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Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS)

8–17 May 2007

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Executive summary

The ICES Working Group for the Assessment of Northern Shelf Demersal Stocks (WGNSDS) met at the Marine Institute, Galway, Ireland during 8th–17th May 2007. The main terms of reference addressed by this year's working group were: to carry out stock assessments and to provide catch forecasts for demersal stocks in the Northern Shelf area; to consider environmental drivers of fish population dynamics and the effects of fisheries on the ecosystems; to update descriptions of the fisheries; to report on national sampling levels and data availability and to consider measurement and estimation of misreporting and discards.

Overview

The assessment status of many stocks in 2007 was unchanged from those of 2006. Both VIa cod and VIIa cod were given observation status. VIb haddock and VIIa sole were classified as benchmark assessments. All other stocks were treated as either update or experimental assessments although the level of exploratory work varied in each case. There was no assessment of *Nephrops* stocks at this year's meeting. In accordance with the terms of reference for this year the information on *Nephrops* contained within this report is an update of catch tables and fishery statistics only. There were no assessments for anglerfish or megrim since only short time-series of data are available for these stocks and until longer time-series of reliable information can be developed they are assigned monitoring status, which allows for the collation of data and preliminary analyses but does not require that a formal analytical assessment be conducted.

As for some other working groups the system of benchmark/update assessments is not closely followed by WGNSDS. In order to accommodate the specific nature of all stocks, additional categories have had to be developed that allow for the working group not to present an analytical assessment in some cases. Furthermore ongoing developments in assessment methods and substantial revisions to stock perceptions from the addition of new data mean that pure update assessments are often difficult to present particularly when management advice is formulated annually. These issues are discussed further in Section 1.9.

For some assessments catch data are considered unreliable in recent years and have been excluded from the assessment. In such cases one of two approaches has been adopted. Either survey data alone are used to determine stock trends in the most recent years of the assessment or alternatively the catch data are retained for all years but a bias factor is estimated for recent years. However, it is likely that improved compliance, monitoring and enforcement along with a reduced fleet size and the Registration of Buyers and Sellers regulations (see Section 1.7.2) have reduced greatly the incidence of misreporting and underreporting, although discarding is still problematic. One result of this is that the catch data in 2006 may be more reliable than in previous years. The working group discussed the option of including the 2006 catch data in the assessment as an accurate and unbiased estimate of removals but concluded that such an approach would not be appropriate. From the point where the landings data are removed, survey information is used to estimate the level of total mortality minus the assumed value of natural mortality. Since the assumed estimate of natural mortality is unlikely to represent all of the mortality beyond that due to fishing, the estimate of total mortality derived from the survey driven assessment cannot be assumed to be a measure of fishing mortality alone. Including the 2006 catch data would revert the model back to estimating fishing mortality for that year only and the time-series would no longer be consistent. This issue is discussed in greater detail in the individual stock sections of the report.

State of the stocks

West of Scotland stocks

SSB of **VIa cod** has been in decline throughout much of the time-series and is estimated in 2006 to be at the lowest observed level. Although the 2005 year class is estimated to be one of the strongest in the series of weak recruitments in recent years, the SSB estimate of 3 500 t in 2006 is so far below B(lim) that there will be a very low probability of recovering the stock above B(lim) by 2009, even if mortality levels on the stock are reduced to zero.

Recent stock trends of **VIa haddock** have been dominated by the very large 1999 year class which caused an increase in SSB until 2002 from which point SSB has declined as the year class has been fished down. Following relatively poor recruitments in the last 3 years SSB is forecast to fall below B(lim) by 2008. The forecast for haddock is based on an assessment that excludes catch data from 1995. Because of this it is not possible to partition removals into landings, discards and other sources of mortality and it is therefore not possible to reach firm conclusions regarding appropriate landings quotas. However, the working group considers that the current downward trend in SSB and recent low recruitment are informative indicators for management advice.

Following above average recruitments in 2000 and 2001, the stock of **VIb haddock** has increased in recent years. Provisional survey data indicate that the 2005 year class is also strong. Although the point estimates of fishing mortality declined to a low value in 2006, estimates of F have shown large year on year changes in the past due to variable fleet activities at Rockall. The TAC for VIb, XII and XIV was increased substantially from 597 t in 2006 to 4 615 t in 2007. The increase in TAC at Rockall together with reduced opportunities in VIa may result in future increases in F as additional fishing effort is attracted into VIb.

The stock of **VIa whiting** is assessed using survey data alone. The abundance indices from the Scottish Q1 and Q4 groundfish surveys show poor ability to track year class signals. The lack of consistent signals in the survey data results in a generally poor fit of the assessment model for which trends in total mortality alter quite markedly with the addition of a single year of data. This is due in part to the assessment model assumptions but also due to the level of noise in the survey data. Although estimates of total mortality are variable, measures of SSB and recruitment have been shown to be robust to model assumptions in survey based assessments. Recent recruitments are estimated to have been low, particularly in 2005 and 2006 and SSB has declined over the last decade to the lowest observed level in the relatively short time-series of the survey.

For a number of years the working group has expressed concerns over the quality of the commercial catch at length data for **anglerfish**. The group has previously attempted assessments of the stock using a number of different approaches but as yet none have proved satisfactory. A number of initiatives have recently been instigated in an attempt to develop the information necessary to assess the stock. A tally-book scheme has been implemented in Scotland to provide information on the spatial and depth distribution on catches; a Scottish industry-science dedicated anglerfish survey began in 2006 and the Irish survey has been extended to include the more southerly region of the Northern Shelf anglerfish stock, and on-board sampling of catches continues through an observer sampling scheme on Scottish vessels. These surveys and sampling schemes have only recently been implemented and there is no time-series of reliable information of sufficient length with which to conduct a formal assessment of the stock. However, there is some evidence to indicate that commercial catch rates have increased in recent years and the stock does not appear to be exhibiting a decline.

Area **VI megrim** continues to be a monitored stock and no analytical assessment has been attempted this year. Concerns regarding the accuracy of reported landings statistics in previous years preclude any assessment based primarily on commercial catch data. Since 2005 several international surveys have been undertaken that have a better spatial coverage of megrim stocks in both VIa and VIb. These will potentially allow for survey based assessments of this stock in the future. An anticipated increase in fishing activity in VIb as a consequence of reduced opportunities in VIa and increased TAC for haddock is expected to lead to increased fishing pressure on the stock of megrim in VIb.

Irish Sea stocks

Two model options for the assessment of **VIIa cod** were considered by the working group. Option 1 estimated unallocated removals from 2000 onwards, including 2006 as discussed earlier in Section 0.1. However, the results of this approach yielded increased bias estimates in 2006 that contradicted port based sampling information which indicated that reported landings may be more accurate in the terminal year. An alternative option was explored by the working group in which no bias was estimated in 2006. The results of this analysis gave estimates of landings that more closely matched those determined from market based observations; however, it indicated a very sharp drop in fishing mortality in 2006 associated with the small landings figure that is assumed to represent all removals in excess of natural mortality. The working group concluded that there was insufficient information in the highly truncated age composition of the stock to allow reliable estimation of catch bias in 2006 and that the true fishing mortality probably lies somewhere between the two estimates. SSB and recruitment were, however, consistently estimated by the two approaches. Medium-term forecasts indicate that SSB will decline to a historic low in 2008 and that there are no non-zero options for mortality that allow rebuilding of SSB to levels above B(lim) by 2009 with a probability greater than 20%.

Both landings and discards are poorly quantified for **VIIa haddock** and the assessment uses survey information alone to provide relative trends in abundance and mortality. Detailed knowledge of this stock is restricted to the relatively short period for which survey information is available. SSB increased substantially following the introduction of the strong 1994 and 1996 year classes. A relatively high mortality rate combined with weaker recruitments led to a decline in abundance in 1999 and 2000 but stronger recruitment in 2001 and 2003/4 has resulted in recent increases in stock abundance.

Landings of **VIIa whiting** have been declining almost continuously since the 1980s. Catches are currently very small and are mostly taken as a bycatch in the 70–80mm mesh *Nephrops* fisheries. In previous years the Q1 and Q4 groundfish surveys have shown divergent trends although both surveys now show a decline in stock abundance. Recruitment appears to have increased since the 1980’s and in spite of a considerable decline in fishery landings, total mortality levels appear to be increasing. The relative contribution of other sources of removals such as predation and emigration are poorly understood at present.

Landings of **VIIa plaice** have steadily declined over the last decade to their lowest recorded level in 2006. Survey information indicates an increase in abundance over the last 10 to 15 years but numbers appear to have declined in the most recent years. This decline in abundance is not shown in the results of the assessment, which shows SSB continuing to increase through to 2006. Very high levels of discarding occur in this fishery and discards are not currently included in the assessment. Consequently catches-at-age may be poorly estimated and this will affect the quality of the assessment. However, assessment methods using catch-at-age information and those using survey data alone consistently indicate that fishing mortality is at a low level and that SSB remains relatively high.

Landings of **VIIa sole** have declined in recent years and were at their lowest recorded level in 2006. The results of this year’s assessment have changed the perception of the state of the stock from last year. They show SSB to have declined in recent years and to have been below B(lim) since 2004. Fishing mortality in recent years is estimated to be slightly above F(lim). Recruitment over the last two decades has been variable but has not shown any of the very large recruitments evident earlier in the time-series and recruitment in the most recent years is estimated to have been very low with the 2004 year class being one of the lowest observed in the 37 year time-series. The short-term forecast indicates that an approximate 80% reduction in fishing mortality would be required in order to bring SSB above B(lim) by 2008.

1 General introduction

1.1 Participants

Mike Armstrong	United Kingdom (England and Wales)
Otte Bjelland	Norway
Richard Briggs (part time)	United Kingdom (Northern Ireland)
Neil Campbell	United Kingdom (Scotland)
Sarah Davy (part time)	Ireland
Wim Demare	Belgium
Helen Dobby	United Kingdom (Scotland)
Jennifer Doyle (part time)	Ireland
Norman Graham	Ireland
Steven Holmes	United Kingdom (Scotland)
Andrzej Jawarski	Scotland
Vladimir Khlivnoy	Russian Federation
Sara-Jane Moore	Ireland
Sten Munch-Petersen	Denmark
Coby Needle	United Kingdom (Scotland)
Matthew Parker-Humphreys	United Kingdom (England and Wales)
Pieter-Jan Schön	United Kingdom (Northern Ireland)
Robert Scott (chair)	United Kingdom (England and Wales)
David Stokes	Ireland

1.2 Terms of reference

2ACFM10: The **Working Group on the Assessment of Northern Shelf Demersal Stocks** [WGNSDS] (Chair: R. Scott, UK (E&W)) will meet at the Marine Institue, Galway from 8–17 May 2007 to:

a) assess the status of and provide management options for 2008 for the stocks of cod, haddock, whiting and megrim in Subarea VI, for cod, haddock, whiting, plaice, sole in Division VIIa, for anglerfish in Subarea IV and Divisions IIa, IIIa and VIa. Update the catch information for *Nephrops* in Subareas Via and VIIa.

b) for the stocks mentioned in a) perform the tasks described in C.Res.2006/2ACFM01.

Terms of Reference *a)* are considered within the individual stock sections which give the results of attempts to assess each stock. Term of Reference *b)* (C. Res. 2006/2ACFM01) requires that several tasks be undertaken in 2007 for each of the stocks mentioned in Term of Reference *a)*. These tasks are listed below, and henceforth referred to as Terms of Reference *c)* to *n)*:

c) Set appropriate deadlines for the submission of data. Data submitted after the deadline may be disregarded at the discretion of the chair.

d) Compile all relevant fisheries data, including data on different catch components (landings, discards, and bycatch) and data on fishing effort. Data should be disaggregated by fisheries/fleets.

e) Assess the status of stocks according to the schedule for benchmark and update assessments as shown below.

f) Provide specific information on possible deficiencies in the 2007 assessments and forecasts.

- Any major inadequacies in the data on landings, effort or discards
- Any major expertise that was lacking

- o Any major inadequacies in research vessel survey data
- o Any major difficulties in model formulation or available software

The consequences of these deficiencies for both the assessment of the status of the stocks and the projections should be clarified

g) Consider knowledge on important environmental drivers for stock productivity (based on input from e.g. WGRED and for the North Sea NORSEPP. If such drivers are considered important for management advice, incorporate such knowledge into assessment and prediction, and comment on the consequences for long-term targets of high yield and low risk.

h) Consider existing knowledge of important impacts of fisheries on the ecosystem.

i) Evaluate existing management plans and develop options for management strategies including target and limit reference points. If mixed fisheries are considered important consider the consistency of target reference points and management strategies.

j) Assess the influence of individual fleet activities on the stocks. For mixed fisheries, assess the technical interactions.

k) Provide an overview of the major regulatory changes (technical measures, TACs, effort control and management plans) and evaluate or assess their (potential) effects.

l) Where misreporting and/or discarding is considered significant provide qualitative and where possible quantitative information by fisheries, and describe the methods used to obtain the information and its influence on the assessment and predictions.

m) Present an overview of the sampling on a national basis of the basic assessment data for the stocks considered according to the template that is supplied by the secretariat.

n) Implement the roadmap for medium and long-term strategy of the group as developed in AMAWGC.

1.3 Stock assignments in 2006

In accordance with the established system of identifying different assessment types C.Res. 2ACFM01 outlined a plan for WGNSDS stocks in 2007. The plan listed Cod stocks in VIa and VIIa as being on the Observation list, stocks of haddock, plaice and sole in the Irish Sea and haddock in the west of Scotland were assigned as update assessments, stocks of whiting in the west of Scotland and haddock and whiting in the Irish Sea were classified as experimental assessments and all other stocks were trends only. No stocks were listed as having benchmark status in 2007.

Based on reviews of each individual assessment by RGNSDS the proposed classification of stock status in 2007 has been modified slightly. Stock assessments for 2007 were conducted on the basis of the following table. The assessment approach adopted for each stock is introduced at the beginning of the individual stock chapter.

OBSERVATION LIST	BENCHMARK	UPDATE	EXPERIMENTAL	MONITORING
Cod VIa	Sole VIIa	Haddock VIa	Whiting VIIa	Megrim VIa
Cod VIIa		Plaice VIIa	Whiting VIa	Megrim VIb
		Haddock VIb	Haddock VIIa	Anglerfish II/IIIa/IV/VI

The stocks considered by WGNSDS are tabulated in Table 1.1, along with the type of assessment carried out, and an indication of whether the approach in 2007 reflects a change to previous practice.

1.4 Environmental and ecosystem information

Term of reference *g)* asks the WG to incorporate existing knowledge on important environmental drivers for stock productivity and management into assessment and predictions, based on input from WGRED, 2006 (ICES, 2006). The WG was further asked to consider important impacts of fisheries on the ecosystem noted by WGRED.

The areas of most interest to WGNSDS comprise the waters to the west of Great Britain and Ireland but the area extends (for some stocks) into the Norwegian Sea and northern North Sea. This area is largely defined by WGRED as regional ecosystem E (Celtic Seas). WGRED has not identified any environmental signals that should be considered in assessment or management in this area, but has stated that the major trends in the ecosystem are the steady warming of the area, particularly in the context of slope current, and the general and continuing reduction of copepod abundance. It was noted that these factors are likely to have an impact on many species but will particularly affect migratory pelagic species.

1.4.1 Environmental drivers of productivity

WGRED notes that eco-region E has attracted less attention than other areas, such as the North Sea and that fewer studies have been conducted in this area. WGNSDS has previously provided information on the environment and ecosystem of the waters in eco-region E. in 2005 environmental and ecosystem information for the Norwegian Sea was provided and in 2006 a study of the potential relationship between sea surface temperature and cod recruitment in the Irish Sea was conducted. No further information on environmental drivers of productivity has been provided by WGNSDS in 2007.

1.4.2 Ecosystem considerations

Grey seals (*Halichoerus grypus*) are common in many parts of the eco-region E, with population estimates ranging from approximately 50 000 to 110 000 animals (SCOS, 2005), the majority being found in the Hebrides and in Orkney. Common seals (*Phoca vitulina*) are also widespread in the northern part of the area with around 15 000 animals estimated (SCOS, 2005). Smaller numbers are seen in Ireland (c. 4 000) with fewer numbers further south.

Recent reports by Hammond and Grellier (2006) and Hammond and Harris (2006) have revised estimates of fish consumption by grey seals in the North Sea and the West of Scotland. These estimates suggest that, in the west of Scotland, consumption of commercially exploited fish populations is increasing and that, in some cases, annual consumption is comparable to ICES population biomass estimates.

It is difficult to reconcile these estimates of fish consumption with the estimates of population abundance from the ICES 2004 assessments. It is possible that the grey seal consumption figures have been overestimated either through overestimation of the seal population size or through biases in the analysis of scats to determine prey compositions. It is also possible that fish population biomass may be underestimated by the assessments through the use of an assumed natural mortality estimate that is too low. The truth may lie in some combination of these scenarios.

The revised estimates of consumption have few consequences for the short-term management advice for cod in area VIa. The assessment is driven solely by survey data from 1995 onwards, and gives estimates of SSB that are very low with high mortality rates in recent years. Consequently the stock remains outside safe biological limits and continues to be subject to recovery measures. However, a revision of natural mortality estimates to accommodate recent changes in seal predation levels may affect the anticipated time required for the cod stock to recover.

1.5 Description of fisheries

AMAWGC, 2006 (ICES, 2006) concluded that further discussions between WGFTFB and ACFM were required before descriptions of mixed fisheries could be revised and reviewed by working groups. Section 17 of this report provides further information on fleet activities in recent years. Information provided to WGNSDS by WGFTFB regarding fishing practices in 2006 has been included in the relevant stock sections.

1.5.1 Fisheries to the West of Scotland and Rockall

The main fleets operating in Division VIa include the mixed roundfish otter trawl fleet, the *Nephrops* otter trawl fleet, the otter trawl fleet targeting anglerfish, megrim, and hake, and the fleet targeting saithe and/or deep-sea species. To a large extent, the roundfish fishery in Division VIa is an extension of the similar fishery in the North Sea, occurring mainly in offshore areas to the north and west of the Hebrides and off the north of Ireland. Conversely, the demersal trawl fishery for *Nephrops* occurs mainly on inshore grounds in the Minches and Clyde. However, there is also an important ‘offshore’ fishery on the Stanton bank. The demersal fisheries in Division VIa and VIb are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish, and whiting, with bycatches of saithe, megrim, and lemon sole.

The majority of the vessels in the demersal fishery are locally-based Scottish trawlers, but trawlers from Ireland, Northern Ireland, England, France, and Germany also participate in this fishery. The importance of Scottish seiners targeted mainly at haddock has been declining in recent years as many of these vessels have switched to pair seining or have been decommissioned. Part of the trawl fleet has diversified into a fishery for anglerfish that has been expanding into deeper water off the northern coast of Scotland. Bycatches in this fishery include megrim, ling, and tusk.

About 200 Scottish trawlers also take part in the fisheries for *Nephrops* on inshore grounds. In recent years Irish vessels have also been targeting *Nephrops* in Division VIa, mainly on the Stanton grounds. These *Nephrops* vessels also land smaller quantities of haddock, cod, whiting, and small saithe, but discard large amounts of whiting and haddock.

The development of a directed fishery for anglerfish has led to considerable changes in the way the Scottish fleet operates. Part of this is a change in the distribution of fishing effort; effort in the roundfish fisheries has shifted away from the traditional inshore areas to more offshore areas and deeper waters. The expansion in area and depth-range fished has been accompanied by the development of specific trawls and vessels to exploit the stock. These vessels mainly use large twin-rig otter trawls with >100 mm mesh. A smaller Irish fleet also targets anglerfish, megrim, and hake on the Stanton bank with 90 mm to 100 mm mesh. This fleet has declined in numbers in recent years and a number of the remaining vessels are focussing on the mixed demersal fishery at Rockall (VIb).

The fishery for anglerfish has expanded into deeper waters with an associated increase in catches. The expansion of this fishery has been further accelerated by the diversion of fishing effort from other stocks subject to more restrictive quotas in recent years and by market opportunities, although there are indications that there may be a partial reversal of this tend due to restrictive quotas and improved control and enforcement (WGFTFB, 2007). A gillnet fishery has developed on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. A preliminary investigation of this fishery suggests high levels of gear loss, widespread dumping of netting, high catch & discarding levels (particularly of monkfish), and a lack of effective management. These fisheries are occurring in areas believed to have been a refuge for adult anglerfish, increasing the vulnerability of the stock to over-exploitation. Immature fish are subjected to exploitation for a number of years prior to first maturity. In 2007 the EC introduced legislation that restricts the maximum amount of netting that can be deployed by an individual vessel (100 km) and the maximum soak time (72 hrs) and the maximum depth that nets can be deployed (600 m). See Section 6 for further details.

The larger Scottish and Irish trawlers fish for haddock at Rockall when opportunities arise for good catches from the Division VIb stock. Vessels from the Russian Federation have fished for haddock and other demersal species at Rockall since 1999 when part of the Bank was designated as being in international waters. Although young saithe are caught by coastal trawlers in Subarea VI, the fishery for saithe essentially takes place on the shelf edge to the west and northwest of Scotland. Traditionally, this fishery has largely been operated by the larger deep-sea French trawlers. However, the number of these vessels has declined in recent years. Since the late 1980s, some of these vessels have diverted their activity toward deep-sea species, notably orange roughy, and some medium-sized trawlers also participate in the fishery for deep-sea species during summer in some years.

The pelagic fishery for herring is mainly operated by UK, Dutch, and German vessels in the north, and by Irish vessels in the south. Substantial misreporting of catches from the North Sea and between the northern and southern stocks occurred in the past, but UK licensing regulations are thought to have reduced misreporting since 1997. In recent years TACs for the northern stock have not been restrictive, presumably because of low effort and a weak market. The Clyde herring fishery has declined sharply in recent years as the stock has suffered from a series of low recruitments. Recent TACs have not been taken and the catches have been less than 1 000 t since 1991.

There is a directed trawl fishery for mackerel and horse mackerel in the area. The mackerel fishery mainly takes place in the fourth and first quarter of the year, when the mackerel is returning from the feeding area to the spawning area. The horse mackerel is mainly fished in the second half of the year. In addition, there are fisheries for blue whiting in the area.

The industrial fisheries in Division VIa are much smaller than in the North Sea. The Scottish sandeel fishery started in the early 1980s, peaking in 1986 and 1988. It is irregular, depending on the availability of the resource and of processing facilities at Shetland, Denmark, and the Faroes. Bycatches in this fishery are very small. The Norway pout fishery is conducted mainly by Danish vessels.

Fisheries interactions to the West of Scotland and Rockall

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Roundfish are caught in otter trawl and seine fisheries, with a 120 mm minimum mesh size that comprises 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 deeper water and of *Nephrops* on the more inshore *Nephrops* grounds. Static gear fisheries with mesh sizes generally in excess of 140 mm are also used to target cod. Saithe are mainly taken in a directed trawl fishery in deeper water along the shelf in Subarea VI. There is thought to be little bycatch of other demersal species associated with the directed fishery.

Large *Nephrops* fisheries take place in discrete areas that comprise appropriate muddy seabed sediment. Targeted *Nephrops* fisheries on these grounds are taken predominantly in trawls with mesh sizes of less than 100 mm using single- or multiple-rig trawls. *Nephrops* fishing grounds are mainly inshore grounds although there are smaller offshore fisheries at Stanton Bank and west of the Hebrides. The bycatch and discarding of other demersal species in the *Nephrops* fisheries is highly variable.

There are trawl and gillnet fisheries targeting hake and anglerfish and otter trawl fisheries targeting hake, megrim, and anglerfish in Subarea VI. The catch of other demersal species associated in these fisheries is uncertain.

There is an international fishery targeting haddock, grey gurnards, and other species at Rockall using small mesh. Successful application of TACs for this stock would require that there is a simple relationship between recorded landings and effort exerted. This assumption is unlikely to be true for Rockall haddock especially when coupled with ways of evading TACs including misreporting, high-grading, and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. Direct effort regulation is therefore suggested as a means of controlling fishing mortality on Rockall haddock.

The shift in fishing effort away from area VIa as part of cod recovery measures obviously reduced the landings of cod from this area, but also caused a reduction in the associated bycatch, especially haddock but also whiting and megrim to a lesser extent.

1.5.2 Fisheries in the Irish Sea

The majority of vessels in the Irish Sea target *Nephrops* with either single- or twin-rig otter trawls. These vessels use either 70 mm diamond mesh with an 80 mm square mesh panel or an 80 mm diamond mesh in their codends, and (by regulation) their landings must consist of at least 35% *Nephrops* by live weight (30% for vessels using 80 mm). These vessels have bycatches of whiting (most of which are discarded) and haddock, cod, and plaice. *Nephrops* catches are highly seasonal with the highest *Nephrops* catches in the summer months. Catch rates are also dependent on tidal conditions, with higher catches during periods of weak tide.

The roundfish fisheries in the Irish Sea are conducted primarily by vessels from the UK and Ireland. A Northern Irish semi-pelagic trawling for cod and whiting developed in the early 1980s. As the availability of whiting declined, this fleet switched to mainly targeting cod and haddock. Irish, Northern Irish, and English and Welsh otter trawlers target plaice, haddock, whiting, and cod, with smaller bycatches of anglerfish, hake, and sole. Some Irish vessels participate in a fishery for rays in the southern Irish Sea. Since 2001, these trawlers have adopted mesh sizes of 100–120 mm and other gear modifications, depending on the requirements of recent EU technical conservation regulations and national legislation.

Fishing effort in the semi-pelagic fleet increased rapidly between the early 1980s and early 1990s before decreasing somewhat in the mid–1990s. Fishing effort in the England and Wales otter trawl vessels longer than 12 m declined rapidly after 1989, and from 1992 to 1995 was about 40% of the effort reported in the 1980s, although it has increased slightly in recent years. There has been a declining trend in fishing effort for Northern Irish otter trawlers also since the early 1990s. Fishing effort for Irish otter trawlers targeting roundfish has declined in recent years as many vessels have switched to *Nephrops* largely driven by restrictive days as sea allocations for larger mesh fisheries.

There is also a beam trawl fishery which takes place mainly in the eastern Irish Sea with vessels from Belgium, Ireland, and the UK. This fishery mainly catches sole with important bycatches of plaice, rays, brill, turbot, anglerfish, and cod. The fishing effort of the Belgian beam-trawl fleet varies in response to the catch-rates of sole in the Irish Sea relative to catch-rates in other areas in which the fleet operates. Fishing effort peaked in the late 1980s following a series of strong year classes of sole, but is presently only about 60% of the peak value.

The other gears employed to catch demersal species are gillnets and tangle nets, notably by inshore boats targeting cod, bass, grey mullet, sole, and plaice.

The main pelagic fishery in the Irish Sea is for herring. In recent years, it has been predominantly operated by one pair of trawlers from Northern Ireland. The size of this fleet has declined to a very low level in recent years.

There are also a number of inshore fisheries in the Irish Sea that target stocks not currently assessed by ICES. These include pot fisheries for crab, lobster, and whelk, hydraulic dredge fisheries for razor clams, and dredge fisheries for scallops.

Decommissioning at the end of 2003 permanently removed 19 out of 237 UK demersal vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that had used demersal trawls with mesh size >=100 mm and had more than 5% cod in their reported landings. The previous round of decommissioning in 2001 removed 29 UK (NI) *Nephrops* and whitefish vessels and 4 UK (E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size >=100 mm and had more than 5% cod in their reported landings. Between 2005 and 2006, 9 Irish vessels which historically reported more than 50% of their activity in VIIa were decommissioned.

1.5.3 Fisheries in other areas covered by the WGNSDS

The fisheries in other areas covered by the WG are described in the relevant stock sections.

1.6 Enumeration of capacity and effort

An analysis of effort trends in divisions VI and VIIa is presented in Section 17 of this report.

1.7 Regulations

1.7.1 TAC regulations

The Regulations specifying Total Allowable Catches (TAC) by species and management area for stocks assessed by WGNSDS are as follows:

	Council Regulation (EC) No:	2848 / 2000	2555 / 2001	2341 / 2002	2287 / 2003	27 / 2005	51 / 2006	41 / 2006
Stock	Management Area	2001 TAC	2002 TAC	2003 TAC	2004 TAC	2005 TAC	2006 TAC	2007 TAC
Cod	Vb $^{\alpha}$, VI, XII, XIV	3700	4600	1808	848	721	613	490
	VIIa	2100	3200	1950	2150	2150	1828	1462
Megrim	Vb $^{\alpha}$, VI, XII, XIV	4360	4360	4360	3600	2880	2880	2880
Anglerfish	IIa $^{\alpha}$, IV $^{\alpha}$	14 130	10 500	7000	7000	10 314	10 314	11 345
	Vb $^{\alpha}$, VI, XII, XIV	6400	4770	3180	3180	4686	4686	5155
Haddock	Vb, VI $^{\alpha}$, XII, XIV	13 900	14 100	8675	~	~	~	~
	Vb, VIa	~	~	~	6503	7600		7200
	VIb $^{\alpha}$, XII, XIV	~	~	~	702	702	597	4615
	VII, VIII, IX, X, CECAF 34.1.1.1 $^{\alpha}$	12 000	9300	8185	9600	11 520	11 520	11 520
	VIIa $^{\beta}$	2700	1300	585	1500	1500	1275	1179
Whiting	Vb $^{\alpha}$, VI, XII, XIV	4000	3500	2000	1600	1600	1360	1020
	VIIa	1390	1000	500	514	514	437	371
Plaice	VIIa	2000	2400	1675	1340	1608	1608	1849
Sole	VIIa	1100	1100	1010	800	960	960	816
Nephrops	VI, Vb $^{\alpha}$	11 340	11 340	11 340	11 300	12 700	17 675	19 885
Nephrops	VII	18 900	17 790	17 790	17 450	19 544	21 498	25 153

$^{\alpha}$: European Community waters, $^{\beta}$: Within the limits of the VII, VIII, IX, X and CECAF 34.1.1.1 TAC, no more than the quantity stated may be taken in Division VIIa.

1.7.2 Registration of buyers and sellers

Under Council Regulation (EEC) No 2847/93 of 12 October 1993 "establishing a control system applicable to the common fisheries policy", member states were requested to introduce legislation requiring that all fish buyers provide sales notes relevant to each purchase, which, amongst other information, details the species, weight, geographic origin, landing point of the landings and details of the vessel from which it was purchased. Article 9 of the regulation stipulates.

"Auction centres or other bodies or persons authorised by Member States, which are responsible for the first marketing of fishery products in a Member State shall submit, upon the first sale, a sales note to the competent authorities of the Member State in whose territory the first marketing takes place. The submission of the sales notes listing all data required under this Article shall be the responsibility of the auction centres or other bodies or persons authorised by Member States."

In effect, this has made it more difficult for buyers to handle misreported landings as they are now legally obliged to provide information on the source, which must correspond with the official landings declaration of the vessel. Failure to provide such information can result in legal action. Article 13 of the regulation states that:

> "Each Member State shall carry out control by means of sampling on its territory in order to verify that the obligations established by this Article are being respected. The intensity of such controls may take account of the intensity of the controls in previous stages."

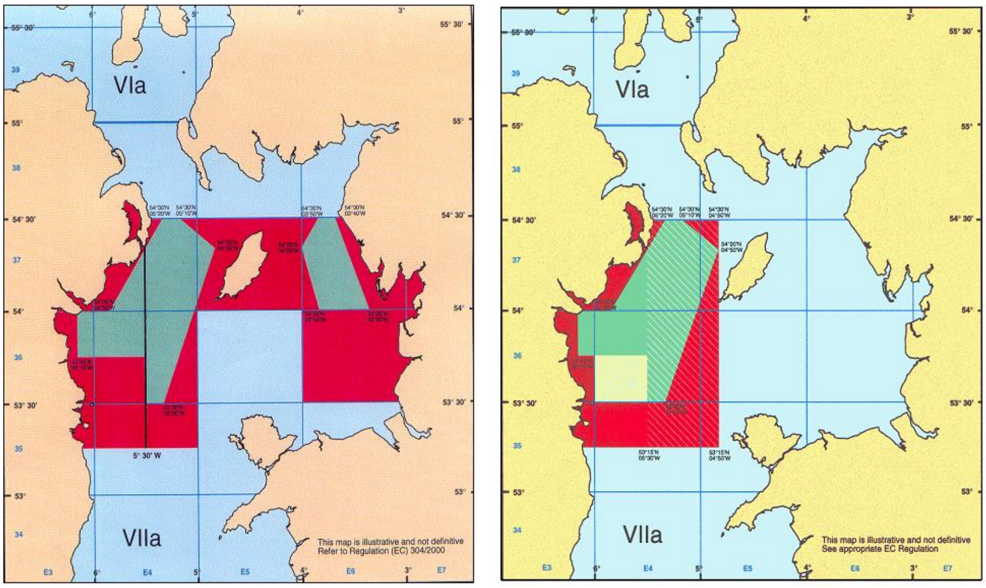
While this legislation has been implemented in a number of member states for some time, Statutory Instruments were only introduced into the UK and Ireland in recent years. While it is unlikely that this has eliminated the practice of underreporting of catches, information from both the UK and Ireland (WGFTFB, 2007) suggest that it has severely curtailed the practice, this in turn is likely to have improved the accuracy of reported landings in comparison to earlier years.

1.7.3 Other regulations

Area closures

Due to the depleted state of the stock and following the advice from ICES, a recovery plan for cod in the Irish Sea was introduced in 2000. Commission Regulation (EC) No 304/2000 established emergency closed areas to fishing for cod between 14 February and 30 April in the western and eastern Irish Sea to protect spawning adults at spawning time (Figure 1.1). Council Regulation (EC) 2549/2000, which came into force on 1 January 2001, with amendments in Council Regulation (EC) No 1456/2001, of 16 July 2001, established additional technical measures for the protection of juveniles.

The closed area in the Irish Sea and additional technical regulations were extended to 2001 in Council Regulation (EC) 300/2001 and to 2002 in Council Regulation (EC) 254/2002. The main difference in the recovery measures for 2002, onwards from those of 2001 is that a closed area remained only in the western Irish Sea time (Figure 1.1). Derogations have existed for fleets targeting *Nephrops* in all years.



2000 2001 – 2003

Figure 1.1. Maps of the Irish Sea (VIIa) closed areas for 2000–2003. The closed area is shaded red and the area open to *Nephrops* derogations is shaded green. The Western Irish Sea closure has continued in subsequent years.

Emergency measures were enacted in 2001 for the west of Scotland, consisting of area closures from 6 March–30 April, in an attempt to maximise cod egg production. These measures were retained into 2003 and 2004. A new closed area was implemented to the west of Scotland in 2004 under Council Regulation (EC) No 2287/2003.

In the west of Scotland there have been unilateral closures by Ireland of a traditional fishery for juvenile cod off Greencastle, Co. Donegal (Figure 1.3). From mid-September 2003 to mid-February 2004 (Irish Statutory Instrument (SI) No. 431 of 2003) closed the area. In December 2003 the closed area was extended along its eastern edge by amendment to the Statutory Instrument (SI No. 664 of 2003). Whilst the initial closure period officially ended in mid-February 2004, fishermen in the local trawl fleet imposed a voluntary exclusion to trawling within the boundaries of the closed area as described in SI 664 of 2003. These fishermen submitted signed declarations effectively banning trawling in the area from February 15th to July 1st 2004. A new Statutory Instrument (SI No. 670 of 2004) reinstated the closed area from 1st November 2004 until 14th February 2005. At a stakeholder meeting in October 2005 another official closure of the Cape grounds for the 2005–2006 season was agreed. A new Statutory Instrument (SI No. 700 of 2005) re-instated the closure of the Cape to all fishing methods from 14th November 2005 until 14th February 2006. Another period of tagging and recapture of cod on the Cape Grounds was undertaken in December 2005–January 2006.

These closures were instigated by the local fishing industry to allow an assessment of seasonal closure as a potential management measure. Over 13 000 cod have been tagged and released during the closures. Most of the cod catch during the closed period is normally taken in the fourth quarter. During 2000–2002 50% of the Irish catch weight of cod in VIa (61% by number) was taken in the fourth quarter. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003–2005. As the Greencastle codling fishery is a mixed demersal fishery, any benefits flowing from the closure are likely to extend to other demersal stocks.

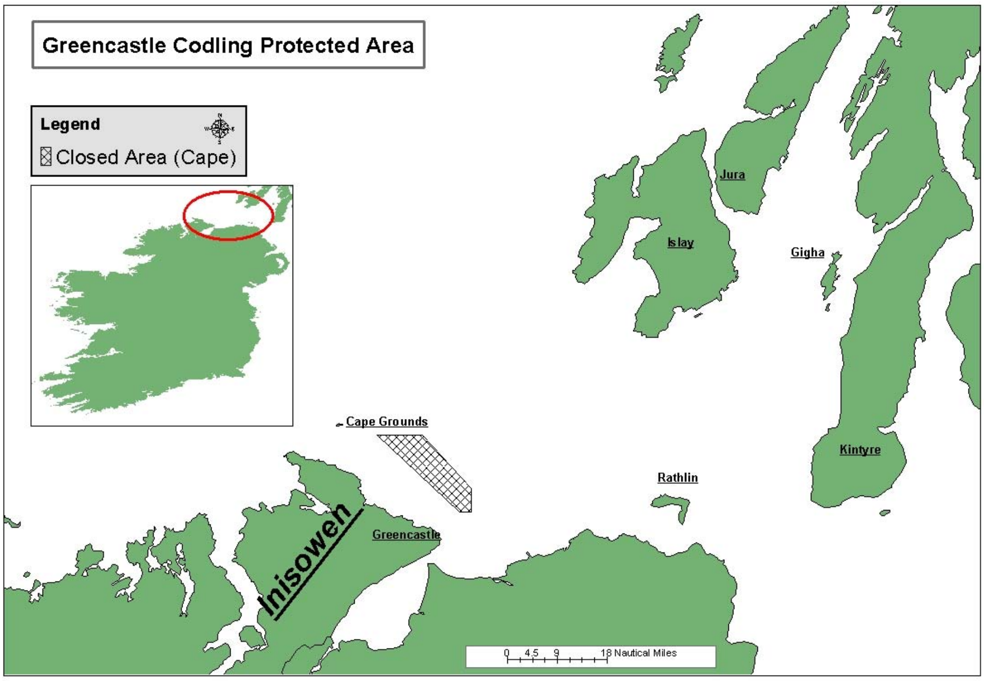


Figure 1.2. Location of the area closed by Irish Statutory Instrument in 2003–4 and 2004–5.

Effort limitation

Annex XVII to Council Regulation (EC) No 2341/2002 regulated fishing effort to the West of Scotland. The extent of effort limitation varied for particular gears. The maximum number of days in any calendar month for which a fishing vessel may be absent from port to the West of Scotland in 2003 was:

- 9 days for demersal trawls, seines or similar towed gears of mesh size ≥100 mm except beam trawls,
- 25 days for demersal trawls, seines or similar towed gears of mesh size between 70 mm and 99 mm except beam trawls, and,
- 23 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

The Regulation included a provision for additional days to be allocated on the basis of the achieved results of decommissioning programmes. A Commission Decision (C (2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. United Kingdom vessels were granted 4 additional days per month (based on evidence of decommissioning programmes). An additional two days was granted to demersal trawls, seines or similar towed gears (mesh ≥100 mm, except beam trawls) to compensate for steaming time between home ports and fishing grounds and for the adjustment to the newly installed effort management scheme.

Monthly effort limitation was extended to the Irish Sea (and other "cod recovery" areas) under Annex V to Council Regulation (EC) No 2287/2003. The restrictions for the West of Scotland and Irish Sea (per month) in 2004 were:

- 10 days for demersal trawls, seines and similar towed gears with mesh size >=100 mm,
- 14 days for beam trawls of mesh size >=80 mm and static demersal nets,
- 17 days for demersal longlines,

- 22 days for demersal trawls, seines and similar towed gears with mesh size 70–99 mm, and,
- 20 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

Additional days were available for vessels meeting certain conditions such as track record of low cod catches. In particular, an additional two days were available for whitefish trawlers (mesh >=100 mm) and beam trawlers (mesh >=80 mm) which spent more than half of their allocated days in a given management period fishing in the Irish Sea, in recognition of the area closure in the Irish Sea and the assumed reduction in fishing mortality on cod.

Council Regulation (EC) No 27/2005 further limited effort in the Irish Sea and West of Scotland (and other "cod recovery" areas). The restrictions for the West of Scotland and Irish Sea (per month) in 2005 were:

- 9 days for demersal trawls, seines and similar towed gears with mesh size >=100 mm,
- 13 days for beam trawls of mesh size >=80 mm and static demersal nets,
- 16 days for demersal longlines,
- 21 days for demersal trawls, seines and similar towed gears with mesh size 70–99 mm, and,
- 19 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

The maximum number of days per month for which demersal trawlers (mesh >=100 mm) may be absent from port was further restricted to 8 days for the West of Scotland, and 10 days for the Irish Sea. The additional effort available to Irish Sea demersal trawlers (mesh >=100 mm) and beam trawlers (mesh >=80 mm) was reduced to one day.

The effort regulations have provided an incentive for some vessels previously using >100 mm mesh in otter trawls to switch to smaller mesh gears, thus claiming a higher number of days at sea. After the implementation of EC Regulation No. 850/98 these vessels will also be required to target either *Nephrops* or anglerfish, megrim, and whiting, with various catch and by catch composition limits. No detailed information is available to quantify how many vessels have switched to using smaller meshes as a result of effort regulation as this information is not reliably recorded in the logbook information for some countries.

Recovery plans

Council Regulation (EC) No 423/2004, of 26 February 2004, established measures for the recovery of cod stocks. These include: Multi-Annual processes for selection of TAC's, restriction of fishing effort, technical measures, control and enforcement, accompanying structural measures and market measures. Council Regulation (EC) No 423/2004 formulated harvest control rules with reference to limit and precautionary reference points. For stocks above $\mathbf{B}_{\mathrm{lim}}$, the harvest control rule requires:

1) Setting a TAC that achieves a 30% increase in the SSB from one year to the next,

2) Limiting annual changes in TAC to ±15% (except in the first year of application), and,

3) A rate of fishing mortality that does not exceed $\mathbf{F}_{\mathrm{pa}}$.

4) For stocks below $\mathbf{B}_{\mathrm{lim}}$ the Regulation specifies that:

5) Conditions 1–3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application,

6) A TAC will be set lower than that calculated under conditions 1–3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application.

Gear regulation and other technical measures

New technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/1998 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Since 2001, cod in Division VIIa have been a legitimate target species for towed gears with a minimum codend mesh size of 100 mm.

The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) changed from 100 mm to 120 mm from the start of 2002. This came under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one-year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002. Cod are a bycatch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size of 80 mm, but landings are restricted through bycatch regulations. Since mid–2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

Regulation (EC) No 423/2004 required that fishing vessels give prior notification of their landing of more than one tonne of cod. Vessels carrying more than two tonnes of cod were also required to land only in designated ports. The permitted margin of tolerance in the estimation of quantities reported in the logbook was reduced to 8% of the logbook figure.

Council Regulation (EC) No 1928/2004, of 25 October 2004, amended Regulation (EC) No 2287/2003 in order to align the provisions for effort limitation, monitoring, inspection and surveillance with those in Regulation (EC) No 423/2004.

A corrigendum to Council Regulation (EC) No 867/2004 amended restrictions on fishing for cod in the West of Scotland in order to avoid unnecessary social and economic hardship. Fishing activities that do not catch cod were permitted within the area closed for cod fishing to the west of Scotland, with the provisions that these activities were clearly defined (shellfish, crustacean and pelagic fishing), enforceable, and did not cause an additional risk to the remaining stock of cod.

Other Regulations specific to particular stocks are described in the relevant stock sections.

1.8 Recent ICES advice in the context of mixed fisheries

1.8.1 Mixed fisheries advice for 2006

For West of Scotland mixed-species fisheries ICES gave the following advice for 2006 (ACFM report, October 2005):

"Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- without catch or discards of cod in Subarea VI;
- without catch or discards of spur dog;
- no directed fishery for haddock in Division VIb;
- concerning deepwater stocks fished in Subarea VI;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for <u>*all*</u> *those species individually, then fishing should not be permitted."*

For Irish Sea mixed-species fisheries ICES gave the following advice for 2006 (ACFM report, October 2005):

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- without bycatch or discards of cod and spur dog, and minimal catch of whiting;
- without jeopardizing the recommended reduction in fishing mortality of haddock;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually, then fishing should not be permitted."

1.8.2 Mixed fisheries advice for 2007

For West of Scotland mixed-species fisheries ICES gave the following advice for 2007 (ACFM report, October 2006):

Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should beapplied simultaneously:

They should fish:

- without catch or discards of cod in Subarea VI;
- with the lowest possible catch for whiting in Via;
- without catch or discards of spur dog;
- without jeopardizing the recommended reduction in fishing mortality of haddock in Division Via;
- concerning deep water stocks fished in Subarea VI, see Volume 9;
- within the biological exploitation limits for all other stocks (see table above).

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually, then fishing should not be permitted.

For Irish Sea mixed-species fisheries ICES gave the following advice for 2007 (ACFM report, October 2006):

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- without bycatch or discards of cod, sole, and spur dog, and with minimal catch of whiting;
- without jeopardizing the recommended reduction in fishing mortality of haddock;
- within the biological exploitation limits for all other stocks (see text table above).

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually, then fishing should not be permitted.

1.9 Recommendations

In consideration of the state of current assessments of WGNSDS stocks the Working Group recommends the following Stock Assignments for WGNSDS in 2008:

OBSERVATION LIST	BENCHMARK	UPDATE	EXPERIMENTAL	MONITORING
Cod VIa	Haddock VIa	Haddock VIb	Haddock VIIa	Megrim VI
Cod VIIa	Sole VIIa		Whiting VIa	Whiting VIIa
	Plaice VIIa		*Nephrops* FU 11/12/13/15	Anglerfish IIa, IIIa, IV & VI
			NephropsFU14	

1.9.1 WGNSDS recommendations regarding anglerfish

WGNSDS notes that anglerfish fisheries have recently developed in areas adjacent to those considered for assessment by the working group but that no assessment or management advice is provided for them. Given the considerable uncertainty regarding the stock dynamics and biological characteristics of this species and also its commercial importance, it is recommended that the collection of assessment data areas such as Subarea V.

1.9.2 WGNSDS recommendations regarding assessment methods

The assessment of many stocks considered by WGNSDS has become heavily reliant on methods that are either completely or partially independent of commercial catch data. Whilst in many cases such methods have been, and continue to be considered appropriate, it has become apparent that for some stock conditions the models are less applicable. It is not clear to many in the working group how such models might be expected to respond to specific stock conditions such as highly truncated age ranges or large changes in fishing effort from one year to another. WGNSDS recommends that a much more comprehensive evaluation of catch free assessment methods be undertaken that will investigate the behaviour of the methods given a wide range of potential stock and fishery situations. The problem of how to predict future landings from such assessments is another issue that remains to be resolved. It is unlikely that such an investigation will be undertaken by WGMG and a separate study group may be required to specifically address these issues.

1.9.3 WGNSDS recommendations regarding unaccounted mortality

The catch independent assessment methods available to WGNSDS provide estimates of total mortality and total removals from the fishery. These estimates include all sources of mortality and it is not possible to disaggregate them into estimates of fishing mortality and mortality resulting from other processes. Information contained in recent reports on the predation of demersal fish stocks by marine mammals suggests that the currently adopted fixed value of $0.2yr^{-1}$ for natural mortality may not be appropriate. WGNSDS therefore recommends that a specific study group should be formed to investigate potential trends in predation mortality similar to the Study Group on Seals that currently investigates such issues in Canadian waters.

1.9.4 A note from the chair of WGNSDS

In recent years the WGNSDS has found it difficult to adequately address its terms of reference. In spite of a number of measures introduced to assist working groups in reducing their workload the situation appears to be getting worse rather than improving. The fundamental problem appears to be the timely provision of data that would allow sufficient work to be conducted prior to the meeting. At this, and previous years meetings the presentations of preliminary analyses for several stocks have been delayed to allow data to be worked up and initial assessment runs to be conducted. The preliminary analysis is a crucial stage in the assessment process and should not be rushed. All too often an assessor that has not had sufficient opportunity to become adequately familiar with their data will not be able to present to the working group all of the issues that are necessary for the group to make consistent and informed decisions about the assessment. These issues are often discovered later in the meeting during the text read-through by which time it is often too late to reverse or amend decisions. An associated problem with delayed submission of data is that many of the assessments then proceed at different rates. It can become almost impossible for the group to take a consistent approach to specific issues when every assessment is running to a different schedule. Timely provision of data and adequate preparation before the meeting would improve this situation considerably.

With the proposed changes to the assessment working group schedules such that all groups will in future meet earlier in the year, it is difficult to envisage any improvement in the timely provision of data for next year. The close proximity of WGNSSK, WGHMM and WGNSDS has stretched resources this year and if WGSSDS is brought forward next year the situation might be expected to deteriorate further.

Another issue affecting the performance of the working group is the level of familiarity and understanding of the methods and associated software employed to assess the stocks. This appears to be deteriorating rather than improving. The WGNSDS has, over the years, taken a progressive approach to adopting and applying new assessment techniques and this is to be encouraged. However, when only a small number of the group fully understand the dynamics of the assessment model, discussion of the results and diagnostics may be limited to just a few individuals. Worse still, the group may be unable to discuss the issue at all. There is therefore a clear requirement for further training in certain areas of advanced assessment techniques and a replacement to the now discontinued WKAFAT training course should be considered.

At the end of the meeting the group briefly discussed the issues that it considered to be priorities for 2008. Three specific topic areas were identified.

- **Method testing**: As discussed in Section 1.9.2 there is an urgent requirement for more comprehensive testing of assessment models under a range of potential stock and fishery scenarios.
- **Discard information**: For some stocks the absence of discards from the assessment represents a significant omission. Information on discards often represents short time-series of patchy sampling. The appropriate raising of discards information to international fishery levels and their incorporation into assessments is a difficult and as yet unresolved problem.
- **Simulation of Management Strategies**: In order to move away from annual assessments and to better identify those assessments requiring greater attention the group proposes to evaluate the sensitivity of management advice to the assessments and their underlying uncertainty.

2 Data and methods

The stocks within the remit of this Working Group are tabulated in Table 2.1 along with the type of assessment carried out and an indication of whether this reflects a change to previous practices.

Table 2.1 2007 Working Group on the Assessment of Northern Shelf Demersal Stocks.
Summary of past and current practices for stock assessment.
SPALY denotes that the Same Procedure As Last Year was used.

	Working Group:					
Stock:	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Division IIa, III, IV and VI						
Anglerfish	Catch-at-size analysis	SPALY	No assessment	No assessment	No assessment	No assessment
Division Via (FU 11, 12 & 13 for *Nephrops*)						
Cod	TSA, short- & medium-term predictions	SPALY	Modified TSA & XSA assessments	SURBA	TSA, no catch 1995-	SPALY
Haddock	TSA, short- & medium-term predictions (& discards)	SPALY	Modified TSA & XSA assessments	SURBA (compared to update of XSA, TSA)	TSA, no catch 1995-	SPALY
Whiting	TSA, short- & medium-term predictions (& discards)	SPALY	Modified TSA & XSA assessments	SURBA (compared to update of TSA)	SURBA	SPALY
Megrim	Separable VPA	SPALY	Collie-Sissenwine Analysis	No assessment	No assessment	No assessment
Nephrops	XSA, Trend analysis	SPALY	No assessment	TV Survey	TV Survey	No assessment
Division VIb						
Haddock	XSA, short-term predictions	No assessment	No assessment	XSA including discards	SPALY	SPALY
Division VIIa (FU 14 & 15 for *Nephrops)*						
Cod	XSA, short- & medium-term predictions	SPALY	XSA & TSA assessment	SURBA	B-Adapt	B-Adapt
Whiting	XSA, short-term predictions (& discards)	SPALY	No assessment	No assessment	No assessment	No assessment
Haddock	XSA, short-term predictions	SPALY	XSA, TSA, SURBA assessments	SURBA	SURBA	SURBA
Plaice	XSA, short- & medium-term predictions	SPALY	ICA, short-term projections	SPALY	SPALY	SPALY
Sole	XSA, short- & medium-term predictions	SPALY	SPALY	SURBA, FSSSPS for forecast	XSA	XSA, short- & medium-term predictions
Nephrops	XSA, Trend analysis	SPALY	No assessment	No assessment	TV Survey	No assessment

2.1 Catch data

2.1.1 Official landings

The Coordinating Working Party on Fishery Statistics (CWP) coordinates collection of nominally reported catch statistics under the STATLANT programme. The website was accessed through http://www.ices.dk/fish/statlant.asp and used to obtain official catch statistics up to 2006.

2.1.2 Misreported landings

The WG has included misreported landings within the "unallocated" landings figures reported for each stock. These unallocated landings represent adjustments to nominal landings figures to correct either for misreporting or for differences between official statistics and data obtained by national scientists. The general term misreporting is used throughout this report to include misreporting by area, misreporting of landings by species and under- or over-reporting of landings.

The main inadequacy in landings data available to WGNSDS is the unknown level of misreporting. Anecdotal information provided by fishermen from several countries indicates that under-reporting of landings of some species has been widespread and significant, particularly for stocks with restrictive TACs. Furthermore there has been evidence of over-reporting of landings of some species for which TACs are not set, or are not restrictive. Mis-allocation of landings into other TAC areas is also known, although the WG has attempted to correct for this where possible: for example Irish Sea cod and Celtic Sea cod.

Previous assessments of some WGNSDS stocks have included estimates of landings by one country based on a quayside survey of landings rather than official log-book data. This resulted in substantial unallocated catches implying significant misreporting, and this was identified by ACFM as a major concern. The Annual Meeting of Assessment Working Group Chairs (AMAWGC) (ICES, 2005) advised that it is no longer acceptable to make estimates of mis- and non-reporting and make corrections to catch data without revealing the sources of both the data and the problems. The Terms of Reference request the WG to provide information on the distribution of misreporting and the methods used to obtain information on misreporting.

As the misreporting estimates used previously by WGNSDS are for one country only, and there is evidence that the practice is more widespread, the WG cannot provide the transparency requested by AMAWGC. However, the absolute values of landings and landings at age, based on reported catches, are considered too biased in recent years to allow an analytical catch-based assessment without a procedure to allow for the potential bias. As the bias can be manifest in apparent trends in survey catchability, WGNSDS has this year adopted assessment methods for west of Scotland and Irish Sea cod, and west of Scotland haddock, that combine the full time-series of survey data with fishery data from an earlier period (also covered by the surveys) when the landings data are considered relatively unbiased. The methods (B-ADAPT and TSA) effectively scale the survey indices to the absolute population estimates derived from the period of un-biased fishery data. The TSA method applied to VIa stocks excluded all fishery data from the estimation from 1995 onwards, whereas the B-ADAPT method applied to Irish Sea cod estimated the bias in total removals from 2000 onwards, but retained the relative age composition data from the fishery. Both methods provide estimates of the total annual removals for a recent period (in excess of the assumed M) consistent with removing any trends in survey catchability. However, the figures may include additional discards or natural mortality as well as any misreported landings.

The history of WG attempts to quantify misreporting is given in the 2000 WG report (ICES CM:2001/ACFM:01). A summary of past practices is given below.

Stocks in subarea VI

Previous Working Groups had expressed a view that misreporting of area VI gadoids had not been significant because of low availability of fish relative to quotas. However, recent Working Groups have not been able to make an informed judgement on misreporting of area VI gadoids. Values for misreported landings of VIa haddock in 1992–1994, inferred from survey data, are given in ICES CM 1996/Assess:1 and ICES CM 1997/Assess:2.

For anglerfish and megrim in Division VIa the existence of a restrictive precautionary TAC in Division VIa but no catch restrictions in the adjacent areas of the North Sea up until 1998 is suspected to have led to extensive reporting of catches from VIa into IVa. Such an effect is apparent in the reported distribution of catches by one nation where catches of anglerfish and megrim reported from the statistical rectangles immediately east of the 4°W boundary (the E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of these species. This proportion has reached up to 57% in the case of anglerfish and 75% in the case of megrim. As it is strongly suspected that the large majority of catches reported from the E6 squares are actually taken in Division VIa the landings totals used in previous assessments of these stocks had been corrected for this effect. The correction was applied by first estimating a value for the true catch in each E6 square and then allocating the remainder of the catch into VIa squares in proportion to the reported catches in those squares. The 'true' catches in the E6 squares were estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean was calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares.

Stocks in division VIIa

Misreporting of cod, haddock and whiting in the Irish Sea has occurred during the 1990s due to restrictive quotas. This has mainly taken the form of misreporting between VIIa and surrounding regions (mainly from the Celtic Sea into the Irish Sea), and misreporting of species compositions (both over- and under-reporting). Reported (official) landings data from one country taking a significant part of the international catch have in the past been adjusted at source for area-misreporting based on local knowledge of fleet activities. Landings at three ports have been estimated since 1991 using a sampling method based on observations made by scientists taking length measurements in the ports. The total landings are estimated either by raising the mean observed catch per landing to total number of landings (by port and gear type) where at least one of the species was reported, or (in some earlier years) adjusting the reported landings by the ratio of observed to reported landings. Further details are given in ICES CM 1999/ACFM:1.

The sample-based estimates of landings at official fish markets exclude any "black" landings made at non-designated ports or times and correct only for misreporting of species compositions. Possible increases in black landings may have occurred in the more recent years when some TACs have been set to achieve substantial reductions in fishing mortality without effective mechanisms for controlling fishing effort to the necessary extent. This is of concern not only for the accuracy of the assessments, but also for the appropriateness of assessment methods such as XSA in which survey and commercial cpue data are evaluated against population numbers reconstructed from commercial catch data (see also Casey, J: Working Document 5; 2002 meeting of WGNSSK ICES CM 2003/ACFM:02). Concerns about the incompleteness of the sample-based landings estimates has resulted this year in the landings of cod from 2000 onwards being treated as biased in a B-ADAPT analysis, although the relative age composition data are retained.

2.1.3 Discards

Implementation of the EU Data Collection Regulation (Commission Regulation (EC) No 1639/2001) has resulted in some discard data being available for most stocks within the scope of WGNSDS. High grading is suspected in some stocks, although its significance has not been possible to estimate.

Unfortunately, the inclusion of new series of discard data in stock assessments is not straightforward. Available discard data are highly variable. The discarding behaviour can change according to fleet, areas, time and importance of a year class. Raising protocols to estimate the total volume of discards in a given stock differ between countries. Sampling and raising procedures therefore need to minimise bias and maximise precision. Unfortunately, it is still difficult to determine the accuracy (or bias) in most discard estimations as raising procedures still rely upon commercial logbook information which suffers from misreporting.

Several methods have been developed to estimate discards of young commercial fish species. These can be considered in two groups; direct and indirect methods of estimation (Sokolov, 2003). Direct methods are based on the measurement of fish directly onboard the fishing vessels (Hylen, 1967; Hylen and Smedstad, 1974; Jermyn and Robb, 1981; Tamsett, 1999). Indirect methods use other data sources and assumptions to calculate discards:

- quantitative estimation of small fish discards can be done on the basis of comparison of length measurements by onboard observers and shore-based sampling of landings (Palsson *et al.*, 2002; Palsson, 2003, Sokolov, 2003),
- results from studies of fishing gear selectivity followed by recalculation of the reported catch (DingsOr, 2001, Matsushita and Ali, 1997),
- analysis of catch length frequencies on the assumption that all fish shorter than a certain length are discarded (Sokolov, 2001),
- interviewing of skippers on their return to harbour and analysis of their reports,
- data provided by skippers directly at sea for a small consideration (Jermyn and Hall, 1978).
- Estimates of discards for Rockall haddock use a gear selectivity ogive applied to survey length frequency distributions for years with no direct observations of dicard rates. The resultant length frequencies are then scaled up to fishery landings.

The choice of one or another method to estimate discards depends on the availability and completeness of initial data. Each stock section includes further comments on available discard data.

2.1.4 Irish Sea enhanced data collection programme

In recent years, the perception of Irish Sea stocks differs between scientists and industry largely due to the degree of uncertainty associated with assessments. In recognition that this is a consequence of poor quality catch data, the Irish and UK industry, through the North Western Waters Regional Advisory Council and with support from both the UK and Irish fisheries administrations and scientific laboratories, have proposed to the EC an enhanced data collection programme and fisher self sampling and enhanced observer sampling programme for the Irish Sea. This programme aims to improve the quality (precision) of catch and discard data, as well as instilling industry confidence in the assessment process, which is currently lacking.

The specific objectives of the programme are:

- Obtain estimates of total catches (removals) of key Irish Sea fish stocks which are sufficiently accurate that they can eventually be used in annual ICES stock assessments.
- Engage the fishing industry in the collection of high resolution data collection.
- Improve precision of current DCR discard programme in ICES area VIIa through enhanced DCR coverage and provision of high resolution effort and total catch data for improved discard raising procedures.
- Provide higher resolution spatial and temporal discard data to assist in developing appropriate discard mitigation strategies for the Irish Sea.
- Link with and enhance existing national and EU programmes e.g. Discard Atlas; EU pilot project on discard implementation issues (FISH/2006/15); English and Irish discard mapping programme.

- Provide a suitable case study to investigate the relationship between fishing effort, gear design and fishing mortality (ICES, 2007).

The UK and Irish administrations obtained agreement at the 2006 December Council of Ministers meeting, that such a programme should be permitted and that additional days at sea allocations (12 days 70–99 mm and 6 days 100 mm+) should be allocated to vessels participating in the programme. The programme is currently awaiting full approval from the European Commission, but is anticipated that this programme will commence in June 2007.

2.2 Biological sampling

Table 2.2 shows which countries provided assessment data to the Working Group for the year 2004 and the form of data provided. An increased amount of discard data was provided to the WGNSDS, 2005 for several stocks. The level of sampling in 2004 for core assessment data (numbers of samples, length measurements and age-length keys) is indicated in Table 2.3, where data were available for individual countries. Unfortunately estimation of the intensity of sampling (through comparison with the total international landings) was not possible for most stocks at WGNSDS, 2005. Deficiencies in sampling (if any) are discussed in the relevant stock section.

Table 2.2 2007 Working Group on the Assessment of Northern Shelf Demersal Stocks. A summary of countries from which 2006 assessment data was provided for the stocks covered by WGNSDS.

Data	Cod			Haddock			Whiting			Plaice	Sole	Megrim		Anglerfish					*Nephrops*				
	VIa	VIb*	VIIa	VIa	VIb	VIIa	VIa	VIb*	VIIa	VIIa	VIIa	VIa	VIb	VIa	VIb	IIa	IIIa	IV	FU11	FU12	FU13	FU14	FU15
Catch weight (main exploiters)	E&W NI No Sc IR F	E&W IR Sc	B E&W Fr IR IoM NI Sc	E&W Fr IR NI No Sc G	E&W IR No R Sc FI	B E&W IR NI Sc Fr	Sc E&W NI IR	E&W IR Sc	B E&W IR NI	B E&W Fr IR NI Sc	B E&W Fr IR NI Sc	Fr IR Sc	Fr IR Sc	E&W IR NI Sc	IR Sc B	No	Dk No	B Dk E&W No Sc	Sc	Sc	Sc	E&W IR NI	E&W IR NI
Catch length	IR Sc		E&W IR NI	Sc	IR R Sc	IR NI	Sc		IR NI	E&W IR NI	B E&W IR	IR	IR	IR Sc	IR Sc	No		Dk No Sc	Sc	Sc	Sc	E&W	IR
Catch ALK	IR Sc		E&W IR NI	Sc	IR R Sc	IR NI	Sc			E&W IR B	B E&W IR	IR	IR										
Catch wt-at-age	IR Sc		E&W IR NI	Sc	IR R Sc	IR NI	Sc			E&W IR B	B E&W IR	IR	IR										

Table 2.2 (continued).

Data	Cod			Haddock			Whiting			Plaice	Sole	Megrim		Anglerfish					*Nephrops*				
	VIa	VIb	VIIa	VIa	VIb	VIIa	VIa	Vib	VIIa	VIIa	VIIa	VIa	VIb	VIa	VIb	IIa	IIIa	IV	FU11	FU12	FU13	FU14	FU15
Discard weight	Sc IR		E&W	Sc		IR NI	Sc		IR	IR E&W									Sc	Sc	Sc	E&W	IR
Discard length	Sc IR		E&W	Sc		IR NI	Sc		IR E&W NI	B IR E&W	B E&W								Sc	Sc	Sc	E&W	IR
Discard ALK	Sc IR		E&W	Sc		IR	Sc		IR														
Effort	IR		E&W IR NI	IR Sc	R IR Sc	IR NI	IR Sc		E&W IR NI	B E&W IR	B E&W IR	IR	IR	Sc NI IR E&W	Sc IR		Dk	E&W Sc Dk	Sc	Sc	Sc	E&W IR	E&W IR NI
CPUE	IR		E&W IR NI	IR Sc	R IR Sc	IR NI	IR Sc		E&W IR NI	B E&W IR	B E&W IR	IR	IR	IR Sc	IR Sc		Dk	Sc Dk	Sc	Sc	Sc	E&W IR	E&W IR NI
Survey indices	IR Sc		E&W IR NI Sc	IR Sc	Sc	IR NI	IR Sc		E&W NI	E&W	E&W	IR		Sc**	Sc**			Sc**					

*=No assessment, **=preliminary

B: Belgium, Dk: Denmark, E&W: England and Wales, Fr: France, G: Germany, IBTS: Combined IBTS data, IR: Republic of Ireland, IoM: Isle of Man, NI: Northern Ireland, No: Norway, NL: Netherlands, Sc: Scotland, Sp: Spain, Sw: Sweden, R: Russian Federation, FI: Faroe Islands

Table 2.3 2007 Working Group on the Assessment of Northern Shelf Demersal Stocks.
Biological sampling levels by stock and country:
Number of fish measured (Length) and aged (Age) from catches in 2006.
Number of samples is shown beneath the sample type in (brackets).
Data submitted by fleet/fishery are shown in **bold** type.

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Cod:																
VIa (landings)									**4 (1)**		**89 (2)**	**9 (1)**			3,414	1,425
VIa (discards)															588	444
VIb (landings)															119	94
VIIa (landings)					**1,275 (11)**	**216**			**4,999 (109)**	**350 (9)**	**2,808 (58)**	**924 (42)**				
VIIa (discards)					S				3 (11)		11 (5)	1				
Haddock:																
VIa (landings)									**443 (3)**						13,439	2,859
VIa (discards)															5,608	990
VIb (landings)							**1,743 (25)**	**149 (7)**			**211 (2)**	**121 (2)**	**44,281 (150)**	**800 (32)**	5,121	594
VIb (discards)																
VIIa (landings)									**6,762 (72)**	**240 (7)**	**2,808 (58)**	751 (24)				
VIIa (discards)									1,327 (11)		1,404 (5)	84				
Whiting:																
VIa (landings)															5,170	1,213
VIa (discards)															4,890	828
VIIa (landings)											**163 (3)**					
VIIa (discards)					S				2,678 (11)		2,520 (5)	122				
Plaice:																
VIIa (landings)	**11,551 (7)**	**547 (8)**			**3,493 (22)**	**574**			**1,332 (11)**		**4,345 (37)**	**586 (21)**				
VIIa (discards)	**S**	**S**			S	S					319 (5)	46				
Sole:																
VIIa (landings)	**13,261 (8)**	**740 (8)**			**4,336 (39)**	**889 (39)**					**95 (22)**	**133 (8)**				
VIIa (discards)	**S**	**S**			S	S					6 (5)	1				

Table 2.3 (continued).

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation [b]		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Megrim:																
VIa (landings)											**380 (3)**	**84 (3)**			*15,496*	*550*
VIa (discards)															*1,820*	
VIb (landings)											**96 (1)**					
VIb (discards)																
Anglerfish [c]:																
IIa (landings)							**2,185 (213)**									
IVa & IIIa (landings)			**1,161 (29)**				**653 (159)**								*16280* [IV]	*785* [IV]
IVa & IIIa (discards)			**81 (9)**												*1007* [IV]	*0*
VIa (landings)											**114 (3)**				*6,030*	*653*
VIa (discards)															*0*	*0*
VIb (landings)																
VIb (discards)																
Nephrops																
FU11 (landings)															**18,151**	
FU11 (discards)															**9,034**	
FU12 (landings)															**18,602**	
FU12 (discards)															**14,616**	
FU13 (landings)															**2,160**	
FU13 (discards)															**2,823**	
FU14 (landings)					**1,154 (4)**											
FU14 **(catches)**					**766 (5)**											
FU15 (landings)											**9,651 (13)**					
FU15 (discards)											**11,355 (13)**					

[a]: Norwegian sampling is carried out at sea, sampling the catch. Includes samples from Danish vessels operating in Norwegian EZ.

[b]: Russian sampling is carried out at sea, sampling the catch. Survey data included

[c]: Only *Lophius piscatorius* are aged.

S: Samples were collected and data was presented to the WG, but information on numbers of age & length samples was not available.

[IV]: Samples from the North sea (Sub-area IV) only.

2.2.1 Compilation and aggregation of catch data

Institutes submitted data to the WGNSDS, 2006 in similar formats to that previously provided. Increasingly formats that may better support mixed-fisheries analyses and assessments are used. For stocks in Divisions VIa and VIIa catch-at-age data have been provided by most countries by fleet/fishery and species rather than by stock. The fleet/fishery groupings used are consistent with those agreed by the SGDFF, 2004 for demersal fisheries in VIa and VIIa. Institutes sometimes did not have sufficient sampling to support disaggregation into fleet specific catch-at-age datasets. In such cases the data co-ordinators allocated the most appropriate alternative age compositions and weights-at-age to the unsampled catch.

The assessment data files are retained on the ICES network in the ASCII format used by the stand-alone assessment packages. All revisions to these files for individual stocks are discussed in the separate stock sections.

The stocks assessed by WGNSDS can be split into groups for which different data compilation and aggregation procedures are used. These groups are the Area VI gadoids, the Irish Sea gadoids, the Irish Sea flatfish, and the *Nephrops* stocks. For the other stocks assessed by this WG, assessments are generally at a more preliminary stage and data compilation had been on a more *ad hoc* basis.

UK (Scotland) data issues–2005

Two important developments occurred in 2005 that have strongly influenced the availability of Scottish fisheries data relating to that year. These developments and their implications for Scottish data for 2005 are discussed below:

<u>Log book database</u>

Fisheries log-book data for Scotland are collected via local fishery offices which populate the Scottish Fishery Information Network database (FIN) electronically FIN is a system operated by Scotland’s fishery protection agency and central fisheries administration. Partially-aggregated information from FIN is routinely transmitted to the FRS Marine Laboratory for entry into its own database.

The introduction into Scotland of Statutory Instrument 2005 No. 286 (The Registration of Fish Sellers and Buyers and Designation of Auction Sites (Scotland) Regulations 2005) meant that FIN had to be modified to account for the enhanced statutory fish-landing reporting requirements under the new regulation. The updated version of FIN went live on 1 September 2005, coinciding with the formal commencement of the enhanced reporting requirements.

It became apparent that under the new version of FIN, not all fishing landings records within FIN were being transmitted to FRS with ICES rectangle data associated with them (but only for data from 1 September onwards). On transfer to the FRS database system, records without this information were rejected. Consequently the Scottish market and discard sampling data could only be applied directly to those records that were accepted by the FRS system. FRS was in a position to know the quantity of landings that were rejected (by species and ICES Division), and so, with the exception of *Nephrops* data, the overall Scottish age compositions have been inflated by these amounts when compiling the international datasets for use by the working group. It was not possible to account for such discrepancies for *Nephrops* because of the multiple functional units that exist within ICES Divisions.

FRS has been assured that the FIN ‘problem’ will be addressed shortly and in a way that should permit revisions of the data supplied to FRS since 1 September 2005. When this happens, Scottish age compositions, *etc.* will be revised.

<u>FRS database</u>

IIa, IIIa, IV & VI anglerfish

Data are supplied to the stock co-ordinators electronically. Data handling and aggregation is handled by standard spreadsheets that incorporate SOP checks at each stage. The files retain the full seasonal and gear disaggregation of the supplied data. Length compositions for landings where no length data are supplied are estimated using user-specified fill-in rules. Assessment files are updated manually and data are stored in spreadsheets with one worksheet per year.

Area VI gadoids

Data are requested by the stock co-ordinator in electronic form in a specific format, although the format is not always adhered to by the Institutes submitting data. The data are then stored in ASCII files that retains the quarterly and gear disaggregation in which the data are supplied. At present the file handling and data aggregation are done by a series of BASIC programs. The programs do not perform any checks on the data. SOP-correction is optional, but is usually applied to ensure consistency given SOP discrepancies in some fleets in the early years of the data. Age compositions for landings where no age data are supplied, are normally estimated using the total age composition across all fleets for which age data are available. More appropriate age compositions and weights-at-age can be allocated to the unsampled catch but this process has to be done externally to the data aggregation program. The programs write a complete set of assessment data files so it is straightforward to update the assessment data each year.

Irish Sea gadoids and area VI Megrim

Data are supplied to the stock co-ordinators electronically. Data handling and aggregation is handled by standard spreadsheets which incorporate SOP checks at each stage. The files retain the full seasonal and gear disaggregation of the supplied data. Age compositions for landings where no age data are supplied are estimated using user-specified fill-in rules. Assessment data files are updated manually. Data are stored in spreadsheets, with one worksheet per year.

Irish Sea flatfish

Data are supplied to co-ordinators electronically, and the data handling and aggregation is handled by a series of spreadsheet macros. Some SOP checking is included in these macros. Raw data are not routinely SOP corrected, although SOP corrections are applied to the combined and smoothed total international weights-at-age. The files retain the full seasonal and gear disaggregation of the supplied data. Age compositions for landings where no age data are supplied are estimated using user-specified fill-in rules. The data for one year are stored in an individual spreadsheet file, making it less straightforward to update data for all years. The process includes independent checking of the data by two people.

