9.   season for survey,
10.  number of variance groups for estimated catchability
     by species and fleet
1 commercial q1:                                    1983 2004 0 1 1 3 3 -1 1 3
1 commercial q3:                                    1983 2004 0 1 1 3 3 -1 3 3
1 commercial q4:                                    1983 2004 0 1 0 2 2 -1 4 3
2 IBTS q1:                                          1983 2006 0 1 1 3 3 -1 1 3
3 EGFS q 3:                                         1992 2005 0 1 0 1 1 -1 3 2
4 SGFS q3:                                          1998 2006 0 0 0 1 1 -1 3 2
5 ibts_q3:                                          1991 2005 0 1 2 3 3 -1 3 2
Variance groups:
Fleet: 1 season 1:                                  1 2 3
Fleet: 1 season 3:                                  1 2 3
Fleet: 1 season 4:                                  0 1 2
Fleet: 2:                                           1 2 3
Fleet: 3:                                           0 1
Fleet: 4:                                           0 1
Fleet: 5:                                           2 3
```

The following SMS model settings were used in the SMS model (summary from SMS.dat):

```
SSB/R relationship:                                        Geometric mean

Object function weighting:
First=catch observations                                                  1.0
Second=CPUE observations                                                  1.0
Third=SSB/R relations                                                     1.0
Minimum CV of commercial catch at age
observations option min.catch.CV):                                  0.20
Minimum CV of S/R relation (option min.SR.CV):             0.20
No. of separate catch sigma groups by species:             4 (one variance
group by age)
Exploitation pattern by age and season:      Age 0 (3rd-4th quarter)
                                             Age 1 (1st, 3rd, 4th quarter)
                                             Ages 2-3 (1st, 3rd, 4th quarter)

If tuning survey index has the value 0 then 5% of the
average of the rest of the observations are used
because the logarithm to zero can not be taken:
Minimum "observed" catch, negative value gives
percentage (-10 ~ 10%) of average catch in age-group
if option>0 and catch=0 then catch=option
if option<0 then catch=average(catch at age)*(-option)/100 -5

Assuming fixed exploitation pattern by age and season

Number of years with zero catch:                           2 (2005, 2006)
```

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1983-present	0-3+	Yes
Canum	Catch at age in numbers	1983-present	0-3+	Yes
Weca	Weight at age in the commercial catch	1983-present	0-3+	Yes
West	Weight at age of the spawning stock at spawning time.	1983-present	0-3+	No
Mprop	Proportion of natural mortality before spawning	Not relevant in SXSA		
Fprop	Proportion of fishing mortality before spawning	1983-present	0-1	Yes
Matprop	Proportion mature at age	1983-present	1-3+	No, 10%age 1, 100% 2+
Natmor	Natural mortality	1983-present	0-3+	No, 0.4 per quarter per age group

Tuning data

Norway pout IV & IIIaN (Skagerak). Stock indices and tuning fleets used in final 2004 benchmark assessment as well as in the 2005-2009 assessments compared to the 2003 assessment.

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT	2007-09 ASSESSMENTS
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	3rd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	1st quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)	4+ (SXSA)
FLT01: comm Q1					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED	NOT USED
	Year range	1982-2003			
	Quarter	2			
	Ages	1-3			
FLT01: comm Q3					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	3	3	3	3
	Ages	0-3	1-3	1-3	1-3
FLT01: comm Q4					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	4	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)	0-3 (SXSA)
FLT02: ibtsq1					
	Year range	1982-2003	1982-2006	1982-2006	1982-2009
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT03: egfs					
	Year range	1982-2003	1992-2005	1992-2005	1992-2008
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT04: sgfs					
	Year range	1982-2003	1998-2006	1998-2006	1998-2008
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT05: ibtsq3		NOT USED			
	Year range		1991-2005	1991-2005	1991-2008
	Quarter		3	3	Q3
	Ages		2-3	2-3	2-3

D. Short-Term Projection

A deterministic short-term forecast is given for the stock. This was done for the Norway pout stock for the first time in 2004. From April 2006 deterministic short-term prognoses were performed for the Norway pout stock.

The forecast was calculated as a stock projection up to 1st of January of the forecast year using full assessment information for the assessment year.

The projection up to 1st of January of the forecast year is based on the SXSA assessment estimate of stock numbers at age at the start of the assessment year. The forecast is using a geometric mean for the stock-recruitment relationship

The forecast uses relevant exploitation pattern.

Ten percent of age 1 is mature and is included in SSB. Therefore, the recruitment in the year after the assessment year does influence the SSB in the following year.

Usually the recruitment in the year after the assessment year is assumed to be at 25% level (25 percentile) of the long term geometric mean. This level has been chosen to take into account that the frequency of strong year classes seems to have decreased in the recent 10-15 year period compared to previously.

A management table is presented from the forecast. The objective set in relation to this is to set the fishing mortality and catch on a level that maintain spawning stock biomass above B_{pa} by 1st of January one - two years after the assessment year with a high probability (95% level).

Catch predictions for 0- and 1-groups are important as the fishery traditionally target the 0-group already in 3rd and (especially in) 4th quarter of the year as well as the 1-group in the 1st quarter of the following year. In the 2004 benchmark assessment it was shown that survey indices in the 3rd quarter seems to predict strong 0-group year classes relatively well when comparing with 0-group indices from commercial fishery (4th quarter) and to 1-group survey indices the following spring.

The deterministic forecast is off course affected by that: (a) the potential catches are largely dependent on the size of a few year classes, (b) the large dependence on the strength of the recruiting 0-group year classes, and (c) added uncertainty (in assessment and potential forecast) arising from variations in natural mortality. However, the forecast is not dependent on any assumption about the strength of the new year class.

The forecast has so far assumed a forecast year fishing pattern scaled to long term seasonal exploitation pattern for 1991-2004 (standardized with yearly Fbar to F(1,2)=1) which has been used in e.g. the 2007 and 2008 ICES WGNSSK Reports (ICES CM 2007/ACFM:30; ICES CM 2008/ACOM:09) and in the ICES AGNOP Report as well (ICES CM 2007/ACFM:39). Recruitment in the forecast year is assumed to the 25th percentile of the SXSA recruitment estimates. In May 2009 an alternative forecast was run using a fishing pattern scaled to the seasonal exploitation pattern in 2008 (standardized with the 2008 Fbar to F(1,2)=1). The background for this alternative forecast is that 2004 was the last year where the directed Norway pout fishery was open in all seasons of the year, except for 2008 where the fishery was open all of the year in the EU Zone (but only May-August in the Norwegian zone). The catches in 2008 have been relatively low and the exploitation pattern between seasons (and ages) is very different from the average previous long term (1991-2004) exploitation pattern. The targeting in the small meshed trawl fishery has changed recently where targeting of Norway pout has decreased mainly due to high fuel prices.

E. Biological Reference Points

Precautionary Approach reference points:

ICES considers that:	ICES proposes that:
B_{lim} is 90 000 t	B_{pa} be established at 150 000 t. Below this value the probability of below average recruitment increases.
Note:	

Technical basis:

$B_{lim} = B_{loss} = 90\ 000$ t.	$B_{pa} = B_{lim}\ e^{0.3-0.4*1.65}$ (SD).
F_{lim} None advised.	F_{pa} None advised.

Biomass based reference points have been unchanged since 1997.

B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 90 000 t. B_{pa} has been calculated from

$B_{pa} = B_{lim}\ e^{0.3-0.4*1.65}$ (SD).

A SD estimate around 0.3-0.4 is considered to reflect the real uncertainty in the assessment. This SD-level also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software (CEFAS 1999). The relationship between the B_{lim} and B_{pa} (90 000 and 150 000 t) is 0.6.

B_{lim} is 90 000 t, the lowest observed biomass

F_{lim} None advised.

F_{pa} None advised.

Management:

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment reflects the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

Based on the estimates of SSB in September 2008, ICES classified the stock at increased risk of suffering reduced reproductive capacity with SSB just below B_{pa} at the start of 2008. The most recent estimates of SSB (Q1 2009) show full reproductive capacity of the stock again (SSB>B_{pa}).

Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). Targeted fishery for Norway pout was closed in 2005, first half year 2006, and in all of 2007 and fishing mortality and effort has accordingly reached historical minima in these periods (**Table** 5.3.6). Fishery was opened again 1st of January 2008 with a preliminary TAC of 41 250 t and a final TAC of 115 kt. For the EU zone the fishery was open all year 2008, while the Norwegian part of the directed Norway pout fishery was restricted to May-August 2008. The fishery did not catch the TAC set in 2008.

Recruitment reached historical minima in 2003-2004 and was low in 2006 (39 billions), but was near to the long term average (at 80 billions, arithmetic mean) in 2005 (75 billions) and 2007 (69 billions) and just above in 2008 (81 billions) (**Tables** 5.3.3 and Table 5.3.6).

On basis of the average 2008 recruitment ICES advised in October 2008 a TAC up to 35 000 t in 2009 which has resulted in management with an initial TAC set for 2009 on 26 000 t in the EC zone and a TAC of 1 000 t in the Norwegian zone. This advice is to be up-dated in light of the real time management advice in May 2009.

From the results of the forecast presented here it can be seen that if the objective is to maintain the spawning stock biomass above B_{pa} by 1st of January 2010 then a catch around 157 000 t can be taken in 2009 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 100 000 t can be taken in 2009. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2009 (corresponding to a F around 0.16) according to the long term management strategies (see section 5.11.1 below).

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment reflect the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

There is consistent bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management should also be provided for the stock in autumn 2009.

Long term management strategies have been evaluated for this stock by ICES (see below).

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the Stock Annex.

In autumn 2006 the management plans and harvest control rules for Norway pout were evaluated by ICES based on an EU request with respect to by-catches in the fishery and evaluation of recent initiatives to introduce more selective fishing methods in the Norway pout fishery (ICES CM 2006/ACFM:35). Recently developed gear technological by-catch devices can reduce by-catches of among other juvenile gadoids significantly). The working group concludes that these devices (or modified forms of those) should be brought into use in the fishery. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

In autumn 2006 the management plans and harvest control rules for Norway pout were evaluated by ICES based on an EU request with respect to by-catches in the fishery and evaluation of recent initiatives to introduce more selective fishing methods in the Norway pout fishery.

The fishery is targeting Norway pout and blue whiting. In managing this fishery, by-catches of cod, haddock, whiting, saithe, herring, and blue whiting should be taken into account, and existing technical measures to protect these by-catch species should be maintained. Furthermore, as commercial, exploratory fishery and provision of recent by-catch information has shown by-catch-ratios to be significant and recent scientific research based on at sea trials in the commercial fishery has shown that use of gear technological by-catch devices can reduce by-catches of juvenile gadoids significantly, the working group concludes that these gear technological by-catch reduction devices (or modified forms of those) should be brought into use in the fishery. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

Long term management strategies

Summary of management plan evaluations

ICES has evaluated and commented on three management strategies, following requests from managers – fixed fishing mortality (F=0.35), Fixed TAC (50 000 t), and a variable TAC escapement strategy. The evaluation shows that all three management strategies are capable of generating stock trends that stay away from B_{lim} with a high probability in the long term and are, therefore, considered to be in accordance with the precautionary approach. ICES does not recommend any particular one of the strategies.

The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. The escapement strategy has higher long term yield compared to the fixed fishing mortality strategy, but at the cost of a substantially higher probability of having closures in the fishery. If the continuity of the fishery is an important property, the fixed F (equivalent to fixed effort) strategy will perform better.

A detailed description of the long term management strategies and management plan evaluations can be found below and in the ICES AGNOP 2007 (ICES CM 2007/ACFM:39), ICES WGNSSK 2007 (ICES CM 2007/ACFM:30) and the ICES AGSANNOP (ICES CM 2007/ACFM:40) reports.

Background

On basis of an joint EU and Norwegian Requests in autumn 2006 with respect to Norway pout management strategies and by-catches in the Norway pout fishery as well as on basis of the work by ICES WGNSSK in autumn 2006 and spring 2007 during the ICES AGNOP 2007 (ICES CM 2007/ACFM:39) ACFM has already by May 2007 evaluated detailed output from management plans and harvest control rules evaluations considering two different management strategies for Norway pout, i.e. the real time escapement management strategy and the long term fixed F or E management strategy. This has been based on use of advanced stochastic simulation models and results from here supplied by DTU-Aqua. The fixed TAC long term management strategy was not evaluated in depth by the ICES AGNOP as it was not considered realistic at that time because of substantial loss in yield, but have later in autumn 2007 associated to the ICES WGNSSK in autumn 2007 (ICES CM 2007/ACFM:30) been evaluated and presented with the two other management strategies. Furthermore, in addition to the ICES response on the EC and Norway joint request on management measures for Norway pout, Denmark has, in autumn 2007, requested ICES to provide a full evaluation of the fixed TAC strategy for Norway pout including an estimation of the long term TAC which would be sustainable with a low probability (5%) of the stock falling below B_{lim}. An ICES ACFM subgroup considered the documentation during the autumn 2007 ACFM meeting and found that some further studies would be required in order to provide a well documented answer. All this was provided through the ICES AGSANNOP Report (ICES CM 2007/ACFM:40).

Long Term Harvest Control Rules for Norway pout in the North Sea and Skagerak

ICES and DTU-Aqua have now provided comprehensive evaluation for 3 types of long term management strategies for the stock which all have been accepted by ICES:

- Escapement strategy
- Long term fixed fishing mortality or fishing effort strategy, and
- Long term fixed TAC strategy,

The conclusions from the evaluation methods used for the three strategies are the following:

Escapement strategy

ICES evaluated an escapement strategy defined as follows: 1) an initial TAC that would be set for the first half of the TAC year, based on a recruitment index, and 2) a TAC for the second half of the year which would be based on a survey assessment conducted in the first half of the TAC year and the setting TAC for the second half of the year based on an SSB escapement rule. This escapement strategy shall generally assure an SSB above B_{pa}, i.e. with a target of obtaining an SSB that is truly above B_{lim} with a high probability (95%). In practice this Harvest Control Rule (HCR) is an escapement strategy with an additional maximum effort. The conclusion is that the equilibrium median yield is around 110 kt, and there is a 50 % risk for a closure of the fishery in the first half-year and a 20–25% risk of a closure in the second half-year. The distribution of F shows that the fishery will mostly alternate between a low and a high effort situation. When the fishery has been closed in the second half-year, there is around 20 % probability for another closure in the following year.

The robustness of the HCR to uncertainties in stock size indicates that annual assessment might not be necessary for this stock; an annual survey index could be sufficient.

Caveats to the evaluation of the escapement strategy:

- The sensitivity of the parameters in the HCR used for TAC in the first half-year has not been fully evaluated;
- Non-random distribution of residuals in the surveys may give biased perceptions and need to be included in the evaluation.

Effort control strategy

The effort control scenario with a fixed F indicates that an F of around 0.35 is expected to give a low (5 %) probability of the stock going below B_{lim}. The scenario appears robust to implementation uncertainties, and a target F below 0.35 and an implementation noise CV around 25 % is expected to give a long-term yield around 90 kt and no closures of the fishery would be needed. This management strategy is not dependent on an yearly assessment because it assumes a direct link between fishing effort and fishing mortality which is also apparent from the historical assessment of this stock.

Caveats to the evaluation of the effort control strategy:

- A regime shift towards a lower recruitment level will not be detected by this approach and there is a risk of over-fishing in such a situation with a fixed effort approach;
- Implementation of a fixed standardized effort (which is not measurable) can be difficult;
- Effort management in by-catch fisheries (e.g. by-catch of Norway pout in blue whiting fishery) is difficult to regulate;
- Effort – F relationships are known to suffer from technological creep and this aspect needs to be tested in the evaluation.

Fixed TAC strategy

The scenario with fixed TAC indicates that a long term TAC on around 50 kt will be sustainable with a low (5 %) probability of the stock going below B_{lim}. ICES concludes that a fixed TAC rule for Norway pout would be in accordance with the precautionary approach provided the fixed TAC is not greater than 50 kt and F does not exceed the value of 0.5, and provided measures are in place to reduce TAC in the exceptional case of a low recruitment in a number of consecutive years. The evaluations indicate that if a target TAC below 50 kt is implemented no closures of the fishery would be needed.

Caveats to the evaluation of the fixed TAC strategy:

- A regime shift towards a lower recruitment level will not be detected by this approach and there is a risk of overfishing in such a situation with a fixed TAC approach;
- For a short-lived species with highly variable recruitment such as Norway pout, a catch-stabilizing strategy (fixed TAC) is likely to imply a substantial loss in long-term yield compared to other strategies if the risk of SSB falling below B_{lim} is to remain reasonably low. This strategy is also sensible in relation to potential risks of regime shifts in the stock-recruitment-relationship.

Conclusions from management strategy evaluations

Not any particular of the management strategies presented above is recommended. All strategies that have a low risk of depleting the stock below B_{lim} are considered to be in accordance with the precautionary approach and being sustainable. The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. It should be noted that this is a long term management strategy evaluation and it is accordingly not possible to switch between strategies from year to year. Often switching between different long term strategies will be in conflict with the basic assumptions behind the evaluations of them.

The evaluation shows that all three types of management strategies (escapement, fixed effort, fixed TAC) are capable of generating stock trends that stay away from B_{lim} with a high probability.

The escapement strategy has a higher long-term yield (110 kt) compared to the fixed effort strategy (90 kt) and the fixed TAC strategy (50 kt) but at the cost of having closures in the fishery with a substantially higher probability. If the continuity of the fishery is an important property, then the fixed effort strategy performs better.

The simulations deal with observation error and implementation error of the management strategies but do not take into account process error in relation to natural mortality, maturity-at-age, or mean weight-at-age in the stock, which could have a significant impact.

The fixed effort strategy does not rely critically on the results of stock assessment models in any particular year. On the other hand, that strategy is very dependent on the possibility of actually implementing an effort scheme, including an account of the by-catch fisheries (e.g. for blue whiting) and ways to deal with effort creep.

The fixed effort strategy and the fixed TAC strategy are likely to imply a substantial loss in long-term yield compared to the escapement strategy if the risk of SSB falling below B_{lim} is to remain reasonably low. These strategies are also sensible in relation to potential risks of regime shifts in the stock-recruitment-relationship.

F. Other Issues

Suggestions for future Benchmark assessment

Recommendations for future assessments:

Coming benchmark assessment should consider new biological information (new estimates of spawning maturity, estimates of growth and growth parameters as well as of natural mortality published recently in ICES J. Mar. Sci. should be evaluated in context of the assessment). This includes recent developments in research survey based natural mortality estimates and new research results on natural mortality for the stock as well as up-dated natural mortality from the MSVPA model. Also variation in maturity at age as well as growth variation in the stock should be considered in relation to the assessment based on new research results. It is suggested that variable M be examined to determine the amount of biomass removed via predation.

Furthermore, consideration of revision of the tuning fleets with special focus on the commercial tuning fleets should be done in a coming benchmark assessment (see also the May 2007 assessment ICES CM 2007/ACFM:18 and 30, as well as the **Stock Annex**. This includes evaluation of the quality of the assessment with respect to inclusion of historical time series for fisheries data. The fluctuations in the fisheries effort over times and between seasons should be evaluated.

Evaluation of survey based assessment and/or more simple assessment methods: Assessment of stock status based exclusively on survey indices should be considered and robustness of survey indices should be considered.

Recent developments in relation to implementation of seasonal stochastic assessment models not dependent on constant exploitation patterns (F-patterns between years and ages) should be considered for the assessment of the stock.

New research findings on developments in by-catch reducing gear devices should be reported and evaluated under ecosystem aspects and fisheries aspects in relation to future benchmark assessment.

Trends and dynamics in landings and other available relevant information of Norway pout in VIa should be evaluated and brought forward to ACOM.

Overview of some recent management measures and regulations relevant for the Norway pout fishery and stock (from STCEF, 2005):

Existing by-catch regulations:

In the agreed EU Council and EU-Norway Bilateral Regulation of Fisheries by-catch regulations in the Norway pout fishery have been established (e.g. EU Regulation No 850/98 (EU, 1998)). The by-catch regulations in force at present for small meshed fishery (16-31mm in mesh size) in the North Sea is that catch retained on board must consist of i) at least 90% of any mixture of two or more target species, or ii) at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species. Provisions regarding limitations on catches of herring which may be retained on board when taken with nets of 16 to 31 mm mesh size are stipulated in EU Community legislation fixing, for certain fish stocks and groups of fish stocks, total allowable catches and certain conditions under which they may be fished. (EU, 1998) At current 40% herring is allowed in the Norway pout fishery.

1. Technical measures by EU:

Mesh size regulations in the North Sea and adjacent areas

Use of towed nets of any size mesh is permitted, however according to the mesh size in use there is an obligation to retain only particular species of fish. These tables are a simplified synopsis of measures in Council Regulation 850/98 and Commission Regulation 2056/2001.

	Conditions for use of towed gear (North Sea and West Scotland)	
Mesh size	**Main target species in North Sea**	**Synopsis of required catch percentages**
b.) 16 to 31mm	Norway pout, sprat	Minimum 60% of one species of Norway pout, sardine, sandeel, anchovy, eels, smelt and some non-human consumption species (with no more than 5% of cod, haddock or saithe, and some upper limits on the percentages of other species such as mackerel, squids, flatfish, gurnards, Nephrops), or at least 90% of any two or more of those species.

Areas closed to some fishing activities

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the "Norway pout box" was introduced where fisheries with small meshed trawls were banned. The "Norway pout box" has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W (see Figure 6.2).

(It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box. Before closure, the Danish and Faeroes fisheries mainly took place in the northwestern North Sea and the Norwegian fishery in the Norwegian Trench (ICES 1977). Based on IBTS samples for the period 1991-2004 (Figure 6.2), 30.0% and 27.5% of Norway pout numbers were estimated to be inside the Norway pout box for the first and third quarter, respectively. It should be noted that the IBTS survey does not cover depths >200 m along the Norwegian Trench, and that no fishery inside the Norway pout box may contribute to overestimation of the abundance relative to area outside).

Area	**Characteristics, Location and Seasonality**	**Purpose**	**Defined in Regulation (EC):**
North-West of Scotland	Annual, closed to all fishing except static gear and pelagic fishing	Reduction of fishing mortality on VIa cod	Annex III 27/2004 (annual measure in place since 2004).

Norway pout box	Prohibited to retain more than 5% of the catch as Norway pout if they are caught within an area boounded by 56°N and the UK coast, 58°N 2°E, 58°N 0°30' W, 59°15' N 0°30'W, 59°15' N 1° E, 60° N 1° E, 60°N 0°, 60°30'N 0°, 60°30'N and the coast of the Shetland Islands, 60°N and the coast of the Shetland Islands, 60°N 3°W, 58°30'N 3°W 58°30'N and the coast of the mainland UK.	Protection of juvenile gadoids (cod, haddock) caught in mixtures with Norway pout)	Article 26 of Regulation 850/98

Minimum landing sizes

These sizes are defined in Annex XII to Regulation 850/1998, though some changes are in effect for 2005 by means of the TAC and quota regulation (Regulation 27/2005). Here sizes for some of the main commercial species only are stated.

Species	Minimum Landing Size in 2005, as North Sea/IIIa	Regulation
Norway pout	None	850/1998

Quotas relevant to the European Community

Quotas have been established by the Community as follows for the relevant species. These figures refer to Total Allowable Catches in Community waters and to quotas for the Community in Norwegian waters.

Year	Sandeel, IIa+IIIa+IV EC zone	Sandeel, IVa, Norway zone	Norway Pout IIa+IIIa+IV, EC zone	Norway pout, Norway zone	Angler-fish, IIa+IVa, EC zone	Angler-fish, IVa Norway Zone
2000	1020000	150000	220000	50000[1]	17660	in 'others'
2001	1020000	150000	211200	50000[1]	14130	in 'others'
2002	918000	150000	198000	50000[1]	10500	in 'others'
2003	918000	131000	198000	50000[1]	7000	in 'others'
2004	826200	131000	198000	50000[1]	7000	in 'others'
2005	660960	10000	0	5000[2]	10314	1800

[1] Including mixed horse mackerel.

[2] Including mixed horse mackerel, and only as by-catches.

Year	Anglerfish Vb, VI, XII, XIV (EC)	Horse mackerel, IIa (EC), IV(EC)	Horse mackerel, Vb (EC waters), VI, VII, VIIIa,b,d,e, XII, XIV	Industrial fish, IV (Norwegian waters)	Other species, IIa, IV, VIa N of 56°30, allocation to NO, FAR, no restriction for EC.	Other species, Norwegian waters of IV
2000	8000	51000	240000	800[1]	5400	11000
2001	6400	51000	240000	800[1]	5400	11000
2002	4770	58000	150000	800[1]	5400	11000
2003	3180	50267	130000	800[1]	5400	11000
2004	3180	50267	137000	800[1]	5400	11000
2005	4686	42727	137000	800[1]	5120	7000

[1] Of which maximum 400 tonnes of horse mackerel.

Effort limits

Days-at-Sea

Since 2003, the Community has limited the number of days that a fishing vessel can be out of port and fishing in the North Sea and adjacent areas. This is implemented through annexes to the TAC and Quota Regulations (2341/2002, 2287/2003, 27/2005). Days at sea may be transferred between vessels with an adjustment for differences in engine power between the vessels. Additional days have been allocated to some member states in respect of decommissioning taking place since 2001.

The baseline days-at-sea allocations (i.e. before additions to take account of decommissioning) were as follows:

Gear type	Otter trawl, 100mm (90mm in IIIa) or over	Beam trawls, 80mm or over	Static demersal nets	Demersal longlines	Otter trawls 70-99mm (70-89mm in Skagerrak)	Trawl fishery 16-31mm
Typical target species	Cod, haddock, whiting	Plaice and sole	Cod, turbot	Cod	Nephrops	Norway pout, sandeel
2003	9	15	16	19	25	23
2004	10	14	14	17	22	20
2005	10 *	13	13	16	21	19

(*) - including one additional day allowable where administrative sanctions are in place.

2. Technical measures by Norway

TACs and effort limits

Norway has no national quotas on anglerfish, sandeel, Norway pout or horse mackerel, for Norwegian vessels in the Norwegian economic zone. These fisheries are regulated by technical measures and effort regulations.

Technical Measures

The Norwegian technical regulations are generally designed to avoid catches of non-targeted species and/or fish below the minimum size. The discard ban on commercially important species is considered a cornerstone of this policy. Other important elements are the surveillance, monitoring and inspections at sea by the Coastguard, the obligation to change fishing grounds, prohibition against fishing for particular species during specific periods or in specific areas, and the development of, and the requirement to use selective fishing gear. The philosophy behind the Norwegian technical regulations is to enable the fishermen to meet their obligation to avoid illegal catches.

The technical regulations are summarised in “Regulations relating to sea-water fisheries” of 22 December 2004.This stipulates the discard ban, the percentage composition of the catch that may be legally caught according to area and type of fishing gear being used, the characteristics of fishing gear that may be used in the fishery on certain species or in different areas, the minimum catching sizes and specific measures to limit catches of fish under the minimum catching size, regulations of mesh design, mesh sizes, selectivity devices etc.

When fishing demersal species for human consumption in the North Sea with trawl or Danish seine, it is prohibited to use gear where the mesh size of any part of the gear is less than 120 mm. In the Norwegian saithe fishery in the EU zone 110 mm may be used in accordance to the EU regulation in the EU zone.

In the North Sea gill net fisheries for cod, haddock, saithe, plaice, ling, pollack and hake it is prohibited to use gill nets where the full mesh size is less than 148 mm. In the fishery for anglerfish the minimum mesh size is 360 mm and in the halibut fishery the minimum mesh size is 470 mm.

Only the most relevant regulations with regard to anglerfish, sandeel, Norway pout and horse mackerel will be highlighted below.

Sandeel and Norway pout

Summary of the Norwegian regulations for sandeel and Norway pout:

- The sandeel fishery is closed from 25 June to 31 March
- Norway pout may only be fished as bycatch in the mixed industrial fishery in all areas under Norwegian fisheries jurisdiction
- Two areas (the Patch bank and the Egersund bank) in the Norwegian economic zone are closed to fishing for Norway pout, sandeel, and blue whiting
- Licensing scheme for vessels fishing with small mesh trawl
- Reduction capacity scheme for vessels fishing with small mesh trawl.

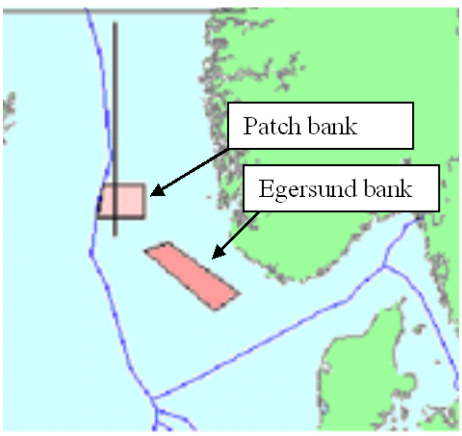
ACFM recommended that effort in 2005 should not exceed 40 % of the effort in 2004. Based upon this advice, the sandeel season in the Norwegian economic zone was further shortened in 2005. The sandeel season, defined as the period when smaller mesh size than 16 mm can be used, was 8 months (March – October) in 2003 and earlier. This season was reduced to April – September in 2003 and to the period 1 April to 23 June in 2005.

Furthermore, as a consequence of the advice on effort reduction Norway and the EU agreed to reduce the exchange of sandeel quotas dramatically compared with previous years. Due to the same reason, Norway did not allocate a traditional quota of sandeel to the Faeroes in 2005.

As a result of the recommendation from ACFM, Norway and the EU have agreed that Norway pout only may be fished as bycatch in 2005. Consequently, Norway pout was excluded from the exchange of quotas between Norway and the Faroes in 2005.

Areas closed to fishing for Norway pout, sandeel and blue whiting

Two areas in the Norwegian economic zone have been closed for fishing on Norway pout, sandeel and blue whiting. The approach has been to close areas were the probability of illegal by-catches of juveniles and not-targeted species, such as cod, saithe, haddock, are considered unacceptable high. This measure could therefore also be mentioned as a measure to protect juveniles of other species than Norway pout and sandeel. As of 1 January 2002 the Patch bank was permanently closed. Before the closure of the Patch bank an annual average of approximately 2.000 tonnes of Norway pout were fished in this area by Norwegian vessels. As from 1 May 2005 a seasonal closure of the Egersund bank in the period 1 December to 31 May was determined (map below). Other areas are under evaluation for permanent or seasonal closure.



Capacity reduction scheme for vessels fishing for sandeel and Norway pout

A small mesh trawl license is required to use a smaller mesh size than 16 mm in the directed fishery for sandeel in the season 15 April – 23 June. The same licence is required in order to participate in the mixed industrial fishery for blue whiting and Norway pout.

The number of vessels holding such a license has been reduced substantially the latter years as a result of the capacity reduction scheme put in place in 2002. The potential number of participating vessel was about 75 vessels in 2001. By May 2005 the number of potential participants has been reduced to about 50. In 2004 38 vessels participated in the sandeel fishery. The number of participating vessels so far in 2005 was 22 as of 24 May 2005.

Additional Danish regulations of the industrial fisheries (see section 5, sandeel, STCEF 2005)..

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Appendix 1. By-catch in Norway pout fisheries and possible reduction of by-catch

By-catches in Norway pout fisheries

Demersal fisheries in the North Sea are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Small-mesh industrial fisheries for Norway pout takes place in the northern and north-eastern North Sea and has by-catches of haddock, whiting, herring and blue whiting. Some cod is also taken as a by-catch, predominantly at ages 0 and 1 (ICES, 2006). With respect to un-intended by-catch in the commercial, small-meshed Norway pout trawl fishery in the North Sea and Skagerrak conducted by Denmark and Norway for reduction purposes ICES ACFM writes that management advice must consider both the state of individual stocks and their simultaneous exploitation. Stocks at reduced reproductive capacity should be the overriding concern for the management of mixed fisheries where these stocks are exploited either as a targeted species or as a by-catch (e.g. ICES, 2006).

Existing by-catch regulations:

In the agreed EU Council and EU-Norway Bilateral Regulation of Fisheries by-catch regulations in the Norway pout fishery have been established (e.g. EU Regulation No 850/98 (EU, 1998)). The by-catch regulations in force at present for small meshed fishery (16-31mm in mesh size) in the North Sea is that catch retained on board must consist of i) at least 90% of any mixture of two or more target species, or ii) at least 60% of any one of the target species, and no more than 5% of any mixture of cod, haddock, saithe, and no more than 15% of any mixture of certain other by-catch species. Provisions regarding limitations on catches of herring which may be retained on board when taken with nets of 16 to 31 mm mesh size are stipulated in EU Community legislation fixing, for certain fish stocks and groups of fish stocks, total allowable catches and certain conditions under which they may be fished. (EU, 1998) At current 40% herring is allowed in the Norway pout fishery.

Important by-catch species:

By-catch of the following species in the commercial, small meshed Norway pout fishery has been un-wanted and a concern for fisheries management: Cod, Haddock, Saithe, Whiting, Monkfish, Herring, and Blue Whiting, where especially by-catch of juvenile haddock and cod as well as larger saithe has been in focus.

By-catch levels from landings statistics:

In Tables A1 and A2 below are presented recent (2002-2005) by-catch levels by species in Danish and Norwegian small meshed industrial trawl fishery in the North Sea and Skagerrak areas targeting Norway pout. For Norway the landings used for consume purposes in the small meshed fishery can only be allocated to industrial fishery for the last two years. IMR does not have access to logbooks from industrial vessels. The Norwegian data are evaluated rather un-certain.

By-catch levels and factors affecting them from commercial fishing trials 2005:

Danish-Norwegian fishing trials and pilot investigations were performed in autumn 2005 in order to explore by-catch- levels in the small meshed industrial trawl fishery in the North Sea targeting Norway pout. The results are given in Working Document No. 22 to the WGNSSK (2006) by *Degel, Nedreaas and Nielsen (2006)*. The trial fishery was performed by two Norwegian commercial trawlers and a Danish commercial trawler traditionally involved in the small meshed industrial trawl fishery in the North Sea and Skagerrak targeting Norway pout. The investigation was in cooperation between the fisheries research institutes DIFRES and IMR. The South Norwegian Trawl Association (SNTA) and the Danish Fishermen's Association (DF) provided the contact to the fishing vessels used.

The fishery was carried out in autumn 2005 within periods and areas of conducting traditional fishery for Norway pout. The Norwegian vessels conducted each a survey to the area vest of Egersund on the edge of the Norwegian Trench. The Danish vessel conducted two surveys at Fladen Ground in and around the closed box for Norway pout fishery in the North Sea. Comparison fishery between one of the Norwegian vessels and the Danish vessel was performed on a spatio-temporally overlapping scale at the Patch Bank, a closed box for Norway pout fishery in an area between the Egersund Bank and Fladen Ground. The Norwegian vessels conducted both day and night fishery while the Danish vessel only fished during day time.

The results (except for the figure and table showing the diurnal variation in the fishery) comprise only hauls from day time fishery conducted with standard trawl gears used in the commercial small meshed industrial fishery targeting Norway pout. The skipper at the Danish vessel decided the positions and fishing design on a smaller fraction of the conducted hauls based on his evaluation of optimizing the fishery economically, while the rest of the hauls were allocated and pre-distributed in two selected ICES statistical squares.

In general the ratio between the Norway pout target species and the sum of by-catch of certain selected species indicate that the by-catch ratio is high in the commercial Norway pout fishery. However, statistical analyses reveal that the fishermen can significantly minimize the by-catch ratio by targeting in the fishery (spatio-temporal targeting, way of fishing, etc.), i.e. when they determine the fishing stations and the fishery performed. The pilot investigations show no general significant spatio-temporal patterns in the by-catch ratio. However, there are from the results obvious geographical and diurnal differences in the species composition of the by-catch between areas and between day and night fishery. The length distributions of the catch rates by species indicate spatial pattens between some of the species caught. These fishing trials and pilot investigations are based on only very few observations, and data are obviously rather uncertain, variable and noisy. In general, it can be concluded that relatively high by-catches can be reduced by specific targeting in the fishery, both with respect to allocation of the fishery in time and space but also in relation to fishermen knowledge about the fishery and resource availability. This demands though that the skippers/fishermen act accordingly when fishing, and a proper at-sea control. The conclusions above relate to using the Turbotrawl and the Expo1300. The few experiments with Jordfraeser and Kolmuletrål 1100 indicate a different species composition, with unchanged or higher by-catch rates of most species and general significant lover catch rates of Norway pout.

With regard to diurnal differences in the catch rates of Norway pout and by-catches of other species, the few results at present indicate significant lower by-catch of Blue whiting during night hauls. The rest of the by-catch species show no diurnal differences

With regard to possible depth differences in the catch rates of Norway pout and by-catches of other species, this matter relates primarily to the areas close to the Norwegian Deep, and more investigations are about to be carried out to document this better.

Technical measures to reduce by-catches.

Regulation of spatio-temporal effort allocation (closed seasons and areas):

The above investigations indicate spatio-temporal differences in catch levels by species in the commercial small meshed fishery for Norway pout as well as an effect of targeting and use of fishing method on the by-catches. However, these patterns are only based on results from pilot investigations. Knowledge about spatio-temporal patterns in catch rates of target species and by-catch species in the fishery are at present not adequate to implement management measures with respect to regulations on spatio-temporal allocation of fishing effort to reduce by-catches.

During the 1960s a significant small meshed fishery developed for Norway pout in the northern North Sea. This fishery was characterized by relatively large by-catches, especially of haddock and whiting. In order to reduce by-catches of juvenile roundfish, the "Norway pout box" was introduced where fisheries with small meshed trawls were banned. The "Norway pout box" has been closed for industrial fishery for Norway pout since 1977 onwards (EC Regulation No 3094/86). The box includes roughly the area north of 56° N and west of 1° W. In the Norwegian economic zone, the Patch bank has been closed since 2002. It is not possible to fully quantify the effect of the closure of the fishery inside the Norway pout box both with respect to catch rates of target and by-catch species as well as effects on the stocks (EU, 1985; 1987a; 1987b; ICES, 1979). There has not been performed fully covering evaluation of the effect of closed areas in relation to interacting effects of technological development in the fishery including changed selectivity and fishing behaviour over time in relation to by-catch rates. These effects can not readily be distinguished.