Nephrops in management area C (West of Scotland)

These fisheries are conducted predominantly by Scotland, and catch data is not provided by other countries. Quarterly length distributions by sex (raised to Scottish *Nephrops* trawler landings) are compiled, and stored in an annual data sheet. These are combined with quarterly discard files in an in-house data aggregation programme, to generate annual length distributions of removals in a single file. For catch-at-age analysis this data file is then sliced with the WGNEPH programme L2AGE, which generates the Lowestoft input files.

Nephrops in management area J (Irish Sea)

Irish Sea *Nephrops* fisheries are conducted mainly by Ireland and the United Kingdom with Northern Ireland taking over 60% of the catch from the western fishery (FU15). A lack of co-operation by the Northern Ireland industry prevented sampling during 2003 and 2004. Quarterly length distributions by sex from Ireland were therefore raised to the international

Nephrops trawler landings and stored in an annual data sheet. These were combined with quarterly discard files, to generate annual length distributions of removals in a single file. For catch-at-age analysis this data file was then sliced with the WGNEPH programme L2AGE, which generates the Lowestoft input files.

2.3 Biological parameters of stocks

Previous ACFM reviewers have commented on the different methods used by the WG to estimate stock weights, and have been particularly concerned at using catch weights as the proxy for stock weights. The declining abundance and age composition in heavily exploited gadoids means that weights-at-age may be poorly estimated for the older ages where few fish may be represented in the age length keys for the catches. This adds unnecessarily to the uncertainties in mean weight-at-age in the forecast, both for catch and stock. In cases where catch (or even worse, landings weights) for partially recruited ages are used as stock weights, the biomass will be over-estimated for these ages. This can lead to incorrect total biomass estimates.

There is a need for this (and presumably other WGs) to develop a consistent methodology for (a) dealing with the variability introduced by small numbers of fish at the older ages in ALKs and (b) to develop robust and consistent methods for estimating stock weights that are not influenced unduly by sampling error and that track real changes in growth of different year classes.

The interaction between maturity ogives and stock weights influences the estimation of reference points for spawning stock biomass. The maturity ogives for some of the stocks assessed by the WG have remained unchanged for many years and may no longer be appropriate. The ogives for Irish Sea cod, plaice and sole were revised following sampling carried out as part of an EU contract to estimate SSB using the annual egg production method. However, the use of these ogives for the full historic series may not be appropriate, particularly in view of the large changes in stock size over time.

Biological data collected under the EU Data Collection Regulation (Comm. Reg. (EC) No 1639/2001) is now being submitted to the WGNSDS Biological data on stocks only partially within EU waters is also being provided. The WG recommends that a comprehensive review of the biological parameters of the stocks should be carried out, including analysis of recent survey data and an evaluation of the information (if available) on which historic estimates have been based.

Biological parameters may be poorly estimated when the declining abundance and contracting age composition of heavily exploited stocks means that few fish could be sampled. The WGNSDS considers that this problem may be alleviated through co-ordinating sampling of fisheries Institutes. WGNSDS notes that a provision exists within the Data Collection Regulation encouraging an improvement in the precision of the estimation of biological parameters through co-operation between EU Member States.

2.4 Fleet catch per unit effort data

Most of the Commercial cpue fleet data provided to the Working Group are described in Appendix 1 and 2 of the report of the 1999 Northern Shelf Demersal Working Group. Some new series were described in the 2002 WG Report (ICES CM 2003/ACFM:04). The geographical areas covered by these fleets in relation to the stock assessment areas are presently being incorporated into the Stock Annexes. These annexes will eventually include descriptions of commercial fleet tuning series, including areas covered, sampling protocols and a time-series of commercial vessel effort distribution for the main gears used in the fishery.

2.5 Fishery-independent surveys

The poor quality of catch information has forced an increased reliance on fishery-independent data at WGNSDS. Some of the survey-based assessments rely heavily on estimates of year class strength from survey data with relatively high variance. The low number of young cod caught by surveys in Division VIa indicates very low catchability of small recruiting year classes on these surveys. At such levels of catchability the survey estimates are highly variable and heavily influence survey-based assessments.

Most surveys providing data to the Working Group are described in Appendix 1 and 2 of the report of the 1999 Northern Shelf Demersal Working Group. The first four years of a new survey series for the Irish Sea (cod, haddock, whiting, plaice and sole) and West of Scotland (Cod, Haddock, Megrim and Whiting) were provided to the WG this year from the Irish (RV *Celtic Explorer*) Quarter 4 IBTS survey. A description of the Underwater Television surveys (UWTV) used for *Nephrops* stocks is given in Section 2.5.1.

Data from series of industry-science collaborative surveys of Irish Sea cod, haddock and whiting, carried out since 2004 under the UK Fisheries Science Partnership are also available to the working group. A Scottish industry-science collaborative survey for anglerfish is also available.

The geographical areas covered by the surveys in relation to the stock assessment areas are presently being incorporated into the Stock Annexes. These annexes will eventually include descriptions of the surveys, including their spatial coverage, sampling protocols and the temporal and spatial trends in distribution and abundance of target species.

2.5.1 Underwater TV surveys for *Nephrops*

Nephrops is a mud-burrowing species that is protected from trawling while within its burrow. Burrow emergence is known to vary with environmental (ambient light level, tidal strength) and biological (moult cycle, females reproductive condition) factors. This means that trawl catch rates may bear little resemblance to population abundance.

Underwater television (UWTV) surveys have been developed to estimate stock size from burrow densities (Bailey *et al.*, 1993; Marrs *et al.*, 1996; Froglia *et al.*, 1997; Tuck *et al.*, 1997). Annual surveys started at the Fladen Ground in the North Sea in 1992, and began to the west of Scotland in 1994.

The underwater TV survey methodology has been described in some detail in the 2006 working group report (ICES, WGNSDS, 2006). The ICES workshop on underwater TV surveys WKUWTV met earlier this year to consider developments in the survey method. WGNSDS will consider this issue again, in the light of the WKUTV findings at its next meeting in 2008.

2.6 Sequential population analysis and recruit estimation: catch-at-age assessments

Where a full analytical assessment was possible, the WG implemented either Extended Survivor's Analysis (XSA) with shrinkage and recruit calibration, Time-Series Analysis (TSA) or Integrated Catch-at-Age analysis (ICA) as the baseline method. This follows the practices adopted at the 1993–2003 Working Group meetings. B-ADAPT has also been employed in the assessment of the stock of cod in Division VIIa and the application of this method to other stocks has been explored. Details of the B-ADAPT method are provided below.

At WGNSDS, 2006 age-based analytical assessments were attempted for stocks of cod and haddock in VIa; cod, plaice and sole in VIIa, and for Rockall haddock. Despite the inability to conduct analytical catch-at-age assessments for some stocks (VIIa Haddock, VIa Whiting) the full sequence of analysis for application of catch-at-age assessments is given here as an indication of the normal practice the WG would adopt for benchmark catch-at-age assessments. Following the recommendations of RGNSDS, 2006 no analytical assessment has been attempted for stocks of whiting in VIIa; megrim in area VI and anglerfish in the Northern Shelf:

a) The age above which catchability can be assumed fixed (the *q*-plateau) is generally the same as that determined for each stock in previous Working Groups. A complete exploratory analysis to determine *q*-plateau and/or appropriate level of shrinkage is only carried out if the values used at previous Working Groups are no longer considered appropriate, or if new tuning series are included. In such cases, the choice of catchability model for the younger age classes is reviewed as the youngest age class cannot automatically be treated as recruits, particularly when the time-series is short.

b) A separable VPA is carried out to screen the catch-at-age data in order to detect if large residuals or unusual patterns reveal anomalies in the data from year to year. The separable VPA was used to select the range of ages over which to run XSA, and to investigate the exploitation pattern.

c) Tuning series are scrutinised in detail independently of the assessment model as follows:

- The WG first considers if the survey or commercial cpue series are potentially capable of providing an unbiased series of population indices for a given range of fish age classes. This is evaluated based on the distribution of fishing or survey stations relative to the known distribution of the stock; the type of fishing gear; the timing of a survey; whether or not changes in survey design or fishing gear over time, or in efficiency of fishing fleets, have been examined and their effect quantified; quality of sampling for length or age; and, in the case of commercial fleets, the absence of discards in the cpue data at any age, the accuracy of the catch and effort data, and the targeting practices of the vessels. Where such evaluations were carried out in previous WG meetings, they are generally not repeated and any fleets previously excluded are not re-considered unless there has been a significant change in the data.
- The internal consistency of the data for each fleet is evaluated by examining the coherence of year class effects at each age. For surveys with multiple ages, the separable model SURBA (survey based assessment) developed at the FRS Marine Laboratory in Aberdeen was run to examine how well the data conform to a simple model of separable year and age effects on mortality.
- The similarity of trends in the indices at each age is examined to check for consistency between fleets.
- The consistency between the tuning data and the commercial catch-at-age data is examined by inspecting catchability residuals from single-fleet Laurec-Shepherd runs, or in some cases weakly-shrunk XSA (usually S.E.=2.5), without taper and using the constant-catchability model for all ages. Age and year effects in log-catchability residuals over the entire time-series of data are examined. Based on the independent examination of tuning fleets, and the single-fleet L-S or XSA runs, a choice is then made on which fleets and age classes may be included in the multi-fleet assessment tuning. The period over which to tune the assessment is decided in such a way as to maximise the precision and minimise the bias in estimates of catchability in the final year, for those age classes where catchability is assumed constant. For a number of years the Working Group avoided progressive down-weighting of data from earlier years using a tricubic taper and had instead used a fixed tuning window of 10 years. As many of the

assessments became more heavily dependent on survey data for tuning, the Working Group decided to abandon the 10 year fixed window approach and to use all years with data based on consistent survey methods. A further argument for this revised approach was to reduce variability introduced by the sudden exclusion of a year with influential catchability residuals. A 20 year tricubic taper is applied where progressive down-weighting of early year's data is considered advisable. Time-series estimates from SURBA and from the catch-at-age analysis of relative spawning stock biomass, catch, and mean fishing mortality are compared.

d) The working group is aware of a lack of consistency in the value of F shrinkage standard error chosen for "weakly shrunk" single fleet XSAs. A range of values between up to 2.0 are used at this year's meeting for exploratory analyses. Whilst it is accepted that the value chosen is very often subjective, the working group does not feel that standardisation to a fixed value would be an appropriate measure. The weighting applied to the F shrinkage estimates is also determined by the strength of the signal in the tuning data. For example the use of an F shrinkage standard error of 2.0 coupled with a tuning fleet which gives consistent information about year class strength might result in very little weight being applied to shrinkage estimates and a weakly shrunk assessment. On the other hand, the use of the same level of F shrinkage with a tuning fleet that gives less consistent year class signals would result in a greater weighting being given to the F shrinkage estimates and a strongly shrunk assessment. Clearly, the value of the F shrinkage standard error on its own cannot be used to denote an assessment as either weakly or strongly shrunk.

e) Once the tuning fleets and the age range for XSA are chosen, ages for which recruit calibration (RCT3-type calibration) is appropriate are identified. These are typically the youngest ages tuned mainly by surveys and for which F-shrinkage gives unstable estimates of survivors. In these circumstances, the XSA fit for these age classes treats catchability as a power function of population size only if the relationship between Ln (adjusted survey indices) and Ln (XSA estimates) in singe-fleet runs is well defined, with an adequate number of observations. In view of concerns about the use of recruit calibration in XSA where the use of such a model may not be justified, all cases where this catchability model is used are reviewed closely by the Working Group using the criteria outlined above. For consistency of notation in the individual stock sections, ages which have been treated as recruits in this manner, and thus where catchability has been treated as a power function of population size are referred to as using the power model, whereas ages where this option has not been used are referred to as ages using the mean-*q* model.

f) The assessment outputs are examined for retrospective patterns in estimates of fishing mortality, SSB and recruitment. The possible sources of such patterns are investigated. If such patterns can not be resolved, additional tuning runs are carried out to investigate if increased shrinkage could reduce the bias in estimates of terminal F. Appropriate levels of shrinkage are also considered in the light of recent trends in F or the presence of individual high values of F over the period to which shrinkage is applied.

g) The detailed diagnostic output of the assessment is inspected. This helps to determine whether estimates for age groups in the final year should be replaced for input to prediction. Unless there is good reason for doing otherwise, the assessment estimates for recruiting age groups are used for the stock predictions. In some cases, these values are overwritten using the geometric mean level of recruitment. The long-term geometric mean is chosen unless strong recent trends in the recruitment time-series indicated that this is inappropriate. In some cases where there is evidence of recent depression of recruitment (for example due to a stock-recruit relationship), the geometric mean is computed over a shorter recent period. If tuned values are to be overwritten and additional recent survey data are available, the RCT3 programme is used to calibrate recruitment levels using its default options. As XSA cannot incorporate survey indices collected after the last year of the catch-at-age data, previous WG's have treated some spring surveys as if they were carried out at the end of the preceding year. The age ranges are then shifted down by one year. A consequence of this is the loss of tuning data for the oldest true age in the survey, which can cause problems for stocks with no other tuning data for these ages. However, the WG has previously been explicitly asked to use the most recent available data in the assessments. The WG therefore reverted to its previous practice of treating some spring surveys as if they were carried out at the end of the preceding year.

Minor exceptions to the implementation of the procedure outlined above are described in the relevant stock sections.

The XSA algorithm contains a feature in the fitting procedure which is intended to reduce the risk of finding a local minimum, and is invoked for the first of each set of ten iterations chosen after the default of 30 have been completed. Results from XSA convergence on 31, 41, 51, etc. iterations should be viewed with caution, as occasionally the feature can have the opposite effect. Carrying out more than 30 iterations is usually unlikely to be very fruitful.

B-adapt

The following text is adapted from Appendix 4 to the 2004 WGNSSK report (ICES CM 2005/ACFM:07), where further details on the background of the model and simulation testing can be found.

Absolute values of landings and landings at age, based on reported catches, for gadoid stocks in Divisions Via and VIIa are considered too biased to enable an analytical age based assessment using conventional assessment methods. Comparisons of analyses using reported catches and analyses using survey data alone indicate a clear mismatch between the levels of reported landings and actual removals. The mismatch may be due to a number of causes (misreporting, non-reporting, 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

$$N_{a,y} = C_{a,y} Z_{a,y} (1-\exp(-Z_{a,y})) / F_{a,y}$$

and for the years with bias

$$N_{a,y} = B_y C_{a,y} Z_{a,y} (1-\exp(-Z_{a,y})) / F_{a,y}$$

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

$$Na,y = ua,y,f / qy,f$$

If the unbiased survey catchability can be calculated, an estimate of bias can be obtained from

$$By = N a,y / (ua,y,f /qy,f)$$

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-parameterized 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 ADAPT model (referred to here as BADAPT) 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.

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

$$N_{a,y} = B_y\, C_{a,y}\, Z_{a,y}\, (1\text{-}\exp(\text{-}Z_{a,y})) \,/\, F_{a,y}$$

$$Na,y = Na+1,y+1 \exp(Za,y)$$

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*:

$$F_o = s\,[F_{o\text{-}1} + F_{o\text{-}2} + \;+ F_{o\ n}] \,/\, n$$

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

$$SSQ_{vpa} = {}_{a,y,f}\{\ \ln u_{a,y,f}\, [\ln q_{a,f} + \ln N_{a,y}\,]\}_2$$

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 CM 2005/ACFM:07, 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 overcapacity 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:

SSQcatches = {ln (*By a* [*Ca,y* CW*a,y*]) ln (*By*+1 *a* [*Ca,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}. 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.

TSA

The following description is taken from Fryer (2001) TSA. Is it the way? working document to the Working Group on Methods of Fish Stock Assessment 2001.

TSA, or 'Time-Series Analysis', provides an attractive framework for modelling commercial catch-at-age data. Despite its name, TSA is not a 'traditional' time-series model involving e.g. autoregressive or moving average terms. Rather, TSA represents a fish stock / fishery in *state space* form. The *state* of the fishery in year *y* is described by the *state vector*, which contains all the information we need to know about numbers-at-age and fishing moralities-at-age in year *y*. The state vector evolves forward over time as determined by the *state equations*. For example, the state equations describe how the numbers-at-age in year *y*+1 depend on the numbers-at-age and fishing moralities-at-age in year *y*. The state vector is unobservable and inference about it is made using observations, typically catches-at-age that are related to the state vector through *observation equations*. The Kalman filter is the algorithm used to estimate the state variables.

TSA was first developed by Gudmundsson (1994). It has been discussed by several Methods Working Groups, where its performance has been shown to compare well with other stock assessment methods. However, TSA failed to catch on (outside Iceland), presumably due to the lack of available and easy-to-use software. In 1997, needing to assess a cod time-series containing several years with survey data but no reliable catch data, I coded a new implementation of TSA. This implementation was later extended to model landings-at-age and discards-at-age separately (Fryer *et al.*, 1998), and has since been used to assess five North Sea or VIa demersal stocks.

This working document has three objectives:

- to summarise the technical details of TSA
- to illustrate the technique (using VIa whiting)
- to discuss the strengths and weaknesses of TSA and to consider where it is going.

Theory

This section summarises the technical details of (the new implementation of) TSA. In essence the approach (for catch-at-age data at least) is identical to that of Gudmundsson (1994), the few modifications being mainly related to model parameterisation. Some details have been omitted for brevity, but these can be tracked down in Gudmundsson (1994), Harvey (1989), or Jones (1993). I first consider catch-at-age analysis, and then go on to consider the modelling of landings-at-age and discards-at-age separately.

The state vector and the state equations

The state of the fishery in year *y* is described by the state vector **s**(*y*), which contains all the information we need to know about numbers-at-age *N(a, y)* and fishing mortalities-at-age *F(a, y)* in year *y* (*a* = 1…A, *y* = 1…*Y*). The state equations describe how the state vector evolves forward in time. The state vector and the state equations clearly go hand in hand, but the state equations are more familiar territory so I'll begin with these.

The numbers-at-age in year *y*+1 depend on the numbers-at-age and fishing mortalities-at-age in year *y* through the usual equation:

$$N(a+1, y+1) = \exp\big(-Z(a,y)\big)\, N(a,y),$$

(with the familiar adjustments for a plus group).

Recruits in year *y*+1 are given by:

$$N(1, y+1) = f(N(\cdot, y)) + \varepsilon_{recruit}(y+1)$$

where *f*(.) is any specified stock-recruit function. The errors $\varepsilon_{recruit}(y+1)$ are assumed to be normally distributed with zero mean and standard deviation $\mathrm{cv}_{recruit}\, f(N(\cdot, y))$; i.e. recruitment is assumed to be distributed with constant coefficient of variation $\mathrm{cv}_{recruit}$. The parameters of the stock-recruit function and $\mathrm{cv}_{recruit}$ are estimated by maximum likelihood (see later). Note that other recruitment formulations are possible: in particular, recruits could be related to a pre-recruit index (see Gudmundsson, 1994).

Fishing mortalities evolve according to the following model (where NID stands for Normal Independent Deviate):

$$\log F(a,y) = U(a,y) + V(y) + \mathrm{NID}\left(0, \big(H(a)\sigma_F\big)^2\right)$$

$$U(a,y) = U(a,y-1) + \mathrm{NID}\left(0, \sigma_U^2\right) \quad a \le a_m < A$$

$$U(a,y) = U(a_m, y) \quad a > a_m$$

$$\text{with the constraint that } \sum_1^{a_m} U(a,y) = 0$$

$$V(y) = Y(y) + \mathrm{NID}\left(0, \sigma_V^2\right)$$

$$Y(y) = Y(y-1) + \mathrm{NID}\left(0, \sigma_Y^2\right)$$

The salient features of the model are that:

- log fishing mortality is separated into an age component $U(a,y)$ and a year component $V(y)$, both of which can evolve over time,
- a_m is an age above which fishing mortality is assumed to be constant (except for local transitory departures),
- the variance σ_Y^2 induces persistent changes in fishing mortality (through the year component *V*),
- σ_V^2 induces transitory changes in fishing mortality (through the year component *V*),
- σ_U^2 induces persistent changes in fishing mortality (through the age component *U*),
- σ_F^2 induces transitory changes in fishing mortality around the separable model *U* + *V*,

- $H(a)$ allows the variability in fishing mortalities to be age dependent; typically $H(a)$ is initially taken to be unity, but can be adjusted if fishing mortalities for some ages (usually the young ages) are more variable than for others,
- the constraint on the $U(a,y)$ is necessary for identifiability.

Finally, the state vector consists of the $N(a,y)$, log $F(a,y), U(a,y), V(y)$ and $Y(y)$.

The observation equations

Catches-at-age depend on the state vector through the usual catch equation:

$$C(a,y) = \frac{F(a,y)}{Z(a,y)}\left(1 - \exp\left(-Z(a,y)\right)\right) N(a,y) + \varepsilon_{catch}(a,y)$$

The $\varepsilon_{catch}(a,y)$ are assumed to be NID with zero mean and standard deviation $\sigma_{catch}\, B_{catch}(a)\, q_{catch}(a,y)$ and represent measurement error in estimating the catch. The $B_{catch}(a)$ are initially taken to be unity, but can be adjusted later if the measurement errors associated with some ages (typically the older ages) are larger than for others. The $q_{catch}(a,y)$ are pre-determined from the catch data, as described by Gudmundsson (1994); if necessary, they can be inflated to decrease the influence of outliers.

The Kalman recursion

The Kalman filter is the algorithm used to estimate the state vector and the model parameters. It is an iterative procedure and works as follows. Suppose we have an estimate of the state vector in year *y* based on all the information available up to and including year *y*. Denote this estimate $\mathbf{s}(y|y)$ and let $\mathbf{P}(y|y)$ be the variance of $\mathbf{s}(y|y)$. The Kalman filter then moves forward to year *y*+1 by:

- using the state equations to predict the state vector in year *y*+1, denoted $\mathbf{s}(y+1\,|y)$, and its associated variance $\mathbf{P}(y+1\,|y)$,
- using the catch equations to predict the catches in year *y*+1, denoted $\mathbf{c}(y+1\,|y)$,
- calculating the *innovation* $\mathbf{I}(y+1)$, the difference between the observed catches $\mathbf{c}(y+1)$ and their predicted values $\mathbf{c}(y+1\,|y)$, with variance $\mathbf{V}(y+1)$,
- combining the innovation $\mathbf{I}(y+1)$ and its variance $\mathbf{V}(y+1)$ with the one-step ahead prediction of the state vector $\mathbf{s}(y+1\,|y)$ and its variance $\mathbf{P}(y+1\,|y)$ to give a new estimate of the state vector $\mathbf{s}(y+1\,|y+1)$ and its variance $\mathbf{P}(y+1\,|y+1)$.

The whole process requires staring values $\mathbf{s}(1|1)$ and $\mathbf{P}(1|1)$ (see Gudmundsson, 1994).

The estimates of the state vector in year *y* are based on the data up to and including that year, so only the estimates in the final year are based on all the available data. We therefore obtain final estimates of the state vector, based on all the data, by a further (backwards) recursive procedure known as *smoothing*.

At each stage of the recursion, we can calculate the log-likelihood of the innovation vector. Maximising the sum of these log-likelihoods allows us to estimate the unknown parameters in the model. These are the parameters of the stock-recruit curve and the associated coefficient of variation $cv_{recruit}$, the four variances associated with the fishing mortality model $\sigma_F^2, \sigma_U^2, \sigma_V^2$, and σ_Y^2, and the variance of the catch data σ_{catch}^2. Three fishing mortalities $F(1,1), F(2,1)$, and $F(a_m,1)$ are required to provide sensible starting values of $\mathbf{s}(1)$ and these must also be estimated. Standard errors of the parameter estimates can also be calculated, but I have not yet implemented this. This is not critical, since it is the variances associated with the state vector that are necessary for making inferences about numbers-at-age, fishing mortalities-at-age, and associated variables such as spawning stock biomass, and these variances just drop out of the Kalman recursion.

Model assessment and adjustment

Model assessment is typically based on standardised catch prediction errors. Although these are not residuals in the true sense, they are useful for identifying outliers or ages where the catch data are more variable. Common adjustments are:

- increasing $q_{catch}(a,y)$ to downweight outliers,
- increasing $B_{catch}(a)$ for older fish, because catch estimates at these ages are based on few individuals,
- increasing $H(a)$ for younger fish, because fishing mortalities are more variable here.

Other adjustments are possible if there are long-term trends in the state variables. For example, a long-term trend in fishing mortality can be incorporated by including a trend parameter θ_Y in the state equation:

$$Y(y) = Y(y-1) + \theta_Y + \mathrm{NID}\left(0, \sigma_Y^2\right).$$

The trend parameter is estimated by maximum likelihood.

Occasional very large year classes are not well modelled by

$$N(1, y+1) = f(N(\cdot, y)) + \varepsilon_{recruit}(y+1)$$

A pragmatic solution is to allow

$$N(1, y+1) = \lambda f(N(\cdot, y)) + \varepsilon_{recruit}(y+1)$$

where $\lambda > 1$ is a multiplier based on prior knowledge of the fishery. Recruitment is still assumed to be distributed with constant coefficient of variation; i.e. the error $\varepsilon_{recruit}(y+1)$ is assumed to be normally distributed with zero mean and standard deviation $\mathrm{cv}_{recruit}\lambda f(N(\cdot, y))$. This approach can be thought of as putting an uninformative prior of the size of very large year classes. In practice the choice of λ does not appear to be particularly important.

Survey data

Survey data is incorporated as follows. Let $S(a,y)$ be the survey index of abundance at age *a* in year *y*. These data are assumed to be related to the state vector by the observation equation:

$$S(a,y) = \Phi(a)\,\Omega(y)\,N(a,y)\exp\left(-\tau\, Z(a,y)\right) + \varepsilon_{survey}(a,y)$$

where $\varepsilon_{survey}(a,y)$ are assumed to be NID with zero mean and standard deviation $\sigma_{survey}B_{survey}(a)\,q_{survey}(a,y)$ and τ denotes the time through the year of the survey. The $\Phi(a)$ are age-specific selectivities, assumed to be constant throughout the survey. Various parameterisations of the age-specific selectivities are possible, but all require some parameters to be estimated by maximum likelihood. Catchability $\Omega(y)$ is allowed to evolve over time, and enters the state vector rather like the year component *V*(*y*) in the fishing mortality model:

$$\Omega(y) = \beta(y) + NID\left(0, \sigma_\Omega^2\right)$$

$$\beta(y) = \beta(y-1) + NID\left(0, \sigma_\beta^2\right)$$

The variances σ_Ω^2 and σ_β^2 induce transitory and persistent changes in catchability respectively, and are estimated by maximum likelihood.

In practice, any number of surveys can be included, but the penalty is the increase in the number of parameters that have to be estimated by maximum likelihood.

Landings-at-age and discards-at-age

Now suppose that we have separate estimates of landings-at-age $L(a,y)$ and discards-at-age $D(a,y)$ and let $P(a,y)$ be the proportion of age *a* fish discarded in year *y*. The $P(a,y)$ are assumed to evolve as:

$$\text{logit } P(a,y) = a_1(y) + a_2(y) \times a + \text{NID}\left(0, \sigma_P^2\right)$$
$$a_1(y) = v_1(y) + \text{NID}\left(0, \sigma_{a1}^2\right)$$
$$v_1(y) = v_1(y-1) + \text{NID}\left(0, \sigma_{v1}^2\right)$$
$$a_2(y) = v_2(y) + \text{NID}\left(0, \sigma_{a2}^2\right)$$
$$v_2(y) = v_2(y-1) + \text{NID}\left(0, \sigma_{v2}^2\right)$$

Here:

- the proportions discarded at age in year *y* vary around a logistic discard curve with intercept $a_1(y)$ and slope $a_2(y)$,
- the discard curves evolve in time; σ_{a1}^2 and σ_{v1}^2 induce transitory and persistent changes in the intercept $a_1(y)$ respectively; similarly σ_{a2}^2 and σ_{v2}^2 induce transitory and persistent changes in the slope $a_2(y)$,
- the variables $\text{logit } P(a,y), a_1(y), a_2(y), v_1(y), v_2(y)$ enter the state vector, and the variances σ_{a1}^2, σ_{a2}^2, σ_{v1}^2 and σ_{v2}^2 are estimated by maximum likelihood.

The observation equations become:

$$D(a,y) = P(a,y)\,\frac{F(a,y)}{Z(a,y)}\left(1-\exp\left(-Z(a,y)\right)\right) N(a,y) + \varepsilon_{discards}(a,y)$$
$$L(a,y) = \left(1-P(a,y)\right)\frac{F(a,y)}{Z(a,y)}\left(1-\exp\left(-Z(a,y)\right)\right) N(a,y) + \varepsilon_{landings}(a,y)$$

where $\varepsilon_{discards}(a,y), \varepsilon_{landings}(a,y)$ are assumed to be NID with zero mean and standard deviation $\sigma_{discards}\ B_{discards}(a)\ q_{discards}(a,y)$, $\sigma_{landings}\ B_{landings}(a)\ q_{landings}(a,y)$ respectively.

2.7 Population analysis and recruit estimation: survey-based assessments

In accordance with the recommendation of the WGNSDS, 2004 Review Group, when the quality of the estimated catch data was poorly validated, the WGNSDS undertook assessments based on standardised scientific surveys. Survey-based analysis was conducted using the SURBA software packages.

SURBA is a development of the RCRV1A model of Cook (1997). It assumes a separable model of fishing mortality, and generates relative estimates for population abundance (and absolute estimates for fishing mortality) by minimising the sum-of-squares differences between observed and fitted survey-derived abundance. The method is described in detail in Needle (2003) and the software is available on the ICES network. SURBA has been used to produce comparative stock analyses in several ICES assessment Working Groups (WGNSSK, 2002, WGNSDS, 2002–2005), and has been scrutinised by the ICES Working Group on Methods of Fish Stock Assessment (WGMG, 2003 and 2004). The version of the software available to WGNSDS, 2006 was Version 3.0. A length-based implementation of the survey-based analysis was provided to WGNSDS, 225 but has not been used in 2006.

The sequence of analysis for application of survey-based age assessments at $WGNSDS_{2006}$ is similar to that adopted for scrutinising tuning series independently of age-based assessment models:

a) The WG first considers if the survey series are potentially capable of providing an unbiased series of population indices for a given range of fish age classes. This is evaluated based on the distribution of fishing or survey stations relative to the known distribution of the stock; the type of fishing gear; the timing of a survey; whether or not changes in survey design or fishing gear over time have been examined and their effect quantified; quality of sampling for length or age. Where such evaluations were carried out in previous WG meetings, they are generally not repeated and any series previously excluded are not reconsidered unless there has been a significant change in the data.

b) The internal consistency of the data for each survey is evaluated by examining the coherence of year class effects at each age. The SURBA model is run to examine how well the data conform to a simple model of separable year and age effects on mortality.

c) The consistency between the survey series is examined by inspecting catchability residuals from SURBA runs for each survey. The similarity of trends in the indices at each age is examined to check for consistency between fleets.

d) Exploratory runs were made to test for the sensitivity to catchability assumptions and degrees of smoothing. Age- and year- effects in log-catchability residuals over the entire time-series are examined. Based on the independent examination of survey series, a choice is then made on which surveys and age classes may be included in the final survey-based assessments.

e) Time-series estimates from SURBA and from the catch-at-age analysis of relative spawning stock biomass, recruitment, and mean total mortality are compared.

2.8 Short-term predictions and sensitivity analyses

For stocks subject to a full analytical assessment, short-term predictions and sensitivity analyses are normally were carried out using either the Marine Laboratory (Aberdeen) programmes (MLA), the MFDP/MFYPR software (Multi-fleet Deterministic Projection/Multi-fleet Yield-Per-Recruit) or FLSTF (Fisheries Library-Short-term Forecast) developed in the FLR framework. Short-term forecasting may also be conducted using the TSA and B-Adapt software. The B-Adapt software enables bootstrapped forecasts for a range of F multipliers to be conducted.

The proportions of F and M before spawning are both set to zero to reflect the SSB calculation date of January 1st.

Short-term predictions are made after deciding on the most appropriate value for recruitment in both the recent period and over the prediction period. Tuned estimates of recruiting year classes, if considered unreliable, are overwritten by a geometric mean value. In some cases, including where very recent survey data were available, recruitment estimates from the RCT3 recruit calibration program are used. Where tuned values are overwritten for prediction purposes, they are either directly replaced (e.g. with a RCT3 estimate), or in some cases the estimate at age 1 is adjusted to age 2 using the ratio of the population estimates of the relevant year class at those ages.

The WG estimates of landings for most stocks can differ substantially from the TAC due to partial uptake of national quotas, misreporting or discarding. Unless there is strong evidence that the catch in the interim year of the short-term forecast will be constrained by the TAC or other measures, the WG assumes *status quo* F in the interim year. In other cases, the value chosen as *status quo* F for each stock is considered in the light of recent variations or trends in the estimates of F. The estimate of *status quo* F used by default in short-term predictions is the unscaled mean F at age for the last three years. This procedure stems from the consideration that while the point estimate of terminal F represents the best available estimate of $F_{\text{Terminal Year}}$, it does not necessarily follow that it will also be appropriate as an estimate of F in the intermediate year and subsequent years. In the absence of any recent trends in F, an unscaled mean is considered a more appropriate estimate of *status quo* F than a scaled value.

The mean F vector is scaled to the mean F in the terminal year if there was clear evidence of a recent trend in F that is considered likely to continue or halt rather than increase again in the short-term. A special case is a trend caused by retrospective bias. In this case, the true level of fishing mortality in the current year is essentially unknown, although it may still be possible to forecast the approximate *status quo* catch. To do this, the correlation between numbers and fishing mortality calculated from a given catch in the last year of the assessment must be retained otherwise the landings forecast may be substantially biased. In this case, a mean F over several years would be inappropriate. However, WGNSDS considers that all forecasts based on assessments with strong retrospective bias must remain suspect.

Over-optimistic forecasts have been noted in some stocks assessed by ICES in which trends in weight-at-age are apparent and future weights are specified as an arithmetic mean of historic values. The WG therefore checks for trends in weights-at-age. For some stocks, the mean weights in the last year are used in forecasts if a recent trend is evident. For some stocks year class effects on growth are taken into account when calculating stock weights for forecasts.

A detailed short-term prediction is made for each stock using the *status quo* F option. The contribution of recent year classes to future SSB and yields was istabulated, and the contribution of different sources of uncertainty to the variance of predicted SSB and yield is estimated where possible by means of sensitivity analysis. The sensitivity analysis programme WGFRAN4 gives estimates of the proportion of the total variance of predicted SSB and catch contributed by different inputs. The description of the abbreviated variable names on the Figures and Tables which show the results of sensitivity analyses for each stock is as follows (*a* is the age at recruitment, numerals indicate years):

VARIABLE:	DESCRIPTION:
N*a*	Population number-at-age *a* in Intermediate Year
WS*a*	Stock weights-at-age *a* in prediction
WH*a*	Catch weights-(landings) at-age *a* in prediction
WD*a*	Catch weights-(discards)-at-age *a* in prediction
M*a*	Natural mortality-at-age *a*
MT*a*	Proportion mature-at-age *a*
SH*a*	Selectivity-(human consumption fleets)at-age *a*
SD*a*	Selectivity (discards)-at-age *a*
sI*a*	Selectivity-(bycatch)-at-age *a*
K*yy*	Year effect on natural mortality in prediction in Intermediate Year
HF*yy*	Year effect on (landings and discards) fishing mortality in Intermediate Year
R*yy*+1	Recruitment in Forecast Year (Intermediate Year +1)

At WGNSDS, 2005 the uncertainty over the assessment of VIIa sole diminished the WG's confidence in deterministic short-term forecasts. The WG therefore adopted an alternative approach for predicting stock development in VIIa sole. A stochastic forecast was given using the software FSSSPS. This software was described by SGMAS, 2005 and has been applied in the assessment of VIIa sole in 2005.

2.9 Reference points

The inability of the Working Group to generate assessments of absolute biomass for most stocks means that the calculation of biomass reference points has not been possible. Furthermore the mortality estimates produced by survey-based assessments may not be directly comparable to mortality derived from other assessment methods. This is because of the influence of catchability assumptions in survey-based assessments. Re-evaluation of F-based reference points is therefore not possible in such cases.

2.10 Quality control and documentation of procedures

The terms of reference for the WG request specific information on major deficiencies in assessments. The problems associated with individual assessments are discussed in the 'quality of assessment' sections within each individual stock section. In many cases, the problems are associated with data quality: e.g. due to misreporting; discard estimates of low precision; survey data with catchability problems, etc. For some stocks such as Irish Sea haddock and plaice, and Rockall haddock, there are clear deficiencies in the data due to the absence of time-series of discard estimates particularly for young fish for which survey indices are available. For anglerfish there are major deficiencies in the understanding of the basic biology of the species that impede the development of appropriate stock assessments. In Rockall haddock and megrim there are major components of the catch for which there is no length or age sampling or a discontinuous time-series of such data.

The Working Group has previously been asked to fully document the methods applied in assessments. The Working Groups intends to provide this documentation in the relevant Stock Annexes for stocks subject to SPALY update assessments. For observation list/benchmark and experimental assessments it is not possible to describe the procedure to the same extent. Elements of such assessments that remain relevant from year to year have been included in the Stock Annex for each stock. Other information is given in the WG report.

2.11 Software

The main software and versions used historically by WGNSDS include:

SOFTWARE	PURPOSE	PROGRAM/VERSION	FILE CREATION DATE
VPA suite (Separable VPA, XSA, Laurec-Shepherd *ad hoc* tuning)	Historical assessment	VPA95.exe Version 3.2	8/6/1998
Retrospective XSA	Retrospective analysis	Retvpa02.exe Version 3.1	18/4/2002
MFDP	Short-term forecast	Visual basic installation	Setup: 29/4/1996 Config: 28/6/2000
MFYPR	Yield-per-recruit	Visual basic installation	Setup: 29/4/1996 Config: 28/6/2000
PASoft (EXCEL add-in)	PA reference points estimation	PASoft with Fishlab.dll	June 1999
MAKEVCF	Header file generator for stock (sensitivity etc.)	Makevcf90.exe	20/5/2002
INSENS	Creates sensitivity & medium-term input files	Insens90.exe	20/5/2002
WGFRANSW	Sensitivity analysis	Wgfransw.exe	22/5/2001
RECAN	Stock-Recruitment modelling	Recan22.exe	7/10/2003
RECRUIT	S/R estimation	Recruit.exe	4/2/2002
RECRUIT2	S/R estimation – small stocks (but limited years)	Recruit2.exe	24/10/1996

SOFTWARE	PURPOSE	PROGRAM/VERSION	FILE CREATION DATE
WGMTERMC	Medium-term analysis	Wgmtermc.exe	3/11/1999
MTMPLOT	Medium-term & contour plotting program	Mtmplot.exe	2/12/1998
Various other plotting routines (PLOTCONV, WPAPLOT, PAPLOT, etc.)	SSB/F trajectory with reference points	e.g. Wpaplot.exe; plotconv.exe, etc.	4/2/2002; 20/11/2000
SURBA	Survey-Based Analysis	Versions 2.20, Version 3.0	6 May 2004, 13 May 2005
Collie-Sissenwine Analysis	Stage-based, Catch-Survey Analysis	Version 2.0.14	June 2003
FSSSPS (FPRESS)	Stochastic Projection Software	FSSmain.r	April 2005
TSA	Time-Series Analysis	Versions compiled at WGNSDS	Program recompiles on execution
B-Adapt	Historical assessment, Forecasting	B-Adapt-F.exe Adapt-16-04-07.exe	13/05/2006 16/04/2005
ICA	Historical assessment	ICA.exe	March 1999
FLR + packages	Data analysis, Historical assessment, Forecasting	See note below	May 2006

2.11.1 FLR

It was intended that in 2007 FLR would be used more widely by WGNSDS for data analysis and conducting assessments, however, for a number of reasons, uptake of the software at this year’s meeting was limited. In a number of cases, exploratory data analyses were conducted using FLR, whilst for the purposes of historical assessment and forecasting assessors generally reverted to the executable versions of the software.

The versions of the FLR packages used by the working group were as follows

- R version 2.3–1
- FLCore version 1.3–6
- FLEDA version 1.3–4
- FLAssess version 1.3–0
- FLSURBA version 1.2–4
- FLXSA version 1.3–0
- FLSTF version 1.4–0

2.12 Information provided as working documents

2.12.1 WD1: Defining metiers in the Irish Sea

Full title: Defining metiers in the Irish Sea–a first multivariate approach. **Authors:** Sarah Davie and Colm Lordan **Summary:** There is an increasing need to take into account “mixed fisheries” approach in management, assessment and sampling of fish stocks. To do this effectively one must define groups of fishing trips with homogeneous fishing patterns or tactics into métiers. Here a range of multivariate statistical methods (PCA, MCA & HAC) are applied to identify Irish métiers in the Irish Sea. Various variables including landing profile, vessel length category, gear and mesh size and month were used in the various cluster analyses. The year 2003 was used as the reference year and 21 individual métiers were identified. The resultant classifications were applied to 2003–2005 data. The *Nephrops* otter trawl metiers using 70–89 mm mesh was the most important identified in terms of number of trips (~1200/y) vessels (~50), fishing effort (~3000 fishing days), and yielded landings (~3kt/y). Several specialised métiers were identified but most metiers caught a number of species. The majority of vessels specialise in a single métier (55%). It is envisage that a similar approach will extended to all areas the Irish fleet operates and that the information will be useful for management, assessment and sampling programmes. **WG Use**: Paper presented to the working group.

2.12.2 WD2: UK (E&W) fisheries science partnership surveys 2004–07

Full title:.Fisheries Science Partnership Surveys of Irish Sea Roundfish 2004–07. **Authors** Mike Armstrong, John Dann, Chris Garrod and Guy Pasco **Summary:** This report presents the results of the fourth in a series of FSP surveys of cod, haddock and whiting in the Irish Sea that commenced in spring 2004, and evaluates the time-series of data on catch-rates, distribution and age composition. In 2007, the commercial whitefish otter trawler FV *Isadale* (Fleetwood) completed 43 valid tows of average duration 4.3 hours in the eastern Irish Sea between 24 February and 13 March. The mid-water trawler *Benaiah IV* (Kilkeel) completed 32 valid tows of average duration 7.4 hours in the western Irish Sea, North Channel and the outer Clyde between 11 February and 8 March. **WG Use:** No formal discussion by the working group but reference is made to this in individual stock sections.

2.12.3 WD3: The FRS industry-science anglerfish survey

Full title: The FRS Industry-Science Anglerfish Survey. **Authors:** Paul Fernandes, Eric Armstrong, Finlay Burns, Phil Copland, Craig Davis, Iain Penny and Liz Clark. **Summary**. In 2005, Fisheries Research Services (FRS) initiated a new project, conducting surveys of the northern shelf, to estimate the abundance and distribution of anglerfish. The project is unique in two aspects: the aim is to produce an absolute abundance estimate (i.e. a total number and biomass of anglerfish), as opposed to an index of relative abundance which is normally produced from surveys; and crucially, the project aims to involve the fishing industry throughout, from planning through to the execution of the surveys. Overall the surveys have been successful despite some terrible weather. There is still some ongoing work to interpret some additional gear measurements, such as trawl height and depth, to use as a proxy for bottom contact, where that data is not available (e.g. in some of the 2006 survey). **WG Use:** The working document was discussed by the group with respect to the potential provision of additional information with which to assess the status of the anglerfish stock. It was noted that Ireland has also conducted an industry-science partnership anglerfish survey in 2006 during which approximately 1000 fish have been tagged in an attempt to better understand the movements of adult fish. The WG concluded that it was not possible to use the information from the survey this year since it represents such a short time-series. However, the WG considers that information from the survey such as the variances of estimates of total abundance could be used in a simulation analysis to examine the performance of management measures that may be applied given survey based information on absolute abundance.

2.12.4 WD4: Q4 UK (E&W) western IBTS survey

Full title: WD4: Q4 western IBTS survey (UK, E&W) in the Irish Sea (VIIa), western English Channel (VIIe), Bristol Channel (VIIf) and Celtic Sea (VIIg-h). **Authors:** Jim Ellis and Alex Tidd **Summary**. In 2002 Cefas began participating in the internationally-coordinated Q4 IBTS for southern and western areas, undertaking a trawl survey of the Irish Sea (VIIa) and western English Channel, Bristol Channel and Celtic Sea (VIIe-h). This document briefly summarises progress in this cruise series.**WG Use:** No formal discussion by the working group but reference is made to this in individual stock sections. No indices of abundance have yet been calculated for this survey, however, a description of the survey methods has been provided and indices of abundance for a number of groundfish stocks should be made available for next year.

2.12.5 WD6: results of Russian studies on the Rockall Bank

Full title: Results of Russian study and fishery of demersal fish species on the Rockall Bank in 2006 **Authors:** Khlivnoy V.N., Filina E.A., and V.I.Vinnichenko **Summary:** In 2006 on the Rockall Bank, Russian study and fishery of bottom species continued. In the course of investigations new scientific and fishery information have been obtained on the biology, distribution and abundance dynamics of haddock, grey gurnard and other bottom species. This working document summarizes the fishery and biological data collected during 2006. **WG use**: No formal discussion by the working group but reference is made to this in individual stock sections.

2.13 References

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Table 2.3 2007 Working Group on the Assessment of Northern Shelf Demersal Stocks.
Biological sampling levels by stock and country:
Number of fish measured (Length) and aged (Age) from catches in 2006.
Number of samples is shown beneath the sample type in (brackets).
Data submitted by fleet/fishery are shown in **bold** type.

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Cod:																
VIa (landings)									**4 (1)**		**89 (2)**	**9 (1)**			3.414	1.425
VIa (discards)															588	444
VIb (landings)															119	94
VIIa (landings)					**1.275 (11)**	**216**			**4.999 (109)**	**350 (9)**	**2.808 (58)**	**924 (42)**				
VIIa (discards)					S				3 (11)		11 (5)	1				
Haddock:																
VIa (landings)									**443 (3)**						13.439	2.859
VIa (discards)															5.608	990
VIb (landings)							**1.743 (25)**	**149 (7)**			**211 (2)**	**121 (2)**	**44.281 (150)**	**800 (32)**	5.121	594
VIb (discards)																
VIIa (landings)									**6.762 (72)**	**240 (7)**	**2.808 (58)**	751 (24)				
VIIa (discards)									1.327 (11)		1.404 (5)	84				
Whiting:																
VIa (landings)															5.170	1.213
VIa (discards)															4.890	828
VIIa (landings)											**163 (3)**					
VIIa (discards)					S				2.678 (11)		2.520 (5)	122				
Plaice:																
VIIa (landings)	**11.551 (7)**	**547 (8)**			**3.493 (22)**	**574**			**1.332 (11)**		**4.345 (37)**	**586 (21)**				
VIIa (discards)	**S**	**S**			S	S					319 (5)	46				
Sole:																
VIIa (landings)	**13.261 (8)**	**740 (8)**			**4.336 (39)**	**889 (39)**					**95 (22)**	**133 (8)**				
VIIa (discards)	**S**	**S**			S	S					6 (5)	1				

Table 2.3 (continued).

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation [b]		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Megrim:																
VIa (landings)											**380 (3)**	**84 (3)**			*15.496*	*550*
VIa (discards)															*1.820*	
VIb (landings)											**96 (1)**					
VIb (discards)																
Anglerfish [c]:																
IIa (landings)							**2.185 (213)**									
IVa & IIIa (landings)			**1.161 (29)**				**653 (159)**								*16280 [IV]*	*785 [IV]*
IVa & IIIa (discards)			**81 (9)**												*1007 [IV]*	*0*
VIa (landings)											**114 (3)**				*6.030*	*653*
VIa (discards)															*0*	*0*
VIb (landings)																
VIb (discards)																
Nephrops																
FU11 (landings)															**18.151**	
FU11 (discards)															**9.034**	
FU12 (landings)															**18.602**	
FU12 (discards)															**14.616**	
FU13 (landings)															**2.160**	
FU13 (discards)															**2.823**	
FU14 (landings)					**1.154 (4)**											
FU14 **(catches)**					**766 (5)**											
FU15 (landings)											**9.651 (13)**					
FU15 (discards)											**11.355 (13)**					

[a]: Norwegian sampling is carried out at sea, sampling the catch. Includes samples from Danish vessels operating in Norwegian EZ.
[b]: Russian sampling is carried out at sea, sampling the catch. Survey data included
[c]: Only *Lophius piscatorius* are aged.
S: Samples were collected and data was presented to the WG, but information on numbers of age & length samples was not available.
[IV]: Samples from the North sea (Sub-area IV) only.

3 Cod in sub-area VI

Cod in Division VIa are currently the subject of a recovery plan. The VIa cod stock is classified as an Observation list assessment.

Because of concerns over the quality of the catch data WGNSDS, 2005 was requested to try to validate the catch data. The WG decided it was very difficult to determine up to which point commercial data can be considered to be reliable and decided on an assessment based only on survey data. However, this precludes forecasting future landings. WGNSDS, 2006 therefore attempted to make a catch based final assessment and forecast, basing the choice of final assessment on that which gave the closest long term trend in SSB to an agreed survey based assessment. To do this commercial data was included from the start of the data series up to 1994 but excluded thereafter. Although this made possible an assessment based on absolute numbers and weights at age the single survey index relied on to drive the latter part of the time series contains too much noise for mean fishing mortality to be estimated with acceptable precision. A similar approach was adopted this year.

At the end of 2005 the “Buyers and Sellers” regulation was introduced in the U.K. and became fully operational from 1st January 2006. Anecdotal reports suggest unallocated landings are reduced since the introduction of this regulation, (see Section 1.7.2).

A report by the sea mammal research unit (SMRU) has estimated annual consumption of cod by grey seals which imply a natural mortality on cod greater than can be accommodated by the standard value of M=0.2 on all ages, see Section 3.1.5.

3.1 Cod in division VIa

3.1.1 Stock definition and the fishery

General information about the stock can be found in the stock annex.

Young adult cod are distributed throughout the waters to the west of Scotland, but mainly occur in offshore areas where they can occasionally be found in large shoals. Tagging experiments have shown that in late summer and early autumn there is a movement of cod from west of the Hebrides to the north-coast areas. There is a return migration in the late winter and early spring. There is only a very limited movement of adult fish between the West Coast and the North Sea. Tagging studies have been conducted to determine the degree of mixing between the West of Scotland and the Irish and Celtic seas and indicate some mixing, (O Cuaig & Officer, 2007).

The demersal whitefish fisheries in Division VIa are predominantly conducted by otter-trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and skates and rays. Recently there has been development of a directed fishery for anglerfish within the Scottish fleet, leading to a shift in fleet effort away from inshore areas to offshore and deeper waters. Fishers report there are no longer any fisheries west of Scotland that target cod. The general features of the fishery are summarised in Section 1.5.

3.1.1.1 ICES advice applicable to 2006 and 2007

ICES advice is in terms of single stock exploitation boundaries and mixed fishery implications. ICES advice for 2006 was:

Single-Stock stock exploitation boundaries:

In relation to agreed management plan

ICES is not in a position to give quantitative forecasts and can therefore not evaluate the management plan and provide upper bounds to a TAC.

In relation to precautionary limits

Since no recovery has been observed in this stock, ICES advises zero catch of cod in 2006.

In relation to target reference points

There will be no gain in the long-term yield by having fishing mortalities above $\mathbf{F}$max (0.19).

Upper limit corresponding to single-stock exploitation boundary for agreed management plan or in relation to precautionary limits. Tonnes or effort in 2006

Since no recovery has been observed in this stock, ICES advises zero catch of cod in 2006.

Mixed fisheries advice:

Mixed fisheries advice for West of Scotland is described in Section 1.7.

The advice for 2007 was:

Single-Stock stock exploitation boundaries:

Exploitation boundaries in relation to existing management plans

Due to the uncertainty in the level of fishing mortality, ICES is not in a position to give quantitative forecasts. In addition the management plan is not explicit about the level of reduction in the catch when the stock is below $\mathbf{B}_{lim}$. Simulations show that fishing should be closed for 3 years in order to bring SSB above $\mathbf{B}_{lim}$.

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

There will be no gain in the long-term yield by having fishing mortalities above $\mathbf{F}_{max}$ (0.19). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

Given the very low SSB estimates, the high fishing mortalities and low recruitment in this stock, ICES advises zero catch of cod in 2007.

Conclusion on exploitation boundaries

As the recovery plan for this stock is considered to be consistent with the precautionary approach only when the fishery is closed for an initial period, and as this is congruent with the advice in relation to precautionary limits, ICES advises a zero catch of cod in 2007.

Mixed fisheries advice:

Mixed fisheries advice for West of Scotland is described in Section 1.7.

3.1.1.2 Management applicable to 2006 and 2007

The 2006 and 2007 TACs for cod in ICES areas Vb (EC waters), VI, XII and XIV were 613 t and 490 t respectively. The minimum landing size of cod in the human consumption fishery in this area is 35 cm.

Technical measures enforced for the West of Scotland including those associated with the Cod recovery Plan are described in Section 1.7. Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth. Under Council Regulation No. 41/2007 their use is permitted down to 600 m subject to restrictions on net length and soak time. The measures are aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on cod. WGFTFB, 2006 reported days at sea allocations under Regulation No. 51/2006 provided no incentive for *Nephrops* fishermen to use a mesh size larger than 80 mm. The STECF meeting to review the cod recovery plan (STECF, 07) concluded the new fishing opportunities for 2007 (Regulation No. 41/2007) had not altered this situation.

At the end of 2005 the "Registration of Buyers and Sellers" regulation was introduced in the U.K. and became fully operational from 1st January 2006. This implemented an EU directive as did the Irish "Sales Notes" legislation. This legislation is described in Section 1.7 but in summary requires that fish processed and sold in the U.K. can be traced through the supply chain.

The following table summarises ICES management advice and E.U. management applied for cod in Division VIa during 2001–2007:

Year	Catches corresponding to ICES advice (t)	Basis	TAC for Vb (EC), VI, XII, XIV (t)	% change in *F* associated with TAC[1]
2001	-	Lowest possible *F*, recovery plan	3 700	–50%
2002	-	Recovery plan or lowest possible *F*	4 600	–10%
2003	-	Closure	1 808	–60%
2004	-	Closure	848	–80%
2005	-	Closure	721	(no assessment)
2006	-	Closure	613	(assessment of relative trends only)
2007	-	Closure	490	>–80%

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

The following area closures have continued in 2006:

1) A closure in the Clyde for spawning cod from 14th February to 30th April. This closure has been operating since 2001 and was last revised by The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002.

2) A closure introduced by Council Regulation No. EC 2287\2003, known as the 'windsock', see Figure 3.1.

A seasonal closure (November-February) of the Greencastle codling fishery was not continued in 2005–2006 or 2006–2007. However, all vessels that fished this ground are now believed to be decommissioned. Closed areas still in operation are shown in Figure 3.1.

When days at sea limits were introduced in 2003, Reg (EC) 2341/2002, a concession was made to the saithe fishery in VIa, on the basis this fishery took little bycatch of other species. The grounds of this fishery run along the shelf edge. A line was therefore defined, to roughly reflect the easterly limit of this fishery, (see Figure 3.1). If vessels are equipped with VMS and fish to the west of the management line, they are not subject to days at sea restrictions, regardless of the catch composition.

3.1.1.3 The fishery in 2006

Tables and figures of total effort by the fleets operating in Division VIa can be found in section 16.

Recorded nominal effort in Scottish trawl fleets using 100 mm+ gears (the gear type most likely to be used if catching cod) has declined rapidly from 8.3 million kWdays in 2001 to 2.1

million kWdays in 2006. The Scottish *Nephrops* fleets are usually synonymous with mesh sizes of 70–79 or 80–89 mm. Reported effort for these gear types shows a more gradual decline in effort with 3.7 million kWdays recorded in 2006 as opposed to 4.8 million kW days in 2001. Since 2003 there has been Scottish vessels using beam trawl gear with mesh 120 mm+. This activity seems to be declining having peaked at 150 000 kWdays and now stands at approximately 80 000 kWdays.

For the Scottish fleet, of 298 vessels of greater than 10 m overall length operating in 2001 30% (96 vessels) were decommissioned by 2004. The WG did not have information on the size and power of the boats decommissioned. This will have a bearing on the effective effort removed from the fishery.

Because of restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on bycatch composition the probability misreporting and under reporting takes place in this fishery is considered to have been high. The days at sea limitations associated with the cod recovery plan and a seasonal closure that operated off Greencastle, Northern Ireland has, however, lead some of the Irish Demersal fleet to switch effort away from VIa. From 2006 misreporting and under reporting are expected to have reduced due to new legislation (the 'Buyers and Sellers' act, see Section 3.1.2.2)

In 2006 inshore creelers operating in both the North Minch and South Minch areas have reported large or significantly increased catches of small cod.

The draft report of the 2007 meeting of the ICES WG on Fish Technology and Fish Behaviour outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological characteristics. Information was provided by Ireland and the UK (which together accounted for 72% of reported cod landings during 2006). Specific points relevant to cod in Division VIa are given below.

Of most significance is the reallocation of effort from Divisions VIa and VIIa into other ICES areas and switching between mesh categories. There appears to have been substantial reductions in effort associated with the larger mesh bands (120 mm+) away from the traditional gadoid fishery in the Division VIa (West of Scotland) and into the *Nephrops* fishery in Division IVa (principally, the Fladen Ground). The change in fishing practice has been carried out by larger (typically over 1000 hp) demersal vessels. The main reason appears to be lack of quota and restrictive day allocations related to the cod recovery plan in Division VIa.

The number of Irish whitefish vessels participating in the targeted monkfish fisheries in Division VIa fell during 2006 and the first quarter of 2007, and there are now only 8–10 Irish vessels in the area (as opposed to more than 20 in 2005). This is due mainly to restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime (see Section 1.7). Cod is a bycatch in this fishery.

3.1.2 Catch data

3.1.2.1 Official Catch Statistics

Official catch data for each country participating in the fishery are presented in Table 3.1. Revisions to catch data are made in Table 3.1 to the 2005 figures.

Landings, discards and catch estimates 1978–2006, as used by the WG, are presented in Table 3.2. The reported landings for 2006 are both the lowest in the available time series. Reported discards are, however, higher than for any year since 2000 and reported catch the highest since 2003. Figure 3.2 shows international landings of cod by ICES statistical rectangle.

3.1.2.2 Quality of the catch data

In recent years there have been concerns that the quality of landings data was deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey used (ScoGFSQ1).

Anecdotal reports suggest that because of the Registration of Buyers and Sellers legislation, increased fishing opportunities in other areas and a general increase in enforcement unallocated landings have been reduced in 2006. The same legislation and enforcement changes are, however, expected to increase discards from vessels still fishing in VIa.

3.1.3 Commercial catch-effort series and research vessels surveys

3.1.3.1 Commercial catch-effort series

A number of commercial Scottish cpue series have been made available in recent years. Irish otter trawl cpue data (IreOTR) were presented for the first time at the 2001 WG meeting. An updated series was presented to the 2002 and 2003 WG meetings.

The commercial cpue data available for this meeting consisted of the following:

- Scottish seiners (ScoSEI): ages 1–6, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 1–6, years 1978–2005.
- Irish otter trawlers (IreOTR): ages 1–7, years 1995–2005.

Commercial effort and landings-per-unit effort are summarised in Table 3.3. For all tuning series, the oldest age given represents a true age, rather than a plus group.

No commercial Scottish cpue series have been used in the final assessment presented by the WG during any of its last eight meetings, although they were previously used in exploratory and comparative analyses. No update of these series was presented to the WG this year.

Misreporting of catch data is expected to be reduced in 2006 but concerns remain over reporting of effort in the IreOTR series. This series has also not been considered as a tuning fleet.

3.1.3.2 Research vessels surveys

Four research vessel survey series for cod in Division VIa are available:

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2007.
- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.
- Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2006.
- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0–4, years 2003–2006.

The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.,* 2001). The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced. There were also problems regarding consistency of survey methodology. The replacement survey (IRGFS) has only been running for four years and is not yet suitable for tuning. The Scottish quarter four survey was presented to the WG for the first time in 2005.

Fleet and survey descriptions are given in the 2006, IBTS working group report (IBTS, 2007). All available survey data are given in Table 3.3. For all tuning series, the oldest age given represents a true age, rather than a plus group.

3.1.4 Age compositions and mean weights at age

3.1.4.1 Landings age composition and mean weights-at-age

Quarterly catch-at-age data were available from Scotland and Ireland. The countries that provide data are listed in Table 2.2, and sampling levels are shown in Table 2.3. Landings age distributions were estimated from market samples. For Irish data, ALKs are occasionally augmented by samples collected during research vessel surveys. The procedures used to aggregate national data sets into total international landings are given in Section 2.2.1.

Total WG estimates of international landings-at-age are given in Table 3.5. Annual mean weights-at-age in landings are given in Table 3.6. Figure 3.5 shows the mean weights-at-age in the landings and discards. A loess smooth has been fitted to the data at each age, with a span including three quarters of the data points. There is no evidence of a trend in weight at ages 1, 2 and 7+ for VIa cod landings, but some evidence of a gradual long term decline at age 3 and a more recent decline at ages 4 to 6.

3.1.4.2 Discards age composition and mean weights-at-age

A summary of the available discard information from the Scottish and Irish sampling programme is given in Table 3.7. Discards of cod only occur regularly at ages one and two, however, in 2006 discards have been recorded for ages one to seven. Numbers discarded at ages one and two are also high compared to recent years. The WG considered the 2006 discard data to be an indicator of the combined effect of restrictive quotas and the buyers and sellers regulation (see Section 3.1.2.2). From Figure 3.5 there is no evidence of a trend in weight at age for VIa cod discards.

WG estimates of discards are based on data collected in the Scottish and Irish discard programmes (raised by weighted average to the level of the total international discards). Historically discard age compositions from Scottish sampling have been applied to unsampled fleets. This is still true for data up to 2002. New raising procedures were initiated for the Irish data (using the methods of Borges *et al.*, 2005) and data from 2003 onwards has been raised by the new method. The revision of the Irish discard data has not yet been applied to earlier years.

Work is ongoing to revise the Scottish discard estimates with an aim to reduce bias and increase precision. A working document provided to WGNSDS, 2004 set out the methodology of this work (Fryer, R. & Millar, 2004).

3.1.4.3 Catch age composition and mean weights-at-age

Total catch numbers and mean weights-at-age are given in Table 3.8 and Table 3.9 respectively. Stock weights are assumed to equal catch weights. The procedure for raising international catch numbers and mean weights at age is given in Appendix 1

3.1.5 Natural mortality and maturity at age

Values for natural mortality (0.2 for all ages and years) and the proportion of fish mature at age are unchanged from the last meeting. The proportion of F and M acting before spawning is set to zero.

A study by the sea mammal research unit (SMRU) on seal predation has indicated that seal predation on cod probably constitutes significant natural mortality, (see Section 3.1.12.1 on Management Considerations).

The maturity ogive used by the WG for this stock is as follows:

AGE	0	1	2	3	4–15+
Mat	0.00	0.00	0.52	0.86	1.00

The maturity data was presented at the 1984 and 1985 meetings of the roundfish working group, (ICES NSRWG 1984 and 1985).

Survey-derived maturity ogives for gadoid stocks in Division VIa were presented as a Working Document to the 2002 WG (Burns and Reid, WGNSDS, 2002 WD 1). The estimates of proportion mature were in accordance with those used in the assessment.

3.1.6 Data screening and exploratory runs

3.1.6.1 Commercial catch data

A plot of log catch curve gradient derived from commercial catch data is shown in Figure 3.6. The trend in gradients over time appear fairly consistent between the age ranges considered (2–5, 2–4 and 3–6). The implication from the figure is of an increasing rate of mortality for cohorts spawned during the 1990s but a reduction in mortality for the 2001 cohort.

Given concerns about misreporting of catch and effort, the commercial catch data are not currently considered for tuning purposes. Because of concerns over misreporting leading to bias, landings and discards numbers later than 1994 have not been used in a final assessment, see Section 3.1.6.3. Weights-at-age for the stock are still required to obtain biomass estimates and so the full series of stock weights was used.

3.1.6.2 Survey data

Figure 3.3 shows five year means of cpue by ICES statistical rectangle from the ScoGFSQ1 survey and Figure 3.4 shows cpue by ICES statistical rectangle from 2006 for the ScoGFSQ4 survey.

Log mean-standardised survey time-series by age and year-class are shown in Figure 3.7. Up to 2001 the ScoGFSQ1 series appears to track well the development of relative year-class strength down cohorts, although this signal is degraded in older ages for some cohorts. From 2002 this coherence appears to be lost. There is also evidence of a positive year effect in the 2007 data. The ScoGFSQ4 tracks ages 1 and 2 well, but not older ages. The IreGFS series tracks year classes well for ages 1 and 2, but not ages 0 and 3. The replacement IRGFS now has data for four years. It can be seen from Figure 3.7. and Table 3.4 that this survey series contains little information on cod.

Log catch curves are shown in Figure 3.8. The figure for the ScoGFSQ1 shows a strong “hook” at the younger ages, with abundance at age two often higher than at age one. The figure for ScoGFSQ4 shows a lack of coherence in this index series.

Comparative scatterplots at age are given in Figure 3.9.

The WG could not use the IreGFS, IRGFS or ScoGFSQ4 survey in survey based analyses using the available software, due to insufficient number of ages consistently tracked by these surveys, (both the IreGFS and ScoGFSQ4 surveys track ages 1 and 2 well but not other ages).

Therefore, all subsequent analyses were carried out using only the ScoGFSQ1 series. A plot of log catch curve gradient derived from the ScoGFSQ1 data is shown in Figure 3.10. For the age ranges considered (2–5, 2–4 and 3–6), only cohorts up to 1994 could be included. This is because in recent years index values of zero have been recorded at age five or six. There is also little consistancy in results between age ranges chosen. Information on mortality trends from the survey series is weak.

3.1.6.3 Exploratory assessment runs

In 2004 ACFM highlighted concerns over the fitting of a persistent trend in survey catchability in previous TSA assessments of gadoid stocks in VIa. Their concern was that allowing a trend in survey catchability made *a priori* assumptions on the quality of survey data as compared to landings data. Differing signals from catch data and survey data may be due to several confounding factors. Misreporting (specifically under reporting) could cause this effect. Spatial and temporal differences in the effort distribution between commercial vessels and survey could also contribute, as could temporal trends in the commercial fleets or natural mortality. At WGNSDS, 2006 it was shown that fixing the variance measuring persistent changes in survey catchability to zero will have little impact, because the divergence between the catch data and the survey data will then be picked up by the variance measuring transient changes in survey catchability. Fixing both variances to zero might have some impact, depending on the relative precision (noise) of survey and catch data. For VIa cod, because it contains less noise than the available survey series catch data will dominate the survey data when fitted by TSA. If the catch data also contains trends in bias, this will result in biased stock trends.

Three methods were considered.

- TSA: giving absolute assessments using commercial landings and discards data up to and including 1994, and incorporating the ScoGFSQ1 index (index values for 1985-2007).
- BADAPT: giving absolute assessments using all commercial landings and discards data, and incorporating the ScoGFSQ1 index for tuning. Catch bias was estimated from 1995-2006.
- SURBA: using ScoGFSQ1 survey data only and giving an assessment of relative trends in biomass.

On the basis that the choice of natural mortality estimates is arbitrary for gadoid stocks, mortality results from the latest version of SURBA are in terms of mean Z, or Z at age. It should be noted that this measure is not an absolute measure of mortality but a measure of the decline down cohorts as measured by a survey, and as such is dependent on the catchability of that survey. However, if the catchability of the survey remains constant over time then the trends in Z should reflect the trends in the absolute Z for the stock.

TSA and BADAPT partition mortality into a component intended to represent natural mortality (M) and a component intended to represent fishing mortality (F). Natural mortality on cod at some or all ages is considered to have become greater than can be accommodated by the standard natural mortality figure of M=0.2. It is also possibly subject to a persistent upward trend. Because they exclude or downweight catch data over a long period and are reliant on survey data (which provides signals of overall mortality), mortality outputs from these models are not considered to represent a fishing mortality F at age for recent years in the time series but rather estimates, (referred to here as ‘Z-0.2’), of total mortality that can not be accounted for by the standard value used for natural mortality.

SURBA analysis

A SURBA run was performed using the same model set up as last year. At WGNSDS, 2006 the index values from the ScoGFSQ1 at ages 3, 4 and 5 in 2001 were downweighted to reduce the influence of a single large haul of cod in this year. Figure 3.9 of the 2006 report shows how this reduces noise in the mean Z time series and improves retrospectives of both mean Z and SSB. The model settings for this year’s run are given below followed by explanations for these settings:

Year range:	1985-2007						
Age range:	1–6						
Catchability at age:	0.0226,	0.1036,	0.200,	0.4167,	0.6885,	1	
Age weighting:	1.0,	1.0,	0.0,	0.0,	0.0,	1.0	for 2001
1.0,	1.0,	1.0,	1.0,	1.0,	1.0	for all other years	
Lambda:	2.0						
Cohort weighting:	not applied						

Age range

At WGNSDS, 2005 runs were conducted to test the sensitivity of the results to use of different age ranges. It was found there was some sensitivity to the age range. The abundance of fish at age 7 in the ScoGFSQ1 is very low. Given the sensitivity to age range included the WG considered age 7 should be left out of the analysis. Abundance numbers are also low for age 6 but it was felt useful information could be lost if this age was also excluded.

Smoothing parameter λ

Survey data estimates of mean Z tend to be noisy. SURBA has an additive penalty function, λ, placed on the variation in year effect of mortality which effectively acts as a smoother. It was found that if no smoothing were used results for mean Z (2–5) could become negative. Smoothing was therefore applied to runs. A lambda value of 2 appeared reasonable, reducing noise in Z without over-smoothing the trends.

Catchabilities (q)

Equal catchabilities were initially set for all ages. This was unlikely to be satisfactory for cod given the “hooked” nature of the log catch curves, (Figure 3.8). Evidence that the catchabilities of younger ages should be reduced can be found from the age effects estimated from SURBA. An ad-hoc method of obtaining positive age effects is to reduce the catchability at age one until the condition is met. It was uncertain to the WG whether the ad-hoc method of reducing catchability at age 1 until all age effects are positive is defensible. An alternative method is to compare raw survey indices with numbers at age estimates from a model using catch at age data. These ratios are then standardised relative to a given reference age. No catch-at-age analysis has been accepted as a final assessment for some years. However, the WGNSDS, 2005 decided that even if there are concerns over mis-reporting of commercial data, so long as the relative catch numbers between ages remains constant the catchabilities generated using a catch-at-age analysis will be valid and it was important to include this additional information on the stock if possible. A TSA run not allowing a trend in survey catchability and using all years of available catch data was chosen to provide the catchabilities for this stock.

Results

Plots of age effects are shown in Figure 3.12 for a version of the model using catchabilities determined by comparison to TSA results (top) and for a version using equal catchabilities at age. For the model assuming equal catchabilities the age effect at age 1 is always negative and one age effect profile is very different to the others. For the model using TSA conditioned catchabilities there is some spread of estimated values at age 1 and a dip in the age effect at the reference age for a number of retrospectives but overall the profiles appear more realistic than in the case of equal catchabilities. Figure 3.12 shows residuals from the two models. Both versions show positive residuals for all ages in the final year. This reflects the signal from the mean standardised survey series by age, (see Figure 3.7). There is little to suggest one model should be preferred over the other from these figures.

Figure 3.13 shows summary plots from the same two models. The model assuming equal catchabilities shows a highly variable time series of mean Z and confidence limits about the full time series encompass negative values. Retrospectives of SSB over the last decade appear more consistent for the model using TSA conditioned catchability at age. This is considered to reflect a greater contribution to SSB coming from younger fish relative to the equal catchability model (abundance estimates are increased by the catchability values) and the ability of the survey to track abundance of the younger ages better than the older ages.

BADAPT

A BADAPT run estimating bias in catch data over the years 1995–2006 was employed. This range of years was chosen to be consistent with comparative TSA runs. Model settings and input parameter settings for the final run are given in Table3.10.

Log index residuals for the ScoGFSQ1 are shown in Figure 3.14. The largest positive residual occurs for three ages in 2001. Because of a single exceptional haul of fish it is 2001 index values that are downweighted to zero for the SURBA assessment (ages 3–5; see above) and downweighted by placing a multiple on variance in TSA assessments (ages 4–6; see Talbe 3.11). Downweighting of individual data points is not possible in BADAPT. A summary plot from the BADAPT run is given in Figure 3.15. The same basic pattern in mean F is seen as with the SURBA run using unequal catchabilities. Although the same long term trend in SSB is seen as for SURBA (and TSA) there are considerable peaks and troughs seen in the second half of the series.

TSA

In light of disparities between assessed trends in SSB between analyses based on catch data and those based on survey data, the WGNSDS, 2004 performed runs with catch data being progressively removed and 1994 was concluded the optimal year after which to remove landings data. At WGNSDS, 2006 the final assessment used catch data up to 1994 only. A run excluding catch data from 1995 was again run this year. Only a run not allowing a persistent trend in survey catchability is included as there is no *a priori* reason to suspect a trend in survey catchability and-without landings data to contrast against-there is no divergence between catch and survey data to measure.

Comparison across models

Figure 3.16 shows mean standardised plots of SSB, recruitment at age 1 and mean Z comparing this TSA run against the SURBA and BADAPT runs using the ScoGFSQ1 data. All results show a downward trend in SSB. The result from TSA shows less variation around the long term trend. There is very high consistency between models when estimating recruitment in recent years. Mean Z results differ considerably between TSA and the other two models. The TSA model only shows very slow change in mean Z from the point where catch data is excluded. The SURBA and BADAPT models show similar variations that are much greater than in TSA. Considering also Figure 3.7 this suggests TSA interprets a greater proportion of the variations in survey abundance at age to be noise than does SURBA or BADAPT.

Both TSA and BADAPT give absolute estimates of catch. This allows the ratio of estimated to observed catch (referred to as bias estimate in BADAPT) to be considered. Figure 3.17 shows these estimates from the two models when catch data is excluded from 1995. Both models show a rise in bias to 2004 followed by a steep decrease. Confidence intervals (represented by ± 2*s.e.) overlap for all years except for 2001–2003. It is probable the downweighting of index data points in 2001 for the TSA model is influential in this respect. Both models are consistent in estimating a big reduction in catch bias over the last two years. The assessments are driven by the survey index in the latter years and can be seen as independent evidence that the introduction of the Buyers and Sellers legislation and potentially changes in fleet behaviour have led to a reduction in unallocated catch.

A TSA run was also performed with catch data excluded for the years 1995–2005 but 2006 catch data included, (i.e. assuming 2006 commercial data to be unbiased). The mean F estimate reduced sharply for the terminal year but the WG concluded that such an approach introduced an inconsistency in the mortality time series. It was considered the mortality estimate reverted from an estimate of mortality over and above M to one of fishing mortality. The WG also considered that the terminal year estimate combined with the current fixed value of natural mortality would be an underestimate of overall mortality.

The mean fishing mortality reference points for VIa cod were determined under the assumption of M=0.2. The values of mean F from the current assessments are estimates of mortality over and above M i.e. mortality from fishing plus non fishing mortality which can not be encompassed within the standard value for natural mortality. For management purposes this combined mortality would still need to fall below the level of Flim, as higher levels of mortality over and above M are considered to have led to stock decline in the early 1980s.

The WG concluded that it would adopt the approach of using TSA run on a reduced set of data and without inclusion of the most recent catch data. This would allow conventional forecasts based on absolute assessment results (forecasts using relative assessment results were considered of limited use in a previous year) while also producing assessment results that matched (to the greatest extent possible) the SSB trends found from an agreed best SURBA run and which can account (to a greater or lesser extent) for unallocated mortality.

3.1.7 Final assessment run

A TSA run using commercial catch data to 1994 and allowing no persistent trend in survey catchability was chosen as the final assessment model. Model settings and input parameter settings for the final run are given in Table 3.11. Final parameter estimates from the TSA run are given in Table 3.12, alongside final run estimates for VIa cod from previous WGs.

A summary plot for this run is shown in Figure 3.18. The disparity between the estimated total catch compared to the supplied commercial data is clear but also is the reduction of this disparity in 2006. There is a noticeable long term downward trend in recruitment although the value for 2006 is the highest value since 2000.

Standardised prediction errors at age from the final assessment run (which can be interpreted as residuals) are shown in Figure 3.19 (landings), Figure 3.20 (discards) and Figure 3.21 (ScoGFSQ1). Errors within ±2 are considered reasonable. Some prediction errors fall just outside of this range but the majority of values are within the range. There is one large value (≈ 4) with respect to age 2 in the ScoGFSQ1. Residuals at all ages show an increase in 2006 from their 2005 level.

Table 3.13 gives the TSA population numbers-at-age and Table 3.14 gives their associated standard errors. Estimated F at age is given in Table 3.15 and standard errors on log fishing mortality are given in Table 3.16. Full summary output is given in Table 3.17.

Retrospectives for the final assessment run are shown in Figure 3.22. Very little retrospective bias is seen with respect to recruitment. The TSA estimated stock-recruit relationship is shown in Figure 3.23. Retrospective bias is also small with respect to SSB although the decline over recent years has become more shallow in the latest assessment compared to last year's. The value of mean F using survey data to 2007 is that much lower than for the retrospective ending in 2005. The latest estimate is, however, more in line with retrospectives ending in earlier years. Figure 3.22 also shows lines at ± 2 se (approximate 95% confidence limits) around the run using all years of data. All retrospectives fall within these proxy confidence limits but the confidence interval for mean F is wide, reflecting uncertainty in estimation of mean F when that estimation is based on the age structure present in survey data. This does little to change the perception of the stock, however, as all mean trends show mean F at or above F_{lim} in this period and the lower confidence limit is always above F_{pa}.

3.1.8 Comparison with last year's assessment

The final run using TSA was conducted using the same basic assumptions and setup as last year's assessment. Although the latest estimate of mean F has seen a clear downward revision of recent values, perceptions of the stock have not changed. Figure 3.24 shows a comparison of SSB, recruitment at age one and mean F (2–5) estimates produced by final run assessments between this year's assessment and assessments going back to 2001.

3.1.8.1 Estimating recruiting year-class abundance

Recruitment was estimated as a ten year geometric mean using estimates from 1996 to 2005 (i.e. omitting the terminal year estimate). Recruitment in 2008 was taken to be equal to that in 2007.

3.1.8.2 Long term trends in biomass, mortality and recruitment

The overall trend in SSB for this stock is decreasing throughout the period for which data is available, (Figure 3.16, Figure 3.18 and Figure 3.22). From Figure 3.18 there is a noticeable long term downward trend in recruitment. The estimate for 2006 is however one of the highest values estimated for the last decade. Mean F shows an upward trend over the majority of the last two decades, but with a decline in the final year.

3.1.8.3 Short-term stock projections

A short term projection was made using WGFRANSW. Mean weights at age have been relatively stable over the recent past so a mean over the last three years was taken to represent the mean weights at age appropriate for a short term projection. Numbers at age in 2006 were taken from the TSA output. CVs were calculated from the standard errors on numbers at age.

It is important to note that the forecast presented here is based on survey estimates of mortality with corresponding population abundance. Whilst the assumed natural mortality and discarding have been accounted for, any additional and unallocated removals from the fishery or other sources have not and are therefore also included in the estimates of 'fishing mortality' used in the forecast. The WG consider the mortality outputs from TSA not to represent F at age but rather estimated total mortality that can not be accounted for by the standard value used for natural mortality (referred to as M and given a standard value of 0.2). These mortality estimates are here referred to as 'Z–0.2' and were not partitioned to give landings and discard F as it was not possible to determine the proportion of the mortality caused by fishing. Three year means of these Z–0.2 estimates were taken. Input data to the short term projection is shown in Table3.18. Management options from the forecast are shown in Table 3.19 and detailed tables of catch numbers at age for status quo F are shown in Table 3.20.

A plot of the short term forecast is shown in Figure 3.25. Results from sensitivity analysis from this forecast is shown in Figure 3.26 and probability profiles in Figure 3.27.

Care should be taken when using the forecast estimates of landings from the human consumption component of the fishery. These values will include estimates of unallocated removals such as misreporting or natural mortality not encompassed by the standard value of M=0.2. The WG recommends that these forecasts are not used to determine a future TAC.

Estimates of SSB corresponding to the different levels of the Z-0.2 mortality should, however, remain appropriate.

3.1.9 Medium-term stock projections

Medium term predictions are not being made at this WG. It was felt that recruitment can not be assumed to conform to historical patterns as the stock is at a historic low.

3.1.10 Yield and biomass per recruit

A yield and biomass per recruit plot is given in Figure 3.28. As outlined in Section 3.1.8.3 ‘F’ is poorly estimated and not considered to represent only fishing mortality. The value of current F has also been averaged over all ages rather than the usual range for this species (ages 2-5).

3.1.11 Biological reference points

ICES has defined the following PA reference points:

REFERENCE POINT	TECHNICAL BASIS
$\boldsymbol{B}_{pa}$=22 000 t	Previously set at 25 000 t, which was considered a level at which good recruitment is probable. This has since been reduced to 22 000 t due to an extended period of stock decline.
$\boldsymbol{B}_{lim}$=14 000 t	Smoothed estimate of $\boldsymbol{B}_{loss}$ (as estimated in 1998).
$\boldsymbol{F}_{pa}$=0.6	Consistent with $\boldsymbol{B}_{pa}$.
$\boldsymbol{F}_{lim}$=0.8	*F* values above 0.8 led to stock decline in the early 1980’s.

3.1.12 Quality of the assessment

Landings

In the recent past, the most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings - species and quantity - is known to have occurred and directly affects the perception of the stock. Furthermore, both TSA and BADAPT are strongly influenced by catch data. There are indications that misreporting has reduced from the beginning of 2006.

Effort

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

Discards

Available discard estimates are calculated mainly from the Scottish sampling program. The method used is to sample on a stratified basis and then raise by some auxiliary variable to, initially, total strata discards, and ultimately international discards. These estimates are prone to bias. At WGNSDS, 2004 a new method of raising discard data was introduced (WD 2), using the same raw data, and which will reduce estimation bias. The method is being applied and tested on data from both the Northern Shelf and North Sea regions before the resulting revised data is released to assessment working groups. Data using the new method was therefore not available for 2007 and so the data as calculated by the existing method was used.

Surveys

The survey used for this assessment changed vessel and tow duration in 1999. Although a correction has been made based on comparative tows, there will be an additional variance associated with this correction factor which will affect the survey index.

Biological factors

Biological responses of cod in VIa as a localised species to high exploitation and low population numbers are so far unknown to the working group. Morphological changes, changes in maturity and fecundity, and changes in distribution may all be causing systematic bias due to long-standing assumptions on mean weight at length and mean maturity at age.

Estimates of high consumption of cod relative to total stock biomass (see Section 3.1.12.1) have raised concerns that natural mortality of cod at younger ages may be significantly greater than the standard value of 0.2 currently assumed.

Forecasts

Short term forecasts are sensitive to the estimation of status quo mean fishing mortality. The WG considers mortality estimates arising from an assessment heavily or wholly based on survey data are poorly estimated and therefore noisy and sensitive to survey catchability. In addition, in the case of VIa cod only one survey series is considered sufficiently long and self-consistent for use in assessment. As stated earlier, concerns over bias in catch data mean the WG also feels unable to make forecasts based on commercial catch-at-age data.

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

3.1.12.1 Management considerations

Assessments based wholly on survey indices or catch at age analysis with recent catch data removed give uncertain estimates of mortality, whether mean overall mortality Z or mean fishing mortality F. These estimates are based on the age structure indicated by the survey series, which are known to be noisy. In contrast spawning biomass and recruitment appear to be robust measures of stock dynamics. All exploratory runs showed SSB for cod in VIa to have declined for 2006.

The EU Cod Recovery Plan regulation, (Council Regulation No. 423/2004) impacts on management measures for 2008, which will be formulated with reference to the estimates and forecasts of SSB in relation to limit and precautionary reference points. For stocks above $\mathbf{B}_{\mathrm{lim}}$, the harvest control rule (HCR) requires:

3) setting a TAC that achieves a 30% increase in the SSB from one year to the next,

4) limiting annual changes in TAC to ± 15% (except in the first year of application), and,

5) a rate of fishing mortality that does not exceed $\mathbf{F}_{\mathrm{pa}}$.

For stocks below $\mathbf{B}_{\mathrm{lim}}$ the Regulation specifies that:

6) conditions 1-3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application,

7) a TAC will be set lower than that calculated under conditions 1–3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application.

The TSA assessment indicates SSB to be below $\mathbf{B}_{\mathbf{lim}}$. The declining trend indicated by this assessment points to SSB for 2006 and 2007 at the lowest observed biomass in the survey series. All indications from this and previous WGs are that the stock is at a historic low level.

The days at sea restrictions imposed in division VIa do not apply west of a line running close to the shelf edge, see Figures 3.1 to 3.3. Figure 3.2 shows that officially reported landings are mostly from statistical rectangles to the west of, or bisected by, the west of Scotland management line. Figure 3.3 shows that historically, significant CPUE of mature cod were obtained from the ScoGFSQ1 in waters outside of effort restrictions. What also seems apparent from the same figure is the contraction of cod into isolated and relatively inshore areas in recent years.

Cod are taken in a mixed demersal fishery with haddock and whiting, and management advice needs to be considered in that context. Interactions between fisheries are discussed in Section 1.5. Given current stock status, fishery practices and the geographic separation between the areas inhabited by cod and *Nephrops* bycatches of cod are not currently significant in the fishery using 70–89mm gear and targeting *Nephrops*.

A report by the Sea Mammal Research unit (SMRU, 2006) gives estimates of cod consumed by grey seals to the west of Scotland for two years, based on analysis of collected seal scats. The estimated values and their confidence limits are given in the following text table:

YEAR	TOTAL CONSUMPTION (TONNES)	95% C.I.	COD TSB FROM 2006 ASSESSMENT (TONNES)
1985	5 372	3 023–8 831	29 459
2002	7 131	4 128–9 920	12 045

These values, although highly uncertain, suggest predation mortality on cod is greater than can be accommodated by the standard value of natural mortality used for gadoid species in ICES division VIa. It has not been possible, however, to quantify the level of mortality caused by seal predation. A scoping study commissioned by FRS Scotland and presented to the WG (Pope, 2007) suggests a possible method for deriving revised natural mortality values.

3.2 Cod in Division VIb

Officially reported catches are shown in Table3.21. No analytical assessment of this stock has been carried out.

Table 3.1: Cod in Division VIa. Official catch statistics in 1985–2006, as reported to ICES.

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

***Preliminary.**

Country	2003	2004	2005	2006*
Belgium				
Denmark				
Faroe Islands		2	0	0.8
France	172	91	79	100.7
Germany	+			2
Ireland	120	34	27.9	18
Netherlands	-			
Norway	46	10		30
Spain	3			
UK (E., W., N.I.)	79	46		
UK (Scotland)	879	413		
UK			403	332.1
Total landings	1,299	596	509.9	483.6

*** Preliminary.**

Table 3.2: Cod in Division VIa. Landings, discards and catch estimates 1978–2006, as used by the WG. Values are totals for fish over the ages 1 to 7+.

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

Table 3.3: Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

SCOSEI	SCOTTISH SEINERS					
1978	2005					
1	1	0	1			
1	6					
33617	743.00	224.48	64.14	41.83	13.01	3.72
38465	120.91	128.90	197.32	25.17	19.13	5.03
38640	403.38	223.25	75.45	37.21	13.44	4.13
37208	26.53	473.12	129.81	42.39	7.95	0.88
36689	405.78	139.18	137.35	31.99	14.11	3.76
38080	1205.65	509.03	65.34	58.51	14.63	4.88
29561	275.95	56.40	78.78	25.58	17.39	10.23
26365	982.36	199.94	27.31	23.41	4.88	4.88
19960	348.05	84.78	30.70	6.35	4.23	1.06

26332	4461.36	552.51	48.68	67.56	18.88	4.97
21383	63.84	451.06	41.87	4.98	3.99	1.00
39350	560.31	138.71	152.45	31.07	6.74	4.16
23235	99.96	566.35	31.11	60.19	11.87	2.06
25787	364.64	132.65	164.98	16.25	28.93	8.39
20273	1390.05	228.60	35.92	46.85	4.09	5.01
24315	86.98	389.31	87.56	10.26	16.08	2.90
21305	175.94	138.49	145.48	23.03	5.90	4.96
21950	134.47	372.92	68.30	60.81	9.78	2.11
15205	82.21	318.54	106.62	17.28	15.61	1.30
11449	317.44	102.89	77.06	23.31	12.33	13.52
11166	98.32	656.93	28.31	12.89	3.30	1.31
8638	40.64	60.26	58.57	2.03	1.08	0.74
6431	243.84	32.99	13.49	7.36	0.39	0.35
5893	7.48	101.54	4.62	0.80	1.05	0.07
3817	32.15	25.07	26.48	2.02	0.62	0.30
2370	8.76	31.65	4.56	2.22	0.07	0.01
1159	0.66	0.69	0.60	0.12	0.44	0.05
476	1.67	3.77	0.74	0.54	0.21	0.03

Table 3.3: (cont) Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

SCOLTR SCOTTISH LIGHT TRAWLERS

1978	2005					
1	1	0	1			
1	6					
127387	2242.51	685.36	185.50	133.92	32.74	7.94
99803	161.44	212.39	485.00	57.12	31.06	6.01
121211	694.04	699.09	328.14	129.35	34.24	10.46
165002	123.59	1588.52	524.05	183.42	31.06	3.88
135280	1623.74	367.84	616.01	163.81	46.10	5.89
112332	1634.45	1408.23	196.00	163.65	51.38	18.08
132217	974.48	593.35	419.46	85.37	93.80	30.56
142815	6421.55	1734.74	218.21	131.35	21.19	22.25
126533	1403.22	376.19	384.35	67.13	30.32	3.25
131720	23524.40	1058.11	143.60	116.68	27.92	12.96
158191	319.66	2464.85	309.82	49.97	37.98	8.00
217443	1795.80	291.27	989.06	200.39	46.89	19.53
142502	195.62	1334.61	87.08	202.71	37.25	6.93
209901	2081.88	815.93	534.85	38.68	97.23	30.51
189288	2197.22	655.91	193.06	240.73	17.16	24.27
189925	246.98	1274.46	301.98	46.14	80.17	10.51
174879	348.87	458.79	463.67	88.90	16.55	22.76
175631	488.40	839.26	188.99	168.65	21.32	4.31
214159	133.75	790.18	355.22	79.78	83.08	9.88
179605	819.38	371.40	394.35	109.46	18.88	18.82
142457	181.66	1343.76	100.25	64.43	21.22	5.63
98993	129.77	226.02	433.87	20.55	19.74	11.62

76157	988.51	233.22	79.43	119.99	6.99	6.12
35698	95.85	461.23	51.31	26.92	24.54	1.39
15174	219.71	85.50	183.12	15.46	5.34	6.88
9357	31.84	192.04	37.63	49.04	2.22	0.82
7113	15.33	25.63	33.93	5.11	10.68	1.20
3063	12.70	37.33	14.32	15.40	2.88	2.79

Table 3.3: (cont) Cod in Division VIa. Landings-effort series made available to the WG. Effort (first column) is given as reported hours fished per year, numbers landed are in thousands.

IreOTR Irish otter trawlers

1995	2005						
1	1	0	1				
1	7						
56335	77	453	115	33	6	1	1
60709	72	200	95	30	15	4	1
62698	215	120	57	24	6	5	2
57403	28	138	16	16	7	3	0
53192	10	65	16	3	2	0	0
46913	131	42	17	6	1	0	0
48358	19	90	14	5	3	0	0
37231	39	32	22	2	1	0	0
39803	7	37	6	5	1	0	0
35140	3	7	3	1	1	0	0
30941	4	8	2	1	0	0	0

Table 3.4: Cod in Division VIa. Survey data made available to the WG. Data used in preliminary and final runs are highlighted in bold. For ScoGFSQ1, numbers are standardised to catch-rate per 10 hours.

SCOGFSQ1 SCOTTISH WEST COAST GROUNDFISH SURVEY

1985	2007						
1	1	0	0.25				
1	7						
10	1.5	23.7	8.6	13.6	3.9	2.5	1.2
10	1.5	6.9	26.8	5.6	7.3	2.5	1.9
10	57.4	16.2	15.3	22.8	3.0	2.8	0.0
10	0.0	64.9	14.2	3.4	2.1	0.7	0.2
10	4.5	7.2	45.1	8.6	1.9	0.5	0.8
10	2.0	24.6	4.1	14.7	4.2	1.6	0.8
10	4.8	5.4	17.4	5.2	13.4	2.8	0.5
10	7.3	11.5	5.4	7.6	3.4	2.3	0.5
10	1.7	38.2	12.7	1.7	1.4	1.1	0.0
10	13.6	14.7	25.1	5.8	1.0	0.0	0.0
10	6.4	23.8	14.0	16.5	1.2	1.9	0.7
10	2.8	20.9	24.1	4.1	2.8	1.3	0.0
10	11.1	7.7	11.6	7.9	4.2	4.7	1.0
10	2.8	30.9	5.3	8.7	3.7	0.6	2.0

10	1.5	8.2	8.2	1.4	3.2	0.5	0.5
10	13.3	5.4	6.9	1.3	0.0	0.4	0.0
10	2.7	18.4	5.7	13.2	19.5	1.1	1.6
10	5.3	4.3	10.6	2.6	0.5	3.0	0.0
10	2.7	16.7	2.0	4.7	1.8	0.7	0.4
10	5.7	3.0	5.6	2.3	1.7	0.0	0.0
10	1.3	1.5	1.2	0	0	0.4	0
10	2.2	1.9	1.1	0.3	0	0	0.3
10	2.1	18.8	3.4	1.2	0	0.6	0

Table 3.4: (cont) Cod in Division VIa. Survey data made available to the WG. For IreGFS, effort is given as minutes towed, numbers are in units.

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

Table 3.4: (cont) Cod in Division VIa. Survey data made available to the WG. For ScoGFSQ4, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising.

SCOGFSQ4	QUARTER 4 SCOTTISH GROUND FISH SURVEY								
1996	2006								
1	1	0.75	1.00						
0	8								
10	0	1	14	5	3	1	0	0	0
10	1	11	2	1	1	1	0	0	0
10	+	15	9	1	0	0	0	0	0
10	2	4	6	9	1	0	0	0	0
10	0	16	3	0	0	0	0	0	0
10	1	2	9	1	1	0	0	0	0
10	1	10	3	7	1	0	0	0	0
10	1	2	11	3	1	0	0	0	0
10	0	5	4	0	+	0	0	0	0
10	+	2	3	0	1	+	0	0	0
10	0	17	6	1	1	0	0	0	0

Table 3.4: (cont) Cod in Division VIa. Survey data made available to the WG. For IRGFS, numbers are standardised to catch rate per hour.

IRGFS	IRISH WEST COAST GROUNDFISH				
2003	2006				
1	1	0.79	0.92		
0	4				
1127	0	10	11	0	0
1200	0	24	10	1	0
960	63	13	7	0	2
1510	0	95	12	0	0

Table 3.5: Cod in Division VIa. Landings at age (thousands).

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

	Age						
Year	1	2	3	4	5	6	7+
1999	132	884	1047	64	48	24	9
2000	765	532	211	231	15	12	13
2001	96	1241	155	63	52	3	4
2002	337	340	522	41	13	14	4
2003	62	516	85	107	6	2	1
2004	44	92	85	11	26	2	1
2005	31	121	43	37	7	6	0.5
2006	17	91	72	21	13	2	1

Table 3.6: Cod in Division VIa. Mean weight-at-age in landings (kg).

	Age						
Year	1	2	3	4	5	6	7+
1966	0.730	1.466	3.474	5.240	4.868	8.711	9.250
1967	0.681	1.470	2.906	4.560	6.116	7.394	8.058
1968	0.745	1.776	2.766	4.721	6.304	7.510	8.278
1969	0.860	1.284	2.821	4.259	6.169	6.374	7.928
1970	0.595	0.955	2.533	4.678	6.016	7.120	8.190
1971	0.674	1.046	2.536	4.167	6.023	6.835	8.100
1972	0.609	1.192	2.586	4.417	6.226	7.585	8.538
1973	0.597	1.181	2.784	4.601	5.625	7.049	8.611
1974	0.611	1.103	2.834	4.750	6.144	7.729	9.339
1975	0.603	1.369	3.078	5.302	6.846	8.572	10.328
1976	0.616	1.397	3.161	5.005	6.290	8.017	9.001
1977	0.629	1.160	2.605	4.715	6.269	7.525	9.511
1978	0.630	1.373	3.389	5.262	7.096	8.686	9.857
1979	0.693	1.373	2.828	4.853	6.433	7.784	9.636
1980	0.624	1.375	3.002	5.277	7.422	8.251	9.331
1981	0.550	1.166	2.839	4.923	7.518	9.314	10.328
1982	0.692	1.468	2.737	4.749	6.113	7.227	9.856
1983	0.583	1.265	2.995	4.398	6.305	8.084	9.744
1984	0.735	1.402	3.168	5.375	6.601	8.606	10.350
1985	0.628	1.183	2.597	4.892	6.872	8.344	9.766
1986	0.710	1.211	2.785	4.655	6.336	8.283	9.441
1987	0.531	1.312	2.783	4.574	6.161	7.989	10.062
1988	0.806	1.182	2.886	5.145	6.993	8.204	9.803
1989	0.704	1.298	2.425	4.737	7.027	7.520	9.594
1990	0.613	1.275	2.815	4.314	7.021	9.027	11.671
1991	0.640	1.095	2.618	4.346	6.475	8.134	10.076
1992	0.686	1.293	2.607	4.268	6.190	7.844	10.598
1993	0.775	1.316	2.940	4.646	6.244	7.802	8.409
1994	0.644	1.292	2.899	4.710	6.389	8.423	8.409
1995	0.606	1.148	2.857	4.956	6.771	8.539	9.505
1996	0.667	1.221	2.738	5.056	6.892	8.088	10.759
1997	0.595	1.210	2.571	4.805	6.952	7.821	9.630
1998	0.605	1.061	2.264	4.506	6.104	8.017	9.612
1999	0.691	1.039	2.194	4.688	6.486	8.252	9.439

Year	Age 1	2	3	4	5	6	7+
2000	0.689	1.261	2.457	4.126	6.666	7.917	8.392
2001	0.654	0.988	2.679	4.568	5.860	7.741	9.386
2002	0.668	1.140	2.330	4.841	6.175	7.192	9.548
2003	0.671	1.016	2.312	3.854	6.220	8.075	8.839
2004	0.609	1.027	2.194	4.396	6.003	8.258	9.678
2005	0.776	1.172	2.624	4.118	4.908	6.753	10.240
2006	0.656	1.169	2.236	3.822	6.172	7.796	11.1

Table 3.7: Cod in Division VIa. Discard dataset from Scottish & Irish sampling programmes, ages 1–7, years 1978–2006. Data from 1978–2001 raised from Scottish sampling only; later data raised from both Irish and Scottish sampling.

Discards at age (thousands).							
	Age						
Year	1	2	3	4	5	6	7
1978	8904	1203	0	0	0	0	0
1979	11	119	0	0	0	0	0
1980	2758	0	0	0	0	0	0
1981	289	1475	0	0	0	0	0
1982	5264	2	0	0	0	0	0
1983	7371	1005	0	0	0	0	0
1984	2117	10	0	0	0	0	0
1985	43508	3122	0	0	0	0	0
1986	4483	10	0	0	0	0	0
1987	52582	159	0	0	0	0	0
1988	714	3256	0	0	0	0	0
1989	8443	25	0	0	0	0	0
1990	1835	158	0	0	0	0	0
1991	3255	319	0	0	0	0	0
1992	12498	143	2	0	0	0	0
1993	595	51	0	0	0	0	0
1994	773	2	0	0	0	0	0
1995	1111	126	0	0	0	0	0
1996	233	86	0	0	0	0	0
1997	1074	27	0	0	0	0	0
1998	472	837	3	0	0	0	0
1999	283	16	0	0	0	0	0
2000	2081	53	0	0	0	0	0
2001	216	373	0	0	0	0	0
2002	508	32	0	0	0	0	0
2003	77	38	8	0	0	0	0
2004	232	21	0	0	0	0	0
2005	108	20	0	0	0	0	0
2006	1242	48	25	2	3	1	0.1

Table 3.7: (cont) Cod in Division VIa. Discard dataset from Scottish & Irish sampling programmes, ages 1–7, years 1978–2006. Data from 1978–2001 raised from Scottish sampling only; later data raised from both Irish and Scottish sampling.

Mean weight-at-age in discards (kg).							
	Age						
Year	1	2	3	4	5	6	7
1978	0.37	0.321	0	0	0	0	0
1979	0.276	0.43	0	0	0	0	0
1980	0.361	0	0	0	0	0	0
1981	0.135	0.326	0	0	0	0	0
1982	0.314	0.392	0	0	0	0	0
1983	0.223	0.374	0	0	0	0	0
1984	0.298	0.435	0	0	0	0	0
1985	0.178	0.346	0	0	0	0	0
1986	0.267	0.305	0	0	0	0	0
1987	0.166	0.37	0	0	0	0	0
1988	0.296	0.283	0	0	0	0	0
1989	0.332	0.59	0	0	0	0	0
1990	0.132	0.454	0	0	0	0	0
1991	0.245	0.351	0	0	0	0	0
1992	0.22	1.03	2.382	0	0	0	0
1993	0.239	0.812	3.723	0	0	0	0
1994	0.24	0.365	0	0	0	0	0
1995	0.203	0.256	0	0	0	0	0
1996	0.226	0.389	0	0	0	0	0
1997	0.321	0.328	0	0	0	0	0
1998	0.23	0.367	0.59	0	0	0	0
1999	0.294	0.299	0	0	0	0	0
2000	0.28	0.421	0	0	0	0	0
2001	0.248	0.417	0	0	0	0	0
2002	0.263	1.021	0	0	0	0	0
2003	0.272	0.57	0.39	0	0	0	0
2004	0.258	0.581	0	0	0	0	0
2005	0.285	0.501	0	0	0	0	0
2006	0.259	1.291	2.649	3.499	6.24	5.581	11.122

Table 3.8: Cod in Division VIa. Total catch at age (thousands).

	Age						
Year	1	2	3	4	5	6	7+
1978	9627	2965	999	695	286	97	75
1979	940	1731	2125	682	342	134	69
1980	3953	3294	2001	796	191	77	37
1981	749	8491	3220	904	182	29	20
1982	7091	1676	3206	1189	367	111	33
1983	9706	5520	1118	1400	468	148	60

Year	Age 1	2	3	4	5	6	7+
1984	4260	2371	2564	448	555	185	59
1985	44863	8191	1269	1091	140	167	79
1986	5275	1495	2055	411	191	40	30
1987	60456	4996	988	905	137	56	26
1988	1722	11592	2193	278	210	39	20
1989	10459	1107	3858	709	113	69	33
1990	2348	4182	432	924	170	23	11
1991	4773	2047	1805	188	266	70	23
1992	13905	2011	577	720	69	58	24
1993	923	3647	1050	131	183	24	36
1994	1715	1209	1545	280	56	51	20
1995	1864	2877	700	630	70	15	11
1996	574	2417	1210	247	204	31	13
1997	2488	1094	989	281	66	62	7
1998	783	4155	296	174	57	16	9
1999	415	900	1047	64	48	24	9
2000	2846	585	211	231	15	12	13
2001	312	1614	155	63	52	3	4
2002	845	372	522	41	13	14	4
2003	139	554	93	107	6	2	1
2004	267	113	85	11	26	2	1
2005	139	141	43	37	7	6	0.5
2006	1259	139	97	23	15	2	1

Table 3.9: Cod in Division VIa. Mean weight-at-age (kg) in total catch.

Year	Age 1	2	3	4	5	6	7+
1978	0.389	0.946	3.389	5.262	7.096	8.686	9.857
1979	0.688	1.308	2.828	4.853	6.433	7.784	9.636
1980	0.440	1.375	3.002	5.277	7.422	8.251	9.331
1981	0.390	1.020	2.839	4.923	7.518	9.314	10.328
1982	0.411	1.467	2.737	4.749	6.113	7.227	9.856
1983	0.310	1.103	2.995	4.398	6.305	8.084	9.744
1984	0.518	1.398	3.168	5.375	6.601	8.606	10.350
1985	0.191	0.864	2.597	4.892	6.872	8.344	9.766
1986	0.334	1.205	2.785	4.655	6.336	8.283	9.441
1987	0.213	1.282	2.783	4.574	6.161	7.989	10.062
1988	0.595	0.929	2.886	5.145	6.993	8.204	9.803
1989	0.404	1.282	2.425	4.737	7.027	7.520	9.594
1990	0.237	1.244	2.815	4.314	7.021	9.027	11.671
1991	0.371	0.979	2.618	4.346	6.475	8.134	10.076
1992	0.267	1.274	2.606	4.268	6.190	7.844	10.598
1993	0.430	1.309	2.940	4.646	6.244	7.802	8.409
1994	0.462	1.291	2.899	4.710	6.389	8.423	8.409
1995	0.365	1.109	2.857	4.956	6.771	8.539	9.505
1996	0.487	1.191	2.738	5.056	6.892	8.088	10.759

Year	Age 1	2	3	4	5	6	7+
1997	0.477	1.188	2.571	4.805	6.952	7.821	9.630
1998	0.379	0.921	2.248	4.506	6.104	8.017	9.612
1999	0.420	1.025	2.194	4.688	6.486	8.252	9.439
2000	0.390	1.186	2.457	4.126	6.666	7.917	8.392
2001	0.372	0.856	2.679	4.568	5.860	7.741	9.386
2002	0.424	1.130	2.330	4.841	6.175	7.192	9.548
2003	0.450	0.986	2.15	3.854	6.220	8.075	8.839
2004	0.314	0.945	2.194	4.396	6.003	8.258	9.678
2005	0.395	1.078	2.624	4.118	4.908	6.753	10.240
2006	0.264	1.211	2.341	3.797	6.184	7.031	11.103

Table 3.10: Cod in Division VIa. BADAPT parameter settings.

Adapt Analysis

2007 COD AREA 6A WITH discards

CPUE data from file cod6aEF.DAT

Catch data for 29 years : 1978 to 2006. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1985	2007	1	6	0	0.25

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
SCOGFS	1	4

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 12 years.

Oldest age F estimates in 1978 to 2007 calculated as 1.000 * the mean F of ages 3–5

Total F penalty applied lambda = 0.500

Individual fleet weighting not applied

Table 3.11: Cod in Division VIa. TSA parameter settings for the final assessment run.

PARAMETER	SETTING	JUSTIFICATION
Age of full selection.	$a_m = 4$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 6, 7+ $B_{survey}(a) = 2$ for age 1, 5, 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	H(1) = 4	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant q by 9)	Landings: age 2 in 1981 and 1987, age 7 in 1989. Discards: age 1 in 1985 and 1992, age 2 in 1998. Survey: age 1 in 2000, age 2 in 1993 and 1994, age 6 in 1995 and 2002, ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins.)	Large values indicated by exploratory prediction error plots.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 and 2 are modelled independently.	
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean η_1 S $\exp(-\eta_2$ S), where S is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	The 1986 year class was large, and recruitment at age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, N(1, 1980) is taken to be normally distributed with mean $5\eta_1$ S $\exp(-\eta_2$ S). The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966–1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant.	

Table 3.12: Cod in Division VIa. TSA parameter estimates for 2002, 2003, 2004 and 2006 assessments and final assessment presented this year. No final assessment using TSA was conducted in 2005. Run 3 from 2004 used a similar approach to this year's final assessment.

Parameter	Notation	Description	2002 WG	2003 WG	2004 WG Run1	2004 WG Run2	2004 WG Run3	2006 WG	2007 WG
Initial fishing mortality	F (1, 1978)	Fishing mortality at age a in year y	0.03	0.64	0.61	0.76	0.64	0.6378	0.6337
	F (2, 1978)		0.25	0.62	0.57	0.79	0.57	0.5333	0.5889
	F (4, 1978)		0.67	0.82	0.64	1.32	0.66	0.5743	0.6879
Survey selectivities	$\Phi(1)$	Survey selectivity at age a	0.83	0.33	0.42	0.81	0.47	0.6275	0.5425
	$\Phi(2)$		4.41	1.98	1.99	3.97	3.19	3.5857	3.7292
	$\Phi(4)$		18.28	10.65	11.06	20.3	14.92	15.9096	14.1997
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.10	0.04	0.07	0.11	0.07	0.0947	0.0741
	σ_U	Persistent changes in selection (age effect in F)	0.10	0.06	0.05	0.06	0.03	0.0242	0.0507
	σ_V	Transitory changes in the year effect in fishing mortality	0.00	0.07	0.08	0.00	0.10	0.0844	0.0984
	σ_Y	Persistent changes in the year effect in fishing mortality	0.16	0.07	0.04	0.20	0.00	0.0425	0
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.24	0.00	0.0	0.24	0.00	0.1224	0.2374
	σ_β	Persistent changes in survey catchability	0.00	0.45	0.48	0.00 (f)	0.00 (f)	0.00 (f)	0.00 (f)
Measurement standard deviations	$\sigma_{landings}$	Standard error of landings-at-age data	0.12	0.13	0.11	0.12	0.10	0.0935	0.0891
	$\sigma_{discards}$	Standard error of discards-at-age data	n/a	0.94	0.96	0.99	1.42	1.2669	1.367
	σ_{survey}	Standard error of survey data	0.36	0.56	0.43	0.46	0.35	0.3887	0.364
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	n/a	0.30	0.28	0.15	0.00	0.00	0.00
	$\sigma_{persistent}$	Persistent trends in discarding	n/a	0.16	0.27	0.23	0.68	0.5735	0.6742
Recruitment	η_1	Ricker parameter (slope at the origin)	0.82	0.62	0.54	0.60	0.80	0.6584	0.7882
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.03	0.003	0.00	0.004	0.01	0.0049	0.0124
	cv_{rec}	Coefficient of variation of recruitment data	0.36	0.56	0.52	0.50	0.49	0.4184	0.5116

Table 3.13: Cod in Division VIa. TSA population numbers-at-age (millions).

	Age						
Year	1	2	3	4	5	6	7+
1978	21.3261	9.4987	2.5669	1.4339	0.5386	0.1696	0.135
1979	29.2047	10.2149	4.2169	1.1372	0.5337	0.1919	0.1071
1980	32.3761	13.8651	4.3625	1.4162	0.2928	0.127	0.0688
1981	10.9716	16.666	6.165	1.8064	0.5047	0.1001	0.068
1982	25.5822	5.1356	6.8072	2.376	0.6757	0.1888	0.0589
1983	15.1415	11.8938	2.1521	2.5922	0.8517	0.2403	0.0886
1984	23.0653	5.8673	4.5143	0.7613	0.8412	0.2725	0.1012
1985	11.6061	11.5524	2.1903	1.4776	0.2253	0.2242	0.104
1986	18.2974	4.1503	3.8719	0.6943	0.3251	0.0605	0.0719
1987	54.8509	9.6042	1.7608	1.3794	0.2267	0.1023	0.0424
1988	5.7198	17.1524	3.6663	0.5559	0.3605	0.0658	0.0405
1989	19.0444	2.4795	5.5527	1.1614	0.1873	0.1106	0.0339
1990	6.0607	8.8676	0.9538	1.4804	0.342	0.0562	0.0416
1991	10.4555	2.9651	3.4516	0.3612	0.4902	0.1227	0.0357
1992	15.9706	4.5922	0.9877	1.1344	0.1252	0.1542	0.0504
1993	6.555	7.8941	1.8284	0.3032	0.3529	0.0431	0.0711
1994	13.5318	3.2163	3.1022	0.5762	0.1115	0.1227	0.0405
1995	11.1818	7.0372	1.4079	1.1122	0.2212	0.0426	0.0632
1996	4.3442	5.6037	2.8337	0.4542	0.422	0.0826	0.0394
1997	15.3005	2.0606	2.1496	0.8331	0.1684	0.1562	0.0445
1998	7.6085	7.5982	0.7577	0.6296	0.3033	0.0618	0.0738
1999	4.5222	3.761	2.8033	0.2047	0.2301	0.1105	0.0495
2000	9.1422	2.2549	1.4044	0.7843	0.0754	0.0847	0.059
2001	3.0339	4.6585	0.847	0.4094	0.3009	0.0288	0.0548
2002	7.4739	1.5347	1.6937	0.2266	0.1531	0.1138	0.0313
2003	2.0074	3.8307	0.5433	0.4488	0.0844	0.0571	0.0543
2004	3.8141	1.0434	1.3332	0.1429	0.163	0.0304	0.0406
2005	2.9839	1.9032	0.3412	0.3169	0.0504	0.0584	0.0255
2006	8.5565	1.5265	0.6157	0.0711	0.1102	0.0174	0.0293
2007*	3.134	4.3846	0.5603	0.1535	0.0261	0.0409	0.0173
2008*	3.6002	1.6556	1.6494	0.1496	0.0574	0.0098	0.0218
GM(78-06)	10.2964	5.0205	2.0080	0.6741	0.2541	0.0904	0.0545

***2007 and 2008 values are TSA-derived projections of population numbers.**

Table 3.14: Cod in Division VIa. Standard errors on TSA population numbers-at-age (millions).

	Age						
Year	1	2	3	4	5	6	7+
1978	3.023	0.6619	0.1209	0.0817	0.0452	0.0259	0.0189
1979	2.3258	0.655	0.1771	0.0585	0.039	0.0257	0.0163
1980	2.6805	0.8476	0.2301	0.0972	0.0285	0.0227	0.0168
1981	1.2124	1.302	0.3328	0.1003	0.036	0.0122	0.0112
1982	2.3098	0.4104	0.3873	0.1365	0.0357	0.0132	0.0041

YEAR	AGE 1	2	3	4	5	6	7+
1983	1.7402	1.0182	0.1174	0.163	0.0654	0.0241	0.0087
1984	1.8968	0.6085	0.2857	0.0509	0.0713	0.036	0.0143
1985	1.498	0.8852	0.151	0.1135	0.0232	0.0371	0.0199
1986	1.4242	0.3369	0.2366	0.0525	0.0411	0.0114	0.0179
1987	9.0827	0.6507	0.0992	0.0959	0.0214	0.0184	0.009
1988	1.0188	1.5983	0.187	0.037	0.0348	0.0105	0.0085
1989	1.9636	0.173	0.5013	0.0718	0.0135	0.0152	0.0063
1990	1.0673	0.4687	0.0529	0.1308	0.0273	0.0067	0.0067
1991	1.4587	0.2164	0.1952	0.0185	0.0416	0.0125	0.004
1992	1.4921	0.3171	0.0674	0.0737	0.0088	0.0194	0.0065
1993	0.8928	0.4722	0.1172	0.0245	0.0332	0.0048	0.0088
1994	2.3101	0.3313	0.2642	0.0598	0.0117	0.0187	0.0057
1995	2.3282	1.2623	0.2107	0.1669	0.0364	0.0074	0.012
1996	1.5939	1.1089	0.5394	0.0845	0.0689	0.0161	0.0081
1997	3.1861	0.6938	0.4636	0.1978	0.0322	0.03	0.01
1998	2.0153	1.5181	0.2689	0.1586	0.077	0.015	0.0188
1999	1.481	0.9288	0.6272	0.0844	0.0606	0.033	0.0148
2000	2.1485	0.6514	0.3656	0.2064	0.0308	0.0256	0.0195
2001	1.1213	1.0256	0.2493	0.1218	0.0741	0.0116	0.0174
2002	1.8008	0.4783	0.4167	0.0766	0.0461	0.031	0.0111
2003	1.0578	0.8708	0.1752	0.1336	0.0291	0.02	0.0186
2004	1.4153	0.453	0.3473	0.0492	0.0512	0.0126	0.0166
2005	1.0678	0.6731	0.1584	0.1065	0.0187	0.0221	0.012
2006	1.2637	0.4875	0.2385	0.0422	0.0377	0.0079	0.0142
2007*	1.2865	0.616	0.1754	0.0661	0.0155	0.0149	0.0088
2008*	1.9191	0.7089	0.3464	0.0547	0.025	0.0061	0.0094
GM(78-06)	1.7434	0.6345	0.2225	0.0830	0.0347	0.0167	0.0112

***2007 and 2008 values are standard errors on TSA-derived projections of population numbers.**

Table 3.15: Cod in Division VIa. TSA estimates for fishing mortality-at-age.

YEAR	AGE 1	2	3	4	5	6	7+
1978	0.5432	0.6195	0.6119	0.7839	0.8133	0.8173	0.8145
1979	0.5727	0.7051	0.8319	1.0364	1.0436	1.0279	1.0116
1980	0.4877	0.6562	0.6825	0.8168	0.8455	0.8258	0.8163
1981	0.5051	0.6866	0.7544	0.7461	0.6827	0.7218	0.7278
1982	0.5905	0.6714	0.7589	0.821	0.8319	0.8273	0.8305
1983	0.6576	0.7433	0.8307	0.9051	0.9136	0.9439	0.9529
1984	0.5461	0.7265	0.8658	0.9675	1.0177	0.988	0.9701
1985	0.7116	0.8646	0.9064	1.1389	1.0369	1.1028	1.0958
1986	0.463	0.6541	0.8101	0.9018	0.8993	0.9021	0.8817
1987	0.7304	0.7681	0.928	1.0754	1.0139	1.0186	1.0257
1988	0.5873	0.7701	0.943	0.8887	0.9577	0.94	0.9301
1989	0.5623	0.7479	0.9914	1.0064	0.9951	1.0132	1.002
1990	0.5091	0.7394	0.7636	0.8929	0.8237	0.809	0.8003

YEAR	AGE 1	2	3	4	5	6	7+
1991	0.6106	0.8674	0.909	0.8597	0.9351	0.9353	0.9436
1992	0.4918	0.7204	0.9465	0.9573	0.8661	0.8547	0.866
1993	0.5133	0.7339	0.9526	0.7999	0.8542	0.8392	0.833
1994	0.4538	0.6215	0.8245	0.7558	0.7578	0.7423	0.7516
1995	0.4898	0.7103	0.9294	0.7729	0.7821	0.7827	0.7833
1996	0.5192	0.7544	1.0095	0.7965	0.7888	0.8003	0.8009
1997	0.5001	0.7704	1.0202	0.8076	0.8017	0.7989	0.8021
1998	0.5053	0.7864	1.0554	0.8058	0.8087	0.8066	0.8062
1999	0.5047	0.7878	1.0646	0.8008	0.8004	0.7991	0.7984
2000	0.4719	0.7691	1.0312	0.751	0.758	0.7595	0.759
2001	0.4967	0.8026	1.0896	0.7853	0.7725	0.7811	0.7816
2002	0.4758	0.8065	1.1003	0.782	0.7821	0.7789	0.7811
2003	0.4933	0.8327	1.1259	0.7998	0.8025	0.799	0.799
2004	0.5044	0.844	1.1758	0.8193	0.8146	0.8166	0.8153
2005	0.4886	0.878	1.2251	0.8453	0.845	0.8413	0.8413
2006	0.4157	0.8032	1.1621	0.7989	0.7928	0.7938	0.793
2007*	0.4381	0.7777	1.1206	0.7826	0.7816	0.7799	0.7802
2008*	0.4413	0.7875	1.1265	0.7844	0.7844	0.7844	0.7844
GM(78-06)	0.5267	0.7499	0.9289	0.8538	0.8516	0.8524	0.8509

***Estimates for 2007 and 2008 are TSA projections.**

Table 3.16: Cod in Division VIa. Standard errors of TSA estimates for log fishing mortality-at-age.

YEAR	AGE 1	2	3	4	5	6	7+
1978	0.2081	0.1362	0.0665	0.0625	0.0744	0.0864	0.0877
1979	0.2113	0.1342	0.0606	0.0541	0.0655	0.0808	0.0837
1980	0.2112	0.1246	0.0643	0.0616	0.0651	0.0816	0.0844
1981	0.2139	0.1031	0.0615	0.0616	0.0719	0.0857	0.0882
1982	0.2064	0.1081	0.0649	0.0658	0.0787	0.0884	0.0941
1983	0.1882	0.0998	0.0617	0.0614	0.0723	0.0844	0.0883
1984	0.2007	0.1082	0.0635	0.0615	0.0676	0.0825	0.0869
1985	0.1928	0.0888	0.065	0.0579	0.0713	0.0797	0.085
1986	0.2102	0.0984	0.065	0.0647	0.0708	0.0875	0.0859
1987	0.1813	0.0953	0.0601	0.0587	0.0755	0.0848	0.0898
1988	0.2072	0.0779	0.0571	0.0638	0.0692	0.0897	0.091
1989	0.1921	0.0833	0.0663	0.0592	0.0707	0.0809	0.0902
1990	0.2072	0.0702	0.0657	0.0647	0.0724	0.0864	0.088
1991	0.1992	0.0684	0.0628	0.0634	0.0689	0.0844	0.0905
1992	0.1977	0.0788	0.0647	0.0659	0.0789	0.0861	0.0927
1993	0.2115	0.0838	0.0742	0.082	0.0915	0.1023	0.1005
1994	0.2213	0.124	0.1132	0.1182	0.1275	0.1282	0.1288
1995	0.2379	0.1491	0.1414	0.1421	0.1426	0.1438	0.1438
1996	0.2416	0.1563	0.1468	0.1464	0.1466	0.1476	0.1478
1997	0.241	0.1646	0.1537	0.1511	0.1515	0.1523	0.1525

	AGE						
YEAR	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1998	0.2469	0.1682	0.1606	0.155	0.1554	0.1563	0.1565
1999	0.2502	0.1759	0.1646	0.1601	0.1595	0.1605	0.1606
2000	0.2533	0.1824	0.1727	0.1636	0.1642	0.1642	0.1644
2001	0.2556	0.1857	0.1746	0.1648	0.1655	0.1665	0.1665
2002	0.2581	0.1924	0.1772	0.169	0.169	0.1699	0.1701
2003	0.2628	0.1949	0.1851	0.1725	0.1727	0.1736	0.1738
2004	0.2621	0.203	0.1855	0.1756	0.1762	0.1771	0.1773
2005	0.2703	0.2078	0.1954	0.1828	0.1828	0.1839	0.1842
2006	0.2735	0.2152	0.2026	0.1916	0.1908	0.1916	0.1919
2007*	0.2817	0.2233	0.2131	0.1991	0.1989	0.1988	0.199
2008*	0.2865	0.2292	0.2192	0.2054	0.2054	0.2054	0.2054
GM(78-06)	0.2230	0.1257	0.0979	0.0955	0.1037	0.1139	0.1165

***Estimates for 2007 and 2008 are standard errors of TSA projections of log *F*.**

Table 3.17: Cod in Division VIa. TSA stock summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight.

*** Estimates 2007, 2008 are TSA projections.**

Year	Landings (000 tonnes)			Discards (000 tonnes)			Total catch (000 tonnes)			Mean F (2–5)		SSB (000 tonnes)		TSB (000 tonnes)		Recruitment at age	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1978	13.5205	13.4051	0.5845	3.6808	3.5452	0.9098	17.2013	17.7837	1.2624	0.7072	0.0338	26.3245	0.7554	40.1627	1.5977	21.3261	3.023
1979	16.0887	15.8597	0.6526	0.0541	4.3067	0.8144	16.1427	27.228	2.1269	0.9043	0.0382	28.6834	0.7932	56.8663	2.1093	29.2047	2.3258
1980	17.8789	17.8362	0.7832	0.9958	3.7767	0.9167	18.8747	25.2127	1.8229	0.7502	0.034	32.5131	1.0861	57.7588	2.0941	32.3761	2.6805
1981	23.8646	22.1854	1.3687	0.5198	1.0934	0.3478	24.3843	24.5834	1.5039	0.7174	0.0308	38.2149	1.2431	53.1059	1.8744	10.9716	1.2124
1982	21.5108	22.763	1.015	1.6539	2.5043	0.7539	23.1647	25.7184	1.5219	0.7708	0.0354	37.2986	1.1788	54.0461	1.7586	25.5822	2.3098
1983	21.3052	20.8843	0.8848	2.0195	1.5249	0.4663	23.3247	22.5073	1.3202	0.8482	0.0352	31.9399	1.0899	43.8262	1.6456	15.1415	1.7402
1984	21.2717	19.6659	0.9585	0.6355	2.3214	0.632	21.9071	23.6555	1.5609	0.8944	0.0377	29.6017	1.144	47.4838	1.9129	23.0653	1.8968
1985	18.6071	17.3593	0.828	8.8246	1.0492	0.3154	27.4317	16.7027	1.0213	0.9867	0.0393	21.7453	0.8893	29.5563	1.2075	11.6061	1.498
1986	11.8201	11.5409	0.6309	1.1998	1.5025	0.3779	13.0199	13.294	0.8518	0.8163	0.035	18.3454	0.7415	28.3589	1.0559	18.2974	1.4242
1987	18.9705	17.8868	0.9292	8.7876	3.1946	1.2051	27.7581	19.7412	1.8965	0.9463	0.0392	19.5667	0.7126	37.8753	2.2728	54.8509	9.0827
1988	20.4133	18.9358	1.2593	1.133	0.7331	0.263	21.5462	18.6898	1.3288	0.8899	0.0342	23.708	0.9814	36.2422	1.7896	5.7198	1.0188
1989	17.1693	15.2827	1.05	2.818	1.8864	0.6078	19.9873	17.0193	1.3149	0.9352	0.0373	21.2071	1.1344	32.3065	1.5768	19.0444	1.9636
1990	12.1755	11.9495	0.6052	0.3141	0.3483	0.1286	12.4896	12.3388	0.7044	0.8049	0.0321	17.8251	0.6923	24.9323	0.9169	6.0607	1.0673
1991	10.9267	10.9045	0.5133	0.9095	0.7404	0.2807	11.8362	11.4988	0.6976	0.8928	0.034	15.3819	0.5628	21.9153	0.8769	10.4555	1.4587
1992	9.0862	8.9822	0.4056	2.9024	1.1405	0.3344	11.9886	9.8021	0.5804	0.8726	0.0379	12.6173	0.4894	20.0531	0.777	15.9706	1.4921
1993	10.3142	10.4562	0.4322	0.1846	0.6353	0.2061	10.4988	11.3638	0.5897	0.8352	0.046	14.5428	0.5872	23.0708	0.9706	6.555	0.8928
1994	8.9279	9.2018	0.4327	0.1863	0.8969	0.304	9.1142	10.8107	0.7295	0.7399	0.0652	14.6929	0.9539	24.1945	1.6664	13.5318	2.3101
1995	9.4385	10.2083	1.3792	0.258	0.694	0.2526	9.6965	11.2759	1.5166	0.7987	0.0843	15.4906	1.6266	23.8885	2.448	11.1818	2.3282
1996	9.4267	11.0502	1.6724	0.086	0.3548	0.1798	9.5127	11.7409	1.7773	0.8373	0.0885	16.4402	1.9516	22.8505	2.7393	4.3442	1.5939
1997	7.0336	8.527	1.537	0.3537	1.4355	0.603	7.3872	10.5515	1.758	0.85	0.0916	12.8506	1.8093	22.0935	2.855	15.3005	3.1861
1998	5.7139	8.1469	1.5151	0.4175	0.5924	0.2796	6.1314	8.5643	1.4672	0.864	0.0938	10.9971	1.5584	17.4769	2.3608	7.6085	2.0153
1999	4.201	7.716	1.4436	0.0879	0.4199	0.2252	4.2889	8.273	1.4894	0.8634	0.0947	11.1272	1.7015	15.741	2.3018	4.5222	1.481
2000	2.9771	6.1747	1.2721	0.6049	0.7331	0.3586	3.582	6.97	1.2463	0.8273	0.0924	9.2619	1.4807	14.5923	2.0994	9.1422	2.1485
2001	2.347	5.8934	1.1174	0.2093	0.2754	0.1781	2.5563	5.9861	1.0781	0.8625	0.0948	8.3952	1.2376	11.7566	1.7081	3.0339	1.1213
2002	2.2426	5.1812	1.1324	0.1662	0.5929	0.3117	2.4089	5.9804	1.121	0.8677	0.0956	7.4549	1.1977	12.0113	1.7862	7.4739	1.8008
2003	1.2411	4.3943	0.9091	0.0458	0.2236	0.1882	1.2869	4.6257	0.9151	0.8902	0.0989	6.1625	0.969	9.0415	1.476	2.0074	1.0578
2004	0.5402	3.72	0.86	0.0718	0.3029	0.1961	0.612	3.9722	0.8501	0.9134	0.1009	5.2792	0.9453	7.3601	1.3159	3.8141	1.4153
2005	0.5114	3.0358	0.8246	0.0406	0.2693	0.1766	0.552	3.2594	0.7825	0.9484	0.1086	4.0443	0.8407	6.3323	1.3079	2.9839	1.0678
2006	0.4545	2.749	0.9371	0.4777	0.6062	0.3442	0.9323	3.2234	0.7069	0.8892	0.1056	3.5306	0.8049	6.8817	1.2053	8.5565	1.2637
2007*	NA	3.8773	0.8201	NA	0.3196	0.2887	NA	4.126	0.729	0.8656	0.1068	4.852	0.773	8.3251	1.2492	3.134	1.2865

YEAR	LANDINGS (000 TONNES)			DISCARDS (000 TONNES)			TOTAL CATCH (000 TONNES)			MEAN F (2–5)		SSB (000 TONNES)		TSB (000 TONNES)		RECRUITMENT AT AGE	
	OBS.	PRED.	SE	OBS.	PRED.	SE	OBS.	PRED.	SE	ESTIMATE	SE	ESTIMATE	SE	ESTIMATE	SE	ESTIMATE	SE
2008*	NA	4.0618	0.9018	NA	0.2902	0.2177	NA	4.3388	0.8809	0.8707	0.1089	5.5346	1.0173	8.1104	1.5832	3.6002	1.9191
Min	0.4545	2.7490	0.4056	0.0406	0.2236	0.1286	0.5520	3.2234	0.5804	0.7072	0.0308	3.5306	0.4894	6.3323	0.7770	2.0074	0.8928
GM	7.1260	10.1237	0.8951	0.4838	0.9149	0.3519	8.0347	11.4171	1.1480	0.8498	0.0551	14.8912	1.0111	23.1103	1.6220	10.2964	1.7434
AM	11.0338	11.7895	0.9632	1.3669	1.3000	0.4192	12.4006	13.5301	1.2256	0.8526	0.0619	17.7670	1.0744	27.6476	1.7140	13.7838	1.9957
Max	23.8646	22.7630	1.6724	8.8246	4.3067	1.2051	27.7581	27.2280	2.1269	0.9867	0.1086	38.2149	1.9516	57.7588	2.8550	54.8509	9.0827

Table 3.18: Cod in Division VIa. Inputs to short-term predictions from final TSA run. Mean weights assumed from final 3 years.

Table_____Cod,VIa

input data for catch forecast and linear sensitivity analysis

LABEL	VALUE	CV	LABEL	VALUE	CV
Number at age			Weight in the stock		
N1	3134	0.41	WS1	0.32	0.20
N2	4384	0.14	WS2	1.08	0.12
N3	560	0.31	WS3	2.39	0.09
N4	153	0.43	WS4	4.10	0.07
N5	26	0.59	WS5	5.70	0.12
N6	40	0.36	WS6	7.35	0.11
N7	17	0.51	WS7	10.34	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.47	0.10	WH1	0.32	0.20
sH2	0.84	0.04	WH2	1.08	0.12
sH3	1.19	0.03	WH3	2.39	0.09
sH4	0.82	0.03	WH4	4.10	0.07
sH5	0.82	0.03	WH5	5.70	0.12
sH6	0.82	0.03	WH6	7.35	0.11
sH7	0.82	0.03	WH7	10.34	0.07
Natural mortality			Proportion mature		
M1	0.20	0.10	MT1	0.00	0.10
M2	0.20	0.10	MT2	0.52	0.10
M3	0.20	0.10	MT3	0.86	0.10
M4	0.20	0.10	MT4	1.00	0.10
M5	0.20	0.10	MT5	1.00	0.00
M6	0.20	0.10	MT6	1.00	0.00
M7	0.20	0.10	MT7	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF07	1.00	0.05	K07	1.00	0.10
HF08	1.00	0.05	K08	1.00	0.10
HF09	1.00	0.05	K09	1.00	0.10

Recruitment in 2008 and 2009

R07	5052	0.62
R08	5052	0.62

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

Stock numbers in 2007 are TSA survivors.

Table 3.19: Cod in Division VIa. Results of short-term forecasts from final TSA run. Management options.

Table_____.Cod,VIa

Catch forecast output and estimates of coefficient of variation (CV) from linear analysis.

	Year							
	2007	2008						
Mean F Ages								
H.cons 2 to 5	0.92	0.00	0.18	0.37	0.55	0.73	0.92	1.10
Effort relative to 2006								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	8.34	8.23	8.23	8.23	8.23	8.23	8.23	8.23
SSB at spawning time	4.87	5.25	5.25	5.25	5.25	5.25	5.25	5.25
Catch weight (,000t)								
H.cons	4.32	0.00	1.25	2.28	3.14	3.85	4.44	4.94
Biomass in year.... 2009								
Total 1 January		15.67	13.50	11.70	10.20	8.95	7.91	7.03
SSB at spawning time		11.45	9.54	7.97	6.68	5.62	4.74	4.01

	Year							
	2007	2008						
Effort relative to 2006								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.14	0.18	0.18	0.18	0.18	0.18	0.18	0.18
SSB at spawning time	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Catch weight								
H.cons	0.14	0.00	0.26	0.18	0.17	0.16	0.16	0.16
Biomass in year.... 2009								
Total 1 January		0.22	0.23	0.24	0.25	0.26	0.28	0.29
SSB at spawning time		0.19	0.20	0.21	0.22	0.23	0.24	0.25

Table 3.20: Cod in Division VIa. Results of short-term forecasts from final TSA run. Detailed tables.

FORECAST FOR YEAR 2007

F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	3134	1073	1073
2	4385	2293	2293
3	560	360	360
4	154	79	79
5	26	13	13
6	41	21	21
7	17	9	9
Wt	8	4	4

Forecast for year 2008

F multiplier H.cons=1.00

	Populations	Catch number	
Age	Stock No.	H.Cons	Total
1	5052	1730	1730
2	1604	839	839
3	1547	993	993
4	140	72	72
5	55	28	28
6	9	5	5
7	21	11	11
Wt	8	4	4

Table 3.21: Cod in Division VIb (Rockall). Official catch statistics.

COUNTRY	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	18	-	1	-	31	5	-	-	-	1	-	-
France	9	17	5	7	2	-	-	-	-	-	-	-
Germany	-	3	-	-	3	-	-	126	2	-	-	-
Ireland	-	-	-	-	-	-	400	236	235	472	280	477
Norway	373	202	95	130	195	148	119	312	199	199	120	92
Portugal	-	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	-	-
Spain	241	1200	1219	808	1345	-	64	70	-	-	-	2
UK (E. & W. & N.I.)	161	114	93	69	56	131	8	23	26	103	25	90
UK (Scotland)	221	437	187	284	254	265	758	829	714	322	236	370
Total	1,023	1,973	1,600	1,298	1,886	549	1,349	1,596	1,176	1,097	661	1,031

COUNTRY	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Faroe Islands	-	-	-	-	n/a	n/a	n/a				
France	-	-	-	-	+	+*	1			0.08	
Germany	10	22	3	11	1	-	-				
Ireland	436	153	227	148	119	40	18	11	7		22.7
Norway	91	55*	51*	85*	152*	89	28	25	23	7	7
Portugal	-	5	-	-	-	-	-				
Russia	-	-	-	-	7	26	-				
Spain	5	1	6	4	3	1		6			
UK (E. & W. & N.I.)	23	20	32	22	4	2	2	3			
UK (Scotland)	210	706	341	389	286	176	67	57			
UK									45	44	28.7
Total	775	962	660	659	572	334	115	102	75	51	58.4

*** Preliminary**

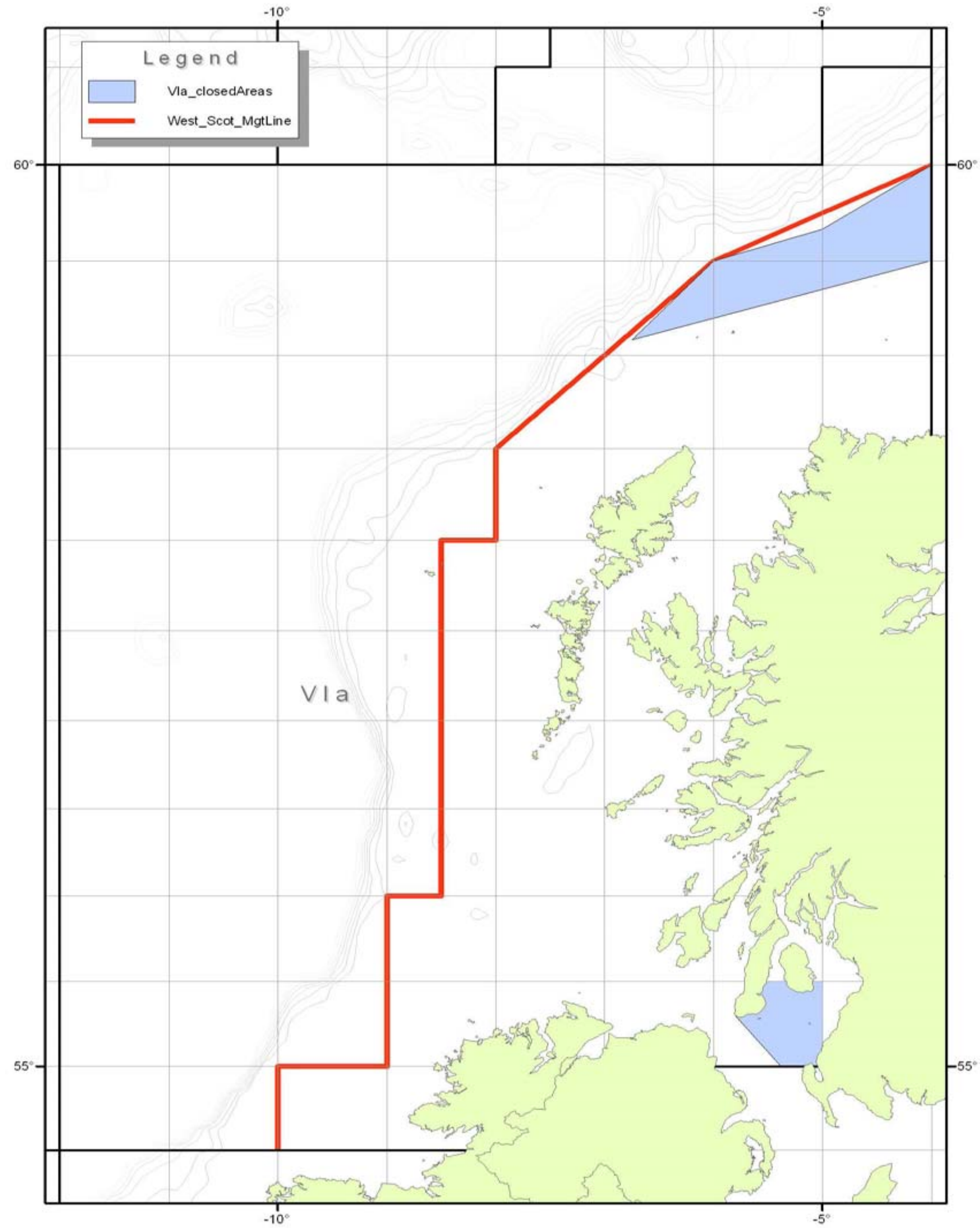


Figure 3.1: Cod in Division VIa. Map showing closed area in the far north east of VIa known as the 'windsock' introduced by Council Regulation No 2287\2003 and closed area in the Clyde -- The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002. Dark line running close to shelf edge is boundary to current cod recovery plan and effort restrictions in VIa (Council Regulation No 41\2006) know as the West of Scotland management line.

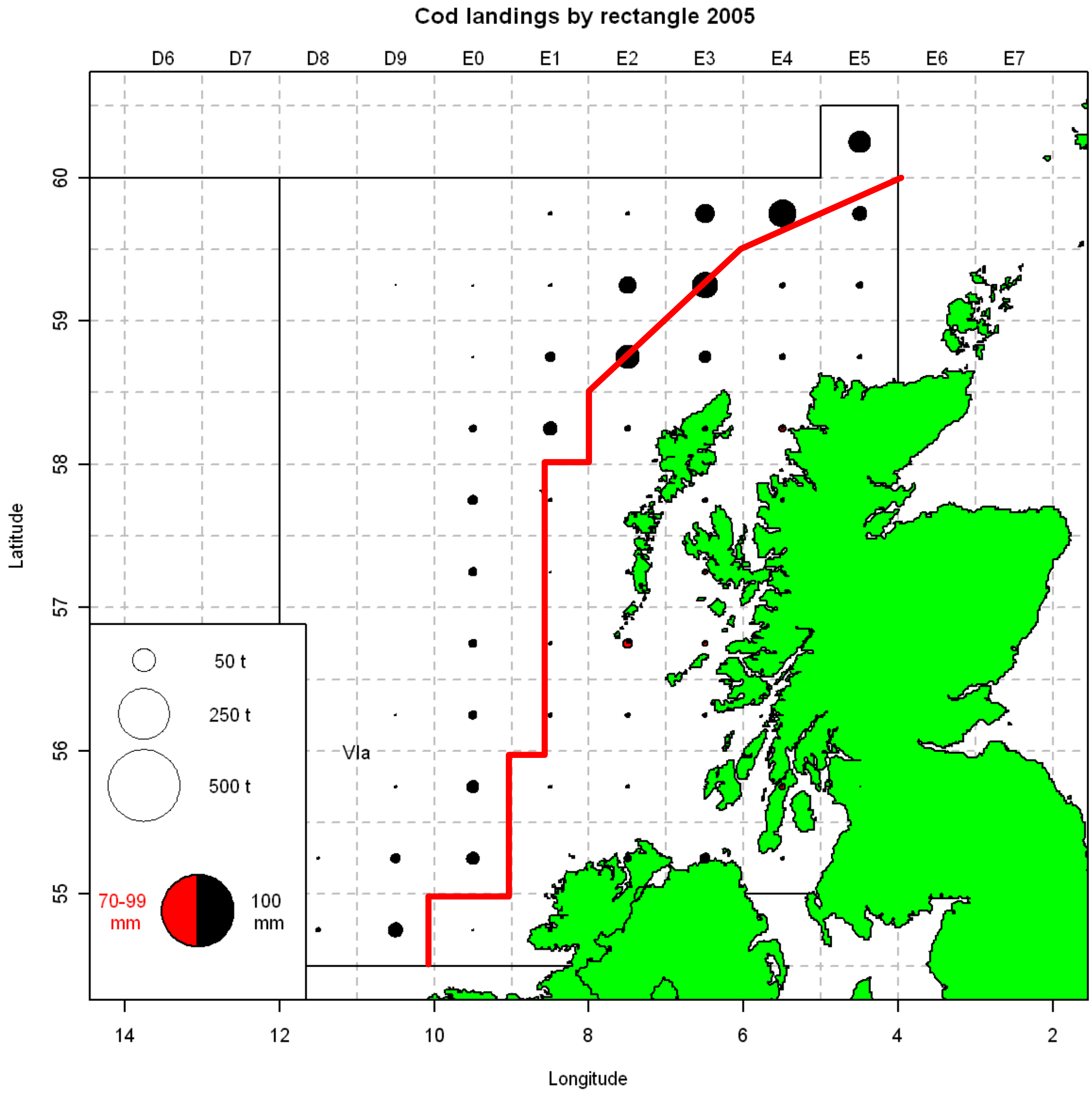


Figure 3.2: Cod in Division VIa. International landings by ICES statistical rectangle. Data compiled from reported landings by Scotland, Ireland and France in 2005. Dark line running close to shelf edge is boundary to current cod recovery plan and effort restrictions in VIa (Council Regulation No 41\2006) know as the West of Scotland management line.

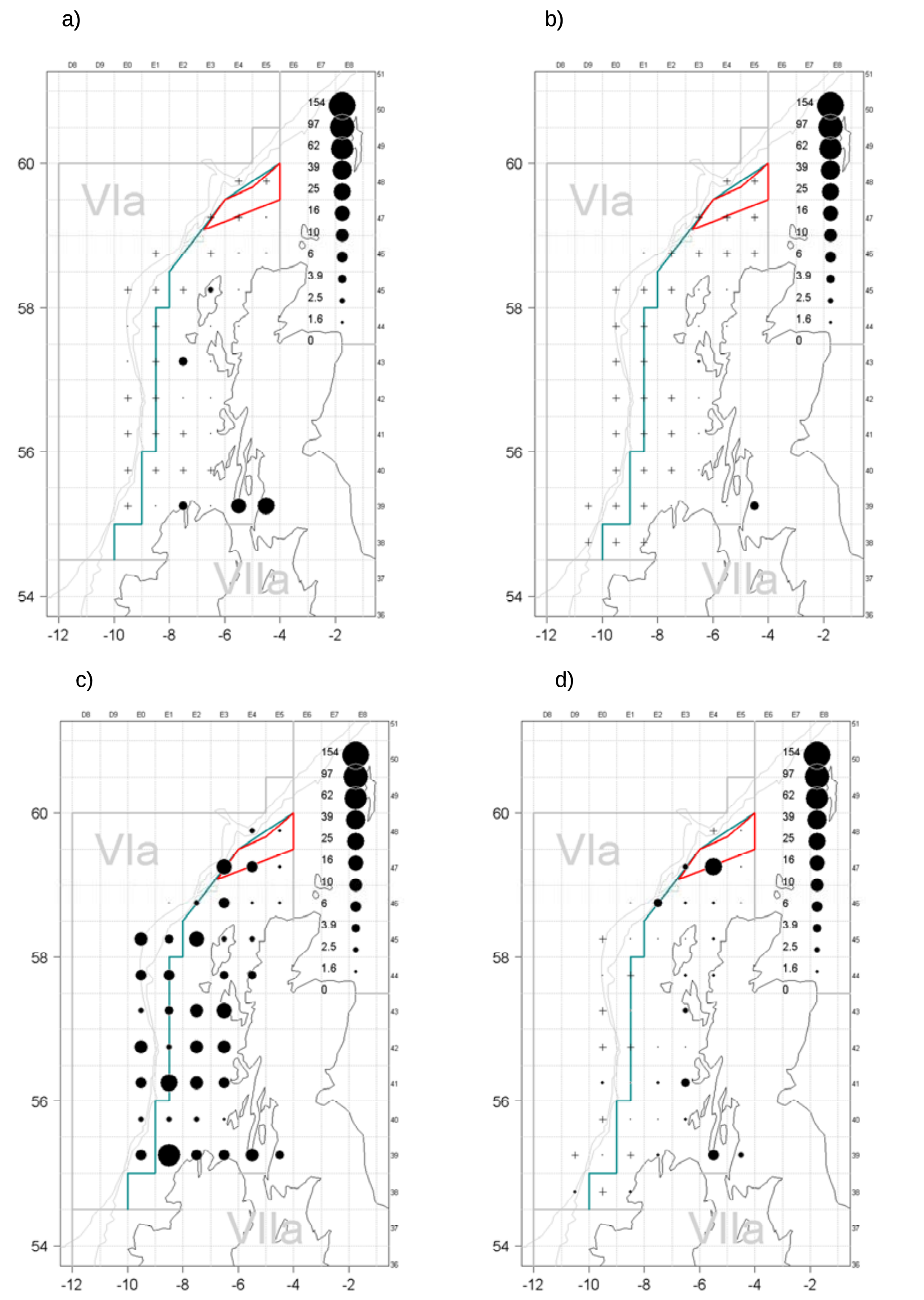


Figure 3.3: Cod in Division VIa. CPUE numbers at age by ICES statistical rectangle resulting from Scottish quarter one ground fish survey (ScoGFSQ1). Maps show the distribution of age 1 fish and fish of age 2+. For each age group five year means are presented. a) age 1 1983–1987; b) age1 2001–2005; c) age 2+ 1983–1987; d) age2+ 2001–2005. A plus indicates a stat square that was sampled but where no fish were found. Enclosed area is closed area known as the 'windsock' introduced by Council Regulation No 2287\2003. Dark line running close to shelf edge is boundary to current cod recovery plan and effort restrictions in VIa (Council Regulation No 51\2006).