Gear technological by-catch reduction devices:

Investigations of gear specific selective devices and gear modifications to reduce unwanted by-catch in the small meshed Norway pout fishery in the North Sea and Skagerrak have been performed in a number of studies. It was recently investigated based on sea trials in year 2000 and reported through an EU Financed Project (EU, 2002), and the results from here have been followed up upon in a scientific paper from DIFRES and CONSTAT, DK (Eigaard and Holst, 2004). Previous investigations of size selective gear devices in the Norway pout trawl fishery in the North Sea was performed by IMR Norway during sea trials in 1997-1999 also published in a scientific paper (Kvalsvik *et al*., 2006), as well as in a number of other earlier studies on the issue. Main results of previous investigations have been reviewed and summarized in Working Document No. 23 to the WGNSSK (2006) by *Nielsen and Madsen (2006)*.

Early Scottish and Danish attempts to divide haddock, whiting and herring from Norway pout by using separator panels, square mesh windows, and grids were all relatively unsuccessful. More recent Faeroese experiments with grid devices have been more successful. A 74 % reduction of haddock was estimated (Zachariassen and Hjalti, 1997) and 80% overall reduction of the by-catch (Anon., 1998).

Eigaard and Holst (2004) and EU (2002) found that when testing a trawl gears with a sorting grid with a 24 mm bar distance in combination with a 108 mm (nominal) square mesh window through experimental, commercial fishery the results showed improved selectivity of the commercial trawl with catch weight reductions of haddock and whiting of 37 and 57%, but also a 7 % loss of Norway pout. The study showed that application of these reduction percents to the historical level of industrial by-catch in the North Sea lowered on average the yearly haddock by-catch from 4.3 to 2.7% of the equivalent spawning stock biomass. For whiting the theoretical reduction was from 4.8 to 2.1%. The purpose of the sorting grid was to remedy the by-catch of juvenile gadoids in the industrial fishery for Norway pout, while the purpose of square mesh window was to retain larger marketable consume fish species otherwise sorted out by the grid. By-catches in this study was mainly evaluated for haddock, whiting and cod, i.e. not for all above mentioned by-catch species of concern in the Norway pout fishery. However, the experiments have shown that the by-catch of important human consumption species in the industrial fishery for Norway pout can be reduced substantially by inserting a grid system in front of the cod-end. The study also demonstrated that it is possible to retain a major part of the larger marketable fish species like whiting and haddock and at the same time maintain substantial reductions of juvenile fish of the same species. The study also gave clear indications that further improvement of the selectivity is possible. This can be obtained by adjusting the bar distance in the grid and the mesh size in the selective window, but further research would be necessary in order to establish the optimal selective design.

The results reported in Kvalsvik *et al*. (2006) include results for more species of concern in the Norway pout fishery. They carried out experimental fishing with commercial vessels first testing a prototype of a grid system with different mountings of guiding panel in front of the grid and with different spacing (25, 22 and 19 mm) between bars, and then, secondly, testing if the mesh size in the grid section and the thickness of the bars influenced the selectivity of the grid system. Two different mesh sizes and three different thicknesses of bars were tested. Based on the first experiments, only a bar space of 22mm were used in the later experiments. These showed respectively that a total of 94.6% (weight) of the by-catch species was sorted out with a 32.8% loss of the industrial target species, where the loss of Norway pout was around 10%, and respectively that 62.4% of the by-catch species were sorted out and the loss of target species was 22%, where the loss of Norway pout was around 6%. When testing selectivity parameters for haddock, the main by-catch species, the parameters indicated a sharp size selection in the grid system.

In conclusion, the older experiments indicate that there is no potential in using separator devices and square mesh panels. Recent and comprehensive experiments with grid devices indicate a loss of of Norway pout at around 10% or less when using a grid with a 22-24 mm bar distance. It is also indicated that there is a considerable loss of other industrial species being blue whiting, Argentine and horse mackerel. A substantial by-catch reduction of saithe, whiting, cod, ling, hake, mackerel, herring, haddock and tusk have been observed. The reduction in haddock by-catch is, however, lowered by the presence of smaller individuals. The Danish experiment indicates that it is possible to retain larger valuable consume fish species by using a square mesh panel in combination with the grid. Selectivity parameters have been estimated for haddock, whiting and Norway pout. These can be used for simulation scenarios including estimates of the effect of changing the bar distance in the grid. Selectivity parameters for more by-catch species would be relevant. However, the grid devices have shown to work for main by-catch species.

A general problem by implementing sorting grids in industrial fisheries is the very large catches handled. Durability and strength of the grid devices used under fully commercial conditions are consequently very important and needs further attention. Furthermore, handling of heavy grid devices can be problematic from some vessels. Grid devices are, nevertheless, used in most shrimp fisheries, where catches often are large.

Conclusions from section

In conclusion, the commercial, exploratory fishery and provision of recent by-catch information has shown by-catch-ratios to be significant in the fishery, however, spatio-temporal differences in catch levels by species has been observed and by-catches can be reduced through targeting and fishing method. Recent scientific research based on at sea trials in the commercial fishery has shown that use of gear technological by-catch devices can reduce by-catches of among other juvenile gadoids significantly. Accordingly, it is recommended that these gear technological by-catch reduction devices (or modified forms of those) are brought into use in the fishery. Introduction of those should be followed up upon by adequate landings or at sea catch control measures to assure effective implementation of the existing by-catch measures.

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Table A1. Landings (tons) per species in the Danish small meshed Norway pout fishery in the North Sea by year and quarter. Landings are divided into the part used for reduction purposes and the part used for human consumption purposes. The latter landings are included in catch in numbers of human consumtion landings

Year	Species	Purpose	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Blank	Total	% of total catch
2005	Norway pout	Reduction						0	0
2004		Reduction	504		1474	5877		7855	87.5
2003		Reduction		45	1556	6322		7923	87.8
2002		Reduction	2,546		5,603	25,567	9,508	43224	78.6
2005	Blue whiting	Reduction						0	0
2004		Reduction	66					66	0.73
2003		Reduction		19	23	8		50	0.55
2002		Reduction	1966		589	950	1171	4676	8.50
2005	Herring							0	0
2004			11		422	304		737	8.21
2003				1	113	222		336	3.73
2002					217	2337	639	3193	5.81
2005	Cod	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction				1		1.3	0.01
		Hum. Con.	0.3		0.2	0.3		0.8	0.01
2003		Reduction				3		3	0.03
		Hum. Con.			0.5	0.8		1.3	0.01
2002		Reduction				3		3	0.01
		Hum. Con.	2		15.4	22.7		40.1	0.07
2005	Haddock	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction	5		49	3		57	0.63
		Hum. Con.	0.2		0.2	0.5		0.9	0.01
2003		Reduction				16		16	0.18
		Hum. Con.			0.1	1.8		1.9	0.02
2002		Reduction			408	1137		1545	2.81
		Hum. Con.	0.7		4.3	9.8		14.8	0.03
2005	Whiting	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction	32		59	141		232	2.58
		Hum. Con.	0.4		0.3	0.2		0.9	0.01
2003		Reduction			51	214		265	2.94
		Hum. Con.			0.3	2		2.3	0.03
2002		Reduction			239	1436		1675	3.05
		Hum. Con.			5.4	5.5		10.9	0.02
2005	Saithe	Reduction						0	0
		Hum. Con.						0	0
2004		Reduction						0	0
		Hum. Con.	0.7		5.8	4.2		10.7	0.12
2003		Reduction		0.4	4	22.8		27.2	0.30
		Hum. Con.						0	0
2002		Reduction			45	201		246	0.45
		Hum. Con.	30		84.3	66.3		180.6	0.33
2005	Other human	Hum. Con.						0	0
2004	Cons. Species	Hum. Con.	0.9		2.7	2.5		6.1	0.07
2003		Hum. Con.		0.6	2.2	6.2		9	0.10
2002		Hum. Con.						0	0
2005	All species	All						0	0
2004		All	626		2023	6331		8980	100
2003		All		66	2025	6929		9020	100
2002		All	4511		6815	31887	11767	54980	100

Stock Annex: Plaice IIIA

Stock specific documentation of standard assessment procedures used by the ICES WGNSSK.

Working group:	North Sea Demersal Working Group
Updated:	14/05/2009
By:	Clara Ulrich, DTU Aqua and Andrea Belgrano, IMR Sweden

A. General

A.1 Stock definition

The stock boundaries have been extensively investigated in the recent years. They were previously often considered as arbitrary and more for management purposes than based on a biological recognised stock separation. Electrophoresis and meristic character indicated that the plaice in IIIa is a mixed population of the Kattegat and the Skagerrak component, which is dominating and a Belt Sea component (Simonsen *et al*., 1988).

In 2006 and 2007, a compilation of comprehensive older Danish tagging data (Boje and Nielsen, WGNSSK 2007, WD) where around 40 000 plaice were marked and released between 1903 and 1964 across all Danish waters, provided some clear patterns about main plaice migration. Most areas showed some westwards direction, but the degree of residency within main management areas was in general very high. There is presence of little average mixing across management areas, may be an possible indication that IIIa could be considered a consistent unit for the stock definition. Although within IIIa, there are some important migration from eastern Skagerrak and North Kattegat, implying that both sub-areas are linked. However, some clear border effects with local mixing were observed, both in the south (between Belt North and South Kattegat) and in the North (between Horns Reef and Western Skagerrak).

Further work combining tag experiments, otolith structure analysis (microstructure and otolith chemistry) and genetic markers should be implemented to depict important recruitment sources for the Kattegat-Skagerrak plaice, nursery areas and migration routes.

The influence of the North Sea stock component, especially via the transport of eggs or larvae could also contribute to the IIIa plaice stock abundance (see Ecosystem aspects).

A.2 Fishery

The fishery is dominated by Denmark, with Danish landings usually accounting for 80 to 90% of the total. Landings are taken year round with a predominance of the period from spring to autumn, by Danish seiners, flatfish gillnetters and beam trawlers. Plaice is also caught within a mixed cod-plaice fishery by otter trawlers, and is a by-catch of other gillnet fisheries. .Plaice is also caught as by-catch in the directed *Nephrops* fishery. Most landings come from Skagerrak, along the Danish Northwestern coast close to the North Sea border. Since 1978, landings have declined from 27 000 to 9 000 tonnes in the late nineties. However, landings in 2001 were the highest since 1992. The fishery traditionally exploited mostly mature individuals (ages 4 to 6), but the landings proportion of fishes aged 2 and 3 has been increasing since 2000. The TAC is usually not restrictive.

The use of beam trawl in the Kattegat is prohibited, but allowed in the Skagerrak. Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land females in area IIIa from january 15th to april 30th.

A.3 Ecosystem aspects

The large scale circulation pattern in the Northern Kattegat depends mainly on interaction between Baltic runoffs and local variation due to wind stress. Nielsen et al., (1998) demonstrated that the abundance of settled 0-group plaice along the Danish coast of the Kattegat depends on transport from the Skagerrak. The 0-group abundance measured in July-August was significantly higher in years when wind conditions during the larval development period (March-April) were moderate to strong. This might imply that larval plaice are food-limited in years when calm conditions prevail during the larval drift period (Nielsen et al., 1998).

Stock dynamics should account for the several reproductively isolated spawning components of a stock (Ruzzante *et al*. 1999: Hilborn *et al*. 2003) in an explicit spatial context, therefore information on the spatial distribution of spawning grounds is crucial for studies and inference on stock structures, and therefore for fisheries management of exploited fish populations.

Further management consideration from an ecosystem perspective have been recently reporter by the Working Group on Multispecies Assessment Methods (WGSAM 2008).

B. Data

B.1 Commercial catch

ICES official landings are available from Belgium, Norway and Germany, and national statistics are available from Denmark, Sweden and the Netherlands. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Catch-at-age and mean weight-at-age in the catch information were traditionally provided by Denmark only. For 2003 data were also provided by Sweden, initially for both areas and since 2007 for Kattegat only. The sampling scheme is broken down by quarter, landing harbours, and fishing area. The total international catches-at-age have been estimated for Kattegat and Skagerrak separately since 1984. Raising procedures were historically performed manually, but ICES InterCatch database has been used for 2008 data.

B.2 Biological

Weight at age in the stock had previously been assumed equal to weight at age in the catch due to unavailable data on stock weights. In 2006, data were made available from IBTS 1st quarter (from 1991) and KASU 1st quarter (from 1997) in IIIa, and the 2006 WG provided revised estimates of stock weight at age. Only 1st quarter surveys and commercial data are used to calculate mean weights in order to generate the stock at the beginning of the year. Only age groups 1-4 are used from surveys as ages 5 and 6 are contradictory and considered too noisy. For older age groups weight at age in 1st quarter are computed from landings sampling from 1995. Before 1995 no information on weights per quarters was available. In summary compilation of stock at age are as follows:

- For age 1-4 (1997+) an average between the mean weight in the KASU and IBTS survey was used.
- Age 1-4 (1991-1996) mean weight from the IBTS survey was applied.
- Age 1-4 (1978-1991) an average from 1991-1995 (IBTS) was used as fixed value.
- Age 5-11 (1995+) mean weight from the commercial fleet first quarter.
- Age 5-11 (1978-1996) an average from (1995-1998) was used as fixed value.

Although the 2006 review group expressed some concerns about the quality of stock weight estimates, the procedure has not been revised since.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

A fixed natural mortality of 0.1 per year was assumed for all years and ages.

The maturity ogive was also revised during the 2006 WG. Previously, maturity was assumed knife-edge distributed: age group 2 was considered immature whereas age 3 and older plaice were considered fully mature. In 2006, a maturity-at-age was established based on IBTS 1st quarter data since 1994. Given large inter-annual variability especially at age group 2, a fixed 1994-2005 average value per age was applied to the entire time series.

B.3 Surveys

Data from four surveys are available. IBTS survey data for Kattegat and Skagerrak for the first and third quarter are provided by Sweden as numbers-per-age and hour on a haul-by-haul basis for the period< starting in 1991and 1995 respectively (no survey was performed in third quarter 2000). Two Danish bottom trawl surveys ('KASU') are conducted by the vessel 'Havfisken' in Kattegat, Belt Sea, and Western Baltic in the first and fourth quarter of each year. The indices time series available from these surveys started in 1996 for the first quarter survey (except 1998), and in 1994 for the fourth quarter survey. Until 2006 both the survey indices of the IBTS and KASU surveys first quarter were shifted from February to the preceding December to allow for full use of the available data. Since 2007, the WG has taken place earlier, in May, and only IBTS data are available for backshifting.

Very few plaice aged 7–9 are caught during the surveys and these ages are removed from the analysis.

B.4 Commercial CPUE

Three Danish fleets, i.e., trawlers, gillnetters, and Danish seiners, were traditionally available for tuning.

In 2006 effort was made to improve the quality of the commercial tuning fleets used in the assessment, both in terms of data checking, fisheries definition and effort standardisation. Two tuning fleets were retained, the Danish seiners and the Danish gillnetters targeting flatfish with 120 to 220 mm nets (vessels larger than 10m), with effort measured as kW*fishing days. The age-disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling.

The fishing effort appears to have been fairly stable over the last decade. There has been a decrease in the fishing effort of towed-geared fleets since 1990, but this trend has been reversing since 1998. The fishing effort of gillnetters has steeply increased over 1990-1994, and steadily decreased since then. All commercial fleets show increase in both the yield and the CPUE in 2001. Highest values and increases are observed for the Danish seiners.

B.5 Other relevant data

None.

C. Historical Stock Development

Analytical assessments were performed every year except in 2008, but they have not been accepted since 2005.

Deterministic modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite until 2005, FLXSA since 2006.

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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 = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Discards at age data have been available since 2002, but area not included in the assessment.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes (=landings)	1978 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers (=landings at age)	1978 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch (=weight at age in the landings)	1978 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1978 – last data year	2 – 10+	Yes
Mprop	Proportion of natural mortality before spawning	1978 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1978 – last data year	2 – 10+	No – the same ogive for all years
Natmor	Natural mortality	1978 – last data year	2 – 10+	No – set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Danish Gillnetters	1987 – last data year	2 – 10+
Tuning fleet 2	Danish seiners	1987 – last data year	2 – 10+
Tuning fleet 3	IBTS Q1 backshifted	1991 – last data year	1 – 6
Tuning fleet 4	KASU Q4	1994 – last data year	1 – 6
Tuning fleet 5	KASU Q1	1995 – last data year	1 – 5
Tuning fleet 6	IBTS Q3	1995 – last data year	1 – 6

C.1 Uncertainty analysis

C.2 Retrospective analysis

Performed with FLR packages

D. Short-Term Projection

not run since 2005

Settings previously used :

Software used: WGFRANSW

Initial stock size. Stock sizes for age 3 and older are taken from the estimated number of survivors from the XSA. The age 2 recruitments are taken as the geometric average over the entire period.

Natural mortality: Set to 0.1 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: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

E. References

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Stock Annex: Plaice in area IV

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North Sea plaice
Working Group:	WGNSSK
Date:	7 February 2009
By:	Jan Jaap Poos

A. General

A.1 Stock definition

The North Sea plaice is defined to be a single stock in ICES are IV. However, data from data storage tag experiments reveal that about one third of plaice released in the Southern Bight of the North Sea visit the eastern English Channel in December and January. In contrast, analysis of the movements of mark-recapture experiments with plaice of a similar size and released at similar times indicates that only 13% of plaice released in the Southern Bight visit the eastern English Channel at this time (Hunter et al., 2004). This difference between DST and mark-recapture experiments is not observed in the central North Sea and German Bight, where the movements of plaice derived from the two approaches are relatively similar (Bolle et al., 2005). The differences may possibly be due to the fact that these fish migrate to their spawning grounds by selective tidal stream transport. Studies (Kell et al., 2004) have shown that the migration between North Sea and the adjacent areas is more problematic for the smaller adjacent areas than it is for management in IV.

Genetic analysis of plaice population structure in northern Europe using microsatellites and mitochondrial DNA data (Hoarau et al., 2004) reveals relatively strong differentiation between "shelf" plaice and those from Iceland and Faeroe, suggesting that deep water may serve as a barrier to movement between these populations. However, within the area of the European continental shelf, only weak differentiation could be detected between North Sea-Irish Sea and other areas (Norway, the Baltic and the Bay of Biscay, Hoarau *et al*., 2004). Although the spatial location of sampling within the North Sea was not sufficient to reveal any sub-structure. The lack of any genetic differentiation between Irish Sea and North Sea plaice populations (Hoarau et al., 2004) despite the evidence from mark-recapture studies that indicate extremely low transfer of individuals between these sea areas (0.36% over 17 years, calculated from (Dunn and Pawson, 2002)) shows how differently genetic and tagging studies provide an understanding fish population structure. Nonetheless, it seems unlikely that Irish Sea and North Sea plaice are a single "stock", at least in a fisheries management sense.

A.2 Fishery

North Sea plaice is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south -eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. Due to the minimum mesh size enforced (80 mm in the mixed beam trawl fishery), large numbers of (undersized) plaice are discarded. Fleets exploiting North Sea plaice have generally decreased in number of vessels in the last 10 years. However, in some instances, reflagging vessels to other countries has partly compensated these reductions. For example, approximately 85% of plaice landings from the UK (England and Scotland) is landed into the Netherlands by Dutch vessels fishing on the UK register. Vessels fishing under foreign registry are referred to as flag vessels. As described by the ICES WGNSSK in 2001 (ICES CM 2002/ACFM:01), the fishing pattern of flag vessels can be very different from that of other fleet segments. Besides having reduced in number of vessels, the fleets have also shifted towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box). Also, the decrease in fleet size may partially have been compensated by slight increases in the technical efficiency of vessels. In the Dutch beam trawl fleet indications of an increase of technical efficiency of around 1.65% by year was found over the period 1990 – 2004 (Rijnsdorp et al., 2006). Because the commercial tuning series are not currently used in the assessment, these estimates do not affect the current assessment.

The Dutch beam trawl fleet, one of the major operators in the mixed flatfish fishery in the North Sea, has seen a shift towards more inshore fishing grounds, changing the catchability of the fleet. This shift may be caused by a number of factors, such as the implementation of fishing effort restrictions, the increase in fuel prices and changes in the TAC for the target species (Quirijns, 2008). However, the contribution of each of these factors is yet unknown. Other factors affecting the catchability of the fleet include the changes in the fishing speed of the vessels, and discarding marketable fish in certain seasons and areas, as a result of the TAC management (Rijnsdorp, 1991)

Conservation schemes and technical conservation measures

Fishing effort has been restricted for demersal fleets in a number of EC regulations (EC Council Regulation No. 2056/2001; EC Council Regulation No 51/2006; e.g N°40/2008, annex IIa). For example, for 2007, Council Regulation (EC) No 41/2007 allocated different days at sea depending on gear, mesh size, and catch composition: Beam Trawls could fish between 123 and 143 days per year. Trawls or Danish seines could fish between 103 and 280 days per year. Gillnets could allowed to fish between 140 and 162 days per year. Trammel nets could fish between 140 and 205 days per year.

Several technical measures are applicable to the plaice fishery in the North Sea: mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box).

Mesh size regulations for towed trawl gears require that vessels fishing North of 55 N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority the plaice fishery takes place, an 80 mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100mm is required. In addition to this, since 2002 a small part of North Sea plaice fishery is affected by the additional cod recovery plan (EU regulation 2056/2001) that prohibits trawl fisheries with a mesh size <120mm in the area to the north of 56°N.

The minimum landing size of North Sea plaice is 27 cm. The maximum aggregated beam length of beam trawlers is 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam -length is 9m. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are ex-empted from the regulation. An evaluation of the plaice box has indicated that:

From trends observed it was inferred that the Plaice Box has likely had a positive effect on the recruitment of Plaice but that its overall effect has decreased since it was established. There are two reasons to assume that the Plaice Box has a positive effect on the recruitment of Plaice: 1) at present, the Plaice Box still protects the majority of undersized Plaice. Approximately 70 % of the undersized Plaice are found in the Plaice Box and Wadden Sea, and despite the changed distribution, densities of juvenile Plaice inside the Box are still higher than outside; 2) In the 80 mm fishery, discard percentages in the Box are higher than outside. Because more than 90 % of the Plaice caught in the 80 mm fishery in the Box are discarded, any reduction in this fishery would reduce discard mortality. There is, however, no proof of a direct relationship between total discard mortality and recruitment.

A.3 Ecosystem aspects

Adult North Sea plaice have an annual migration cycle between spawning and feeding grounds. The spawning grounds are located in the central and southern North Sea, overlapping with the distribution area of Sole. The feeding grounds are located more northerly than the sole distribution areas. Juvenile stages are concentrated in shallow inshore waters and move gradually off-shore as they become larger. The nursery areas on the eastern side of the North Sea contribute most of the total recruitment. Sub-populations have strong homing behaviour to specified spawning grounds and rather low mixing rate with other sub-populations during the feeding season (de Veen, 1978, Rijnsdorp and Pastoors, 1995). Genetically, North Sea and Irish Sea plaice are weakly distinguishable from Norway, Baltic and Bay of Biscay stocks using mitochondrial DNA (Hoarau et al., 2004).

Juvenile plaice were distributed more offshore in recent years. Surveys in the Wadden Sea have shown that 1-group plaice is almost absent from the area where it was very abundant in earlier years (van Keeken et al., 2007). The Wadden Sea Quality Status Report 2004 (Vorberg et al., 2005) notes that increased temperature, lower levels of eutrophication, and de-cline in turbidity have been suggested as causal factors, but that no conclusive evidence is available; taking into account the temperature tolerance of the species there is ground for the hypothesis that a temperature rise contributes to the shift in distribution.

A shift in the age and size at maturation of plaice has been observed (Grift et al., 2007, Grift et al., 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. This shift is thought to be a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate is reduced after maturation.

B. Data

B.1 Commercial catch

Discard sampling programmes started in the late 1990s to obtain discard estimates from several fleets fishing for flatfish. These sampling programmes give information on discard rates from 1999 but not for the historical time series. Observations indicate that the proportions of plaice catches discarded are high (80% in numbers and 50% in weight: (van Keeken et al., 2004)) and have increased since the 1970s (51% in numbers and 27% in weight: (van Beek, 1998)) The discards time series are derived from Dutch, Danish, German and UK discards observations for 2000 – 2007. For the period prior to that, a reconstructed discard time series for 1957 – 1999 exists, based on a re-constructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Section 9.2.3).

The discard data from the sampling programmes in the individual countries are raised totals, based on samples from onboard observers. These observers generally take length structured samples that are

The UK discards estimates have strong interannual variation, caused by the low sample sizes, and sampling different strata in the UK fleet. For example, the UK discard samples for 2007 were taken mainly from the UK *Nephrops* and otter trawl fishery. These fisheries represent only a small fraction of the total UK plaice landings, and raising the UK discards using only samples from this fleet would potentially lead to incorrect estimates. Since the UK landings represents 24% of the total nominal landings, obtaining accurate discard estimates is crucial. In order to gain better estimates of discards, the proportionality of the English discards to the Dutch discards is calculated in the observations since 2000. The UK estimates are recalculated assuming a constant ratio between the UK and Dutch discard numbers at age:

$$\hat{D}_{a,y}^{UK} = \frac{\sum_{y=2002}^{2007} D_{a,y}^{UK}}{\sum_{y=2002}^{2007} D_{a,y}^{NL}} \times D_{a,y}^{NL} \qquad 1.$$

where $D_{a,y}^{UK}$, $\hat{D}_{a,y}^{UK}$, and $D_{a,y}^{NL}$ are the observed and estimated UK, and observed Dutch discard numbers of year *y* and age *a*, respectively

After raising to the fleet total and estimation of discards -at age using age length keys from the Dutch BTS surveys, discard observations at age are thus available from the Dutch, Danish, German and the UK discard sampling programmes. The sampling effort in the Dutch and UK programmes is given in The quality of the estimation of total discards numbers at age depends on the quality of the available discards data, which are derived from low sampling level discards observations within the four countries that have provided discard estimates.

Discards at age were raised from the Dutch and UK sampling programmes by effort ratio (based on hp days at sea for the Dutch fleets, and on trips for the UK fleets). Discards at age from the Danish and German sampling programs were raised by landings. Discards at age for the other fleets for which no estimates were available, were calculated as a weighted average of the Dutch, Danish, German and UK discards at age and raised to the proportion in landings (tonnes). This is the same method as used in the final assessment by WGNSSK 2005 (method B).

A self sampling programme for discards was started by the Dutch beam trawl fishery in 2004, and is still running. This sampling program has a high number of samples, taken on board by the fishermen, estimating the percentage of discards by volume. The program indicates a strong spatial pattern in the discarding of the fleet. The percentage discards estimated in the self sampling program is significantly lower than that in the Dutch sampling programme in the same years (Aarts and van Helmond, 2007).

To reconstruct the number of plaice discards at age before 2000 that are required for an XSA assessment, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution o-gives (ICES CM 2005/ACFM:07 Appendix 1). Alternatively, the discards previous to 2000 can be estimated using the statistical catch-at-age approach as described in (Aarts and Poos, 2009).

Landings

The landings by country are collected by different countries, segregated by sex for the Netherlands and Belgium (accounting for approximately 50 % of the landings). Age structure is available for the Netherlands, France, Germany, Denmark and Belgium (accounting for approximately 75% of the landings). The total age structured landings are estimated using a weighed procedure for the age structure by country, based on the proportionality of the weight of the total landings.

B.2 Biological

Weight at age

The stock weights of age groups 1 -4 are calculated using modeled mean lengths from survey and back -calculation data (see ICES CM 2005/ACFM:07 Appendix 1) and converted to mean weight using a fixed length -weight relationship. Stock weights of the older ages are based on the market samples in the first quarter. Stock weight at age has varied considerably over time, especially for the older ages. Discard weights at age are calculated the same way as the stock weights of age groups 1 -4, after which gear selection and discarding ogives are applied. Landing weights at age are derived from market sampling programmes. Catch weights at age are calculated as the weighted average of the discard and landing weights at age. There appear to be cohort effects on landings weight at age, which are also reflected in the stock weights at age. In addition to the cohort effects, there is a long term decline in weight at age for the older ages. The stock weights of the older ages are based on the market samples in the first quarter. In these market samples, the sex ratio for the older ages may be skewed towards one of the sexes. The WG suggests a more in depth study into the causes and consequences of the perceived decreases in stock weights for the next benchmark assessment.

Natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. These values are probably derived from war-time estimates (Beverton and Holt, 1957).

Maturity

A fixed maturity ogive is used for the estimation of SSB from the assessment in North Sea plaice, assuming maturity-at-age 1 is 0, maturity-at-age 1 and 2 is 0.5, and older ages are fully mature. However maturity at-age is not likely to be constant over time (Grift *et al*. 2003, Grift *et al*. 2007) (Grift et al., 2007, Grift et al., 2003). The effects of assuming a constant maturity-at-age on the management advice was discussed in a study by (Kell and Bromley, 2004). However, a study of the effect of the fluctuations of natural mortality on the SSB by the WG in 2004 showed that incorporating the historic fluctuations had little effect on SSB estimates in the period 1999 -2003.

B.3 Surveys

Three different survey indices can been used as tuning fleets are:

- Beam Trawl Survey RV Isis (BTS -Isis)
- Beam Trawl Survey RV Tridens (BTS -Tridens)
- Sole Net Survey in September -October (SNS)

Additional Survey indices that can be used for recruitment estimates are (Table 8.2.12):

- Demersal Fish Survey (DFS)

The Beam Trawl Survey RV Isis (BTS -Isis) was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south -eastern part of the North Sea (RV Isis). Since 1996 the BTS -Tridens covers the central part of the North Sea, extending the survey area of the surveys. Both vessels use an 8-m beam trawl with 40 mm stretched mesh codend, but the Tridens beam trawl is rigged with a modified net. Owing to the spatial distribution of both BTS surveys, consider-able numbers of older plaice and sole are caught. Previously age groups 1 to 4 were used for tuning the North Sea plaice assessment, but the age range has been extended to 1 to 9 in the revision done by ACFM in October 2001.

The Sole Net Survey (SNS & SNSQ2) was carried out with RV Tridens until 1995 and then continued with the RV Isis. Until 1990 this survey was carried out in both spring and autumn, but after that only in autumn. The gear used is a 6 m beam trawl with 40 mm stretched mesh cod -ends. The stations fished are on transects along or perpendicular to the coast. This survey is directed to juvenile plaice and sole. Ages 1 to 3 are used for tuning the North Sea plaice assessment; the 0 -group index is used in the RCT3. In an attempt to solve the problem of not having the survey indices in time for the WG, the SNS was moved to spring in 2003. However, because of the gap in the spring series these data could not be used in the plaice assessment or in RCT3. In 2004, the SNS was moved back to autumn as before, based on the recommendation of the WGNSSK in 2004.

The 1997 survey results for the 1995 and 1996 year classes (at ages 1 and 2) in the BTS and SNS surveys cannot be used in the assessment, owing to age reading problems in that year. Also, the research vessel survey time series have been revised in May 2006 by WGBEAM (ICES 2006), because of small corrections in data bases and new solutions for missing lengths in the age -length-keys.

When WGBEAM will provide these combined series, those should be used instead in the assessment.

The Demersal Fish Survey (DFS) is the more coastal of the surveys, conducted by several countries. This survey is not used in the assessment, but rather used to estimate the recruitment of juvenile fish in the RCT3 analysis. The survey estimates abundances for North Sea plaice age 0 and age 1. However, the age 1 has not been used for recruitment estimation since a number of years, and the time series for this age was stopped in 2005. The UK contribution to the DFS survey was revised in 2008, affecting the estimates between 2001 and 2006.

B.4 Commercial LPUE

Commercial age structured LPUE series (consisting of an effort series and landings-at-age series) that can be used as tuning fleets are:

- The Dutch beam trawl fleet (since 1989)
- The Dutch beam trawl fleet corrected for spatial effort allocation (since 1997)
- The UK beam trawl fleet excluding all flag vessels (between 1990 and 2002)

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. Up until 2002, the age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time.

The WG used both survey data and commercial LPUE data for tuning until the mid 1990s. The commercial LPUE was calculated as the ratio of the annual landings over the total number of fishing days of the fleet. At that time, however, it was realised that the commercial LPUE data of the Dutch beam trawl -fleet, which dominated the fishery, were likely to be biased due to quota restrictions. Vessels were reported to adjust their fishing patterns in accordance to the individual quota available for that year. Fishers reported to leave productive fishing grounds because they lacked the fishing rights and moved to areas with lower catch rates of the restricted species with a bycatch of non -quota, or less restricted species.

A method that corrects for the spatial effort allocation is to calculate LPUEs at a smaller spatial scale, e.g. ICES rectangles, and then calculate the average of these ICES rectangle-specific LPUEs. Age-information is available at this spatial level since 1997, and LPUE series could be used for tuning an age structured assessment method (alternatively, age -aggregated tuning series could be used in other analytical assessment methods than XSA). Only under the assumption that discarding is negligible for the older ages, the LPUE represents CPUE, and this time-series could be used to tune age structured assessment methods.

Also, ageaggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns and Poos 2007), by area and fleet component, can be used as indication of stock development. Available are

- The Dutch beam trawl fleet (only large cutters with engine powers above 221 kW)
- The UK beam trawl flag vessels landing in the Netherlands (only large cutters with engine powers above 221 kW)
- Several Danish fleets (trawl, gillnet and seines) mainly operating in the Northern area
- Effort of the Dutch beam trawl fleet and of the English beam trawl vessels landing in the Netherlands, by area and fleet component.

B.5 Other relevant data

To be done

C. Historical Stock Development

There are currently two methods that could be used to provide an assessment of North Sea plaice, being XSA, and a model developed by (Aarts and Poos, 2009). The XSA uses the reconstructed discard set described in the catch section. The Aarts and Poos methods estimates the discards from the mortality signals in the surveys, the landings-at-age and the discards-at-age in the most recent period. WKFLAT 2009 suggest to run both models concurrently, in order to estimate the stability of the Aarts and Poos method.

Model used as a basis for advice

The North Sea plaice is based on the XSA stock assessment. Settings for the final assessment are given below:

Setting/Data	Values/source
Catch at age	Landings (since 1957, ages 1- 10) + (reconstructed) discards based on NL, DK + UK + GE fleets. Discards reconstruction between 1957-1999), observations since 2000
Tuning indices	BTS -Isis 1985-2007 1-8 BTS -Tridens 1996-2007 1-9 SNS 1982 -2007 1-3
Plus group	10
First tuning year	1982
Time series weights	No taper
Catchability dependent on stock size for age <	1
Catchability independent of ages for ages >=	6
Survivor estimates shrunk towards the mean F	5 years / 5 years
s.e. of the mean for shrinkage	2.0
Minimum standard error for population estimates	0.3
Prior weighting	Not applied

The Aarts and Poos model

Setting/Data	Values/source
Catch at age	Landings (since 1980, ages 1:9) + discards based on observations since 2000 NL, DK + UK + GE fleets (ages 1:8). No reconstruction
Tuning indices	BTS -Isis 1985-2007 1-8 BTS -Tridens 1996-2007 1-9 SNS 1980-2007 1-3
Plus group	No plus group
First tuning survey year	1980
Catchability independent of ages for ages >=	8 (for catches)
Minimum standard error for likelihood function	0.05
Prior weighting	Not applied

D. Short-term Projection

Because the assessment on which the advice is based is currently a fully deterministic XSA, the short term projection can be done in FLR using FLSTF (1.4.3). Weight -at-age in the stock and weight -at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2007. The proportion of landings at age was taken to be the mean of the last three years, this proportion was used for the calculation of the discard and human consumption partial fishing mortality. Population numbers at ages 3 and older are XSA survivor estimates.

Numbers at age 2 are based on RCT3 estimates if the estimates from RCT3 show sufficient consistency.

Numbers at age 1 and recruitment of the incoming year-class are taken from the long-term geometric mean of age 1 assessment estimates, where the most recent 4 years are removed from the time-series. The management options are given for three different assumptions on the F values in the intermediate year;

a) F is assumed to be equal to the estimate for F in the final year of the assessment,

b) F is 0.9 times F in the final year of the assessment, and

c) F is set such that the landings in the intermediate year are equal to the TAC of that year.

E. Medium-Term Projections

Generally, no medium term projections are done for this stock.

F. Long-Term Projections

Generally, no medium term projections are done for this stock.

G. Biological Reference Points

The current reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock/recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ be set at 160 000 t and that $\mathbf{B_{pa}}$ then be set at 230 000 t using the default multiplier of 1.4. $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t. In 2008, a target F was added to the reference points, based on the F stated in the long term management plan for plaice an sole. This target F is supposedly based on an estimates of F_{msy}.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	160 000 t	B_{loss} = 160 000 t, the lowest observed biomass in 1997 as assessed in 2004.
	B_{pa}	230 000 t	Approximately 1.4 B_{lim}.
	F_{lim}	0.74	F_{loss} for ages 2–6.
	F_{pa}	0.60	5th percentile of F_{loss} (0.6) and implies that B_{eq}>B_{pa1}) and a 50% probability that SSB_{MT} ~ B_{pa}.
Targets	F_{mgt}	0.3	EU management plan

(unchanged since 2004, target added in 2008)

The F_{msy}, F_{max} and $F_{0.1}$ should be estimated given the 10 most recent years of the stock assessment.

H. Other Issues

None identified

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Stock Annex: Plaice in Division VIId

Working Group:	**ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)**

A. General

A.2 Stock Definition

There is mixing of plaice between the North Sea and VIId both as adults and juveniles. Analysis of tagging data shows that around 40% of the juvenile plaice in VIId come from nursery grounds in the North Sea. The eastern Channel supplies very few recruits to the North Sea. There is also an adult migration between the North Sea and Channel with 20-30% of the plaice caught in the winter in VIId were from migratory North Sea fish. Separation between VIId and the western Channel (VIIe) is much clearer. VIId does not receive significant numbers of juvenile plaice from VIIe but contributes around 20% of the recruits to VIIe. Similarly, around 20% of the adult plaice spawning in VIId may have spent part of the year in VIIe but few plaice tagged in VIIe during the spawning period are recaptured in VIId. It can be concluded that there is considerable interchange of plaice from the North Sea into VIId but a much smaller interchange between VIId and VIIe. Since the exploitation patterns between the three areas are very different, it has been concluded that separate assessments should be carried out.