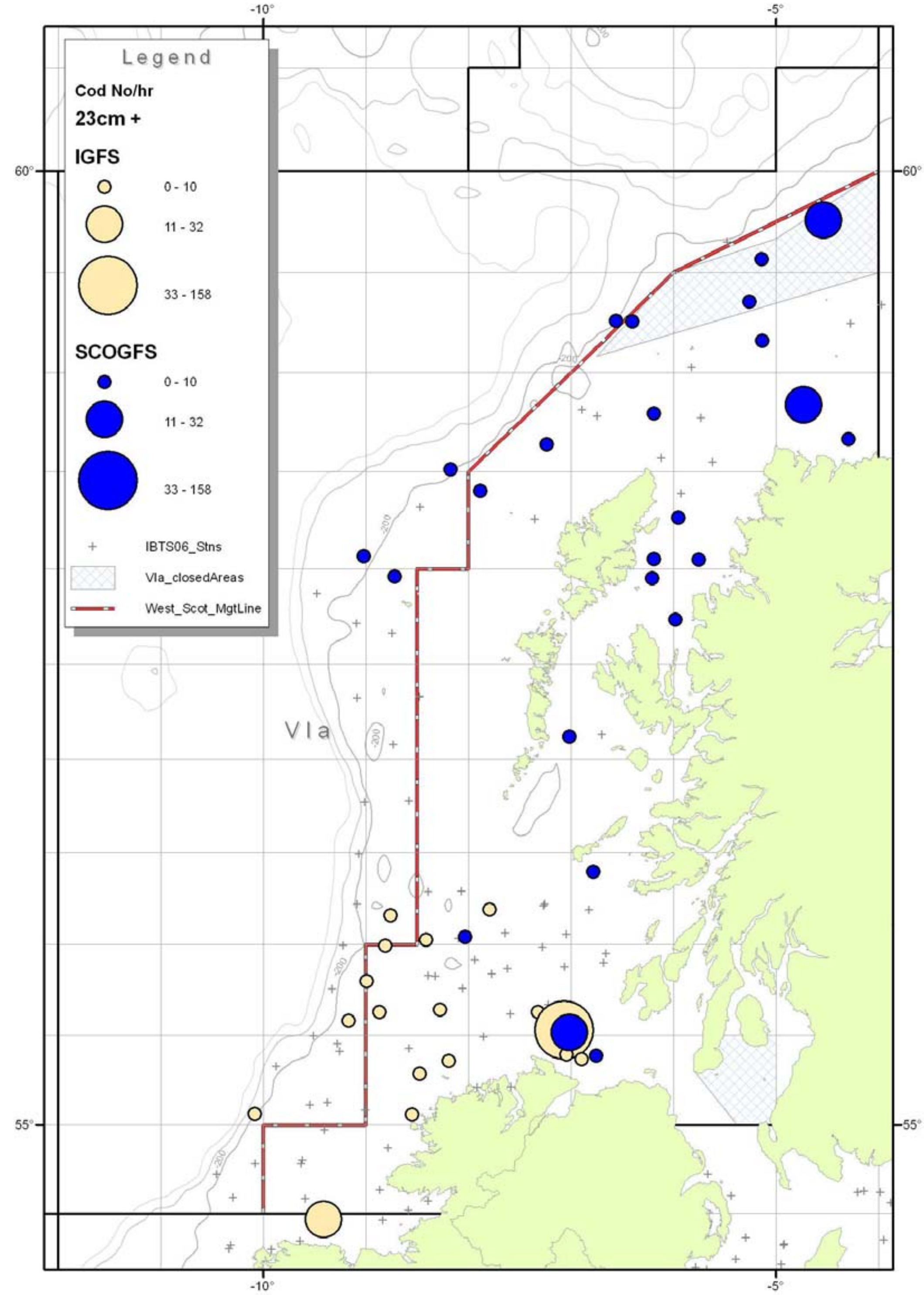
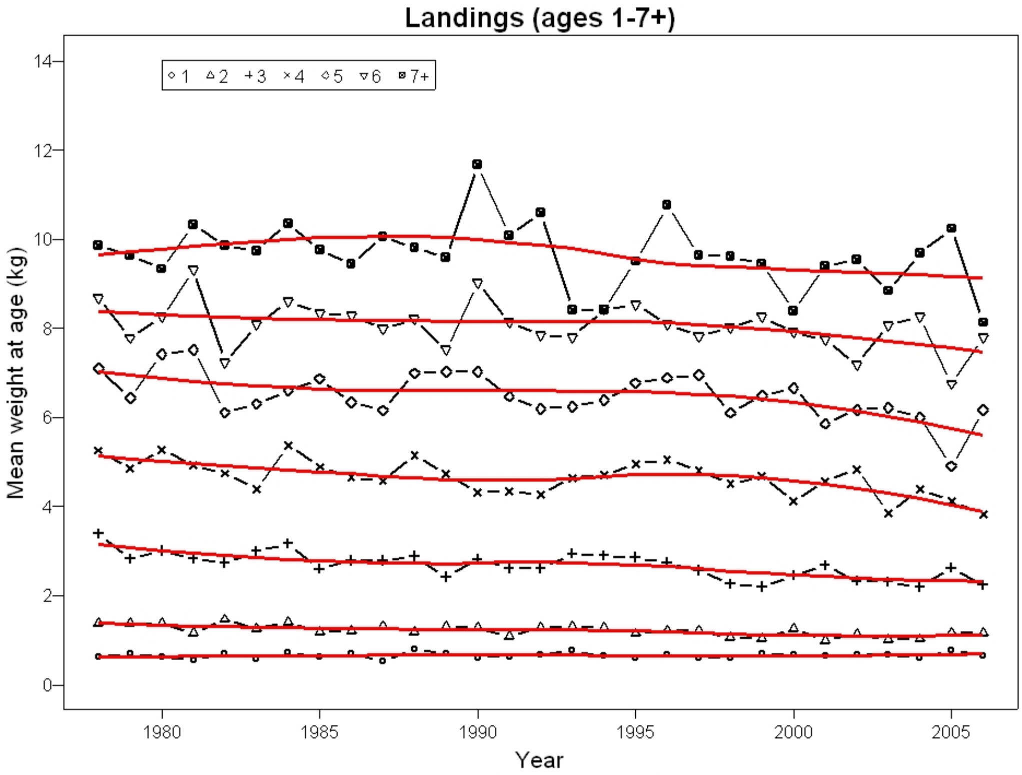


Figure 3.4: Cod in Division VIa. CPUE numbers for fish greater than 23 cm length (proxy for age 1+) by ICES statistical rectangle resulting from quarter four surveys. Scottish quarter four ground fish survey (ScoGFSQ4) and Irish ground fish survey (IRGFS).



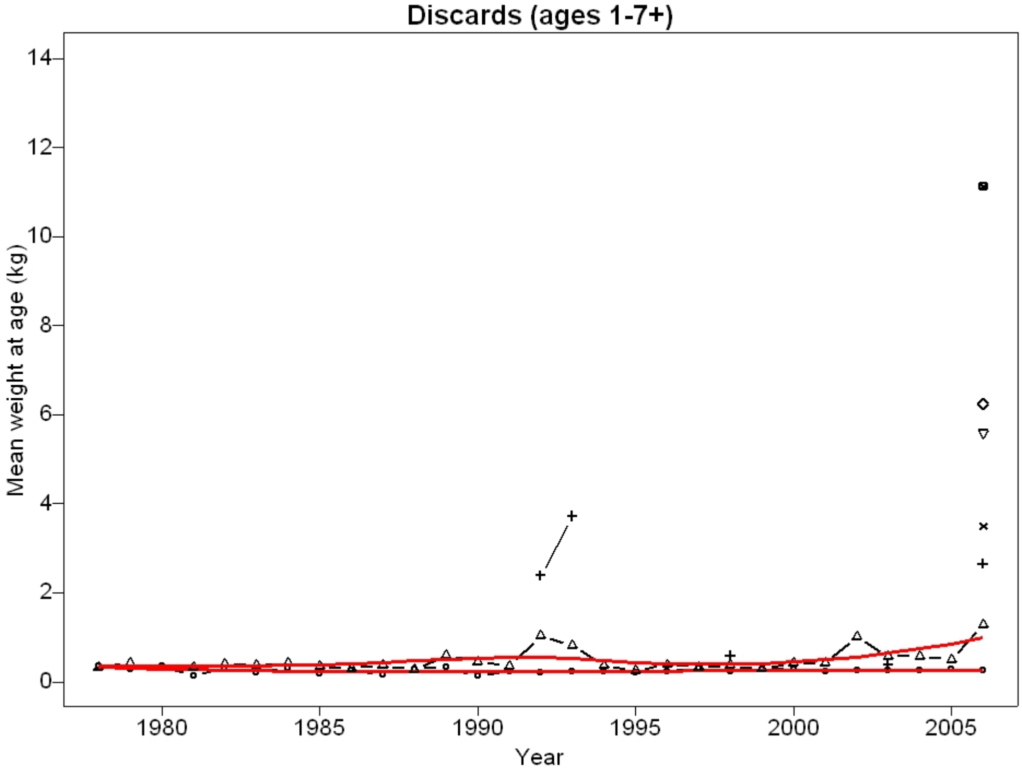


Figure 3.5: Cod in Division VIa. Mean weights-at-age in landings and discards.

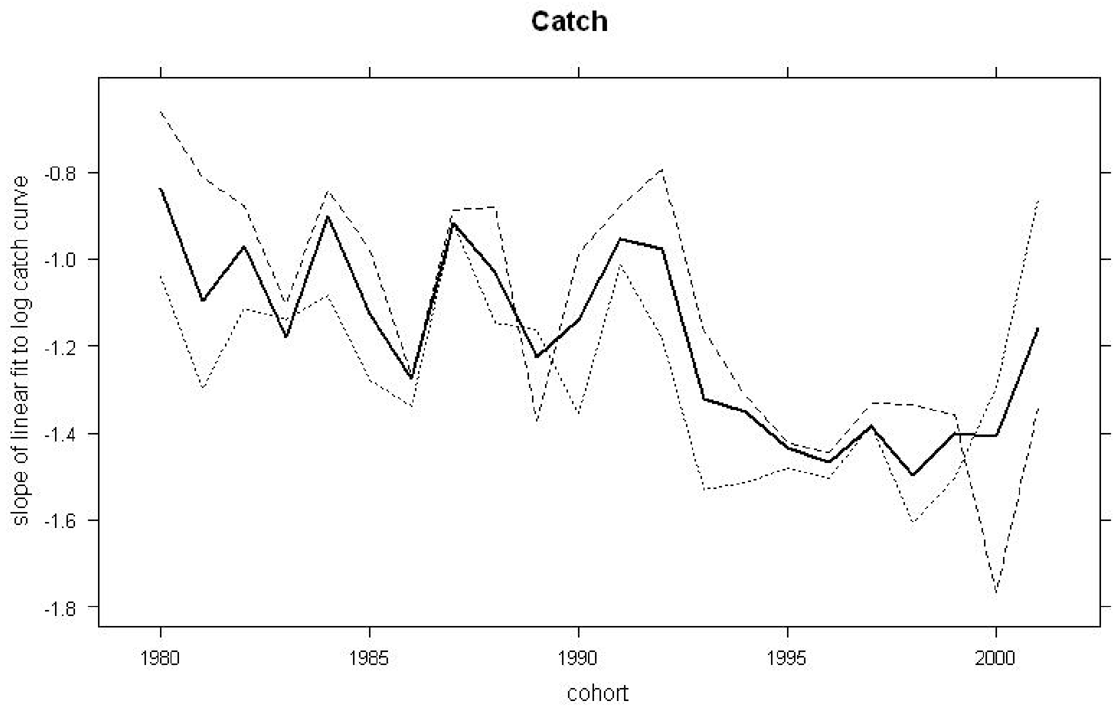


Figure 3.6: Cod in Division VIa. Log catch curve gradient plot using WG commercial catch at age data. Solid line shows time series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–6. Increasing mortality is indicated by the slope value becoming more negative.

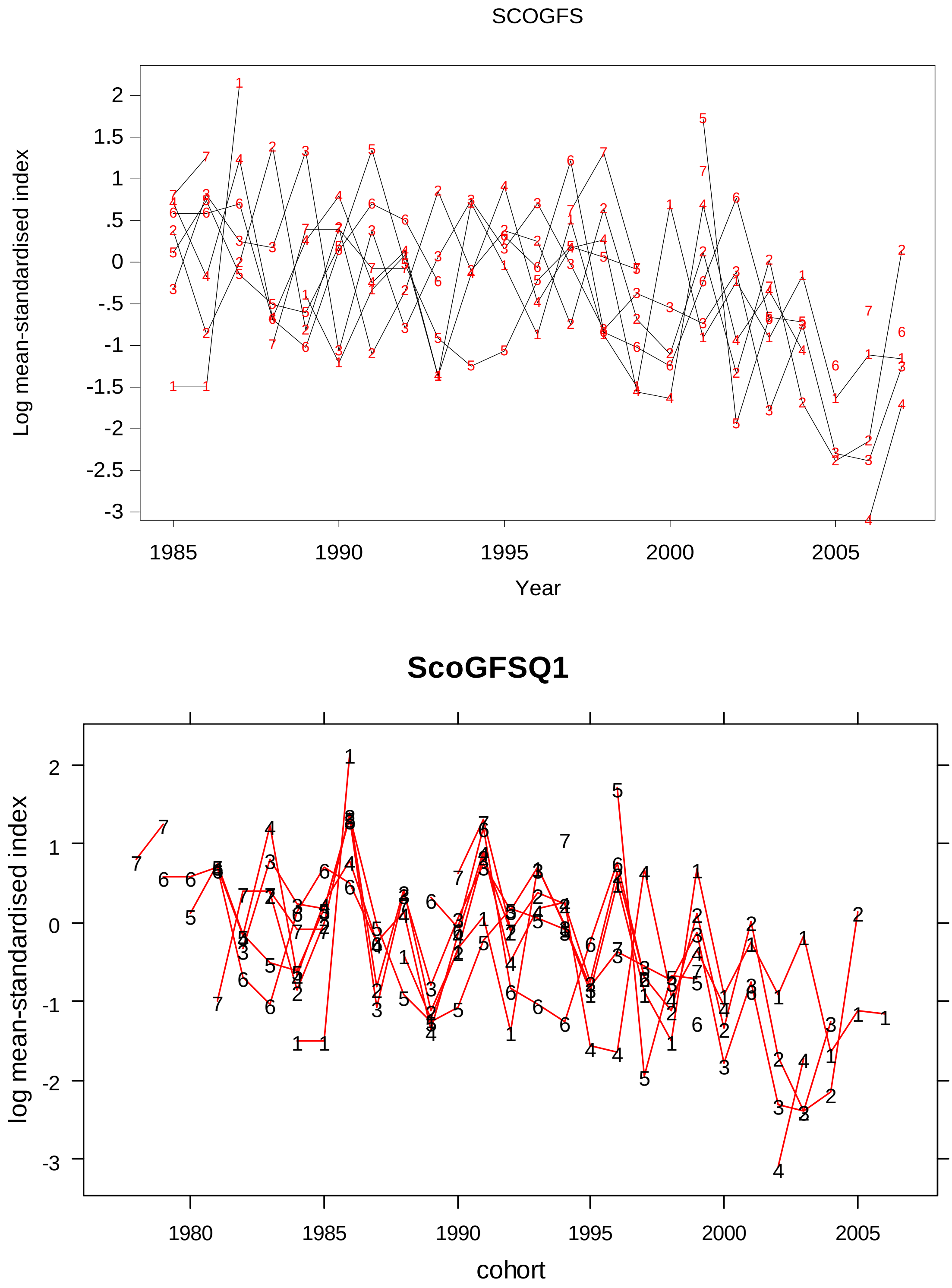
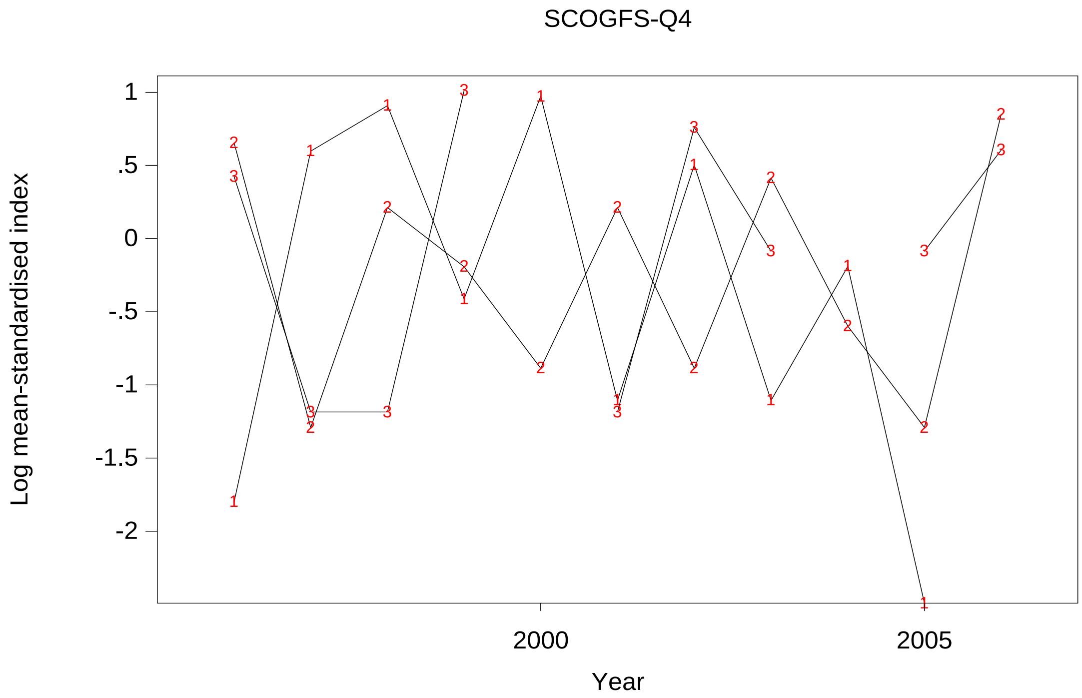


Figure 3.7a: Cod in division VIa. Log mean standardised survey index across all available ages. Scottish quarter one ground fish survey (ScoGFSQ1) by age(top) and by cohort (bottom).



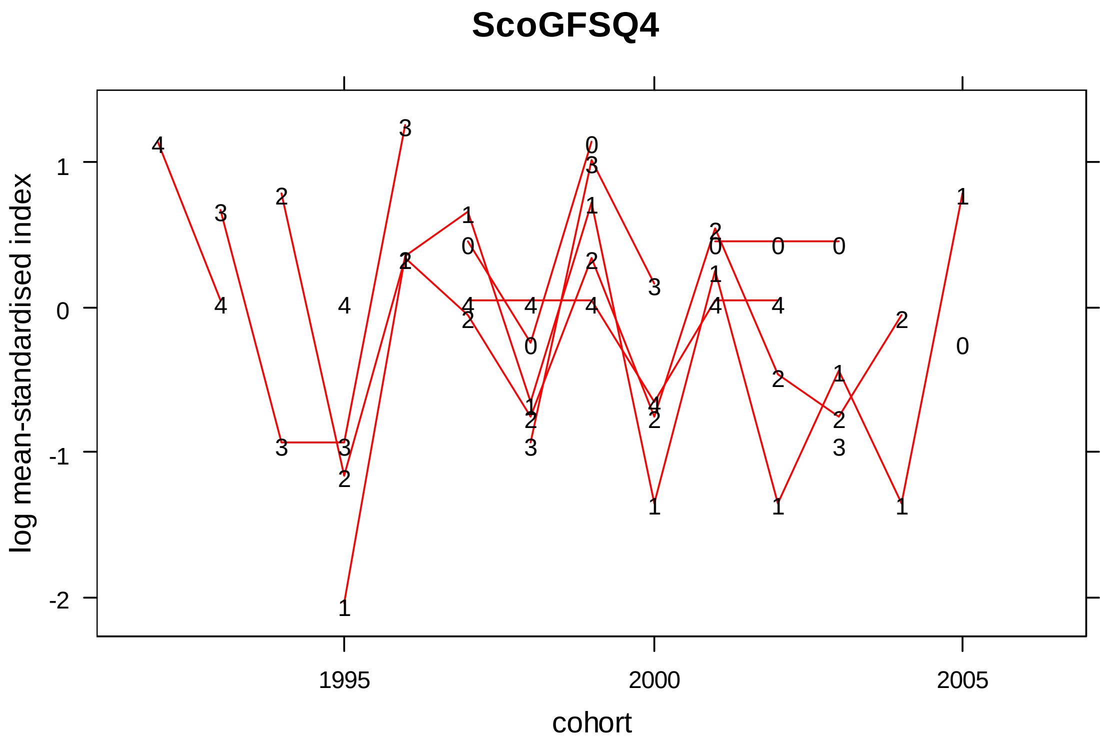
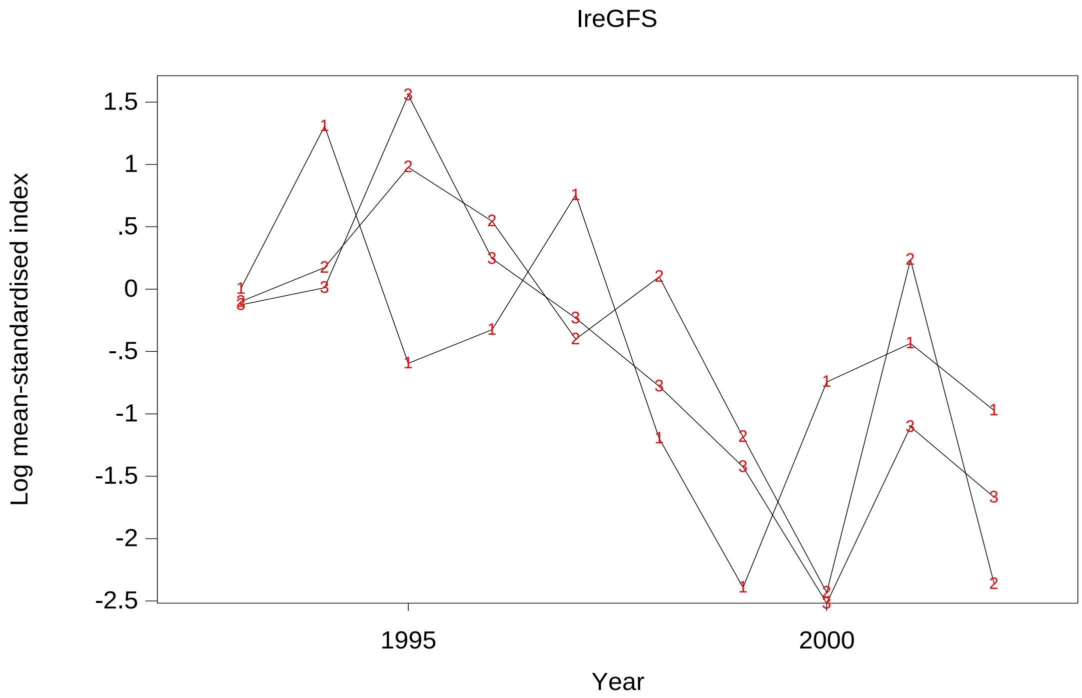


Figure 3.7b: Cod in division VIa. Log mean standardised survey index across all available ages. Scottish quarter four ground fish survey (ScoGFSQ4) by age(top) and by cohort (bottom).



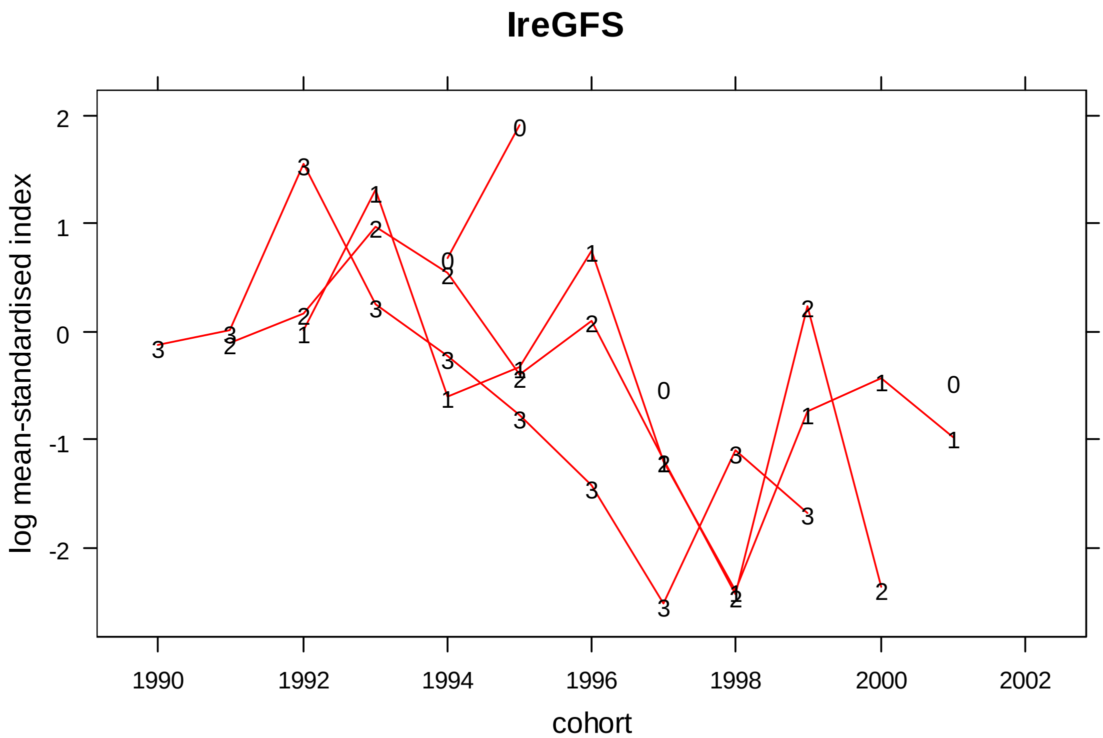
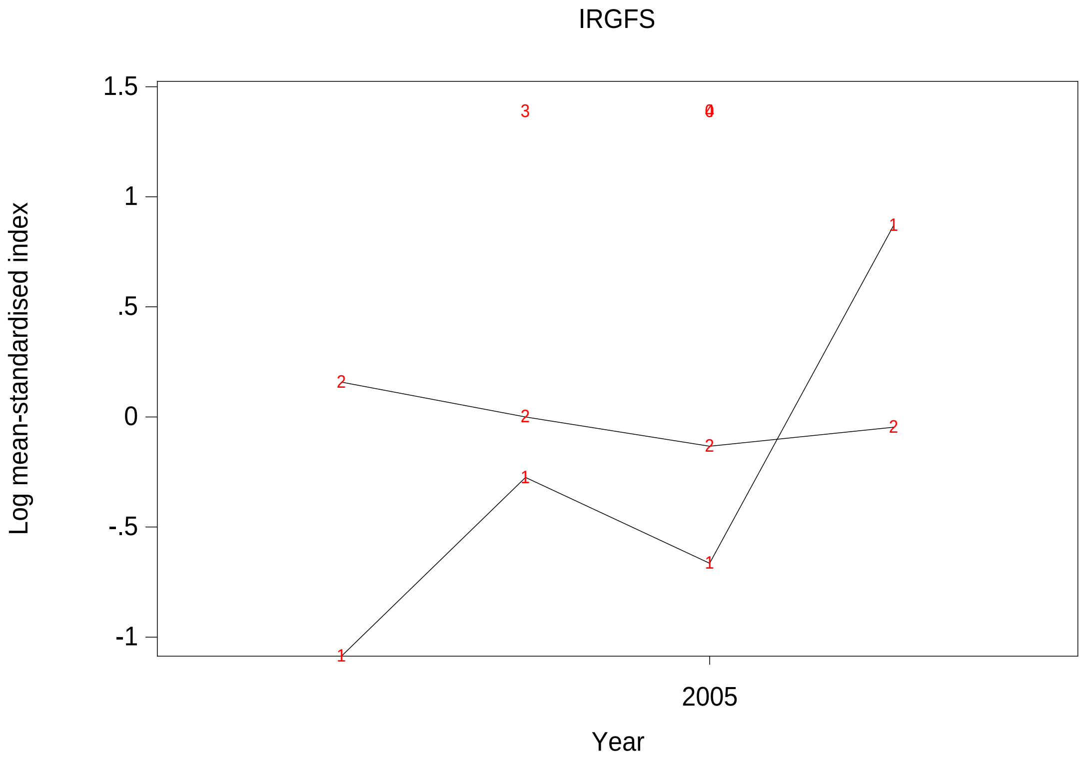


Figure 3.7c: Cod in division VIa. Log mean standardised survey index across all available ages. Irish ground fish survey (IreGFS) by cohort.and Irish ground fish survey (IRGFS) by age (top) and by cohort (bottom).



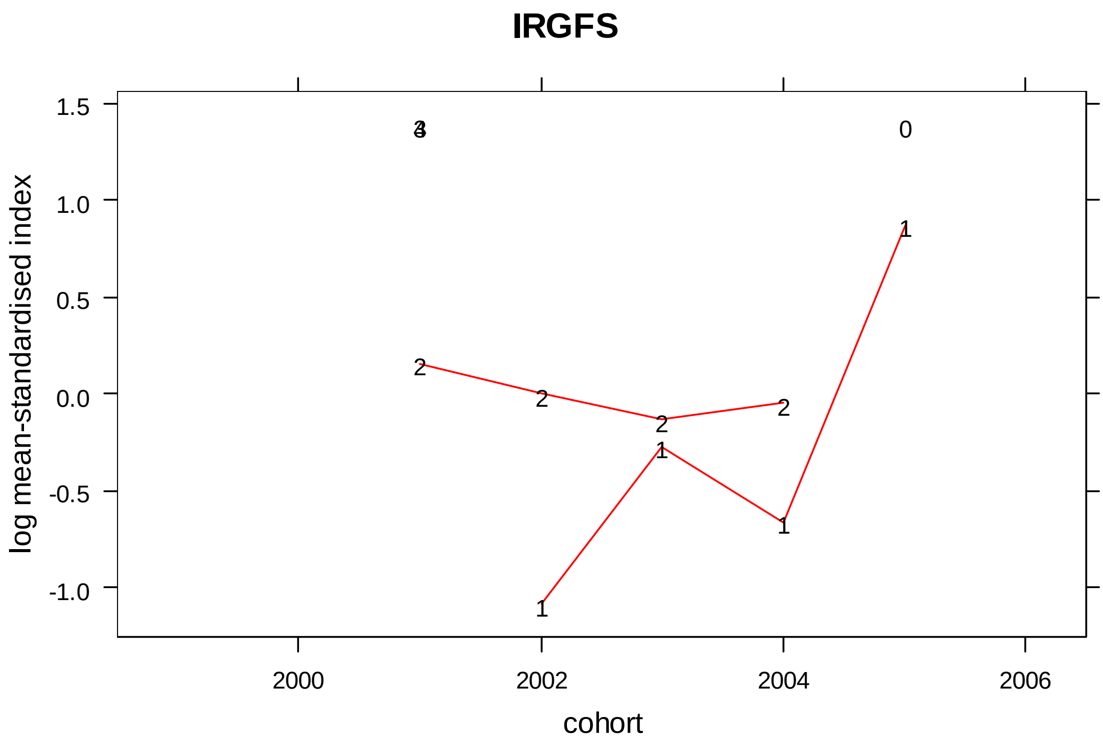
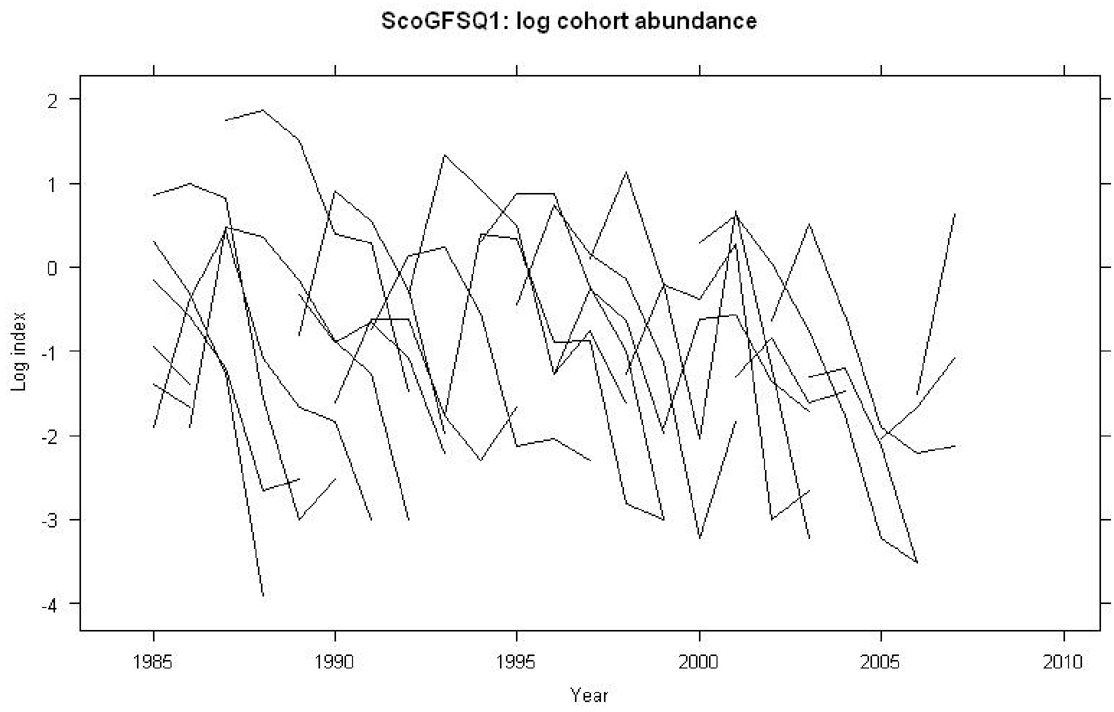


Figure 3.7d: Cod in division VIa. Log mean standardised survey index across all available ages. Irish ground fish survey (IRGFS) by age (top) and by cohort (bottom).



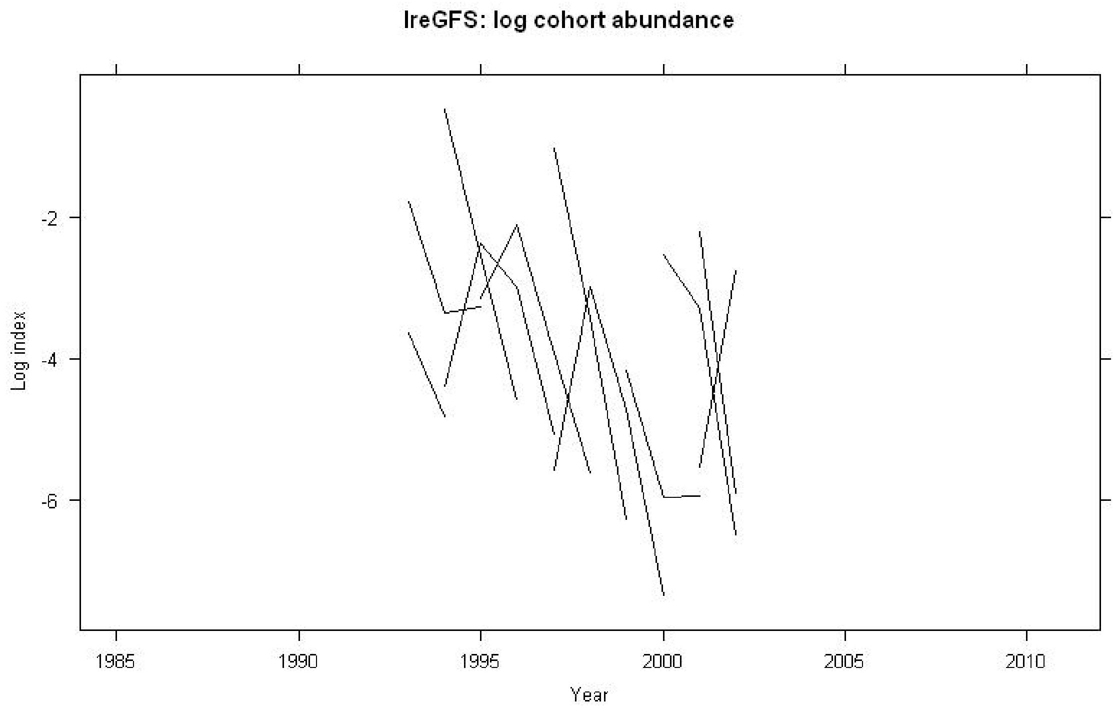
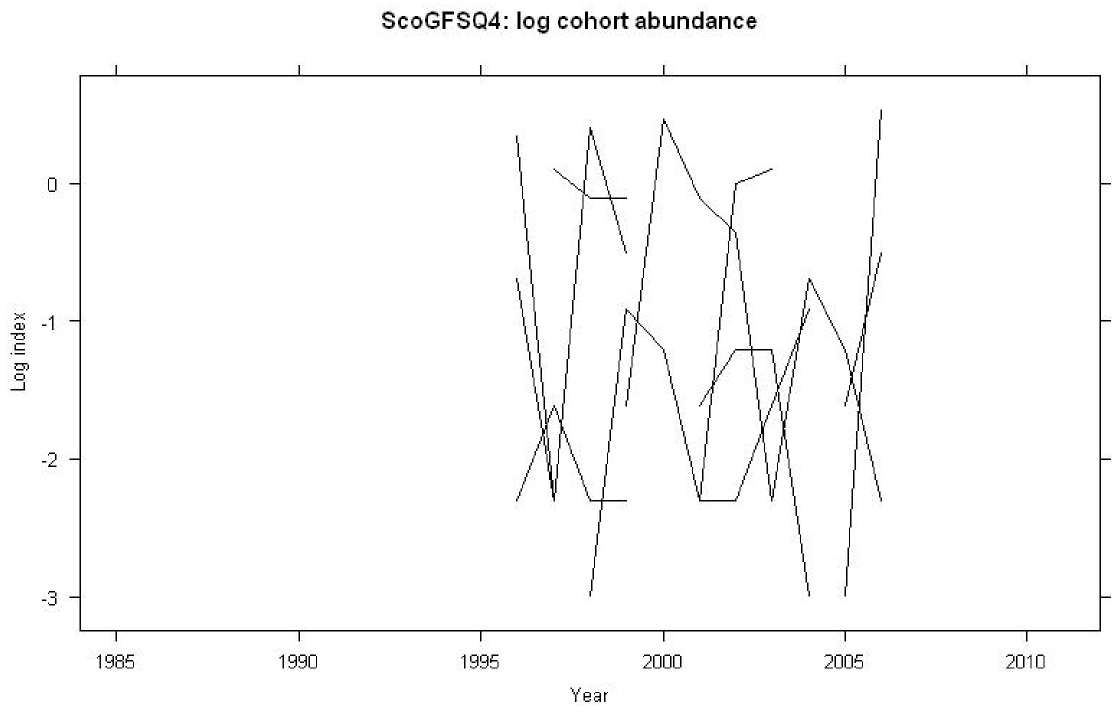


Figure 8: Cod in Division VIa. Log catch curves from from available survey series. Scottish quarter one ground fish survey (ScoGFSQ1); ages 1–6, Irish ground fish survey (IreGFS); ages 0–3, Scottish quarter four ground fish survey (ScoGFSQ4); ages 0–5 and new Irish ground fish survey (IRGFS); ages 0–4.



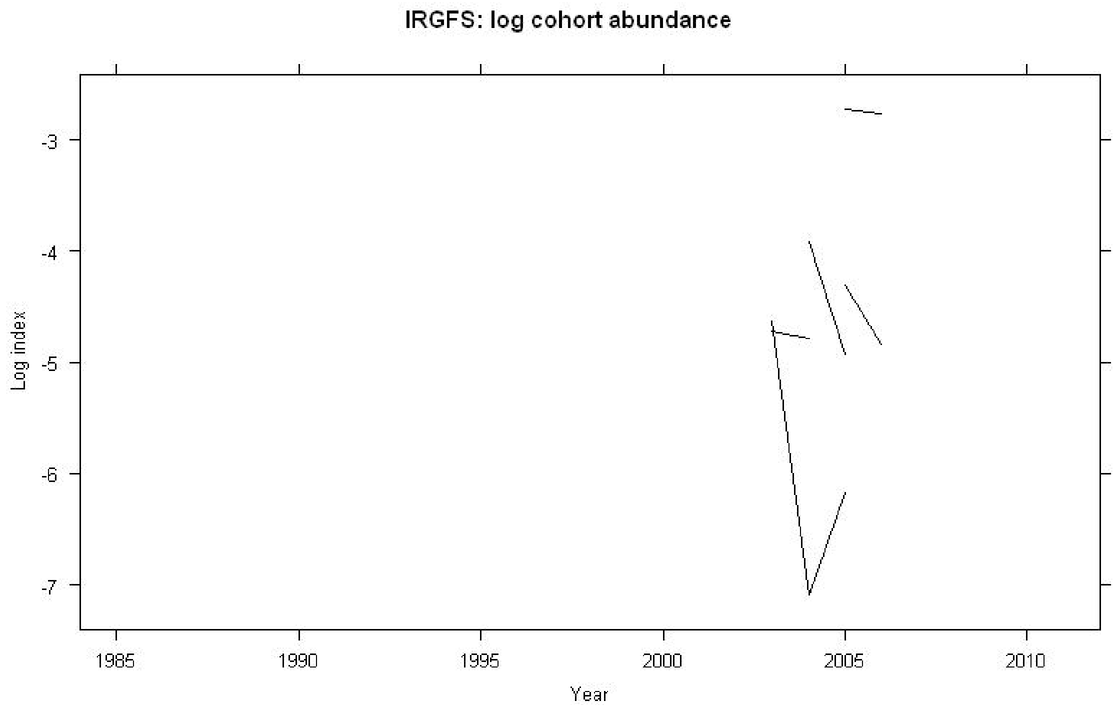


Figure 3.8: (cont): Cod in Division VIa. Log catch curves from from available survey series. Scottish quarter one ground fish survey (ScoGFSQ1); ages 1–6, Irish ground fish survey (IreGFS); ages 0–3, Scottish quarter four ground fish survey (ScoGFSQ4); ages 0–5 and new Irish ground fish survey (IRGFS); ages 0–4.

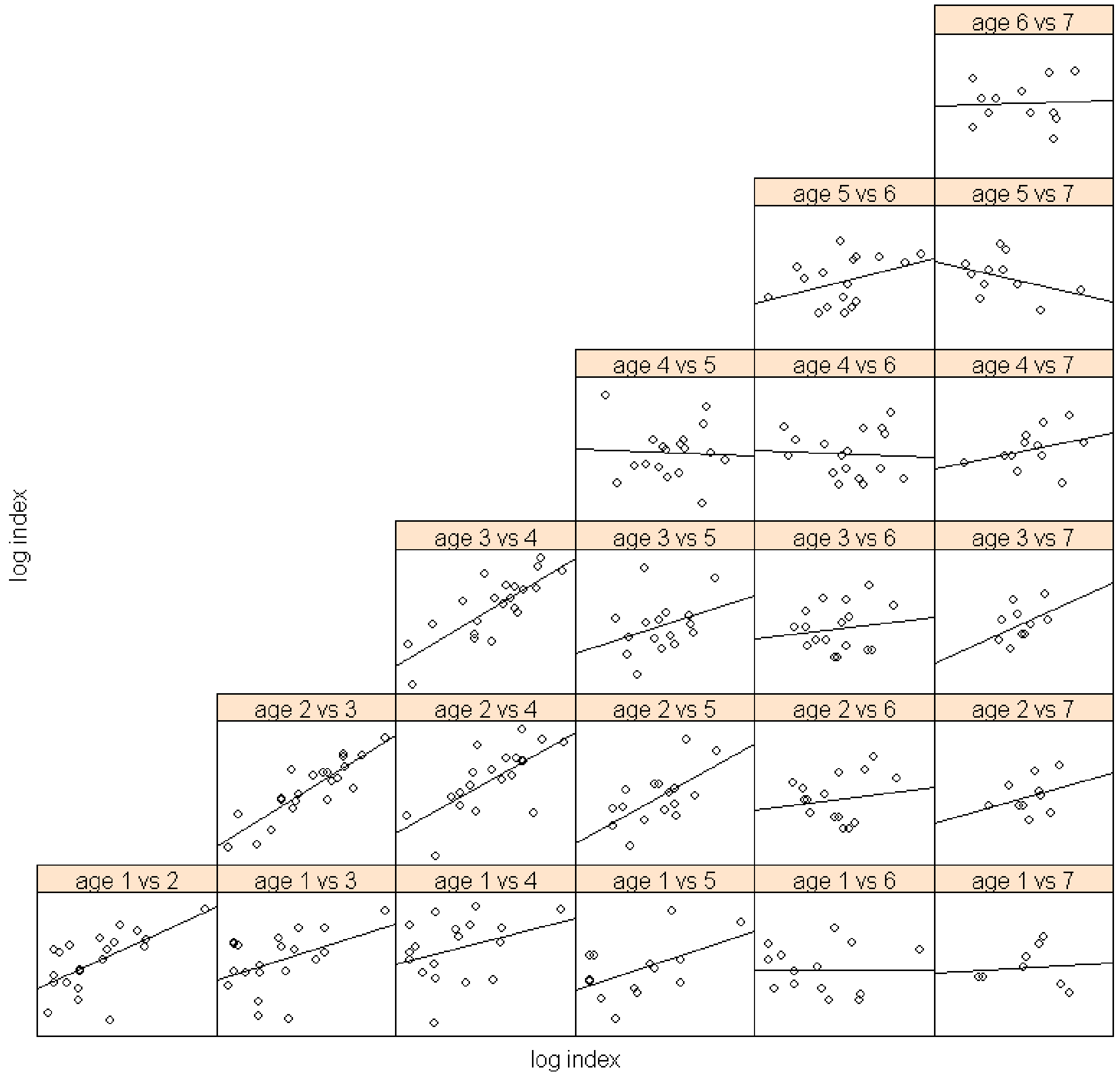


Figure 3.9: Cod in Division VIa. Comparative scatterplots at age for available survey series. Scottish quarter one ground fish survey (ScoGFSQ1).

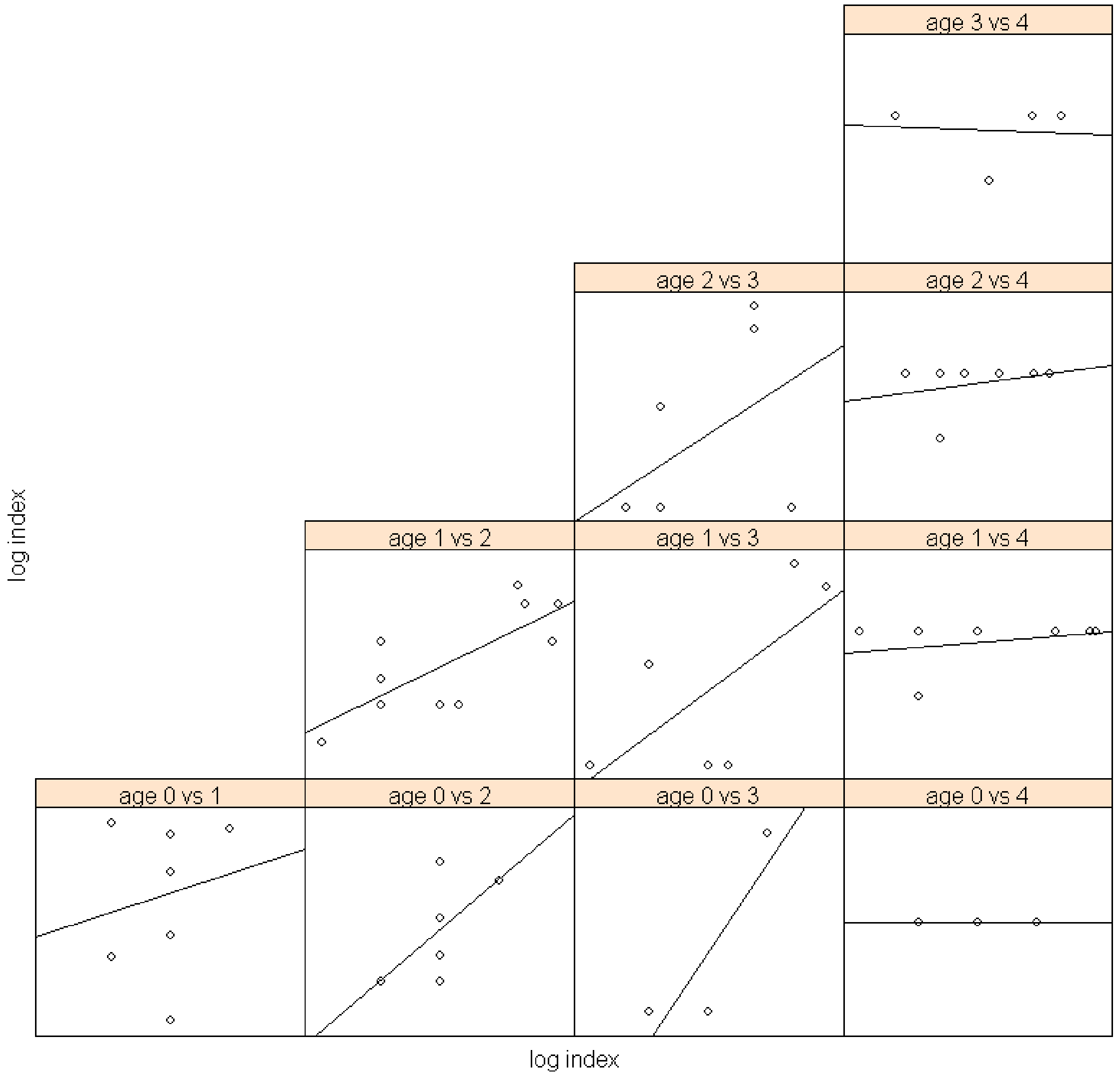


Figure 3.9b: Cod in Division VIa. Comparative scatterplots at age for available survey series. Scottish quarter four ground fish survey (ScoGFSQ4).

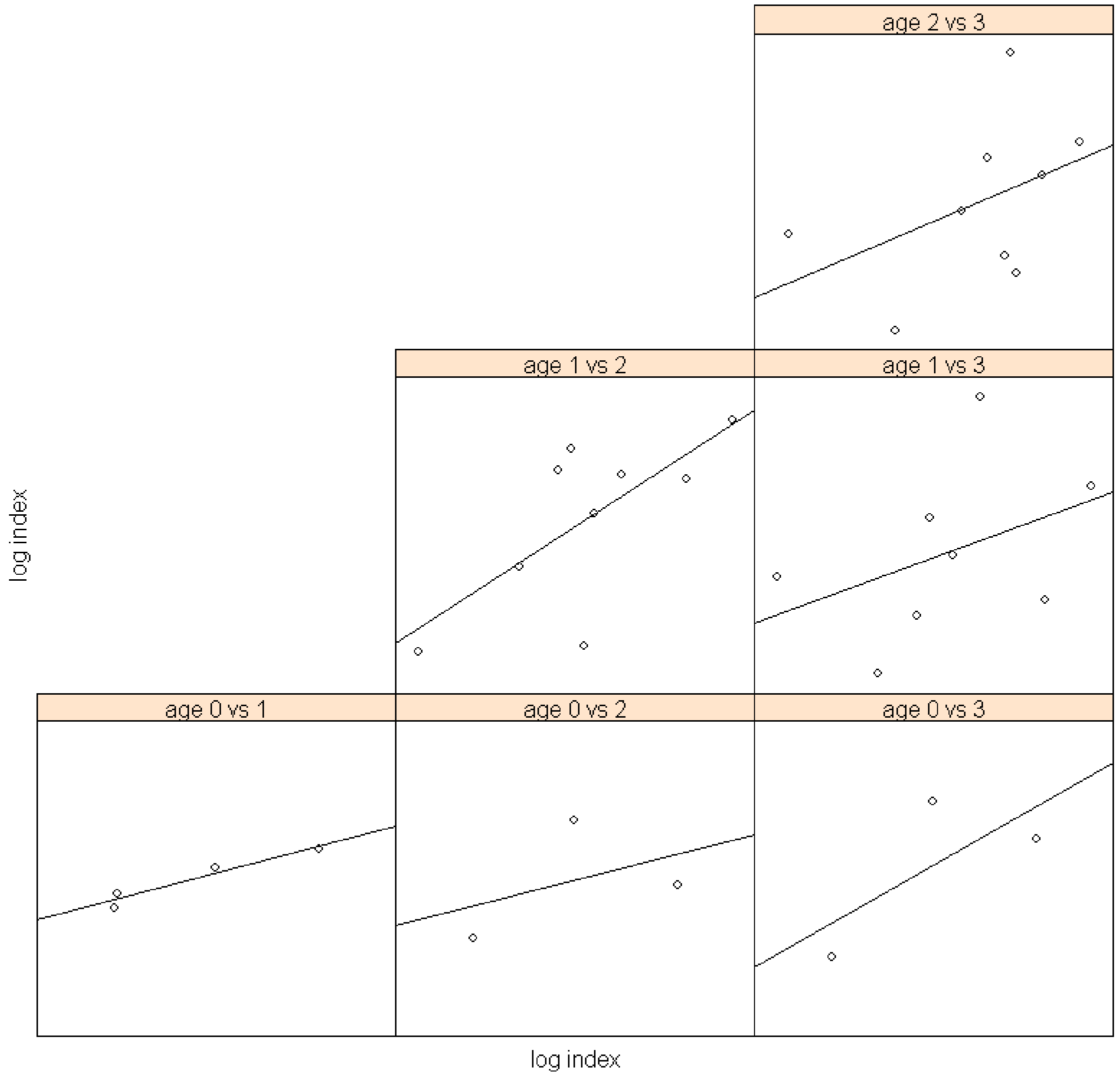


Figure 3.9c: Cod in Division VIa. Comparative scatterplots at age for available survey series. Irish ground fish survey (IreGFS).

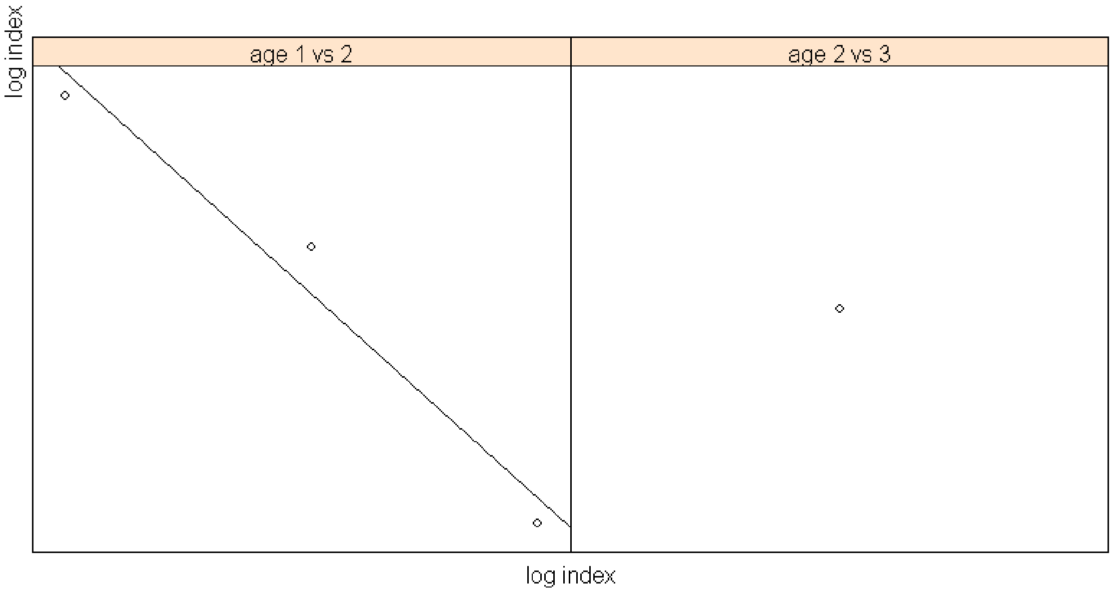


Figure 3.9d: Cod in Division VIa. Comparative scatterplots at age for available survey series. New Irish ground fish survey (IRGFS).

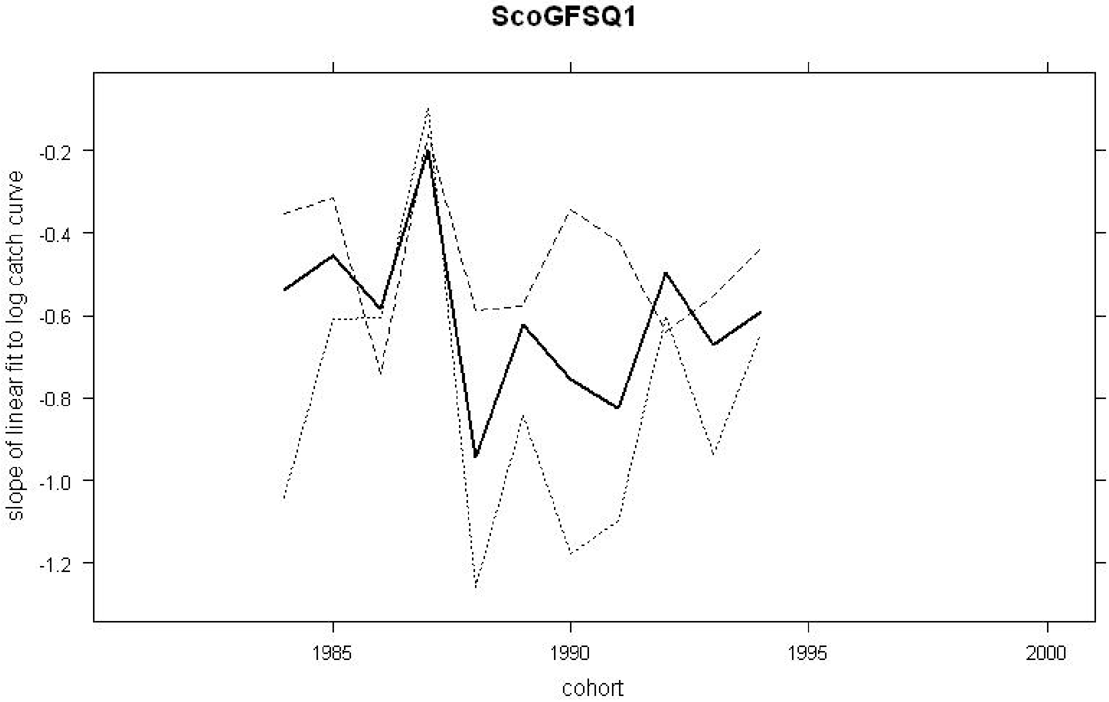
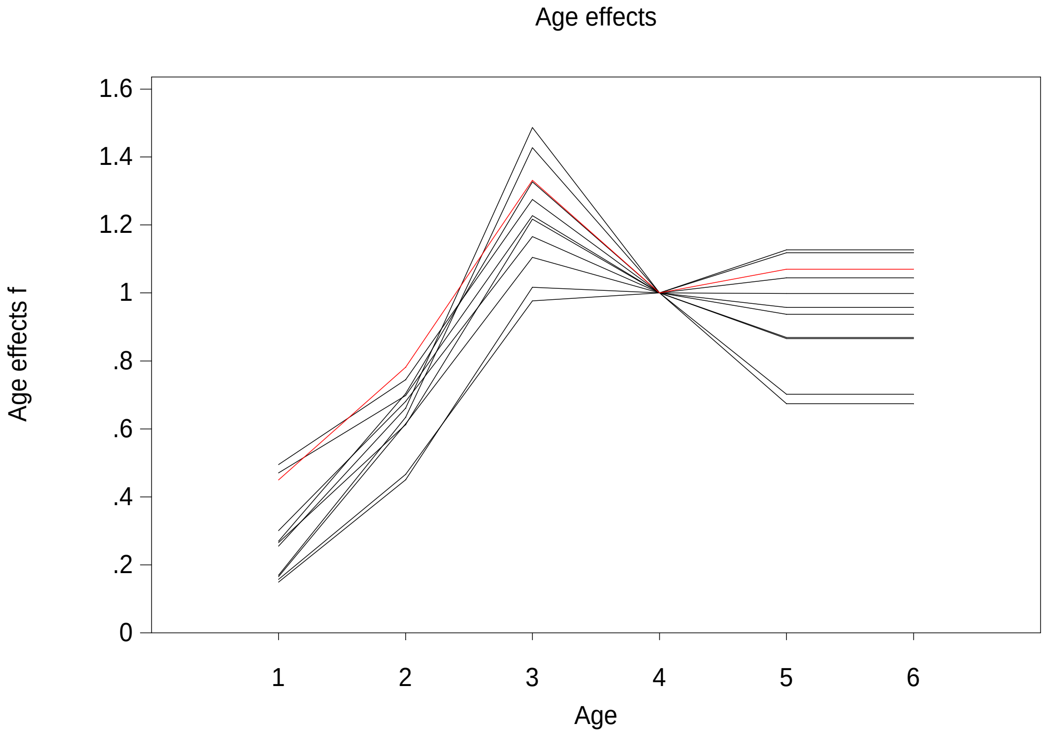


Figure 3.10: Cod in Division VIa. Log catch curve gradient plot using ScoGFSQ1 index data. Solid line shows time series of gradient of linear fit to curve over the age range 2–5, dashed line over the ages 2–4 and dotted line over the ages 3–6. Increasing mortality is indicated by the slope value becoming more negative.



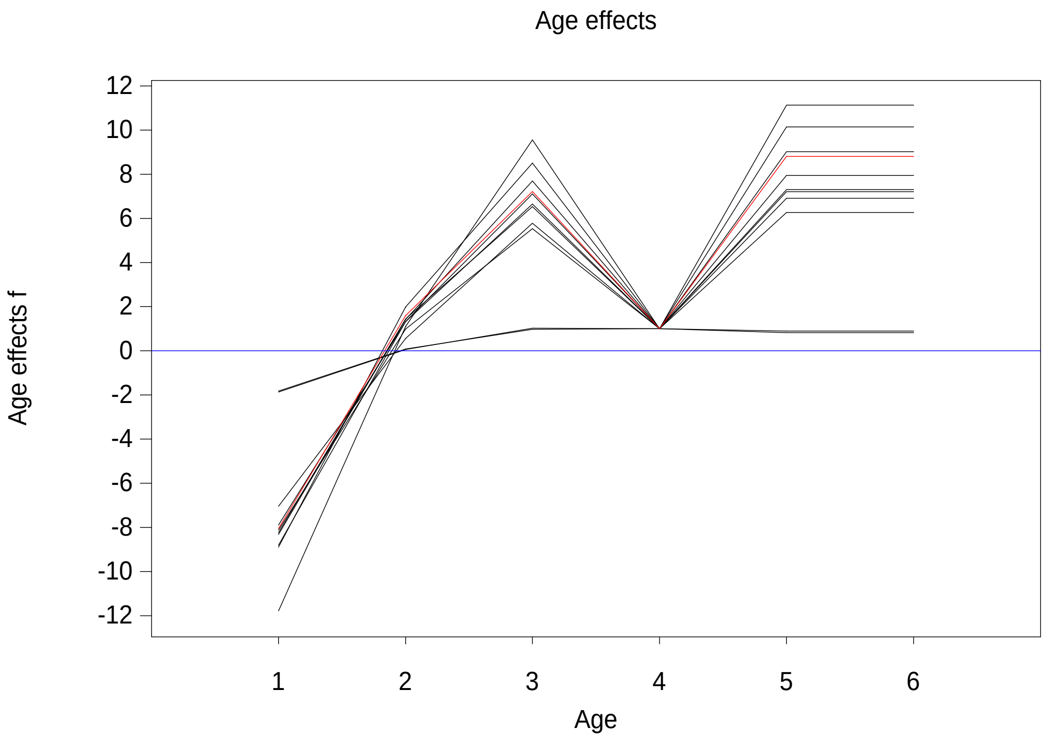
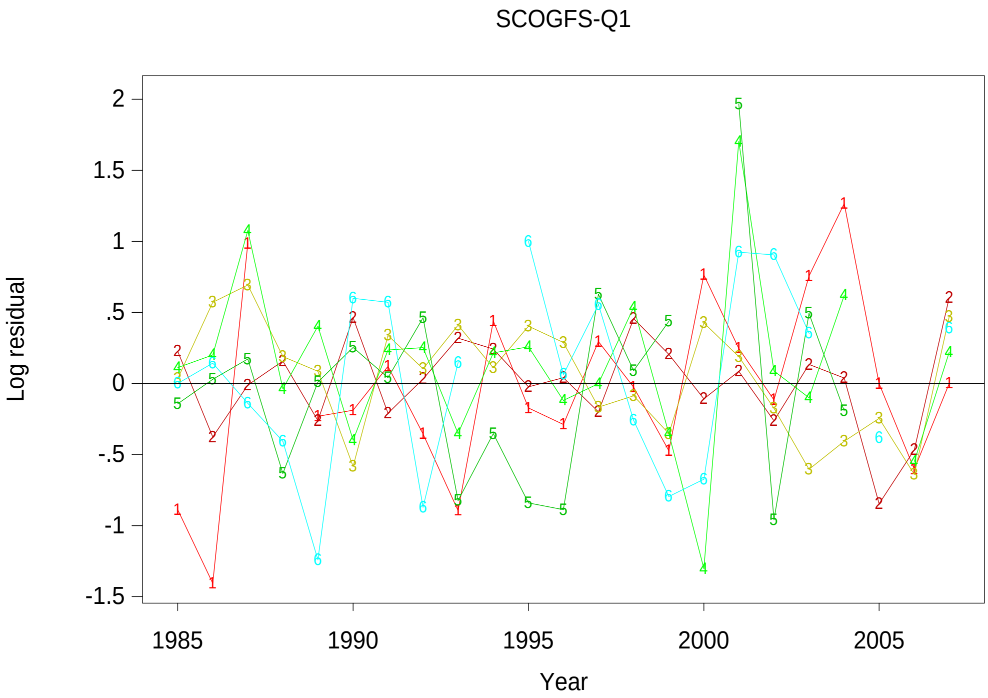


Figure 3.11: Cod in Division VIa. Comparison of SURA run using ScoGFSQ1 survey catchabilities derived by comparison to TSA estimates and assuming equal catchability-at-age. Age effects of SURBA runs including retrospectives.



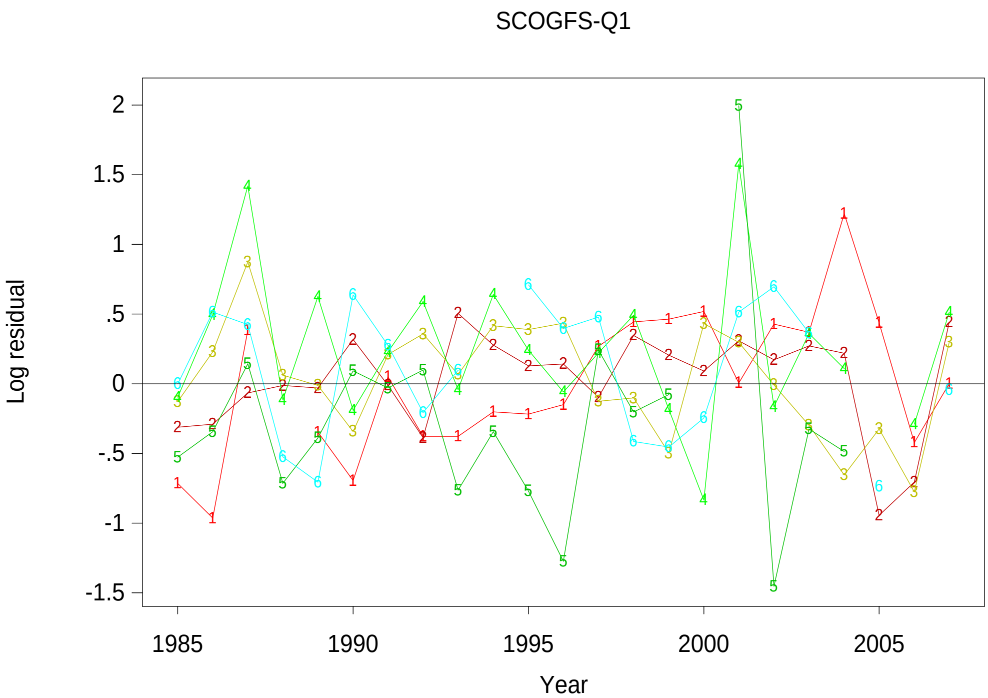


Figure 3.12: Cod in Division VIa. Residuals from top) SURBA run using ScoGFSQ1 and settings as used at WGNSDS$_{06}$ to compare to final assessment. Catchabilities at age were updated using TSA run including all catch data up to 2006; bottom) SURBA run using ScoGFSQ1 and assuming equal catchability-at-age.

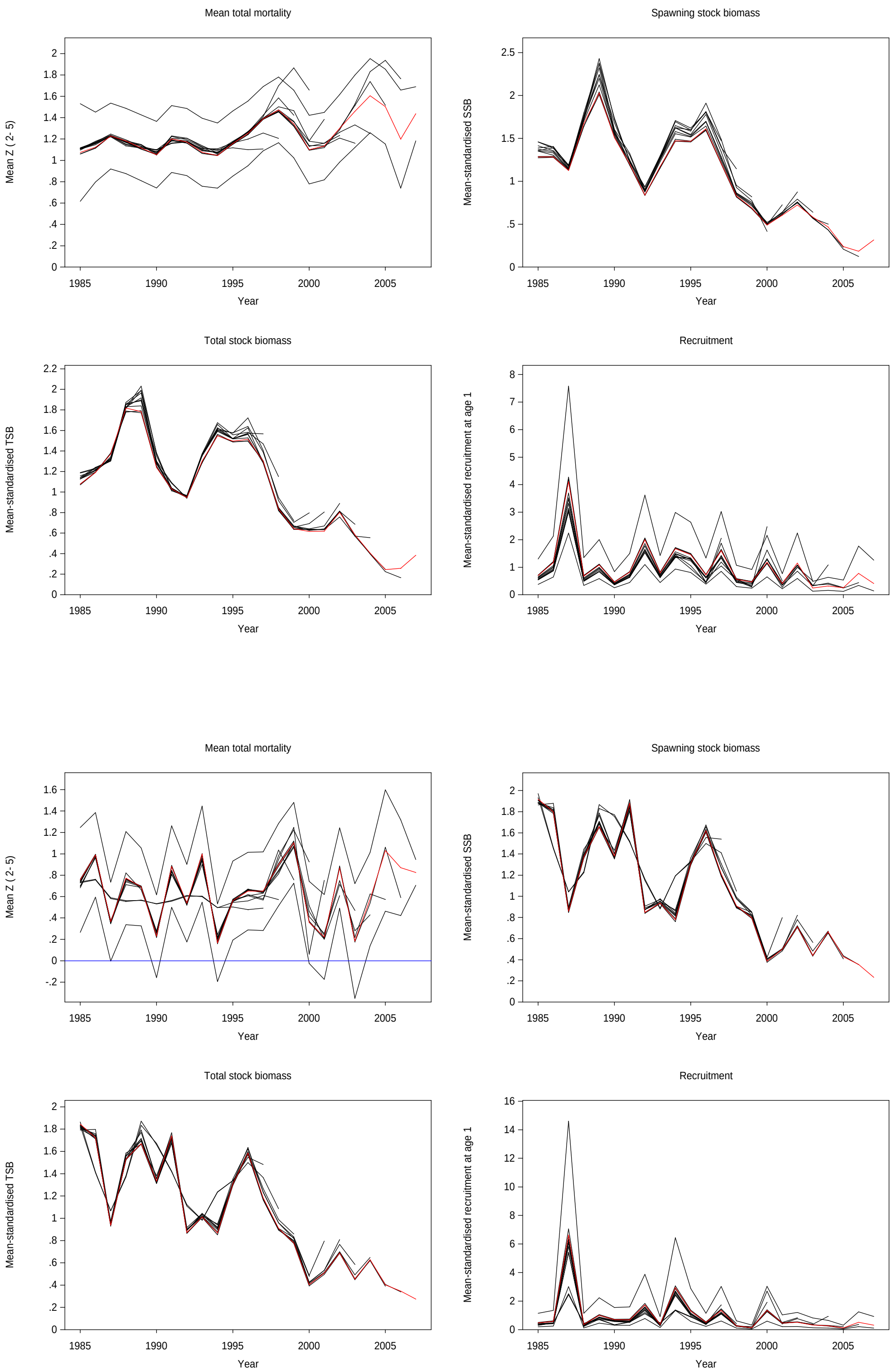


Figure 3.13: Cod in Division VIa. Retrospective summary plots of top) SURBA run using ScoGFSQ1 and settings as used at WGNSDS, 2006 to compare to final assessment. Catchabilities-at-age were updated using TSA run including all catch data up to 2006; bottom) SURBA run using ScoGFSQ1 and assuming equal catchability-at-age.