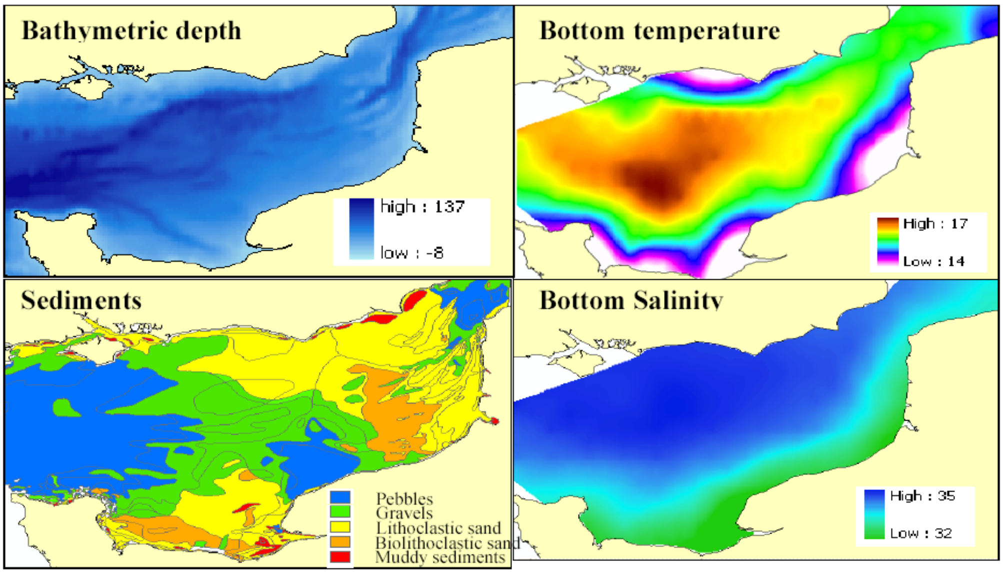
The management area for channel plaice is a combined one between VIId and VIIe. TACs are obtained by combining the agreed TAC from each area.

A.3 Fishery

Plaice is mainly caught in beam trawl fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. There is only light activity by this fleet between April and September. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10m operating on a daily basis within 6 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is not available but comparison with the North Sea suggests that discarding levels in excess of 40% by weight are likely. Discard survival from small otter trawlers can be in excess of 50% (Millner et al., 1993). In comparison discard mortality from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek et al 1989).



A.3 Ecosystem Aspects

Figure 1 Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by kriging. (in Vaz *et al.* 2004)

Biology : Adult plaice feed essentially on annelid polychaetes, bivalve molluscs, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel, spawning occurs from December to March between 20 and 40 m. depth. At the beginning, pelagic eggs float at the surface and then progressively sink into deeper waters during development. Hatching occurs 20 (5-6°C) to 30 (2-2.5°C) days after fertilization. Larvae spend about 40 days in the plankton before migrating to the bottom and moving to coastal waters when metamorphosing (10-17 mm). The fry undergo relatively fast growth during the first year (*Carpentier et al., 2005*).

Environment: This bentho-demersal species prefers living on sand but also gravel or mud bottoms, from the coast to 200 m depth. The sepcies is found from marine to brackish waters in temperate climate (*Carpentier et al., 2005*)..

Geographical distribution : Northeast Atlantic, from northern Norway and Greenland to Morocco, including the White Sea; Mediterranean and Black Seas (*Carpentier et al., 2005*)..

Vaz *et al*. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Fig.2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

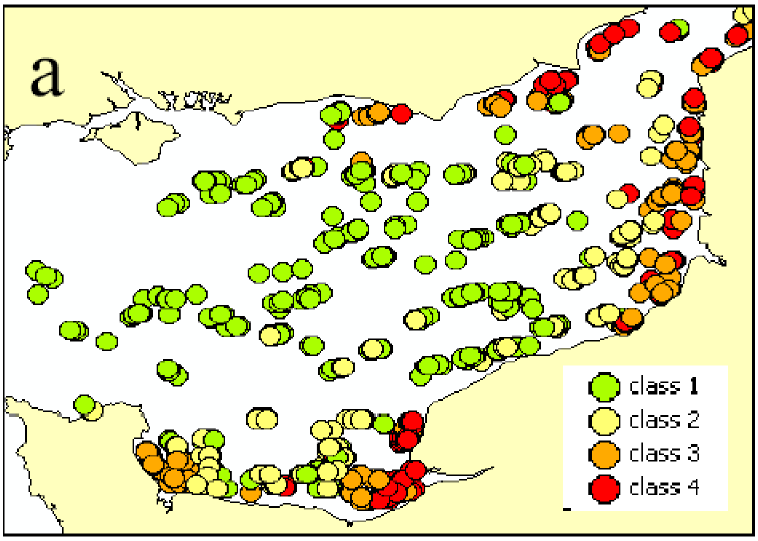


Figure 2 : Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities. (In Vaz *et al*., 2004)

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

B. Data

B.2 Commercial Catch

The landings are taken by three countries France (47% of combined TAC), England (13%) and Belgium (40%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books (CHECK).

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch.

France

French commercial landings in tonnes by quarter, area and gear are derived from logbooks for boats over 10m and from sales declaration forms for vessels under 10m. These self declared production are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. This first year of collection will be incomplete in term of time coverage, therefore the use of these data should be investigated only from 2005.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the October GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The length not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m who do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. . No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation.

The gear group used for length measurements are beam trawl, otter trawl and net.

Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

Country	Numbers	Weights-at-age
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are supplied as FISHBASE files containing quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\ple_eche or w:\ifapdata\eximport\nsskwg\ple_eche.

B.2 Biological

Natural mortality

Natural mortality was assumed constant over ages and years at 0.1 as in the North Sea.

Maturity

The maturity ogive used assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weight at age

Prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole. The database was revised back to 1990.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

B.3 Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled (Cf. Annex 1). Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October (Annex 2). Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

B.4 Commercial CPUE

Three commercial fleets have been used in tuning. UK inshore trawlers, Belgian beam trawl fleet and French otter trawlers as well as three survey fleets.

The effort of the French otter trawlers is obtained by the log-books information on the duration of the fishing time weighted by the engine power (in KW) of the vessel. Only trips where sole and/or plaice have been caught is accounted for.

B.5 Other Relevant Data

None.

C. Historical Stock Development

Deterministic Modelling

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

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 estimate are shrunk = 1.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning.

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1980 – last data year	2– 10+	Yes
Canum	Catch at age in numbers	1980 – last data year	2– 10+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	2– 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1980 – last data year	2– 10+	Yes - assumed to be the weight at age in the Q1 catch
Mprop	Proportion of natural mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	2– 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	2– 10+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	2– 10+	No – set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet1	English commercial Inshore trawl	1985 – last data year	2 – 10
Tuning fleet2	Belgian commercial Beam trawl	1981 – last data year	2-10
Tuning fleet3	French trawlers	1989 – last data year	2 -10
Tuning fleet4	English BT survey	1988 – last data year	1 – 6
Tuning fleet5	French GFS	1988 – last data year	1 -5
Tuning fleet6	International YFS	1987 – last data year	1 -1

C.1 Uncertainty Analysis

C.2 Retrospective Analysis

D. Short-Term Projection

Model used: Age structured

Software used: IFAP prediction with management option table and yield per recruit routines

Initial stock size: Taken from XSA for age 3 and older. The number at age 2 in the last data year is estimated using RCT3. The recruitment at age 1 in the last data year is estimated using the geometric mean over a long period (1980 – last data year)

Natural mortality: Set to 0.1 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 weight of the three last years

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 (2-6) to the level of the last year

Intermediate year assumptions:

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

The segmented stock/recruitment relationship is considered not significant (ICES, 2003a). There is therefore no consistent basis to build a medium term projection.

F. Long-term projections, yield per recruit

G. Biological Reference Points

Blim = 5400 t.

Bpa = 8000 t.

Flim = 0.54

Fpa = 0.45

H. Other Issues

None.

I. References

Beek, F.A. van, Leeuwen, P.I. van and Rijnsdorp, A.D. 1989. On the survivalof plaice and sole discards in the otter trawl and beam trawl fisheries in the North Sea. ICES C.M. 1989/G:46, 17pp

Carpentier, A., Vaz, S., Martin, C. S., Coppin, F., Dauvin, J.- C., Desroy, N., Dewarumez, J.- M., Eastwood, P. D., Ernande, B., Harrop, S., Kemp, Z., Koubbi, P., Leader-Williams, N., Lefèbvre, A., Lemoine, M., Loots, C., Meaden, G. J., Ryan, N., Walkey, M., 2005. Eastern Channel Habitat Atlas for Marine Resource Management (CHARM), Atlas des Habitats des Ressources Marines de la Manche Orientale, INTERREG IIIA, 225 pp.

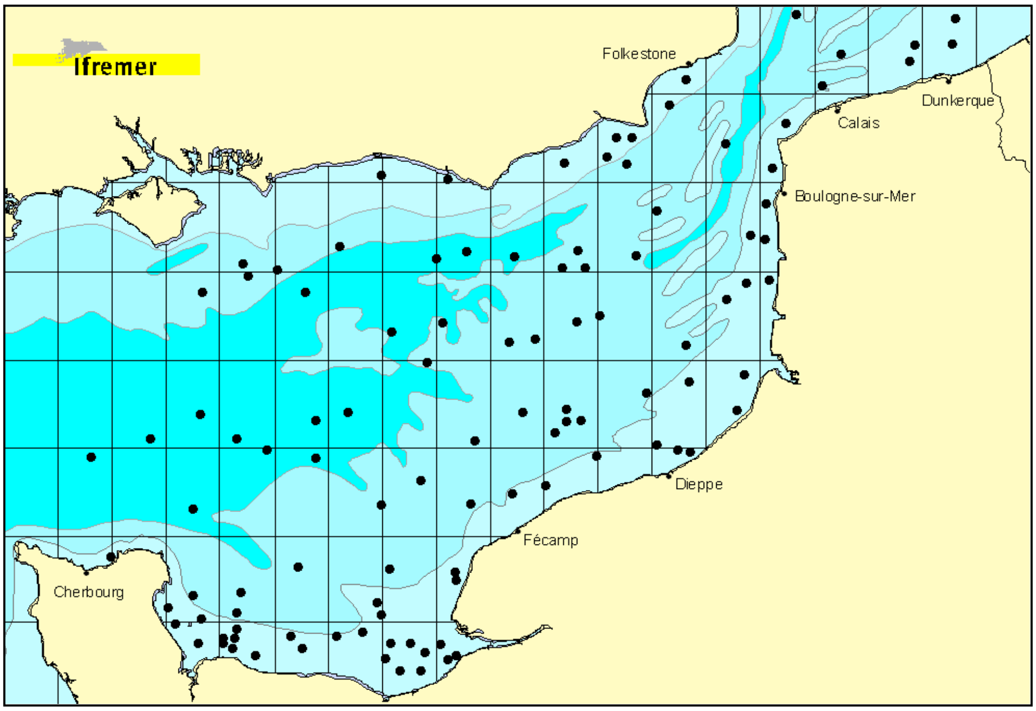
ICES 2003a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, October 2002. ICES CM 2003/ACFM:02

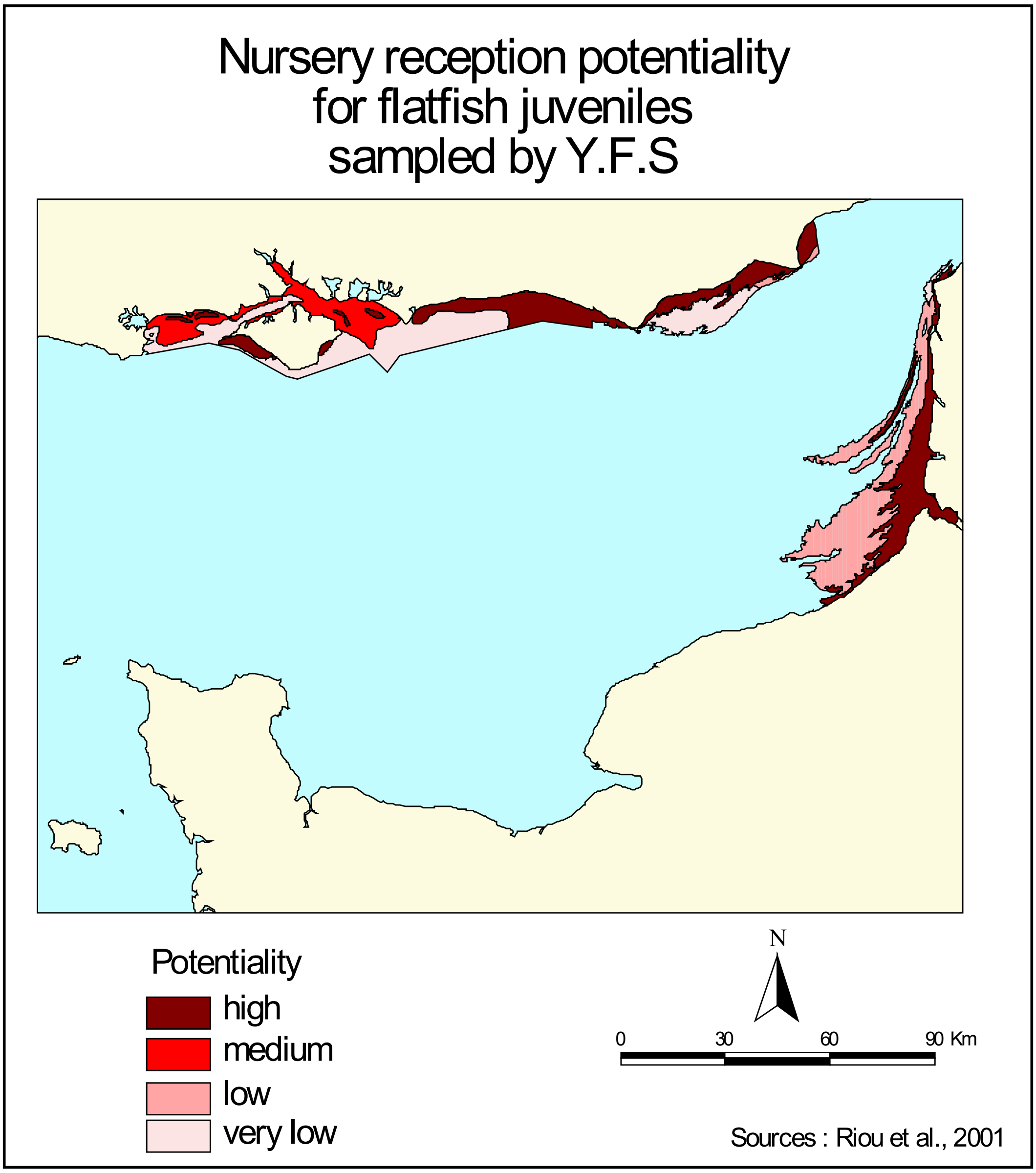
ICES 2003b. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management ICES CM 2003/ACFM:15

Millner, R.S., Whiting, C.L and Howlett, G.J. 1993. Estimation of discard mortality of plaice from small otter trawlers using tagging and cage survival studies. ICES C.M. 1993/G:24, 6pp

Riou et al. 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel : application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125-135**Appendix 1** – Nursery reception potentiality for flatfish used as a basis for the combination of FR and UK YFS

Appendix 2 – FR GFS. Sampling tows location grid





Potentiality surface (Km²)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low – Medium – High)	1271.2	1528.2

Stock Annex: Sole in Division VIId

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Sole in Division VIId (Easter Channel)
Working Group:	ICES Working Group for the Assessment of Demer sal Stocks in the North Sea and Skagerrak (WGNSSK)
Date:	February 2009
Revised by	Willy Vanhee (WKFLAT)

A. General

A.1 Stock definition

The sole in the eastern English Channel (VIId) are considered to be a separate stock from the larger North Sea stock to the east and the smaller geographically separate stock to the west in VIIe. There is some movement of juvenile sole from the North Sea into VIId (ICES CM 1989/G:21) and from VIId into the western Channel (VIIe) and into the North Sea. Adult sole appear to be largely isolated from other regions except during winter, when sole from the southern North Sea may enter the Channel temporarily (Pawson, 1995). The assessment does not take account of these stock movements.

A.2 Fishery

There is a directed fishery for sole by small inshore vessels using trammelnets and trawls, which fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. There is also a directed fishery by English and Belgian beam trawlers who are able to direct effort to different ICES divisions. These vessels are able to fish for sole in winter before the fish move inshore and become accessible to the local fleets. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localized areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. In France, there are some few small beam trawlers operating inshore in a few local areas, and offshore trawlers fishing for mixed demersal species taking sole as a bycatch.

The minimum landing size for sole is 24 cm. Demersal gears permitted to catch sole are 80 mm for beam trawling and 90 mm for otter trawlers. Fixed nets are required to use 100 mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

A.3 Ecosystem aspects

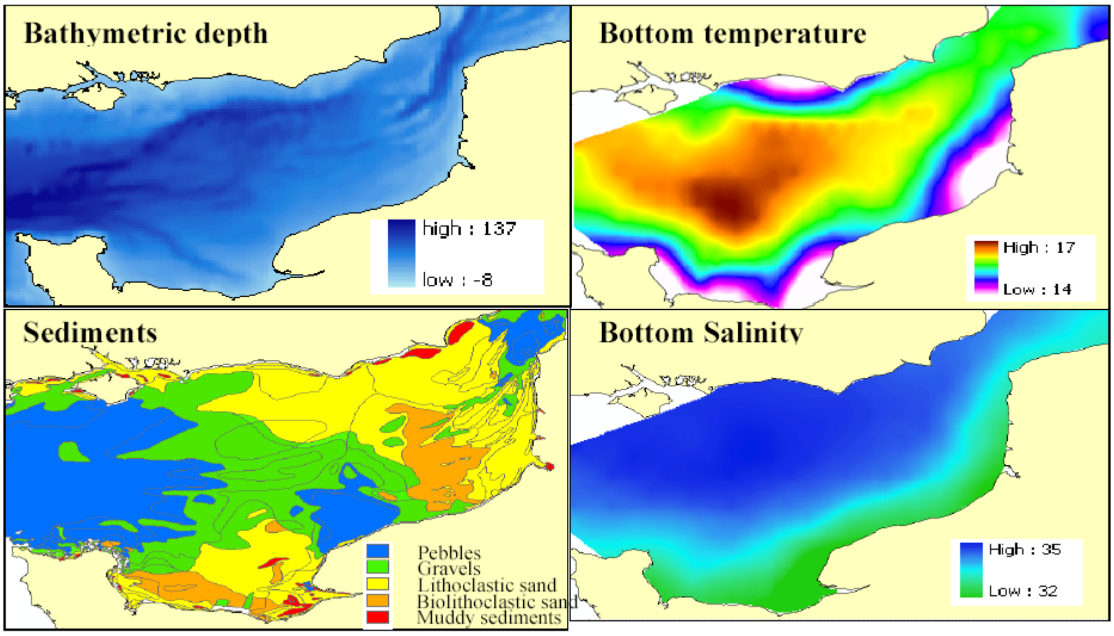


Figure 1. Eastern English Channel physical and hydrological features: Bathymetric depth and simplified sediment types representation. Survey bottom temperature and bottom salinity (averaged for 1997 to 2003) obtained by Kriging. (in Vaz *et al*., 2004).

Biology: Adult sole feeds on worms, small molluscs and crustaceans. In the English Channel, reproduction occurs between February and April, mainly in the coastal areas of the Dover Strait and in large bays (Somme, Seine, Solent, Mont-Saint-Michel, Start and Lyme Bay). Pelagic eggs hatch after 5 to 11 days leading to larvae that are also pelagic and that will metamorphose into benthic fry after 1 or 2 weeks. Juveniles spend the first 2 or 3 years in coastal nurseries (bays and estuaries) where fast growth occurs (11 cm at 1 year old) before moving to deeper waters.

The spatial distribution of life stages of common sole demonstrates a particular pattern: larval distribution (on spawning grounds) and juvenile distribution (in nursery grounds) overlap. If larvae are found everywhere during spring, the potential habitat for stage 2 larvae is along the Flanders coast and near the Pays de Caux, to the central zone of the English Channel. Older larvae have a more coastal habitat preference, which can be explained by a retention phenomenon linked to estuaries.

Environment: A benthic species that lives on fine sand and muddy seabeds between 0 and 150 meters depth. It ranges from marine to brackish waters in temperatures between 8 and 24°C.

Geographical distribution: Eastern Atlantic, from southern Norway to Senegal, Mediterranean Sea including Sea of Marmara and Black Sea.

Vaz *et al*., 2007 used multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature. One Group (class 4 in Figure 2 below) was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

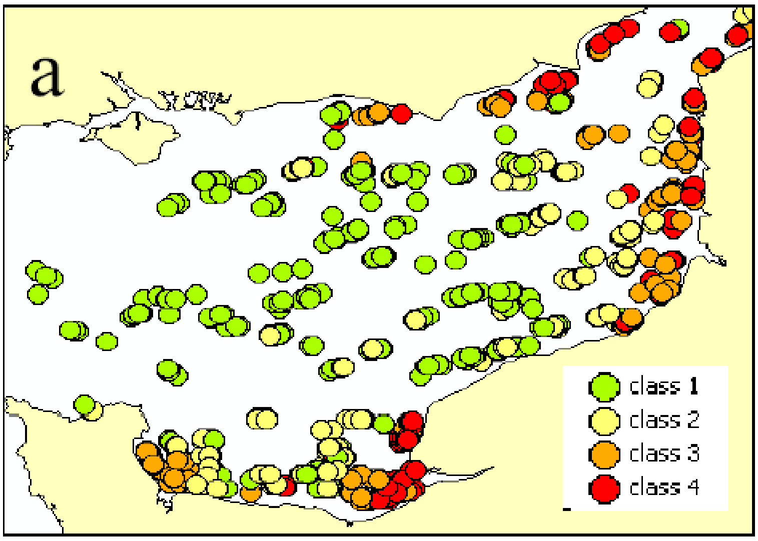


Figure 2. Spatial distribution of Fish Subcommunities in the Eastern Channel from 1988 to 2003. Observed assemblage type at each station, These illustrate the gradation from open sea community to coastal and estuarine communities (In Vaz *et al.*, 2004).

Community evolution over time: (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

B. Data

B.1 Commercial catch

The landings are taken by three countries: France (50%), Belgium (30%) and England (20%). Age sampling for the period before 1980 was poor, but between 1981 and 1984 quarterly samples were provided by both Belgium and England. Since 1985, quarterly catch and weight-at-age compositions were available from Belgium, France, and England.

An initiative for undertaking combined sampling of VIId sole between France, Belgium and the UK has been agreed from January 2008. The result was a framework for the collection of age data in relation to an international ALK. The division VIId has been stratified in three geographical areas and the data collected in line with them for 2008.

These data will be used to provide the assessment advice in 2009. A limited otolith exchange was arranged between the laboratories involved, specifically looking at VIId sole, in order to assess the likely quality of the ALK provided. The reason for restricting the exchange to those involved in the reading of VIId sole was so that any stock-specific issues could be addressed. The agreement achieved between institutes was 91% across all ages.

Belgium

Belgian commercial landings and effort information by quarter, area and gear are derived from logbooks.

Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium).

Quarterly sampling of landings takes place at the auctions of Zeebrügge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours.

Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level.

In 2003 a pilot study started on on-board sampling with respect to discarded and retained catch. Since 2004 it is part of the DCR.

France

French commercial landings in tonnes by quarter, area and gear are derived from logbooks for boats over 10m and from sales declaration forms for vessels under 10 m. These self declared productions are then linked to the auction sales in order to have a complete and precise trip description.

The collection of discard data has begun in 2003 within the EU Regulation 1639/2001. The first years of collection were incomplete in term of time and métier coverage. It is expected an increase of sampling effort from 2009 designed for the use of the information for assessment purpose, as required by ICES/ACOM.

The length measurements are done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne. Samplings from Grandcamp and Port-en-Bessin are used for raising catches from Cherbourg to Fecamp and samplings from Dieppe and Boulogne are used to raise the catches from Dieppe to Dunkerque.

Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the October GFS survey in quarter 4. These are aged and combined to the quarterly level and the age–length key thus obtained is used to transform the quarterly length compositions. The lengths not sampled during one quarter are derived from the same year close quarter.

Weight, sex and maturity-at-length and -at-age are obtained from the fish sampled for the age–length keys.

England

English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12 m which do not complete logbooks. For those over 12 m (or >10 m fishing away for more than 24 h), data are taken from the EC logbooks. Effort and gear information for the vessels <10 m is not routinely collected and is obtained by interview and by census. .No information is collected on discarding from vessels <10 m but it is known to be low. Discarding from vessels >10 m has been obtained since 2002 under the EU Data Collection Regulation and is also relatively low.

Length samples are combined and raised to monthly totals by port and gear group for each stock. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the international level. Age structure from otolith samples are combined to the quarterly level, and generally include all ports, gears and months. For sole the sex ratio from the randomly collected otolith samples are used to split the unsexed length composition into sex-separate length compositions. The quarterly separate age–length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions. At this stage the age compositions by gear group are combined to give total quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

Weight-at-age is derived from the length samples using the length/weight relationship W=aL^b, where a and b are reference condition factors for the stock.

The text table below shows which countries supply which kind of data:

KIND OF DATA SUPPLIED QUARTERLY					
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
Belgium	x	x	x		x
England	x	x	x		x
France	x	x	x		x

Data are supplied as FISHBASE files containing quarterly numbers-at-age, weight-at-age, length-at-age and total landings. The files are aggregated by the stock coordinator to derive the input VPA files in the Lowestoft format. No SOP corrections are applied to the data because individual country SOPs are usually better than 95%. The quarterly data files by country can be found with the stock co-ordinator.

The resulting files (FAD data) can be found at ICES and with the stock co-ordinator, either in the IFAP system as SAS datasets or as ASCII files on the Lowestoft format, either under w:\acfm\nsskwg\2002\data\sol_eche or w:\ifapdata\eximport\nsskwg\sol_eche.

B.2 Biological

Natural mortality

Natural mortality is assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used is knife-edged with sole regarded as fully mature at age 3 and older as in the North Sea.

Weight-at-age

Prior to 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with North Sea sole.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

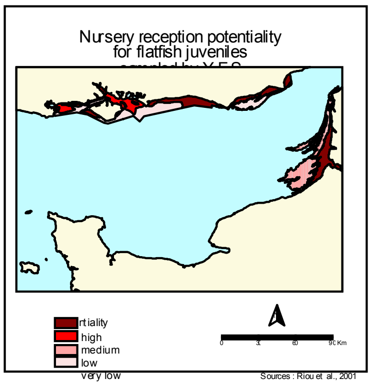
B.3 Surveys

A dedicated 4 m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest.

In addition, inshore small boat surveys using 2 m beam trawls are undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, the English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the full period back to 1981. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*., 2001) has demonstrated that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45% (See table and figure below).

Nursery reception potential used for the combination of FR and UK YFS

Potentiality surface (Km²)	South England	Bay of Somme
High	756	575.1
Medium	484.7	0
Low	30.5	953.1
Very low	993.3	21.3
Total	2264.5	1549.5
Total (Low–Med–High)	1271.2	1528.2



However, the UK component of the YFS was last conducted in 2006. In the absence of any update of the UK component of the YFS index the available time-series of the UK component should still be used in the assessment next to the French component of the YFS index. The lack of information from the UK YFS may impede the recruitment estimates and therefore the forecast.

B.4 Commercial cpue

Three commercial fleets have been used in tuning. The Belgian beam trawl fleet (BEL BT), the UK Beam Trawl fleet (UK BT) and a French otter trawl fleet (FR OT). The two beam trawl fleets carry out fishing directed towards sole but can switch effort between ICES areas. The UK BT cpue data are derived from trips where landings of sole from VIId exceeded 10% of the total demersal catch-by-weight on a trip basis.

The effort of the Belgian beam trawl fleet is corrected for horse power, based on a study carried out by IMARES and CEFAS in the mid 1990s (no reference available). The study calculated an effort correction for HP applicable to sole and plaice effort in the beam trawls fisheries. The corresponding equations for sole is P=0.000204 BHP^1.23.

This horsepower correction for the commercial Belgian beam trawl fleet should still be applied. However, if a new corrected effort series is available (based on Section 4.2.4.1 in ICES 2009) it should be used under condition that this is reviewed and approved by ICES.

No French commercial tuning data are available for the otter trawl and fixed nets. A first attempt to create an effort series for the French trammelnets has been presented but is not deemed sufficient. If a new effort series is produced this too should be used under condition that they are reviewed and approved by ICES.

B.5 Other relevant data

None.

C. Historical stock development

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

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 = 0.500

Since 2004-S.E. of the mean to which the estimate are shrunk = 2.000

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Catch data available for 1982–present year. However, there were no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986–present are used in tuning.

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1982–last data year	2–11+	Yes
Canum	Catch-at-age in numbers	1982–last data year	2–11+	Yes
Weca	Weight-at-age in the commercial catch	1982–last data year	2–11+	Yes
West	Weight-at-age of the spawning stock at spawning time.	19682–last data year	2–11+	Yes-assumed to be the same as weight-at-age in the Q2 catch
Mprop	Proportion of natural mortality before spawning	1982–last data year	2–11+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1982–last data year	2–11+	No-set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1982–last data year	2–11+	No-the same ogive for all years
Natmor	Natural mortality	1982–last data year	2–11+	No-set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Belgian commercial BT	1986–last data year	2–10
Tuning fleet 2	English commercial BT	1986–last data year	2–10
Tuning fleet 3	English BT survey	1988–last data year	1–6
Tuning fleet 4	UK YFS	1987–2006	1–1
Tuning fleet 5	French YFS	1987–last data year	1–1

D. Short-term projection

Model used: Age structured

Software used: MFDP

Initial stock size is taken from the XSA for age 3 and older and from RCT3 for age 2. The long-term geometric mean recruitment is used for age 1 in all projection years.

Since 2004 initial stock size for age 2 was taken from XSA.

Natural mortality: Set to 0.1 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 weight over the last three years

Weight-at-age in the catch: Average weight over the three last years

Exploitation pattern: Average of the three last years, scaled to the level of Fbar (3-8) in the last year

Intermediate year assumptions: F status quo

Stock recruitment model used: None, the long-term geometric mean recruitment-at-age 1 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-term projections

Not performed for this stock.

In the past an age structured model was used (WGMTERMc software). Medium-term projections were carried out with settings as in short-term projection except for the weights in the catch and in the stock which are averaged over the last 10 years. Since 2005 medium-term projections have not been done for this stock.

F. Long-term projections, yield-per-recruit

Not performed for this stock.

In the past an age structured model was used (WGMTERMc software). Medium-term projections were carried out with settings as in short-term projection except for the weights in the catch and in the stock which are averaged over the last 10 years. Since 2005 medium-term projections have not been done for this stock.

G. Biological reference points

	Type	Value	Technical basis
Precautionary approach	Blim	Not defined	
	Bpa	8000 t	Lowest observed biomass at which there is no indication of impaired recruitment. Smoothed Bloss
	Flim	0.55	Floss, but poorly defined; analogy to North Sea and setting of 1.4 Fpa = 0.55. This is a fishing mortality at or above which the stock has displayed continued decline.
	Fpa	0.40	Between Fmed and 5th percentile of Floss; SSB>Bpa and probability (SSBmt<Bpa), 10%: 0.4.
Targets	Fy	Not defined	

(unchanged since 1998)

H. Other issues

None.

I. References

CEFAS 1999. PA software users guide. The Centre for Environment, Fisheries and Aquaculture Science, CEFAS, Lowestoft, United Kingdom, 22 April 1999.

Riou et al., 2001. Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel: application of a combined method using generalized linear models and a geographic information system. Aquatic Living Resources. 14 (2001) 125–135.

Vas et al., 2007, Modelling Fish Habitat Suitability in the Eastern English Channel. Application to community habitat level. ICES CM 2004/P:26

Stock Annex: Whiting in Subarea IV and Division VIId

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Whiting in Subarea IV and Division VIId
Date:	24th February 2009
Revised by	Colin Millar

A. General

A.1. Stock definition

Whiting is known to occur exclusively in some localised areas, but for the most part it is caught as part of a mixed fishery operating throughout the entire year. Adult whiting are widespread in the North Sea, while high numbers of immature fish occur off the Scottish coast, in the German Bight and along the coast of the Netherlands.

Tagging experiments, and the use of a number of fish parasites as markers, have shown that the whiting found to the north and south of the Dogger Bank form two virtually separate populations (Hislop & MacKenzie, 1976). It is also possible that the whiting in the northern North Sea may contain 'inshore' and 'offshore' populations. The report of the SGSIMUW (ICES – WGNSSK 2005) documents the work performed on whiting stock identity issues.

A.2. Fishery

For whiting, there are three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel.

Northern area

In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. Some vessels operating to the east of this area are using 130 mm mesh. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Minimum mesh size in *Nephrops* trawls is 80mm but a range of larger mesh sizes are also used when targeting *Nephrops*. Whiting is becoming a more important species for the Scottish fleet, with many vessels actively targeting whiting during a fishing trip and Scottish single seiners have been working closer to shore to target smaller haddock and whiting. Technological developments have included a shift towards pair trawling and the development of double bag trawls which reduce costs compared to twin trawling. The derogation in the EU effort management scheme allowing for extra days fishing by vessels using 90 mm mesh gears with a 120 mm square mesh panel close to the codend (a configuration which releases cod) has so far, been taken up by few vessels.

Recent fuel price increases and a lack of quota for deep-water species has resulted in some vessels formerly fishing in deep-water and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting. Following the major decommissioning schemes a few years ago by the UK, there have not been further reductions, although a number of boats have taken advantage of oil support work and effort has probably been reduced.

Eastern English coast

Whiting are an important component in the mixed fishery occurring along the English east coast. Industry reports suggest better catch rates here than are implied by the overall North Sea assessment. Darby (2006, 2007 WD7) analysed the catch per unit of effort (CPUE) of the English fishery. In recent years vessels have been reporting unusually high catch rates of large whiting. Catch rates appear to have peaked and have recently begun to decline but are still well above historic levels. There is evidence from the CPUE data of the English fishery that relative catch rates of age 5 and age 6 fish have increased recently (since 2004) to a considerably greater extent than relative abundance seen in the International Bottom Trawl Survey (IBTS) or ICES assessment for these ages (WGNSSK 08 Figures 12.1.1 and 12.1.2).

General

There has been a displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

Whiting are a by-catch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

Historically, by-catch of whiting by industrial fisheries for reduction purposes was an important part of the catch, but due to the recent reduced fishery for sandeel and Norway pout the impact of this fishery on the whiting stock is considered much reduced.

Recent changes in fleet dynamics

WGFTFB(2008) reported use of bigger meshes in the top panel of beam trawler gear by Belgium vessels with an expected reduction in by-catch of roundfish species, especially haddock and whiting. Fluctuations in fuel costs can cause changes in fishing practices. WGFTFB(2008) reported a shift for Scottish vessels from using 100mm-110mm for whitefish on the west coast ground (Area VI) to 80mm prawn codends in the North Sea (area IV), with increased fuel costs considered the major driver.

Conservation schemes and technical conservation measures

The present technical regulations for EU waters came into force on 1 January 2000 (EC 850/98 and its amendments). The regulations prescribe the minimum target species' composition for different mesh size ranges. Additional measures were introduced in Community waters from 1 January 2002 (EC 2056/2001).

Effort regulations in days at sea per vessel and gear category were in place from 2003 to 2008 and the limits for individual categories can be seen in the following references;

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

In 2008 additional provisions were introduced (points 8.5-7, Annex IIa, EC 40/2008) to provide Member States greater flexibility in managing their fleets, in order to encourage a more efficient use of fishing opportunities and stimulate fishing practices that lead to reduced discards and lower fishing mortality of both juvenile and adult fish. This measure allowed a Member State that fulfilled the requirements laid out in EC 40/2008 to manage a fleet (i.e. group of vessels with a specific combination of geographical area, grouping of fishing gear and special condition) to an overall kilowatt-days limit for that fleet, instead of managing each individual vessel in the fleet to its own days-at-sea limit. The overall kilowatt-days limit for a fleet is initially calculated as the sum of all individual fishing efforts for vessels in that fleet, where an individual fishing effort is the product of the number of days-at-sea and engine power for the vessel concerned. From 2009 (EC 43/2009) the kilowatt-days limit by fleet became the default effort control measure and revised gear groupings were introduced.

In 2008 Scotland adopted the provisions under points 8.5-7, Annex IIa, EC 40/2008 and the scheme was dubbed the 'Conservation Credits Scheme'. Vessels signing to this scheme were granted an additional 21 days at sea. The scheme included various measures including technical measures

- A one net rule (derogation for Scottish seiners until the end January 2009). This is likely to improve the accuracy of reporting of landings to the correct mesh size range.
- Requirement to use a 110mm SMP with an 80mm codend. Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110mm SMP. Smaller increase in L50 of perhaps 10% for cod.
- From February 2008 there has been a concerted effort not to target cod by use of real time closures of areas recording high cod catch rates. Implication: that there will be greater effort exerted on haddock, whiting, monk, flats and Nephrops.

There was almost universal participation in the Conservation Credits Scheme from all Scottish fleet sectors. An alternative option to install a 120mm SMP at 4-9m used with a 95mm x 5mm double codend was not taken up by the Scottish prawn fleet despite offering 39 extra days at sea (concerns over loss of prawns due to twisting and too great a loss of marketable haddock and whiting).