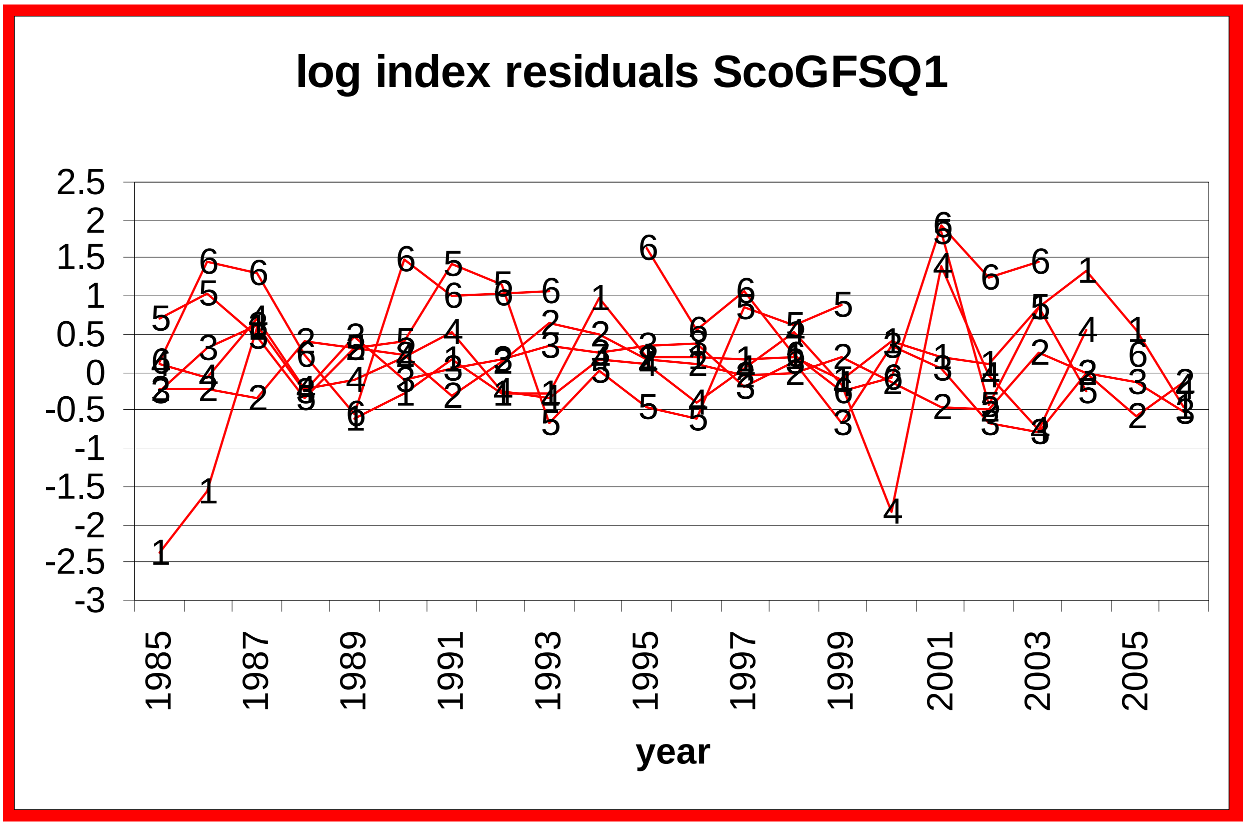


Figure 3.14: Cod in Division VIa. Residuals from BADAPT run using ScoGFSQ1 and estimating catch bias for the years 1995 to 2006.

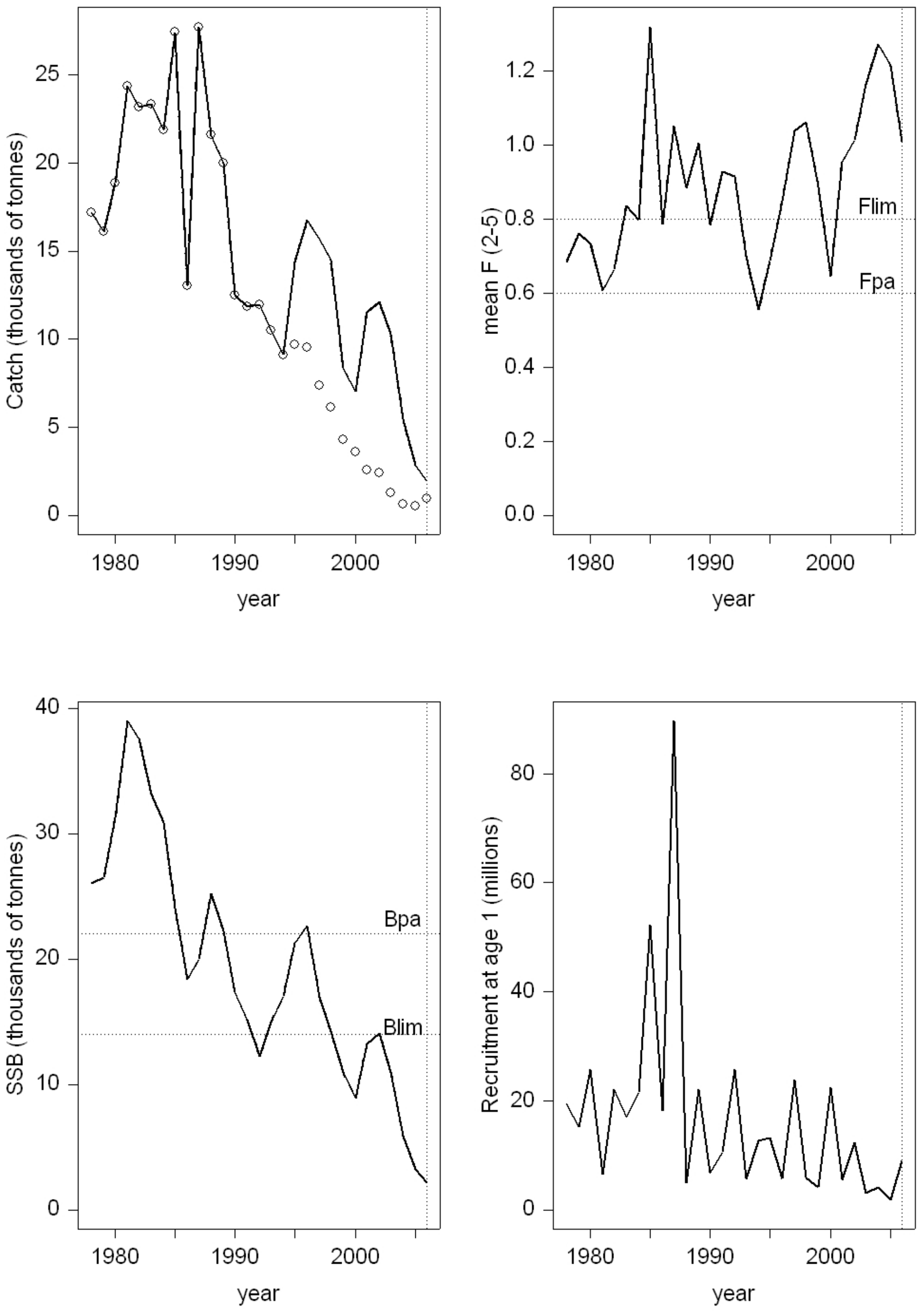


Figure 3.15: Cod in Division VIa. Summary plot of BADAPT run using ScoGFSQ1 and estimating catch bias for the years 1995 to 2006. In frame showing catches, circles represent reported catches while line represents estimated catches.

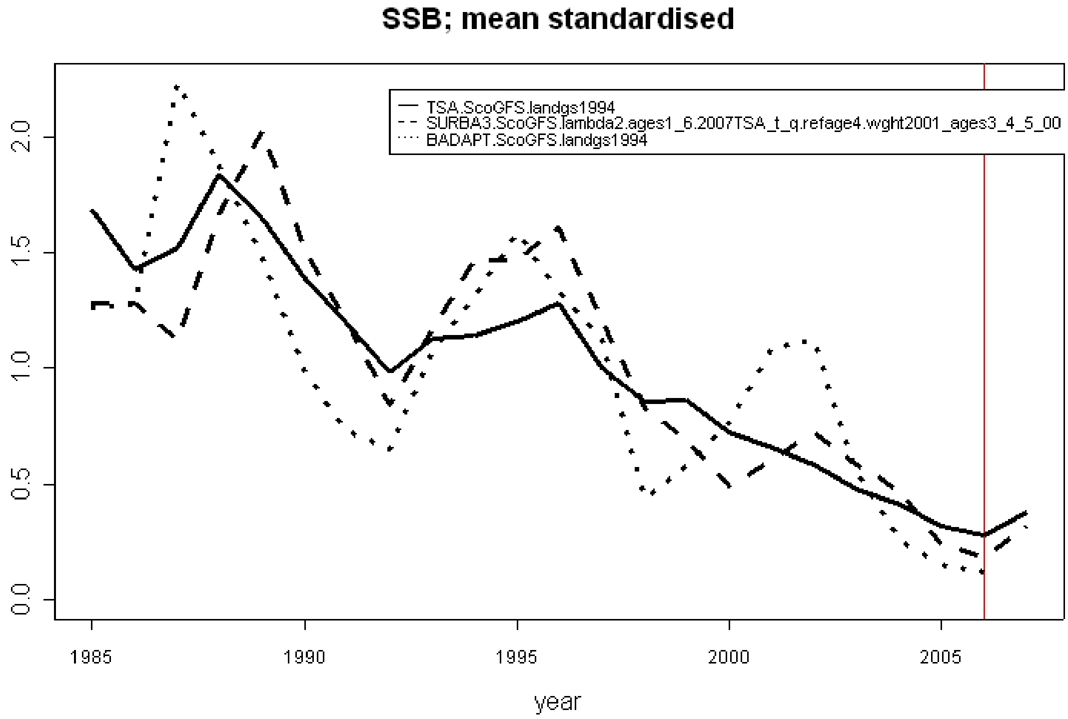
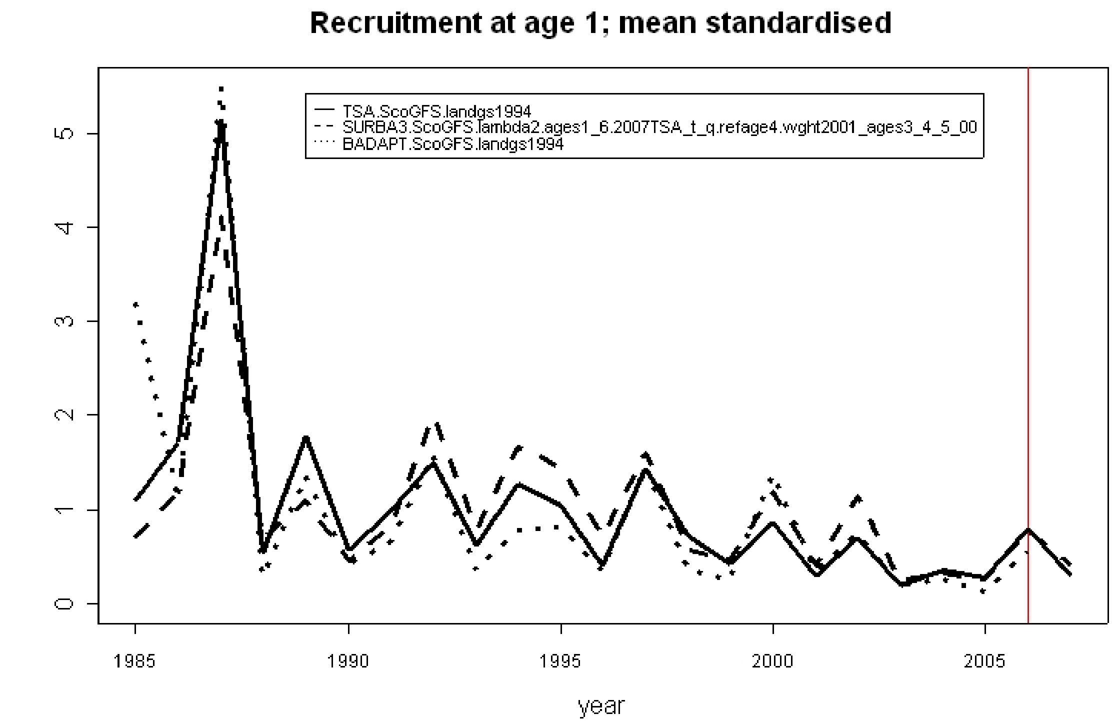


Figure 3.16: Cod in Division VIa. Mean standardised SSB, Rec and mean Z. Comparison of TSA SPALY run using commercial catch data to 1994 only and no trend in survey catchability (TSA.ScoGFS.landgs1994); SURBA run using Scottish quarter one ground fish survey data and settings as used for comparison at WGNSDS, 2006, (SURBA3.ScoGFS.lambda2.ages1_6.2007TSA_t_q.refage4_wght2001_ages3–4–5–00) and BADAPT run allowing estimation of catch bias between 1995 and 2006 (BADAPT.ScoGFS.landgs1994).



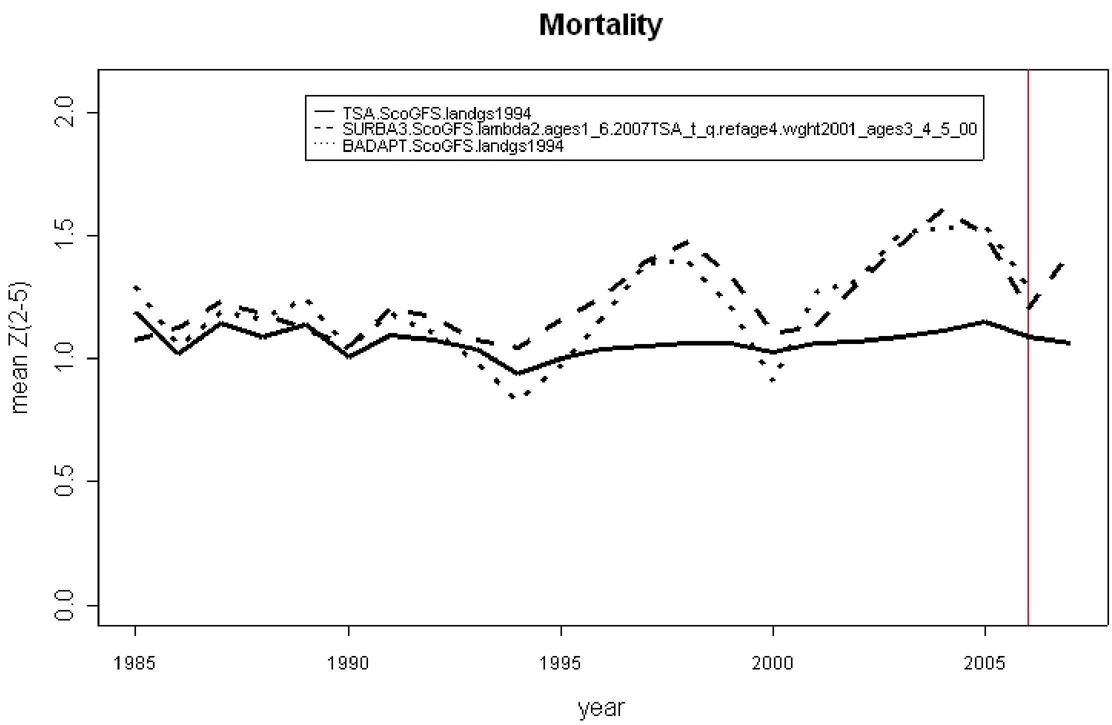


Figure 3.16 (cont)

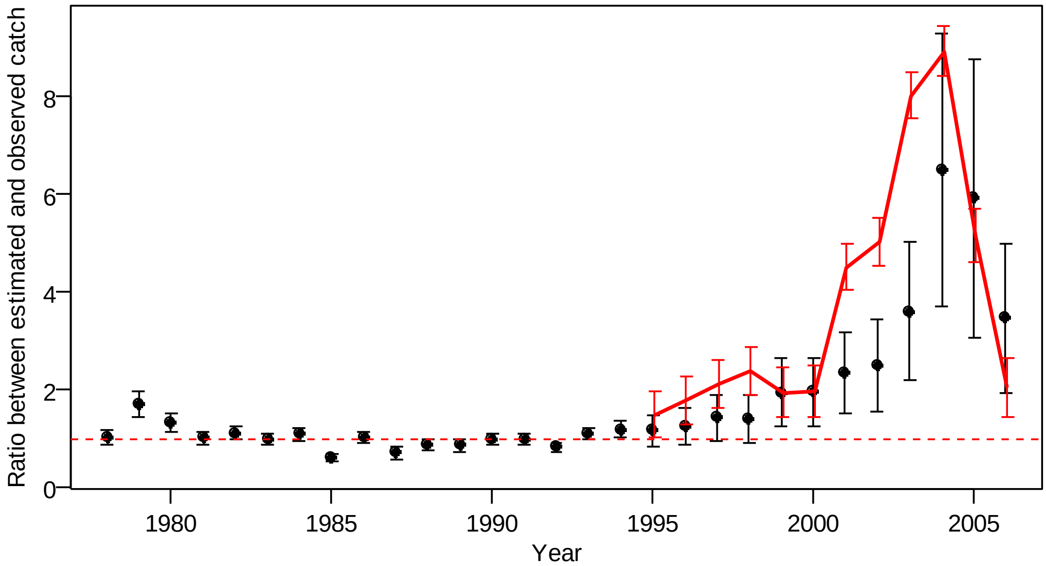


Figure 3.17: Cod in Division VIa. Ratio of estimated to observed catch using TSA (round symbols) and BADAPT (solid line). Bars show ± 2 s.e. Both TSA excludes catch data and BADAPT estimates bias from 1995 to 2006 inclusive.

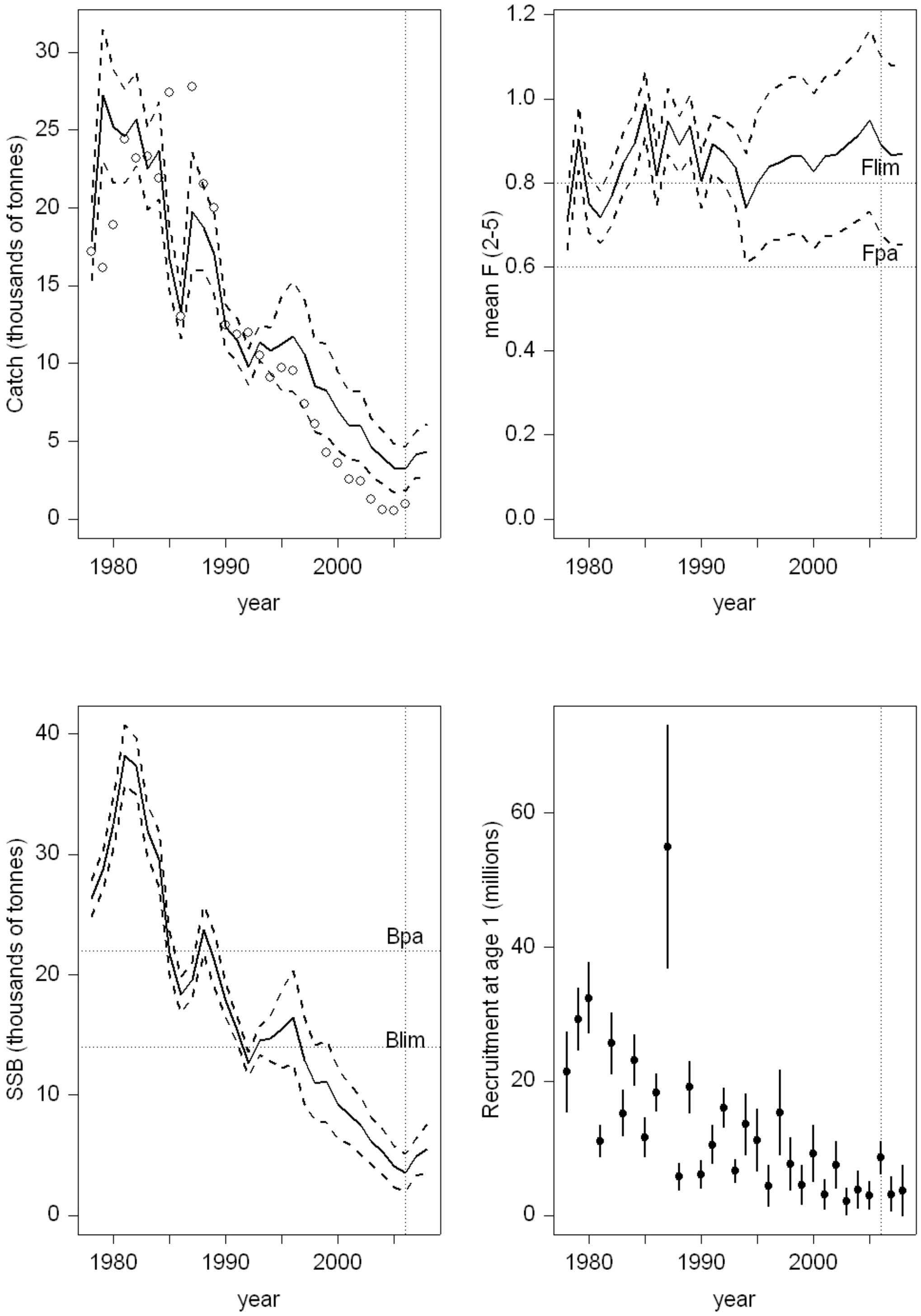


Figure 3.18: Cod in Division VIa. Summary plot of TSA final run. (landings & discard data excluded from 1995 onward).

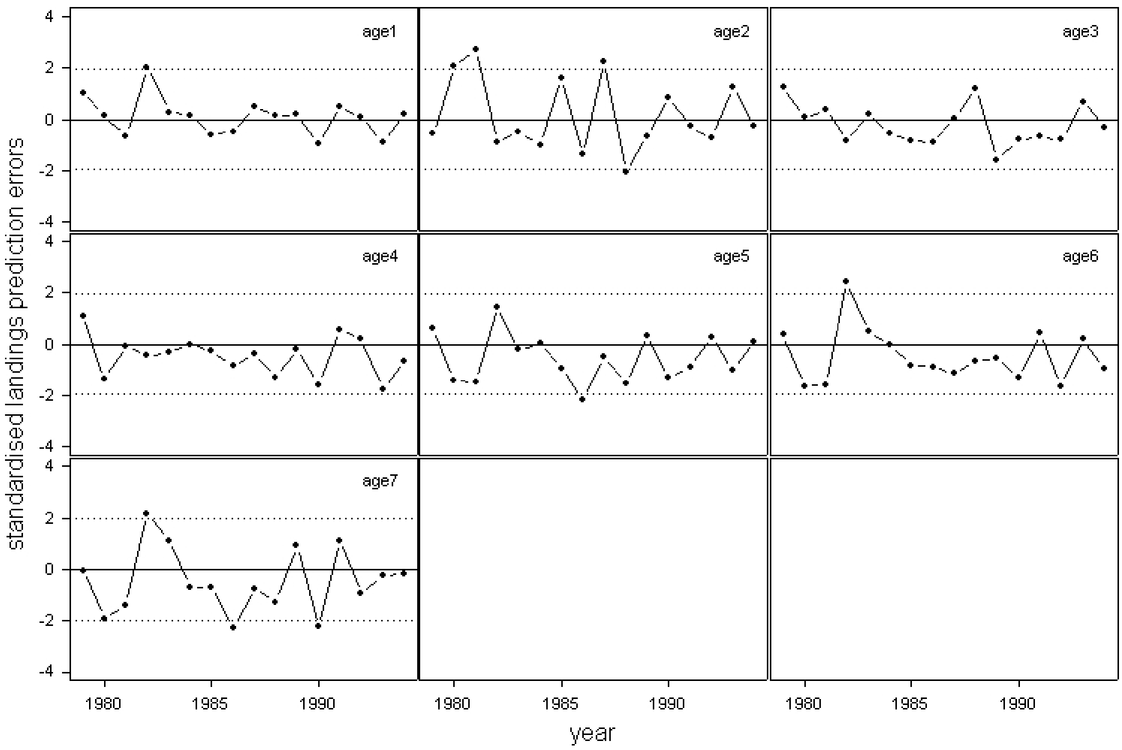


Figure 3.19: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for landings.

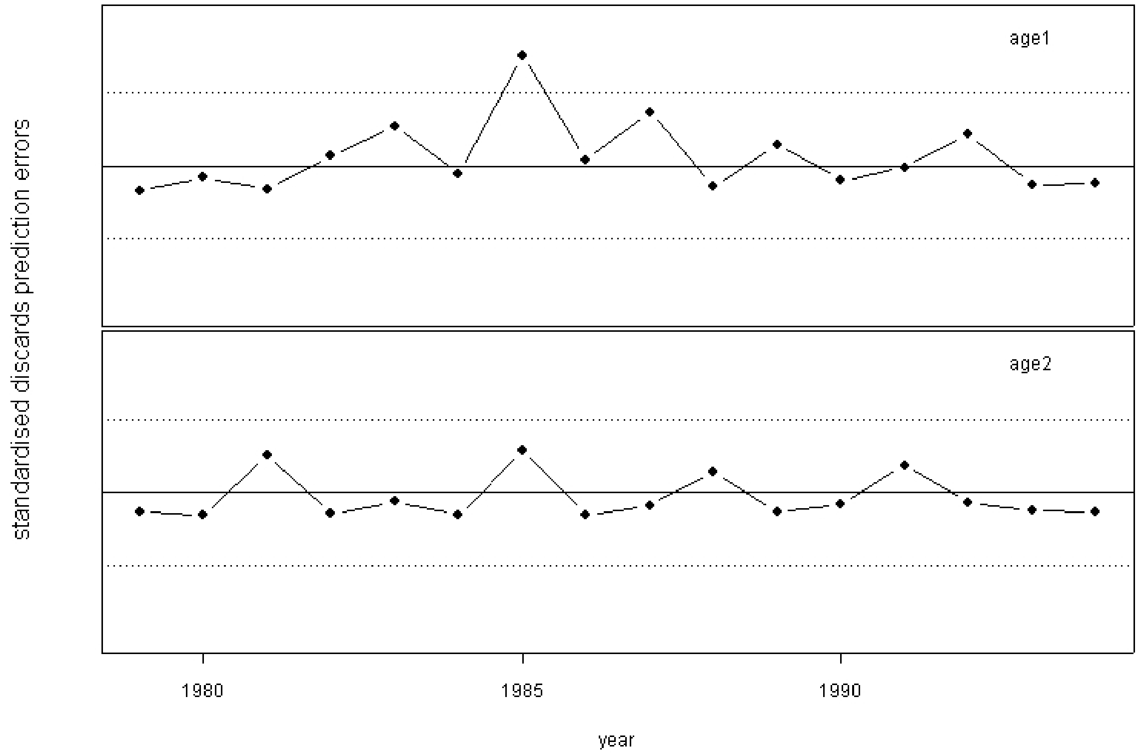


Figure 3.20: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for discards.

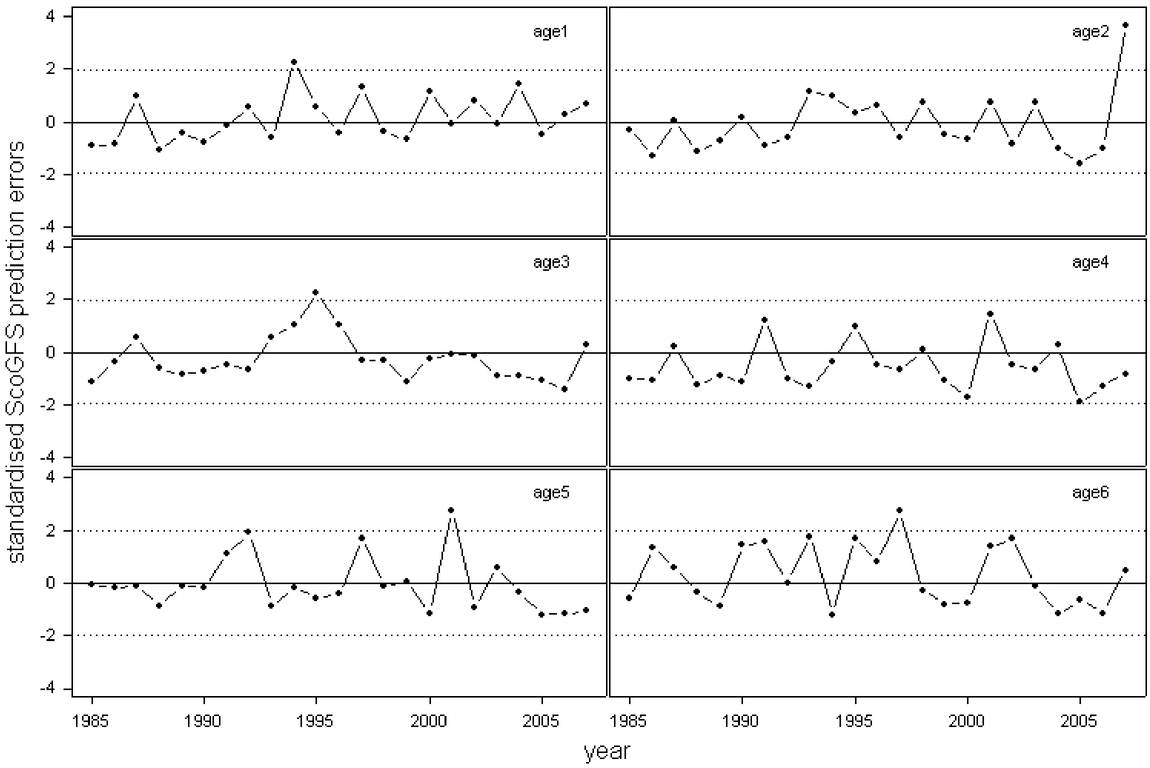


Figure 3.21: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for ScoGFSQ1.

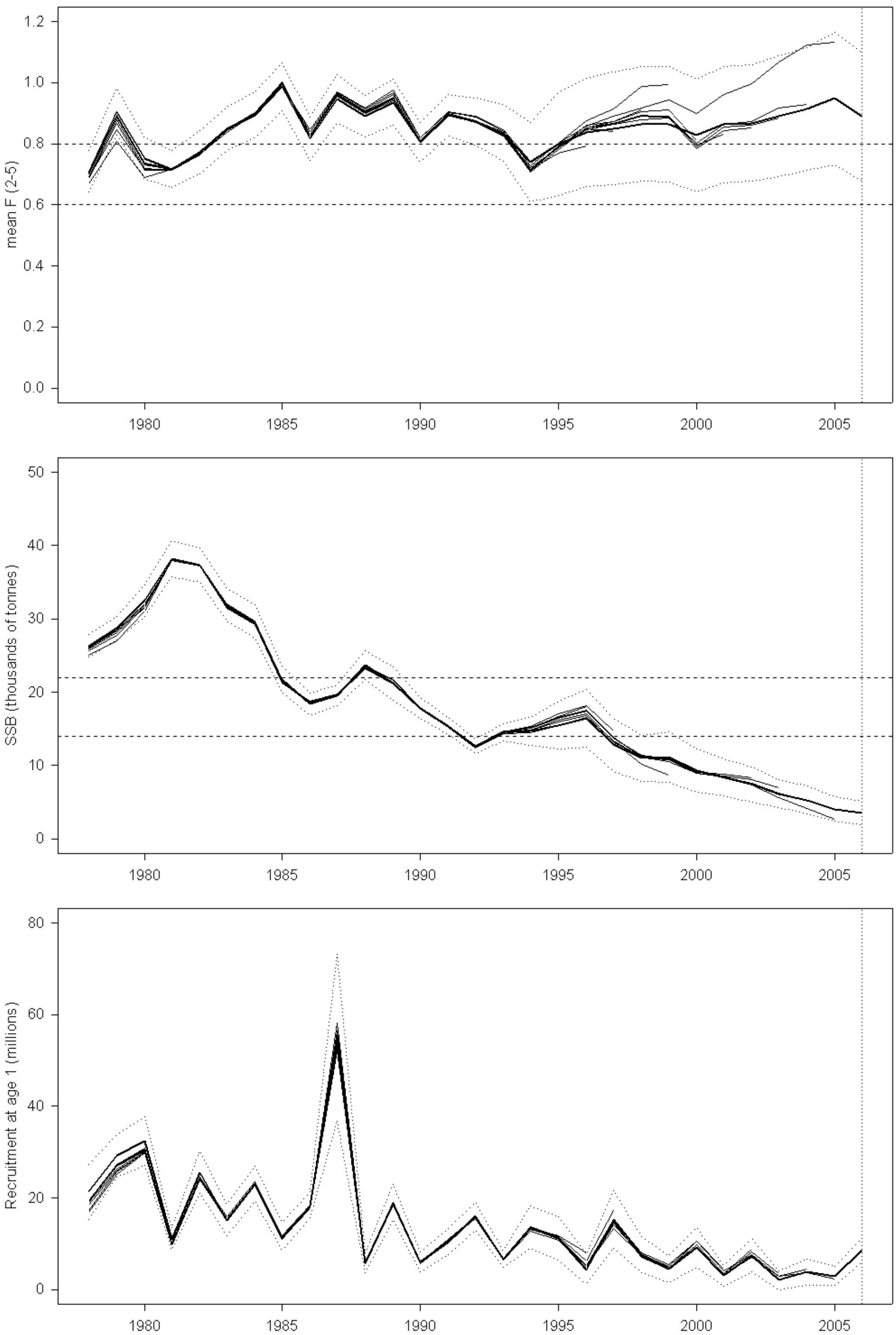


Figure 3.22: Cod in Division VIa. Retrospective plots of TSA final run. Biological reference points are given by dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.

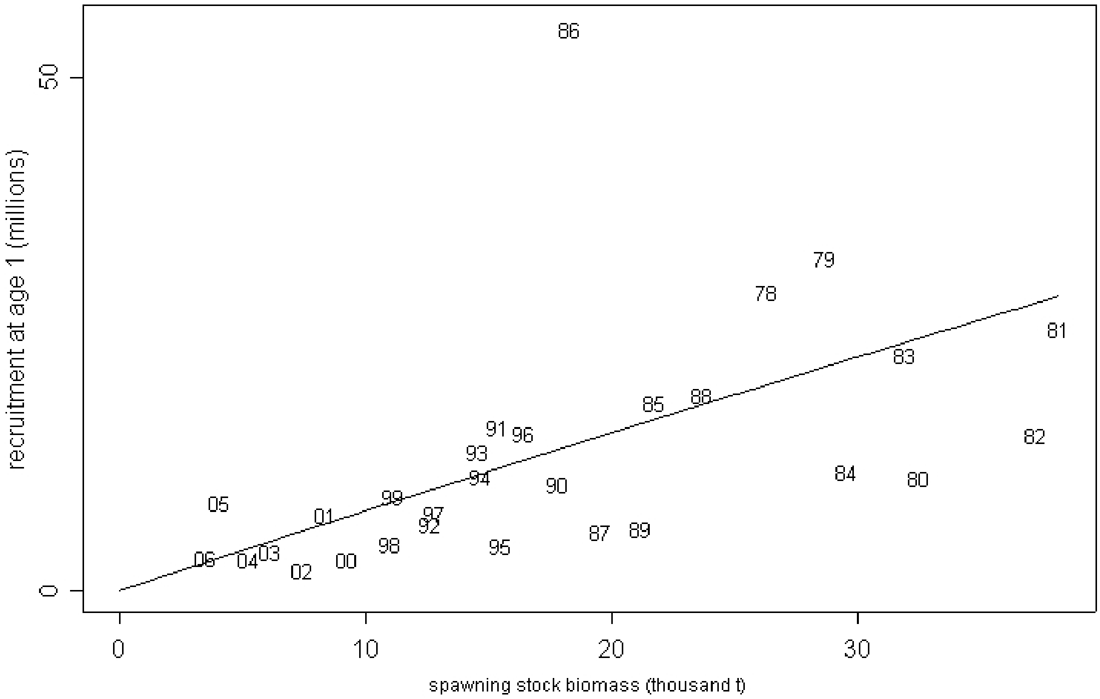


Figure 3.23: Cod in Division VIa. TSA final run. Stock-recruit relationship.

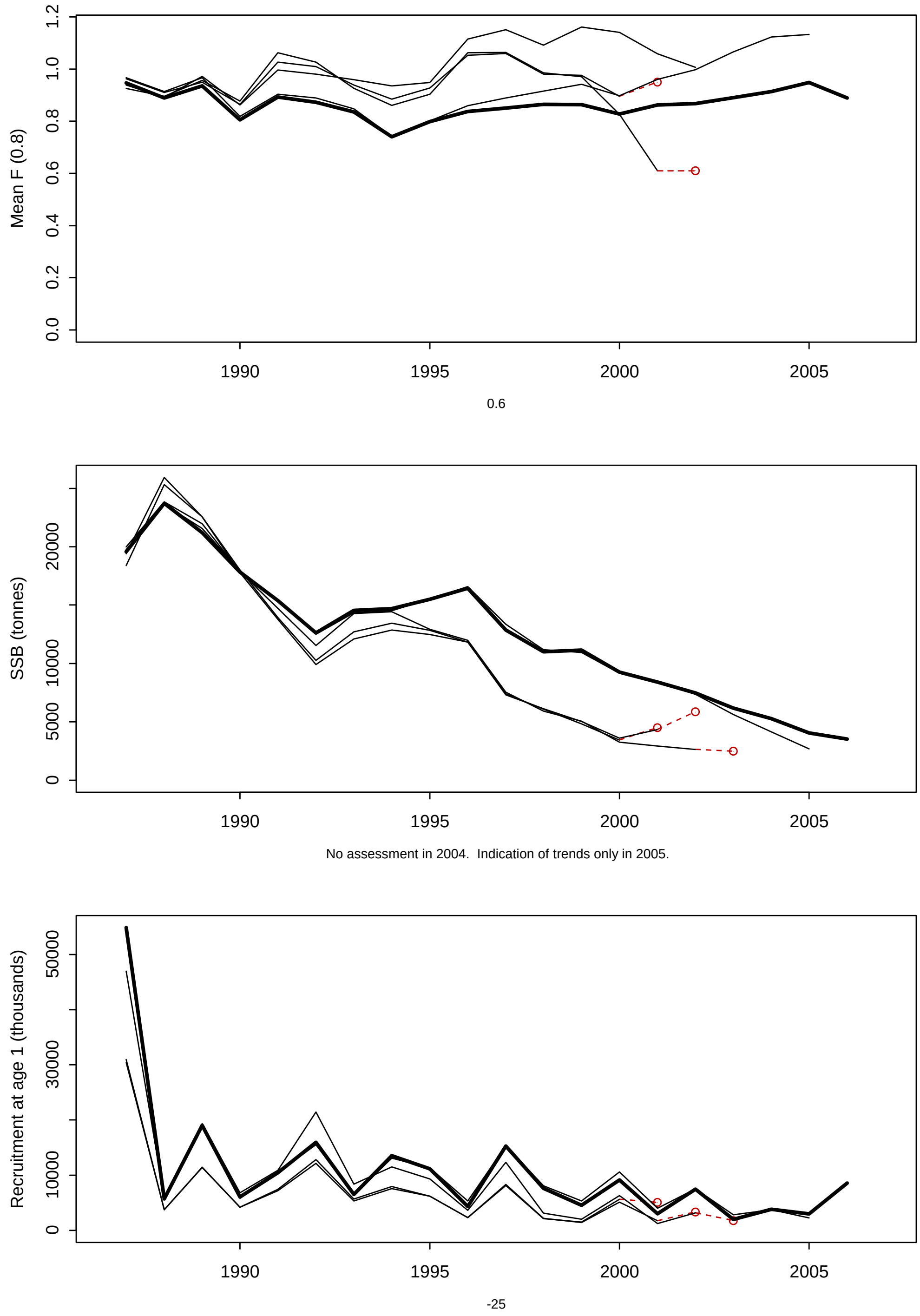


Figure 3.24: Cod in Division VIa. Plot showing SSB, recruitment at age 1 and mean F (2–5) . Stock summaries from successive WG meetings. Dotted lines and open circles indicate forecasts. Note: no analytic assessments were carried out in 2004 and 2005, while no catch forecasts were produced in 2006 and 2007.

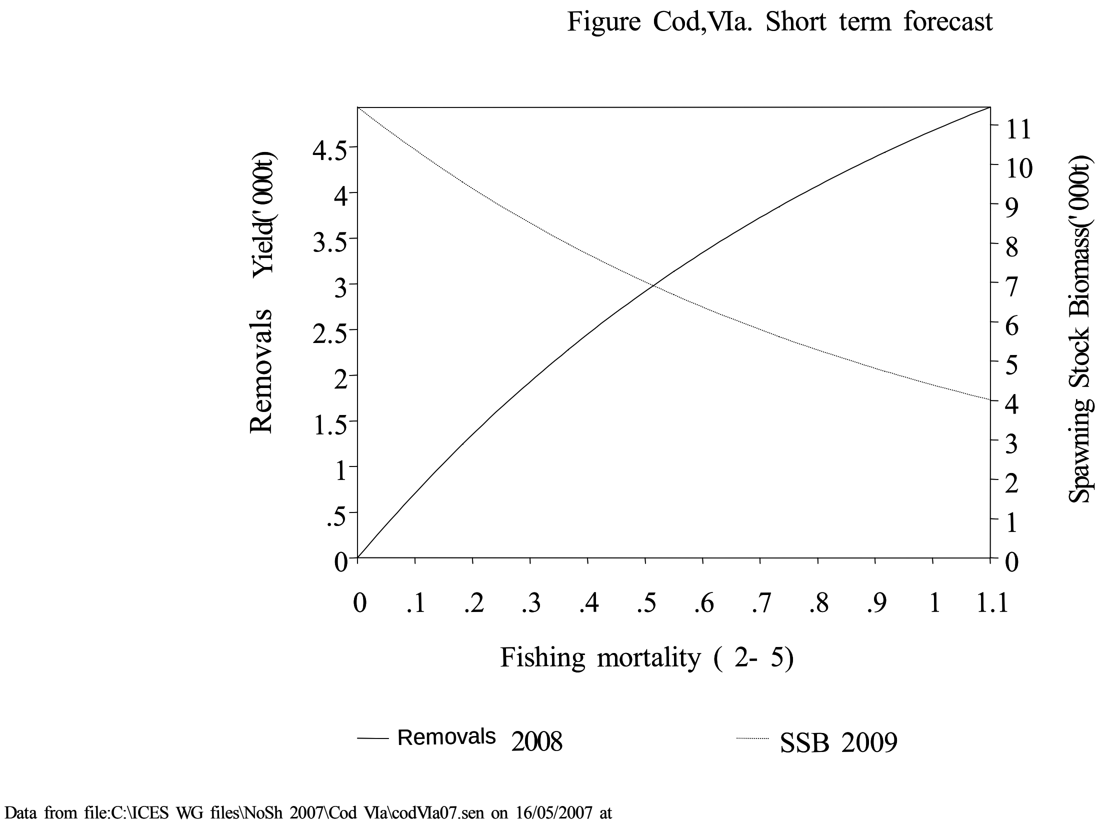


Figure 3.25: Cod in Division VIa. Short term forecast.

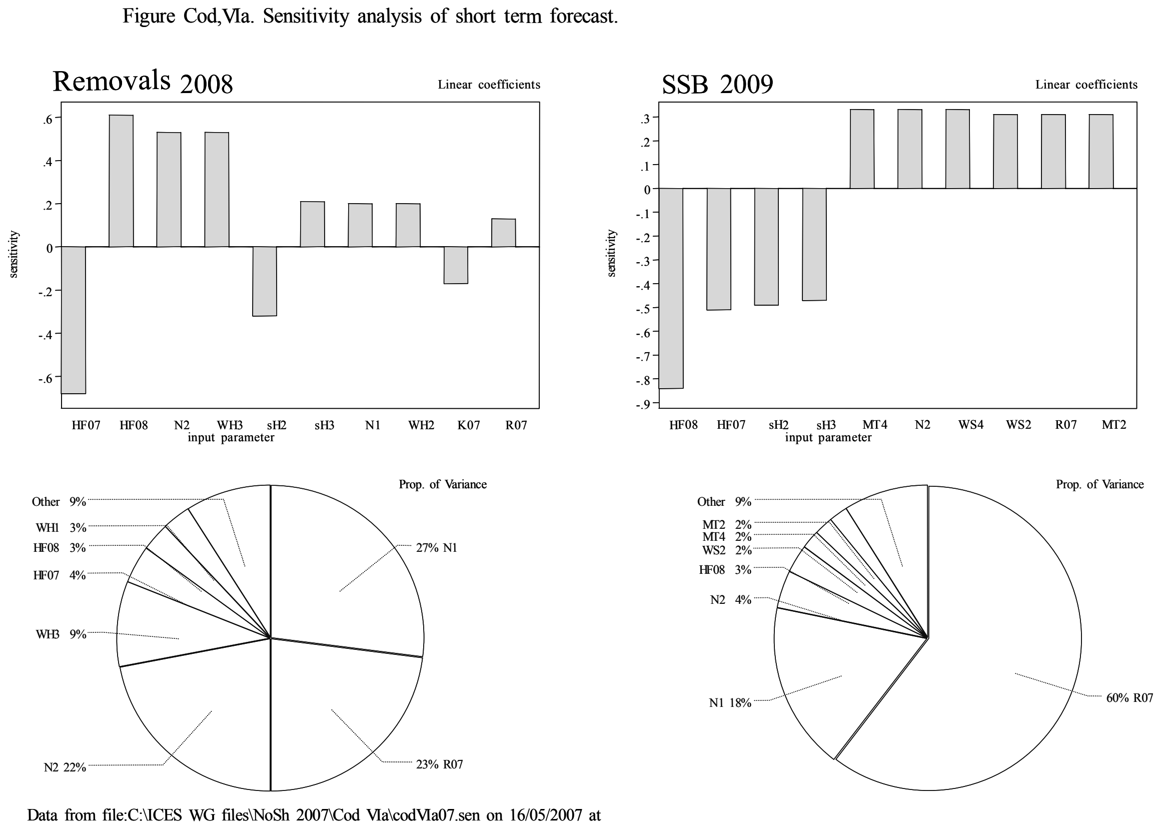


Figure 3.26: Cod in Division VIa. Sensitivity analysis of short term forecast.

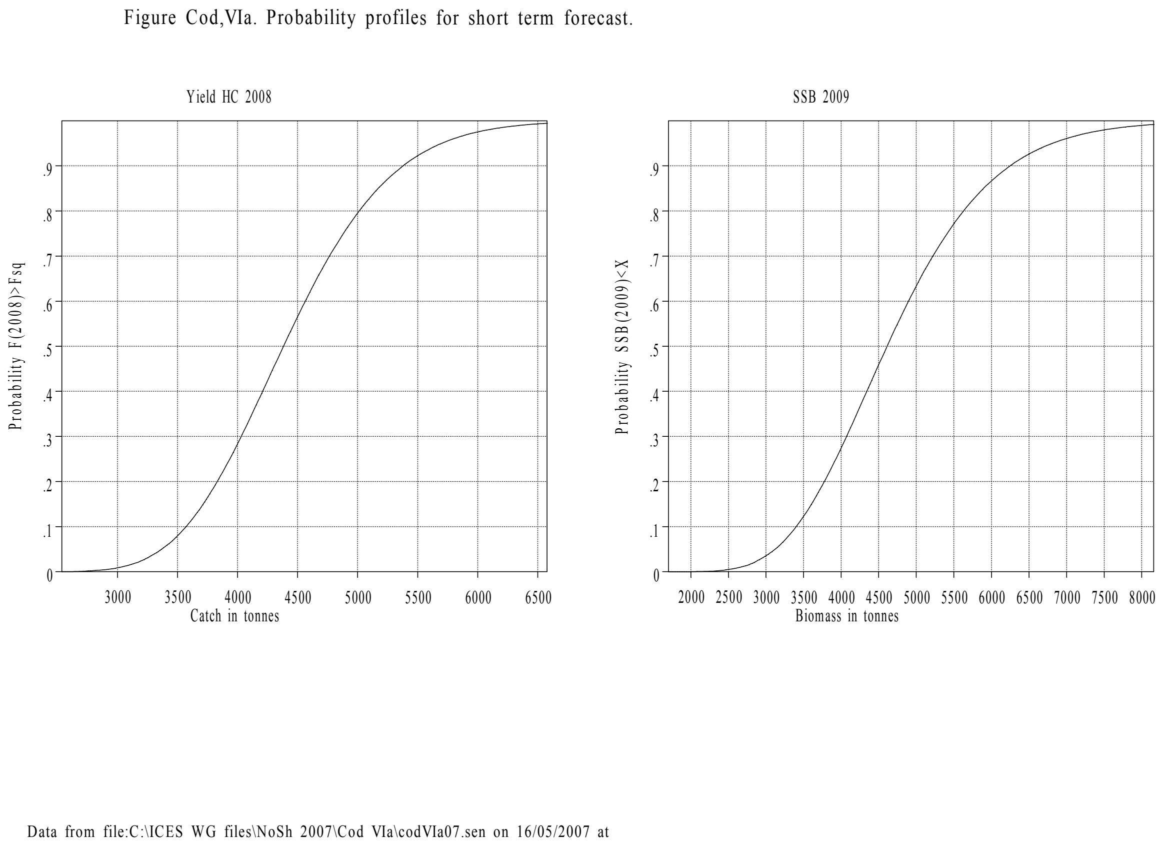


Figure 3.27: Cod in Division VIa. Probability profiles for short term forecast.

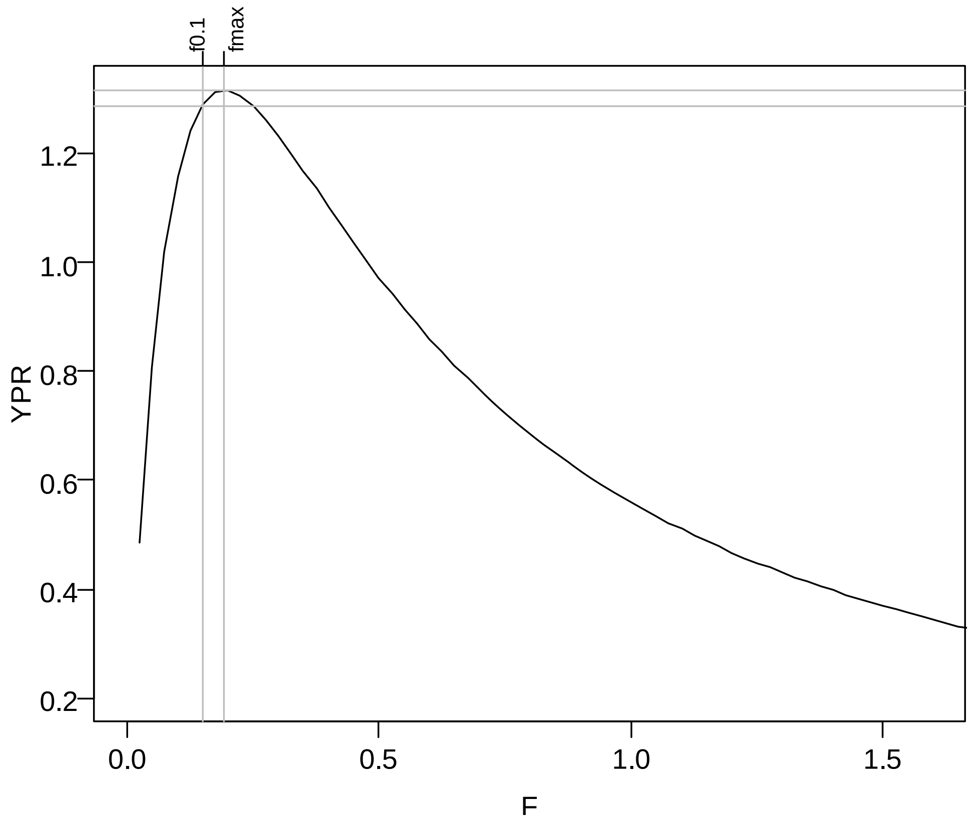


Figure 3.28: Cod in Division Via. Yield and biomass per recruit.

4 Haddock in Subarea VI

4.1 Haddock in Division VIa

In the report of its 2006 meeting (ICES-WGNSDS, 2006), the WG recommended that a benchmark assessment be carried out for haddock in Division VIa. The likely workload for all assessment WGs meeting in 2007 was subsequently evaluated by ACFM at its October 2006 meeting. It was decided that all assessments in 2007 should be treated as updates where possible, excepting those for which experimental or exploratory analyses are appropriate. However, during the 2007 WG meeting concerns were raised about the potential impact on management advice of using a plus-group at age 8 when the dominant large 1999 year class has reached that age in 2007, and also about the removal in the previous assessment of older ages in the Scottish Q4 groundfish survey (ScoGFS Q4). Several exploratory analyses were carried out to address these issues, as described below. The final assessment reported in this Section uses the same procedure as last year with two additional ages in the ScoGFS Q4 dataset.

A Stock Annex is not available for this stock. It is not clear to the WG what this would contain in any case. Data problems have meant that assessment methods have been in a state of almost constant flux over recent years, so there is a standard methodology for only a very few Northern Shelf stocks. In addition, delays in the implementation of the Intercatch system have led to various *ad hoc* approaches to data collation which are not suitable for inclusion in a Stock Annex.

4.1.1 General

4.1.1.1 Fisheries

The fishery for haddock in Division VIa (West of Scotland) takes place as part of a mixed fishery, with varying proportions of other species present in the catches depending on location and time of year. Most of the haddock are caught by medium sized trawlers operating outwith the inshore areas of the Minches and Firth of Clyde. Cod is present in some locations and management arrangements directed at conserving this species have had a major effect on haddock fishing in recent years. In particular, decommissioning in the Scottish fleet, the implementation of restrictive days at sea regulations and the presence of a closed area for cod to the north west of Scotland (where haddock catches are also made) have had the effect of reducing activity for haddock.

Anecdotal reports from the Scottish industry indicate that there has been little directed fishing for haddock in Division VIa thus far during 2007 (and also 2006, although to a lesser extent). This is partly due to poor weather, but is also a response to management measures. The UK Registration of Buyers and Sellers regulation (see Section 1.7.2), which came into force in 2006, is thought by the industry to have very strictly limited the incidence of underreporting in the area, although discarding may have increased to compensate. The regulation has also been effective in moving effort away from areas with over-quota fish. In contrast to previous years, the industry has not highlighted fuel prices as an overriding factor determining fishing patterns in 2007. The differences in effort and quota allocations between Divisions VIa and VIb (Rockall) may also have led to a certain amount of misreporting between the two areas, although the extent of this cannot be quantified directly.

The draft report of the 2007 meeting of the ICES WG on Fish Technology and Fish Behaviour outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological characteristics. It should be noted that the report does not pertain to all fisheries involved in the area, as information was provided only by Ireland

and the UK (which, however, together accounted for 96% of reported haddock landings during 2006). The specific points made in relation to haddock in Division VIa are given below.

Of most significance is the reallocation of effort from Divisions VIa and VIIa into other ICES areas and switching between mesh categories. There appears to have been substantial reductions in effort associated with the larger mesh bands (120mm+) away from the traditional gadoid fishery in the Division VIa (West of Scotland) and into the *Nephrops* fishery in Division IVa (principally, the Fladen Ground). Surprisingly, this shift has mostly been carried out by larger (typically over 1000hp) demersal vessels: the main reason appears to be lack of quota and restrictive days allocations related to the cod recovery plan in Division VIa. While there has been a general decline in the haddock fishery in Division VIa, both Irish and Scottish sources suggest that there is an increasing focus in the corresponding Division VIb (Rockall) fishery. In addition, a few Scottish fishermen are testing the viability of using paired gear (both seine and trawl) at Rockall: if this proves successful, then there is the distinct possibility that effective effort in Division VIb will increase considerably. This fishery is particularly attractive given the lack of effort restrictions in this area.

The number of Irish whitefish vessels participating in the targeted monkfish fisheries in Division VIa (which may have had a by-catch of haddock) fell during 2006 and the first quarter of 2007, and there are now only 8–10 Irish vessels in the area (as opposed to more than 20 in 2005). This is due mainly to restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime. The remaining vessels have moved to the Porcupine Bank *Nephrops* fishery or targeted “mixed” demersal fisheries with single trawls for megrim, monkfish, *Nephrops* and hake in Divisions VIIc-k. An Irish decommissioning round during 2005 is also thought to have removed the few remaining Irish vessels that traditionally target cod on the Cape grounds of Division VIa.

4.1.1.2 ICES advice

Following the ACFM meeting in October 2002, ICES recommended the closure of all fisheries for cod as a target or by-catch species. This advice was based on very low estimated stock size, poor recent recruitments, and continued high fishing mortality. Haddock are a key component of the mixed whitefish demersal fishery in Division VIa which also targets cod, and advice for the two species has generally been linked in the past (although the nature and strength of the linkage is uncertain). For this reason, ICES advised that fishing for haddock in Division VIa should not be permitted unless ways to harvest haddock without incidental catch or discards of cod could be demonstrated.

The form of ICES’ advice changed in 2003 to take more account of the mixed nature of the fisheries prosecuting haddock. Management of haddock since then has been considered as part of wider concerns in the Celtic Sea and West of Scotland ecosystem.

The advice relating to the single-species exploitation boundary in 2006 was:

> *“Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects:*
>
> *The current estimated fishing mortality is 0.49. There will be no gain to the long-term yield by having fishing mortalities above $\boldsymbol{F}_{max}$ (0.21). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.*
>
> *Exploitation boundaries in relation to precautionary limits:*
>
> *In order to maintain SSB above $\boldsymbol{B}_{pa}$ in 2007, ICES recommends a reduction in fishing mortality to less than 0.35. This corresponds to landings less than 8,000 t in 2006. Due*

> *to recent poor recruitments and in order to maintain SSB above $\boldsymbol{B}_{pa}$ also after 2007, a TAC for 2006 well below 8,000 t should be considered."*

The advice relating to the single-species exploitation boundary for 2007 was:

> *"Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects:*
>
> *The current estimated fishing mortality is uncertain, but is likely to be well above $\boldsymbol{F}_{max}$. There will be no gain to the long-term yield by having fishing mortalities above $\boldsymbol{F}_{max}$ (0.29). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.*
>
> *Exploitation boundaries in relation to precautionary limits:*
>
> *In order to maintain SSB above $\boldsymbol{B}_{pa}$ in 2008, ICES recommends a reduction in fishing mortality to less than 0.44. This corresponds to landings of less than 7200 t in 2007."*

The general advice regarding the Celtic Sea and West of Scotland in 2007 is given in Section 1.7.

4.1.1.3 Management

Management of cod is by TAC and technical measures. The agreed minimum landing size for haddock in Division VIa is 30 cm. There is no formal management plan in place. Further regulations implemented for the west of Scotland, including technical measures associated with the cod recovery plan and the UK Registration of Buyers and Sellers regulation, are described in Section 1.7.2.

The following table summarises ICES management advice and the EC management applied for haddock in Division VIa during 2004–2007:

Year	Single-species exploitation boundary	Basis	TAC for Vb (EC), and VIa	% change in *F* associated with TAC[1]	2007 WG estimate of landings
2004	12.2	$\mathbf{F}_{pa}$	6.50	-50%	3.20
2005	7.6	0.75 * $\mathbf{F}_{pa}$	7.60	-30%	3.15
2006	8.0	0.7 * $\mathbf{F}_{pa}$	7.81	+3%	5.72
2007	7.2	0.87 * $\mathbf{F}_{pa}$	7.20	-8%	-

Values are thousand tonnes. [1]Based on *F*-multipliers from forecast tables.

4.1.2 Data available

4.1.2.1 Catch

Official (reported) catch data for each country participating in the fishery are given in Table 4.1.1. Note that data for 2006 are preliminary pending final submissions. The fishery is predominantly prosecuted by Scottish and Irish vessels (see Figure 4.1.1). In previous years commercial data have been collated by FRS (Aberdeen), using a suite of VAX programs as described in Kunzlik (WD5). These are now obsolete, and in the continued absence of a functional version of the Intercatch system, data for 2006 were collated by FRS via a spreadsheet system. This was a tractable simplification of the VAX system which used data aggregated on a national level, rather than a fleet level.

The reliability of catch data for this stock has been a concern for several years, due to issues such as mis- or under-reporting and potentially unaccounted discarding. It has not been possible to quantify the extent of these unallocated removals, leading to the use in the 2006 meeting of a modified TSA assessment method which did not use catch data after 1994. Changes in 2006 in regulations and fleet behaviour are likely to have improved the quality of catch data (see Section 4.1.1.1), which is now thought to be more representative of the true catch. This issue is explored further in Section 4.1.3.3 below.

4.1.2.2 Age compositions

Total catch-at-age data are given in Table 4.1.2, while catch-at-age data for each catch component are given in Tables 4.1.3–4.1.4. The full available year and age range are given for completeness: however, it should be noted that data preceding 1978 are not used in the assessment, as the split of total catch into landings and discards was based on hypothesis rather than data for the earlier period. The specification of the appropriate age range to use is explored in Section 4.1.3.3 below. Quarterly catch-at-age data for years before 2006 were available from both Scotland and Ireland: for 2006, biological sampling data was only provided by Scotland. The countries that provide data are listed in Table 2.2, and sampling levels are shown in Table 2.3.

WG estimates of discards are based on data collected in the Scottish and Irish discard programmes (raised by weighted average to the level of the total international discards). Historically discard age compositions from Scottish sampling have been applied to the unsampled fleets. The revision of the Irish discard data to accommodate a new raising procedure and the provision of a time-series will require that the overall time-series of discard estimates is recalculated. Work is also underway to revise the Scottish discard estimates with an aim to reduce bias and increase precision. A working document set out the methodology of this work at the 2004 WG and it is expected that changes will be made once parallel work for the North Sea is completed.

4.1.2.3 Weight-at-age

The weights-at-age for this stock are generated by applying a fixed weight-length relationship to observations on fish length: for this purpose a combination of Scottish and Irish weight-length relationships were used, depending on data availability. This procedure gives an approximation only to weights-at-age, and does not incorporate effects such as changes in condition. The estimated weight-at-age for the total catch in Division VIa is given in Table 4.1.5. This is calculated as a weighted average of the corresponding weights-at-age in landings and discards: the latter are given in Tables 4.1.6 and 4.1.7. Weight-at-age in the stock is assumed to be equal to the weight-at-age in the total catch, in the absence of a sufficiently long time-series of survey-based weight measurements. The weights time-series are also plotted in Figures 4.1.2–4.1.4. These show that weights-at-age in landings (and, by extension, catch and stock) for fish aged 3 and older have declined considerably over the last 20 years or so. Weights-at-age in discards are relatively constant.

4.1.2.4 Maturity and natural mortality

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

AGE	1	2	3+
Proportion mature	0.00	0.57	1.0

These maturity values were derived from a French survey carried out in Division VIa in 1983. They were first discussed in the 1984 meeting of the North Sea Roundfish Working Group (ICES-NSRWG, 1984), and were first used at the 1985 meeting (ICES-NSRWG, 1985). Proportions of *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

4.1.2.5 Catch, effort and research-vessel data

Reported effort has declined in recent years to very low levels in both Scottish fleets for which effort data are available to the WG (pair trawlers and light trawlers; see Table 4.1.8). The historic mean levels of lpue (landings-per-unit-effort) for these fleets were more constant, although variable. However, problems with effort recording mean that these estimates are unlikely to be valid: further details are available in the report of the 2000 meeting of the ICES WG on the Assessment of Demersal Stocks in the North Sea and Skaggerak (ICES-WGNSSK, 2000). For this reason, commercial Scottish lpue data has not been used in the current assessment. Data are also available (although not updated to 2006) from the Irish trawler fleet (IreOTB; Table 4.1.8), but are not used in the assessment due to concerns about targeting leading to hyperstability.

Four research-vessel survey series are available for the assessment of haddock in Division VIa: the first- and fourth-quarter Scottish groundfish surveys (ScoGFS Q1 and ScoGFS Q4), the discontinued Irish groundfish survey (IreGFS), and the new Irish groundfish survey (IRGFS). The reports of the 2006 meeting of the WG (ICES-WGNSDS 2006) and the 2007 meeting of the IBTS WG (ICES-IBTSWG, 2007) explored the available survey data in detail. Both ScoGFS Q1 and Q4 were accepted for use in the 2006 assessment, and this practice has been continued this year (albeit with an increase in the number of ages used from the ScoGFS Q4 survey – see Section 4.1.3.2). The IreGFS series was not considered further due to problems with internal consistency (ICES-WGNSDS, 2006), while the new IRGFS series still only has four years of data and cannot yet be considered for tuning purposes.

All survey series available for tuning the assessment are given in Table 4.1.9, with those data used in the final assessment highlighted. Figures 4.1.5 and 4.1.6 gives the log mean-standardised ScoGFS Q1 and Q4 indices plotted by year class or cohort. This shows that the two surveys have generally tracked year classes consistently well, with the exception of a period during the early to mid–1990s during which the surveys performed less well.

Bivariate scatterplots by cohort are given in Figures 4.1.7 and 4.1.8. for the full datasets of the ScoGFS Q1 and Q4 series respectively. Catch curves from the two series are also given in Figure 4.1.9. The data for age–8 in the Q1 survey has not previously been used, as the assessment uses a plus-group at age–8. However, Figure 4.1.7 demonstrates that the data at this age in the Q1 survey are consistent with earlier years, so would be available for use should the need arise. Similarly, age–6 and age–7 from the Q4 survey were not used in the 2006 assessment, but the WG concludes from Figures 4.1.8 and 4.1.9 that there is no reason why this should be so and they have been reinstated in the current assessment. On the other hand, Figure 4.1.8 also shows that age-0 from the Q4 survey is not a reliable indicator of year class strength, and those data have not been included.

Plots of the spatial distribution of the Q1 IBTS surveys (which includes ScoGFS Q1), split by length class (<20 cm and ≥20 cm), are given in Figures 4.1.10 and 4.1.11**.** These are taken from ICES-IBTSWG (2007), and are indicative of distributions in Division VIa in winter 2006. Work is underway to produce age-structured survey plots for Division VIa only.

4.1.3 Data analyses

4.1.3.1 Reviews of last year's assessment

Several concerns were raised by June 2006 meeting of RGNSDS regarding last year's haddock assessment. These are summarised as follows:

- RGNSDS suggested removing Scottish commercial lpue time-series from the report altogether. The WG decided to retain this information for completeness (see Section 4.1.2.5): while it is recognised that their interpretive value is currently low, ongoing work is attempting to make more and better used of data from commercial sources and it is important that these lpue data are not lost to public scrutiny.

- The use of the Ricker stock-recruit model as a component in the TSA model fit was criticised, with a geometric-mean (GM) model suggested as a better alternative. While it is the case that the slope at the origin is model rather than data driven, the available stock-recruit data do suggest a decline in recruitment at high stock sizes which cannot be replicated using a GM. For this reason the Ricker model has been retained in the TSA analyses (see Section 4.1.3.3).
- The unusual retrospective pattern noted by RGNSDS last year is still present this year (see Section 4.1.3.3). The reason for this is still unknown, and there has been insufficient intersessional time for full simulation testing of the modified TSA (nor for SURBA, also mentioned in this context by RGNSDS). This issue has not been explored further in the current work, but retrospective bias is being studied by the Methods WG (ICES-WGMG, 2007).

4.1.3.2 Exploratory survey-based analyses

The stock trends indicated by the survey series alone were explored using SURBA (Version 3.0, see Section 2.7). Three main runs were carried out, using each series individually and together. For the base case runs, the reference age was set at 4 and the smoothing parameter λ was fixed to 1.0. These runs were carried out using ages 1–8 for the ScoGFS Q1 series, and ages 1–7 for the ScoGFS Q4 series. For the former, observed stock weights-at-age 8 were used rather than the plus-group weights used in subsequent catch-at-age based analyses.

Figure 4.1.12 compares stock summary outputs from the three runs. These show some discrepancies during the early to mid-1990s, which was also the period in which neither survey tracked year class strength well (see Figure 4.1.6). Concordance between the survey-based stock estimates is good in recent years, however. Detailed results for single-series runs are available in the stock files.

Figures 4.1.13 to 4.1.15 show model fits, residuals and retrospective analyses for the two-fleet SURBA run (using both ScoGFS Q1 and Q4), while the stock summary is given in Table 4.1.10. The key points of the model fit are that mean $Z_{2\text{-}6}$ has been stable since a sharp decline in 2001; recruitment estimates have fallen from the highest value in 2000 (the 1999 year class) to the lowest in 2007; and SSB has similarly fallen from a peak in 2003. The residuals are reasonable, with no strong evidence of unaccounted year-effects or trends, and there is very little retrospective bias or noise.

An analysis of the sensitivity of the model fit to three *ad hoc* run settings, namely reference age, smoothing and catchability at age 1, was carried out using the scan facility in SURBA. Summary plots from this exercise are given in Figures 4.1.16 to 4.1.18. The model fits are mostly quite insensitive to these settings, with two exceptions: the smoothing parameter has a strong flattening effect on mean Z estimates, and a low assumed catchability on the youngest age gives rise to very different total stock biomass estimates. The latter is not a real issue, as it is unlikely that catchability on age-1 in a survey would be 10% of catchability on age–2 (as the exercise suggests). The choice of which smoothing parameter to use is more difficult, as SURBA cannot be used to determine its value directly.

On the basis of these exploratory survey-based analyses, the WG concludes that:

a) the extension of the ages used in the surveys is appropriate, and that

b) the surveys are internally consistent and yield similar indications of population trends for recent years.

4.1.3.3 Exploratory catch-based analyses

Exclusion of catch data from 1995 onwards

In its 2006 meeting (ICES-WGNSDS 2006), the WG expressed grave concerns over the quality and validity of commercial catch data since 1995. The causes of these problems in previous years are thought to have been issues such as area misreporting, some underreporting, and (potentially) unaccounted misreporting. The approach taken in last year's meeting was to remove catch data for 1995–2005 from the assessment, and run a modified TSA model (see Section 2.7) which is based on catch and survey data up to 1994, and survey data only thereafter.

It is likely that improved compliance monitoring and enforcement, along with a reduced fleet size and the UK Registration of Buyers and Sellers regulation (Section 1.7.2), have reduced greatly the incidence of misreporting and underreporting (although discarding is still problematic). One result of this is that the catch data from 2006 may be more reliable that in previous years and the WG discussed whether this data year should be used in the assessment (still removing years 1995–2005). The WG concluded that this would be logically inappropriate. From 1995 onwards the model is using survey data to estimate, in effect, total mortality Z minus a fixed natural mortality component M (where M is unlikely to represent all the unaccounted mortality). Including the 2006 catch data would switch the model back to estimating fishing mortality F for that year only, and the time-series would no longer be consistent. For this reason, numbers-at-age from commercial catches for 1995–2006 were excluded from further analysis.

Exclusion of age-0 data

Although haddock in Division VIa are not landed at age–0 (that is, in the same year in which they were spawned), fish of that age do appear in discard samples and in the Q4 Scottish groundfish survey. The WG therefore considered whether data on age–0 fish should be included in the assessment. However, the Q4 survey data on age-0 does not provide a reliable indication of year class strength (see Figure 4.1.8). Furthermore, the catch curves for commercial data on ages 0–10 in Figure 4.1.19 show that catchability of age–0 fish is low and variable (since the "hooks" at the start of each curve are very variable in length and direction).

Choice of plus-group

The other main issue with the assessment concerns the choice of plus-group. In recent years the assessment has used a plus-group at age 8, as both catch and survey data are sparse at older ages. However, the fish of the 1999 year class (which is estimated to have been the largest in the available time-series) are aged 8 in 2007 (the intermediate year) and aged 9 in 2008 (the quota year). The WG was therefore concerned that an inappropriate application of a mean plus-group weight to the 1999 year class in short-term forecasts might reduce the accuracy of the forecasts.

To investigate this, TSA was run using a plus-group at age 10 and simple deterministic forecasts were carried out on a spreadsheet. The forecasts were then repeated using the same starting point, but with the plus-group changed to age 8 (and mean weights-at-age changed accordingly). Finally, the landings yields from the two forecasts were compared to determine whether the choice of plus-group would have any management implications in terms of quota advice. It transpired that changing from a plus-group at age 10 to one at age 8 increased the 2007 landings yield by 19 tonnes (+0.29%), and reduced that in 2008 by 81 tonnes (-1.60%). These changes will have no practical management implications, and the WG therefore decided to retain the plus-group at age 8 used in previous assessments. The catch curves for the reduced age range 1–7 are given in Figure 4.1.20 (the plus-group is not shown in this plot), and indicate no remaining consistency problems with catch data.

4.1.3.4 Conclusions

Following the exploratory analyses summarised above, the WG concluded that a modified TSA assessment similar to that presented in the 2006 report would represent the most appropriate available assessment of haddock in Division VIa. The only modification to the procedure used last year was an extension of the age range in the ScoGFS Q4 survey to 1–7, as no justification could be found for the exclusion of ages 6 and 7 in the previous assessment. The following text table summarises the data ranges used in recent assessments, while Table 4.1.11 shows the evolution of the corresponding TSA parameter estimates (changes for 2007 are highlighted in bold).

DATA	2006 ASSESSMENT	2007 ASSESSMENT
Catch data	Years: 1978–1994 Ages: 1–8+	Years: 1978–1994 Ages: 1–8+
Survey: ScoGFS Q1	Years: 1985–2006 Ages: 1–7	Years: 1985–2007 Ages 1–7
Survey: ScoGFS Q4	Years: 1996–2005 Ages: 1–5	Years: 1996–2006 Ages 1–7
Survey: IreGFS	Not used	Not used

4.1.4 Final assessment and historical stock trends

Summary plots from the final assessment are given in Figure 4.1.21, while corresponding summary tables are presented in Tables 4.1.12 and 4.1.13 (abundance), Tables 4.1.14 and 4.1.15 (fishing mortality), and Table 4.1.16 (stock summary). Mean $F_{2\text{-}6}$ is estimated to have been stable at or around F_{pa} since 2003, but a sequence of low recruitments have led to a fall in SSB from the peak in 2002. Estimated and observed catches diverged considerably from 1995 onwards, but this trend appears to have reversed and the difference between the two (which represents unaccounted removals) is now small (Figure 4.1.22). This could indicate a beneficial effect of management regulations and changes in fleet behaviour in 2006, and is supported by anecdotal information from the fishing industry (see Section 4.1.3.3).

Standardised prediction errors are given in Figures 4.1.23 (landings), 4.1.24 (discards), 4.1.25 (ScoGFS Q1) and 4.1.26 (ScoGFS Q4). Although some outliers remain, none are large enough to invalidate the model fit and there are no time-trends in recent years. The TSA stock-recruit plot is presented in Figure 4.1.27. The development of persistent and transitory trends in survey catchability is summarised in Figures 4.1.28 (ScoGFS Q1) and 4.1.29 (ScoGFS Q4), which show that there are no unaccounted catchability trends.