A.3. Ecosystem aspects

Results from key runs of the North Sea MSVPA in 2002 and 2003 indicate three major sources of mortality. For ages two and above, the primary source of mortality is the fishery, followed by predation by seals, which increases with fish age. For ages 0-1, though more notable on 0-group, there is evidence for cannibalism. This is corroborated by Bromley et al. (1997), who postulate that multiple spawning over a protracted period may provide continued resources for earlier spawned 0-group whiting.

Results from key runs of the North Sea Multispeces assessment in 2008 indicate that, as a predator, whiting tend to feed on (in order of importance): whiting, sprat, Norway pout, sandeel and haddock. A notable predator on 0-group whiting is grey gurnards.

Distribution maps of survey (IBTS) indices show a change in distribution of the stock. They show low recruitment in recent years (2003 to 2008), but also an apparent shift in where the recruiting year-class is found. Therefore catch rates from localised fleets may not represent trends in the overall North Sea and English Channel population. The spatial distribution of IBTS whiting catch rates during recent years (Figures 1 and 2) also indicate that ages 3+ whiting are located primarily around the north east coast of England and the east coast of Scotland with very low catch rates in the southern North Sea. The results support the idea of a spatial contraction of the stock as its total abundance declines following recent poor recruitment. Further supporting evidence is the displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

B. Data

B.1. Commercial catch

For North Sea catches, human consumption landings data and age compositions are provided by Scotland, England, France, the Netherlands, Belgium, Norway and Germany. Discard data are provided by Scotland, England, the Netherlands and Germany and used to estimate total international discards. Other discard estimates do exist (Section 1.11.4, 2002 WG), but have not been made available to Working Group data collators. Since 1991 the age composition of the Danish industrial by-catch has been directly sampled, whereas it was calculated from research vessel survey data during the period 1985–1990. Norway provides age composition data for its industrial by-catch. Whiting industrial by-catch has been low since 1996 due to the limited fishery for Norway pout and a reduced sandeel fishery in 2005, 2006 and 2007.

In 2006 the samples used to raise Danish industrial bycatches (accounting for 98% of the industrial bycatch that year) were taken from Norwegian vessels whose catches have a different age structure. The data for 2006 have been replaced with an estimate $\hat{n}_{a,y}$ given by

$$\hat{n}_{a,y} = \hat{N}_y \hat{p}_a,$$

where $\hat{p}_a$ is the mean proportion at age over the years 1980 to 2005, and $\hat{N}_y$ is estimated to give a sums of products correction (SOP) factor of 1 by

$$\hat{N}_y = \frac{W_y}{\sum_a \hat{p}_a \hat{w}_a},$$

where W_y is the reported weight of industrial bycatch. Here $\hat{w}_a$ have been estimated by taking the mean weights at age in the industrial bycatch over the period 1995 to 2005 (zero weights are taken as missing values).

For eastern Channel catches, age composition data are supplied by England and France. England supplies discard estimates however France does not. Since France now lands approximately 30% of the total North Sea and eastern Channel landings, this lack of data is considered an important issue. There is a small industrial fishery in this area.

In 2002, the working group decided to truncate the catch data to start from 1980. This was due to the very large change in estimated recruitment levels around 1980 that was present in the assessment. The working group could not determine whether this was due to a shift in the recruitment regime or because discard data for years prior to 1978 were not measured but estimated according to a discard ogive. This may not have been representative of discarding during the earlier period. Biological reference points for this stock had originally been established on the basis of the truncated series, so this represented no change with respect to them.

B.2. Biological

Weight at age

Weight at age in the stock is assumed to be the same as weight at age in the catch. Unrepresentative sampling of industrial bycatch in 2006 and 2007 resulted in poor estimates of the mean weights at age and these have been replaced by the mean weight at age for the period 1995 to 2005 (zero weights are taken as missing values).

Natural mortality

Natural mortality values used in assessments up to 2008 are rounded averages of estimates produced by previous key runs of the North Sea MSVPA (see Section 1.3.1.3 of the 1999 WG report: ICES CM 2000/ACFM:7) and considered constant with time. However the Working Group on Multi Species Assessment Methods in 2008 (ICES 2008) showed substantial changes in predation mortalities on whiting over time. Revised time series of natural mortality values are available every two years and WKBENCH2 (ICES 2009) concluded the time series values should be used and updated when new values are available. The current values used in both the assessment and the forecast are presented in Table 1.

Maturity

The maturity ogive is based on North Sea IBTS quarter 1 data, averaged over the period 1981-1985. The maturity ogive used in both the assessment and forecast is:

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1.00	1.00	1.00	1.00	1.00	1.00

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to zero.

B.3. Surveys

The first quarter International Bottom Trawl Survey (IBTS Q1) is undertaken in February and March of each year, and covers depths of roughly 35 m to 200 m in the whole of the North Sea basin. The IBTS indices combine haul data from multiple vessels belonging to national institutes. As such it uses a higher density of survey stations than the constituent national surveys, with several hauls per statistical rectangle.

In previous assessments the Scottish third quarter Groundfish Survey (SCOGFSQ3) and English third quarter Groundfish Survey (ENGGFSQ3) were used as independent surveys. The SCOGFSQ3 is carried out in August each year, and covers depths of roughly 35 m to 200 m in the North Sea to the north of the Dogger Bank. It samples at most one survey station per statistical rectangle. In 1998 the coverage of this survey was extended into the central North Sea, but the index available to the Working Group has been modified so as to cover a consistent area throughout the time-series. The English third quarter Groundfish Survey (ENGGFSQ3) is carried out in August each year, and samples at most one station per rectangle. It covers depths of roughly 35 m to 200 m in the whole of the North Sea basin. In 1991 the ENGGFSQ3 changed fishing gear from the Granton trawl to the GOV trawl. For this reason the English groundfish survey is treated as two independent series.

The time-series of the survey indices of whiting supplied by the French Channel Groundfish Survey (FRAGFS) was revised in 2002. In 2001, the Eastern Channel was split into five zones. Abundance indices were first calculated for each zone, and then averaged to obtain the final FRAGFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. In 2002, it was thought more appropriate first to raise abundance indices to the level of ICES rectangles, and then to average those to calculate the final abundance index. Previous to the 2002 WG, only the hauls in which whiting were caught were used to derive abundance indices. This procedure biased estimates, and therefore, the indices supplied from 2002 are calculated on the basis of all hauls. However lack of internal consistency of this series means it has not been used in the assessment to date.

There is an unresolved problem in that the surveys available provide a different indication of stock trends before 1990 compared to an assessment based on catch data (Figure 3). The IBTS indices combine haul data from multiple vessels belonging to national institutes and periodically these vessels are replaced. In 1998 FRS (Aberdeen) introduced a new survey vessel; it was considered at the time that no evidence existed to say the new vessel had different catchabilities to the old vessel (Zuur et al. 1999). This is now generally considered not to be the case. WKROUND investigated the possibility that changes in survey catchability over the period from the mid 1980s to the mid 1990s accounts for this mismatch. The required change in catchability was estimated to be approximately a factor of two. Details of the investigations can be found in the benchmark report. Evidence for a change in catchability was not found (although the meeting recommended further work) but the following was concluded with respect to survey data.

- Only IBTS Q1 and IBTS Q3 indices should be used. The SCOGFS and ENGGFS are incorporated into the IBTS Q3 survey which is involves several other fleets and is likely to better represent the North Sea as a whole.
- The IBTS Q1 survey should only be used from 1984 because the gear employed was not standardised before this date.

The IBTS Q1 and IBTS Q3 data can be downloaded from the DATRAS website at

http://datras.ices.dk/Data_products/Download/Download_Data_public.aspx

B.4. Commercial CPUE

Effort data are available for two Scottish commercial fleets: seiners (SCOSEI) and light trawlers (SCOLTR), both for the years 1978-2006. Non-mandatory reporting of fishing effort for these fleets means that they cannot be viewed as reliable for use for catch-at-age tuning.

Effort data are available for two French commercial fleets: otter trawl (FRATRO) 1986-2006 and beam trawl (FRATRB) 1978-2001. The same comment on non-mandatory reporting of fishing effort applies to these fleets.

Available commercial CPUE data is presented in Table 2.

B.5. Other relevant data

The North Sea Fishers' Survey presents fishers' perceptions of the state of several species including whiting. The survey covers the years 2003-2008, (Laurenson, 2008).

C. Historical Stock Development

The following outlines the method currently used for North Sea whiting. Due to unresolved issues with data, this method cannot be considered as benchmarked. WKROUND considered that recent trends in the North Sea and eastern Channel whiting stock are appropriately estimated by the current assessment and are suitable for providing management advice. The assessment uses survey data and catch data from 1990 ignoring any issues prior to 1990. The outstanding issues and proposed directed research are detailed in ICES (2009).

Model used: Extended Survivor Analysis (XSA)

Software used: FLXSA run under

FLCORE 2.0

FLR 2.0

R 2.8.0

Model Options chosen:

Tolerance (tol):	1e-09
Maximum allowed iterations (maxit):	1000
Minimum standard error for surveys (min.nse):	0.3
Time series weighting in years (tsrange):	100
Time series weighting power (tspower):	0
Years of catch data to use (window):	100
Max age of power relationship in selection (rage):	0
First age of full selection (qage):	5
F shrinkage tolerance (Fse):	2.0
No. at age shrinkage; last # years (shk.yrs):	3
No. at age shrinkage; oldest # ages (shk.ages):	4

Mean F is taken over ages 2-6.

Mean weights at age in the catch is assumed equal to mean weights at age in the stock.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980-	NA	Yes
Canum	Catch at age in numbers	1980-	1-8+	Yes
Weca	Weight at age in the commercial catch	1980-	1-8+	Yes
West	Weight at age of the spawning stock at spawning time.	1980-	1-8+	Yes
Mprop	Proportion of natural mortality before spawning	1980-	1-8+	No
Fprop	Proportion of fishing mortality before spawning	1980-	1-8+	No
Matprop	Proportion mature at age	1980-	1-8+	No
Natmor	Natural mortality	1980-	1-8+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	IBTS Q1	1991-	1-6+
Tuning fleet 2	IBTS Q3	1991-	1-6+
Tuning fleet 3	NA		
….			

D. Short-Term Projection

The following outlines the method currently used for North Sea whiting. Due to unresolved issues with data, this method cannot be considered as benchmarked. The outstanding issues and proposed directed research are detailed in ICES (2009).

Model used: MFYDP

Software used: MFYDP

Initial stock size: RCT3 estimate of recruitment at age 1. XSA survivors at start of intermediate year for ages 2 and above.

Maturity: As used for historic stock development.

F and M before spawning: Zero

Weight at age in the stock: Mean over the last three years. Mean weights at age have generally been consistent over the recent period but there are trends at some ages.

Weight at age in the catch: Set equal to mean weights at age in the stock.

Exploitation pattern: Mean F-at-age pattern over the final 5 years scaled to F(2-6) in the terminal year. Scaling justified by recent stability of F(2-6) values.

Intermediate year assumptions: F status quo.

Stock recruitment model used: Geometric mean over the most recent 4 years.

Procedures used for splitting projected catches: Application of partial Fs. Partial Fs derived by considering proportions of the catch at age in the terminal year.

E. Medium-Term Projections

Not done for this stock.

F. Long-Term Projections

Not done for this stock

G. Biological Reference Points

The previously defined precautionary reference points (based on data from 1980 onwards) are no longer considered appropriate because of discrepancies between survey data and the catch data in the period before 1990. The assessment is now based on the period where catch and survey data are consistent (from 1990 onwards).

Yield and spawning biomass per Recruit F-reference points (2007):

	Fish. Mort. Ages 2–6	Yield/R	SSB/R
Average last 3 years	0.39	0.0527	0.26
F_{max}	0.19	0.0137	0.12
$F_{0.1}$	0.10	0.0128	0.17

Candidates reference points consistent with high long-term yields and a low risk of depleting the productive potential of the stock are in the range of $F_{0.1}$–F_{max}.

H. Other Issues

None identified.

I. References

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Laurenson, C. H. (2008). North Sea Stock Survey 2008. NAFC Marine Centre, Shetland, UK. 112pp.

Table 1: Whiting in IV and VIId. Smoothed values for natural mortality extracted from the SMS keyrun 2008.

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1980	1.34	1.40	0.71	0.47	0.45	0.42	0.40	0.37	0.31
1981	1.35	1.39	0.69	0.47	0.44	0.42	0.40	0.37	0.31
1982	1.35	1.37	0.67	0.46	0.44	0.41	0.39	0.37	0.31
1983	1.35	1.35	0.65	0.45	0.43	0.41	0.39	0.37	0.31
1984	1.35	1.33	0.62	0.44	0.42	0.40	0.38	0.36	0.31
1985	1.36	1.32	0.60	0.43	0.42	0.39	0.37	0.36	0.31
1986	1.36	1.31	0.57	0.42	0.41	0.38	0.37	0.35	0.31
1987	1.37	1.30	0.55	0.41	0.40	0.38	0.36	0.34	0.30
1988	1.39	1.30	0.53	0.40	0.39	0.37	0.35	0.34	0.30
1989	1.41	1.31	0.51	0.39	0.38	0.37	0.35	0.34	0.31
1990	1.44	1.31	0.50	0.38	0.37	0.36	0.34	0.33	0.31
1991	1.47	1.32	0.49	0.37	0.37	0.36	0.34	0.33	0.31
1992	1.52	1.33	0.48	0.37	0.36	0.35	0.34	0.33	0.31
1993	1.57	1.35	0.47	0.36	0.36	0.35	0.34	0.33	0.31
1994	1.63	1.36	0.47	0.36	0.35	0.35	0.33	0.33	0.31
1995	1.70	1.38	0.47	0.36	0.35	0.35	0.33	0.33	0.32
1996	1.77	1.41	0.47	0.35	0.35	0.35	0.33	0.33	0.32
1997	1.83	1.43	0.47	0.35	0.34	0.35	0.33	0.33	0.32
1998	1.90	1.45	0.47	0.35	0.34	0.34	0.33	0.33	0.32
1999	1.95	1.48	0.47	0.35	0.34	0.34	0.33	0.33	0.32
2000	2.00	1.51	0.47	0.34	0.33	0.34	0.33	0.33	0.32
2001	2.03	1.55	0.48	0.34	0.33	0.34	0.33	0.33	0.32
2002	2.05	1.58	0.49	0.34	0.33	0.34	0.34	0.34	0.32
2003	2.06	1.62	0.50	0.35	0.33	0.34	0.34	0.34	0.32
2004	2.05	1.65	0.52	0.35	0.33	0.34	0.34	0.34	0.33
2005	2.03	1.68	0.53	0.35	0.33	0.35	0.35	0.35	0.33
2006	2.01	1.71	0.55	0.35	0.33	0.35	0.35	0.36	0.34
2007	1.99	1.73	0.56	0.36	0.33	0.35	0.36	0.36	0.34

Table 2 Whiting in IV and VIId. Complete available tuning series.

SCOSEI_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	325246	14994	29308	43711	15390	1058	1409	201	36	0
1979	316419	90750	41092	28124	14745	6084	677	156	3	0
1980	297227	27032	73704	37658	11915	9368	2556	260	229	27
1981	289672	8727	22244	25048	10552	2402	2084	374	41	4
1982	297730	3721	7032	26194	13117	2713	539	277	81	5
1983	333168	11565	14957	21690	34199	9831	2155	407	158	16
1984	388035	4923	24016	20670	14986	21269	4715	960	87	50
1985	381647	20068	20263	19696	8956	4796	8013	1363	334	18
1986	425017	139498	48705	34509	11341	2624	1098	1771	216	7
1987	418536	13793	52715	38939	18440	3638	1097	298	348	16
1988	377132	2502	28446	44869	12631	4072	679	64	21	17
1989	355735	6879	15704	41407	23710	4769	1323	112	43	11
1990	252732	14230	124636	27694	29921	14768	721	207	23	0
1991	336675	11952	44964	63414	10436	8730	1743	195	94	0
1992	300217	16614	19452	21217	27962	2805	1958	565	32	3
1993	268413	9564	31623	26013	12458	14446	899	332	153	8
1994	264738	9236	21452	22571	11778	5531	5612	204	116	15
1995	204545	8288	22153	30007	9019	3875	1373	1270	86	15
1996	177092	5732	26021	21430	10506	3483	1031	296	289	28
1997	166817	6628	8974	16231	9922	4445	575	110	62	37
1998	150361	3711	4695	6806	6840	3670	1417	244	13	2
1999	93796	13384	13750	7009	6068	3462	1684	409	77	3
2000	69505	5176	11208	6458	2112	1972	836	298	90	7
2001	36135	607	6352	5592	1715	486	353	146	66	11
2002	21830	1017	3349	7716	2182	363	140	79	23	6
2003	15371	388	1089	2514	2980	1046	256	30	17	5
2004	15663	282	689	1912	2003	1711	456	108	16	4
2005	16149	1131	1889	994	1638	1852	1035	362	41	1
2006	13539	25	435	874	695	966	960	433	99	18

SCOLTR_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	236944	8785	19910	30722	14473	956	1612	635	72	6
1979	287494	171147	42910	23155	17996	4058	377	286	57	5
1980	333197	20806	58382	38436	9525	9430	1864	144	145	3
1981	251504	6576	19069	21550	9706	1777	1455	310	9	1
1982	250870	5214	8197	26681	12945	3334	647	339	74	16
1983	244349	37496	17926	12535	19234	6124	1217	183	141	26
1984	240775	38267	16048	10784	6307	9019	2371	479	13	30
1985	267393	28761	9368	7617	3086	1333	2901	443	173	14
1986	279727	8138	8572	9578	4109	767	425	609	52	2
1987	351131	18761	25933	16161	5954	1183	388	116	129	4
1988	391988	2398	15779	22526	5128	1641	207	31	15	6
1989	405883	20319	10052	21390	10837	2394	448	33	54	2
1990	371493	3677	35322	7665	8960	3423	160	40	5	0
1991	408056	8727	11908	22146	3192	2906	629	50	41	0
1992	473955	17581	14551	11823	15418	1500	1160	304	13	0
1993	447064	16439	20513	14386	6591	10105	574	204	97	24
1994	480400	4133	15771	13005	6454	2710	2997	172	84	14
1995	442010	9248	15887	19322	6262	2983	1092	1132	89	3
1996	445995	6662	12461	13523	9223	3012	861	282	243	9
1997	479449	2557	6768	15603	9464	4535	628	181	52	31
1998	427868	5096	5350	8058	9507	4312	1729	276	58	12
1999	329750	26519	20672	9295	6706	4080	2051	487	41	7
2000	280938	8385	16220	9287	3788	2621	1470	602	79	7
2001	245489	1303	11409	10419	3287	745	431	247	66	27
2002	184099	980	4653	11067	3686	818	221	180	60	13
2003	98721	871	1639	3986	5136	2080	286	73	59	7
2004	63953	224	1088	2225	2463	2168	669	123	18	15
2005	54905	954	2414	1236	1448	1901	831	251	26	2
2006	51456	66	495	1487	990	1055	1067	604	105	6

Table 2 (cont'd) Whiting in IV and VIId. Complete available tuning series.

FRATRO_IV units = individuals

year	effort	0	1	2	3	4	5	6	7	8
1986	56099	19	1542	1892	7146	3783	600	158	39	2
1987	71765	12	2508	4985	1271	5713	413	258	92	70
1988	84052	0	2537	8982	3223	704	1321	123	55	1
1989	88397	27	2958	3740	5629	1654	209	280	47	11
1990	71750	38	3210	6170	3781	2456	365	29	44	2
1991	67836	323	4465	6084	2864	1412	777	85	6	3
1992	51340	355	3427	6498	1940	635	358	96	5	0
1993	62553	938	3950	4586	4307	877	290	68	40	6
1994	51241	87	7006	3298	1191	612	108	11	8	1
1995	57823	263	6331	6125	2674	544	99	19	0	2
1996	50163	577	5523	4743	3214	890	156	8	12	0
1997	48904	267	1961	4677	3929	1020	221	18	3	0
1998	38103	567	4893	1959	533	161	68	36	0	2
1999	-9	51	7652	2886	1453	960	500	133	46	31
2000	30082	129	7367	8191	2453	1056	737	455	345	95
2001	50846	3357	10767	15476	6923	3227	1701	638	345	128
2002	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9
2003	52609	625	9277	16880	7857	5528	1701	188	19	23
2004	21074	0	938	367	919	946	743	256	36	4
2005	23683	0	1037	1665	386	178	149	103	52	14
2006	19100	4.918	4402.199	2229.464	373.059	37.178	183.608	226.409	0.27	-9

FRATRB_IV units = individuals

year	effort	1	2	3	4	5	6	7	8	9
1978	69739	1153	10312	14789	8544	807	1091	227	34	4
1979	89974	698	12272	14379	10884	3789	394	315	45	14
1980	63577	90	5388	11298	4605	4051	1004	78	71	10
1981	76517	144	6591	13139	8196	2090	1644	314	16	10
1982	78523	173	1643	16561	11241	3948	1035	539	119	14
1983	69720	500	4407	8188	16698	5541	1061	228	126	19
1984	76149	317	4281	7465	4576	5999	1596	308	32	26
1985	25915	315	3653	2942	1225	566	599	117	12	4
1986	28611	891	3830	3991	1202	369	94	160	22	1
1987	28692	431	4823	3667	2152	497	166	48	46	3
1988	25208	150	2718	4815	1125	530	100	31	3	4
1989	25184	448	2064	4351	1877	314	106	10	4	1
1990	21758	164	3794	2124	2010	620	55	13	1	0
1991	19840	292	2224	3829	819	657	138	15	3	0
1992	15656	365	1598	1686	2204	248	195	44	3	0
1993	19076	173	1225	2633	1141	1233	97	37	14	4
1994	17315	108	1806	1721	1466	413	430	29	8	1
1995	17794	114	1023	3304	1537	1163	240	212	14	7
1996	18883	21	655	1594	1438	482	199	38	30	10
1997	15574	40	357	1407	1139	606	86	16	10	2
1998	14949	32	126	317	326	192	63	8	2	1
1999	-9	96	490	489	684	452	239	59	14	1
2000	11747	47	1148	2968	1205	320	298	124	54	5
2001	6771	298	649	528	150	36	36	14	6	2

FRATRO_7D units = individuals

year	effort	1	2	3	4	5	6	7
1986	257794	2587	2250	7741	4463	804	198	19
1987	188236	1955	5050	907	4606	331	218	54
1988	215422	2233	7957	2552	537	1193	127	61
1989	320383	2578	3916	6006	1490	216	343	50
1990	257120	2492	5240	3363	2168	251	30	51
1991	294594	4009	8177	3985	2625	1474	155	11
1992	285718	5733	10924	3241	882	587	171	3
1993	283999	3158	6543	8607	1677	442	124	79
1994	286019	13932	7980	3269	1776	444	40	21
1995	268151	6301	8450	5261	1217	264	63	8
1996	274495	6140	6466	5465	1623	324	47	14
1997	282216	3320	8144	6608	1974	451	59	8
1998	291360	9921	6863	2385	781	265	105	15
1999	-9	-9	-9	-9	-9	-9	-9	-9
2000	215553	7096	7026	1734	1724	1375	877	675
2001	163848	89	6101	10124	3976	2563	2303	1040
2002	192589	985	1922	6247	6476	2270	461	463
2003	296717	155	6896	5489	5551	2397	312	65
2004	89127	1831	706	2312	2945	2611	902	109
2005	108369	5813	3730	793	813	720	510	262
2006	78600	2864	1912	457	133	800	1013	0

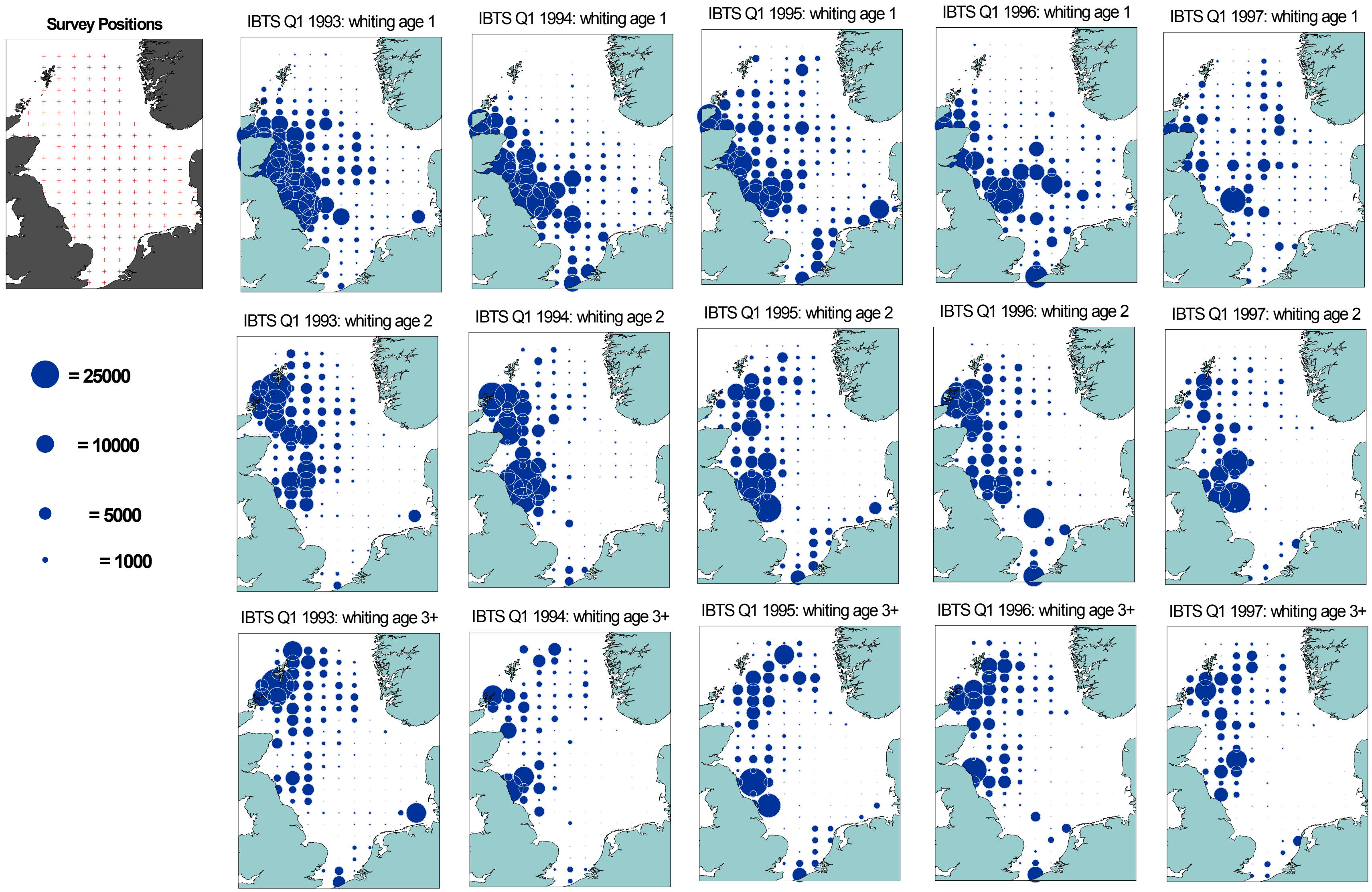


Figure 1 Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.

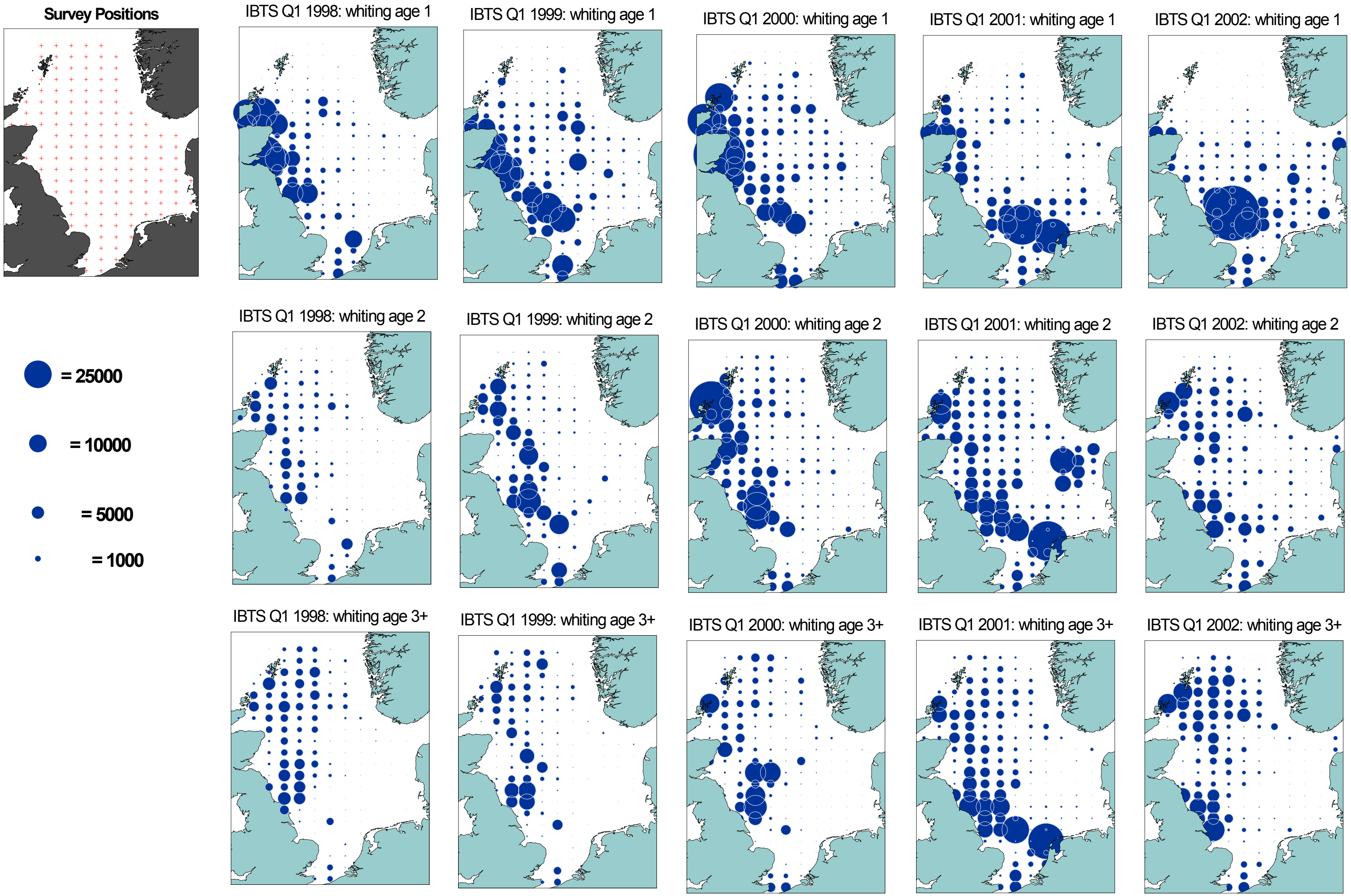


Figure 1 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey**

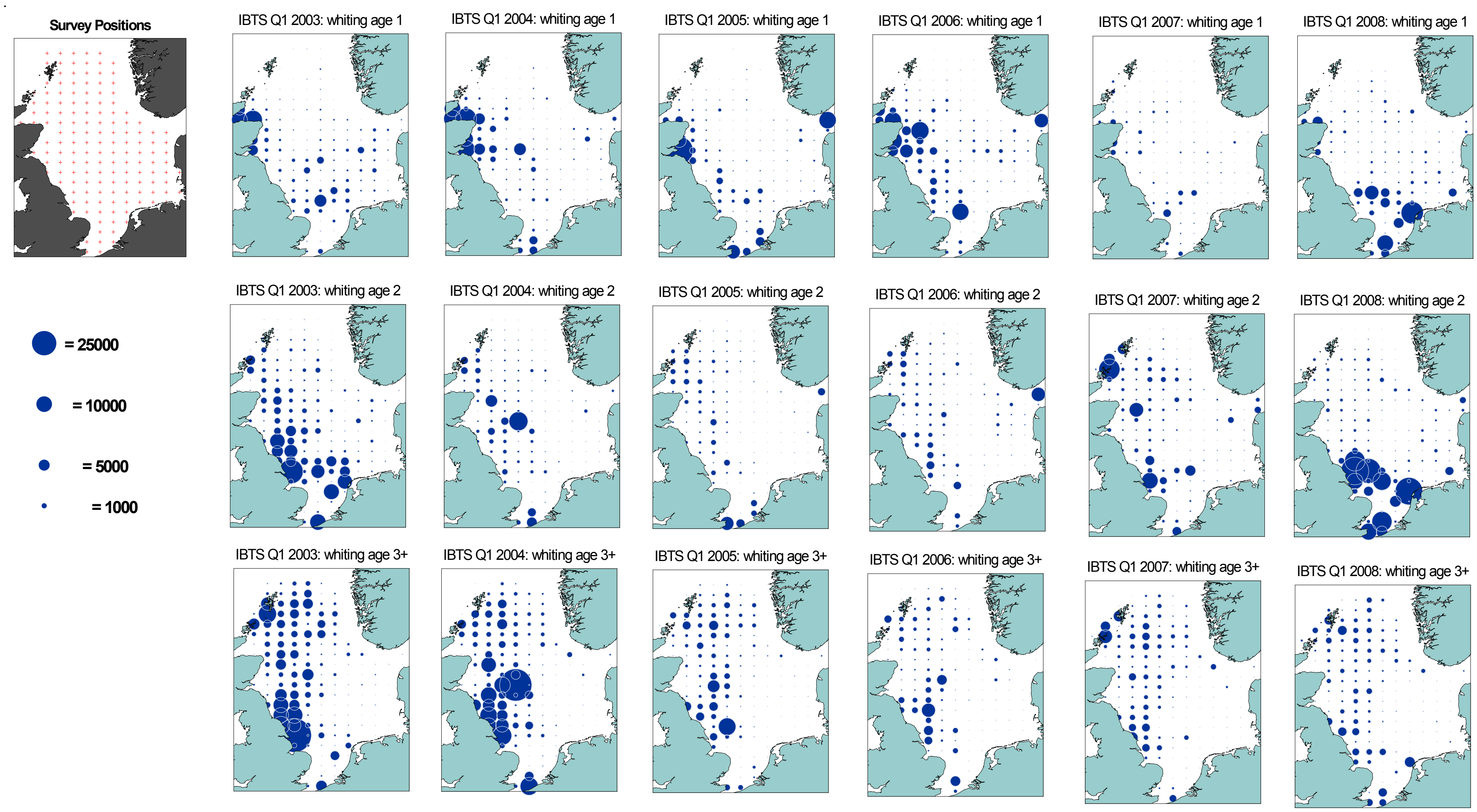


Figure 1 (cont.) **Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey.**

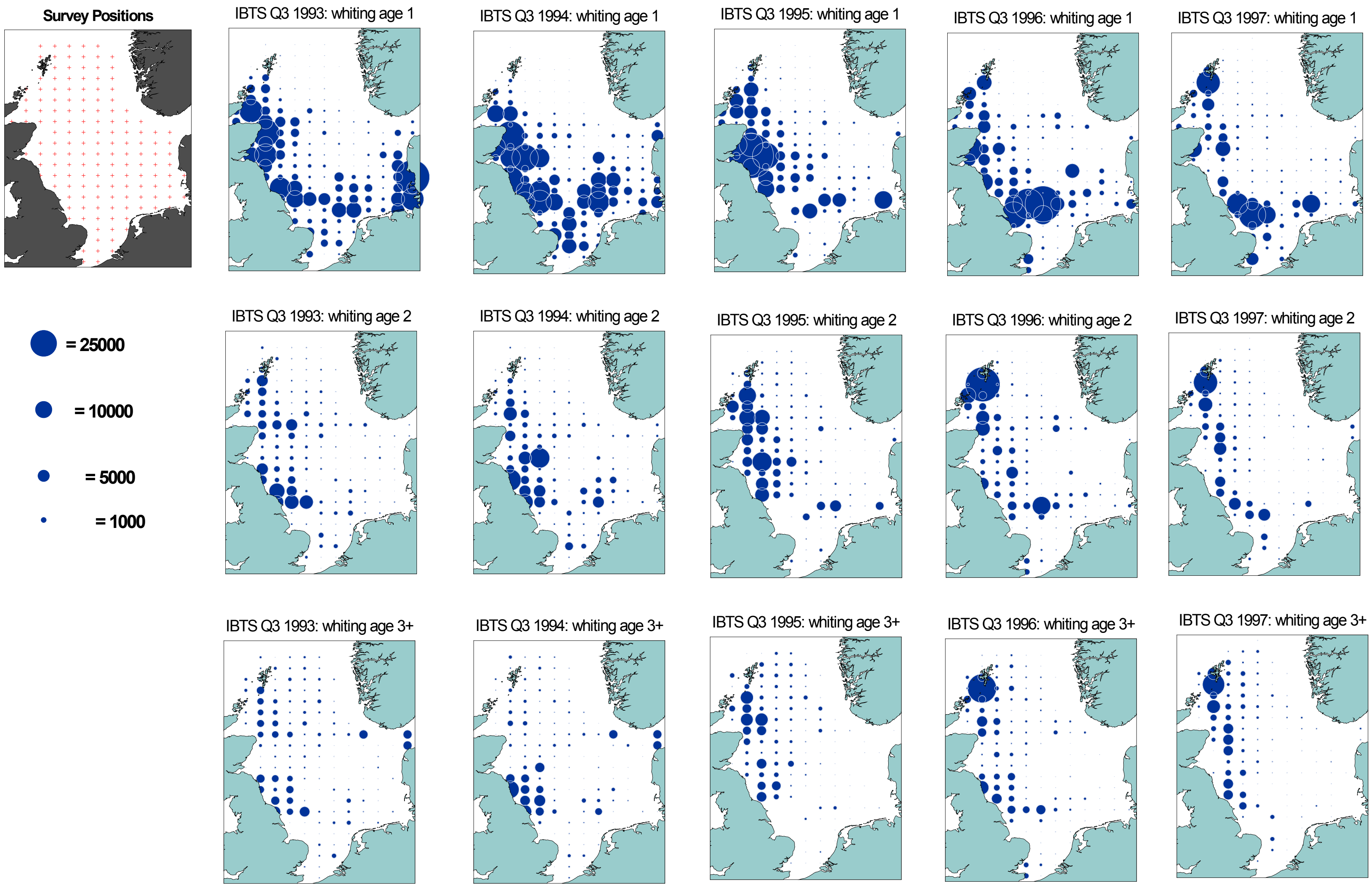


Figure 2 Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.

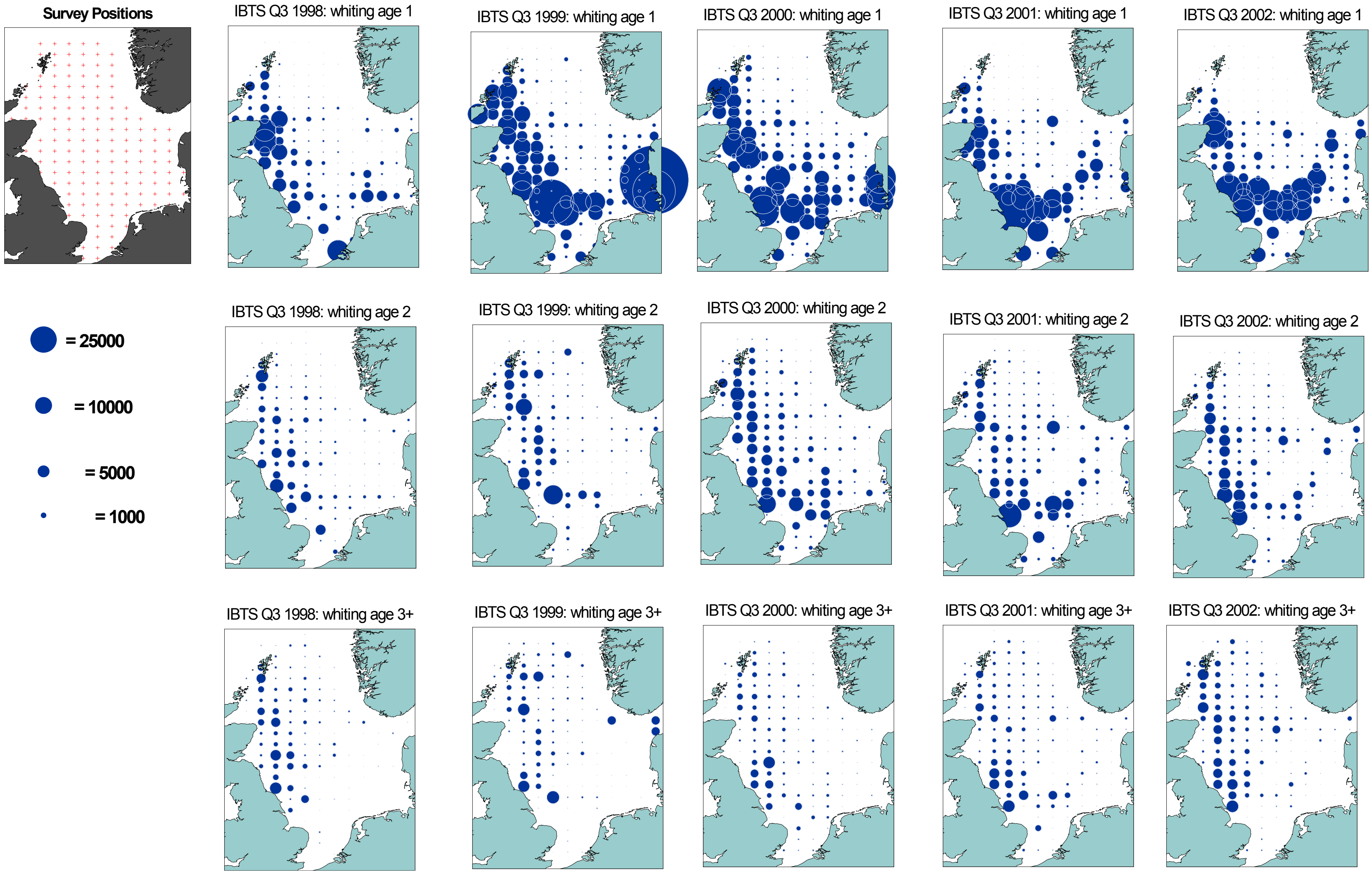


Figure 2 (cont.) Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.

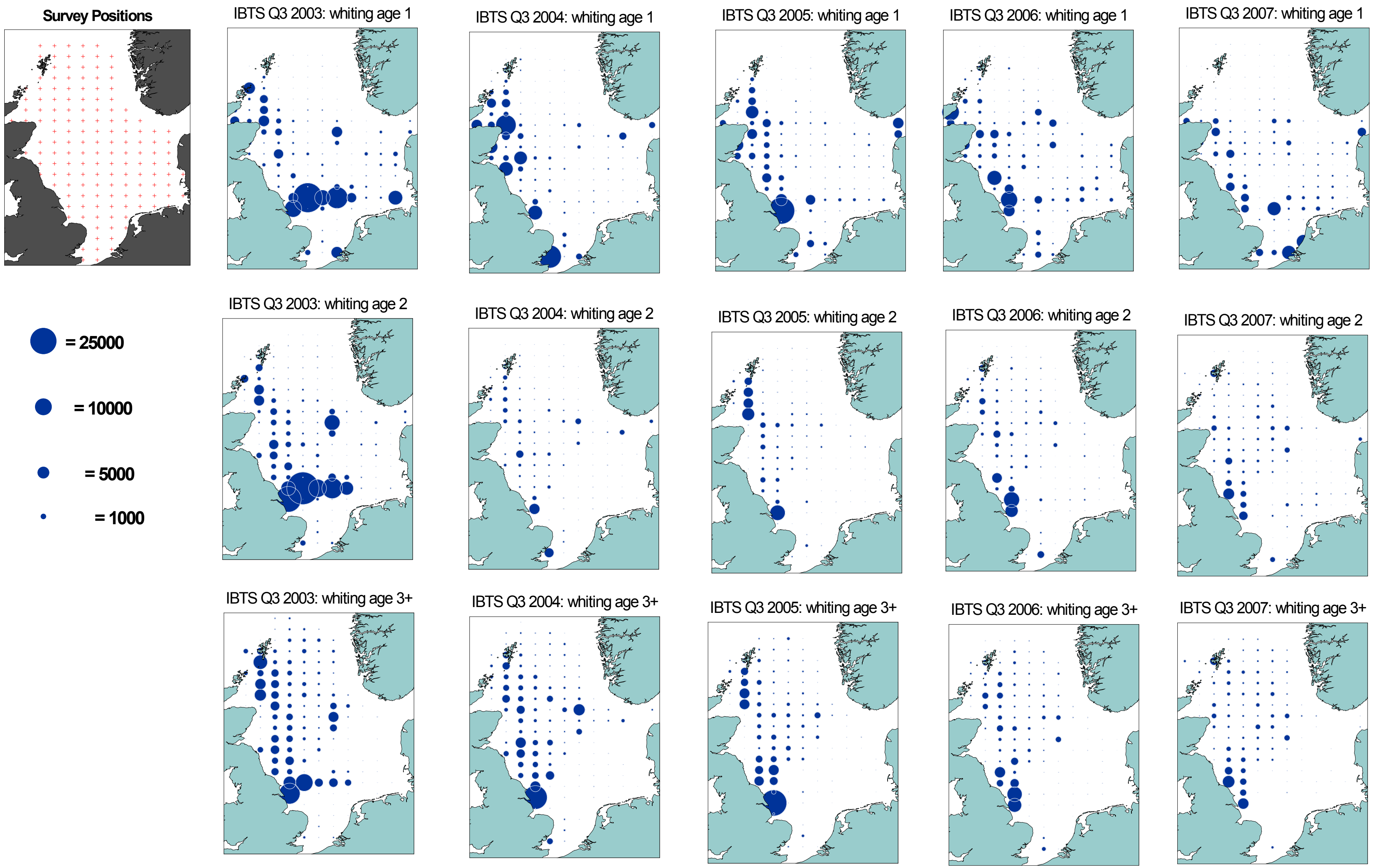


Figure 2 (cont.) Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey.

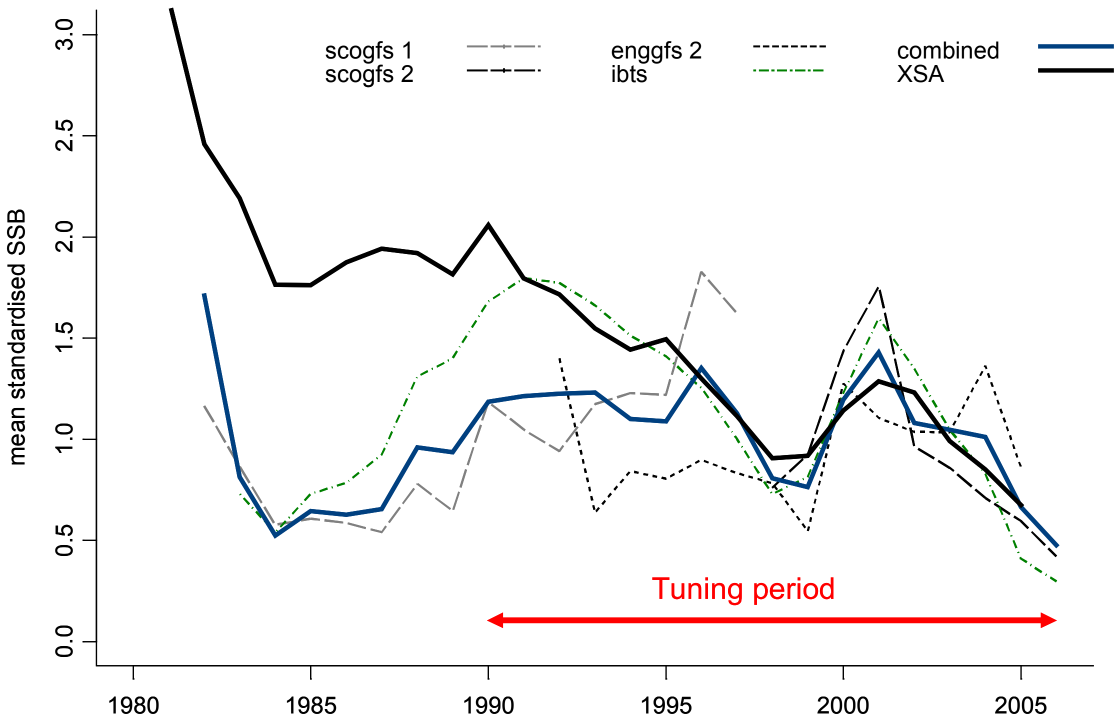


Figure 3 Catch based estimated of spawning stock biomass (black line) shown along side survey based estimates of spawning stock biomass (blue, and dashed lines), the blue line showing an estimate based on all the surveys. These are scaled so that the mean of each line over the years 1996 – 2006 is one.

Stock Annex: FU6, Farn Deeps

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Farn Deeps Nephrops (FU06
Date:	06/03/2009 (WKNEPH2009)
Revised by	Ewen Bell/Jon Elson

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 Farn Deeps area the *Nephrops* stock inhabits a large continuous area of muddy sediment extending North from 54° 45′ - 54° 35′N and 0° 40′ - 1° 30′N with smaller patches to the east and west.

A.2. Fishery

In 2001 the cod recovery plan was introduced and the number of vessels recorded in this fishery and landing into England increased from around 160 in 2000 to and fluctuated around 200 between 2001 and 2003. In 2004 the number returned to around 160 vessels but stepped up to 230 vessels in 2006. Although a small increase was apparent in the number of the local fleet turning to *Nephrops* the increase in the number of visiting Scots, Northern Irish and other English vessels was greater. Visiting Scottish vessels consistently make up about 30 to 40% of the fleet during the season and account for between 20 and 30% of the landings by weight. Since 2000 there has been an increase in the effort of vessels targeting *Nephrops* using multi rig trawls. In 2004 they accounted for about 10% of the landings by weight and 20% by 2006. Over 25% of the entire fleet uses multi rigs mainly through an influx of up to 19 Northern Irish and 30 Scottish multi riggers visiting the area - coming into the fishery for the frst time over the last two years. Both single and multi trawl fleets were affected by Technical Conservation Measures and Cod recovery plans. The single trawl fleet in general switched from a 70mm to an 80 mm cod end mesh in 2002. Multi rigged vessels targeting prawns use 95mm cod end mesh. The average vessel size of the visitors has remained relatively stable but average horse power has increased. With decommissioning the average size and power of the local fleet has declined slightly. Currently the average size of the local fleet is 11m with an average engine power of around 140 kW.

The fishery is exploited throughout the year, with the highest landings made between October and March. Fishing is usually limited to a trip duration of one day with 2 hauls of 3-4 hours being carried out. The main landing ports are North Shields, Blyth, Amble and Hartlepool where, respectively, on average 45, 32, 10 and 7% of the landings from this fishery are made.

The minimum landing size for *Nephrops* in the Farn Deeps is 25mm CL. Discarding generally takes place at sea, but can continue alongside the quay. Landings are usually made by category for whole animals, often large and medium and a single category for tails. However, landings to merchants of one category of unsorted whole and occasionally one of tails is becoming more common. Depending on the number of small, the category of tails is often roughly sorted as whole and left on deck for tailing later. This category is only landed once tailed. The local enforcement agency is discouraging the practice of tailing after tying up alongside.

Regulations

UK legislation (SI 2001/649, SSI 2000/227) requires at least a 90mm square mesh panel in trawls from 80 to 119mm, where the rear of the panel should be not more than 15m from the cod-line. The length of the panel must be 3m if the engine power of the vessel exceeds 112 kW, otherwise a 2m panel may be used. Under UK legislation, when fishing for *Nephrops*, the cod-end, extension and any square mesh panel must be constructed of single twine, of a thickness not exceeding 4mm for mesh sizes 70-99mm, while EU legislation restricts twine thickness to a maximum of 8mm single or 6mm double.

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30'N.

Legislation on catch composition for fishing N or S of 55° along with other cod recovery measures may have affected where and when effort is targeted which in turn could affect catch length distributions. This latitude bisects the Farn Deeps *Nephrops* fishery.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Three types of sampling occur on this stock, landings sampling, catch sampling and discard sampling providing information on size distribution and sex ratio. Landing and catch sampling occurs at North Shields, Blyth, Amble and Hartlepool.

Historically, estimates of discarding were made using the difference between the catch samples and the landings samples. For the period prior to 2002, catch length samples and landings length samples are considered to be representative of the fishery. An estimate of retained numbers at length was obtained for this period from the catch sample using a discard ogive estimated from data from the 1990s, a raising factor was then determined such that the retained numbers at length matched the landings numbers at length. This raising factor was then applied to the estimate of discard numbers at length.

More recently, there has been concern that the landings sampling may be missing portions of the landings landed as tails (as opposed to whole individuals) thus leading to an artificial inflation of the estimated discards. On-board discard sampling has been of sufficient frequency since 2002 to enable the estimation of discards from these data. There are two modes of operation for "tailing" in the FU6 *Nephrops* fishery, some vessels tail at sea, others tail at the quayside. Discard estimates from the latter category only sample those animals discarded at sea, the undersize individuals discarded at the quayside are not sampled, consequently the proportion of discards at sizes below MLS for this tailing practice are very low (Figure B.1.1). Discard trips, which saw discarding of less than 50% of individuals below MLS, were ignored. Annual discard ogives showed no systematic change, therefore a single ogive was constructed from the pooled data from 2002–2007 (Figure B.1.2). This was then applied to the catch data to produce estimates of landings at length.

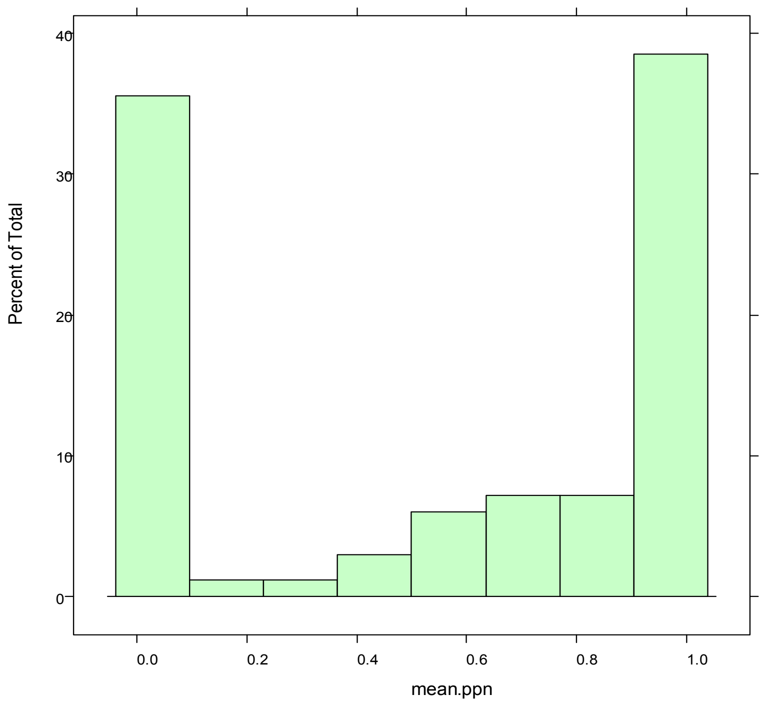


Figure B.1.1. Farn Deeps (FU 6): Histogram of proportion individuals <26mm discarded.

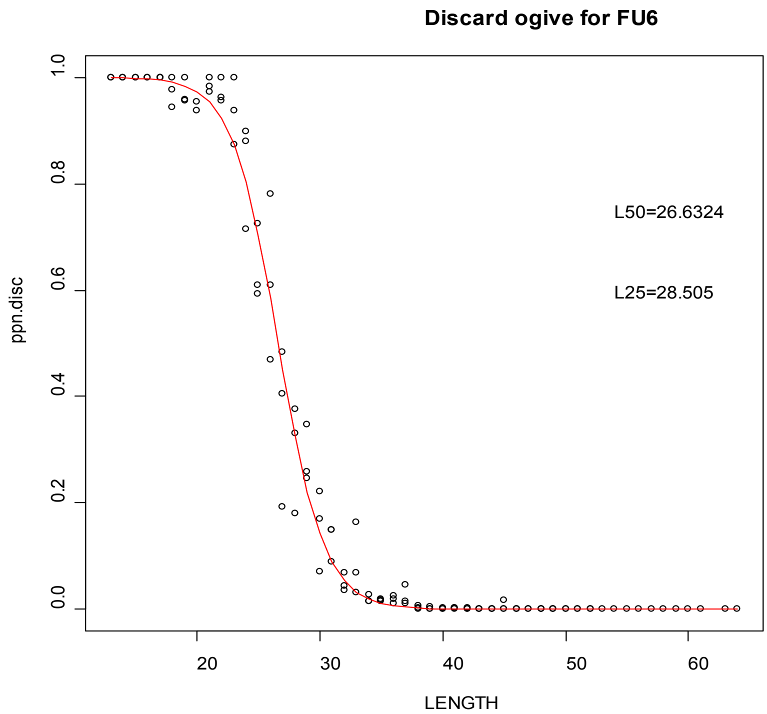


Figure B.1.2. Farn Deeps (FU 6): Discard ogive selected for FU6 *Nephrops*, trip level data pooled to year.

B.2. Biological

Mean weights-at-age for this stock are estimated from fixed weight-length relationships derived from samples collected from this fishery (Macer unpublished data)

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 based on Morizur, 1982. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The size at maturity for females was recalculated at ICES-WKNEPH 2006 to be 24.8mm CL 24 mm CL was used in assessments prior to 2009. A sigmoid maturity function is now used: L25 = 24.5mm, L50 = 25mm

Growth parameters are estimated from observations from this fishery (Macer, unpublished data) and comparison with adjacent stocks.

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 the value for females is based on observations on 50% berried CL.

Discard survival (previously set at 25 %) was set to zero from 1991.

Summary:

Growth :

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 58mm, k = 0.06,

Size at maturity L25=24.5mm, L50=25mm.

Weight length parameters:

Males a = 0.00038, b = 3.17

Females a= 0.00091, b = 2.895

Discards

Discard survival rate: 0% .

Discard proportion: 29.5%

B.3. Surveys

Abundance indices are available from the following research-vessel surveys:

Underwater TV survey: years 1996 – present. Surveys have been conducted in Spring and/or Autumn each year but only consistently in Autumn from 2001. In 2008 there was an historical revision of burrow density estimates from the TV survey. Previous estimates of burrow density had assumed that station density was independent of burrow density based analysis that showed there was no evidence of differences in trends in burrow density between the different strata in the fishery (ICES WGNEPH, 2000). The assumption led to an unstratified mean density being used and multiplied by the total area to arrive at overall abundance. Analysis of burrow density by rectangle has since shown that the distribution of stations is positively correlated with burrow density and therefore the unstratified mean density will overestimate burrow density. In order to compensate for the bias in sampling density, burrow abundance estimates are made for each rectangle and then summed to give the new total.

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 as follows.

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 6: Farn Deeps	<=2009	1.3	0.85	1.05	1	

B.4. Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- UK Nephrops trawl gears. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for English and Scottish *Nephrops* trawlers (single trawl and multiple trawl) is raised to the total landings reported by the four gear goups - *Nephrops* single trawl, multiple *Nephrops* trawl, Light trawl and multiple demersal trawl. There is no account taken of any technological creep in the fleet.

The registered buyers and sellers legislation brought in by the UK in 2006 changed the reporting procedure, which effectively breaks the continuity in the series at that point. The accuracy of the reported landings has significantly improved since then but there is currently little that can be done to determine and correct for any differences in the two series.

B.5. Other relevant data

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 the future).

D. Short-Term Projection

1. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. 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
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	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
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None

F. Long-Term Projections

None

G. Biological Reference Points

None specified.

Harvest ratios equating to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
$F_{0.1}$	8.2%
F_{max}	13.3%

H. Other Issues

I. References

Stock Annex: FU7, Fladen Ground

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Fladen Ground *Nephrops* (FU 7)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

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. 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. The Fladen Ground is located towards the centre of the northern part of Division IV. Its eastern boundary is adjacent to the Norwegian Deeps area, while its western boundary borders the Moray Firth functional unit (FU9). There is some evidence for overlap of habitat at the boundary of these areas. The ground represents one of the largest areas of soft muddy sediments in the North Sea and there are wide variations in sediment composition across the ground. *Nephrops* is distributed throughout the area and is associated with various benthic communities reflecting the variations in physical environment.

A.2. Fishery

The Fladen fishery (FU7), the largest Scottish *Nephrops* fishery, takes a mixed catch with haddock, whiting, cod, monkfish and flatfish such as megrim, also making an important contribution to vessel earnings. The Fladen *Nephrops* fleet comprises vessels from 12m up to 35m fishing mainly with 80mm twin-rig. The fleet has a diverse range of boats, and includes some of the largest most modern purpose built boats in the Scottish fleet and vessels which have recently converted to *Nephrops* fishing.

The area supports well over 100 vessels and the majority of the fleet (80%) fish out of Fraserburgh, with the other important ports being Peterhead, Buckie, Macduff, and Aberdeen. Boats fish varying lengths of trip between 3 days (small boats) and 8-9 day trips (larger vessels). During 2006 and 2007 around 20 vessels joined the fleet and 5 ongoing new boat builds have the capability to fish at Fladen. Some whitefish vessels have converted to *Nephrops* twin-rigging.

The Fladen fishery generally follows a similar pattern every year, with different areas of the Fladen grounds producing good fishing at different times of the year (boats fish the north of the ground in winter, then move east towards the sector line in the summer). During 2004-5 this seasonal pattern was less apparent with fishing being good throughout the year on a range of grounds. There was also no lull in catch rates which traditionally happens in April-May. In 2006 however, there was a return to a more usual pattern of fishing with catches poor for most of the spring and slowly getting better throughout the summer. Some participating vessels explored slightly different areas to fish in 2006, particularly on the eastern edge of the ground. Bad weather at the start of 2006 and part of 2007 also contributed to the slower start to the fishery in these years. In some years, high squid abundance in the Moray Firth attracts Fladen vessels but in the last two years this was not so evident compared to 2005.

Other developments include the capability of freezing at sea and in one case, processing at sea. A recent tendency towards shorter trip lengths and improved handling practice is associated with market demand for high quality *Nephrops* which appears to have increased dramatically. The implementation of buyers and sellers legislation in 2006 has reduced the problem of underreporting and prices have risen, while weighing at sea has improved the accuracy of reported landings.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length compositions of Scottish landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are considered adequate for providing representative length structure of removals at the Fladen Ground. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests a rapid increase since 2003. It is likely, however, that improved reporting of landings data) in recent years particularly arising from 'buyers and sellers legislation has contributed to the increase. The high levels have been maintained since 2003. In addition, effort recording in terms of hours fished is non-mandatory and therefore it is unclear whether these trends and those that are discussed below are actually indicative of trends in LPUE.

Males consistently make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary. In earlier years effort was generally highest in the latter part of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, and in common with the overall figure has shown a marked increase since then. This suggests that exploitation (or other external factors) are not disproportionately affecting one sex or the other. LPUE is fairly similar through the year for males but for females there is no consistent pattern in these data.

LPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the size above which the effects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a rise in LPUE in all categories since 2001. There is, however, no apparent lag between the increased LPUEs of <35mm animals and >35mm animals which one might expect if the reason was increasing abundance.

B.2. Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Parameters applied in a preliminary length-based assessment and age (with length) based simulation to inform the catch forecast process were as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Von Bertalanffy growth parameters are as follows:

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 56mm, k = 0.10,

Size at maturity = 25mm

Weight length parameters:

Males a = 0.0003, b = 3.25

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%.

Discard proportion: 13.8%

B.3. Surveys

TV surveys using a stratified random design are available for FU 7 since 1992 (missing survey in 1996). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

On average, about 60 stations have been considered valid each year with over 70 stations in the last three years. Data are raised to a stock area of 28153 km^2 based on the stratification. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate (Figure B3–1). Most of the variance in the survey is associated with this variable sediment which surrounds the main centres of abundance. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground but in 2007, higher densities were also recorded in the more northerly parts of the ground. In general the confidence intervals have been fairly stable in this survey.

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 Fladen are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 7: Fladen	<=2009	1.45	0.9	1	1	

B.4. Commercial CPUE

Scottish *Nephrops* trawl gears: Landings, discards and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5. Other relevant data

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 the future).

D. Short-Term Projection

1. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. 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
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	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
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None presented

F. Long-Term Projections

None presented

G. Biological Reference Points

Harvest ratios equivalent to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm.

F-reference point	Harvest ratio
F0.1	9.3%
Fmax	15.8%

H. Other Issues

I. References

Table B1-1. ***Nephrops*****, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish** ***Nephrops*** **trawlers, 1981-2007 (data for all** ***Nephrops*** **gears combined, and for single and multirigs separately).**

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.8	6177	47.5	130.2	1097	8.6	127.6
2005	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7
2006	9469	65.7	144.1	7149	50.2	142.4	2320	15.5	149.7
2007	11054	69.6	158.8	8232	52.2	157.7	2822	17.4	162.2

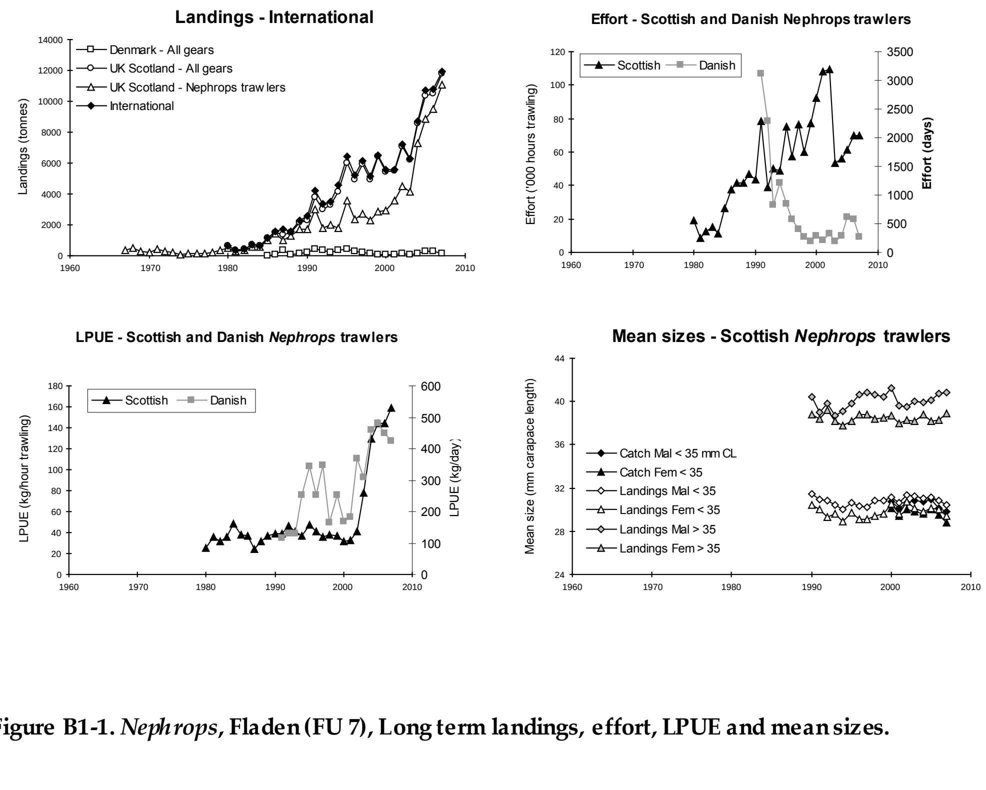


Figure B1-1. ***Nephrops*****, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.**

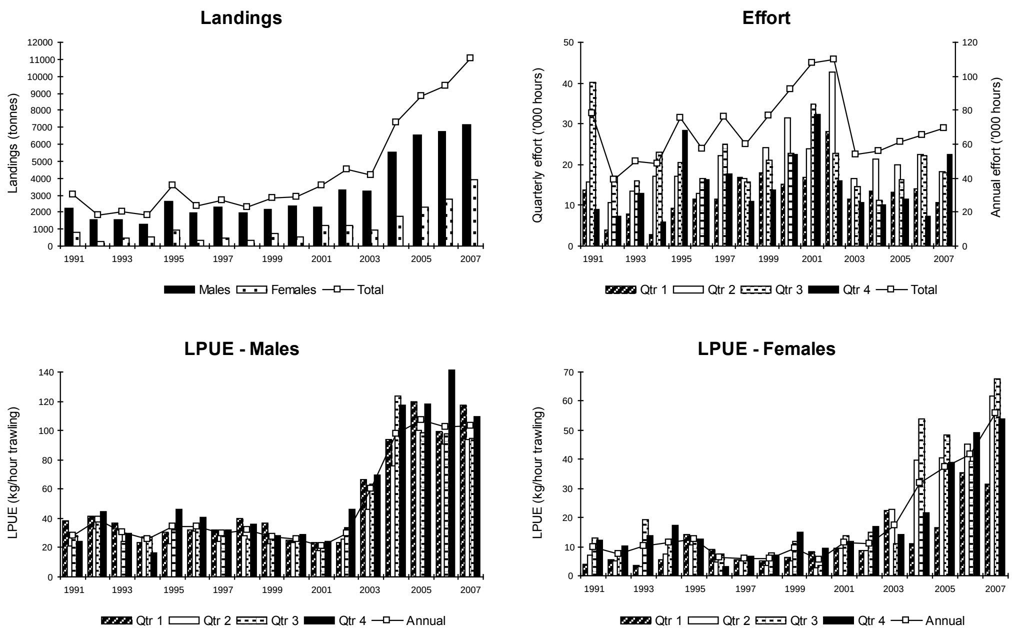


Figure B1-2. ***Nephrops*, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.**

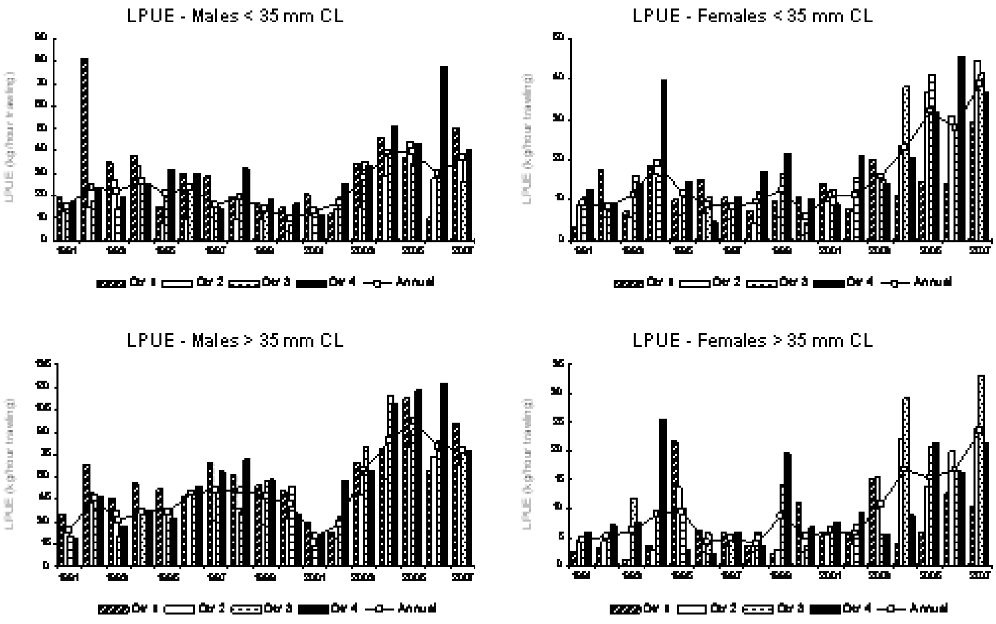


Figure B1-3. ***Nephrops*, Fladen (FU 7), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.**

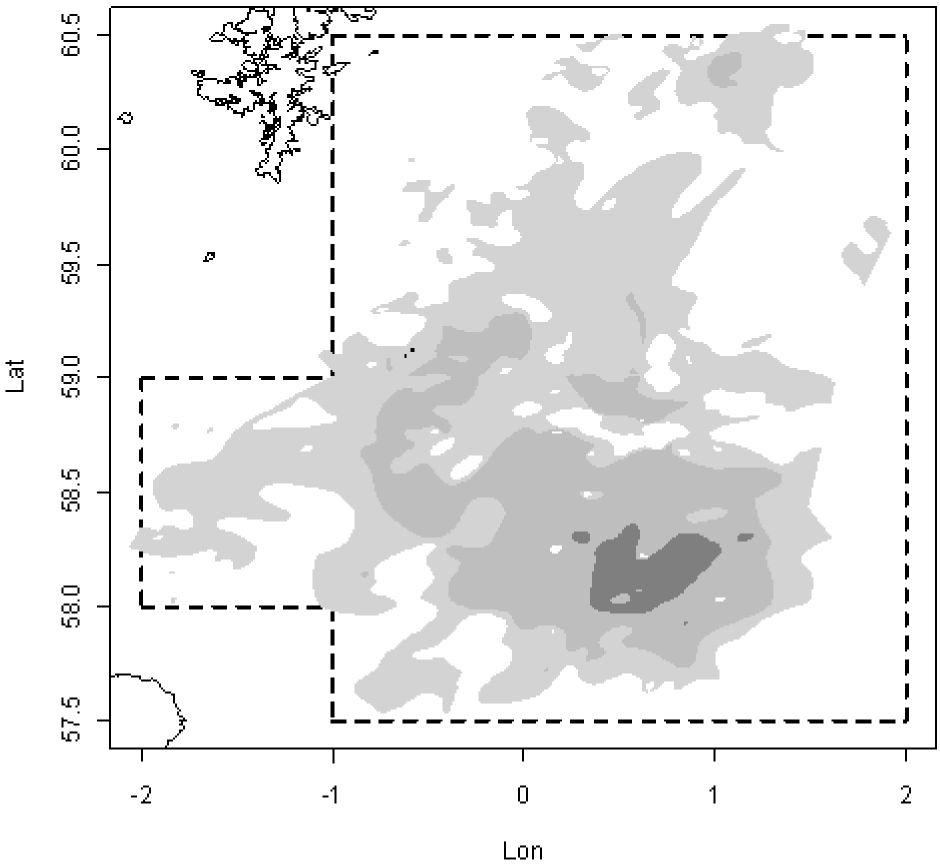


Figure B3–4. Distribution of *Nephrops* sediments in the Fladen Ground (FU 7). Thick dashed lines represent the boundary of the functional unit. Sediments are: Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy.

Stock Annex: FU8, Firth of Forth

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Firth of Forth *Nephrops* (FU 8)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

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. 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. The Firth of Forth is located close inshore to the Scottish coast, towards the west of the central part of Division IV. The mud substrate in the Firth of Forth area is mainly muddy sand and sandy mud, and there is only a small amount of the softest mud. The population of *Nephrops* in this area is composed of smaller animals. Earlier research suggested that residual currents moving southward from this area transport some larvae to the Farn Deeps – recent larval surveys have not been undertaken, however, and it is unclear how significant this effect is. Outside the functional unit, a *Nephrops* population is found on a smaller patch of mud beyond the northern boundary, off Arbroath.

A.2. Fishery

The *Nephrops* fishery is located throughout the Firth but is particularly focussed on grounds to the east and south east of the Isle of May. Grounds located further up the Firth occur in areas closer to industrial activity and shipping.

Most of the vessels are resident in ports around the Firth of Forth, particularly at Pittenweem, Port Seton and Dunbar. Some vessels, normally active in the Farn Deeps, occasionally come north from Eyemouth and South Shields. During 2006 and 2007 the number of vessels regularly fishing in the Firth of Forth was been around 40 (23 under 10m and 19 over 10m vessels). This number varies seasonally with vessels from other parts of the UK increasing the size of the fleet. Local boats sometimes move to other grounds when catch rates drop during the late spring *Nephrops* moulting period. Traditionally, Firth of Forth boats move south to fish the Farn Deeps grounds. Single trawl fishing with 80 mm mesh size is the most prevalent method. Some vessels utilise a 90mm codend. A couple of vessels have the capability for twin rigging. Night fishing for *Nephrops* is commonest in the summer. Day fishing is the norm in winter. A very small amount of creeling for *Nephrops* takes place, this is mostly by crab and lobster boats.