Estimated and observed discard rates (proportions at age) are given in Figure 4.1.30. Discard model fits are good for the years 1978–1994 when discard data are included in the estimation. Agreement remains close until 2002, when the values begin to diverge (note that the "estimated" discard ogive is actually fixed after 1994, as there are no new discard data included in the model after that year). Although the overall discard estimates are very close to observations in 2006 (see Figure 4.1.21), Figure 4.1.30 suggests that the discarding pattern by age in 2006 is still somewhat different to the model.

The results of retrospective analyses are summarised in Figures 4.1.31 to 4.1.33. There is little bias in these plots. Most retrospective bias is thought to be caused by mismatch between catch and survey data (ICES-WGMG, 2007), and as only survey data are used in the TSA model after 1994 the absence of strong retrospective patterns is not surprising. However, there are some deviations in SSB estimates during the early to mid–1990s, which corresponds to the period when neither survey was able to track year class strength well (see Section 4.1.2.5). Finally, Figure 4.1.34 compares TSA-derived population estimates with two SURBA runs (with smoothing parameter λ set to 1.0 and 3.0, respectively). SSB and recruitment estimates are very consistent. Mortality estimates from the standard SURBA model are noisy, but increased smoothing leads to good agreement with the TSA estimates.

4.1.5 Recruitment estimates

The TSA assessment provides estimates of recruitment for the forecast years 2007 and 2008. The value for 2007 (that is, the 2006 year class at age 1) is based largely on the ScoGFS Q1 datum for that year (along with a degree of time-series smoothing), and as it is based on observations it is appropriate to use it in the forecast. The value for 2008 (that is, the 2007 year class at age 1) is not generated directly by data, but rather the underlying Ricker stock-recruit model that is included by TSA as part of the overall model fit. Figure 4.1.27 gives the stock-recruit scatterplot. As already discussed in Section 4.1.3.1 in relation to last year's reviews, the WG conclude that there is sufficient evidence of a decline in recruitment at high stock sizes for the inclusion of the Ricker component in the TSA model to be appropriate. Given this, it would be inconsistent to argue that the Ricker-based recruitment forecast for 2008 cannot be used. For this reason the WG decided to use the TSA forecast for 2008 as well as for 2007. As last year, a long-term (1978–2006) geometric mean is used for subsequent years. The recruitment options are summarised in the following table: the values used in the forecast are highlighted in bold.

YEAR	TSA	GM (78–06)
2007	**23425** (~ ScoGFS)	100179
2008	**107895** (Ricker)	100179
2009	-	**100179**

Figure 4.1.35 demonstrates the close agreement between the TSA-generated recruitment estimates, and the indices from the two surveys. The plot also illustrates the available forecast recruitment options.

4.1.6 Short-term forecasts

Figure 4.1.36 gives the time-series at age of fishing mortality estimate, along with the mean over ages 2–6. This suggests that *F* has stabilised or slightly increased at all ages since 2002.

TSA produces short-term forecasts as part of every standard model run. The recruitment values used in these forecasts have been discussed in Section 4.1.5. The model will also forecast fishing mortality rates. It does so by iterating forward the time-series model that had been fitted to historical data. These forecast mortalities therefore retain the time-series characteristics of the preceding data. However, it is not clear to the WG what the precise statistical properties of these mortality forecasts are. It is likely that they follow a pattern of damped oscillation towards an eventual steady state, but without further analysis the WG did not feel confident in using them as the basis for a forecast.

There were three main options open to the WG in determining fishing-mortality selection patterns to be used in the forecast: a simple three-year mean, the most recent estimate (2006), and TSA-generated selection patterns. These are plotted in Figure 4.1.37. The three-year mean is similar to the most recent estimate, while the TSA forecast is similar for most ages except age 4 for which it is around 0.05 higher. However, as discussed above, the WG have reservations about the properties of the TSA forecasts. In addition, the final-year (2006) TSA estimate is the most uncertain in the time-series. Consequently the WG concluded that a three-year mean should be used, as last year. This is, in any case, very close to the final-year estimate.

The WG did not consider what discard proportion to use in the forecast. As highlighted in Section 4.1.3.3, the assessment is survey-based from 1995 onwards and estimates total **removals** from that year to the present. It is not possible to subsequently partition estimated removals back into landings, discards, and other sources of mortality, because it is not known what proportion of the difference between observed and estimated removals is due to fishing. It is also likely (in any case) that changes in regulations and fishing practices in Division VIa will alter discarding practice. The forecasts presented in this Section are therefore intended to be used as forecasts of total **removals**, rather than landings for direct TAC advice purposes. This is an unavoidable consequence of series of recent years of poor-quality commercial catch data (although, as we have seen, the reliability of these data may have improved in 2006).

The final key issue for the forecast is that of weights-at-age, and in particular, the slow growth observed in recent year classes. Figure 4.1.38 demonstrates this with linear models fitted to cohort-based mean weights-at-age data. A number of recent year classes appear to be growing more slowly than has been the case in the more distant past. The plot of linear model slopes in Figure 4.1.39 confirms this trend, except for the most recent year classes which appear to be growing more rapidly (although the linear model fits are based on very few data points for these year classes). Table 4.1.17 demonstrates the consequences if the standard practice of using three-year means for weights-at-age is used–the weights-at-age for the 1999 year class jump from 0.563 kg at age 7 to 1.122 kg at age 8 and above, and this cannot be realistic.

As an alternative, the linear models discussed above were used as the basis for predictions for those cohorts with sufficient data (year class 1996–2003). For each of these cohorts, the linear models were projected three years ahead. The subsequent dataset of projected cohorts was converted back to a year-based dataset. Values for younger ages could not be obtained by this procedure, as time-series for contributing cohorts were too short to fit linear models, so three-year means were used for these ages. The forecast weights for the plus-group (age 8+) were constructed from the cohort-based projections for ages 8–10 and estimated abundances for age 8–10 from an earlier TSA run undertaken with an extended plus-group (see Section 4.1.3.3). This yielded slightly different population estimates than the final assessment, but is only used here to generate abundance-weighted averages of forecast weights.

Table 4.1.18 gives the results of this process. The 1999 year class, which forms the bulk of the plus-group in the forecasts, now has estimates of mean weight that are much more consistent with its growth history. The short-term forecast program used (WGFRANSW from the MLA suite) cannot account for changing *F* within a forecast, so for this purpose only the 2007 *F* values from Table 4.1.18 were used. Figure 4.1.39 plots the mean weight estimates and forecasts, and illustrates the sharp drop in the mean weight of the plus-group as the slow-growing 1999 year class enters it.

Table 4.1.19 presents the inputs to the short-term forecast. Outputs from the forecast are given in Tables 4.1.20 (management options) and 4.1.21 (detailed tables), and Figures 4.1.40 (sensitivity analysis), 4.1.41 (probability profiles) and 4.1.42 (short-term forecast). Results of the forecast at *status quo F* are summarised in the following table:

YEAR	REMOVALS (000 T)	SSB (000 T)
2007	11.2	24.7
2008	10.4	19.3
2009	-	20.8

It is worth reiterating that this year's forecast for haddock in Division VIa is based on an assessment principally driven by survey data since 1995. Because of this, it is not possible to partition estimated removals into landings, discards, and other sources of mortality. It is therefore not possible to reach firm conclusions regarding appropriate landings quotas. However, the WG concludes that the current downwards trend in SSB and continued low recruitment are informative indicators for management advice.

4.1.7 Yield-per-recruit

Results of a yield-per-recruit analysis are shown in Figure 4.1.43. Current *F* is uncertain, but the best estimate ($F = 0.56$) is well above the estimate of $F_{0.1}$ (= 0.19).

4.1.8 Medium-term forecasts

Stochastic medium-term projections were not produced for this stock. The reliance of the fishery on intermittent large year classes, and the fluid nature of the fishery and related management, make the usefulness of medium-term projections questionable in any case.

4.1.9 Biological reference points

B_{pa} is set at 30 000 tonnes and is defined as B_{lim}*1.4. B_{lim} is defined as the lowest observed SSB, considered to be 22 000 tonnes when the current reference points were established in 1998. F_{pa} is 0.5 on the technical basis of a high probability of avoiding SSB falling below B_{pa} in the long-term. F_{lim} is not defined.

4.1.10 Quality of the assessment

Figure 4.1.44 summarises stock assessment results from several successive WGs. The estimates from this year's assessment are reasonably consistent with those from more recent years, the principal differences being a small increase in *F* and a small decrease in SSB. Assessments carried out in 2002 and 2003 give a different stock perception, but they were based on a different assessment approach in which all available catch data were used.

Landings and discards

Quotas for haddock in Division VIa appear to have started to become restrictive in or around 1995. Anecdotal evidence suggests that these and other strict management measures led to increasing unreliability of landings data from the commercial fleets prosecuting the fishery from 1995 to 2005. The approach taken in this WG is to assess the stock using a modified TSA model which does not include catch data from 1995 onwards, and which thus models removals rather than catches. Measures such as the UK Registration of Buyers and Sellers legislation (Section 1.7.2) appear to have improved the reliability of commercial landings data for 2006. While it is not appropriate to simply add these data to the model at the end of the time-series, the survey-based estimates do indicate that the discrepancy between observed and estimated removals has fallen sharply in 2006.

Effort

With the increased requirement for vessels to operate with VMS it is likely that the quality of effort data will improve. This will lead to improved time-series of effort data in the future but still leaves uncertainties regarding the earlier years in the time-series. Currently commercial cpue or lpue data cannot be used in the assessment with any confidence.

Surveys

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

Weights-at-age

The growth characteristics of this haddock stock are very variable, and seem to be strongly driven by cohort effects rather than year effects: that is, early life-history events determine the subsequent growth potential of each cohort. In this assessment, simple linear growth models have been fitted to cohort weights-at-age data and used to generate weights-at-age in the forecast. These models fit reasonably well, but this approach is quite simplistic and may be missing important nuances in growth characteristics such as variable growth within a cohort. Work is underway at FRS (Aberdeen) and elsewhere to develop improved models of growth, and it is hoped that these will improve stock forecasts in the future.

Model formulation

Models such as the modified TSA used this year, based largely on survey data, are becoming the *de facto* standard in several ICES assessments for which problems exist with commercial catch data (see this report, and also ICES-WGNSSK, 2006). Other examples include BADAPT and SURBA (see Section 2.7). While these are essential to address data problems, it needs to be borne in mind that there are two main problems with such approaches. Firstly, survey data are based on far fewer samples, and are therefore more variable, than catch data. It is therefore likely that precision is sacrificed (to a certain extent) to reduce bias. Secondly, a survey-based assessment estimates removals from the stock and total mortality, rather than landings and fishing mortality, and is therefore more difficult to use as the basis of quota advice than corresponding catch-based approaches.

4.1.11 Management considerations

Haddock in Division VIa are not managed through a formal management plan, but any advice for haddock needs to take account of corresponding advice for cod and other mixed-fishery considerations.

At the *status quo* rate of removals, and given assumptions about growth and recruitment, the estimated SSB is forecast to drop below B(lim) in 2008, and to remain below it in 2009. This is a consequence of a series of poor recruitments. However, anecdotal evidence and fishery observations suggest that regulations and changes in fishing patterns in 2007 are reducing fishing mortality, and thus rate of removals. The assumption of a *status quo* rate of removals may therefore not be realistic. The stock status is revised downwards somewhat from last year's assessment–this appears to be due to a combination of very low recruitment estimate from the 2007 Q1 survey, and a slightly higher rate of removals and a slightly lower SSB in final assessment year. The current estimate of 1999 year class recruitment is very similar to previous assessments, while weights' modelling is similar except that reduced weights of the 1999 and 2000 year classes are applied to the plus-group in this year's assessment.

It must be emphasised that the forecast given in this section is a projection of removals, *not* landings. Care therefore needs to be taken when interpreting the forecast in the context of management advice for the purposes of setting quotas. In the absence of any indications of a strong incoming year class, it is inevitable that SSB will continue to decline in the short-term. However, as mentioned above, the rate of that decline may be less than suggested in this forecast.

Changes in fishing behaviour during 2006 and 2007 will have strong implications for management decisions. Of most significance is the reallocation of effort from Divisions VIa and VIIa into other ICES areas and switching between mesh categories. There appears to have been substantial reductions in effort associated with the larger mesh bands (120 mm+) away from the traditional gadoid fishery in the Division VIa (West of Scotland) and into the *Nephrops* fishery in Division IVa (principally, the Fladen Ground). The main reason appears to be lack of quota and restrictive days allocations related to the cod recovery plan in Division VIa. While there has been a general decline in the haddock fishery in Division VIa, both Irish and Scottish sources suggest that there is an increasing focus in the corresponding Division VIb (Rockall) fishery. In addition, a few Scottish fishermen are testing the viability of using paired gear (both seine and trawl) at Rockall: if this proves successful, then there is the distinct possibility that effective effort in Division VIb will increase considerably. This fishery is particularly attractive given the lack of effort restrictions in this area.

The number of Irish whitefish vessels participating in the targeted monkfish fisheries in Division VIa (which may have had a by-catch of haddock) fell during 2006 and the first quarter of 2007, and there are now only 8–10 Irish vessels in the area (as opposed to more than 20 in 2005). This is due mainly to restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime. The remaining vessels have moved to the Porcupine Bank *Nephrops* fishery or targeted “mixed” demersal fisheries with single trawls for megrim, monkfish, *Nephrops* and hake in Divisions VIIc-k. An Irish decommissioning round during 2005 is also thought to have removed the few remaining Irish vessels that traditionally target cod on the Cape grounds of Division VIa.

Special attention needs to be given to considering the sporadic nature of haddock recruitment, and how to manage periods of low recruitment interspersed with large, occasional pulses. More generally, management of haddock in Division VIa has not yet been the subject of an empirical evaluation of the type carried out in 2006 for North Sea haddock (ICES-WGNSSK, 2006). This needs to be done in order to determine the likely efficacy of the current management approach.

Table 4.1.1. Haddock in Division VIa. Nominal landings (000 t), as officially reported to ICES and estimated by the WG.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005[1]	2006[1]
Belgium	8	9	-	9	1	7	1	+	1	3	2	2	1	2	+	+		+	
Denmark	+	+	+	+	1	1	-	1	1	-	+	-	-	-	-	+	-		
Faroe	-	13	-	1	-	-	-	-	-	-	-	-	n/a	n/a			4		1
Islands	3 001	1 335[1,2]	863[1,2]	761[1,2]	761	1 132	753	671	445	270	394[1]	788	282	160	151	183	173	233	250
France	4	4	15	1	2	9	19	14	2	1	1	2	1	1	+	-		+	7
Germany	2 731	2 171	773	710	700	911	746	1 406	1 399	1447	1 352	1054	677	744	672	497	194	n/a	521
Ireland	54	74	46	12	72	40	7	13	16[1]	21[1]	28	18	70	32	30	23	4	21	17
Norway	-	-	-	-	-	-	-	-	-	-	2	4	9	4	4	5			
Spain	114	235	164	137	132	155	254	322	448	493	458	315	199	201	237				
UK (E &	35																		
W)[3]	15 151	19 940	10 964	8 434	5 263	10 423	7 421	10 367	10 790	10 352	12 125	8 630	5 933	5 886					
UK (N. Ire)															6 225	4,688	3 002	2 972	4 941
UK (Scot.)																	1		
UK (total)																			
Netherlands																			
Total reported	**21 098**	**23 781**	**12 825**	**10 065**	**6 932**	**12 678**	**9 201**	**12 794**	**13 102**	**12 587**	**14 360**	**10 813**	**7 163**	**7 030**	**7 113**	**4,884**	**3 007**	**3 227**	**5 737**
WG estimates	**21 136**	**16 688**	**10 135**	**10 557**	**11 350**	**19 060**	**14 243**	**12 368**	**13 453**	**12 874**	**14 401**	**10 430**	**6 952**	**6 731**	**7 097**	**5,334**	**3 199**	**3 148**	**5 723**

[1]Preliminary.

[2]Includes Divisions Vb(EC) and VIb.

[3]1989–2002 N. Ireland included with England and Wales.

n/a = Not available.

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

Table 4.1.2. Haddock in Division VIa. Total catch-at-age numbers (000s). Values used in the final assessment are boxed.

	Age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	451	1059	1341	72461	6816	294	274	174	11	6	6	0	0	0	0	0	24
1966	5953	1595	529	1113	47431	1926	64	32	57	0	0	0	0	0	0	0	57
1967	40122	19185	19332	951	265	24979	400	9	14	4	0	0	0	0	0	0	19
1968	27	129418	38393	3079	356	681	14063	727	43	9	0	0	0	0	0	0	52
1969	2742	84	160706	10260	1434	268	379	4576	191	9	0	0	0	0	0	0	200
1970	17189	6317	519	95114	2770	173	89	145	585	13	2	0	0	0	0	0	600
1971	6604	71481	3915	3328	79966	545	127	7	20	175	16	0	0	0	0	0	212
1972	14215	20713	85141	2718	2336	53823	504	50	19	0	67	0	0	0	0	0	86
1973	19589	47387	16907	19477	258	1222	33193	150	32	6	125	0	0	0	0	0	163
1974	63698	68837	11562	10757	6317	83	447	11463	104	34	31	0	1	4	0	0	174
1975	6849	179349	34957	3339	3350	1882	95	98	3454	72	8	0	0	0	0	0	3534
1976	4227	24337	72330	15224	1588	1491	868	21	7	1103	4	0	5	0	0	0	1119
1977	4552	13109	3468	35948	5705	680	495	308	28	11	259	5	0	0	0	0	304
1978	57	15942	2095	971	24357	2938	351	247	338	7	17	211	3	0	0	0	575
1979	5697	70070	17282	1865	470	9863	833	114	145	28	3	1	42	1	0	0	221
1980	13	22729	21927	5636	922	143	3082	229	22	5	21	3	0	4	0	0	54
1981	764	251	83911	20697	1768	194	39	822	39	14	2	2	1	0	1	0	60
1982	136	15492	5019	73676	8167	898	108	272	288	31	12	1	0	0	0	0	332
1983	2084	14524	20233	6040	36122	3398	597	41	194	195	40	15	0	0	0	0	444
1984	269	98976	8626	12910	6242	22790	2449	371	43	44	73	3	0	0	0	0	162
1985	155	22820	78922	4667	4184	1789	11189	964	84	4	8	56	4	0	0	1	157
1986	2979	8127	11235	45367	1823	916	449	2611	344	38	7	15	1	3	0	0	409
1987	1498	89021	16824	10150	23857	1452	1116	642	1818	326	20	15	9	3	12	0	2203
1988	7582	10007	58414	7598	4185	9255	428	235	177	935	45	3	1	3	2	0	1167
1989	3773	5010	3420	25724	2755	1556	3634	255	84	87	437	56	1	1	0	0	666
1990	437	37247	5856	1884	12158	871	279	519	48	22	12	2	0	0	0	0	85
1991	8921	36924	21991	1259	834	5132	412	283	410	24	11	5	6	0	0	1	457
1992	4332	51840	18971	11331	565	236	1577	157	37	108	25	0	0	0	0	0	169
1993	2196	43659	60785	20763	4669	306	219	915	70	107	44	25	1	2	0	0	250
1994	2843	19484	32638	21527	5671	1579	76	175	237	17	16	9	1	0	0	0	279
1995	7692	17580	15759	23599	6865	1472	387	34	111	90	2	0	0	0	0	0	203
1996	10249	33344	39812	6641	10225	3663	1007	324	23	40	12	4	0	0	0	0	80
1997	2984	23843	10507	21550	2178	2668	870	259	59	1	7	1	0	0	0	0	67
1998	2058	11421	18001	8032	15116	1352	1036	377	124	45	2	4	1	0	0	0	175
1999	6898	6179	18055	11569	3004	4919	579	452	96	12	2	1	2	1	0	0	115
2000	5709	50142	6642	8596	4213	1055	1104	205	133	21	1	0	0	0	0	0	156
2001	11818	11023	33496	2432	3666	1521	533	314	65	25	11	0	3	0	0	0	104
2002	1362	16427	12394	32248	833	714	549	238	144	18	9	0	0	0	0	0	172
2003	3861	6972	5592	6848	12830	222	209	70	34	12	10	0	0	0	0	0	56
2004	2727	15159	6506	2384	3839	6706	286	101	26	6	2	2	0	0	0	0	37
2005	3965	7190	6202	3700	2116	2669	2704	57	42	5	1	1	0	0	0	0	48
2006	817	16031	4831	3844	3801	3109	2731	2750	33	26	5	0	0	1	0	0	65

Table 4.1.3. Haddock in Division VIa. Landings-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	0	33	463	60967	6753	294	274	174	11	6	6	0	0	0	0	0	24
1966	0	58	175	1082	46902	1926	64	32	57	0	0	0	0	0	0	0	57
1967	0	595	6136	782	262	24979	400	9	14	4	0	0	0	0	0	0	19
1968	0	3665	12439	2573	354	681	14063	727	43	9	0	0	0	0	0	0	52
1969	0	3	45819	8766	1423	268	379	4576	191	9	0	0	0	0	0	0	200
1970	0	169	170	78402	2747	173	89	145	585	13	2	0	0	0	0	0	600
1971	0	1925	1149	2665	78909	545	127	7	20	175	16	0	0	0	0	0	212
1972	0	576	26700	2225	2312	53823	504	50	19	0	67	0	0	0	0	0	86
1973	0	1252	5301	16109	256	1222	33193	150	32	6	125	0	0	0	0	0	163
1974	0	1706	3318	8625	6261	83	447	11463	104	34	31	0	1	4	0	0	174
1975	0	4629	10534	2735	3315	1882	95	98	3454	72	8	0	0	0	0	0	3534
1976	0	745	22563	12358	1571	1491	868	21	7	1103	4	0	5	0	0	0	1119
1977	0	451	1317	29456	5645	680	495	308	28	11	259	5	0	0	0	0	304
1978	0	1030	1006	813	23620	2912	344	247	338	7	17	211	3	0	0	0	575
1979	0	2068	10448	1761	468	9810	833	114	145	28	3	1	42	1	0	0	221
1980	0	2505	12871	5341	915	143	3082	229	22	5	21	3	0	4	0	0	54
1981	0	200	20553	15695	1768	194	39	822	39	14	2	2	1	0	1	0	60
1982	0	250	1342	46283	8004	898	108	272	288	31	12	1	0	0	0	0	332
1983	0	568	4917	4585	34659	3387	597	41	194	195	40	15	0	0	0	0	444
1984	0	3341	4386	10754	5959	20352	2449	371	43	44	73	3	0	0	0	0	162
1985	0	939	19434	4437	4112	1782	11031	964	84	4	8	56	4	0	0	1	157
1986	0	603	4812	26770	1823	916	449	2611	344	38	7	15	1	3	0	0	409
1987	0	4254	7388	9206	23551	1452	1116	642	1818	326	20	15	9	3	12	0	2203
1988	0	847	20687	6873	4091	9205	428	235	177	935	45	3	1	3	2	0	1167
1989	0	927	1414	18417	2744	1556	3633	255	84	87	437	56	1	1	0	0	666
1990	0	787	3198	1342	9450	848	279	519	48	22	12	2	0	0	0	0	85
1991	0	2145	10578	1217	834	5131	412	283	410	24	11	5	6	0	0	1	457
1992	0	691	10194	10010	553	236	1575	157	37	108	25	0	0	0	0	0	169
1993	0	745	15008	15975	4594	290	219	910	70	107	44	25	1	2	0	0	250
1994	0	1017	6326	15037	5240	1484	76	175	237	17	16	9	1	0	0	0	279
1995	0	540	3669	12774	6483	1472	387	34	111	90	2	0	0	0	0	0	203
1996	0	437	9457	4968	8626	3622	1007	324	23	40	12	4	0	0	0	0	80
1997	0	883	2831	16921	2125	2638	870	259	59	1	7	1	0	0	0	0	67
1998	0	1345	7129	5675	13387	1352	1036	377	124	45	2	4	1	0	0	0	175
1999	0	346	5501	7159	2960	4864	493	452	96	12	2	1	2	1	0	0	115
2000	0	759	2507	5864	3841	1054	1090	205	133	21	1	0	0	0	0	0	156
2001	0	245	8535	1822	3523	1393	533	314	65	25	11	0	3	0	0	0	104
2002	0	177	1227	13557	691	707	549	199	144	18	9	0	0	0	0	0	172
2003	0	21	1029	2150	8809	221	206	69	34	11	10	0	0	0	0	0	55
2004	0	14	245	804	1819	4071	286	100	26	6	2	2	0	0	0	0	37
2005	0	7	287	792	1252	1212	2018	57	42	5	1	1	0	0	0	0	48
2006	0	67	567	1513	2300	2504	2259	2192	33	26	5	0	0	1	0	0	65

Table 4.1.4. Haddock in Division VIa. Discards-at-age numbers (000s). Values used in the final assessment are boxed.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	451	1026	877	11494	63	0	0	0	0	0	0	0	0	0	0	0	0
1966	5953	1537	354	31	529	0	0	0	0	0	0	0	0	0	0	0	0
1967	40122	18590	13196	169	3	0	0	0	0	0	0	0	0	0	0	0	0
1968	27	125753	25954	506	3	0	0	0	0	0	0	0	0	0	0	0	0
1969	2742	81	114887	1493	11	0	0	0	0	0	0	0	0	0	0	0	0
1970	17189	6148	348	16712	23	0	0	0	0	0	0	0	0	0	0	0	0
1971	6604	69556	2766	663	1057	0	0	0	0	0	0	0	0	0	0	0	0
1972	14215	20137	58442	494	24	0	0	0	0	0	0	0	0	0	0	0	0
1973	19589	46135	11607	3368	2	0	0	0	0	0	0	0	0	0	0	0	0
1974	63698	67131	8244	2132	56	0	0	0	0	0	0	0	0	0	0	0	0
1975	6849	174721	24423	604	35	0	0	0	0	0	0	0	0	0	0	0	0
1976	4227	23593	49767	2866	17	0	0	0	0	0	0	0	0	0	0	0	0
1977	4552	12658	2152	6492	59	0	0	0	0	0	0	0	0	0	0	0	0
1978	55	**14911**	**1090**	**157**	**738**	**27**	**7**	**0**	0	0	0	0	0	0	0	0	**0**
1979	5697	**68002**	**6833**	**104**	**2**	**53**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1980	13	**20224**	**9057**	**295**	**7**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1981	764	**51**	**63359**	**5002**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1982	136	**15241**	**3678**	**27393**	**163**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	2084	**13957**	**15316**	**1456**	**1464**	**12**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1984	269	**95634**	**4240**	**2156**	**284**	**2438**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	155	**21882**	**59488**	**231**	**71**	**6**	**159**	**0**	0	0	0	0	0	0	0	0	**0**
1986	2979	**7524**	**6423**	**18597**	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	1498	**84767**	**9436**	**944**	**306**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	7582	**9160**	**37727**	**725**	**95**	**49**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	3773	**4083**	**2007**	**7308**	**11**	**0**	**1**	**0**	0	0	0	0	0	0	0	0	**0**
1990	437	**36460**	**2658**	**542**	**2708**	**23**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1991	8921	**34779**	**11413**	**42**	**0**	**1**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	4331	**51148**	**8776**	**1322**	**12**	**0**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1993	2196	**42914**	**45777**	**4787**	**74**	**16**	**0**	**5**	0	0	0	0	0	0	0	0	**0**
1994	2843	**18467**	**26312**	**6490**	**432**	**94**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1995	7692	**17040**	**12090**	**10825**	**382**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	10249	**32907**	**30354**	**1674**	**1599**	**41**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	2984	**22961**	**7676**	**4629**	**53**	**30**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	2058	**10075**	**10872**	**2357**	**1728**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1999	6898	**5834**	**12554**	**4410**	**44**	**54**	**86**	**0**	0	0	0	0	0	0	0	0	**0**
2000	5709	**49383**	**4136**	**2731**	**372**	**1**	**14**	**0**	0	0	0	0	0	0	0	0	**0**
2001	11818	**10778**	**24961**	**611**	**143**	**128**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2002	1362	**16250**	**11168**	**18692**	**142**	**8**	**0**	**39**	0	0	0	0	0	0	0	0	**0**
2003	3861	**6951**	**4564**	**4697**	**4021**	**2**	**2**	**1**	0	0	0	0	0	0	0	0	**0**
2004	2727	**15146**	**6261**	**1580**	**2021**	**2635**	**0**	**1**	0	0	0	0	0	0	0	0	**0**
2005	3965	**7184**	**5915**	**2908**	**864**	**1457**	**686**	**0**	1	0	0	0	0	0	0	0	**1**
2006	817	**15964**	**4263**	**2331**	**1501**	**605**	**471**	**557**	0	0	0	0	0	0	0	0	**0**

Table 4.1.5. Haddock in Division VIa. Weights-at-age (kg) in total catch. Values used in the final assessment are boxed.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	0.040	0.160	0.242	0.412	0.692	0.916	1.041	1.249	1.517	1.920	1.833	0.000	0.000	0.000	0.000	0.000	1.713
1966	0.040	0.162	0.251	0.555	0.572	1.041	1.125	1.325	1.522	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.522
1967	0.040	0.160	0.266	0.569	0.573	0.667	1.177	1.844	1.611	2.355	0.000	0.000	0.000	0.000	0.000	0.000	1.786
1968	0.040	0.159	0.264	0.567	0.823	0.731	0.811	1.430	1.903	2.516	0.000	0.000	0.000	0.000	0.000	0.000	2.005
1969	0.040	0.158	0.243	0.526	0.916	1.042	1.024	0.999	1.569	2.065	0.000	0.000	0.000	0.000	0.000	0.000	1.590
1970	0.040	0.161	0.230	0.368	0.812	1.283	1.262	1.043	1.342	1.791	1.213	0.000	0.000	0.000	0.000	0.000	1.352
1971	0.040	0.160	0.248	0.341	0.546	1.040	1.313	1.651	1.426	1.466	2.042	0.000	0.000	0.000	0.000	0.000	1.506
1972	0.040	0.160	0.249	0.380	0.530	0.546	0.984	1.499	1.538	0.000	1.551	0.000	0.000	0.000	0.000	0.000	1.548
1973	0.040	0.159	0.251	0.384	0.597	0.512	0.571	1.185	1.706	2.202	1.520	0.000	0.000	0.000	0.000	0.000	1.581
1974	0.040	0.159	0.248	0.368	0.527	0.764	0.685	0.798	1.142	1.319	1.229	0.000	0.833	0.890	0.000	0.000	1.183
1975	0.040	0.159	0.260	0.428	0.581	0.832	1.027	1.001	1.009	1.190	2.523	0.000	0.000	0.000	0.000	0.000	1.016
1976	0.040	0.159	0.256	0.459	0.592	0.831	1.095	1.585	1.084	1.243	1.806	0.000	1.679	0.000	0.000	0.000	1.246
1977	0.040	0.161	0.274	0.406	0.684	0.800	1.128	1.337	1.117	1.394	1.339	1.593	0.000	0.000	0.000	0.000	1.325
1978	0.068	**0.134**	**0.278**	**0.388**	**0.516**	**0.827**	**1.045**	**1.152**	1.399	2.126	1.376	1.208	1.627	0.000	0.000	0.000	**1.338**
1979	0.032	**0.182**	**0.325**	**0.457**	**0.730**	**0.777**	**1.040**	**1.491**	1.944	1.735	1.569	1.781	1.119	1.590	0.000	0.000	**1.754**
1980	0.077	**0.134**	**0.319**	**0.572**	**0.719**	**0.998**	**0.985**	**1.143**	1.565	1.632	1.879	2.862	0.000	1.482	0.000	0.000	**1.747**
1981	0.082	**0.252**	**0.245**	**0.467**	**0.887**	**0.975**	**1.376**	**1.294**	1.347	1.366	1.314	1.785	1.587	0.000	1.677	0.000	**1.379**
1982	0.038	**0.157**	**0.273**	**0.376**	**0.746**	**1.126**	**1.539**	**1.549**	1.514	1.738	2.068	1.543	0.000	0.000	0.000	0.000	**1.555**
1983	0.050	**0.178**	**0.282**	**0.461**	**0.557**	**1.002**	**1.370**	**1.716**	1.558	1.556	1.555	1.999	0.000	0.000	0.000	0.000	**1.572**
1984	0.059	**0.149**	**0.319**	**0.456**	**0.688**	**0.667**	**1.087**	**1.392**	2.075	1.882	1.417	1.864	0.000	0.000	0.000	0.000	**1.724**
1985	0.019	**0.138**	**0.268**	**0.486**	**0.636**	**0.802**	**0.868**	**1.272**	1.277	1.695	2.014	2.152	2.741	0.000	0.000	4.141	**1.694**
1986	0.064	**0.182**	**0.270**	**0.362**	**0.637**	**0.903**	**1.115**	**1.043**	1.418	1.517	1.832	1.925	1.504	2.635	0.000	0.000	**1.463**
1987	0.028	**0.168**	**0.270**	**0.418**	**0.566**	**0.880**	**1.105**	**1.250**	1.147	1.149	1.851	2.774	3.040	2.828	2.664	0.000	**1.182**
1988	0.085	**0.170**	**0.254**	**0.444**	**0.562**	**0.704**	**1.027**	**1.280**	1.279	0.879	1.618	0.990	3.424	3.994	4.150	0.000	**0.984**
1989	0.052	**0.226**	**0.301**	**0.402**	**0.625**	**0.749**	**0.894**	**1.115**	1.465	1.357	0.949	1.388	2.807	3.008	0.000	0.429	**1.110**
1990	0.073	**0.112**	**0.355**	**0.445**	**0.534**	**0.891**	**1.108**	**1.280**	1.823	1.682	2.288	1.964	2.506	0.000	0.000	0.000	**1.860**
1991	0.058	**0.184**	**0.297**	**0.547**	**0.618**	**0.678**	**0.931**	**1.053**	1.091	1.755	3.290	2.170	1.343	0.000	0.000	2.869	**1.201**
1992	0.050	**0.133**	**0.321**	**0.437**	**0.766**	**0.892**	**0.932**	**1.407**	1.493	1.564	2.180	0.000	0.000	0.000	0.000	0.000	**1.639**
1993	0.037	**0.108**	**0.277**	**0.458**	**0.650**	**0.861**	**0.898**	**1.022**	1.514	1.210	1.578	2.304	1.800	2.405	0.000	0.000	**1.483**
1994	0.031	**0.169**	**0.253**	**0.405**	**0.611**	**0.698**	**0.929**	**0.959**	0.909	1.243	1.319	1.961	2.430	0.000	0.000	0.000	**0.992**
1995	0.030	**0.149**	**0.274**	**0.354**	**0.553**	**0.833**	**0.978**	**1.322**	1.059	0.940	1.953	1.996	2.492	0.000	0.000	0.000	**1.020**
1996	0.047	**0.128**	**0.243**	**0.404**	**0.462**	**0.645**	**0.750**	**0.754**	1.122	1.163	1.046	1.141	0.000	3.167	0.000	0.000	**1.137**
1997	0.048	**0.153**	**0.263**	**0.394**	**0.614**	**0.730**	**0.925**	**1.057**	0.921	2.024	1.630	2.252	0.000	3.033	0.000	0.000	**1.020**
1998	0.089	**0.164**	**0.283**	**0.382**	**0.502**	**0.689**	**0.802**	**0.951**	1.006	1.064	2.488	2.585	3.322	2.591	0.000	0.000	**1.077**
1999	0.035	**0.172**	**0.255**	**0.365**	**0.494**	**0.611**	**0.729**	**0.840**	1.067	1.465	1.465	3.246	1.993	2.954	2.829	0.000	**1.172**
2000	0.053	**0.127**	**0.270**	**0.361**	**0.447**	**0.572**	**0.719**	**0.840**	0.749	1.186	1.262	0.000	2.168	0.000	0.000	0.000	**0.813**
2001	0.050	**0.112**	**0.242**	**0.403**	**0.432**	**0.514**	**0.657**	**0.808**	1.029	0.975	1.089	3.361	0.597	0.000	0.000	0.000	**1.015**
2002	0.048	**0.118**	**0.208**	**0.307**	**0.521**	**0.606**	**0.632**	**0.636**	0.810	1.995	0.916	0.000	2.698	0.000	0.000	0.000	**0.939**
2003	0.036	**0.124**	**0.239**	**0.282**	**0.382**	**0.652**	**0.648**	**0.908**	0.945	1.232	1.393	2.682	0.000	0.000	0.000	0.000	**1.086**
2004	0.033	**0.112**	**0.189**	**0.290**	**0.313**	**0.373**	**0.541**	**0.715**	0.782	0.853	1.396	3.976	0.000	0.000	0.000	0.000	**0.988**
2005	0.053	**0.103**	**0.198**	**0.295**	**0.451**	**0.429**	**0.525**	**1.163**	0.916	1.467	2.084	3.491	2.275	0.000	0.000	0.000	**1.018**
2006	0.024	**0.155**	**0.254**	**0.326**	**0.388**	**0.471**	**0.496**	**0.563**	1.242	1.182	1.682	2.675	0.000	3.889	5.471	0.000	**1.294**

Table 4.1.6. Haddock in Division VIa. Weights-at-age (kg) in landings. Values used in the final assessment are boxed.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	0.000	0.273	0.295	0.440	0.695	0.916	1.041	1.249	1.517	1.920	1.833	0.000	0.000	0.000	0.000	0.000	1.713
1966	0.000	0.315	0.324	0.563	0.575	1.041	1.125	1.325	1.522	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.522
1967	0.000	0.285	0.374	0.635	0.576	0.667	1.177	1.844	1.611	2.355	0.000	0.000	0.000	0.000	0.000	0.000	1.786
1968	0.000	0.259	0.367	0.627	0.827	0.731	0.811	1.430	1.903	2.516	0.000	0.000	0.000	0.000	0.000	0.000	2.005
1969	0.000	0.199	0.314	0.570	0.921	1.042	1.024	0.999	1.569	2.065	0.000	0.000	0.000	0.000	0.000	0.000	1.590
1970	0.000	0.348	0.261	0.389	0.817	1.283	1.262	1.043	1.342	1.791	1.213	0.000	0.000	0.000	0.000	0.000	1.352
1971	0.000	0.295	0.328	0.360	0.549	1.040	1.313	1.651	1.426	1.466	2.042	0.000	0.000	0.000	0.000	0.000	1.506
1972	0.000	0.285	0.325	0.406	0.532	0.546	0.984	1.499	1.538	0.000	1.551	0.000	0.000	0.000	0.000	0.000	1.548
1973	0.000	0.259	0.329	0.408	0.599	0.512	0.571	1.185	1.706	2.202	1.520	0.000	0.000	0.000	0.000	0.000	1.581
1974	0.000	0.264	0.328	0.393	0.530	0.764	0.685	0.798	1.142	1.319	1.229	0.000	0.833	0.890	0.000	0.000	1.183
1975	0.000	0.277	0.365	0.465	0.585	0.832	1.027	1.001	1.009	1.190	2.523	0.000	0.000	0.000	0.000	0.000	1.016
1976	0.000	0.251	0.345	0.504	0.596	0.831	1.095	1.585	1.084	1.243	1.806	0.000	1.679	0.000	0.000	0.000	1.246
1977	0.000	0.307	0.370	0.437	0.689	0.800	1.128	1.337	1.117	1.394	1.339	1.593	0.000	0.000	0.000	0.000	1.325
1978	0.000	**0.257**	**0.353**	**0.419**	**0.524**	**0.832**	**1.060**	**1.152**	1.399	2.126	1.376	1.208	1.627	0.000	0.000	0.000	**1.338**
1979	0.000	**0.269**	**0.386**	**0.467**	**0.732**	**0.779**	**1.040**	**1.491**	1.944	1.735	1.569	1.781	1.119	1.590	0.000	0.000	**1.754**
1980	0.000	**0.251**	**0.373**	**0.587**	**0.722**	**0.998**	**0.985**	**1.143**	1.565	1.632	1.879	2.862	0.000	1.482	0.000	0.000	**1.747**
1981	0.000	**0.289**	**0.357**	**0.502**	**0.887**	**0.975**	**1.376**	**1.294**	1.347	1.366	1.314	1.785	1.587	0.000	1.677	0.000	**1.379**
1982	0.000	**0.285**	**0.369**	**0.452**	**0.754**	**1.126**	**1.539**	**1.549**	1.514	1.738	2.068	1.543	0.000	0.000	0.000	0.000	**1.555**
1983	0.000	**0.479**	**0.424**	**0.518**	**0.568**	**1.004**	**1.370**	**1.716**	1.558	1.556	1.555	1.999	0.000	0.000	0.000	0.000	**1.572**
1984	0.000	**0.273**	**0.388**	**0.486**	**0.705**	**0.713**	**1.087**	**1.392**	2.075	1.882	1.417	1.864	0.000	0.000	0.000	0.000	**1.724**
1985	0.000	**0.283**	**0.346**	**0.494**	**0.641**	**0.803**	**0.875**	**1.272**	1.277	1.695	2.014	2.152	2.741	0.000	0.000	4.141	**1.694**
1986	0.000	**0.294**	**0.373**	**0.440**	**0.637**	**0.903**	**1.115**	**1.043**	1.418	1.517	1.832	1.925	1.504	2.635	0.000	0.000	**1.463**
1987	0.000	**0.276**	**0.337**	**0.435**	**0.570**	**0.880**	**1.105**	**1.250**	1.147	1.149	1.851	2.774	3.040	2.828	2.664	0.000	**1.182**
1988	0.000	**0.310**	**0.338**	**0.462**	**0.567**	**0.706**	**1.027**	**1.280**	1.279	0.879	1.618	0.990	3.424	3.994	4.150	0.000	**0.984**
1989	0.000	**0.372**	**0.406**	**0.468**	**0.625**	**0.749**	**0.894**	**1.115**	1.462	1.357	0.948	1.388	2.807	3.008	0.000	0.429	**1.109**
1990	0.000	**0.335**	**0.443**	**0.532**	**0.618**	**0.908**	**1.108**	**1.280**	1.823	1.682	2.288	1.964	2.506	0.000	0.000	0.000	**1.860**
1991	0.000	**0.287**	**0.382**	**0.556**	**0.618**	**0.678**	**0.931**	**1.053**	1.091	1.755	3.290	2.170	1.343	0.000	0.000	2.869	**1.201**
1992	0.000	**0.310**	**0.384**	**0.461**	**0.777**	**0.892**	**0.932**	**1.407**	1.493	1.564	2.180	0.000	0.000	0.000	0.000	0.000	**1.639**
1993	0.000	**0.313**	**0.395**	**0.509**	**0.655**	**0.889**	**0.898**	**1.026**	1.514	1.210	1.578	2.304	1.800	2.405	0.000	0.000	**1.483**
1994	0.000	**0.280**	**0.352**	**0.454**	**0.633**	**0.723**	**0.929**	**0.959**	0.909	1.243	1.319	1.961	2.430	0.000	0.000	0.000	**0.992**
1995	0.000	**0.293**	**0.375**	**0.415**	**0.567**	**0.833**	**0.978**	**1.322**	1.059	0.940	1.953	1.996	2.492	0.000	0.000	0.000	**1.020**
1996	0.000	**0.285**	**0.363**	**0.445**	**0.492**	**0.649**	**0.750**	**0.754**	1.122	1.163	1.046	1.141	0.000	3.167	0.000	0.000	**1.137**
1997	0.000	**0.275**	**0.365**	**0.425**	**0.621**	**0.735**	**0.925**	**1.057**	0.921	2.024	1.630	2.252	0.000	3.033	0.000	0.000	**1.020**
1998	0.000	**0.265**	**0.331**	**0.416**	**0.524**	**0.689**	**0.802**	**0.951**	1.006	1.064	2.488	2.585	3.322	2.591	0.000	0.000	**1.077**
1999	0.000	**0.313**	**0.353**	**0.420**	**0.496**	**0.614**	**0.820**	**0.840**	1.067	1.465	1.465	3.246	1.993	2.954	2.829	0.000	**1.172**
2000	0.000	**0.265**	**0.347**	**0.410**	**0.465**	**0.572**	**0.724**	**0.840**	0.749	1.186	1.262	0.000	2.168	0.000	0.000	0.000	**0.813**
2001	0.000	**0.243**	**0.332**	**0.457**	**0.439**	**0.538**	**0.657**	**0.808**	1.029	0.975	1.089	3.361	0.597	0.000	0.000	0.000	**1.015**
2002	0.000	**0.254**	**0.321**	**0.383**	**0.566**	**0.608**	**0.632**	**0.691**	0.810	1.995	0.916	0.000	2.698	0.000	0.000	0.000	**0.939**
2003	0.000	**0.240**	**0.311**	**0.389**	**0.428**	**0.654**	**0.651**	**0.917**	0.946	1.253	1.395	2.682	0.000	0.000	0.000	0.000	**1.091**
2004	0.000	**0.253**	**0.329**	**0.394**	**0.391**	**0.448**	**0.541**	**0.718**	0.782	0.853	1.396	3.976	0.000	0.000	0.000	0.000	**0.988**
2005	0.000	**0.270**	**0.358**	**0.415**	**0.542**	**0.596**	**0.594**	**1.167**	0.921	1.467	2.084	3.491	2.275	0.000	0.000	0.000	**1.023**
2006	0.000	**0.291**	**0.348**	**0.392**	**0.437**	**0.508**	**0.527**	**0.621**	1.242	1.182	1.682	2.675	0.000	3.889	5.471	0.000	**1.294**

Table 4.1.7. Haddock in Division VIa. Weights-at-age (kg) in discards. Values used in the final assessment are boxed.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	8+
1965	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1966	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1967	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1968	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1969	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1970	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1971	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.040	0.156	0.215	0.265	0.279	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.059	**0.125**	**0.208**	**0.231**	**0.259**	0.265	0.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.032	**0.180**	**0.230**	**0.272**	**0.266**	0.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.077	**0.120**	**0.243**	**0.287**	**0.334**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.082	**0.106**	**0.209**	**0.360**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.038	**0.155**	**0.238**	**0.247**	**0.363**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.050	**0.165**	**0.237**	**0.283**	**0.298**	0.536	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.059	**0.145**	**0.248**	**0.303**	**0.331**	0.278	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.019	**0.132**	**0.242**	**0.326**	**0.362**	0.423	0.353	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.064	**0.173**	**0.193**	**0.248**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.028	**0.163**	**0.218**	**0.247**	**0.281**	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	0.085	**0.157**	**0.208**	**0.279**	**0.331**	0.341	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.052	**0.193**	**0.226**	**0.237**	**0.491**	0.961	1.423	0.000	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	2.810
1990	0.073	**0.108**	**0.250**	**0.228**	**0.242**	0.268	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.058	**0.178**	**0.218**	**0.278**	**0.000**	0.263	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.050	**0.130**	**0.247**	**0.258**	**0.242**	0.000	0.947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.037	**0.105**	**0.238**	**0.287**	**0.382**	0.348	0.000	0.430	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.031	**0.163**	**0.229**	**0.291**	**0.337**	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.030	**0.144**	**0.243**	**0.281**	**0.310**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.047	**0.126**	**0.206**	**0.282**	**0.300**	0.317	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.048	**0.148**	**0.226**	**0.283**	**0.340**	0.317	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.089	**0.151**	**0.251**	**0.298**	**0.337**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.035	**0.163**	**0.213**	**0.276**	**0.318**	0.311	0.206	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.053	**0.125**	**0.223**	**0.257**	**0.259**	0.625	0.337	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.050	**0.109**	**0.211**	**0.243**	**0.254**	0.245	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.048	**0.117**	**0.196**	**0.253**	**0.305**	0.456	0.000	0.358	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.036	**0.123**	**0.223**	**0.233**	**0.282**	0.462	0.439	0.496	0.591	0.432	0.689	0.000	0.000	0.000	0.000	0.000	0.493
2004	0.033	**0.112**	**0.183**	**0.237**	**0.242**	0.256	0.000	0.411	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.053	**0.103**	**0.190**	**0.262**	**0.320**	0.290	0.322	0.416	0.493	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.493
2006	0.024	**0.154**	**0.241**	**0.284**	**0.313**	0.318	0.348	0.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4.1.8. Haddock in Division VIa. Commercial effort and tuning series made available to the WG. Effort (first column) is given as reported hours fished per year; numbers landed are in thousands. Note that a) these data are not used in the final assessment; b) 2006 data were not available to the WG; and c) effort in European fisheries is not mandatory, so the effort data given here are underestimates.

Scottish pair trawl (ScoPTR)

		Age						
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1988	73448	1836.79	19333.629	2791.134	1561.027	3555.323	132.086	47.031
1989	69051	358.121	622.245	6453.549	833.344	617.05	1530.389	96.988
1990	24365	2656.973	1209.336	432.811	2413.249	161.21	59.431	119.9
1991	33826	2528.117	3815.61	267.76	165.98	1059.521	75.441	58.562
1992	24141	1531.621	1587.775	1068.706	80.518	28.226	195.827	17.505
1993	23975	1784.422	8049.086	3189.459	582.533	48.833	41.065	141.79
1994	21003	602.661	2354.895	2614.523	861.39	226.916	7.311	14.371
1995	22848	2494.133	1573.402	3915.253	1501.48	365.819	103.337	3.1
1996	22237	3993.635	7475.948	1085.826	2281.053	1002.653	282.516	73.796
1997	8552	1327.954	1136.375	3876.218	340.837	523.864	192.329	37.903
1998	8425	416.432	2137.106	1315.696	2734.416	232.941	149.879	35.896
1999	2483	450.826	1936.938	1521.928	399.642	641.984	47.192	34.913
2000	2335	1545.384	394.239	620.963	319.038	45.263	69.646	15.32
2001	1342	4.767	230.091	97.936	241.187	46.188	10.688	37.264
2002	14	31.473	115.105	120.723	2.223	2.909	1.247	0.356
2003	5	38.548	107.443	150.615	288.114	29.322	4.005	0.232
2004	88	52.807	141.598	40.075	98.517	221.673	13.792	2.687
2005	0	9.956	22.448	31.323	22.161	32.8	106.663	0.189

Irish otter trawl (IreOTB)

		Age						
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1995	56335	222	298	530	461	92	28	98
1996	60709	165	531	670	281	175	33	12
1997	62698	99	358	515	282	339	133	89
1998	57403	51	1092	552	312	186	218	232
1999	53192	98	315	437	266	198	109	123
2000	46913	50	131	188	303	158	76	65
2001	48358	14	304	144	101	126	100	44
2002	37231	31	162	388	27	65	97	47
2003	42899	4	36	108	231	29	36	29
2004	35140	0	33	82	71	82	11	13
2005	30941	1	23	41	56	87	29	7

Table 4.1.8. cont. Haddock in Division VIa. Commercial effort and tuning series made available to the WG. Effort (first column) is given as reported hours fished per year; numbers landed are in thousands. Note that a) these data are not used in the final assessment; b) 2006 data were not available to the WG; and c) effort in European fisheries is not mandatory, so the effort data given here are underestimates.

Scottish light trawl (ScoLTR)

		Age			
Year	**Effort**	**2**	**3**	**4**	**5**
1965	37387	22.091	1642.12	168.954	6.998
1966	40538	2.929	0	702.277	20.987
1967	80916	1326.106	72.823	6.981	188.483
1968	65348	514.409	132.176	9.014	13.019
1969	106586	6100.801	273.493	81.818	4.989
1970	129741	60.985	7188.79	93.986	17.997
1971	129187	426.996	323.964	7715.896	29.996
1972	154288	20885.215	447.018	197.01	4635.228
1973	93992	1171.622	1396.082	8.999	18.998
1974	88651	950.263	706.156	425.086	4.001
1975	132353	4525.993	476.288	360.261	320.234
1976	139225	11482.937	2002.98	171.894	208.87
1977	143547	362.858	3581.037	660.848	94.978
1978	127387	205.97	157.024	1412.263	205.04
1979	99803	2419.532	162.972	32.994	802.863
1980	121211	3869.366	1034.891	183.982	37.996
1981	165002	14862.966	4468.331	423.043	40.004
1982	135280	958.723	17379.104	1721.828	70.994
1983	112332	5747.308	1345.07	10272.253	662.105
1984	132217	2210.088	3687.112	809.84	6080.328
1985	142815	16310.439	905.133	691.017	214.069
1986	126533	2565.893	13292.803	408.899	163.349
1987	131653	4040.797	2770.494	6465.25	249.058
1988	158191	17326.463	2369.239	1008.226	2273.141
1989	217443	1459.316	10332.354	934.04	394.722
1990	131360	1293.654	541.378	3520.472	213.722
1991	209901	8386.068	414.358	218.113	1814.306
1992	189288	3850.242	2937.112	133.408	49.73
1993	189925	17312.309	6469.671	1479.199	89.402
1994	174879	7106.326	6307.283	1574.576	409.496
1995	175631	4850.552	9835.464	2704.111	551.303
1996	214159	15882.858	2665.141	4524.729	1511.694
1997	179605	4231.875	9987.962	882.602	1119.138
1998	142457	6845.462	3530.308	7753.948	573.554
1999	98993	6266.816	4506.559	1124.841	2152.395
2000	76157	2725.197	4725.382	2259.356	499.511
2001	35698	14958.081	1246.235	2075.946	687.201
2002	15174	4200.486	16918.947	400.382	421.166
2003	9357	2114.331	2803.164	6108.682	76.951
2004	7117	3675.178	1203.565	2307.81	3900.374
2005	3063	1643.009	1317.835	787.027	955.533

Table 4.1.9. Haddock in Division VIa. Available research-vessesl survey data. Values used in the final assessment are boxed.

ScoGFS Q1

Year	Age 1	2	3	4	5	6	7	8
1985	1104	4085	68	80	141	388	27	1
1986	753	1669	1877	17	14	47	90	5
1987	5518	446	460	690	25	34	25	67
1988	571	3610	303	112	246	10	4	8
1989	178	488	1701	98	49	69	5	1
1990	2577	87	54	296	26	6	36	3
1991	1591	1763	92	25	184	9	4	15
1992	3618	1193	321	12	13	28	6	1
1993	5371	5922	675	167	0	2	18	2
1994	1151	2300	787	126	39	3	1	8
1995	7112	1074	1697	485	65	30	10	4
1996	4401	3742	315	456	125	20	11	3
1997	4262	2018	1915	147	151	53	2	1
1998	5034	2720	616	562	40	64	19	7
1999	941	2989	687	168	128	15	11	2
2000	7936	553	440	97	13	20	1	3
2001	3421	5762	143	146	34	16	6	1
2002	2339	3246	5293	56	70	24	9	3
2003	2650	1696	1449	1874	23	34	18	4
2004	1397	2765	869	1199	609	11	3	5
2005	573	633	1402	351	512	402	5	3
2006	633	892	539	397	156	170	51	2
2007	99	2019	296	121	192	82	89	65

ScoGFS Q4

Year	Age 0	1	2	3	4	5	6	7
1996	2907	761	656	70	137	57	24	6
1997	3713	1359	282	151	25	26	14	4
1998	399	1640	486	148	137	17	33	5
1999	4670	366	574	267	92	68	11	18
2000	2959	4231	147	191	59	25	5	3
2001	3083	2219	3563	48	138	22	12	2
2002	2943	1709	1770	2841	34	50	24	8
2003	293	2023	965	1470	639	28	17	3
2004	542	574	1068	410	649	524	5	9
2005	286	419	409	410	223	309	87	1
2006	19	543	233	162	281	79	100	40

IreGFS

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

IRGFS

Year	Effort (hours)	Age 0	1	2	3	4	5	6	7	8	9	10
2003	1127	207	7588	2382	839	355	22	30	7	0	3	2
2004	1200	86	2163	3322	1281	941	957	60	10	21	0	0
2005	960	233	1160	767	778	315	87	3	0	0	1	0
2006	1510	313	207	1027	381	1337	543	130	59	0	0	0

Table 4.1.10. Haddock in VIa. Stock summary from two-series SURBA model run.

YEAR	REC		SSB		TSB		MEAN Z(2-6)	
	est	se log	est	se	est	se	est	se
1985	1.183	0.232	1.612	NA	2.429	NA	0.977	0.239
1986	1.16	0.217	1.254	NA	1.573	NA	0.721	0.192
1987	6.054	0.232	1.075	NA	2.205	NA	1.11	0.187
1988	0.568	0.219	1.203	NA	1.804	NA	0.873	0.186
1989	0.382	0.245	1.176	NA	1.322	NA	1.343	0.185
1990	1.853	0.225	0.452	NA	0.702	NA	1.052	0.184
1991	2.03	0.222	0.485	NA	1.042	NA	1.016	0.185
1992	3.409	0.219	0.647	NA	1.319	NA	0.966	0.186
1993	4.432	0.225	0.87	NA	1.67	NA	1.028	0.184
1994	2.055	0.191	1.086	NA	1.808	NA	0.342	0.186
1995	6.891	0.209	1.726	NA	2.975	NA	1.147	0.182
1996	3.62	0.198	1.511	NA	2.518	NA	1.195	0.169
1997	3.933	0.201	1.441	NA	2.348	NA	1.216	0.151
1998	4.587	0.187	1.137	NA	2.245	NA	1.008	0.152
1999	1.052	0.207	1.214	NA	1.788	NA	1.307	0.151
2000	14.157	0.225	0.7	NA	2.586	NA	1.454	0.148
2001	8.469	0.174	1.596	NA	3.577	NA	0.717	0.151
2002	4.163	0.173	2.499	NA	3.626	NA	0.593	0.151
2003	5.292	0.199	2.679	NA	3.706	NA	0.976	0.15
2004	1.714	0.203	1.73	NA	2.261	NA	0.845	0.152
2005	1.072	0.233	1.548	NA	1.777	NA	1.01	0.154
2006	1.511	0.267	0.871	NA	1.197	NA	0.68	0.173
2007	0.125	0.446	0.786	NA	0.919	NA	0.845	0.084

Table 4.1.11. Haddock in Division VIa. TSA parameter estimates from this year's assessment, along with those from previous assessments for comparison. * = fixed parameter.

PARAMETER	NOTATION	DESCRIPTION	2003	2004	2005	2006	2007
INITIAL FISHING MORTALITY	F (1, 78)	Fishing mortality-at-age a in year y	0.42	0.28	0.26	0.23	0.25
	F (2, 78)		0.67	0.5	0.51	0.5	0.56
	F (4, 78)		0.53	0.51	0.51	0.51	0.52
SURVEY SELECTIVITIES SCOGFS Q1	Φ(1)	ScoGFS Q1 survey selectivity at age a	3.99	2.25	2.35	2.49	2.58
	Φ(2)		4.84	2.71	2.45	2.55	3.01
	Φ(4)		2.1	1.51	2.11	2.19	2.04
SURVEY SELECTIVITIES SCOGFS Q4	Φ(1)	ScoGFS Q4 survey selectivity at age a	-	-	-	1.99	1.62
	Φ(2)		-	-	-	1.99	1.76
	Φ(4)		-	-	-	2.25	2.39
FISHING MORTALITY S.D.	σF	Transitory changes in overall F	0	0.11	0.1	0.1	0.12
	σU	Persistent changes in selection (age effect in F)	0.05	0.04	0.01	0	0.09
	σV	Transitory changes in the year effect in F	0.27	0.23	0.22	0.23	0.23
	σY	Persistent changes in the year effect in F	0	0.14	0.09	0.09	0.07
SURVEY CATCHABILITY S.D.	σΩ1	Transitory changes in ScoGFS Q1 catchability	0	0.08	0.18	0.3	0.19
	σβ1	Persistent changes in ScoGFS Q1 catchability	0.14	0.00*	0.00*	0.00*	0.00*
	σΩ2	Transitory changes in ScoGFS Q4 catchability	-	-	-		0.16
	σβ2	Persistent changes in ScoGFS Q4 catchability	-	-	-		0.00*
MEASUREMENT S.D.	σlandings	Standard error of landings-at-age data	0.22	0.25	0.23	0.2	0.2
	σdiscards	Standard error of discards-at-age data	0.51	0.43	0.45	0.42	0.41
	σsurvey	Standard error of ScoGFS Q1 survey data	0.4	0.34	0.53	0.57	0.33
	σsurvey	Standard error of ScoGFS Q4 survey data	-	-	-	0.57	0.22
DISCARD CURVE PARAMETERS	σP	Transitory changes in overall discard proportion	0.5	0.19	0.2	0.19	0.18
	σα1	Transitory changes in discard-ogive intercept	0	0.15	0.02	0	0.14
	σν1	Persistent changes in discard-ogive intercept	0.26	0.21	0.22	0.21	0.32
	σα2	Transitory changes in discard-ogive slope	0.34	0.01	0.03	0.21	0.23
	σν2	Persistent changes in discard-ogive slope	0.02	0.61	0.43	0.23	0.002
TREND PARAMETERS	θν1	Trend parameter for discard-ogive intercept	0.00*	0.00*	0.00*	0.00*	0.00*
	θν2	Trend parameter for discard-ogive slope	0.00*	0.00*	0.00*	0.00*	0.00*
RECRUITMENT	η1	Ricker parameter (slope at the origin)	9.1	9.63	9.71	9.73	9.06
	η2	Ricker parameter (curve dome occurs at 1/η2)	0.33	0.29	0.31	0.29	0.3
	cvrec	Standard error of recruitment data	0.52	0.89	0.89	0.9	0.62

Table 4.1.12. Haddock in Division VIa. Estimates of population abundance (in thousands) from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	69116	7836	2450	65356	4535	602	502	1079
1979	136155	42487	4096	1057	25072	1407	203	567
1980	472072	84437	17721	1594	394	8990	365	231
1981	58752	328241	45460	6781	611	168	3685	178
1982	74318	40169	197106	22264	3214	295	85	1798
1983	48463	49615	23554	103176	11078	1621	145	911
1984	336664	28622	26223	11626	50323	5436	780	522
1985	75280	195474	11694	9424	4812	21057	2208	530
1986	60103	42247	96025	5044	3897	2138	8625	1178
1987	245153	39349	22680	48398	2579	2037	1138	5044
1988	20909	137084	14931	7977	16647	842	644	2102
1989	17434	10436	59024	5528	2819	5897	314	996
1990	97390	8964	4224	23502	1981	949	1954	439
1991	127184	58279	3301	1816	9848	831	410	1008
1992	183623	72256	24326	1217	719	3669	322	542
1993	180309	119508	35332	10162	530	330	1604	383
1994	65377	109567	46606	10350	3322	159	95	609
1995	186246	37064	54414	18707	3923	1349	65	281
1996	112649	113477	16485	20227	7073	1479	527	133
1997	146899	64279	48552	5502	7224	2507	534	240
1998	163571	83632	25720	15110	1948	2574	868	271
1999	31225	97097	34699	8822	5929	775	1045	441
2000	543159	18548	37366	10117	3212	2045	279	532
2001	208626	321610	7542	10384	3076	1055	601	253
2002	105737	141304	173482	2819	4142	1218	435	339
2003	128863	74082	86294	87348	1294	1867	584	366
2004	50797	89736	44609	46852	37760	580	828	429
2005	40968	34596	53248	21344	23260	17634	262	580
2006	60690	27001	19293	23674	8904	10029	7121	350
2007*	23425	40094	14961	8476	10350	3820	4294	3146
2008*	107895	15500	22373	6660	3641	4465	1653	3207

***Estimates for 2007 and 2008 are TSA forecasts.**

Table 4.1.13. Haddock in Division VIa. Standard errors of estimates of population abundance (in thousands) from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	7057	620	261	438	964	178	117	288
1979	11917	4140	323	137	1790	518	104	175
1980	33246	7099	2087	189	79	1165	303	122
1981	5685	23582	4494	988	113	50	742	201
1982	7063	4072	15610	2308	525	71	32	485
1983	5716	5058	2451	7940	1233	292	43	277
1984	33143	3334	2566	1229	3805	597	143	133
1985	7558	18846	1324	1070	464	2064	356	103
1986	5773	3988	8659	494	448	279	1305	231
1987	28265	3554	2296	4419	249	240	170	788
1988	3531	13600	1381	882	1780	118	136	403
1989	3252	1262	5791	575	351	793	62	216
1990	10192	1424	474	2573	237	162	404	120
1991	11541	6067	436	181	1018	104	76	197
1992	15545	5990	2450	152	70	463	53	100
1993	17527	10509	2843	1066	55	33	230	58
1994	11817	12659	4826	1138	339	15	15	92
1995	28453	7366	7960	3045	670	212	11	55
1996	18507	17473	3486	3920	1359	305	108	32
1997	21140	9749	7461	969	1215	457	118	54
1998	21482	11836	4046	2523	270	386	160	53
1999	9828	13189	5310	1223	805	102	164	80
2000	97279	5031	6179	1738	477	363	54	112
2001	21765	44247	1505	1625	504	169	146	63
2002	15950	13300	20127	382	556	162	68	72
2003	15680	9867	9111	10900	165	257	87	65
2004	8152	10221	5581	4633	4405	83	132	69
2005	7964	5111	6096	2640	2369	2199	43	95
2006	19574	4772	2733	3300	1189	1342	1217	65
2007*	34714	12363	2553	1432	1544	579	753	635
2008*	67983	22968	7647	1769	933	1154	437	901

***Estimates for 2007 and 2008 are TSA forecasts.**

Table 4.1.14. Haddock in Division VIa. Estimates of fishing mortality from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	0.283	0.410	0.641	0.780	0.775	0.759	0.741	0.750
1979	0.283	0.582	0.735	0.742	0.779	0.757	0.769	0.762
1980	0.175	0.411	0.577	0.655	0.572	0.597	0.601	0.589
1981	0.180	0.313	0.499	0.471	0.481	0.458	0.487	0.481
1982	0.205	0.332	0.433	0.494	0.475	0.492	0.507	0.488
1983	0.300	0.442	0.423	0.477	0.486	0.504	0.498	0.520
1984	0.330	0.601	0.762	0.682	0.667	0.700	0.707	0.683
1985	0.377	0.514	0.630	0.655	0.606	0.684	0.638	0.624
1986	0.220	0.416	0.486	0.465	0.444	0.428	0.464	0.465
1987	0.375	0.769	0.829	0.862	0.915	0.936	0.888	0.867
1988	0.389	0.636	0.782	0.818	0.825	0.784	0.790	0.809
1989	0.379	0.624	0.700	0.798	0.836	0.860	0.852	0.843
1990	0.309	0.697	0.645	0.670	0.669	0.636	0.665	0.660
1991	0.358	0.670	0.743	0.725	0.786	0.748	0.784	0.754
1992	0.217	0.484	0.673	0.635	0.556	0.615	0.604	0.589
1993	0.298	0.729	1.015	0.889	0.912	0.993	0.940	0.948
1994	0.366	0.492	0.705	0.770	0.690	0.688	0.733	0.709
1995	0.299	0.596	0.785	0.764	0.770	0.740	0.754	0.756
1996	0.363	0.650	0.901	0.829	0.836	0.817	0.809	0.820
1997	0.370	0.715	0.967	0.839	0.820	0.863	0.841	0.840
1998	0.327	0.680	0.867	0.736	0.719	0.698	0.752	0.737
1999	0.334	0.755	1.040	0.824	0.861	0.822	0.817	0.844
2000	0.325	0.750	1.081	0.998	0.917	1.018	0.959	0.967
2001	0.194	0.425	0.789	0.719	0.709	0.675	0.727	0.707
2002	0.165	0.292	0.497	0.579	0.597	0.535	0.540	0.558
2003	0.164	0.336	0.393	0.631	0.609	0.621	0.608	0.597
2004	0.183	0.323	0.537	0.499	0.562	0.593	0.577	0.569
2005	0.216	0.384	0.610	0.674	0.641	0.707	0.692	0.674
2006	0.213	0.391	0.623	0.629	0.644	0.647	0.663	0.650
2007*	0.213	0.383	0.609	0.645	0.641	0.638	0.641	0.642
2008*	0.216	0.392	0.621	0.656	0.656	0.656	0.656	0.656

***Estimates for 2007 and 2008 are TSA forecasts.**

Table 4.1.15. Haddock in Division VIa. Standard errors of estimates of log fishing mortality from the final TSA run.

	Age							
Year	1	2	3	4	5	6	7	8+
1978	0.207	0.140	0.141	0.108	0.124	0.142	0.149	0.146
1979	0.236	0.139	0.122	0.124	0.116	0.134	0.150	0.148
1980	0.214	0.140	0.139	0.123	0.136	0.127	0.150	0.152
1981	0.210	0.140	0.132	0.130	0.135	0.148	0.148	0.156
1982	0.204	0.148	0.134	0.125	0.131	0.142	0.158	0.148
1983	0.209	0.139	0.151	0.118	0.126	0.136	0.152	0.147
1984	0.197	0.138	0.119	0.131	0.115	0.137	0.151	0.153
1985	0.188	0.144	0.138	0.120	0.126	0.129	0.149	0.152
1986	0.210	0.143	0.132	0.126	0.130	0.138	0.147	0.153
1987	0.201	0.116	0.120	0.102	0.109	0.128	0.143	0.135
1988	0.206	0.132	0.116	0.110	0.112	0.130	0.145	0.141
1989	0.212	0.144	0.127	0.111	0.115	0.121	0.146	0.143
1990	0.197	0.134	0.139	0.120	0.123	0.133	0.145	0.150
1991	0.188	0.133	0.136	0.113	0.114	0.131	0.147	0.143
1992	0.204	0.135	0.128	0.123	0.126	0.133	0.151	0.150
1993	0.207	0.125	0.108	0.108	0.110	0.136	0.141	0.149
1994	0.225	0.187	0.175	0.154	0.161	0.175	0.182	0.181
1995	0.355	0.266	0.245	0.225	0.229	0.233	0.237	0.237
1996	0.350	0.257	0.247	0.221	0.221	0.226	0.230	0.232
1997	0.344	0.242	0.211	0.197	0.202	0.205	0.211	0.213
1998	0.358	0.241	0.220	0.212	0.209	0.216	0.220	0.222
1999	0.370	0.239	0.221	0.214	0.212	0.218	0.221	0.223
2000	0.382	0.254	0.215	0.206	0.205	0.210	0.216	0.218
2001	0.392	0.258	0.227	0.214	0.215	0.219	0.222	0.225
2002	0.409	0.280	0.237	0.220	0.215	0.223	0.224	0.228
2003	0.415	0.273	0.240	0.205	0.210	0.213	0.218	0.221
2004	0.434	0.294	0.249	0.218	0.218	0.224	0.227	0.229
2005	0.443	0.314	0.251	0.208	0.209	0.216	0.221	0.223
2006	0.462	0.338	0.275	0.236	0.232	0.240	0.242	0.245
2007*	0.497	0.386	0.350	0.318	0.317	0.317	0.318	0.318
2008*	0.511	0.405	0.373	0.343	0.343	0.343	0.343	0.343

***Estimates for 2007 and 2008 are TSA forecasts.**

Table 4.1.16. Haddock in Division VIa. Stock summary from final TSA run. "Obs." denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield. "Pred." are TSA estimates, and "SE" denotes standard errors. *Estimates for 2007 and 2008 are TSA projections.

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2-6)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1978	17178	20827	1449	2327	2310	495	19505	23061	1577	0.673	0.052	42316	959	52480	1364	69116	7057
1979	14820	16167	1409	13857	7109	1655	28678	23416	2447	0.719	0.054	32720	1865	63510	3286	136155	11917
1980	12759	13772	1385	4715	11454	2166	17474	26245	3007	0.562	0.045	36708	2310	111766	5519	472072	33246
1981	18233	19721	2300	15048	13589	2340	33281	33662	3568	0.444	0.038	79001	4238	128403	6586	58752	5685
1982	29635	31136	3863	10063	7503	1438	39698	36913	4058	0.445	0.038	103933	6303	120324	6457	74318	7063
1983	29405	29960	2951	6787	5464	964	36192	35252	3224	0.466	0.038	91336	4930	105953	5177	48463	5716
1984	30012	30407	2514	16343	14984	3098	46355	44722	4315	0.682	0.052	66582	3284	120782	6269	336664	33143
1985	24393	23633	2052	17444	15401	2998	41837	38744	4261	0.618	0.049	67327	3831	100225	5976	75280	7558
1986	19561	20605	2221	7153	4959	930	26714	24341	2532	0.448	0.037	61032	3759	76876	4138	60103	5773
1987	27012	29297	2424	16193	13616	3041	43205	42937	4217	0.862	0.057	54849	3107	100706	6015	245153	28265
1988	21136	20955	1913	9536	8806	1847	30672	29602	3133	0.769	0.054	46446	2720	64974	4146	20909	3531
1989	16688	17875	1996	2981	2587	583	19669	19824	2152	0.764	0.055	37828	2632	43118	2839	17434	3252
1990	10135	11018	1271	5387	3166	659	15522	13275	1451	0.663	0.052	22384	1658	34739	2167	97390	10192
1991	10557	10283	930	8691	9370	1715	19248	20093	2276	0.734	0.055	21880	1386	52764	3189	127184	11541
1992	11350	10290	999	9163	8802	1384	20513	19845	1958	0.593	0.047	30175	1733	64449	3366	183623	15545
1993	19060	18721	1607	16811	16199	2259	35871	35051	2871	0.908	0.065	44601	2460	78395	4326	180309	17527
1994	14243	14070	1380	11098	12136	2142	25342	26235	2750	0.669	0.085	44140	3351	67108	5400	65377	11817
1995	12368	17339	4229	8552	11162	3263	20920	27791	6119	0.731	0.146	40319	4906	72354	7726	186246	28453
1996	13453	15443	4409	11364	12560	3557	24817	27793	6514	0.807	0.155	37961	5008	64262	7678	112649	18507
1997	12874	17514	4627	6470	13373	3700	19344	31320	6295	0.841	0.142	40590	4811	70304	7209	146899	21140
1998	14401	13072	3844	5535	14646	3949	19936	28511	5959	0.740	0.131	35403	4019	72465	7013	163571	21482
1999	10430	15317	4788	4891	10666	3339	15321	26182	5159	0.860	0.152	36750	3927	52776	5728	31225	9828
2000	6952	13514	4136	7899	19830	8005	14851	32992	9498	0.953	0.164	24851	3339	96048	13844	543159	97279
2001	6731	12578	6670	6657	20454	6660	13389	33347	8601	0.663	0.120	54871	6847	111676	12113	208626	21765
2002	7097	22026	8193	8880	10855	4752	15977	29774	6328	0.500	0.093	75502	7156	100690	8260	105737	15950
2003	5334	25410	6379	4104	7451	2966	9438	29562	5711	0.518	0.092	70806	6222	94321	7239	128863	15680
2004	3199	20124	5098	4380	5278	2205	7579	21362	4214	0.503	0.094	52620	4226	65589	4968	50797	8152
2005	3148	23903	5352	3546	3891	2023	6694	22658	4142	0.603	0.109	49360	4083	56528	4478	40968	7964
2006	5723	13748	3298	5161	3812	1671	10884	16224	3445	0.586	0.118	33020	3257	45345	5187	60690	19574
2007*	NA	10679	2899	NA	2816	1543	NA	12081	2974	0.583	0.163	26007	3310	32572	6411	23425	34714

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean F(2-6)		SSB (tonnes)		TSB (tonnes)		Recruitment (000s at age 1)	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
2008*	NA	8658	2800	NA	3702	2378	NA	11188	3568	0.596	0.178	19978	5214	34702	10903	107895	67983
Min	3148	10283		2327	2310		6694	13275		0.444		21880		34739		17434	
GM	12572	17997		7566	8639		20846	27291		0.651		45816		74713		100179	
AM	14755	18922		8656	10049		23411	28301		0.666		49493		78929		139577	
Max	30012	31136		17444	20454		46355	44722		0.953		103933		128403		543159	

Table 4.1.17. Haddock in Division VIa. Mean weights-at-age in total catches (or stock). Forecasts in this table are based on simple three-year means, and were NOT used in forecasts. The weights for the 1999 year class are highlighted in red and boxed.