Nephrops is the main target species with diversification by some boats to squid, and also surf clams. Only very small amounts of whitefish are landed. The area is characterised by catches of smaller *Nephrops* and discarding is sometimes high. The latest information for 2007 suggests that large catches of small *Nephrops* were taken. In the past, small prawns generally led to high tail:whole prawn ratios in this fishery but in recent years a small whole prawn 'paella' market developed.

In 2006, buyers and sellers regulations led to increased traceability and improved reporting of catches. This continued and improved further in 2007 and the reporting of landings is now considered to be much more reliable.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered adequate for providing representative length structure of removals in the Firth of Forth. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests that the stock is currently very abundant but the recent improvements in reporting of landings (due to 'buyers and sellers' legislation) may mean this is an artefact generated by more complete landings data. In addition, effort recording in terms of hours fished is non-mandatory which will also affect the trends in LPUE.

Males consistently make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary. Effort is generally highest in the 3rd quarter of the year in this fishery, but although the pattern was fairly stable in the early years, the pattern does not appear as strong in recent years and is 2007 was fairly evenly spread throughout the year. LPUE of both sexes has fluctuated through the time series and is currently at a high level. The comments about the quality of landings data are relevant here too. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the size above which the affects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1999, with a decline after this, followed by a steady increase in both sexes from 2002 onwards. The CPUE for larger individuals showed a similar pattern with higher values in the most recent years.

B.2. Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Assumed biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Growth parameters

Males; L_∞ = 66mm, k = 0.163

Immature Females; L_∞ = 66mm, k = 0.163

Mature Females; L_∞ = 58mm, k = 0.065,

Size at maturity = 26mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00085, b = 2.91

Discards

Discard survival rate: 25%.

Discard rate: 34.6%

B.3. Surveys

TV surveys using a stratified random design are available for FU 8 since 1993 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. On average, about 40 stations have been considered valid each year with more stations sampled in the last three years. The survey in 2006 was conducted in December so that densities may not be strictly compatible with the remainder of the series. Abundance data are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground is predominantly of coarser muddy sand (Figure B3–1). Depending on the year, high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area. Abundance is generally higher towards the central part of the ground and around the Isle of May. In recent years higher densities have been recorded over quite wide areas. Confidence intervals have been fairly stable in this survey.

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 Firth of Forth are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 8: Firth of Forth	<=2009	1.23	0.9	1.05	1	

B.4. Commercial CPUE

Scottish *Nephrops* trawl gears: Landings, discards and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5. Other relevant data

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 the future).

D. Short-Term Projection

1. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. 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
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	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
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None presented

F. Long-Term Projections

None presented

G. Biological Reference Points

Harvest ratios equivalent to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm.

F-reference point	Harvest ratio
F0.1	8.0%
Fmax	13.7%

H. Other Issues

I. References

Table B1-1. ***Nephrops*****, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).**

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8
2006	2437	61.4	39.7	2432	61.0	39.9	5	0.4	14.2
2007	2622	57.6	45.5	2601	57.1	45.6	21	0.5	43.2

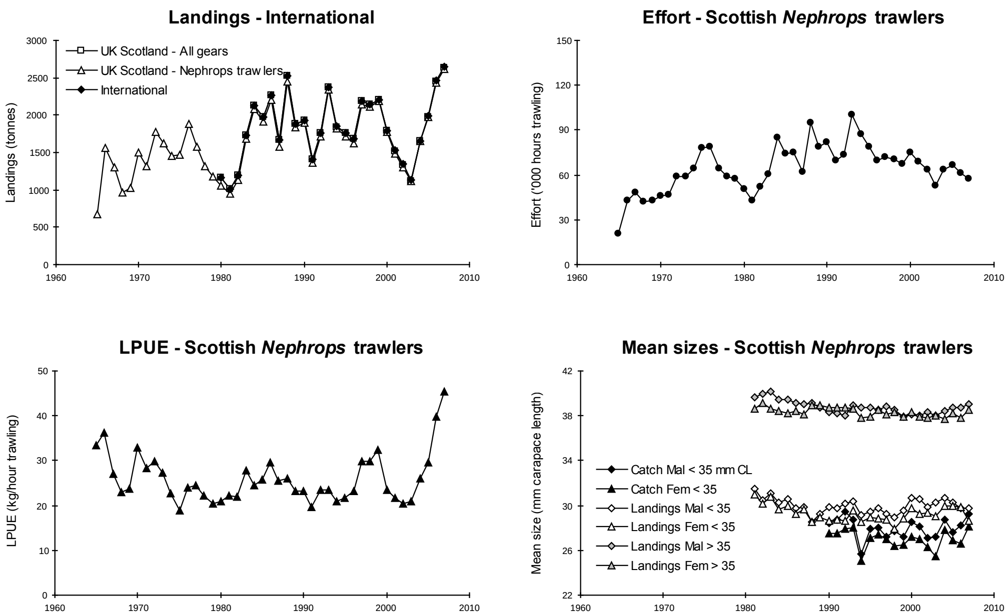


Figure B1-1. ***Nephrops*****, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.**

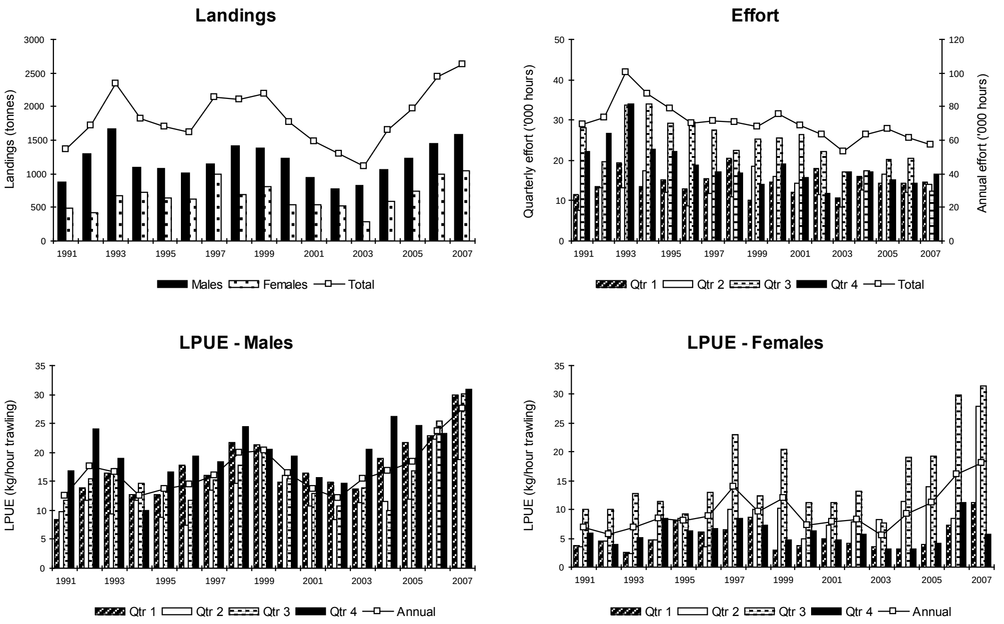


Figure B1-2. ***Nephrops*, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.**

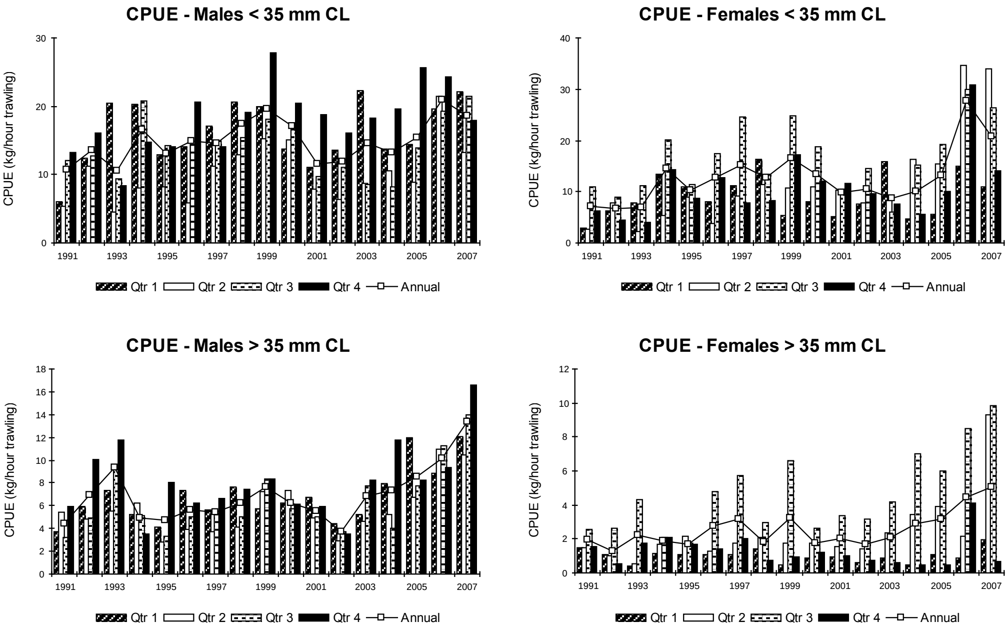
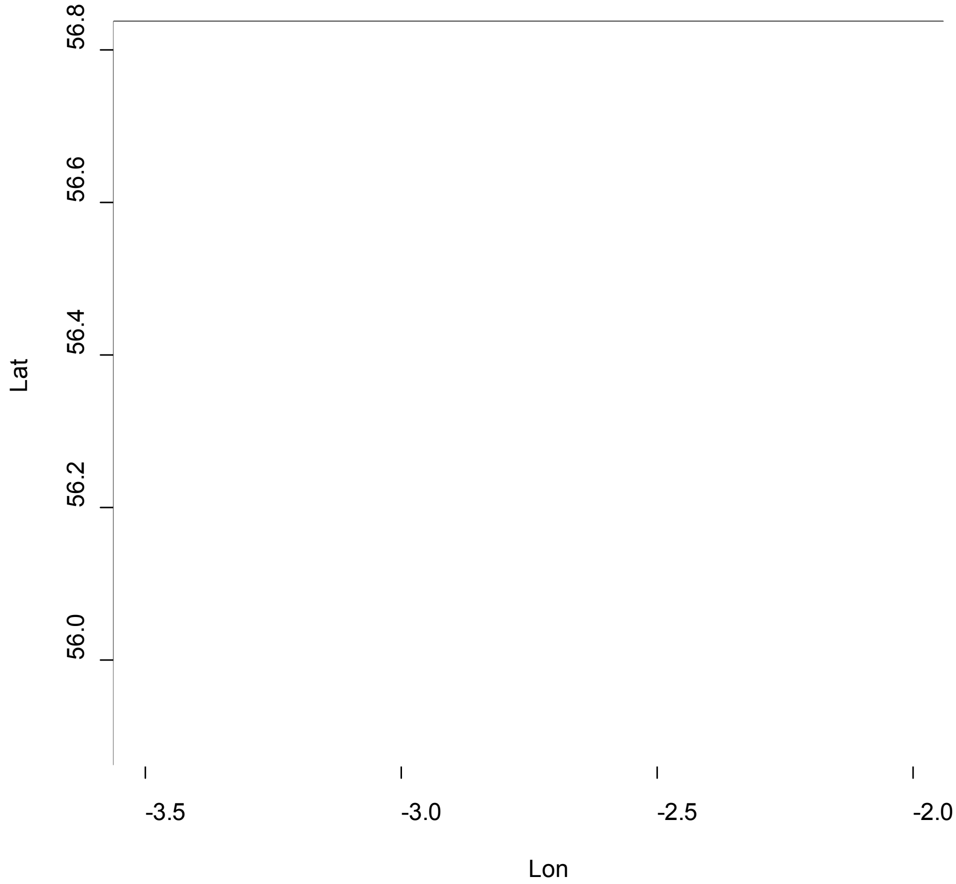


Figure B1-3. ***Nephrops*, Firth of Forth (FU 8), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.**


Lat
56.0
56.2
56.4
56.6
56.8
-3.5
-3.0
-2.5
-2.0
Lon

Stock Annex: FU9, Moray Firth

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Moray Firth *Nephrops* (FU 9)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

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. 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. The Moray Firth is located to the north west of Division IV. In common with other *Nephrops* fisheries the bounds of the Functional Unit are defined by the limits of muddy substrate. The major *Nephrops* fisheries within this management area fall within 30 miles of the UK coast. The Moray Firth (FU9) is a relatively sheltered inshore area, that supports populations of juvenile pelagic fish and relatively high densities of squid at certain times. The Moray Firth borders the Fladen funtional unit (FU7) and there is some evidence of *Nephrops* populations lying across this boundary.

A.2. Fishery

The Moray Firth area is fished by a number of the smaller class of *Nephrops* boat (12-16m) regularly fishing short trips from Buckie, Helmsdale, Macduff and Burghead. Most boats still fish out of Burghead, and are about 15 in number; leaving and returning to port within 24 hours (day boats). Many of the smaller boats are now only manned by one or two people. Several of the larger *Nephrops* trawlers fish the outer Moray Firth grounds on their way to or from the Fladen grounds (especially when they are fishing the Skate Hole area). Also in times of bad weather many of the larger *Nephrops* trawlers which would normally be fishing the Fladen grounds fish the Moray Firth grounds. In recent years a squid fishery has been seasonally important in the Moray Firth. Squid appear to the east of the Firth and gradually move west during the Summer, increasing in size as they shift. During the autumn the movement is reversed. A large fishery took place in 2004 that attracted a number of *Nephrops* vessels and in 2005, additional vessels joined in the seasonal fishery, but catches were noticeably down in 2006. In 2007 however the fishery for squid improved again and a number of boats switched effort until around October, with some boats fishing squid until December.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered adequate for providing representative length structure of removals in the Moray Firth. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests that the stock increased in the early- 1980s, declined to a stable level over the next 12 years or so and has recently increased to its highest level in 2007. It is thought that gear efficiency changes have occurred over time, particularly in relation to multiple trawl gears but this has not been quantified. Additionally, improved reporting of landings data in recent years arising from 'buyers and sellers' legislation is likely to also to have contributed to the increase in LPUE. Furthermore, effort recording is non-mandatory in terms of hours fish and therefore it is unclear whether these trends and those that are discussed below are actually indicative of trends in LPUE.

Males generally make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary, and females landings exceeded males in 1994. Effort is generally highest in the 3rd quarter of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, but has shown an increase since then. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1995, with a slight decline after this and relatively stable values from 2001 onwards. There is a peak in catches of small males in 2006 quarter 4 but taken annually the pattern is relatively stable. The CPUE for larger males shows relatively stable levels during the late 1990's, and slightly higher levels in the most recent years, particularly from 2003 onwards. CPUE for large females declined in 2005 but have risen again over the past two years, and showed a significant large value in 2007 quarter 3.

B.2. Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Assumed biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

Summary

Growth parameters:

Males; L∞ = 62mm, k = 0.165

Immature Females; L∞ = 62mm, k = 0.165

Mature Females; L∞ = 56mm, k = 0.06,

Size at maturity = 25mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%

Discard rate: 7.4%

B.3. Surveys

TV surveys are available for FU 9 since 1993 (missing survey in 1995). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops.*

On average, about 36 stations have been considered valid each year, and are raised to a stock area of 2195 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground is predominantly of coarser muddy sand (Figure B3–1) and most of the variance in the survey is associated with a patchy area of this sediment to the west of the ground. Abundance has generally been higher towards the west of the ground but in recent years higher densities have been recorded throughout, and are quite evenly distributed at the east and west ends in 2006 and 2007. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

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 Moray Firth are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 9: Moray Firth	<=2009	1.31	0.9	1	1	

B.4. Commercial CPUE

Scottish *Nephrops* trawl gears: Landings at age and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory.

Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5. Other relevant data

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 the future).

D. Short-Term Projection

1. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. 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
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	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
Fcurrent	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 F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
F0.1	8.9%
Fmax	16.6%

H. Other Issues

I. References

Table B1-1. *Nephrops*, Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	36.7	35.4	1298	36.7	35.4	na	na	na
1982	1034	28.2	36.7	1034	28.2	36.7	na	na	na
1983	850	21.4	39.7	850	21.4	39.7	na	na	na
1984	960	23.2	41.4	960	23.2	41.4	na	na	na
1985	1908	49.2	38.8	1908	49.2	38.8	na	na	na
1986	1933	51.6	37.5	1933	51.6	37.5	na	na	na
1987	1723	70.6	24.4	1723	70.6	24.4	na	na	na
1988	1638	60.9	26.9	1638	60.9	26.9	na	na	na
1989	2102	69.6	30.2	2102	69.6	30.2	na	na	na
1990	1700	58.4	29.1	1700	58.4	29.1	na	na	na
1991	1284	47.1	27.3	571	25.1	22.7	713	22.0	32.4
1992	1282	40.9	31.3	624	24.8	25.2	658	16.1	40.9
1993	1505	48.6	31.0	783	28.1	27.9	722	20.6	35.0
1994	1178	47.5	24.8	1023	42.0	24.4	155	5.5	28.2
1995	967	30.6	31.6	857	27.0	31.7	110	3.6	30.6
1996	1084	38.2	28.4	1057	37.4	28.3	27	0.8	33.8
1997	1102	47.7	23.1	960	42.5	22.6	142	5.1	27.8
1998	739	34.4	21.5	576	28.1	20.5	163	6.3	25.9
1999	813	35.5	22.9	699	31.5	22.2	114	4.0	28.5
2000	1343	49.5	27.1	1068	39.8	26.8	275	9.7	28.4
2001	1188	47.6	25.0	913	37.0	24.7	275	10.6	25.9
2002	1526	35.5	43.0	649	27.2	23.9	234	7.9	29.6
2003	1718	41.1	41.8	737	25.3	29.1	135	3.6	37.5
2004	1818	36.9	49.3	1100	29.2	37.7	123	2.5	49.2
2005	1526	37.6	40.6	1309	34.0	38.5	217	3.6	60.3
2006	1718	41.1	41.8	1477	37.4	39.5	241	3.7	65.1
2007	1818	36.9	49.3	1503	32.4	46.4	315	4.5	70.0

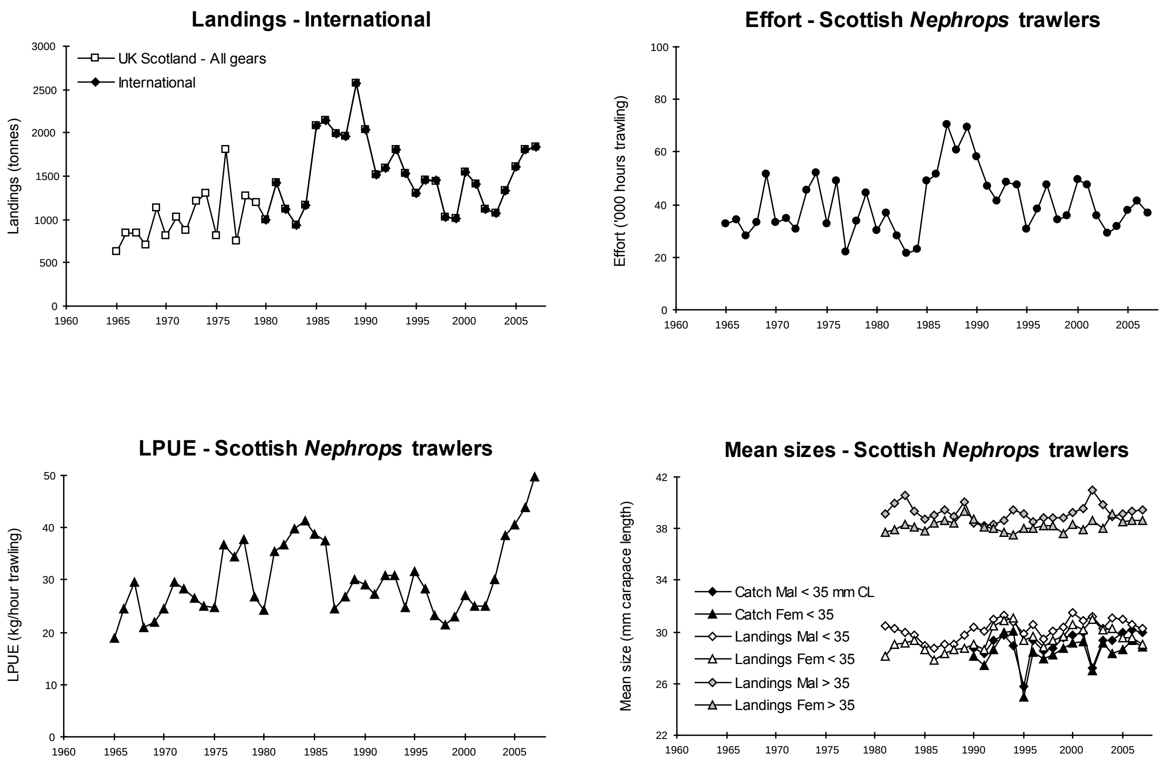


Figure B1-1. ***Nephrops*****, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.**

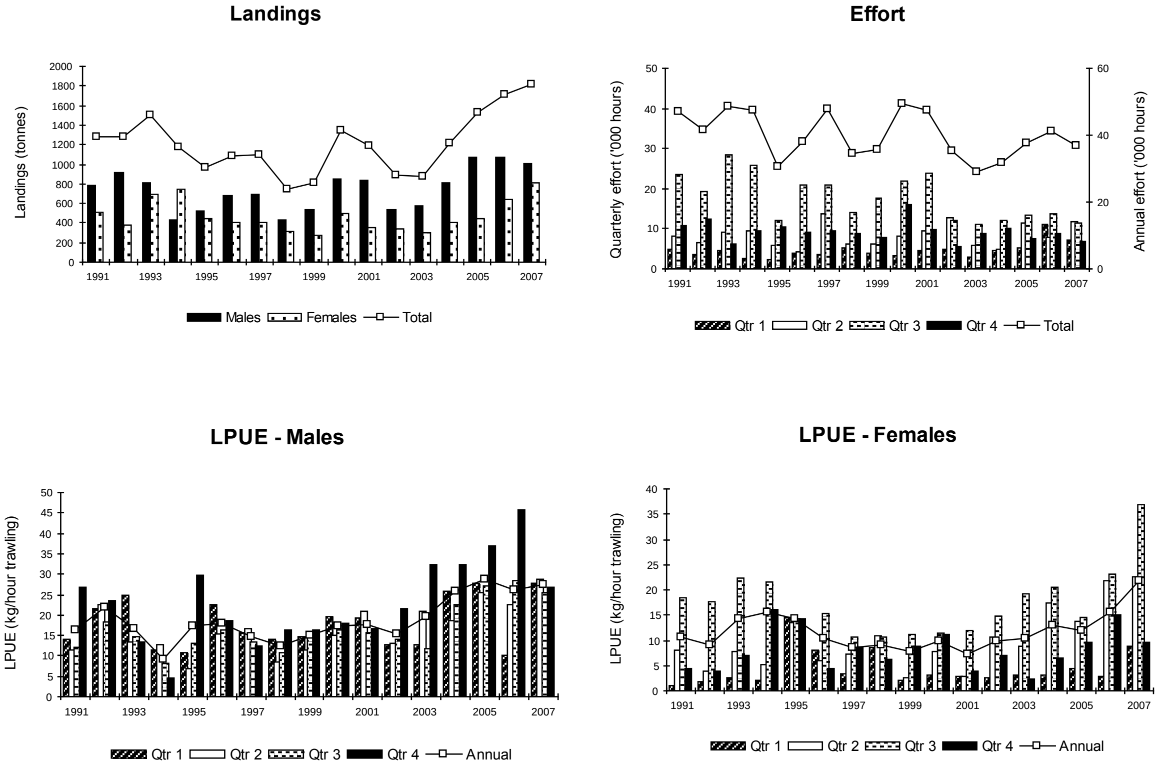


Figure B1-2. ***Nephrops*****, Moray Firth (FU 9), Landings, effort and unstandardised LPUEs by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

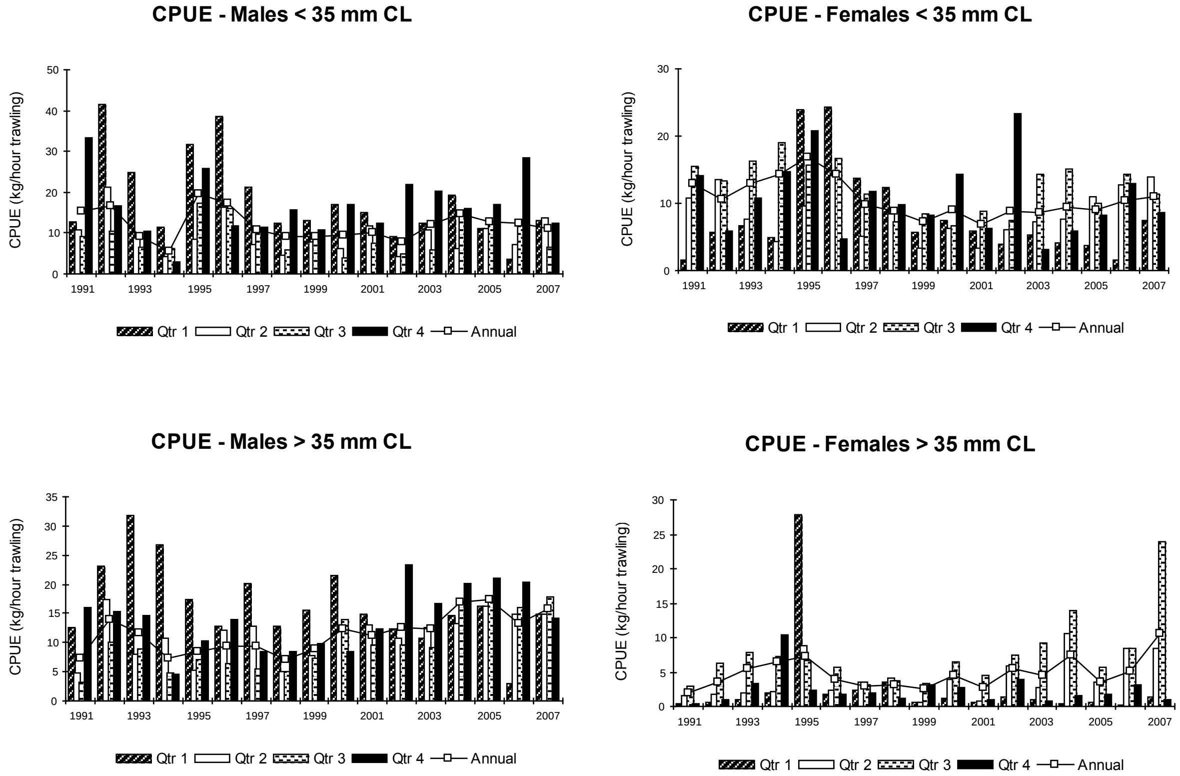
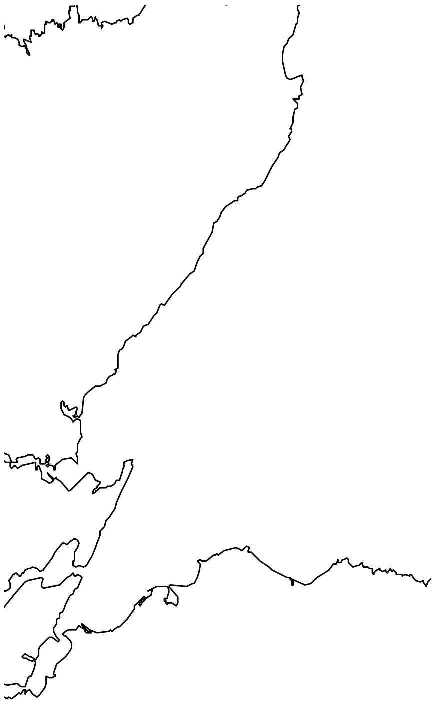


Figure B1-3. ***Nephrops*****, Moray Firth (FU 9), CPUEs by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**



Stock Annexes – Sandeel in IV

Quality Handbook ANNEX:__SAN-NSEA

Stock specific documentation of standard assessment procedures used by ICES.

Working group: North Sea Demersal Working Group

Updated: 21/09/2009 Steen Christensen (sc@aqua.dtu.dk)

Sandeel in IV

General

Stock definition

For assessment purposes, the European continental shelf was divided into four regions for sandeel assessment purposes up to 1995: Division IIIa (Skagerrak), northern North Sea, southern North Sea, and Shetland Islands and Division VIa. These divisions were based on regional differences in growth rate and evidence for a limited movement of adults between divisions (e.g. ICES CM 1977/F:7, ICES CM 1991/Assess:14.). The two North Sea divisions were revised in 1995, and it was decided to amalgamate the two stocks into a single stock unit with two fleets, one fleet in the northern North Sea and one in the southern North Sea. The Shetland sandeel stock is assessed separately. ICES assessments have used these stock definitions since 1995.

Sandeels are largely stationary after settlement and the North Sea sandeel fishery must be considered as exploiting a complex of local populations (Proctor et al. 1998, Wright et al. 1998). Recruitment to local areas may not only be related to the local stock, as some interchange between areas situated close to each other seems to take place during the early phases of life before settlement.

Based on the distribution and simulated dispersal of larval stages, Wright et al. (1998) suggest that the North Sea stock could be split into six areas, including the Shetland as a separate population. Assessments have tentatively been made for some of these areas (Pedersen et al. 1999) and there was high correlation between the results from the study and the assessment made by the WG for the whole North Sea. Presently there are insufficient information about sandeel biology, especially about the intermixing of the early life stages between spawning aggregations, to allow for and alternative separation of the North Sea into separate population units to be assessed.

Recent studies indicate a low interchange of pre-settled sandeels between the spawning grounds identified (Christensen et al. Accepted, Christensen et al. Submitted). These results also indicate that the population structure suggested by Wright et al. (1998) need to be revised. Work is currently conducted to do this.

Fishery

Technical measures for the sandeel fishery include a minimum percentage of the target species at 95% for meshes < 16 mm, or a minimum of 90% target species and maximum 5% of the mixture of cod, haddock, and saithe for 16 to 31 mm meshes.

Most of the sandeel catch consists of the lesser sandeel *Ammodytes marinus*, although small quantities of other Ammodytoidei spp. are caught as well. There is little by-catch of protected species (ICES WGNSSK 2004).

The fishery is seasonal. The geographical distribution of the sandeel fishery varies seasonally and annually, taking place mostly in the spring and summer. In the third quarter of the year the distribution of catches generally changes from a dominance of the west Dogger Bank area back to the more easterly fishing grounds.

The sandeel fishery developed during the 1970s, and landings peaked in 1997 and 1998 at more than 1 million tons. There was a steep drop in total landings from 2002 to 2003, after which they have remained been low (Figure 4.2.1.1 and Table 4.2.1.2). The average landings in the last 20 years are on 632 000 t and total landings in 2009 were 348 000 t.

The spatial distribution of sandeel landings is considered as a good representation of stock distribution, except for areas where severe restrictions on fishing effort is applied (i.e. the Firth of Forth, Shetland areas, and Norwegian EEZ in 2006 and 2009). Up to 2002 and particularly prior to 1998, most landings of sandeels in March were taken from the eastern North Sea banks whilst sandeel landings in April-June were mainly from the west Dogger Bank. In some years a relatively large part of the sandeel landings are taken from the central and eastern North Sea along the Danish west coast. From 1991, grounds off the Scottish east coast have been targeted particularly in June. However, since 2000 the banks in the Firth of Forth area have been closed to fishing.

Large variations in the fishing pattern occurred concurrent with the decline in the total fishery and CPUE in 2003. The distribution of landings in the southern North Sea in 2003 to 2005 seemed more extensive than the typical long-term pattern in the same area. Further, grounds usually less exploited became more important for the total fishery during the same period. In 2006 there was another large change in the fishing pattern, when the fishery showed a strong concentration at the fishing grounds in the Dogger Bank area. Although this overall large variation in fishing pattern there is a general high importance for most years of the Dogger Bank area.

In the Northern North Sea, mainly NEEZ, the change in the spatial pattern was significantly different from southern part. The highest landings from a single statistical square were taken in 1995 on the Vikingbank, the most northerly fishing ground for sandeel in the North Sea. However, in 1996 landings from the Vikingbank dropped substantially, and since 1997 have been close to null. The marked reduction in landings around 2000 in NEEZ was accompanied by a marked contraction of the fishery to a small area in the southern part of NEEZ, the Vestbank area. In this area landings remained high in 2001 and 2002 due to the strong 2001 year-class. However, the 2001 year-class was only abundant in the Vestbank area, which resulted in a highly concentrated fishery and the decimation of the year-class before it reached maturity in 2003. This may have led to the collapse of the sandeel fishery in NEEZ. In the EU EEZ any contraction of the fishery has been less apparent.

The sandeel fishing season was unusual short in both 2005 and 2006, starting later and ending earlier than in previous years. The late start of the fishery was partly because the Danish fishery first opened the 1st April, in accordance with a national regulation introduced in 2005. Further, weekly data on the oil content of sandeels in the commercial landings, provided by Danish fish meal factories, indicated a late onset of sandeels feeding season in both 2005 and 2006 and that sandeels therefore became available to the fishery later than usual. Landings in the second half year of both 2005 and 2006 were on a low level compared to previous years. Only 14.000 tones were recorded in 2005 and 17.000 tones in 2006.

Regulation of the fishery is no explanation to the small fishery observed from 2003 and on-wards. The TAC in force has never been restrictive in the sandeel fishery, and in 2005 (the only year when additional regulation was introduced) the fishery was first regulated in July after the main fishing season.

There was a 50% decline in the number of Danish vessels (from 200 to 98 vessels) fishing sandeels from 2004 to 2005.

The Danish industrial vessels were, in 2007, given individual tradable quotas (ITQ) on sandeels. The introduction of ITQ accelerated the change towards fewer and larger vessels, and in 2009 only Danish 84 were fishing sandeels.

In 2007 the regulation of the fishery was a strong limitation on the effort used. In 2008, when the TAC was not reached, high fuel prices and low prices of fish meal were claimed by the industry to limit the fishery. The reduction of fleet capacity in combination with the introduction of ITQ is now considered to be a strong limitation of effort.

Also for the Norwegian fleet a drastic decline in number of vessels fishing sandeels has been observed in recent years. Of the 41 Norwegian vessels that fished sandeel in 2007, 9 participated for the first time. Since 1998 25 of the 41 vessels entered the fishery during this 10 yr period, 9 vessels were rebuilt (either extended or had larger engines installed) whereas only 7 vessels remained unaltered. In addition, there is likely to be a continuous increase in efficiency due to improvement in fishing gear, instruments etc.

Ecosystem aspects

Due to the stationary habit of post-settled sandeels (DIFRES unpublished information, Gauld 1990), a patchy distribution of the sandeel habitat (Jensen et al. 2001, Jensen and Rolev 2004), and a limited interchange of the planktonic stages between the spawning areas (Christensen et al. Accpeted, Christensen et al. Submitted, Gauld et al. 1998) the sandeel stock in IV consist of a number of sub-populations (Wright et al. 1998).

The catches of sandeels in area IV consist mainly of the lesser sandeel Ammodytes marinus. However, other species of sandeels is also caught. At some of the grounds in the Dogger Bank area the smooth sandeel Gymnammodytes semisquamatus can be important, and in the catches from more coastal grounds the other Ammodytes species Ammodytes tobianus can be impor-tant. The greater sandeel Hyperoplus lanceolatus appears in the catches from all grounds, but usually in insignificant numbers compared to A. marinus. The population dynamics of A. tobi-anus, G. semisquamatus, and H. lanceolatus are largely unknown, and so are the possible ef-fects on these species of commercial fisheries.

The stock dynamics of sandeels is driven by a highly variable recruitment and a high natural mortality in addition to fishing. The recruitment seems more linked to environmental factors than to the size of the spawning stock biomass. This was confirmed by analyses carried out by the ICES Study Group on Recruitment Variability in North Sea Planktivorous Fish (ICES-SGRECVAP 2006). SGRECVAP considered there was a common trend in recruitment for herring, Norway pout and sandeel with significant shift in recruitment in 2001. However, it could not be assumed that the same mechanism was common for all three species. It was clear that the poor sandeel recruitment from 2002 occurred at low spawning-stock biomass. Further, although the decline in recruitment in sandeels could be linked to both the NAO index and to annual average abundance of Calannus finmarchicus in the central North Sea, it was not possible to determine the mechanisms driving recruitment in sandeels or the link between changes in the environment and sandeel population dynamics.

ACFM consider that there is a need to ensure that the sandeel stock remains high enough to provide food for a variety of predator species.

The decline in the sandeel population concurrent with a markedly change in distribution (ICES WGNSSK 2007) has increased the possibility of local depletion, of which there now is some evidence (ICES WGNSSK 2007). This may be of consequence for marine predators that are dependent on sandeels as a food source.

Sandeels are important prey species for many marine predators, but the effects of variation in the size of this stock on predators are poorly known. Although the direct effects of sandeel fishing that have been identified on other species fished for human consumption, e.g. haddock and whiting are relatively small in comparison to the effects of directed fisheries for human consumption species there is still relatively scant information on the indirect effects of the sandeel fishery.

In 1999 the U.K called for a moratorium on sandeel fishing adjacent to seabird colonies along the U.K. coast and in response the EU requested advice from ICES. An ICES Study Group, was convened in 1999 to assess whether removal of sandeel by fisheries has a measurable effect on sandeel, whether establishment of closed areas and seasons for sandeel fisheries could ameliorate any effects, and to identify possible spatial and/or temporal restrictions of the fishery as specifically as possible. The ICES Advisory committees (ACFM and ACE) accepted the advice from the study group. STECF (1999) agreed with this ICES advice and the EU advised to close the fishery whilst maintaining a commercial monitoring. A 3-year closure, from 2000 to 2002, was decided. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was maintained for three years (see e.g. Wright et *al.* 2002) and has been extended until 2007, with a small increase in the effort of the monitoring fishery. There is presently no decision on weather a full commercial sandeel fishery will be reopened in the Firth of Forth area.