Year	Age 1	2	3	4	5	6	7	8+
1999	0.172	0.255	0.365	0.494	0.611	0.729	0.840	1.163
2000	**0.127**	0.270	0.361	0.447	0.572	0.719	0.840	0.894
2001	0.112	**0.242**	0.403	0.432	0.514	0.657	0.808	1.018
2002	0.118	0.208	**0.307**	0.521	0.606	0.632	0.636	0.943
2003	0.124	0.239	0.282	**0.382**	0.652	0.648	0.908	1.082
2004	0.112	0.189	0.290	0.313	**0.373**	0.541	0.715	0.887
2005	0.103	0.198	0.295	0.451	0.429	**0.525**	1.163	1.167
2006	0.155	0.254	0.326	0.388	0.471	0.496	**0.563**	1.313
2007	0.123	0.214	0.304	0.384	0.424	0.521	0.814	**1.122**
2008	0.123	0.214	0.304	0.384	0.424	0.521	0.814	**1.122**
2009	0.123	0.214	0.304	0.384	0.424	0.521	0.814	**1.122**

Table 4.1.18. Haddock in Division VIa. Mean weights-at-age in total catches (or stock). Forecasts in this table are based on a combination of simple three-year means (for younger ages) and linear model projections, and WERE used in forecasts. The weights for the 1999 year class are highlighted in red and boxed.

Year	Age 1	2	3	4	5	6	7	8+
1999	0.172	0.255	0.365	0.494	0.611	0.729	0.840	1.163
2000	**0.127**	0.270	0.361	0.447	0.572	0.719	0.840	0.894
2001	0.112	**0.242**	0.403	0.432	0.514	0.657	0.808	1.018
2002	0.118	0.208	**0.307**	0.521	0.606	0.632	0.636	0.943
2003	0.124	0.239	0.282	**0.382**	0.652	0.648	0.908	1.082
2004	0.112	0.189	0.290	0.313	**0.373**	0.541	0.715	0.887
2005	0.103	0.198	0.295	0.451	0.429	**0.525**	1.163	1.167
2006	0.155	0.254	0.326	0.388	0.471	0.496	**0.563**	1.313
2007	0.123	0.214	0.304	0.426	0.473	0.589	0.568	**0.666**
2008	0.123	0.214	0.304	0.384	0.533	0.563	0.681	**0.691**
2009	0.123	0.214	0.304	0.384	0.424	0.640	0.653	**0.759**

Table 4.1.19. Haddock in Division VIa. Inputs to short-term forecasts.

Label	Value	CV	Label	Value	CV
Number-at-age			Stock weight		
N1	23425	1.48	WS1	0.12	0.23
N2	40094	0.31	WS2	0.21	0.16
N3	14961	0.17	WS3	0.30	0.06
N4	8476	0.17	WS4	0.43	0.16
N5	10350	0.15	WS5	0.47	0.10
N6	3820	0.15	WS6	0.59	0.04
N7	4294	0.18	WS7	0.57	0.55
N8	3146	0.20	WS8	0.67	0.32
Removals selectivity			Removals weights		
sH1	0.20	0.09	WH1	0.12	0.23
sH2	0.37	0.10	WH2	0.21	0.16
sH3	0.59	0.08	WH3	0.30	0.06
sH4	0.60	0.15	WH4	0.43	0.16
sH5	0.62	0.08	WH5	0.47	0.10
sH6	0.65	0.09	WH6	0.59	0.04
sH7	0.64	0.09	WH7	0.57	0.55
sH8	0.63	0.09	WH8	0.67	0.32
Natural mortality			Prop.mature.		
M1	0.20	0.10	MT1	0.00	0.10
M2	0.20	0.10	MT2	0.57	0.10
M3	0.20	0.10	MT3	1.00	0.10
M4	0.20	0.10	MT4	1.00	0.00
M5	0.20	0.10	MT5	1.00	0.00
M6	0.20	0.10	MT6	1.00	0.00
M7	0.20	0.10	MT7	1.00	0.00
M8	0.20	0.10	MT8	1.00	0.00
Relative effort			Year effect for M		
HF06	1.00	0.08	K06	1.00	0.10
HF07	1.00	0.08	K07	1.00	0.10
HF08	1.00	0.08	K08	1.00	0.10
Recruitment					
R08	107895	0.63			
R09	100178	1.26			
Prop. F before spawning	0.0				
Prop. M before spawning	0.0				

Table 4.1.20. Haddock in Division VIa. Results of short-term forecasts: management options.

	Year 2007	2008						
Mean F Ages 2 to 6								
Removals	0.56	0.00	0.11	0.23	0.34	0.45	0.56	0.68
Mult. relative to 2006								
Removals	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	31.3	34.0	34.0	34.0	34.0	34.0	34.0	34.0
SSB at spawning time	24.7	19.3	19.3	19.3	19.3	19.3	19.3	19.3
Weight (,000t)								
Removals	11.2	0.0	2.5	4.8	6.9	8.7	10.4	12.0
Biomass in year.... 2009								
Total 1 January		52.3	49.3	46.6	44.1	41.9	39.8	37.9
SSB at spawning time		31.8	29.2	26.7	24.6	22.6	20.8	19.2

	Year 2007	2008						
Mult. relative to 2006								
Removals	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.18	0.31	0.31	0.31	0.31	0.31	0.31	0.31
SSB at spawning time	0.12	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Weight								
Removals	0.15	0.00	0.44	0.28	0.25	0.24	0.23	0.23
Biomass in year.... 2009								
Total 1 January		0.40	0.42	0.43	0.45	0.47	0.48	0.50
SSB at spawning time		0.31	0.32	0.33	0.33	0.34	0.35	0.36

Table 4.1.21. Haddock in Division VIa. Results of short-term forecasts: detailed tables.

Forecast for year 2007
Mortality multiplier = 1.00

Populations		Removals number	
Age	Stock No.	Rems.	Total
1	23425	3932	3932
2	40094	11200	11200
3	14961	6100	6100
4	8476	3503	3503
5	10350	4356	4356
6	3820	1670	1670
7	4294	1867	1867
8	3146	1348	1348
Wt	31	11	11

Forecast for year 2008
Mortality multiplier = 1.00

Populations		Removals number	
Age	Stock No.	Rems.	Total
1	107895	18110	18110
2	15639	4369	4369
3	22770	9285	9285
4	6792	2807	2807
5	3806	1602	1602
6	4579	2002	2002
7	1635	711	711
8	3217	1379	1379
Wt	34	10	10

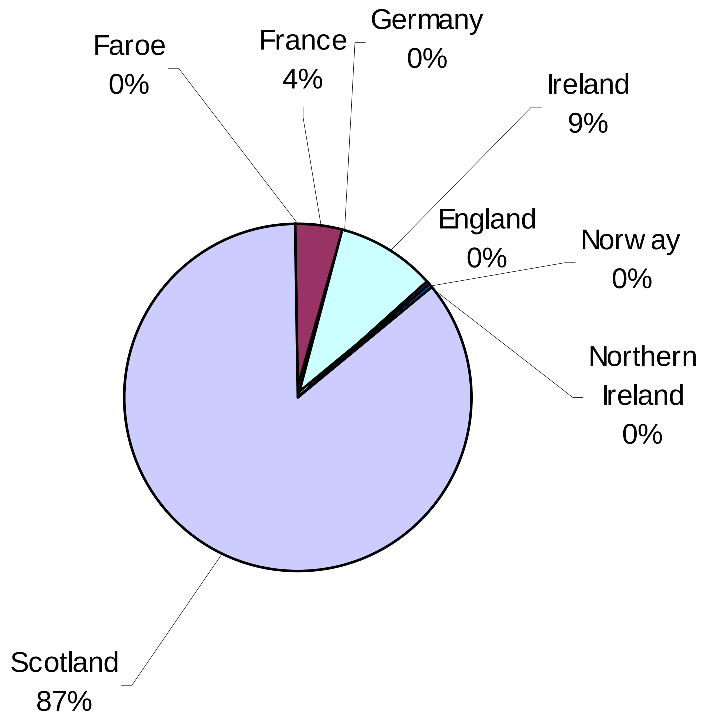


Figure 4.1.1. Haddock in Division VIa. National contribution to landings in 2006 as estimated by the WG.

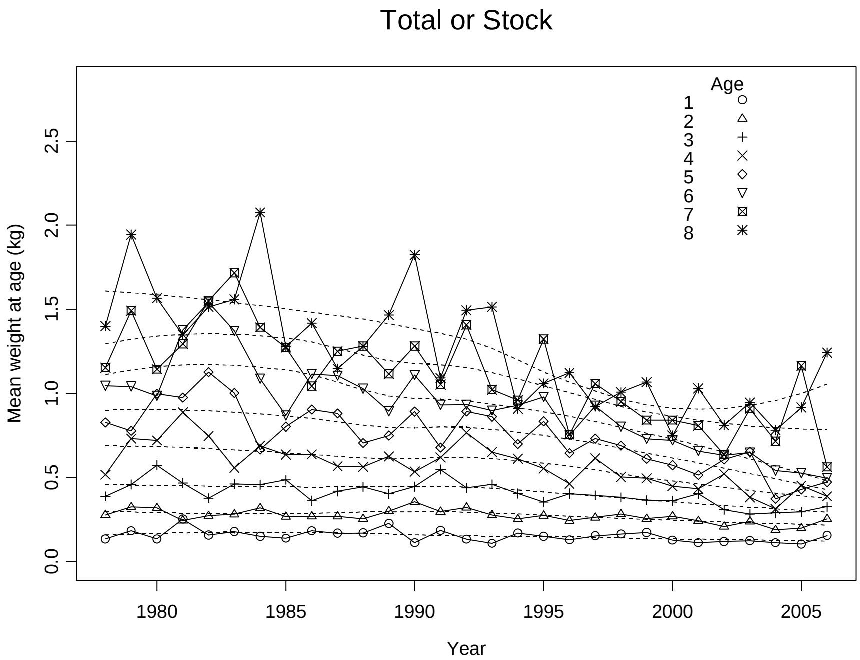


Figure 4.1.2. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (also used for stock weights). Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

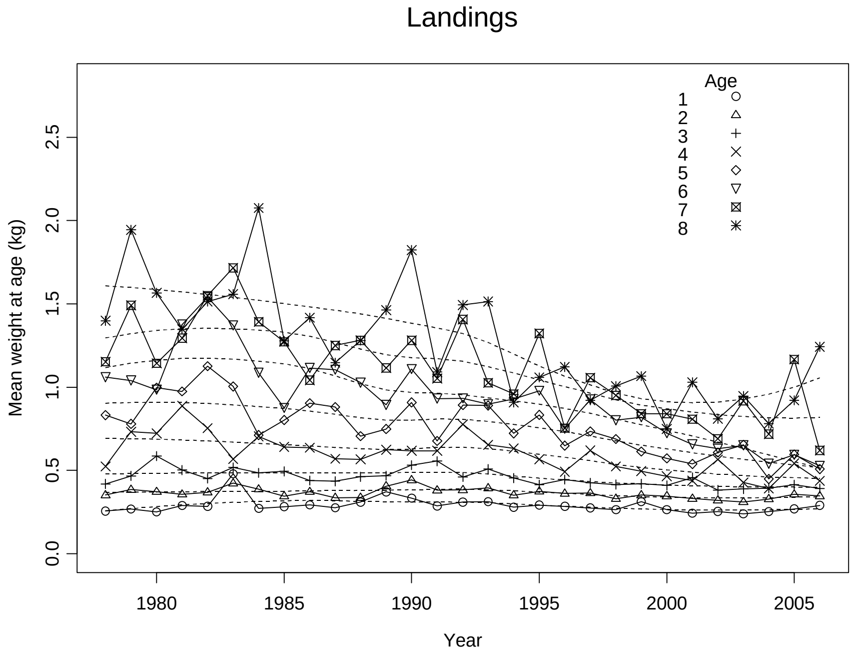


Figure 4.1.3. Haddock in Division VIa. Mean weights-at-age (kg) in landings. Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–8+ are shown here.

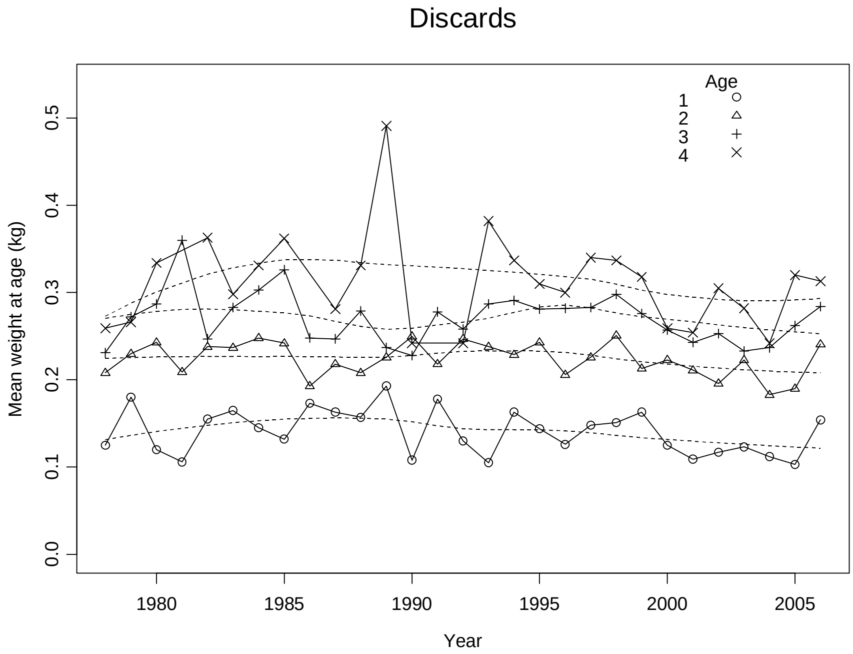


Figure 4.1.4. Haddock in Division VIa. Mean weights-at-age (kg) in discards. Dotted lines show loess smoothers fitted through each time-series at age. For clarity, only ages 1–4 are shown here.

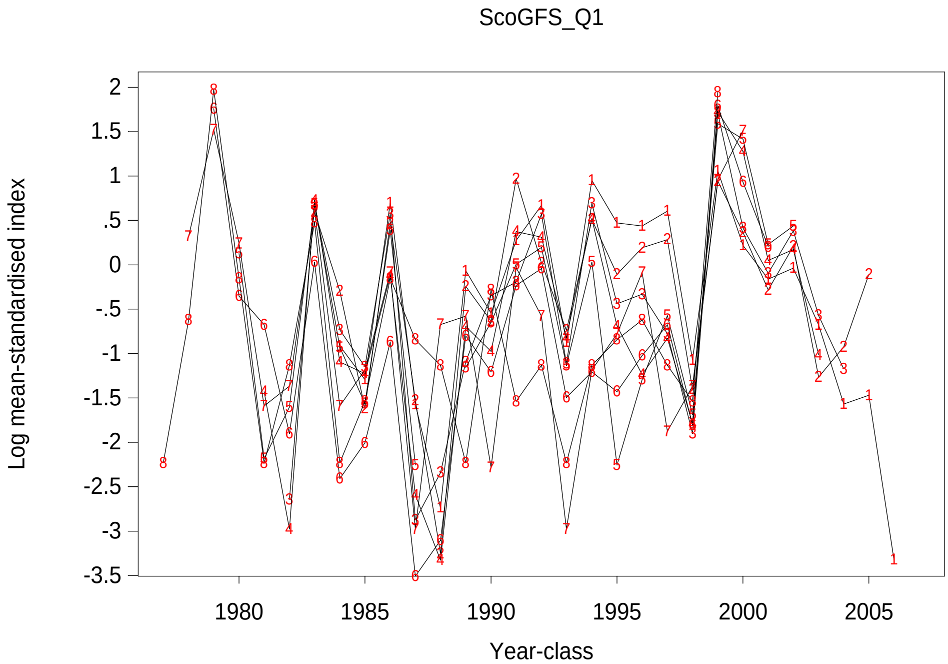


Figure 4.1.5. Haddock in Division VIa. Log mean-standardised ScoGFS Q1 indices, plotted by year class for ages 1–8.

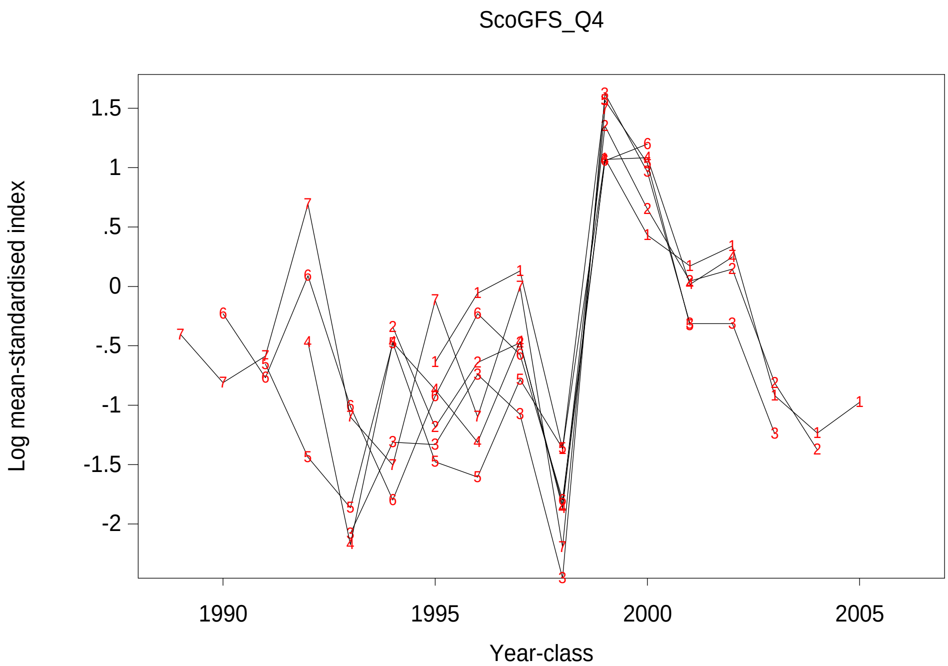


Figure 4.1.6. Haddock in Division VIa. Log mean-standardised ScoGFS Q4 indices, plotted by year class for ages 0–7.

ScoGFS_Q1: Comparative scatterplots at age

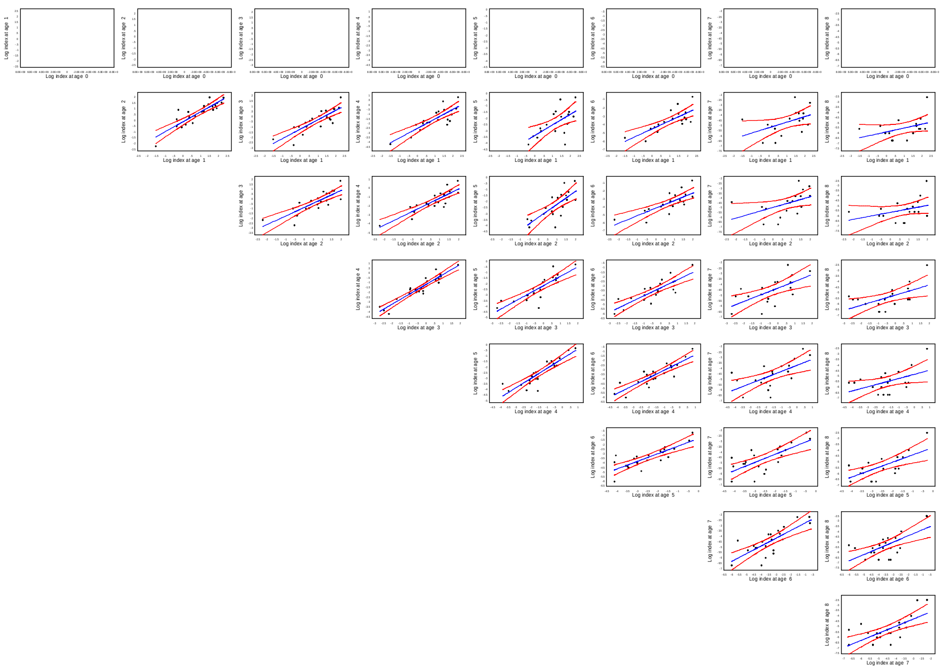


Figure 4.1.7. Haddock in Division VIa. Bivariate cohort-based scatterplots at age for the ScoGFS Q1 survey series for ages 1–8.

ScoGFS_Q4: Comparative scatterplots at age

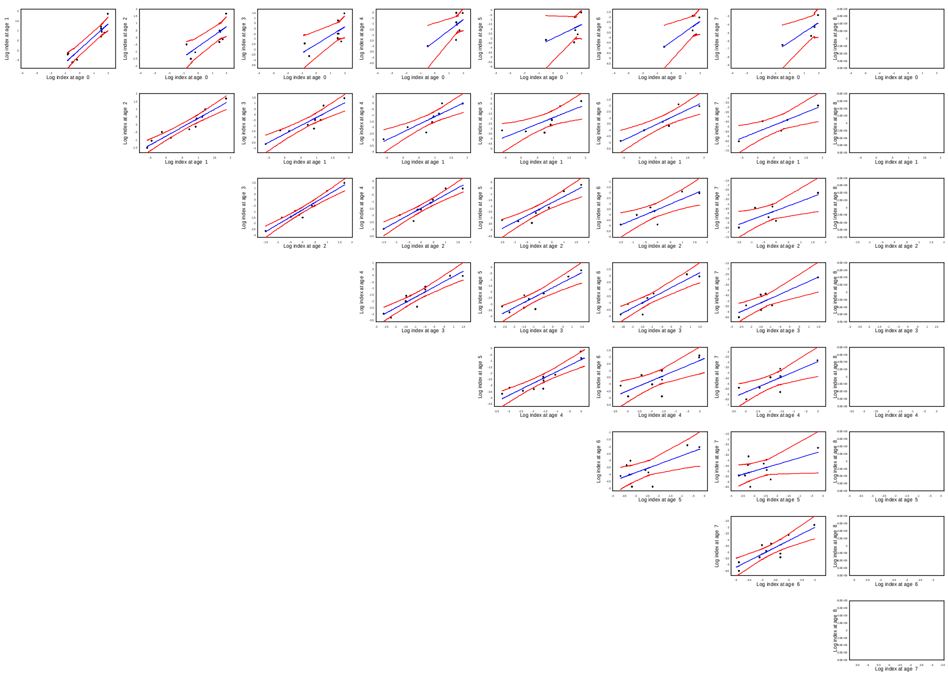


Figure 4.1.8. Haddock in Division VIa. Bivariate cohort-based scatterplots at age for the ScoGFS Q4 survey series for ages 0–7.

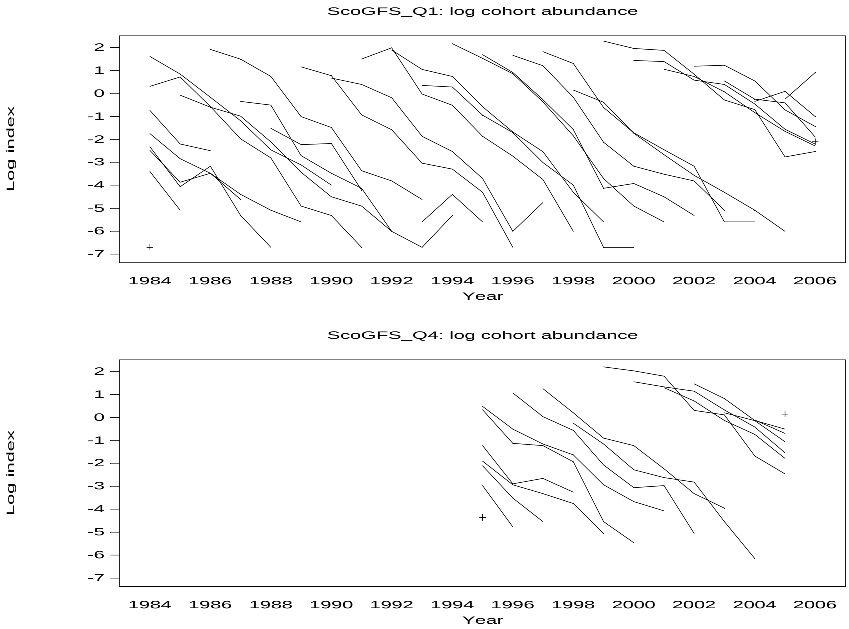


Figure 4.1.9. Haddock in Division VIa. Log survey indices plotted by cohort for ScoGFS Q1 (upper, ages 1–8) and ScoGFS Q4 (lower, ages 0–7).

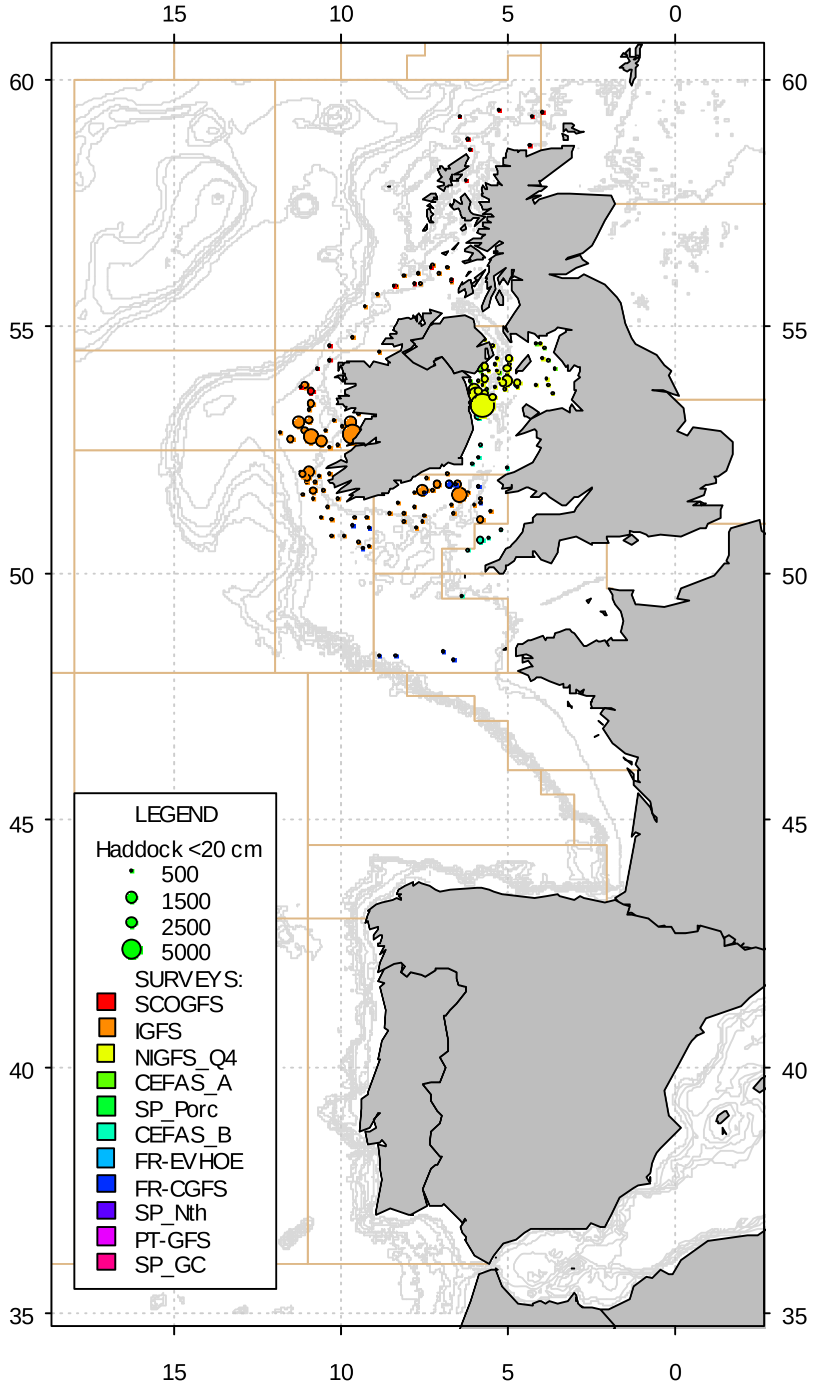


Figure 4.1.10. Haddock in Division VIa. Catches in numbers per hour of 0-group haddock (<20 cm) in autumn/winter (Q4) 2006 IBTS surveys. The catchability of the different gears used in these surveys is not constant; therefore these maps do not reflect proportional abundance in all the areas but within each survey. Source: ICES-IBTSWG (2007).

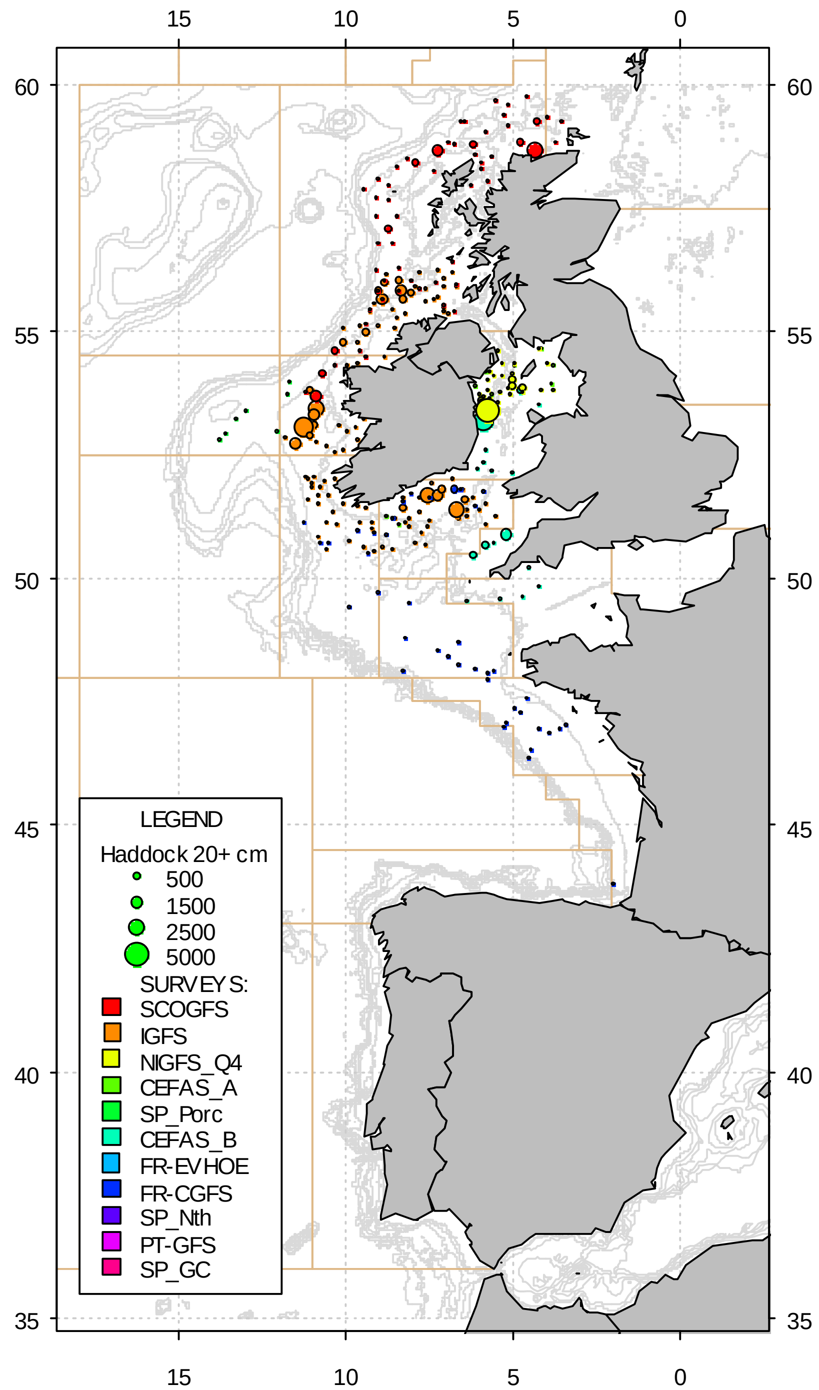


Figure 4.1.11. Haddock in Division VIa. Catches in numbers per hour of 0–group haddock (>=20 cm) in autumn/winter (Q4) 2006 IBTS surveys. The catchability of the different gears used in these surveys is not constant; therefore these maps do not reflect proportional abundance in all the areas but within each survey. Source: ICES-IBTSWG (2007).

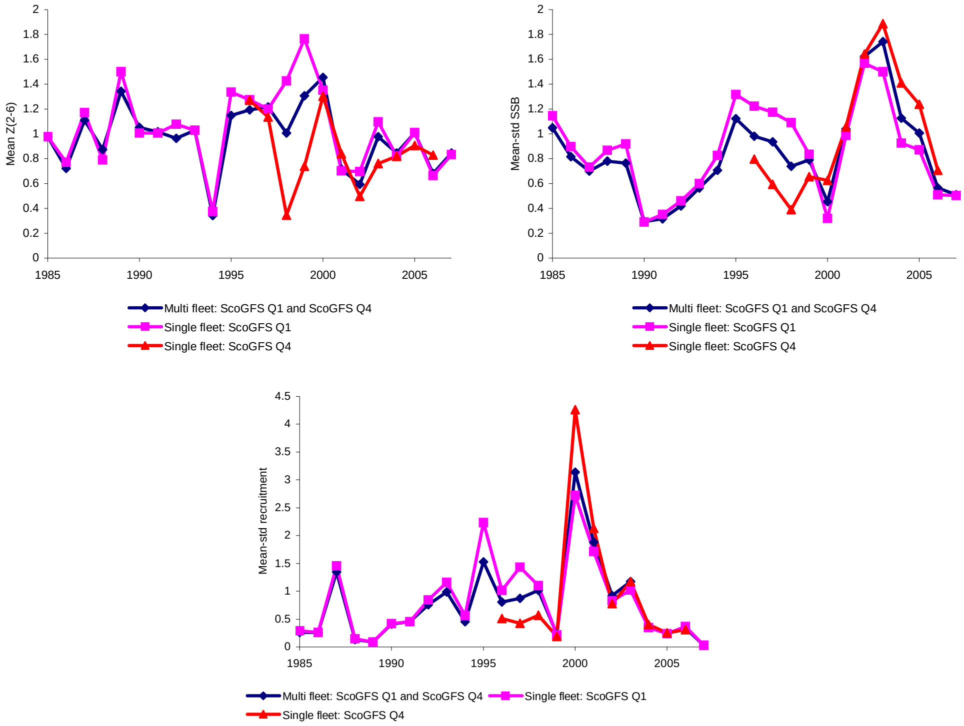


Figure 4.1.12. Haddock in Division VIa. Comparisons of three SURBA analyses, using ScoGFS Q1, ScoGFS Q4, and both together.

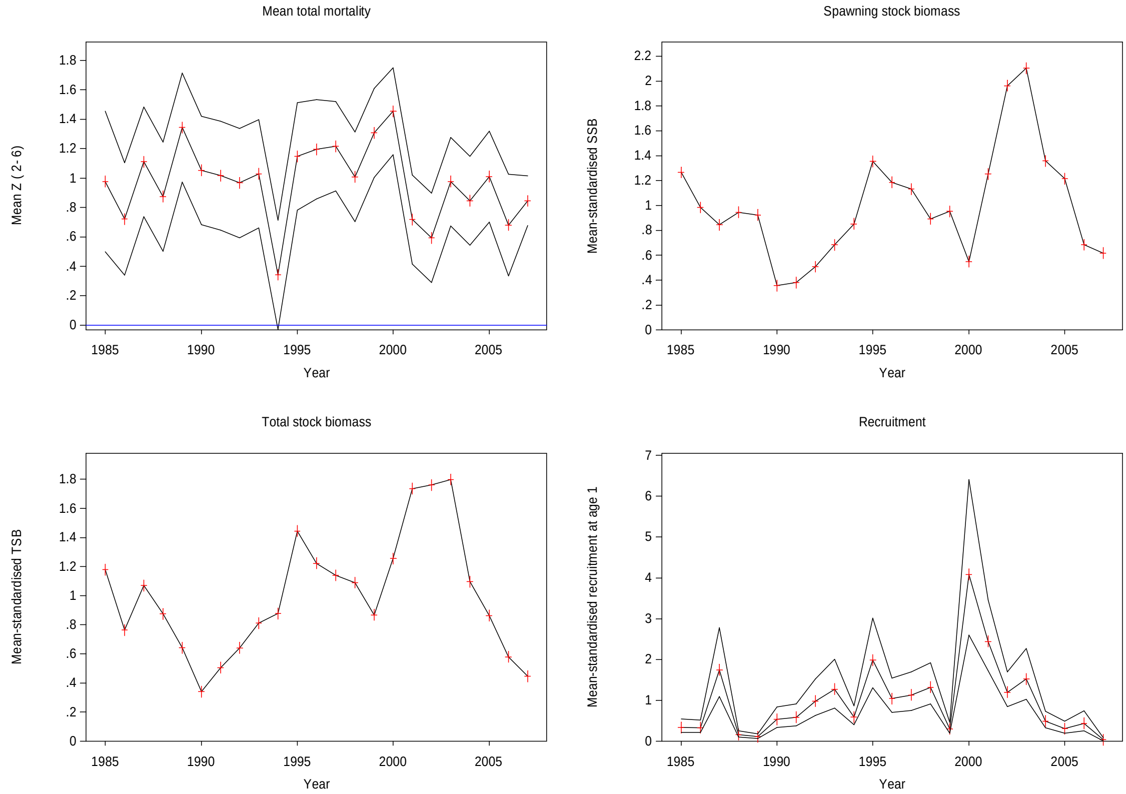


Figure 4.1.13. Haddock in Division VIa. SURBA model results for two-series run (using ScoGFS Q1 and Q4).

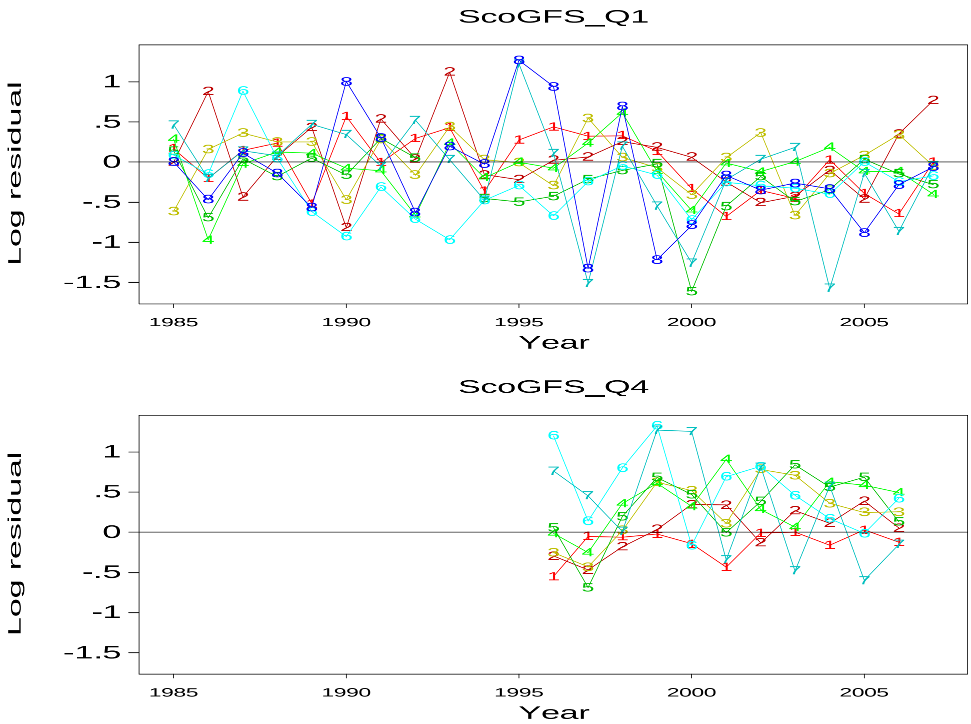


Figure 4.1.14. Haddock in Division VIa. SURBA model residuals for two-series run (using ScoGFS Q1 and Q4).

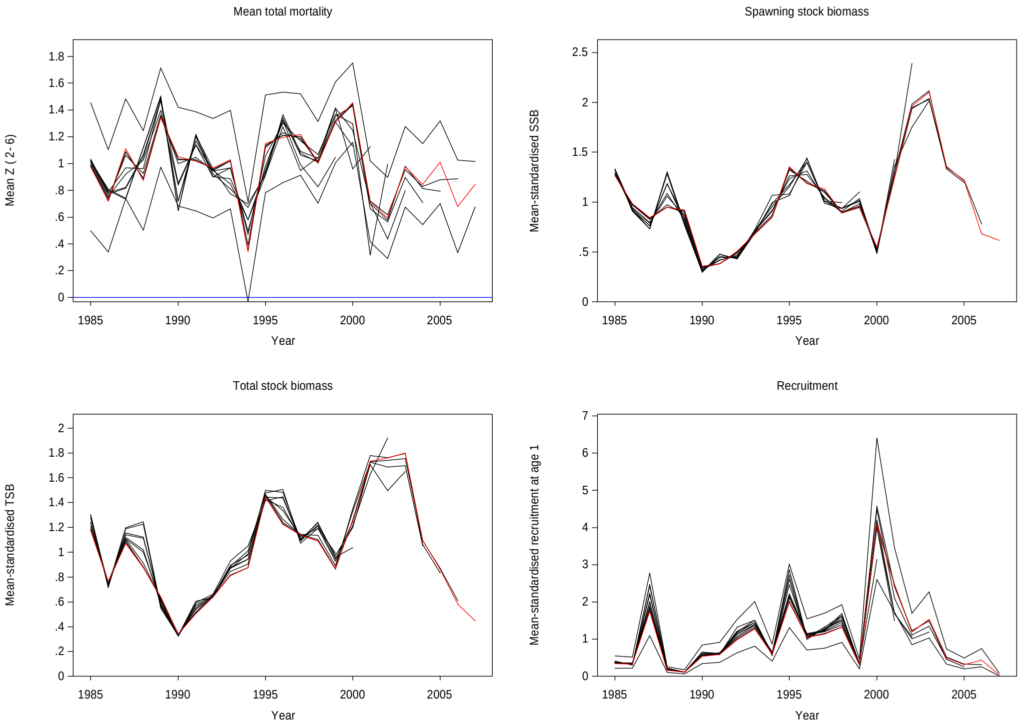


Figure 4.1.15. Haddock in Division VIa. SURBA model retrospective results for two-series run (using ScoGFS Q1 and Q4).

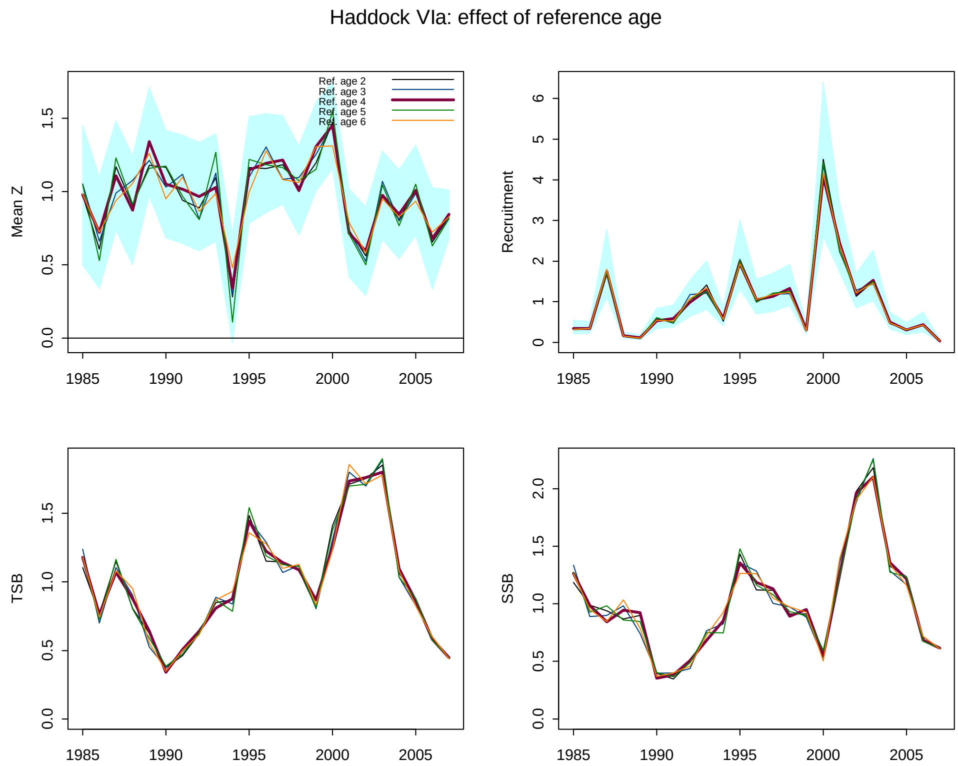


Figure 4.1.16. Haddock in Division VIa. Analysis of sensitivity of SURBA-estimated results to choice of reference age (two-series run). The light-blue shading indicates the confidence limits about the base case run (reference age=4).

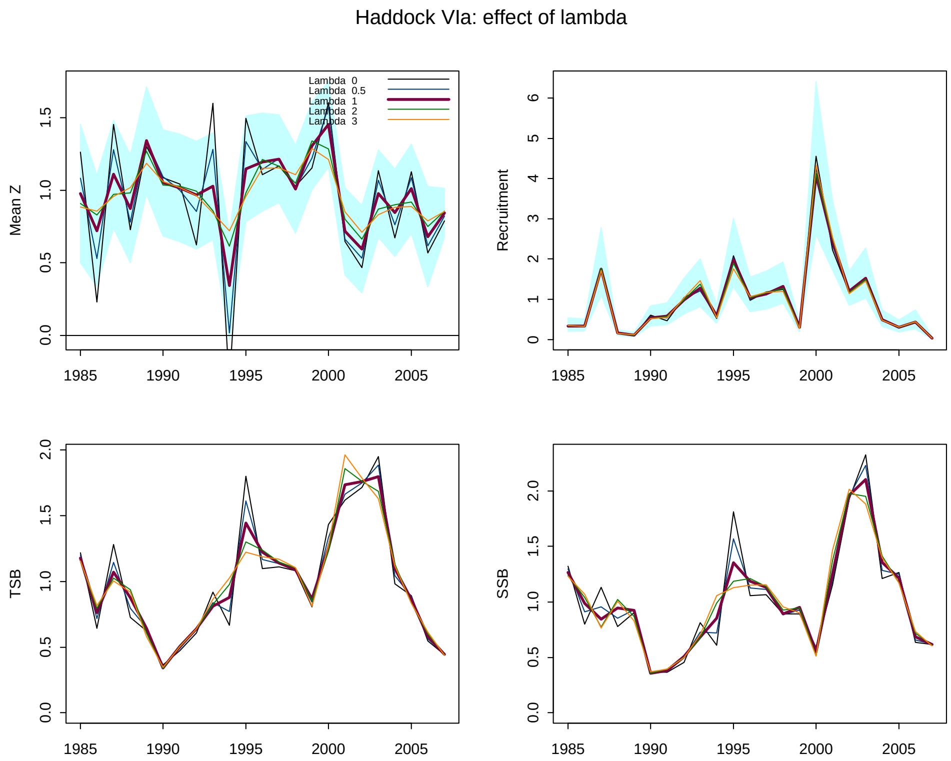


Figure 4.1.17. Haddock in Division VIa. Analysis of sensitivity of SURBA-estimated results to choice of smoothing parameter λ (two-series run). The light-blue shading indicates the confidence limits about the base case run (λ =1).

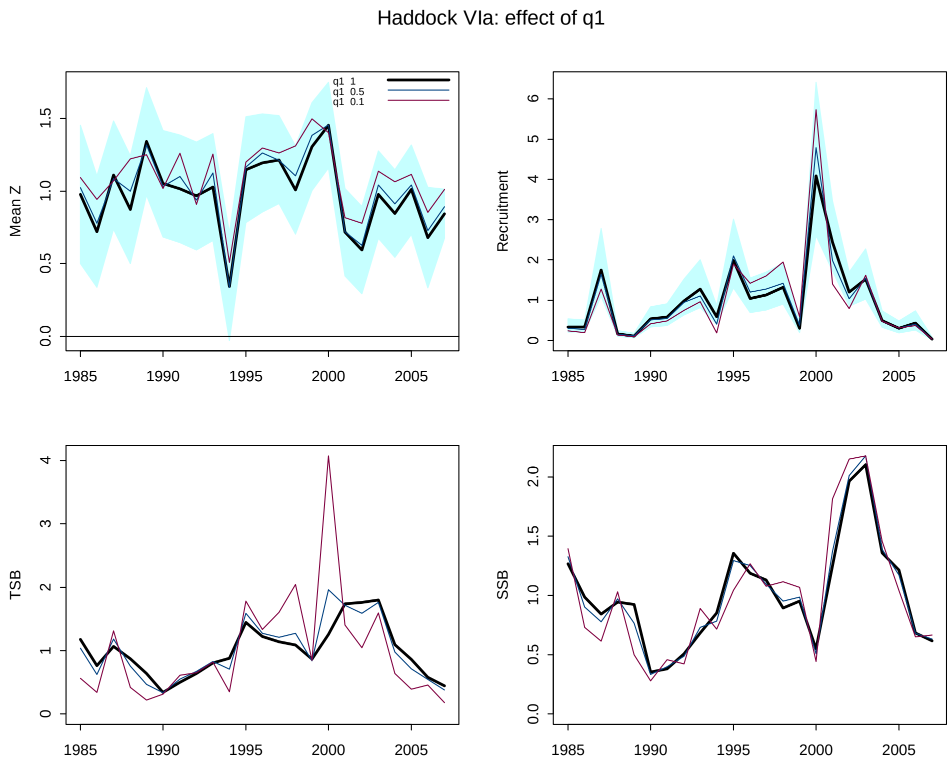


Figure 4.1.18. Haddock in Division VIa. Analysis of sensitivity of SURBA-estimated results to choice of catchability q_1 on the youngest age (two-series run). The light-blue shading indicates the confidence limits about the base case run (q_1=1).

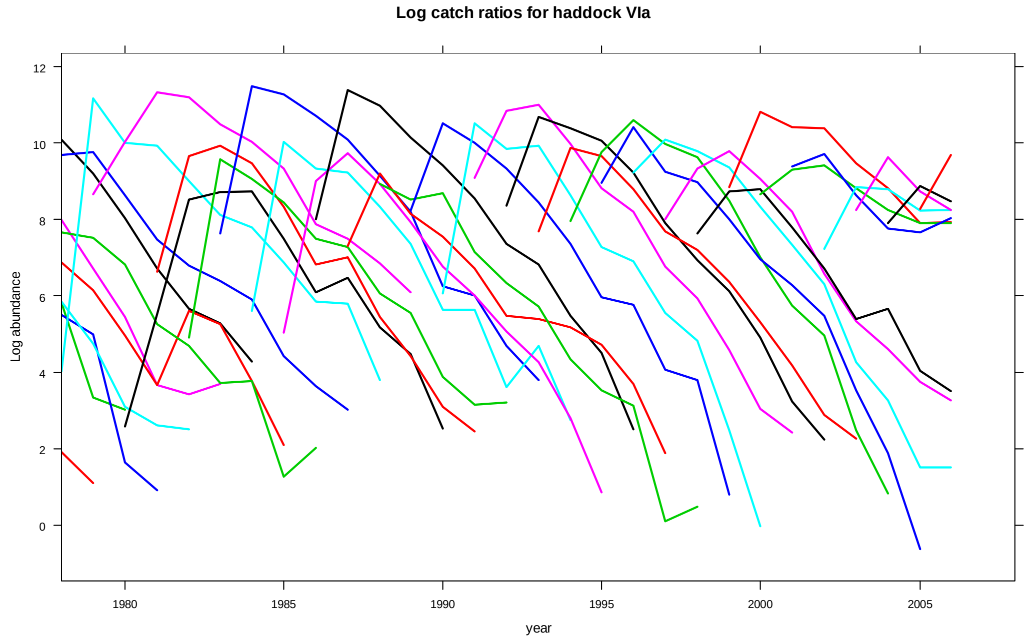


Figure 4.1.19. Haddock in Division VIa. Catch curves (log catch numbers by cohort) from commercial catch data (ages 0–10).

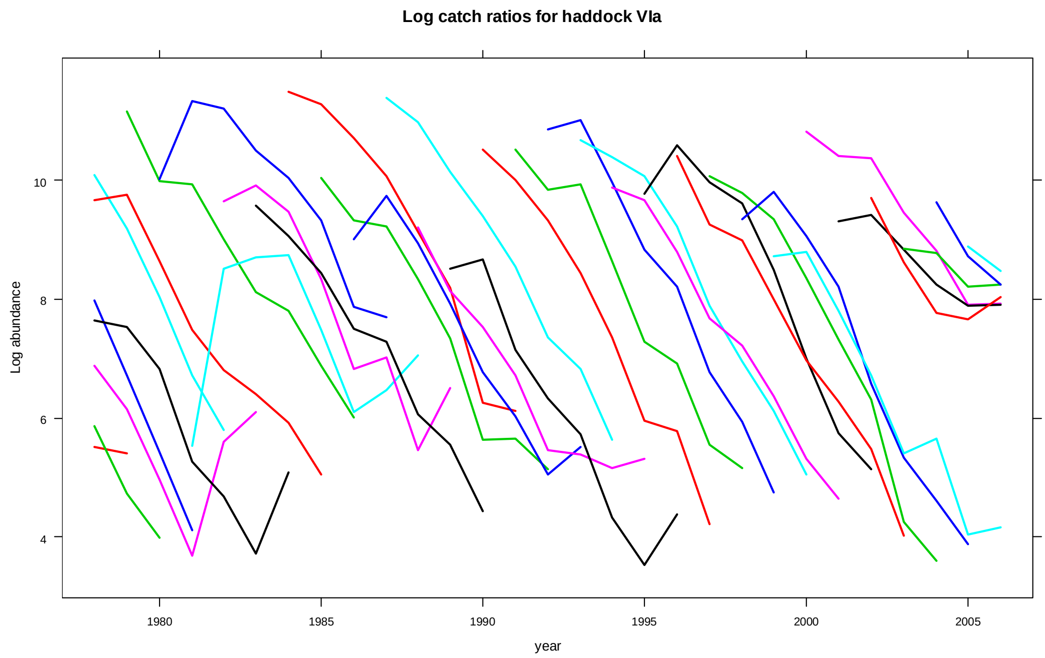


Figure 4.1.20. Haddock in Division VIa. Catch curves (log catch numbers by cohort) from commercial catch data (ages 1–7).

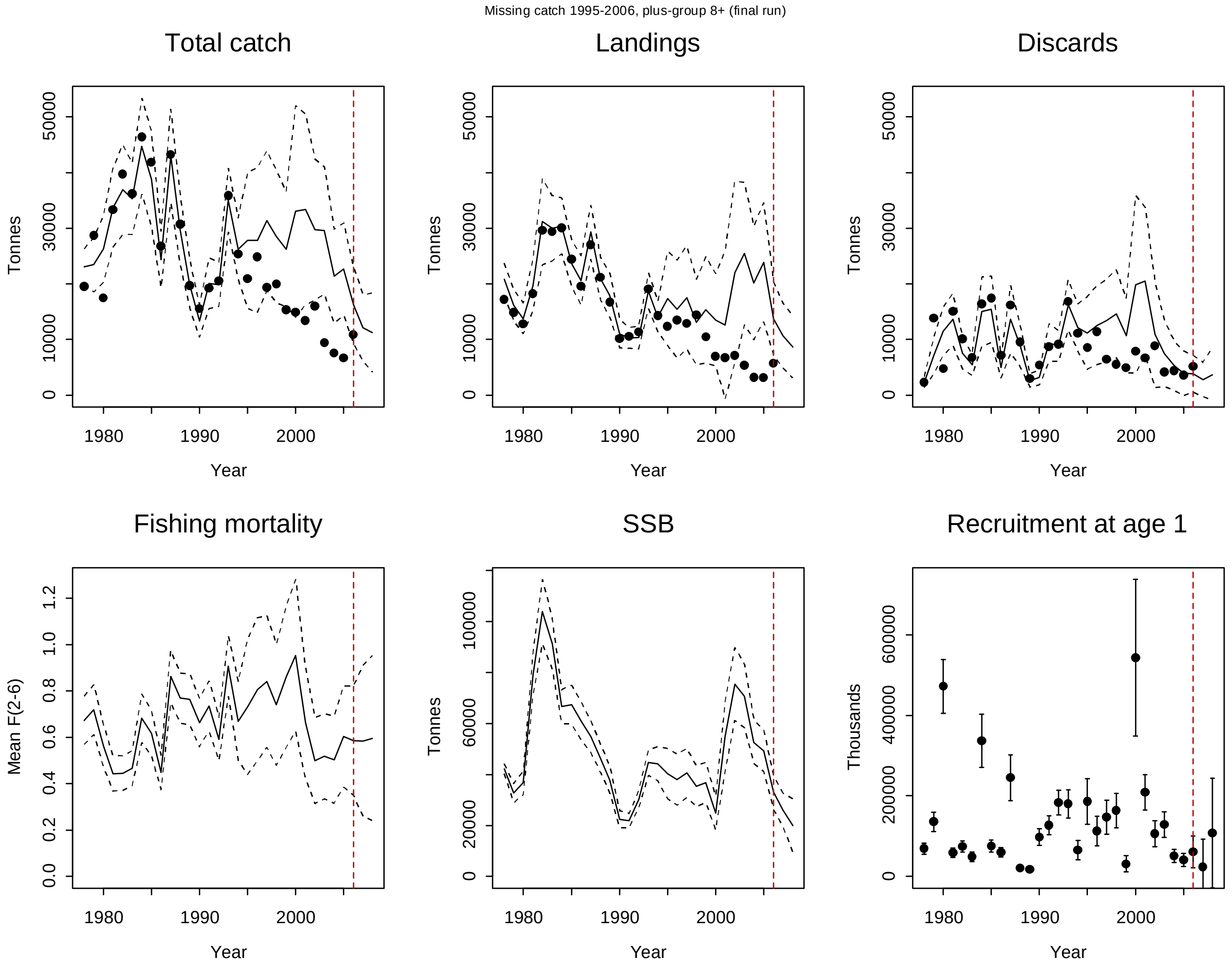


Figure 4.1.21. Haddock in Division VIa. TSA stock summaries from the final run (missing catch data from 1995 onwards). Estimates are plotted with approximate pointwise 95% confidence bounds. Dots indicate observed values for catch, landings and discards. The vertical line in each plot delineates the last year of the historical assessment (2006): estimates to the right of these lines are TSA-based forecasts.

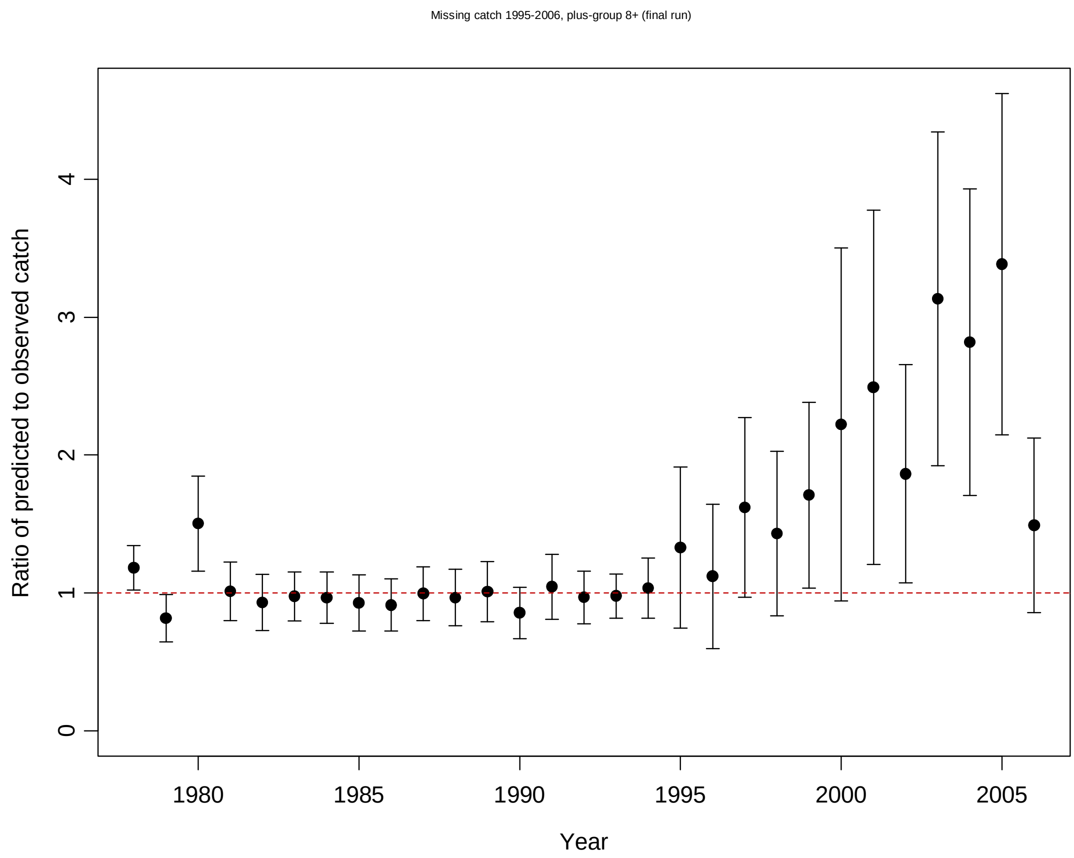
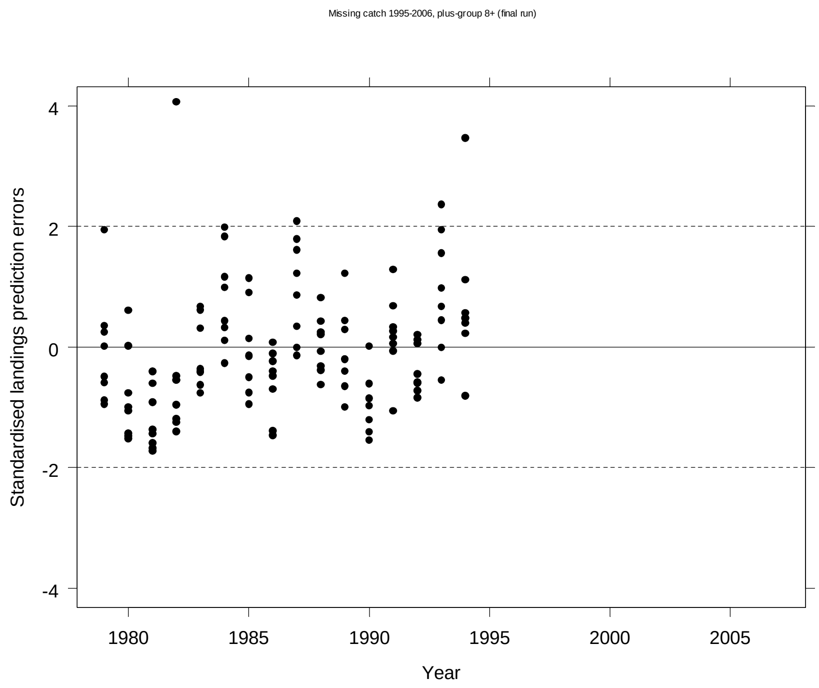


Figure 4.1.22. Haddock in VIa. Ratio of TSA-estimated to observed catch with approximate pointwise 95% confidence limits of the TSA estimates. Catch data are excluded from the model from 1995 onwards.



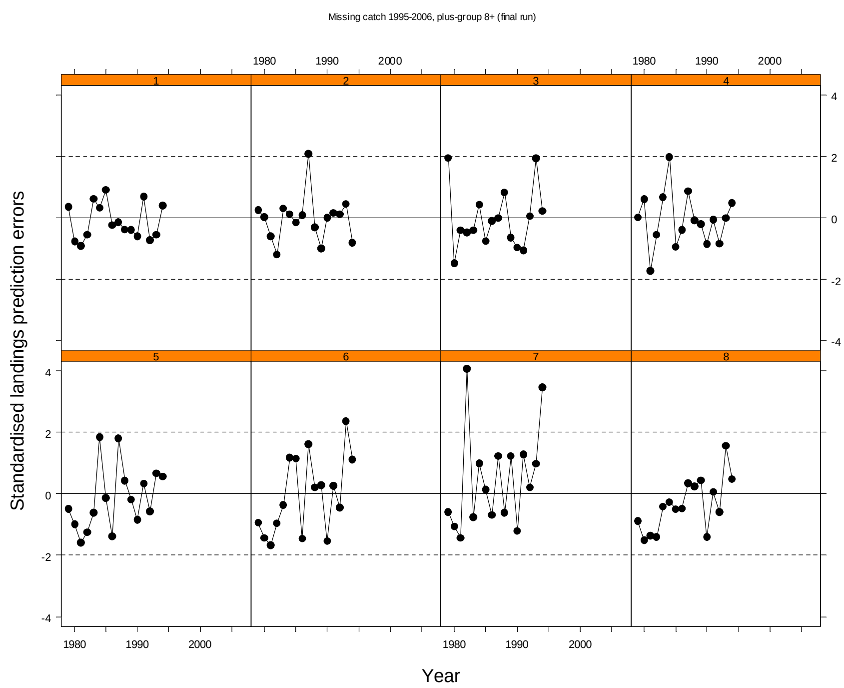
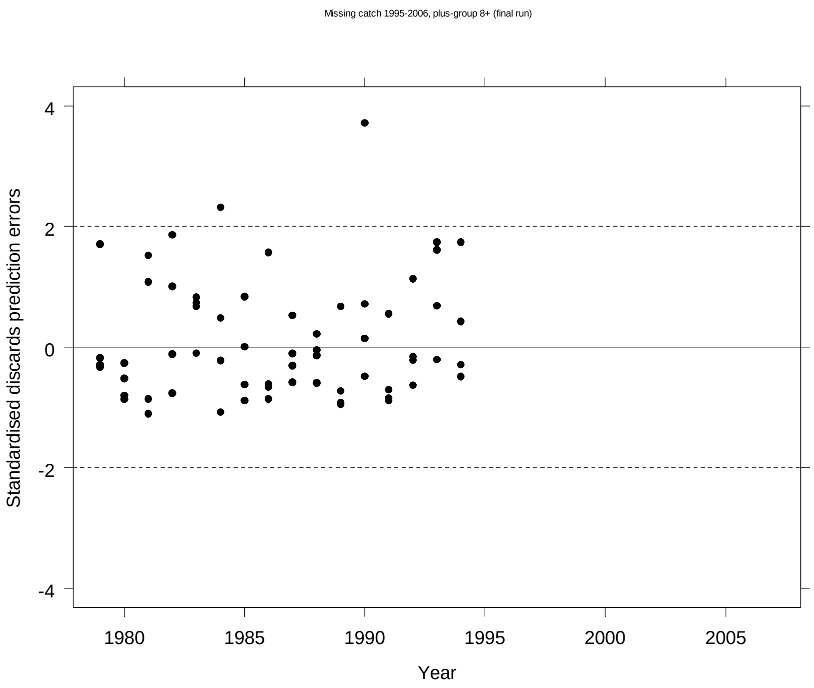


Figure 4.1.23. Haddock in Division VIa. Standardised landings prediction errors from the final TSA run.



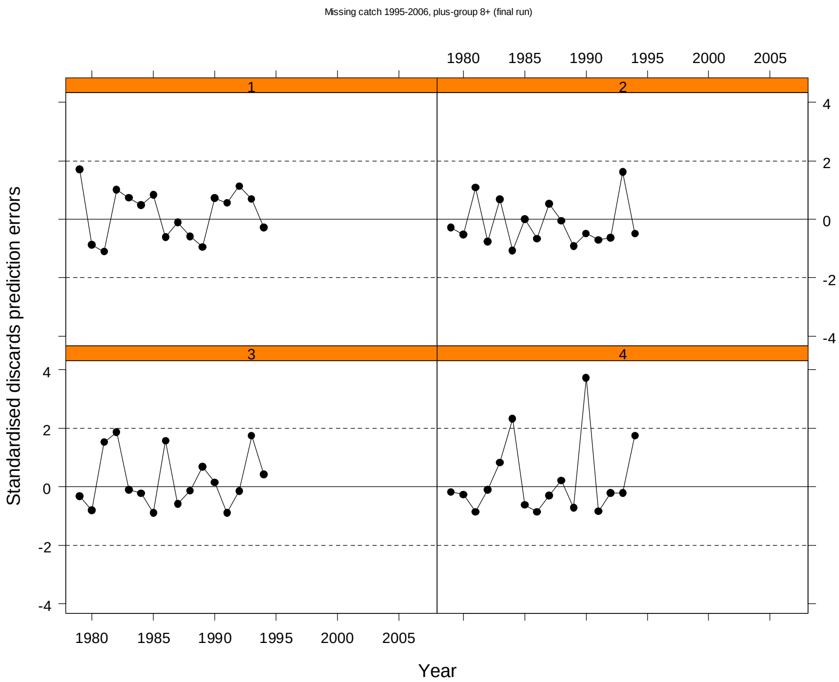
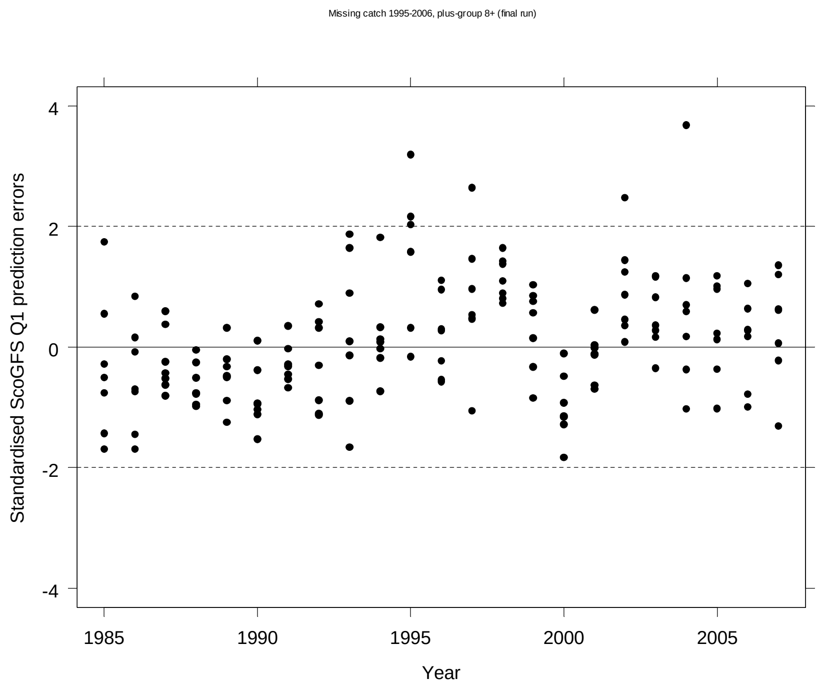


Figure 4.1.24. Haddock in Division VIa. Standardised discards prediction errors from the final TSA run.