In general, fishing on sandeel aggregations at a distance less than 100 km from seabird colonies has been found to affect some surface feeding bird species, especially black-legged kittiwake and sandwich tern (Frederiksen et al. 2004, 2005). Recent research of effects on seabird predators due to changes in sandeel availability showed that black-legged kittiwake Rissa tridactyla in the Firth of Forth area off the Scottish east coast was related to abundance of both 1+ group, the age class targeted by the fishery, and 0 group sandeels. The same relationship was not found for six other sandeel dependent seabird species. Controlling for environmental variation (sea surface temperature, abundance of larval sandeels and size of adult sandeels), Frederiksen et al. (submitted) found that breeding productivity in the seabird colony on the Isle of May was significantly depressed by the fishery during periods of unregulated fishery for one surface-feeding seabird species (black-legged kittiwake), but not for four diving species. The mechanism by which the fishery affects the seabird however remains unclear as the fishery is not always in direct competition with the birds. The strong impact on these surface-feeding species, while no effects are documented found for diving species, could result from its inherently high sensitivity to reduced prey availability, from changes in the vertical distribution of sand lance at lower densities, or from sand lance showing avoidance behaviour to fishery vessels.

The ecosystem effects of industrial fisheries are discussed in the Report of the ICES Advisory Committee on Ecosystems, June 2003, Section 11 (ICES Cooperative Research Report No. 262).

Other ecosystem effects of the sandeel fishery are discussed in section 16.5 and in the ICES Report of the Advisory Committee on Ecosystems, June 2003, Section 11.

Data

Commercial catch

In the last 20 years the landings of sandeels in IV have been taken mainly by Denmark and Norway with UK/Scotland, Sweden and Faroes Isl. contributing a much smaller part of total landings.

Age, length and weight at age data are available for Denmark and Norway. This data is used to estimate numbers by age in the landings. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight at age for the southern North Sea are based only on Danish age compositions.

Denmark More details to be included in this section

Industrial species are not sorted by species before processing and it is assumed that the landings consist of one species only in the calculation of the official landings. The WG estimate of landings is based on samples for species composition taken by the Fishery Inspectors controling of the by-catch regulation. At least one sample (10-15 kg) per 1000 tons landings is taken and these samples are used to estimate average species composition by area (ICES rectangles) and month. This species/area/period key, logbook data (spatial distribution) and landings slip data (quantity) are used to derive the Danish WG estimates of landings of sandeel and by-catch of other species (further information can be found in ICES, 1994/Assess:7; Dalskov, 2002).

Norway Text to be inserted by Norway

For Norway and Sweden, the official landings and the WG estimated landings are the same.

UK/Scotland Text to be inserted by UK/Scotland

Sweden Text to be inserted by Sweden

The text table below shows which country supplies which kind of data:

	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
Denmark	x	x	x		x
Norway	x	x	x		x
UK/Scotland	x				
Sweeden	x				
Farao Islands	x				

All input files are Excel spreadsheet files.

The national data sets have been imported in a database aggregated to international data by DIFRES.

The combined Danish and Norwegian age composition data and weight at age data are applied on the landings of UK, Sweeden and Farao Isl., assuming catches from these countries have the same age composition and weight at age as the Danish and Norwegian landings.

Biological

Historically, assessments were done separately for the Northern and Southern North Sea. In recent years, the assessment has been done for the whole North Sea, but data are still compiled separately for the two areas. The catch numbers and weight at age data for the Northern North Sea are constructed by combining Danish and Norwegian data by half-year.

The catch numbers and weight-at-age data for the northern North Sea were constructed by combining Danish and Norwegian data by half-year. Prior to 1996, the Norwegian age composition data were based on Danish ALK's. Catch numbers and weight-at-age for the southern North Sea are based on Danish age compositions. The mean weight at age in the catch used in the assessment is the mean weights at age in the catch for the Southern and Northern North Sea weighted by catch numbers. The mean weight at age in the stock is copied from the mean weight in the catch first half-year, and an arbitrary chosen weight at 1 gram was used for the 0-group.

Mean weight at age shows large fluctuations over time, especially the large changes in mean weight from 1994 to 1996, which, partly, may be explained by a change in the methodology used for age determination (ICES 1995) that was applied from 1995 and 1996.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Values for natural mortalities are the same as used since 1989 (ICES CM 1989/Asssess:13). During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005). The time series of natural mortality only include up to 2003, so 2003 estimates were copied to 2004 and 2005. In contras to the fixed values of natural mortality used in previous sandeel assessments, the natural mortalities estimated by ICES-SGMSNS (2005) show large variability over years. The most significant differences between the natural mortalities of sandeels used in previous sandeel assessments and those estimated by ICES-SGMSNS (2005) are those for age-0 sandeels. The natural mortalities of age-0 sandeels estimated by ICES-SGMSNS (2005) are about twice as high than those used in previous sandeel assessments.

The proportion mature is assumed constant over the whole period with 100% mature from age 2 and 0% of age 0 and 1. Recent research indicates however, that there are large regional variations in age at maturity of *Ammodytes marinus* in the North Sea (Boulcott et al. 2006). Whilst sandeels in some areas seem to spawn at age 2 or older, sandeels in other regions seem to mature and spawn at age 1. As the decision to spawn at age 1 or 2 is an annual event, it is likely that there are large regional and annual variations in the fraction of the populations of the sandeels that contribute to the spawning. The age at maturity keys used in the assessment might thus considerably underestimate the spawning biomass of sandeels in the North Sea.

The fishing fleet catches sandeels in different parts of the North Sea during the year, and the fishing pattern changes from year to year. Because sandeels, *Ammodytes marinus*, in the North Sea consist of a number of sub populations (section 1.1.1) the industrial fishery target different part of the sandeel populations during the year and between years. There seem to be significant spatial and temporal variations in emergence behaviour (e.g. Rindorf *et al*. 2000) and growth (e.g. Boulcott et al. 2006, Pedersen et al. 1999; Wright et al. 1998) of sandeels in the North Sea. Further, there are age/length dependent variations in the burrowing behaviour of sandeels (Kvist et al. 2001). The information about age compositions in the catches and the age and weight relationships thus represent average values over time and space and reflect the variability in emergence behaviour and growth. For example, weight at age of sandeels seems to vary both between years and between Danish and Norwegian catches.

Surveys

There is no survey time-series available for this stock. As no recruitment estimates (abundance of age-0 sandeels second half year) from surveys are available, recruitment estimated in the assessments are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

The need for fishery independent information on sandeel distribution and abundance has been highlighted by ICES-WGNSSK (2006 and 2007). The demand for such information has increased due to the recent years decline in the North Sea sandeel stock concurrent with large changes in distribution and in the fishing pattern.

Different survey approaches are presently investigated by European research institutes, to establish a time series of fishery independent abundance estimates for sandeels in the North Sea. This is not a trivial job, because of the unpredictable emergence behaviour of sandeels, i.e. any sampling approach must take account of that part of the population can be in the water column as well as in the sea bed (Greenstreet et al. 2006). Further, more in total 238 individual sandeel fishing grounds are identified (Jensen and Rolev 2004). The total area of the sandeel fishing constitutes 15831 km2.

Descriptions of the survey methods that are presently explored and preliminary information from these surveys are given by ICES WGNSSK (2006 and 2006) and ICES_AGSAN (2007).

Commercial CPUE

As in previous assessments effort data from the commercial fishery in the northern and southern North Sea are treated as two independent tuning fleets, separated into first and second half year.

Because of the trends in the residuals for 1-group sandeels in the first half year, the two tuning fleets in the first half year were in the final assessment from 2005 split into two time periods, i.e. before and after 1999. This change in the tuning series removed the trends in the residuals of log stock numbers, and the tendency to underestimate F and overestimate SSB was reduced. Information about the size of the trawls used by Danish vessels fishing sandeels show an increase in trawl size from 1988 to 1994 and a larger increase from 1997 to 1998. This is a clear indication of an increase in catchability of the Danish vessels fishing sandeels, due to gear technology. However based only on this information it is not possible to quantify the likely change in catchability over the years.

The following tuning series were are available for the assessment:

Fleet 1: Northern North Sea 1983 - 1998 first half year

Fleet 2: Northern North Sea 1999 - present first half year

Fleet 3: Southern North Sea 1983 - 1998 first half year

Fleet 4: Southern North Sea 1999 - present first half year

Fleet 5: Northern North Sea 1983 - present second half year

Fleet 6: Southern North Sea 1983 - present second half year

The effort data for the southern North Sea prior to 1999 are only available for Danish vessels, but since 1999 Norwegian vessels have also provided effort data. The effect of this on the assessment is analysed in this year's assessment. The reason for including the Norwegian effort data for first half year for the southern North Sea into the tuning fleet is that in recent years Norwegian catches in the southern North Sea in first half year constitute a significant part of Norwegian landings in the North Sea. The tuning fleet used for the northern North Sea is a mixture of Danish and Norwegian vessels. A separation of the Danish and Norwegian fleets is presently not possible, due to the lack of Norwegian age-length keys for the period before 1996. Separate national fleets would have been preferable because this would have made procedure for the generation of the tuning series more transparent. This issue should be addressed at the next benchmark assessment.

The size distribution of the fleet has changed through time. Therefore effort standardisation is required. The assumption underlying the standardisation procedure is that CPUE is a function of sandeel abundance and vessel size. Standardised effort is calculated from standardised CPUE and total catch. CPUE is standardized to a vessel size of 200 Gross Tonnes (GR) using the relationship:

$CPUE=a*GR^{b}$ (1)

where a and b are constants and GR is vessel size in GR

The constants a and b were prior to 2003 estimated for each year by performing the regression analysis:

$Ln(C/e)=ln(a)+b*ln(GR)$ (2)

where C=catch in ton, e=effort in days spend fishing, and the rest of the parameters are as in (1).

Since 2003 the parameters in (2) have estimated using catch and effort data on single trip level, instead of average values of catch and effort for each vessel size category (see ICES 2004). The data used for the regression is logbook data for the Danish industrial fleet for the years 1984 to 2003 and first half year of 2004. General linear models were used to estimate the parameters in:

$ln(CPUE) = d_{y}+ f_{y}*ln(GR)$ (3)

where y=year, GR=vessel size in GR as defined in Table 1, and the remaining factors are constants. Log transformation was required to stabilise the variance in CPUE to fit the model although it does result in a more skewed distribution of GT leading to the smaller vessels receiving a higher weight in the subsequent regression. The GLM was carried out by half year (first and second half year) and area (northern and southern North Sea) to generate estimates of effort for the fleets presently used in the assessment of sandeels in IV. Type III analysis was used to test for significance of parameters. All analyses were weighted by the number of days spend fishing, as the variation on the average catch per day fishing decreases with the number of days fished. The results of the analysis and the parameter estimates are given in Table 13.1.3.2.

The parameters estimated in (3) were used to estimate CPUE for a vessel size of 200 GR from:

$CPUE=e^{dy}*200^{fy}$ (4)

Mean CPUE of Danish and Norwegian fleets, after the Norwegian CPUE had been standardised to a vessel size of 200 GR, was estimated as a weighted mean weighted by the catches sampled used to estimate CPUE. Total standardised effort was afterwards estimated from the combined Danish and Norwegian CPUE and total international catches.

As no recruitment estimates from surveys are available, recruitment estimates are based exclusively on commercial catch-at-age data. The tuning diagnostics indicate that the 0-group CPUE is a poor predictor of recruitment.

There is a relatively poor correlation between the tuning indices and the stock, which may be due to the fact that several sub-stocks are assessed as a single unit.

Other relevant data

None.

Estimation of Historical Stock Development

The Seasonal XSA (SXSA) developed by Skagen (1993) was up to 2001 used for stock assessment of sandeel in IV. Annual XSA was tried in 2002 WG where it was concluded that the two approaches gave similar results. For a standardization of methodology, it was decided to shift to XSA in 2003. In 2004 SXSA was used again for the final assessment, the reason being that data were available for the first half year of 2004 for the assessment. SXSA has been used os the final assessment since 2004. The XSA are used for comparison using the following settings:

Time series weights	none
Power model	no
Catchability independent of age	>=2
F-shrinkage S.E.	1.5 (5 years and 2 ages)
Min. standard error for pop. estimate	0.3
Prior weighting	none
Number of iterations	20
Convergence	Yes

In the SXSA weighting of estimated catchabilities (rhat) is set manually, where last years data is down weighted compared to previous years. Estimated survivors are weighted from manually entered data, where estimates of survivors are given a lower weighting in the second half of the year. This setting was chosen because the fishery inflicts the majority of the fishing mortality in the 1st half of the year and thus the signal from the fishery is considered less reliable in the second half.

During the benchmark assessment in 2004 (ICES-WGNSSK 2005) the effect of changing some of the default settings was explored. The assumption in the assessment of constant catchability for the tuning fleets over years, was analysed. Further, the effect of weighting the survivors with the inverse variance of the estimated log catchability, instead of the manual weighting, was explored. At last, the effect of down weighting last half years data in the estimation of the inverse catchability was analysed. There were no major effects on the assessment results of changing these settings, i.e. the same trends were seen in SSB, R and F. It was therefore decided to keep the default settings.

During the 2005 WG meeting the SMS model was used as a comparison to the SXSA. The SXSA and SMS explorative runs gave quite similar results for the time trend of SSB, but the absolute levels differ between model configurations. The main difference in the explorative runs is in the estimate of fishing mortality. Fs for the most recent years were estimated higher and more variable by the SMS model. All SXSA runs showed a decrease in F since 2001, while SMS estimated a step decrease in F in 2003 followed by a seep increase in 2003 and subsequently decreases in 2004 and 2005. Both SXSA and SMS assume constant catchability in the CPUE time series. In addition, SMS assumes constant catchability (or more correctly, constant exploitation pattern) for the F-model and catch data. CPUE time series are however, subset of the total international catch data and changes in the exploitation pattern will violate the assumption of constant catchability for the CPUE time series. Said in another way; if exploitation pattern changes, the assumptions for both models are violated. It is difficult to judge whether the SXSA assumption that catch data are exact, or the SMS assumption that exploitation pattern are constant, violates the assumptions most. The F values from SXSA shows a very variable exploitation pattern from year to year, and extreme F values for age 4. This indicates that there might be a considerable sampling uncertainty in the international catch at age data, which SMS might be better to handle. However, SXSA was chosen for the final assessment, because the model is the default model for this stock and SXSA does not rely on the assumption of constant exploitation pattern in catch at age data.

During the WGNSSK 2005 meeting an exploratory assessment was carried out, using the natural mortality for sandeels estimated by ICES-SGMSNS (2005, see section

1.1.2). The assessment using the natural mortalities estimated by ICES-SGMSNS (2005) showed similar trends in SSB as the assessment using the fixed natural mortalities, whereas the estimates of recruitment and F, were generally higher in assessment using the natural mortalities estimated by ICES-SGMSNS (2005). This difference was mainly due to the larger natural mortality for the 0-group sandeels used in the assessment using the natural mortalities estimated by ICES-SGMSNS (2005). There was no difference in the performance of the two assessments, and as such, no basis for an objective choice between configurations. Because the SGMSNS group express some reservation about the quality of the estimate of natural mortality for the most recent years these natural mortalities have not been used in the final assessment for sandeels in IV.

The low number of age groups makes the assessment highly sensitive to estimated terminal fishing mortalities for the oldest age (age 3). This in combination with an assumed constant and poorly determined proportion mature makes the SSB estimate highly uncertain.

In the 2009 assessment the exploratory analyses indicated that the perception of the stock and the retrospective bias were sensitive to the tuning fleets from the northern North Sea in particular.

The settings of SXAS as used in the SPALY run gives equal and fixed weighting to the CPUE indices from the northern and southern areas. This seems unreasonable as the overall effort and catch proportions in the two areas have changed over the years. In recent years the fishing effort in the northern North Sea have declined both in absolute terms and relative to the effort applied in southern North Sea. For example the average total standardised effort in the period 1983 – 2002 estimated at 5620 days declined to an average at 1620 days in the period 2003 – 2009. In 2009 the effort in this area was estimated at 840 days only. Furthermore in 2006 and 2009 the Norwegian EEZ was closed to fishery. In these years the fishery from the northern North Sea was restricted to very few squares in sampling area 3.

All the exploratory assessments that down weighted the influence of the northern CPUE indices provided significantly less biased retrospective patterns than the SPALY assessment. In addition the residuals are decreased when the northern tuning fleets are down weighted in the assessment.

As it was not possible to find an objective way to exclude parts of the northern CPUE indices from the assessment it was decided to adopt exploratory assessment 4 as the final run. In this run model and data determine the weighting of the individual tuning fleets. The same approach is also used in the Norway Pout assessment also using the SXSA model.

Short-Term Projection

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes. Quantitative estimates of recruits (age 0) in the year of the assessment are not available at the time of the WG. Traditional deterministic forecasts are therefore not considered appropriate.

The high natural mortality of sandeel and the few year classes in the fishery make the stock size and catch opportunities largely dependent on the size of the incoming year classes.

0-group CPUE is a poor predictor of recruitment (ICES-WGNSSK 2003) why traditional deterministic forecasts are not considered appropriate. However, because of the low sandeel stock WGNSSK provided indicative short term prognoses during the meetings from 2004 and on, using a range of scenarios for the recruitment and exploitation pattern.

The short term forecasts from 2004 and 2005 overestimated the SSB in 2005 and 2006 by a factor 2-3 when compared to the SSB estimated by the SXSA in 2006. This overestimation bias was addressed during the 2006 WG meeting, carrying out a short term forecast, where the start population and the F-s-at-age in the first half year of 2006 was corrected according to the bias identified in the assessment. In order to estimate potential bias in the terminal population sizes and F's, an analysis was made from the retrospective SXSA runs. A bias factor was determined for each year by dividing the terminal estimate of each retrospective run with the "true" value as estimated by this year's final assessment. The bias factor taken forwards to the short term forecast was the mean ratio over the period 2000-2005. As retrospective corrections continue to be made for several years, the bias correction factors for the most recent 1-2 years may be underestimates. Additional analyses were made to investigate the change in bias correction when comparing terminal values with "converged" values taken from retrospective runs 1 or 2 years later. This demonstrated that the bulk of the correction is made in the first year with much smaller corrections in the second year.

Medium-Term Projections

Not done

Long-Term Projections

Not done

Biological Reference Points

There is no management objective set for this stock. There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Management of fisheries should try to prevent local depletion of sandeel aggregations, particularly in areas where predators congregate.

In 1998 ACFM proposed that $\mathbf{B}_{lim}$ be set at 430,000 t, the lowest observed SSB. The $\mathbf{B}_{pa}$ was estimated at 600,000 t, approximately $\mathbf{B}_{lim}$ * 1.4. This corresponds to that if SSB is estimated to be at $\mathbf{B}_{pa}$ then the probability that the true SSB is less than $\mathbf{B}_{lim}$ will be less than 5% (assuming that estimated SSB is log normal distributed with a CV of 0.2). No fishing mortality reference points are given. These reference points are based on an assessment using another tuning method than used from 2002 (see section 1.2.4).

Other Issues

Recent investigations (Greenstreet et al. 2006) showed the biomass of age 1+ sandeels increased sharply in the Firth of Forth area in the first year of the closure and remained higher in all four of the closure years analysed, than in any of the preceding three years, when the fishery was operating. Further, the biomass of 0-group sandeels in three of the four closure years exceeded the biomass present in the three years of commercial fishing. The closure appears to have coincided with a period of enhanced recruit production.

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Annex 4: Assessment Methods and Software

Assessment methods

XSA and SXSA

Extended Survivors' Analysis (XSA; Darby and Flatman 1994) has been used for catch-at-age analysis for most stocks, although it has not been selected as the final assessment in all cases. Three implementations were used. Some older analysts used version 3.1 of the Lowestoft VPA DOS based package. For an increasing number of stocks, younger members of the group used the version (FLXSA) incorporated in the FLR package (FLR Team 2006) following validation against the DOS based version and further development which have resulted in the ability to produce tuning diagnostics output. Seasonal XSA (Skagen 1993, 1994) was used for analyses of Norway pout and sandeel to allow for seasonal data.

For XSA assessments, a full tuning window was used, either with or without a 20-year tricubic time-taper depending on the stock. The general exploratory approach was as follows (Darby and Flatman 1994):

- A separable analysis was carried out to explore the internal consistency of the catch-at-age data, and also to judge whether the plus group was appropriately chosen.
- For appropriate tuning series, single fleet runs were carried out using Laurec-Shepherd *ad hoc* tuning. These runs were used to explore the consistency of research-vessel survey indices or commercial CPUE indices with the catch-at-age data.
- An XSA run was performed with all selected tuning series, no power model (no dependence of catchability on stock size for any age), light shrinkage (s.e. = 2.0), and the oldest available age for the catchability plateau. Tuning diagnostics from this run were examined to determine what the plateau age should be, and whether a power catchability model would be appropriate on any of the younger ages.

If an update assessment was being run the first two steps in this process were generally omitted. Shrinkage was kept light if possible (so that s.e. = 2.0). If there were trends in recent fishing mortality estimates, then heavy shrinkage was not used as this would lead to retrospective bias. Stronger shrinkage (s.e. = 0.5) was only considered for those cases in which recent *F* fluctuated without trend, where survey indices were noisy, and where the use of strong shrinkage improved retrospective patterns. In some cases the level of shrinkage had a minimal effect on overall conclusions, and so was left unchanged from previous years.

Following these exploratory steps, a final run was performed. Residuals and the results of retrospective analyses were scrutinised to evaluate the quality of the assessment (or at least, whether survey and commercial data were in agreement about stock trends).

Seasonal XSA (SXSA) was used in the sandeel and Norway pout assessments (Sections 4 and 5) to estimate fishing mortalities and stock numbers at age by half-year, using data up to and including the first half year of 2006. SXSA weights the estimated survivors from manually entered data or according to the variance of the estimated log catchability. The WG used the standard setting with user-defined weighting factors, where estimates of survivors are given a lower weighting in the second half of the year. This setting is used because the fishery inflicts the majority of fishing mortality in the 1st half of the year (when oil content of the fish is higher) and thus the signal from the fishery is considered less reliable in the second half. The residuals used to evaluate the quality of the assessment are equivalent to the log catchability residuals obtained from the standard XSA, and are calculated as:

$$residuals = \log\left(\frac{\hat{N}}{N}\right)$$

where N is the stock number-at-age derived from the VPA and $\hat{N}$ is the stock number-at-age derived from the CPUE index for each tuning fleet.

B-ADAPT

The following text is adapted from Appendix 4 to the 2004 WGNSSK report (ICES-WGNSSK 2004), where further details on the background of the model and simulation testing can be found. The model was extended further in 2006 with the addition of bootstrap uncertainty estimation; this is described in Section 14 of this report and in the 2006 report of the Methods WG (ICES-WGMG 2006).

In recent years indices of North Sea cod population abundance N and fishing mortality F calculated from survey catch per unit effort (CPUE) have indicated higher levels of abundance and mortality rates than those estimated by catch at age analysis. Within the model diagnostics generated from fits of catch at age models to the North Sea cod assessment data, the inconsistencies between the population abundance estimated from the two data sources have been apparent in the residuals about the mean of log survey catchability (q = CPUE/N). The residuals have been positive in recent years at the majority of ages, a pattern that is consistent across surveys. This indicates a mismatch between the levels of reported landings and actual removals. The latter may be due to a number of causes (misreporting, nonreporting, unaccounted discards, natural mortality, changes in catchability of fleet or surveys), and while these cannot be distinguished, an alternative model can be used to estimate a more realistic level of removals than indicated by the reported landings.

It is straightforward to show that if bias is present in the data on removals, the magnitude and sign of the log catchability residuals is proportional to the degree of bias. If $C_{a,y}$ represents catch at age a in year y, $N_{a,y}$ population numbers at age by year, $F_{a,y}$ fishing mortality at age by year, $Z_{a,y}$ total mortality (fishing + natural mortality M) and B_y the bias in year y; in the years without bias

$$N_{a,y} = C_{a,y}\ Z_{a,y}\ (1\text{-}\exp(\text{-}Z_{a,y}))\ /\ F_{a,y}$$

and for the years with bias

$$N'_{a,y} = B_y\, C_{a,y}\ Z_{a,y}\ (1\text{-}\exp(\text{-}Z_{a,y}))\ /\ F_{a,y}$$

Survey catch per unit effort ($u_{a,y,f}$, where f denotes fleet or survey) is related to population abundance by a constant of proportionality or catchability $q_{a,f}$ which is assumed, in this study, to be constant in time and independent of population abundance

$$N_{a,y} = u_{a,y,f}\ /\ q_{y,f}$$

If the unbiased survey catchability can be calculated, an estimate of bias can be obtained from

$$B_y = N'_{a,y} / (u_{a,y,f} / q_{yf})$$

Gavaris and Van Eeckhaute (1998) examined the potential for using a relatively simple ADAPT model structure to estimate the removals bias of Georges Bank haddock. Their model fitted a year effect for the bias in each year of the assessment time series under the assumption that bias does not distort the age composition of landings, only the overall total numbers. The authors determined that the model was over-parameterised and that it was necessary to introduce a constraint, that one year-class abundance was known exactly, in order to estimate the remaining catchability, bias and population abundance parameters. They concluded that, for the data sets to which they applied the model, the indices of abundance from trawl surveys were so highly variable that this resulted in estimates of bias with wide confidence intervals and therefore the model could only be used as a diagnostic tool.

A modification to the Gavaris and Van Eeckhaute (1998) ADAPT model (referred to here as B-ADAPT) can be made by assuming that the time series of landings can be divided into two periods; a historic time series in which landings were relatively unbiased and a recent period during which landings at age were biased by a common factor across all ages. The fit of the model to the early period of unbiased data provides estimates of appropriately scaled population abundance and survey catchability, thereby removing the indeterminacy noted by Gavaris and Van Eeckhaute (1998).

Note that it is assumed that during both periods, landings numbers at age have relatively low random sampling variability (relative to survey variance) so that the population numbers at age can be determined using the virtual population analysis (VPA) equations. This assumption has been found to hold for the North Sea cod by the EMAS project (EMAS 2001) which examined the errors associated with current sampling programs.

Within B-ADAPT, population numbers are estimated from the VPA equations

$$N_{a,y} = B_y C_{a,y} Z_{a,y} (1\text{-exp}(\text{-}Z_{a,y})) / F_{a,y}$$

$$N_{a,y} = N_{a+1,y+1} \exp(Z_{a,y})$$

where B_y is estimated for years in which bias was considered to have occurred and defined as 1.0 for years without bias. Selection is assumed to be flat topped with fishing mortality at the oldest age defined as the scaled (s) arithmetic mean of the estimates from n younger ages, where n and s are user defined. That is for the oldest age o:

$$F_o = s \ [F_{o-1} + F_{o-2} + \ldots + F_{o-n}] \ / \ n$$

The parameters estimated to fit the population model to the CPUE calibration data are the surviving population numbers $N_{a,fy}$ at the end of the final assessment year fy (estimated for all ages except the oldest) and the bias B_y in each year of the user selected year range. Under the assumption of log normally distributed errors, the least squares objective function for the estimated CPUE indices is

$$SSQ_{vpa} = \Sigma_{a,y,f} \{ \ln u_{a,y,f} - [\ln q_{a,f} + \ln N_{a,y}]\}^2$$

The year range of the summation extends across all years in the assessment for which catch at age data is available and also (if required) the year after the last catch at age data year. This allows for the inclusion of survey information collected in the year of the assessment WG meeting.

Testing with simulated data (ICES-WGNSSK 2004, Appendix 4) established that increasing the uncertainty in the survey indices results in estimates of bias and the derived fishing mortality that are more variable from year to year. One solution to this problem is to introduce smoothing to the model estimates.

A constraint used frequently in stock assessment models is that of restricting the amount that fishing mortality can vary from year to year. This reflects limitations on the ability of fleets to rapidly increase capacity and the lack of historic effort regulation reducing catching opportunities. However, given the current over-capacity in the fleets prosecuting the North Sea cod fishery this form of smoothing constraint was not considered appropriate.

Anecdotal information supplied by the commercial industry has indicated that the recent severe changes in the TAC have not been adhered to. Therefore it was considered more appropriate to apply smoothing to the total catches, across the years in which the bias was estimated. Smoothing of catches was introduced by an addition to the objective function sum of squares:

$$SSQ_{catches} = \lambda \Sigma \{\ln (B_y \Sigma_a [C_{a,y} CW_{a,y}]) - \ln (B_{y+1} \Sigma_a [C_{a,y+1} CW_{a,y+1}])\}^2$$

Here $CW_{a,y}$ are the catch weights at age a in year y and natural logarithms were used to provide residuals of equivalent magnitude to those of log catchability within SSQ_{vpa}. λ is a user defined weight that allowed the effect of the smoothing constraint to be examined. The year range for the summation of the catch smoothing objective function was from the last year of the unbiased catches to the last year of the assessment.

The total objective function used to estimate the model parameters was therefore

$$SSQ = SSQ_{vpa} + SSQ_{catches}$$

The least squares objective function was mimimised using the NAG Gauss–Newton algorithm with uncertainty estimated using two methods, calculation of the variance covariance matrix and bootstrap re-sampling of the log catchability residuals to provide new CPUE indices.

SMS

SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) is an age-structured multi-species assessment model which includes biological interactions. However, the model can be used with one species only. In "single species mode" the model can be fitted to observations of catch-at-age and survey CPUE. SMS uses maximum likelihood to weight the various data sources assuming a log-normal error distribution for both data sources. The likelihood for the catch observation is then as defined below:

$$L_C = \prod_{a,y,q} \frac{1}{\sigma_{catch}(aa)\sqrt{2\pi}} \exp(-(\ln(C(a,y,q)) - \ln(\hat{C}(a,y,q)))^2 / (2\sigma^2_{catch}(aa)))$$

where C is the observed catch-at-age number, $\hat{C}$ is expected catch-at-age number, y is year, q is quarter, a is age group, and aa is one or more age groups.

SMS is a "traditional" forward running assessment model where the expected catch is calculated from the catch equation and F-at-age, which is assumed to be separable into an age selection, a year effect and a season (year, half-year, quarter) effect.

As an example, the F model configuration is shown below for a species where the assessment includes ages 0–3+ and quarterly catch data and quarterly time step are used:

$$F = F(a_a) \times F(y_y) \times F(q_q),$$

with *F*-components defined as follows:

F(*a*):

Age 0	Fa_0
Age 1	Fa_1
Age 2	Fa_2
Age 3	Fa_3

F(*q*):

	q1	q2	q3	q4
Age 0	0.0	0.0	Fq	0.25
Age 1	$Fq_{1,1}$	$Fq_{1,2}$	$Fq_{1,3}$	0.25
Age 2	$Fq_{2,1}$	$Fq_{2,2}$	$Fq_{1,3}$	0.25
Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

F(*y*):

Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	…
1	Fy_2	Fy_3	Fy_4	Fy_5	Fy_6	Fy_7	Fy_8	Fy_9	….

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ in the first year are set to constants to obtain a unique solution. For annual data, the $F(q_q)$ is set to a constant 1and the model uses annual time steps.

One *F*(*a*) vector can be estimated for the whole assessment period, or alternatively, individual *F*(*a*) vectors can be estimated for subsets of the assessment periods. A separate *F*(*q*) matrix is estimated for each *F*(*a*) vector.

For the CPUE time series the expected CPUE numbers are calculated as the product of an assumed age (or age group) dependent catchability and the mean stock number in the survey period.

The likelihood for CPUE observations, L_S, is similar to L_C, as both are assumed log-normal distributed. The total likelihood is the product of the likelihood of the catch and the likelihood for CPUE ($L = L_C * L_{CPUE}$,). Parameters are estimated from a minimisation of -log(*L*).

The estimated model parameters include stock numbers the first year, recruitment in the remaining years, age selection pattern, and the year and season effect for the separable *F* model, and catchability at age for CPUE time series.

SMS is implemented using ADModelBuilder (Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but has extensively been tested over the last two years on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average *F* or SSB from the Hessian matrix. Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (MCMS; Gilks *et al*. 1996) to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation including CV can be used.

SAM

SAM is a statistical state-space model in which all observations (catches, indices, and possibly more) have measurement error, and population processes are stochastic. The amount of variability in observation and process errors is estimated in SAM. Model parameters are estimated using maximum likelihood methods based on the marginal likelihood function. This likelihood function is integrated over process errors, and is considered to provide better estimates of model parameters compared to other approximate approaches (de Valpine and Hilborn, 2005). Estimation of uncertainties for all quantities of interest (F , SSB, and stock sizes) is an integral feature of the model. It assumes stochastic survival from one year to the next and models fishing mortality as a random walk, thus enabling selectivity to drift over time throughout the modelling period. It also handles missing observations in both catch and surveys. It should be noted that this approach does not have the convergence properties typical of backwards VPAs such as XSA and ADAPT. SAM incorporates new software (the random effects module for AD Model Builder http://www.admb/project.org), which uses a combination of automatic differentiation and the Laplace approximation (MacKay, 2003) to solve high dimensional non-linear models with unobserved random variables efficiently. It is based on all the standard assessment equations (such as the catch equation, the stock equation, and standard stock-recruitment relationships). Observations are time series of catches in numbers and survey indices. WKROUND WD14 (ICES WKROUND 2008) contains a mathematical description of the model and outlines the key model features in more detail

SURBA

SURBA (version 3.0) is based on a simple survey-based separable model of mortality. The implementation used at this year's WG includes a Windows user interface which facilitates plotting of results and summary diagnostics. It was used to perform exploratory analyses for most stocks.

The model was first applied to European research-vessel survey data by Cook (1997, 2004), but it has a long history in catch-based fisheries stock assessment (Pope and Shepherd 1982, Deriso et al 1985, Gudmundsson 1986, Johnson and Quinn II 1987, Patterson and Melvin 1996; see Quinn II and Deriso 1999 for a summary). The separable model used in SURBA assumes that total mortality $Z_{a,y}$ for ages *a* and *y* can expressed as $Z_{a,y} = s_a \times f_y$, where s_a and f_y are respectively the age and year effects of mortality. Note that this differs from the usual assumption in that total mortality *Z* is the quantity of interest, rather than fishing mortality *F*. Then, given $Z_{a,y}$, abundance $N_{a,y}$ can be derived as

$$N_{a,y} = r_{y_0} \exp\left(-\sum_{m=a_0}^{a-1} \sum_{n=y_0}^{y-1} Z_{m,n} \right)$$

where a_0 and $y_0 = y - a - a_0$ are respectively the age and year in which the fish measured as $N_{a,y}$ first recruit to the observed population. Thus the abundance at each age and year of a cohort is given by the recruiting abundance r_{y_0} of the relevant cohort modified by the cumulative effect of mortality during its lifetime. Parameters are estimated by minimizing the sum-of-squares of observed and estimated abundance indices.

ASPIC

ASPIC is a package which fits a general biomass non-equilibrium surplus-production model of the Schaefer type that does not require age-structured data (Prager 1994; Prager et al 1996). In this year's WG meeting, it was used in exploratory analyses for plaice in Division IIIa (see Section 7.3.4). Details and downloads are available at http://www.sefsc.noaa.gov/mprager/aspic.html.

Methods

Development of indicators for quality and performance of catch at age analysis

At present, assessments are evaluated largely through qualitative visual inspection of results such as catchability residuals. It could be argued that this is not sufficient, and should be supplemented by a more quantitative approach. One way of potentially improving assessment methodology is summarised below.

Marchal et al. (2003) proposed three criteria to evaluate the relative performance of different assessments.

The first criterion is the precision of the estimates of log-catchability for each tuning fleet. This criterion is investigated by examining the coefficient of variation (CV) relative to the log-catchability estimates:

$$\mathrm{CV(f,a)} = \frac{\sigma(\mathrm{f,a})}{\ln[q(\mathrm{f,a})]} \qquad (1.1)$$

where ln[q(f,a)] is the estimated value of log-catchability for the fleet f at age a and σ(f,a) the standard deviation associated to the log-catchability residuals. Low CV should correspond to a "good" assessment.

The second is the measure of the trends in the annual trajectories of log-catchability residuals for each tuning fleet. This is investigated by examining the first order auto-correlation ACR of the Log-catchability residuals ε(f,y,a):

$$\mathrm{ACR(f,a)} = \frac{\mathrm{COV}(\varepsilon(\mathrm{f,y-1,a}), \varepsilon(\mathrm{f,y,a}))}{\mathrm{VAR}(\varepsilon(\mathrm{f,y,a}))} \qquad (1.2)$$

where COV refers to the covariance function and VAR to the variance function. Values of ACR close to -1 characterise oscillations around a stable mean; values between -1 and 0 are associated to low trends; 0 value identify a pure random process; 0 to 1 values mean that there is a persistence phenomena within the time series (if one year show positive residual it is likely that the next year residual will be positive too) and value around 1 characterise trends in the residuals time series. One way to interpret this criterion is to compare its value with a confidence interval $[-2N^{-1/2}, 2N^{1/2}]$ were N is the number of observations (i.e. the number of years). If the criterion belongs to the confidence interval, it can't be interpreted as significantly different from zero. Otherwise the criterion is interpreted as mentioned above.

Those two criteria characterize the fleet performances in an assessment. They are both investigated based on single fleet XSA, and then can be directly compared between runs.

The third criterion is based on the retrospective pattern as the visual way of assessing the quality of the analysis. It evaluates the consistency of the retrospective patterns by measuring the distance between the annual trajectories relative to fishing mortality, SSB and recruitment. Yearly indices are calculated according to the equation below, measuring the variation between the "most recent truth" (the final assessment) and the values estimated by earlier assessments. The accuracy of an assessment is defined by the ability of earlier assessments to predict the truth (Darby and Flatman, 1994), i.e. the narrower is a retrospective pattern, and the more reliable the assessment is :

$$RI1(y) = \frac{\sum_{i=\max(y,T_A)}^{T-1} \left(\frac{X(y,i) - X(y,T)}{X(y,T)} \right)^2}{T - \max(y, TA) - 1} \qquad (1.3)$$

Where X is successively Fbar, SSB and R, in year y (between T_0 and T), assessed in year i (comprised between max (y, T_A) and T-1). T_0 is the first year of the data period, T_A the year of the first assessment and T the year of the last assessment. . Dividing the sum of square by the number of years used to calculate it, allows the comparison between all the years indices. These yearly indices are then summed (in equation (4)) over the data period to obtained a synthetic index per variable per assessment.

$$RI2 = \sum_{y=T_0}^{T} [IX1(y)] \qquad (1.4)$$

Marchal et al. (2003) only calculated the index with the double summation (equations 1.3 and 1.4) combined without dividing the index IX1 by the number of years). However, watching the time evolution of the dispersion gives information about the number of years before the convergence occurs. For both IX1(y) and IX2 the closer to 0 is the value, the better the assessment is.

A last index is also calculated for each variable of interest from the retrospective analysis. The yearly retro deviation index IX3 measures the distance between the value estimated for each terminal year (i) by retro-assessments and the value estimated for the same year by the assessment made one year later (i+1) (see equation (5)).

$$RI3(i) = \frac{X(i,i) - X(i,i+1)}{X(i,i+1)} \qquad (1.5)$$

These indices measure the bias that might be induce year after year, and allows trends investigation, or recurrent bias detection. Marchal et al (2003) concluded that the combination of all those criteria is a useful way to interprete the change in the assessment's outputs in order to choose among the options to be set for the final assessment.

The WG disagreed with this conclusion. Indices of retrospective bias are reasonable indicators of assessment quality, as long as they are used to promote close investigation of the underlying data rather than quick fixes such as heavy shrinkage. The remaining indicators proposed by Marchal et al (2003) show merely whether surveys are different from catch data: they do not show whether the assessment is good or not. Modifying an assessment to reduce log-catchability residuals, for example, may serve simply to produce a result driven largely by catch data – and this may in itself be problematic. The indicators may be objective, but there is also a danger that they could be misleading.

FLR

The complexity of fisheries systems and their management require flexible modelling solutions for evaluations. The FLR system is an attempt to implement a framework for modelling integral fisheries systems including population dynamics, fleet behaviour, stock assessment and management objectives (www.flr-project.org; FLR Team 2006). FLR consists of a number of packages for the open source statistical computer program R, centred around conventions on the representation of stocks, fleets, surveys etc. A broad range of models can be set up, encompassing population dynamics, fleet dynamics and stock assessment models. Moreover, previously developed methods and models developed in standard programming languages can be incorporated in FLR, using interfaces for which documentation is being written.

The stock assessment tools in FLR can also be used on their own in the WG context. The combination of the statistical and graphical tools in R with the stock assessment facilitates the exploration of input data and results. Currently, an effort is being made to incorporate stock assessment models that are used in some of the ICES working groups. Methods for reading in VPA suite files and setting plus-groups in data age structured data are also being developed. Currently XSA, SURBA, ICA, B-ADAPT, and a number of others have been incorporated in the package, and development is continuing.

One of the potential applications of the FLR tool within a WG context is running analyses of the sensitivity of model fits to user-defined parameter settings (ICES-WGMG 2006). An example of this is given in the stock section for saithe (Section 11), and was used during exploratory analyses for several other stocks. This approach cannot yet be used to generate probabilistic assessments, although research is continuing.

FLR has also been used extensively in this report as a framework for management plan evaluations for North Sea haddock and cod. These are described in full in Section 16.1 and 16.2.

Recruitment estimation

For several stocks, recruitment estimates are made using RCT3 (Shepherd 1997). This was the case when recruitment indices from 2006 surveys are available, or when *F*-shrinkage in XSA had relatively high weighting on the estimation of recruiting survivors. This creates some inconsistencies in the approaches used. The survey indices may end up being used twice for recruitment estimation – once in the survivors' analysis (and thus in the VPA recruitment) and again with the same survey indices in RCT3. For plaice, haddock, whiting and cod, large discrepancies have been observed in recent Working Groups in the recruitment predicted by RCT3 and the observed recruitment in XSA. In most cases RCT3 seems to overestimate recruitment and WGNSSK considers this may partly explain the overestimation of landings in the short term forecasts for these species.

A problem with the use of the power model for recruiting age groups in XSA, is that it cannot be restricted to those tuning fleets for which the use of this model is appropriate. In the present implementation of XSA the use of the power model may solve problems in some fleets while creating problems in other fleets. The fact that the *F*-

shrinkage cannot be turned off for recruiting age groups has in some cases been seen to have an undesirably strong influence on recruitment estimates derived from XSA.

Short-term prognoses and sensitivity analyses

Short-term prognoses (forecasts) are made for all stocks for which a final assessment is presented. Half-year forecasts are produced for the industrial stocks in order to give ACFM further information on which to base advice in the current situation of low biomass. These are based on survivors' estimates at the end of the second quarter in the year of the meeting (final assessment year + 1) from Seasonal XSA or SMS, rolled forwards to the start of the first quarter in the next using assumed mortality and weights-at-age.

Forecasts in all other cases were based on initial stock sizes as estimated by XSA or B-ADAPT (in a number of cases supplemented with separate recruitment estimates as described above), natural mortalities and maturity ogives as used in the age based assessment model, and mean weights at age averaged over recent years (normally 3). For haddock, the mean weight-at-age of the large 1999 and moderate 2000 year-classes in the forecast has been modelled using a fitted growth curve. Fishing mortalities-at-age in forecasts are taken to be either the final year values, or a scaled or unscaled mean *F*-pattern over the most recent 3 years (depending on whether or not mean *F* showed a recent trend).

Forecasts and corresponding sensitivity analyses were undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

Short-term forecasts have been given on a stock basis, which in some cases includes more than one management area. For management purposes the catch forecast has been split by Sub-area and Division on the basis of the distribution of recent landings.

Stock-recruit modelling and medium-term projections

To be done

Estimation of biological reference points

Yield and spawning stock biomass per recruit are undertaken using either the Aberdeen suite of forecast programs, the MFDP/MFYPR software, or more recent implementations in the FLR suite. Where the latter have been used, they have been cross-checked with the equivalent standard software.

Precautionary approach reference points

Precautionary approach reference points are intended to remain unchanged from year to year, **unless** substantial changes occur in the data used (e.g. if discards are included for the first time) or the method employed. When reviewed the change point models developed by Obrien and Maxwell (2003) and PASOFT (Smith et al.) are used to provide values.

Software versions

The following table lists the versions of each item of software that was used by the WG.

SOFTWARE	PURPOSE	VERSION
ASPIC	Surplus-production modelling.	Unknown (most recent available version is 5.15).
B-ADAPT	Catch-at-age analysis with estimated misreporting	Compiled 13/09/2006.
FLR	Fisheries toolbox in R: assessments, forecasts, management-plan evaluations.	Core versions 1.3.1 and 2.0 plus *ad hoc* additions.
INSENS	Generation of input files for Aberdeen Suite programmes.	Compiled 20/05/2002.
MFDP	Short-term forecast.	Unknown.
MFYPR	Yield-per-recruit analysis.	Unknown.
RCT3	Recruitment estimation.	Compiled 26/08/1996.
REFPOINT	Calculation of reference points and yield-per-recruit.	Compiled: 12/06/1997.
RETVPA00	Retrospective analysis for XSA.	Compiled 12/06/2002.
SMS	Catch-at-age analysis with a stochastic multi-species model	September 2006.
SAM	State-space Assessment model	UNknown
SURBA	Survey-based analysis.	3.0 (compiled 02/09/2005).
SXSA (Seasonal XSA)	Catch-at-age analysis for seasonal fisheries.	Compiled 01/09/2004.
VPA95 (Lowestoft VPA suite)	Catch-at-age analysis (separable VPA, Laurec-Shepherd tuning, XSA).	Compiled 08/06/1998.
WG FRANSW	Short-term forecasts and sensitivity analysis.	1.0 (compiled 22/05/2001).

Annex 5 –Technical Minutes of the North Sea ecosystem Review Group

Review of ICES	**WGNSSK Report 2009**
Reviewers:	Gary Melvin (Canada, chair)
	Outi Heikinheimo (Finland)
	Norman Graham (Ireland)
Chair WG:	Chris Darby
Secretariat:	Barbara Schoute

General

The WNSSK was one of 3 working groups reviewed by the North Sea Review Group (RG). The RG acknowledges the intense effort expended by the working group to produce the report and the work required to complete their documentation in a timely manner..

The Review Group considered the following stocks:

cod-347d	Cod in Subarea IV (North Sea), Divison VIId (Eastern Channel) and IIIa West (Skagerrak)
had-34	Haddock in Subarea IV (North Sea) and Division IIIa (Skagerrak - Kattegat)
nep-6	*Nephrops* in Division IVb (Farn Deeps, FU 6)
nep-7	*Nephrops* in Division IVa (Fladen Ground, FU 7)
nep-8	*Nephrops* in Division IVa (Firth of Forth, FU 8)
nep-9	*Nephrops* in Division IVa (Moray Firth, FU 9)
nop-34	Norway Pout in Subarea IV (North Sea) and IIIa (Skagerrak - Kattegat)
ple-eche	Plaice in Division VIId (Eastern Channel)
ple-kask	Plaice in Division IIIa (Skagerrak - Kattegat)
ple-nsea	Plaice Sub-area IV (North Sea)
sai-3a46	Saithe in Subarea IV (North Sea) Division IIIa West (Skagerrak) and Subarea VI (West of Scotland and Rockall)
san-nsea	Sandeel in Subarea IV excluding the Shetland area
sol-eche	Sole in Division VIId (Eastern Channel)
sol-nsea	Sole in Sub-area IV (North Sea)
whg-47d	Whiting Sub-area IV (North Sea) & Division VIId (Eastern Channel)
whg-kask	Whiting in Division IIIa (Skagerrak - Kattegat)

Stocks which may need a benchmark in future are:

- Haddock in Subarea IV (North Sea) and Division IIIa (Skagerrak - Kattegat) scheduled 2010
- Plaice in Division VIId (Eastern Channel), scheduled for 2010

Cod in Subarea IV (North Sea), Division VIId (Eastern Channel), and IIIa West (Skagerrak) cod_347d

1) **Assessment type: update** (Not formally signed off by EG)
2) **Assessment**: analytical
3) **Forecast**: medium term forecast presented, with no short term forecast due to uncertainties in final year F estimates
4) **Assessment model**: B-Adapt and contrasted with SAM
5) **Consistency**: This stock was subject to a benchmark assessment in 2009, which concluded that B-Adapt continue as the preferred assessment method.
6) **Stock status**: B<Blim, Flim<F<Fpa, R in 2008 may be one of the lowest recorded in the survey series. Final year estimates of F are considered uncertain.
7) **Man. Plan.**: Agreed 2008: reduce fishing mortality to 0.4. The main elements in the plan are annual adjustments to F via effort control. Adjustments dependant on SSB relative to reference points.

General comments

Downward trends in F from the high values in 2000 are observed and SSB is estimated to have increased for the second consecutive year, albeit from very low levels. The increase in SSB is largely derived from the relatively strong 2005 year class maturing. While these trends can be taken as ‘green shoots’ it is premature to state that ‘the stock has began to recover’ particularly given the historically low recruitment based on the Q1 IBTS 2009 survey and the very high levels of discarding being observed in the fishery. Even with a continued decline in F, the stock is well below Blim and if recruitment continues to be impaired, the prognosis is still poor (relative to Bpa).

The high levels of discarding are particularly worrying and clearly demonstrate that TAC’s are not constraining F sufficiently. The assessment output shows that F from discarding is now equal to or greater than F apportioned to landings. It appears that restrictive TAC's and available effort are mismatched and recovery is being constrained by discarding.

There are a number of initiatives to reduce discards described, but based on the discard information presented; thus far these have been inadequate. A review of available mitigation options and their potential would be informative from a management perspective.

Technical comments

The methodology is well explained and there are no specific comments.

Conclusions

The assessment has been performed correctly and estimates of stock status are consistent with other methods e.g. SURBA, SAM

Haddock in Subarea IV (North Sea) and Division IIIa (Skagerrak – Kattegat) had-34

1) **Assessment type: Update**
2) **Assessment**: Analytical
3) **Forecast**: Short-term forecast presented
4) **Assessment model**: XSA tuned with 3 survey fleets, EngGFS, ScoGFS, and IBTS Q1.
5) **Consistency**: The assessment and input parameters have remained essentially unchanged for the past 3 years. Retrospective analysis indicates no large deviations between annual assessments.
6) **Stock status**: B (203,000t) > Bpa (140,000t) and > Blim (100,000t) for 2008, F(0.25)<Fpa (0.70)<Flim (1.0). F decreased from 0.41 in 2007. The 2005 moderate year-class is now entering the fishery; however recruitment in 2007 and 2008 was below average. The SSB is expected to continue to decline unless a good year-class appears.
7) **Man. Plan.**: F below a restricted TAC when F_{HCR}>= 0.3 specified in the EU–Norway management plan. Management Plan adhered to since 1999. SSB likely to remain above Bpa fishing at Fpa until 2011and longer under agreed management plan (HCR).

General comments

The WG has identified a number of concerns associated with the assessment that are to be addressed at the upcoming benchmark assessment. The RG supports these issues being reviewed. Exploratory analysis (catch at age and single fleet) show similar trends and the small residuals support consistent catch data.

There have been some very significant changes in the weights at age in 2008 for ages 4-7. This will have an impact on biomass estimates.

No large retrospective pattern for SSB or F.

Many factors have changed in this fishery with the Conservation Credit Scheme (CCS). Real-time closures for cod, one –net rules, etc have likely changed exploitation patterns.

Haddock is both a targeted and mixed fishery with cod, whiting and *Nephrops* and should be considered as such in management.

Age structure could be expanded given they are actually be aged (Table 12.2.2.1). Also noted that plus group is larger than any since mid-1970's.

Technical comments:

As this is an update with nothing has really changed, except another year's data, since the last assessment the concerns and recommendations of previous reviews still apply.

Conclusions

RG agrees with the WG on the conclusions for this stock.

Nephrops in Division IVb (Farn Deeps, FU6) nep-6

1) **Assessment type**: update
2) **Assessment**: analytical /trends
3) **Forecast**: presented
4) **Assessment model**: Underwater TV absolute abundance using fishery data
5) **Consistency**: New approach used for the 2009 assessment
6) **Stock status**: All available data suggest that the stock continues to be at a low level or depleted state. Recruitment signals infer 2008 to be low.
7) **Man. Plan.**: There is no agreed management plan for this stock. Precautionary reference points have not been defined. .

General comments

The following comments are generic to all *Nephrops* stocks for which advice is presented.

For the *Nephrops* stocks assessed using UWTV surveys, a new method has been developed (WKNEPH, 2009) and used for the 2009 advice. This provides absolute abundance estimates and permits a catch options table based on a range of harvest ratios. There are a number of underlying assumptions with this approach and these assumptions should be explored to assess how sensitive catch forecasts are to them. These are associated with quantification of survey bias, mean weights of *Nephrops* in the landings and discard rates. The RG consider that the variance of the estimates used should be determined and a sensitivity analysis, particularly with respect to catch forecasts, be conducted using a range of input values.

From the stock annex, there appears to be considerable differences in mean weights and discard rates between FU's e.g discard rates FU 6 = 29.5% FU 9 7.4%, mean weights FU 7= 28.05g and FU 8 =19.84g. While there may be fishery specific reasons for these differences, and that they may be correlated, these are not adequately described and no information is presented on the variance of these estimates. The EG should be conscious that pooling data e.g. discard ogives, can result in a biased estimate due to over influence of trips with high catches. Discard rates across years (from the figure of length distributions) suggest that the discard rates vary considerably, e.g. Fig 3.3.5.3, the discard rates in 2002 look very different to the length profile in 2001. A more detailed breakdown of discard rates, tabulated and presented with variance estimates between years would be useful.

The approach assumes that the entire distribution of the stock (or at least the fishery) is surveyed. It is not clear from the stock annex if this assumption is true, the basis of the survey design should be described including VMS data from the fishery and habitat mapping. The EG should be conscious that VMS data is only available from vessels over 15m and may therefore not provide sufficient data alone to describe the spatial extent of the fishery.

General Comments Specific to FU6

The RG agrees with the view of the EG in that this stock is showing serious declines in the recent past. Signals from the TV survey and fishery dependant data suggest a downward trend, although the TV survey from 2008 suggests that this has stabilized but LPUE and catch data continues to show a downward trend. Although trends in fishery dependant data (LPUE) as an indicator of stock trends are not used in the final assessment, the EG are encouraged to incorporate the estimates of twin trawl usage into the effort estimates. Sangster and Breen (1998)[1] observed an increase in *Nephrops* catches of 420% when using twin-rigged gear in comparison to a single net.

[1] Sangster, G.I. and Breen, M., 1998.Gear performance and catch comparison trials between a single trawl and a twin rigged gear. Fisheries Research, 36, pp15-26.

Technical comments

Trends in abundance for several FU's are presented as having been 'reworked' e.g. Fig 3.3.4.5. These have revised earlier estimates significantly. There is no evidence of 'reworking' the time series for FU6. It is not clear whether this is considered an issue for this FU.

Conclusions

The assessment has been performed correctly.

The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.

Nephrops in Division IVa (Fladen Ground, FU7) nep-7

1) **Assessment type**: update
2) **Assessment**: analytical /trends
3) **Forecast:** presented
4) **Assessment model**: Underwater TV absolute abundance using fishery data
5) **Consistency**: New approach has been used for the 2009 assessment
6) **Stock status**: All available data suggest that the stock has increased. UWTV data indicates abundance to be at the highest level in the time series
7) **Man. Plan.**: There is no agreed management plan for this stock. Precautionary reference points have not been defined. .

General comments

The abundance of this FU is estimated using the same methodology as FU6 and therefore the general comments on sensitivity to input parameters are also valid for FU7

Technical comments

The EG note that the UWTV survey does not fully encompass the distribution of the stock/fishery and that this may result in an underestimation of abundance. The EG are encouraged to investigate methods to correct for this. This may be important if the stock contracts and TAC's become restrictive due to under estimation of the abundance.

Given the concerns about Scottish effort and landings statistics, the EG should remove figures and tables associated with trends in LPUE as these are considered 'unrepresentative of actual trends in LPUE'.

Given that effort in terms of hours fished are not mandatory in Scotland, the EG are encouraged to re-express effort in terms of days or kw.days. This applies for all FU's.

Harvest ratio's for F0.1 and Fmax are significant lower for 2008 than previous years due to revision on size of *Nephrops* inhabiting the borrows.

There are no agreed precautionary exploitation boundaries for this stock. The EG should not specifically identify one catch option in the 'quality of the assessment section'

Conclusions

The assessment has been performed correctly.

The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.

Nephrops in Division IVb (Firth of Forth, FU8) nep-8

1) **Assessment type**: update
2) **Assessment**: analytical /trends
3) **Forecast**: presented
4) **Assessment model:** Underwater TV absolute abundance using fishery data
5) **Consistency**: New approach has been used for the 2009 assessment
6) **Stock status:** All available data suggest that the stock has increased. UWTV data indicates abundance to be slightly higher than estimated in 2007. Stock has been at a relatively high level since 2003.
7) **Man. Plan**.: There is no agreed management plan for this stock. Precautionary reference points have not been defined.

General comments

The abundance of this FU is estimated using the same methodology as FU6 and therefore the general comments on sensitivity to input parameters are also valid for FU8

Technical comments

Given the concerns about Scottish effort and landings statistics, the EG should remove figures and tables associated with trends in LPUE as these are considered 'unrepresentative of actual trends in LPUE'.

There are no agreed precautionary exploitation boundaries for this stock. The EG should not identify one specific catch option.

The RG note from figure 3.3.4.4 that an area has been identified outside the boundaries of the FU that are considered to be suitable habitat for *Nephrops*. It is not clear whether any landings are associated with this area. Can the EG please comment.

Conclusions

The assessment has been performed correctly.

The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.

Nephrops in Division IVa (Moray Firth, FU9) nep-9

1) **Assessment type**: update
2) **Assessment**: analytical /trends
3) **Forecast**: presented
4) **Assessment model**: Underwater TV absolute abundance using fishery data
5) **Consistency**: New approach has been used for the 2009 assessment
6) **Stock status**: All available data suggest that the stock has reduced in the past few years but appears stable and above the long term mean. In contrast to the views of the EG, the RG consider that there is some evidence that recruitment may have reduced recently (due to shift in size distribution and little discarding).
7) **Man. Plan.**: There is no agreed management plan for this stock. Precautionary reference points have not been defined. . Estimated harvest ratio for 2008 between F0.1 and Fmax and should not be allowed to increase further

General comments

The abundance of this FU is estimated using the same methodology as FU6 and therefore the general comments on sensitivity to input parameters are also valid for FU9

Technical comments

Given the concerns about Scottish effort and landings statistics, the EG should remove figures and tables associated with trends in LPUE as these are considered 'unrepresentative of actual trends in LPUE'.

There are no agreed precautionary exploitation boundaries for this stock. The EG should not identify one specific catch option.

The catch length data presented in fig 3.3.5.3 suggests that discarding has reduced in recent years. The RG does not fully agree with the EG view that the there is no evidence from the size distribution to suggest over exploitation. Discarding in recent years tends towards zero, which is in sharp contrast to the patterns presented for the first half of the time series. This may indicate reduced recruitment.

Conclusions

The assessment has been performed correctly.

The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.

Norway Pout in ICES sub area IV and division IIIa nop-34

1) **Assessment type**: update
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SXSA (seasonal extended survivors analysis)
5) Consistency: Not fully consistent with last year assessment as 3rd quarter survey indices were not back-shifted
6) **Stock status**: B>Bpa, no F reference points but F is estimated to be below natural mortality at 0.12, R is just above the long term mean
7) **Man. Plan**.: There is no agreed management plan for this stock although ICES provides advice on three management strategies for the stock

General comments

The only major difference from last year assessment is that no back shifting of the Q4 survey was undertaken. The EG presented a contrast with last years assessment and no discernable differences in either SSB or F is noted. The EG are encouraged to further explore the impact of the fishery in the context of the EAF, with particular reference to maintaining a sufficient biomass as a primary food source for other species and the extent of by-catch associated with the fishery due to the small minimum mesh size which does not afford protection for human consumption species.

Danish and Norwegian vessels using small mesh trawls in the north-western North Sea.

Last year's review recommended further work is needed on the commercial tuning fleet data, exploration of an alternative stock assessment model that removes commercial lpue data and link between effort and F should be explored. This years RG agrees.

Conclusions

The assessment has been performed correctly and the RG agrees with the conclusions

Plaice in Division VIId (Eastern Channel) ple-eche

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: Short-term using FLR with average F for last 3 years
4) **Assessment model**: XSA, with 3 commercial fleets and 3 survey fleets.
5) **Consistency**: The assessment and input parameters have remained essentially unchanged since last year's assessment.
6) **Stock status**: SSB (4336t) < Blim (5600t) < Bpa (8000t), and F(0.63) >Flim(0.54 >Fpa (0.45) in 2008. The SSB for the stock is estimated to be near its lowest level and below Blim. F also exceeds the biological reference points. Projections based on better than average year-classes in 2006 and 2007 suggest the stock will increase slightly to above Blim. Recruitment in 2008 (24 million) is close to 2007,and higher than the GM (15 millions) for the period 2000 – 2006.
7) **Man. Plan.**: The eastern channel plaice stock is currently at a very low level and the TAC is at risk of harvesting unsustainably.

General comments

The 2008 the review group identified a number comments/issues regarding this stock and the assessment which will hopefully be addressed at the upcoming benchmark assessment. They also concluded that the assessment is indicative of trends only.

The assessment has been generally considered unreliable for the past several years.

Since 2000 there has been a tendency for the assessment to overestimate SSB and recruitment and to underestimate F.

Landings at age and the commercial activities are somewhat dependent upon the fishing area declaration, which may vary from year to year. It is also evident from the information presented that there is a fair amount of discarding of small fish or high grading for older/larger fish.

The stock structure of the species in unknown.

Technical comments

There is a divergence in the commercial and survey indices that began about 2003 that may reflect a change in catchability of the commercial fleet. The surveys occur after most of the plaice are landed. The indices are also noisy. Recruitment estimate estimates for 2007 and 2008 are unreliable. 2008-2009 year-classes estimated from average 2000-2006 for projections.

Conclusions

The RG agrees with the WG on the conclusions for this stock.

Plaice in Division IIIa (Skagerrak – Kattegat) ple-kask

1) **Assessment type**: Exploratory
2) **Assessment**: not presented
3) **Forecast**: not performed
4) **Assessment model**: XSA 2 commercial tuning fleets Danish gillnetters and seiners, 4 surveys.
5) **Consistency**: Retrospective analysis large shows deviations between annual assessments
6) **Stock status**: Bpa = 24 000t and Fpa= 0.73. Neither Blim or Flim are defined. No reliable estimate of stock status. Indicators suggest that exploitation may be sustainable. No sign of impaired recruitment.
7) **Man. Plan**.: Status of western part uncertain due to mixing with the North Sea. Surveys show a relative decline in eastern portion since peak in 2006. TAC has not been prohibitive.

General comments

Shift in source of landing from east to west. Almost 88% now come from Skagerrak. Most fisheries occur on border between Skagerrak and the North Sea , thus source of catch may be uncertain. Stock origin is also unknown

No final assessment, last accepted analytical assessment was in 2004.

Working group considers that an analytical assessment is not appropriate until the issues of catch-age and survey spatial coverage are resolved.

Exploratory assessment plagued by large fluctuations in SSB and F with strong retrospective patterns.

Technical comments

CAA shows limited ability to track cohorts. Similar problems were observed with the commercial tuning fleets.

Conclusions

RG agrees with the WG on the conclusions.

Plaice Sub-area IV (North Sea) ple-nsea

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: Short-term forecast presented
4) **Assessment model**: XSA, recommended shift to SCA some time in the future. 3 surveys used to tune model
5) **Consistency**: The assessment and input parameters have remained essentially unchanged since last year's assessment. Retrospective analysis indicates overestimate of SSB, under estimate of F.
6) **Stock status**: SSB (345 000) > Bpa (230 000t) >Blim (160 000t), and F(0.25) < Fpa (0.60) < Flim(0.74 >in 2008. The estimate of SSB for 2009 is 388 000t and has been increasing over the last 4 years, especially in 2008. F reduced to 0.25. Recruitment roughly constant or just below long term average. Strong retrospective pattern for SSB and F with overestimated of SSB and under for F in the last 3 years.
7) **Man. Plan.**: Long term management Plan implemented in 2008 to ensure stocks of sole and plaice return to within safe biological limits. The management under the EU plan is for F=0.3. Fishing effort has been substantially reduced.

General comments

Discards are a major problem in this fishery and can affect estimates of stock status. Landing and discards have been about equal since 2001.

Sole mesh size for beam trawl generates high discards of plaice.

May be a shift in fishing pattern toward coastal areas in the southern North Sea.

Short term forecast indicates SSB will remain well above Bpa.

Under "Quality of the Assessment" Second paragraph - Table 8.3.7 should be Figure 8.3.11

Technical comments

Large differences observed in the tuning indices trends. One index indicates higher stock abundance than the other two. Also general decline recently for commercial indices, yet general increase from trawl surveys. Residual patterns with indices for final XSA.

LPUE index used in process, but excluded from the final assessment run for management advice reduced biomass and increased F.

Maturity ogive seems a bit flat in the middle, i.e. 2 and 3 at 0.5

Conclusions

RG agrees with the WG on the conclusions.

Saithe in Sub-areas IV (North Sea), VI West of Scotland), and Division IIIa (Skagerrak) sai - 3a46

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: Short-term forecast presented
4) **Assessment model:** XSA, 3 commercial and 1 survey fleet for tuning.
5) **Consistency**: The assessment and input parameters have remained essentially unchanged since last year's assessment. No major concerns about retrospective patterns for SSB and F
6) **Stock status:** SSB (260586t) > Bpa (200000t), > Blim (106 000t), and F(0.27)<Fpa (0.40) <Flim(0.60) in 2008. SSB is expected to remain above Bpa and F below Fpa beyond 2011 at current harvest levels
7) **Man. Plan.**: There is an EU and Norway agreement which includes a 15% rule. F should be no more than 0.3. The current estimate is below the target F. EU Norway management Plan in place. There are differences in minimum landing size between EU and Norway.

General comments

Estimates of recruitment are uncertain in recent years. The 2005 year-class was thought to be strong in last year's assessment, this year there are no indication it has developed.

TAC lower than landings.

Quality of the assessment is considered good, lacks a good index of recruitment.

Technical comments

No reliable recruitment index for age 3.

Conclusions

RG agrees with the WG on the conclusions.

Sandeel in Subarea IV (North Sea excluding Shetland) san-nsea

1) **Assessment type**: N/A
2) **Assessment**:
3) **Forecast**: N/A
4) **Assessment model**:
5) **Consistency**:
6) **Stock status**: N/A
7) **Man. Plan.**:

General comments

Technical comments

Update scheduled for September 2009.

Conclusions

Sole in Division VIId (Eastern Channel) sol- eche

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: Short-term forecast presented
4) **Assessment model**: XSA, 2 commercial fleets and 3 survey fleets for tuning
5) **Consistency**: The assessment and input parameters have remained essentially unchanged since last year's assessment. Retrospective patterns show good consistency between estimates in successive years for SSB and F, but not recruitment.
6) **Stock status**: SSB (12762t) > Bpa (8000t), > Blim (N/A), and Fpa (0.40) < F(0.45) <Flim(0.55) in 2008. SSB is expected to remain near Bpa and F greater Fpa beyond 2011 at current harvest levels.
7) **Man. Plan.**: EU Council Regulations have not reduced effort directed at sole in this area.

General comments

In 2008 stock was considered as having full reproductive capacity and is at the risk of being harvested unsustainably.

Large discard of plaice from this area due to smaller mesh size for sole

Last two years (2006/2007) recruitment estimated to be well below average.

Lack of UK YFS data for 2007 and 2008 will affect the quality of recruitment estimates and thus forecasts.

Likely that SSB will decrease to Bpa or slightly below in short term (by 2011) due to weak year classes 2006 and 2007.

Technical comments

RG last year noted a similar residual pattern for sole and plaice, but this was not addressed at the WKFLAT.

Maturity ogive knife-edged at age 3.

Conclusions

RG agrees with the WG on the conclusions.

Sole in Sub-area IV (North Sea) sol-nsea

1) **Assessment type**: update
2) **Assessment**: analytical
3) **Forecast**: short-term forecast presented
4) **Assessment model**: XSA
5) **Consistency**: Retrospective analysis: Underestimation of F (exception 2007), overestimation of SSB, recruitment unbiased.
6) **Stock status**: F below Fpa, SSB above Bpa, strong year class 2005 F= 0.34 in 2008 which is below Fpa (0.4). The SSB 40 000 t in 2008 above both Blim (25 000t) and Bpa (35 000 t).
7) **Man. Plan.**: Biol. reference points, EU management plan: Target F 0.2. Evaluated by ICES 2008.

General comments

Fishing effort and fishing mortality have been substantially reduced since 1995. Mixed fisheries for sole and plaice complicates the management, current minimum mesh size is suitable for sole but generates high discards of plaice. Sole stock dynamics is heavily dependent on occasional strong year classes. Evolutionary effects of fishing: age and size at first maturity shifted to younger ages from 1980 onwards. This will be one of the issues in the next benchmark assessment.

Technical comments

The scenarios in the short-term forecasts are almost similar and therefore there is no big difference in the results – uncertainty in the results is certainly larger than the differences.

Figures 10.3.2. and 10.3.4.: It seems that in the retrospective analysis the commercial indices were used in the analysis for mean F (black lines in Fig. 10.3.2.) but survey indices for recruitment and SSB (grey lines)? Check which series was used in actual calculations.

Fig. 10.4.1.: The bottom right panel is landings, not recruitment. Caption needs to be changed.

Fig. 10.6.2.: The equilibrium curves presented here do not fit the with the data points. Recruitment seems not to be dependent of the SSB, and the yield not dependent on F. Are there environmental effects that determine the recruitment? Could such factors be incorporated in the analysis? The number of recruits and SSB have been fluctuating within a steady range since the latter half of the 1990s even if F has been decreasing.

Conclusions

The assessment has been performed correctly but the reference points may be uncertain. The stock seems to fluctuate almost irrespective of the fishing effort.

Whiting Sub-area IV (North Sea) & Division VIId (Eastern Channel) whg-47d

1) **Assessment type**: Update
2) **Assessment**: analytical
3) **Forecast**: short-term forecast presented
4) **Assessment model**: XSA
5) **Consistency**: According to retrospective analysis large deviations between annual assessments
6) **Stock status:** Low SSB, recent recruitment impaired, F low from 2002 to 2005, after that F increased particularly at younger ages. B_{lim} = 225,000 t; B_{pa} = 315,000 t; F_{lim} = 0.90; F_{pa} = 0.65.SSB in 2008 the lowest level since the beginning of the time-series in 1990. Fishing mortality increased in recent years to twice F_{max}. Recruitment has been very low since 2001.
7) **Man. Plan.**: Reference points agreed by the EU and Norway, unchanged since 1999, WG considers not applicable.

General comments

The WG states that due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

There has been a likely increase in discarding in some areas due to unaffordable quota. Value of whiting has increased in recent years.

Retrospective pattern all over the place. Fig 12.3.15

The working group considers the status of the stock unknown with respect to biological reference points. Nevertheless all indications are that the stock is at a historical low level relative to the period since 1990. Recent measures to improve survival of young cod and increased uptake of more selective gear in the North Sea and Skagerrak, should be encouraged for whiting.

The survey data and commercial catch data contain different signals concerning the stock

Technical comments

Status of the stock unknown with respect to biological reference points

Conclusions

RG agrees with the WG on the conclusions.

Whiting in Division IIIa (Skagerrak - Kattegat) whg-kask

1) **Assessment type: SALY**
2) **Assessment**: not presented
3) **Forecast**: not presented
4) **Assessment model**:
5) **Consistency**:
6) **Stock status**:
7) **Man. Plan**

General comments

The WG states that the new data available for this stock are too sparse to revise the advice from last year and therefore no assessment of this stock was undertaken.

Technical comments

Conclusions

Nephrops in Division IVa (Noup, (FU 10) nep-10

1) Assessment type:

2) **Assessment**: N/A

3) **Forecast**:

4) **Assessment model**: Underwater TV absolute abundance

5) **Consistency**: Surveys are sporadic with last occurring in 2007

6) **Stock status:** Unknown

7) **Man. Plan**.: There is no agreed management plan for this stock. Precautionary reference points have not been defined. .

General comments

No new information for 2007 or 2008 for this small fishery.

Technical comments

Given the concerns about Scottish effort and landings statistics, the EG should remove figures and tables associated with trends in LPUE as these are considered 'unrepresentative of actual trends in LPUE'.

Conclusions

No advice requested and no assessment undertaken

Nephrops in Division IVa (Norwegian Deeps, (FU 32) nep-32

1) **Assessment type:** Trends
2) **Assessment**: N/A
3) **Forecast**: N/A
4) **Assessment model:**
5) **Consistency**:
6) **Stock status:** No change since 2008 evaluation. Current fishery appears sustainable
7) **Man. Plan.**: There is no agreed management plan for this stock. Precautionary reference points have not been defined. .

General comments

Based on Danish LPUE, thus highly uncertain. There may be some technology creep.

Technical comments

Conclusions

No advice requested and no assessment undertaken

Nephrops in Division IVb (Off Horn Reef, FU 33) nep-33

1) **Assessment type**: Nil
2) **Assessment**: N/A
3) **Forecast**: N/A
4) **Assessment model**: N/A
5) **Consistency**:
6) **Stock status**: Unknown
7) **Man. Plan.**: There is no agreed management plan for this stock. Precautionary reference points have not been defined. .

General comments

Only on Danish LPUE, thus highly uncertain. There may be some technology creep. Large (~50%) catch by Netherlands in 2008

Technical comments

Conclusions

No advice requested and no analysis presented

Nephrops in Division IVbc (Botney Gut - Silver Pit, (FU 5) nep-5

1) **Assessment type:**
2) **Assessment**: Not conducted
3) **Forecast**: N/A
4) **Assessment model:** N/A
5) **Consistency**:
6) **Stock status**: Evaluation of stock difficult.
7) **Man. Plan.**:

General comments

There has been a real lack of information from this area in the past few years (since 2005). This is combined with a significant increase in the LPUE for Denmark which may reflect a technology creep. However, there is no indication of a downward trend.

Technical comments

Conclusions

No advice requested and no assessment undertaken

Nephrops in Division IIIa (Skagerak Kattegat, (FU 3,4) nep-iiia

1) **Assessment type**:
2) Assessment: Not conducted
3) **Forecast**: N/A
4) **Assessment model**: N/A
5) **Consistency**:
6) **Stock status**: Current levels of exploitation appear to be sustainable. No estimate of SSB.
7) **Man. Plan:**

General comments

WG recommends both FU 3 and 4 be merged into a single FU.

There was been limited sampling of the Skagerak area in 2007 and 2008, but ok in Kattegat.

Technical comments

Last year there were a number of issues associated with the TV indices. The WG decided that the TV indices should be considered a measure of absolute abundance. They also pointed out that the camera detects burrows smaller than the fishery takes. Only a portion is available to the fishery and the harvest ratios need to be revised downward.

Conclusions

No advice requested and no assessment undertaken

Sandeel in Subarea IVa (Shetland area) san-shet

1) **Assessment type**: N/A
2) **Assessment**:
3) **Forecast**: N/A
4) **Assessment model**:
5) **Consistency**:
6) **Stock status**: N/A
7) **Man. Plan.**:

General comments

Technical comments

Update scheduled for September 2009, perhaps.

Conclusions