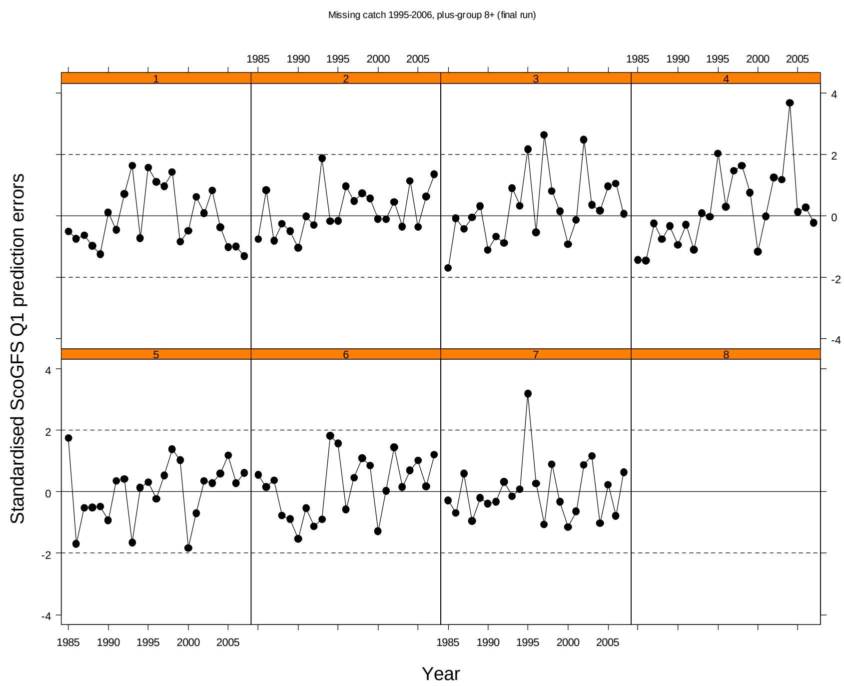
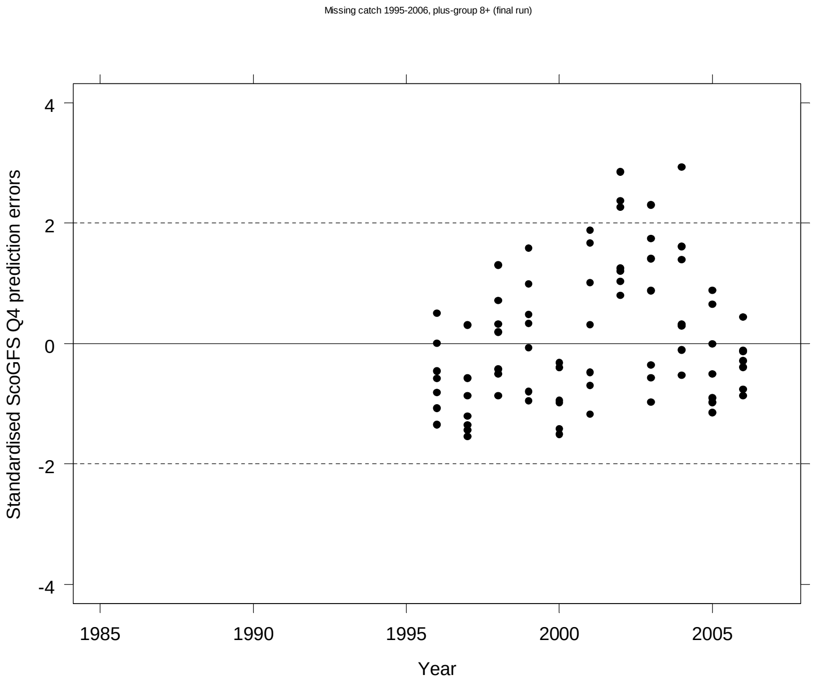


Figure 4.1.25. Haddock in Division VIa. Standardised ScoGFS Q1 prediction errors from the final TSA run.



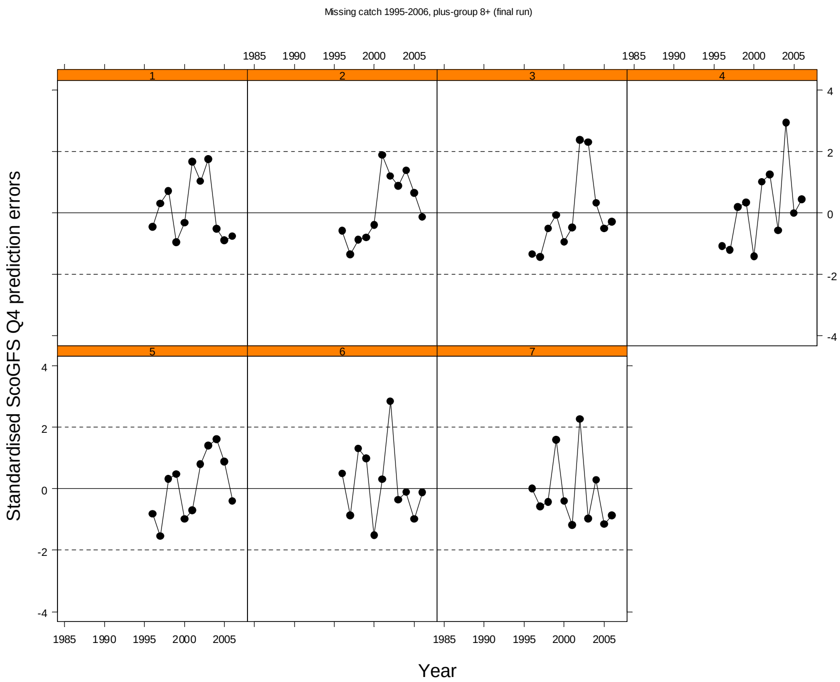


Figure 4.1.26. Haddock in Division VIa. Standardised ScoGFS Q4 prediction errors from the final TSA run.

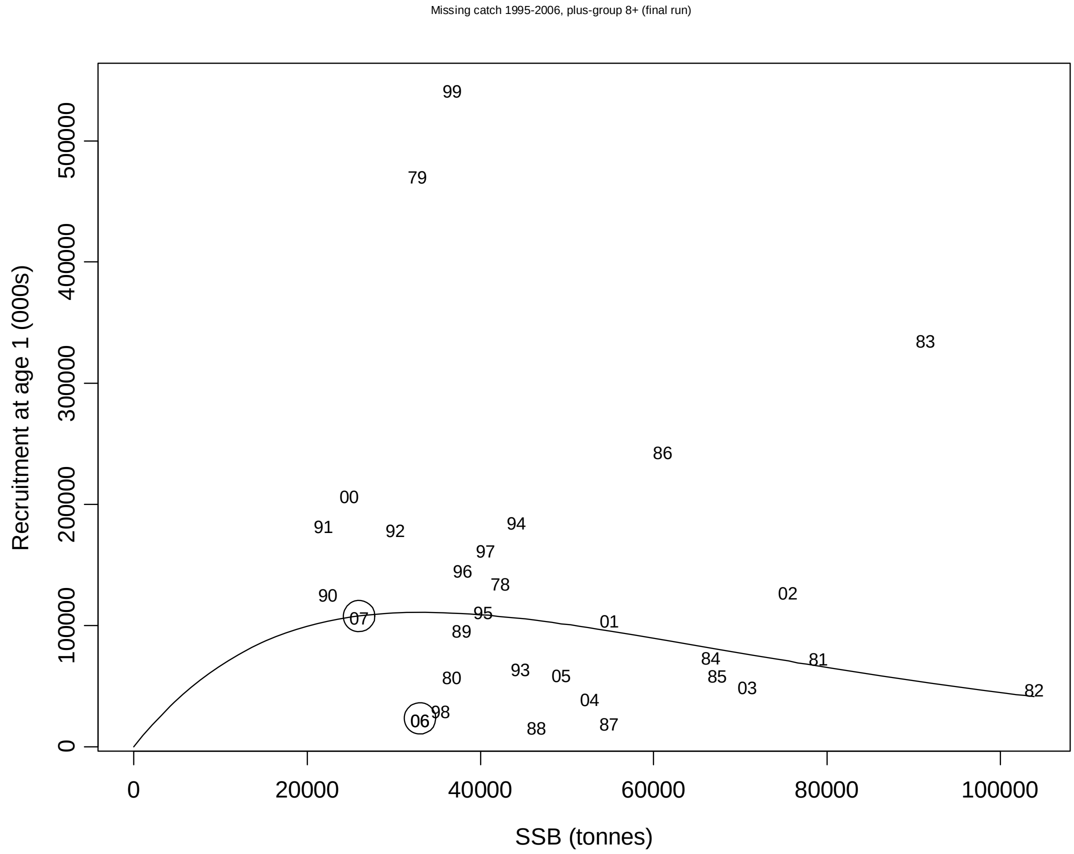


Figure 4.1.27. Haddock in Division VIa. Stock-recruit plot from the final TSA run. Predicted recruitment are circled, for the 2006 year class recruiting in 2007 (using ScoGFS Q1 data) and the 2007 year class recruiting in 2008 (based on the underlying Ricker model).

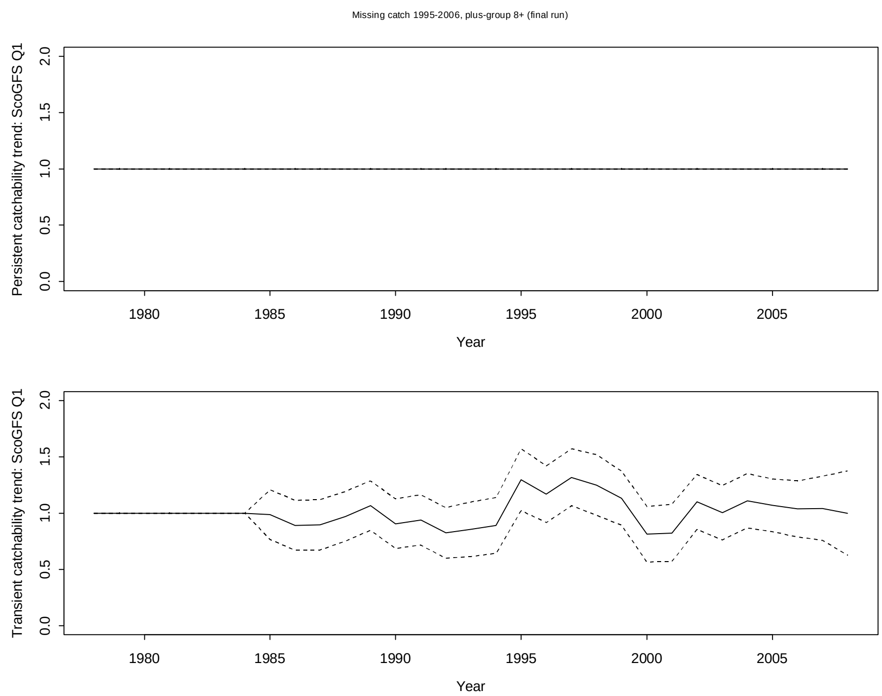


Figure 4.1.28. Haddock in Division VIa. Estimates of persistant (upper) and transitory (lower) trends in ScoGFS Q1 survey catchability. Dotted lines give confidence limits.

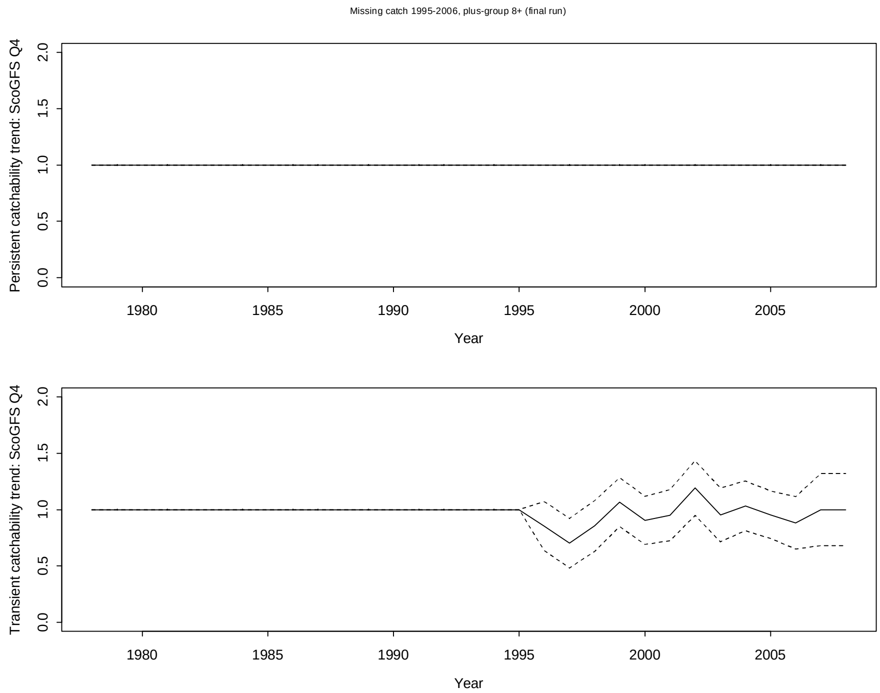


Figure 4.1.29. Haddock in Division VIa. Estimates of persistant (upper) and transitory (lower) trends in ScoGFS Q4 survey catchability. Dotted lines give confidence limits.

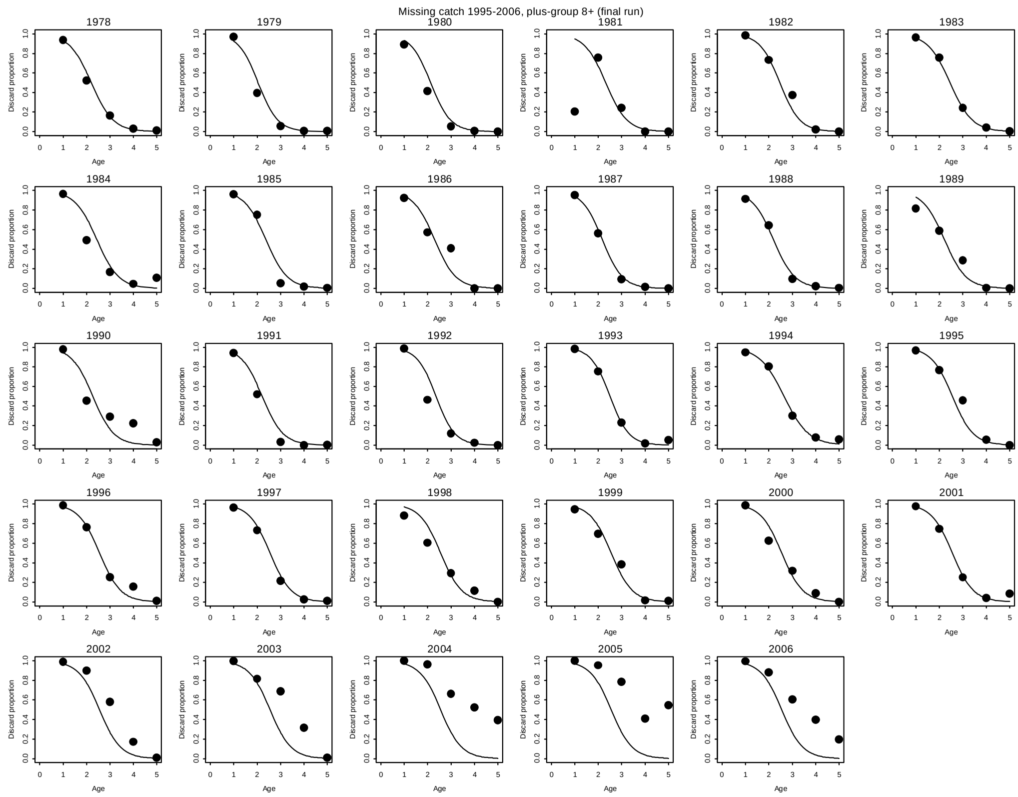


Figure 4.1.30. Haddock in Division VIa. Fitted (lines) and observed (dots) discard proportions at age from the final TSA run.

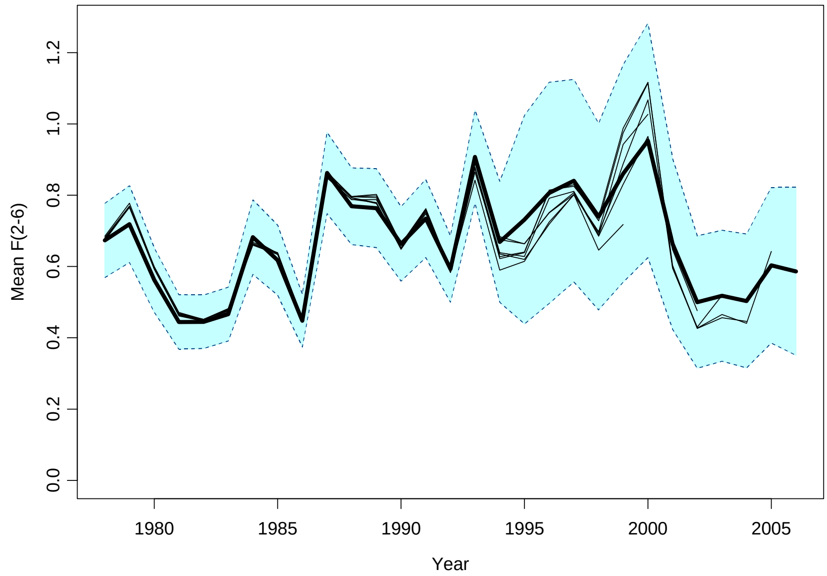


Figure 4.1.31. Haddock in Division VIa. Mean $F_{2\text{-}6}$ estimates from retrospective TSA runs.

Figure 4.1.32. Haddock in Division VIa. SSB estimates from retrospective TSA runs.

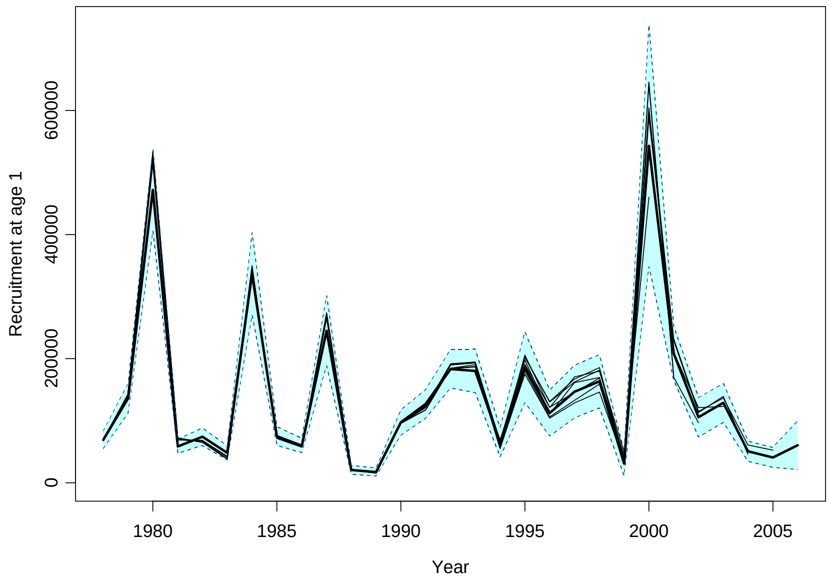


Figure 4.1.33. Haddock in Division VIa. Recruitment estimates from retrospective TSA runs.

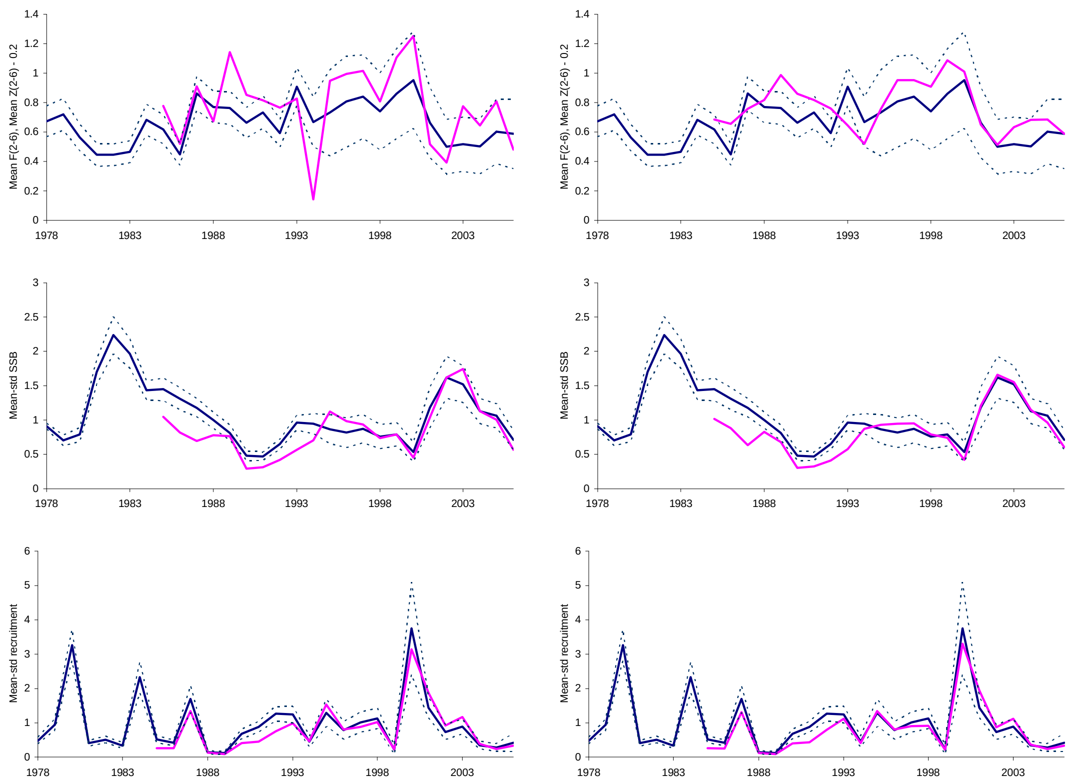


Figure 4.1.34. Haddock in Division VIa. Comparison of TSA and SURBA population estimates. Left: SURBA fits with standard smoothing (λ = 1.0). Right: SURBA fits with increased smoothing (λ=3.0). Dotted lines give approximate pointwise 95% TSA confidence intervals.

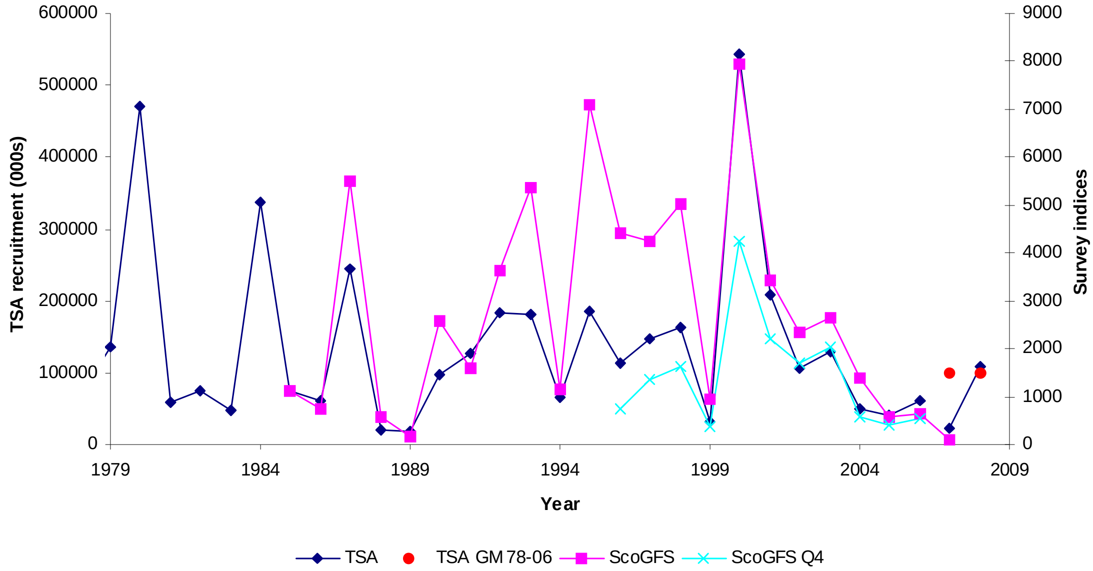


Figure 4.1.35. Haddock in Division VIa. Time-series of recruitment at age 1 from the final TSA assessment, along with the long-term (1978–2006) geometric mean and the age-1 indices from the Q1 and Q4 ScoGFS survey series.

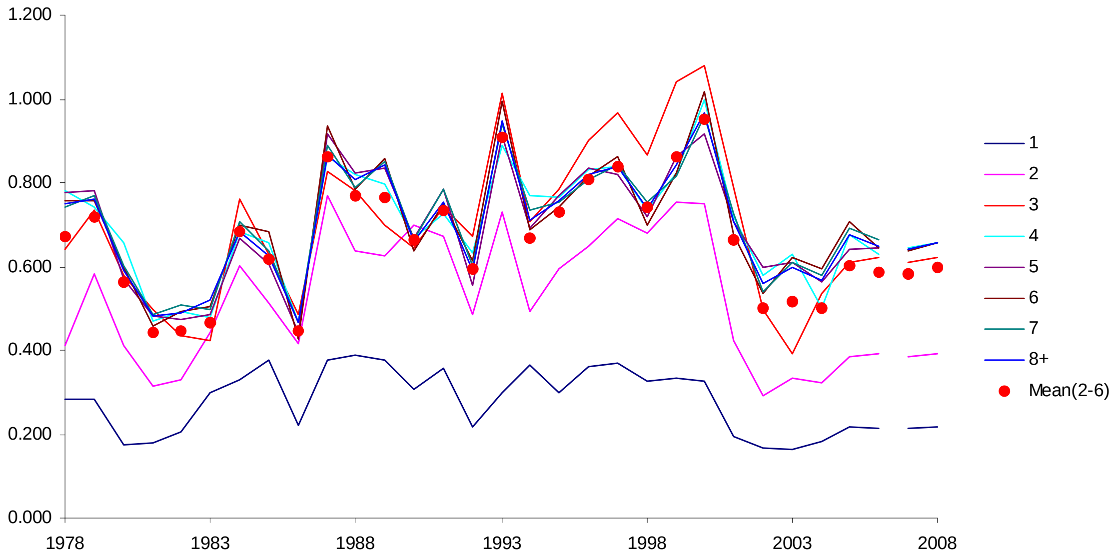


Figure 4.1.36. Haddock in Division VIa. Time-series of estimated fishing mortality-at-age, along with the mean over ages 2–6. Values for 2007 and 2008 are TSA-generated forecasts.

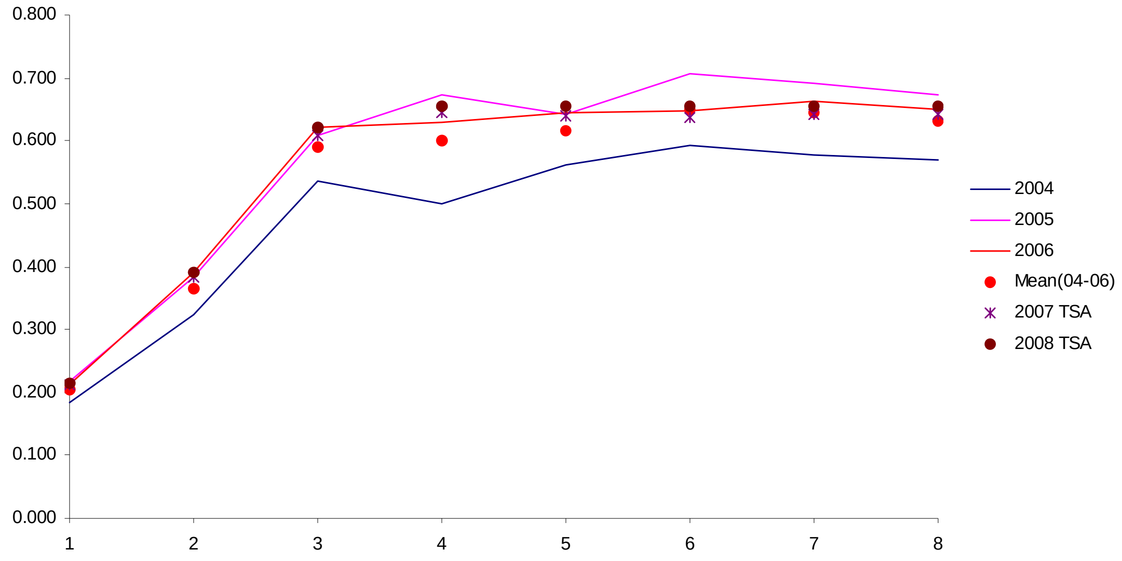


Figure 4.1.37. Haddock in Division VIa. Candidates for fishing mortality-at-age in short-term forecasts. Lines dented 2004, 2005 and 2006 indicate the TSA estimates for those years. Points marked 2007 TSA and 2008 TSA show the TSA-generated forecast values from the final assessment.

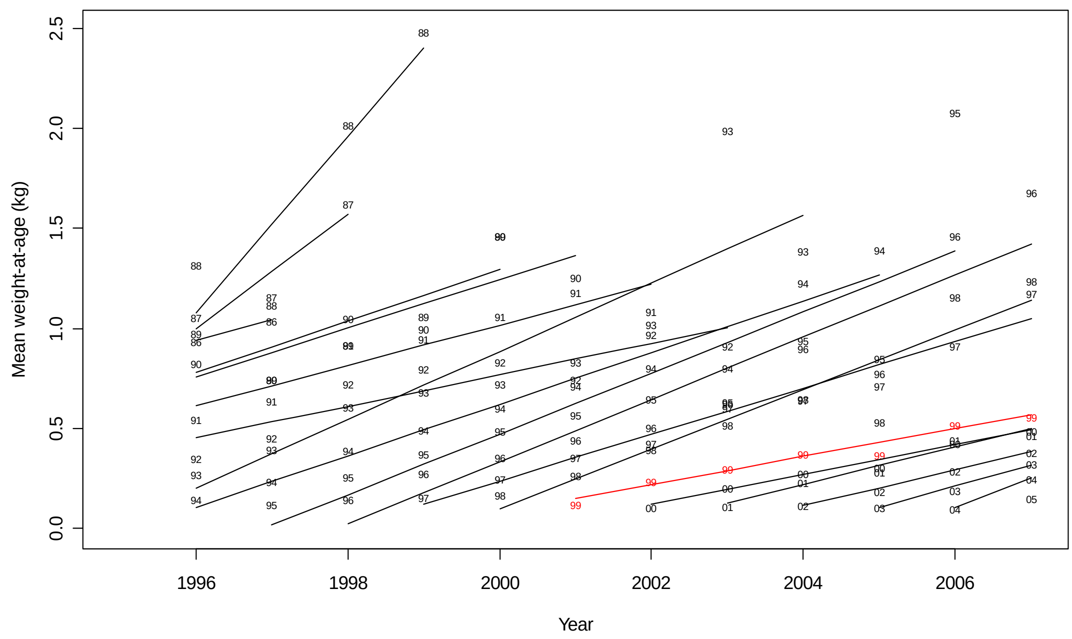


Figure 4.1.38. Haddock in Division VIa. Mean weights-at-age (kg) in total catch (or stock), tracked by year class with a linear model fit: the 1999 year class is highlighted in red.

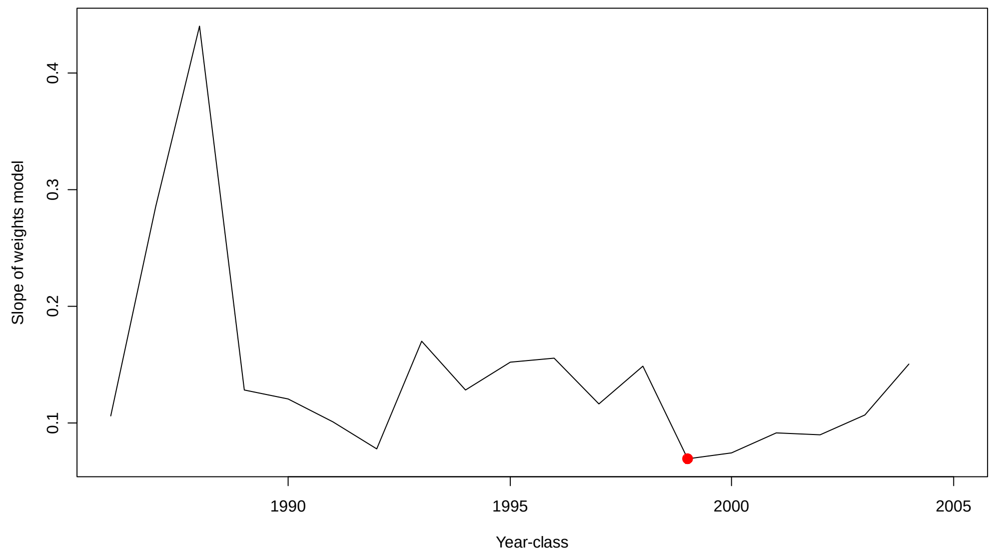


Figure 4.1.39. Haddock in Division VIa. Slopes of the linear models fitted to mean weights-at-age (kg) in total catch (or stock) for year classes (see Figure 4.1.38). The 1999 year class is highlighted in red.

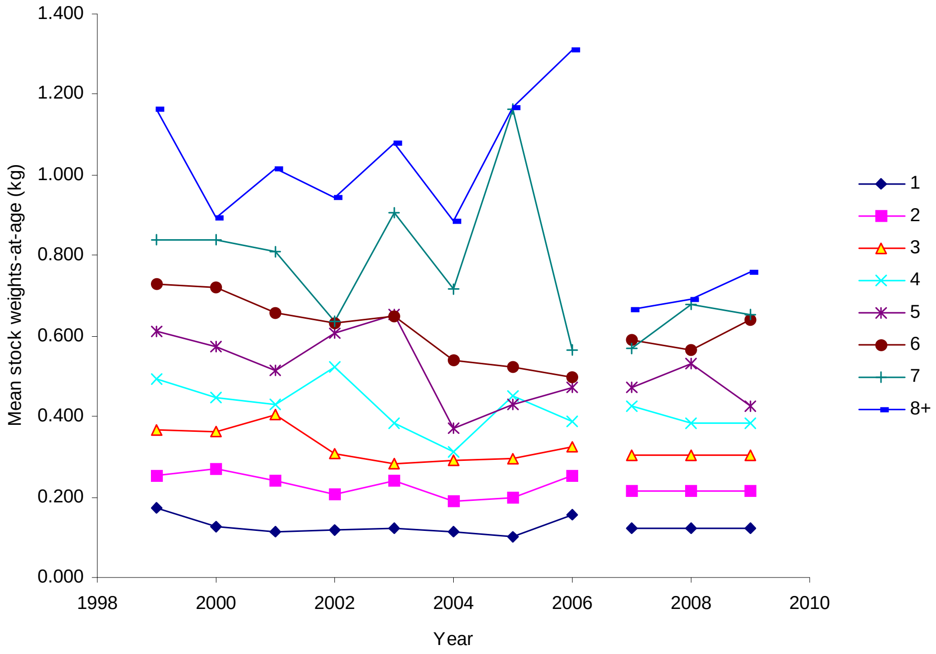


Figure 4.1.39. Haddock in Division VIa. Estimated (1999–2006) and forecast (2007–2009) mean weights-at-age in total catch (or stock).

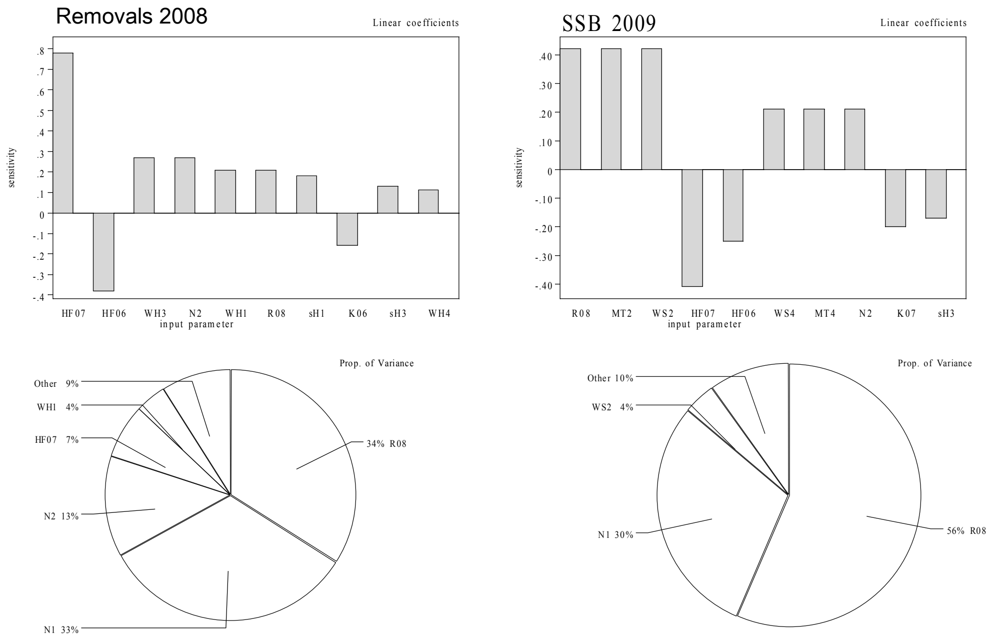


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Figure 4.1.40. Haddock in Division VIa. Sensitivity analysis of short-term forecast.

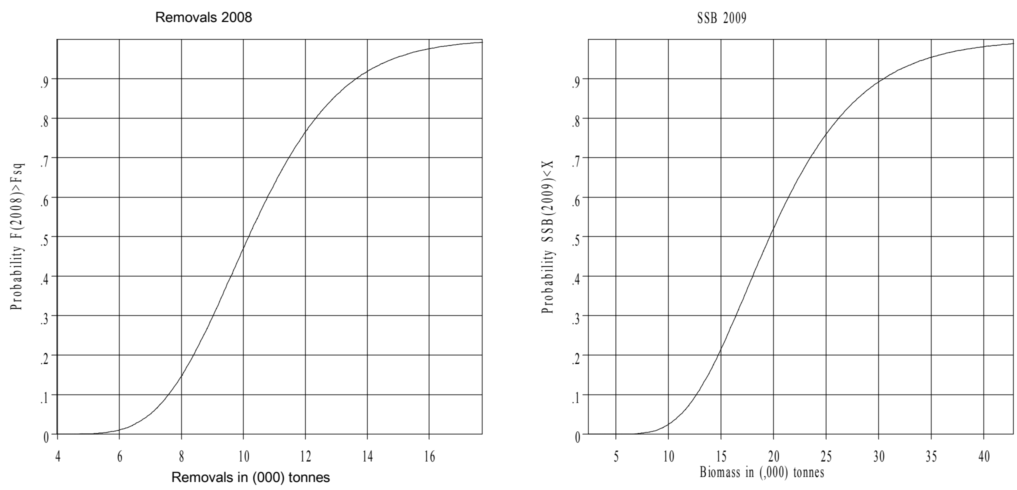

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Figure 4.1.41. Haddock in Division VIa. Probability profiles for short-term forecast.

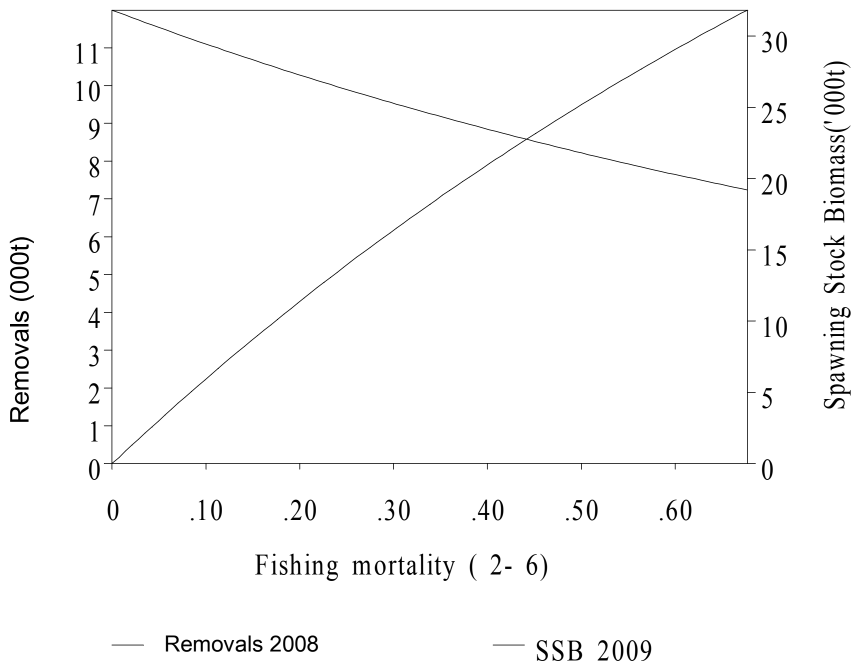


Figure 4.1.42. Haddock in Division VIa. Summary of short-term forecast.

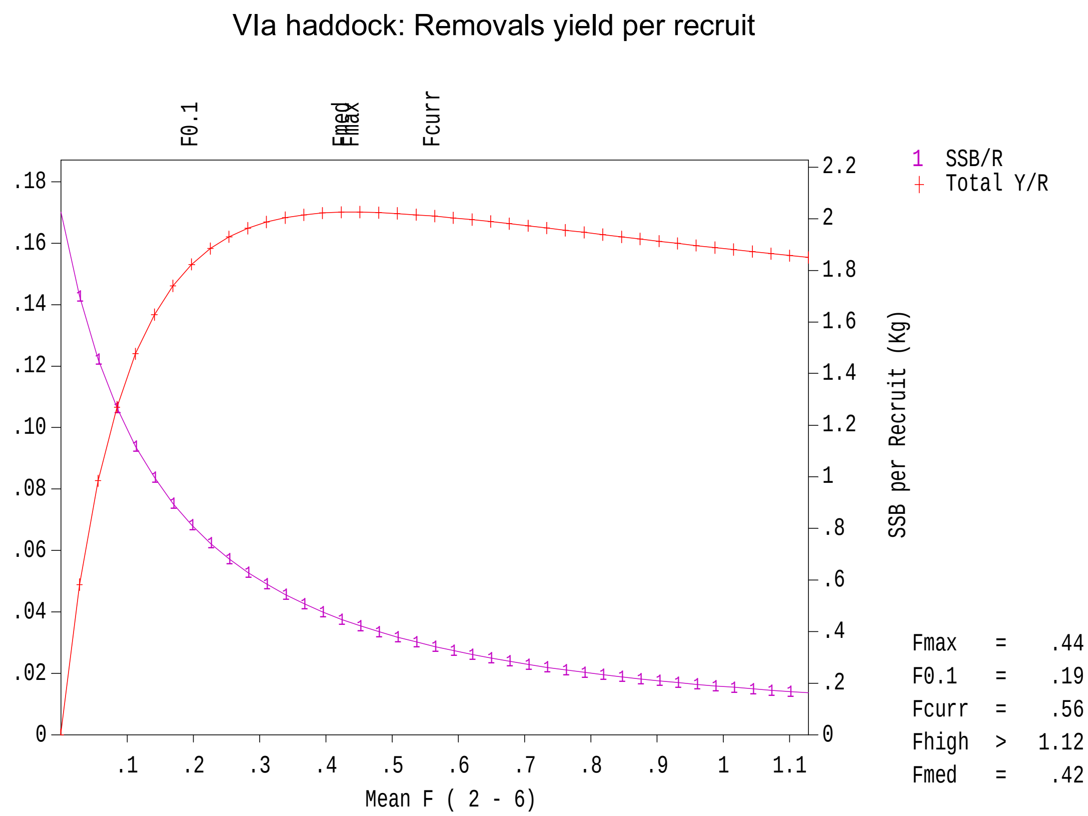


Figure 4.1.43. Haddock in Division VIa. Results of yield-per-recruit analysis.

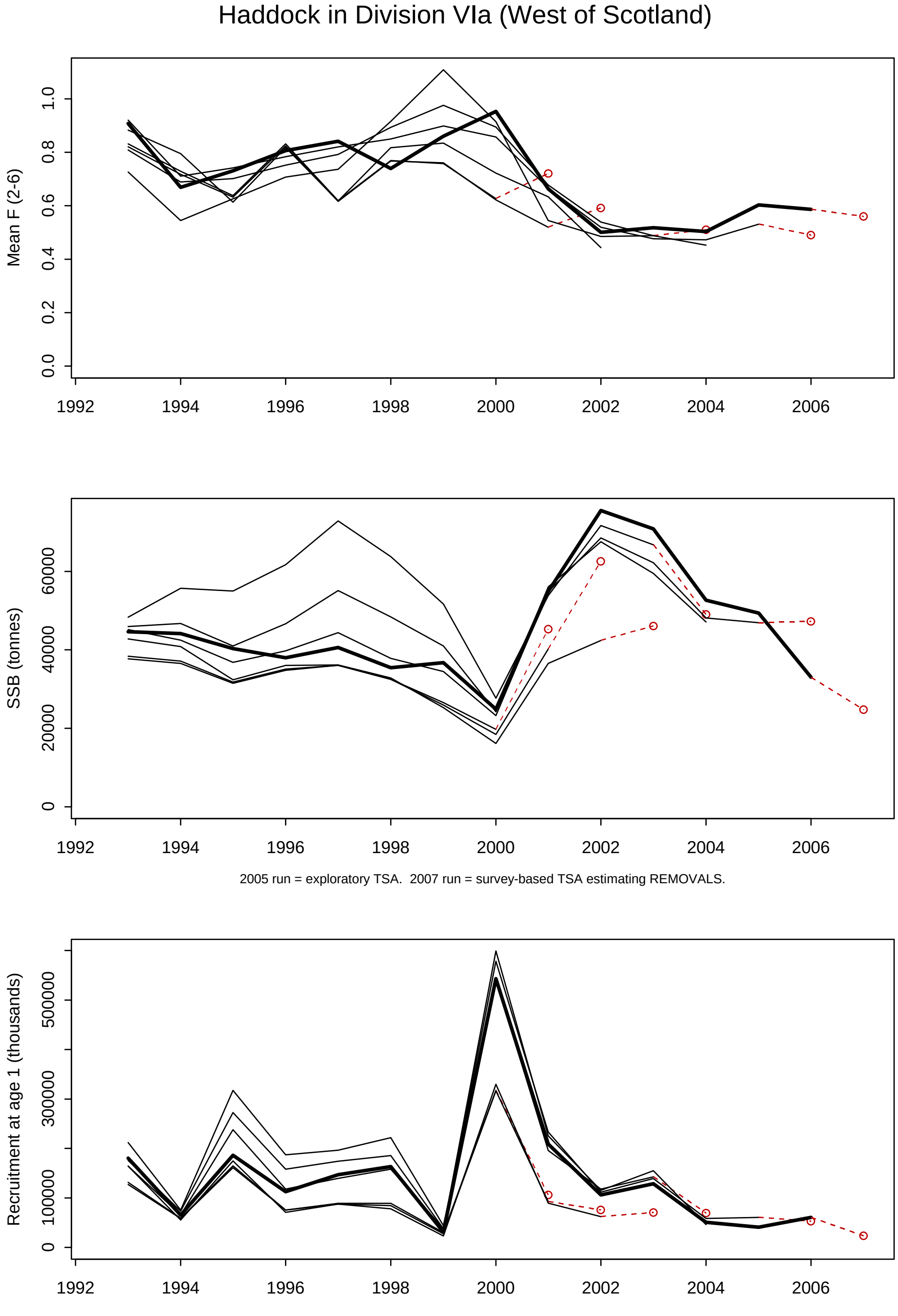


Figure 4.1.44. Haddock in Division VIa. Stock summaries from successive WG meetings. Dotted lines and open circles indicate forecasts.

4.2 Haddock in Division VIb

The lack of information on discards from the European fleets required that the assessments in 2001–2003 approximated the Russian catch as EU landings equivalents above the EU minimum landing size. This approach was necessary to avoid the possible misinterpretation of the sudden appearance of the Russian catch of smaller haddock as evidence of strong recruitment. However, the approach underestimated the total catch from the fishery.

WGNSDS 2004 was presented with an experimental assessment (Khlivnoy, 2004) which allows modelling of the total catch (including discards) of the Irish, Scottish and Russian fleets. To facilitate the potential use of different models for the experimental assessment of Rockall haddock the WG collated separate Russian and EU catch-at-age matrices. In the Technical Minutes of its October 2004 meeting, the review group (RGNSDS) recommended that the WG evaluate this approach at 2005 meeting. At its meeting in August 2005, RGNSDS recommended that the WGNSDS should explore alternative (experimental) approaches to assessment and advice using the data from existing and future planned surveys. The Rockall haddock assessment was accepted by the 2006 review group. The same method of assessment has been applied since 2004.

4.2.1 The fishery

The development of the Rockall haddock fishery is documented in the 2001 Working Group report and in the report of the ICES Group meeting on Rockall haddock convened in January 2001 (ICES, 2001). That meeting was set up to respond to a NEAFC request for information on the Rockall haddock fishery. NEAFC had agreed to consider regulation of the international fishery in 2001 and the report of the Expert Group was considered by ACFM working by correspondence prior to the NEAFC meeting.

The Rockall haddock fishery changed markedly in 1999 when a revision of the EU EEZ placed the southwestern part of the Rockall plateau in international waters. This has opened opportunities for other nations, notably Russia, to exploit the fishery in this area. The table of Official Statistics (Table 4.2.1) now includes Russian catches from the Rockall area.

The Russian fleet started fishing operations in international waters at Rockall in May-October 1999. The Russian haddock fishery uses bottom trawls with cod-end mesh size of 40–100 mm (mainly 40–70 mm) and retains haddock of all length classes in the catch. This fishery targets concentrations of haddock mainly during the spring and the beginning of summer. Russian catches increased from 458 t in 1999 to 2 154 t in 2000. In 2001, they were markedly reduced to 630 t due to the introduction of a closed area and low density of fish concentrations. Russian catches increased again in 2002–2004 from 1 630 to 5 844 t. In 2005, they decreased to 4 708 t and are estimated to be 2 154 t in 2006.

Prior to 1999, the UK and Ireland fisheries had been principally summer fisheries but in more recent years the Scottish and Irish fishery was conducted throughout the year with the peak in April-May. This shift in the fishery appears to have followed the discovery of concentrations of haddock in deeper water to the west of Rockall, at depths between 200 m and 400 m. High catch rates attracted effort into the area. However, catch rates in 2000 were reported to be poor in deeper water. Anecdotal evidence suggests that increased discarding has been associated with the deeper-water fishery compared to the traditional fishery at northern Rockall. In 2004–2006, a considerable proportion of EU landings were taken in the international waters. Historical fishing patterns of the Scottish fleet on Rockall is presented by Newton *et al.* (2004).

The pattern of fishing at Rockall, with vessels fishing on concentrations of haddock during spring, and increased activity by Russian vessels, is reported to have occurred in 2000, indicating a marked expansion of the fishery in 1999 and 2000.

There are some indications that, due to a general decline in catches by the Scottish and Irish fleets in Division VIa, there is an increasing focus in the Rockall fishery in Division VIb (FTFB report to this WGNSDS). Paired gear (both seine and trawl) are to be tested by some Scottish fishermen, which, if it proves successful, can lead to a considerable increase in effective effort in VIb. The fishery at Rockall seems particularly attractive given the lack of effort restrictions in this area.

Information on the Russian fishery and biological investigations from commercial vessels fishing in Rockall during 2006 are presented in WD7.

An analysis of the spatial and depth distributions of Rockall haddock in association with oceanographic variables is presented by Vinnichenko and Sentyabov (2004), a WD to WGNSDS, 2004. Changes in distribution have occurred over a period coincidental with changes in oceanographic variables. Information on oceanographic conditions on Rockall bank in spring 2005 is presented by Sentyabov (2005).

4.2.1.1 ICES advice applicable to 2006 and 2007

The advice in 2005 for the fishery in 2006 (single stock exploitation boundaries) was as follows:

"Catches in 2006 should be reduced to the lowest possible level."

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

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

"Target reference points have not been agreed for this stock. There is no gain in yield by having a target above $F_{0.1}$ (0.18)."

Exploitation boundaries in relation to precautionary limits

Fishing mortality should be less than F_{pa}, corresponding to catches less than 7,100 t in 2007.

4.2.1.2 Management applicable to 2006 and 2007

The TAC for Haddock VIb has previously been set for Subarea Vb, VI, XII and XIV combined and was 8 675 t in 2003, with a limitation on the amount to be taken in Vb and VIa. In 2004, the TAC for Division VI was split and the VIb TAC for Haddock was included with Divisions XII and XIV. The TAC for VIb, XII and XIV was set at 702 t in 2004 and 2005 and at 597 t in 2006. The TAC in 2007 was set at 4 615 t (an almost eight-fold increase compared to TAC in 2006)

The ICES advice, agreed TAC for EC waters and WG estimates of landings are summarised below. All values are in tonnes.

YEAR	CATCHES CORRESPONDING TO ICES ADVICE (VIB)	BASIS	AGREED TAC	WG LANDINGS
2002	<1 300	Reduce F below 0.2	1 300[a]	2 571
2003	-	Lowest possible F	702[a]	5 961
2004	-	Lowest possible F	702[b]	6 400
2005	-	Lowest possible F	702[b]	5 191
2006	-	Lowest possible F	597[b]	2 760
2007	<7 100		4 615[b]	

a) TAC was set for Divisions VIa and VIb (plus Vb1, XII and XIV) combined with restrictions on quantity that can be taken in Vb and VIa. The quantity shown here is the total area TAC minus the maximum amount which is allowed to be taken from Vb and VIa.

b) In 2004, the EU TAC for Division VI was split and the VIb TAC for haddock was included with XII and XIV. This value is the TAC for VIb, XII and XIV.

In May 2001, the International Waters component of statistical rectangle 42D5, which is mainly at depths less than 200 m, was closed by NEAFC to all fishing activities, except with longlines. In spring 2002, the EU component of this rectangle, again mostly shallow water, was also closed to trawling activities (EC No 2287/2003). The total Rockall Haddock Box is bounded by the following coordinates:

Latitude	Longitude
57°00'N	15°00'W
57°00'N	14°00'W
56°30'N	14°00'W
56°30'N	15°00'W

These management measures for the International Waters were in force up to 2006 inclusive.

At the 25th Annual Meeting of NEAFC (in November 2006), a closure of three areas on the Rockall Bank to bottom fishery was proposed to protect cold-water corals: North West Rockall, Logachev Mounds and West Rockall Mounds (NEAFC AM, 2006). This measure will be in force for the period 1 January 2007–31 December 2009.

The minimum landing size of haddock taken by EU vessels in Rockall is 30 cm. There is no minimum landing size for haddock taken by non-EU vessels in international waters.

4.2.1.3 The fishery in 2006

Russian fishery in 2006

In 2006 the Russian fishery for haddock started in the late March. Haddock predominated in catches (on average, 60–90% of catch) to the end of June. In April-June, the bulk of Russian catch was taken under the maximum fishing efficiency. In that period, the fishing efficiency of Tonnage Class 10 vessels was higher than in 2005 and amounted to 7.5–10.5 t of haddock per fishing day (Tables 4.2.2 and 4.2.3). The number of trawlers operating in this area varied from 1 to 6. In May–June, catch rates in the haddock fishery declined while the proportion of blue whiting (*Micromesistius poutassou*) in catches increased (Table 4.2.3). The number of vessels in the haddock fishery decreased to 2–3 trawlers in May and one vessel in June. In August-September, there were 1–4 Russian vessels operating in the area of the bank. The fishery was based on mixed concentrations of haddock (40–60%), blue whiting (30–60%) and gurnard (0.1–70%).

The total Russian catch in 2006 in the Rockall area taken by bottom trawls was 3.7 thousand tonnes of fish including 2.1 thousand tonnes of haddock (Tables 4.2.2 and 4.2.3). Blue whiting and gurnard were the second and third most important fish species. Besides, small quantities of redfish species, saithe (*Pollachius virens*), ling (*Molva molva*) and blue ling (*Molva dypterygia*) were recorded in the catches.

Scottish fishery in 2006.

The number of Scottish vessels fishing at Rockall and the number of trips made to Rockall declined substantially from 2000 onwards (WD6 to WGNSDS, 2004). In 2006, a total of 13 Scottish vessels were fishing in the area. In contrast, officially reported effort (in hours) at Rockall increased in 2003 and 2004, but it is not known to what extent this reflects an increase in targeting haddock (see below for discussion of effort). The effort declined in 2005 and 2006. Scottish landings in 2006 are estimated to be 440 t (Table 4.2.4).

The landings data include a small number of English vessels landing from VIb (most likely deep-water vessels) which slightly increased the reported hours fished in VIb, but not necessarily with a corresponding increase in the landings of haddock.

Irish fishery in 2006

The landings of haddock from VIb by Irish fleet in 2006 totalled 40 t (a decline from 105 t in 2005) and were taken by the otter trawl fleet, the only Irish fleet working in this area. Of this total, 19 t (or 46%) was landed in Quarter 2, 11 t (28%) in Quarter 3, 10 t (24%) in Quarter 4. Only 0.64 t (2%) was landed in Quarter 1 (Table 4.2.5). This reflects the concentration of effort by the otter trawl fleet in Quarters 2–4.

Norwegian fishery in 2006

The Norwegian demersal fleet fishing on the Rockall Bank consisted entirely of longliners and targeted mainly ling (*Molva molva*) and tusk (*Brosme brosme*). Haddock constituted by-catch in this fishery. There were in total 7 Norwegian vessels fishing at Rockall in 2006 (also 7 in 2004 and 5 in 2005). Norwegian landings of haddock increased to 123 t in 2006, following a period of low catches in 2001–2005 (32–70 t).

4.2.2 Catch data

4.2.2.1 Official catch statistics

Nominal landings as reported to ICES are given in Table 4.2.1, along with Working Group estimates of total estimated landings. Reported international landings of Rockall haddock in 1991–2005 were about 4.0–6.0 thousand tonnes, except for 2001–2002, when they decreased down to 2.3–3.0 thousand tones. In 2006, they were also low at 2.7 thousand tonnes.

Revisions to official catch statistics for previous years are also shown in Table 4.2.1.

4.2.2.2 Quality of the catch data

Anecdotal evidence suggests that misreporting of haddock from Rockall have occurred historically (which may have led to discrepancies in assessment), but an estimation of overall magnitude is not possible.

4.2.3 Commercial catch-effort data

Commercial cpue series are available for Scottish trawlers, light trawlers, seiners, Irish otter trawlers and Russian trawlers fishing in VIb. The effort data for these five fleets are shown in Figure 4.2.1 and Table 4.2.6. Russian and Scottish data show a peak in effort for 2000 and 2004. The peak in Russian effort for 2000 is mainly due to the 10th class tonnage vessels targeting the large scale grey gurnard fishery. In the last two years, the Russian effort in bottom fishery decreased due to economic reasons. In 2005 the number of trawling hours decreased by 16% compared to the previous year, and in 2006 by 2.8 times (Figure 4.2.1). As a result, despite the increase in fishing efficiency, the haddock catch was less by twice.

The effort data from the Scottish fleets are known to be unreliable due to changes in the practices of effort recording and non-mandatory effort reporting (see the report of the 2000 WGNSSK, CM 2001/ACFM:07, for further details). It is unknown what proportion of Scottish and Irish effort was applied directly to the haddock fishery. The apparent effort increase may just be the result of more exact reporting of effort due to VMS, but another suggestion is that it arises from a ‘days at sea’ measure. Working at Rockall keeps ‘days at sea’ elsewhere intact (the years in question do correspond to the introduction of the days at sea legislation) and it is possible that vessels are either working extra days in VIb or they are simply reporting extra days from VIb. It is difficult to conclude which of these scenarios is more likely.

The Irish otter trawl effort series indicated a reduction in effort in recent years and effort with the effort in 2004 being the lowest in the time-series. The majority of this effort is concentrated in Quarter 2.

In 2006, Russian fishing efficiency increased compared to that in 2005 (Figure 4.2.2). In the period of directed Russian fishery (April-June), the catch of haddock per a trawling hour increased from 0.49 t to 0.72 t for a trawler of BMRTPT type (Tonnage Class 10), from 0.39 t to 0.70 t per a trawling hour Tonnage Class 9. The rise of fishing efficiency was not recorded only in the vessels of Tonnage Class 9. Vessels of Tonnage Class 10 had one of the highest fishing efficiency in recent years which was only less than in 2003 (Figures 4.2.2 and 4.2.3). Dynamics of catches per effort for this type of vessels agrees well with year-to-year variations of total biomass (Figure 4.2.3) (WD7).

The WG decided that the commercial cpue data, which do not include discards and have not been corrected for changes in fishing power despite known changes in vessel size, engine power, fish-finding technology and net design, were unsuitable for catch-at-age tuning.

4.2.4 Research vessel surveys

There is only one research survey index available for VPA assessment this stock (Figure 4.2.4, Table 4.2.7). However, from 1997 onwards this Scottish survey was only conducted in September of alternate years. Due to concerns about the haddock stock at Rockall some extra time was allocated to carry out a partial survey in September 2002. Full surveys were conducted in both 2005 and 2006. The Scottish survey is conducted on 49 standard trawl stations. However, the survey area and number of stations varied in different years. The majority of stations are within the 200 m depth contour. In 2002 the survey was carried out in the central and northern parts of the bank. In 1999 the survey switched from using an Aberdeen 48’ bottom trawl to a GOVtrawl and from 60 min tows to 30 min tows. The indices have been adjusted for tow duration, but no calibration has been made for gear changes. A 20 mm mesh size is used on the survey.

In spring 2005, the Russian trawl-acoustic survey (TAS) for haddock on the Rockall Bank was conducted for the first time (Oganin *et al.*, 2005). However, no such survey was carried out in 2006. In the 2005 survey, the trawl survey method estimated the total stock number at 190.63×10^6 individuals and its biomass at 43.4×10^3 t (see the table below). The acoustic survey yielded a haddock biomass estimate of 60.0×10^3 t with the abundance of 225.9×10^6 (see the 2006 WGNSDS report for more details of the trawl-acoustic survey). The estimates of haddock abundance and biomass from the two methods are quite similar.

Survey type	Area component	Area (sq. miles)	Total stock		Spawning stock	
			Abundance (10^6)	Biomass (10^3 t)	Abundance (10^6)	Biomass (10^3 t)
Trawl survey	Whole	5 554	190.6	43.4		
Acoustic survey	International waters	3 374	144.2	41.1	133.0	38.5
	EU zone	2 180	81.7	18.9	52.4	16.3
	Whole	5 554	225.9*	60.0*	185.4	54.8

***Pelagic component estimated to make up 13.7%.**

4.2.5 Age compositions and mean weights-at-age

The total annual catch was estimated by summing up data on landings and discards.

4.2.5.1 Landings age composition

Age composition and mean weight by age of Scottish and Irish landings were obtained from port sampling. Data on the volume, length-age and weight composition of landings for the period from 1988 to 1998 correspond to values used at this WG (WGNSDS).

In 2002, there was no sampling of the Russian catch and therefore the length composition has to be estimated for this year.

In 2002 and 2003, the structure of the Russian fishery on the Rockall Bank was the same: the same vessels were operating with the same gear in the same fishing areas. The relationship between the haddock length composition obtained from the trawl survey and that in the Russian catches is assumed to be the same for 2002 and 2003 i.e. it is assumed that the length dependent selectivity pattern in 2002 is the same as that in 2003 as there no changes to the fishery in these years. The relationship is described as:

$$P_L = S_L p_L \qquad (1)$$

where P_L–portion of fish with length L in catches, p_L–portion of fish with length L in the stock (survey), S_L–proportion of fish of length L taken aboard. S_L is determined using a theoretical selectivity curve (Figure 4.2.5) which may be described by Formula (2):

$$S_L = \frac{1}{1 + \exp(S_1 - S_2 L)}. \qquad (2)$$

where S_L–portion of taken aboard fish with this or that size in the stock size composition, L–size group, S_1 and S_2–coefficients.

The selectivity curve (Figure 4.2.5), fitted to the data on catch measurements in different periods of the Russian fishery in 2003 is described well by equation (2) with coefficients S_1=12.539, S_2=0.4951. The estimated length frequency distributions for 2003 are compared to the measured length frequency distributions for this year in Figure 4.2.6. The size distribution in the Russian catch in 2002 is then estimated by applying the theoretical selectivity curve to the survey length frequency in 2002.

To determine the age composition in Russian catches in 2002, the combined age length key for all years of Russian catches was used.

4.2.5.2 Discards age composition

The haddock catch is underestimated as a result of unaccounted for discarding of small individuals in the Scottish and Irish fisheries in most years. On Russian vessels, the whole catch of haddock is kept onboard and therefore, total catch is equivalent to landings.

Haddock discards onboard Scottish vessels in 1999 and 2001 and Irish vessels in 1995, 1997, 1998, 2000 and 2001 were determined directly. In other years, indirect estimates of discarding were calculated.

The direct estimates from the Scottish trawlers in 1985, 1999 and 2001 showed a higher proportion of discards of small haddock: from 12 to 75% by weight (Table 4.2.8) (and up to 80–90% of catch abundance. Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels also reaches considerable values (Table 4.2.9).

Total numbers and weight landed and discarded by age on the Scottish observer trips in 1999 and 2001 are presented in Tables 4.2.10 and 4.2.11.

The analysis of the discard data collected by Scottish scientists in 1999 and 2001 indicated that only a relatively small proportion of fish taken aboard is landed (Figure 4.2.7). The probability of being retained increases with increasing fish length (Stratoudakis *et al.*, 1999; Palsson *et al.*, 2002; Palsson, 2003; Sokolov, 2003). The relationship between the number of individuals caught and number discarded may be described by the following relationship:

$$ND_L = PD_L \times NP_L \qquad (3)$$

where ND_L–number of discarded fish with length L, NP_L–number of fish caught with length L, PD_L–portion of discarded fish with length L.

The length composition of fish taken onboard by Scottish and Irish trawlers was calculated by applying the logistic selectivity curve (Figure 4.2.8) to the haddock stock length composition obtained from the survey. The selectivity parameters were calculated from Scottish and Irish catches taken by trawls with mesh size that are typical for the fleets of those countries operating at Rockall. The parameters were calculated as S_1=12.608, S_2=0.4360 for the Scottish fleet and S_1=26.248, S_2=0.8524 were used for Irish catches.

The catch at length compositions obtained by the theoretical curve of selectivity agree well with available results of catch measurements in 1999 and 2001and the distributions are compared in Figure 4.2.9.

The proportion of fish discarded from catches at different sizes may be determined and modeled using a logistic curve (Figure 4.2.10) described by the following equation:

$$PD_L = \frac{1}{1+\exp(-b(L-DL_{50}))} \qquad (4)$$

where L–size group, DL_{50}–fish length, under which 50% of this size fish caught are discarded and b–a constant, reflecting the angle of curve slope. The parameters were determined from research on discards by Scottish vessels (Table 4.2.12). The following values were used in subsequent calculations: DL_{50}=34.66 cm, b=–0.8764. Logistic curve of discards may be described by Formula (2) using coefficient values: S_1=–15.494, S_2=–0.4565.

To determine abundance of discards the following procedure was used:

a) A theoretical catch at length distribution (%) was calculated by applying the theoretical selectivity curve to the survey length composition.

b) An estimate of total catch at length was made by summing the reported landings by length to the number of discards at length calculated from the assumed discard ogive and the landings at length data.

c) An intermediate theoretical catch size distribution in numbers is calculated by dividing the estimate of the total numbers retained (numbers greater than 34cm) in B by the fraction retained from the theoretical catch length distribution calculated in A.

d) Theoretical discard size frequency is then calculated by applying the theoretical discard ogive to the intermediate theoretical catch size distribution.

The spreadsheet containing these calculations can be found in the stock file.

Calculations where the discard curve was applied agree well with the results of size composition measurements by Scottish vessels in 1999 and 2001 (Figure 4.2.11).

Aboard Irish vessels, larger fish are retained (Figure 4.2.12). The portion of discards was calculated by Formula (2) with coefficients S_1=–10.093, S_2=–0.2459, from the combined 1995–2002 Irish discard trips.

Scottish and Irish vessels fishing for haddock at Rockall became subject to a minimum mesh size of 100 mm between 1987 and 1992. Due to these changes in gear, 1991 was used as the starting year for the assessment as it is considered that by this year the majority of vessels were using the new mesh size and therefore the discard ogive can be assumed to be the same for all years.

The Russian fleet fish in the areas covered only partially by the bottom trawl surveys. However, Russian vessels retain all haddock and therefore there is no need to calculate discards. There is no information on large-scale fisheries of other countries outside the surveyed area. In addition, available data on the real length composition of catches indicate a correspondence between length composition obtained by the results from surveys and commercial catches, including the catches obtained in the parts of Russian fishery (Figures 4.2.6 and 4.2.9).

The amount of discarded haddock by age was determined using a length-age key derived by the data collected during the trawl survey allowing for selectivity of the fishery (Figure 4.2.8).

In 1998 and 2000, the trawl survey for haddock in the Rockall Bank area was not carried out. To determine the haddock length composition in these years, the length distribution was calculated from the survey data in the previous and following years.

For this purpose, the length-age matrices characterizing the stock status in the years before and after the missing data year were obtained. The length-age distribution from the year before the missing year was projected forward on the basis of mean growth increment at age and estimated total mortality. Similarly the distribution from the year after was projected backwards. The length composition in the missing year was then calculated from these two estimates.

The total loss (Z) used in the calculation described above was determined by minimization of values of deviation square sum between survey age group abundance values in previous and following years by the data from surveys and calculated data. At that, the factor of age effect (S_a) was taken into account. The mean growth increment at age was also estimated from the survey data. The method of calculation is explained further in WD8 to WGNSD, 2004 and a spreadsheet showing the calculations is in the stock file.

Figures 4.2.13 and 4.2.14 and Table 4.2.13 show landings, discards and total catch by number and weight. Landings, discards and total catch-at-age by number are shown in Tables 4.2.14–4.2.16.

4.2.5.3 Mean weights-at-age

Mean weights-at-age in total catch, landings, discards and stock are shown in Tables 4.2.17–4.2.20. The mean weights-at-age in the stock are assumed to be the same as the catch weights. The temporal dynamics of haddock mean weights-at-age in the total catch (including discards) and in the stock are shown in Figure 4.2.15.

4.2.6 Natural mortality and maturity-at-age

In the absence of any direct estimates of natural mortality, M has been set at 0.2 for all ages and years. MSVPA estimates for the North Sea haddock stock give estimates of M of 2.05 at age 0, 1.65 at age 1, 0.40 at age 2, 0.25 at ages 2 and 4, and 0.20 at ages 5+ (ICES CM, 2003/ACFM:02). Similarly, large values of M at the younger ages at Rockall would have implications for interpretation of fishing mortality patterns from survey-based methods such as SURBA which essentially estimate total mortality conditional upon assumptions regarding survey catchability at age.

Natural mortality coefficient and portion of mature individuals by age used for estimation correspond to those adopted by Working Group before. At present there are no estimates of haddock natural mortality on the Rockall Bank, therefore, M was taken as 0.2 for all ages.

Previous Working Groups have adopted a maturity ogive with knife-edge maturity-at-age 3 in assessments of this stock (see the table below).

AGE	1	2	3	4	5	6	7+
PROPORTION MATURE	0	0	1	1	1	1	1

ACFM in 2001 encouraged the WG to investigate a more realistic maturity ogive for this stock. At the 2002 Working Group combined sex maturity ogives were presented to the WG for Russian sampling in 2000–2001 and Scottish sampling in 2002. In 2003 new sex disaggregated maturity data were supplied to the Working Group for Russian sampling. The results of all these recent studies indicate that a high proportion of both females and males at age 2 were mature.

The data from new Russian histological examination of haddock gonad samples mass sexual maturation occurs at age of two years with length of 25 cm (WGNSDS WD6, 2006). These data agree well with the results of recent Scottish research in compliance with which the majority of fish become mature at the age of 2 years (ICES 2003; Newton *et al.*, 2004). Visual estimation of maturity stage of post-spawning haddock on the Rockall Bank in expeditions leads to considerable errors. For more precise estimation of length and age at maturity for haddock it is necessary to conduct investigations in pre-spawning and spawning periods as well as to collect gonads for further histological analysis (see WGNSDS WD6, 2006 for further details).

Research on determining more precise values for natural mortality and maturity ogive parameters should be continued and new estimates could be used in future stock assessments.

4.2.7 Catch-at-age analysis

4.2.7.1 Data screening and exploratory runs

Data on catches by age

Before 2005, the calculation of catch-at-age data assumed that catches were equal to landings.

The landings of haddock aged 1 were not large and it was hard to consider the catch of this age fish. The results from Scottish and Irish investigations showed that the abundance in discards exceeded that of landings. Discarded fish are, primarily, haddock aged 1–2 (Tables 4.2.10–4.2.11). Figures of log catch-by-age show that these values are much less variable when discards are included (Figures 4.2.16–4.2.21). Data on catches, landings and discards by age are given in Tables 4.2.14–4.2.16.

Tuning data

The Scottish trawl survey was the only survey index available to the working group. Plots of log cpue by age, year and year class are shown in Figures 4.2.22–4.2.24.

A SURBA 3.0 run was carried out to analyse the survey data. Previous working groups have concluded that the first three years of the survey should not be used in assessments and that age 0 data were a poor indicator of year class strength. Here, the runs were actually conducted using the survey data from 1991 onwards to be consistent with the period over which the catch-at-age assessment could be run (the settings: lambda=1.0, reference age=3). A summary of the results and residuals is shown in Figure 4.2.25. SSB shows a declining trend since 1995 but increasing in 2003–2004. The estimates of the temporal component of F are very noisy, but indicates a steep decline since 2000. Retrospective analysis showed consistent estimation of SSB and F (2-5) (Figure 4.2.26a).

Comparative scatterplots of log index at age are shown in Figure 4.2.26b. The survey shows relatively good internal consistency in tracking year class strength through time.

Exploratory assessment runs

The following settings (the same as those explored in WGNSDS, 2006) were adopted for the present exploratory XSA runs:

1) Full year-range of tuning data (1991–2006); catchability independent of age for age classes 1 and over; q-plateau at age 5; shrinkage over last 3–5 years and 3 oldest age classes; shrinkage SE=0.5–2.0.

2) Full year-range of tuning data (1991–2006); catchability dependent on stock size for age classes younger 4; q-plateau at age 5; shrinkage over last 4 years and 3 oldest age classes; shrinkage SE=0.5–1.0.

Log catchability residuals obtained in three runs of the constant-catchability model for all ages (with shrinkage SE: 0.5, 1.0 and 2.0) showed a period of reduced catchability from 1997 to 2002 and an increase in 2003 (see WGNSDS, 2006 and the stock files for this assessment).

The use of the power model at ages 1–3 resulted in significant slopes less than 1.0 at ages 2 and 3 in the plots of adjusted survey cpue against XSA population estimates. The use of the power model at ages 1–3 and shrinkage of 1.0 (adjusted survey cpue against XSA population estimates are shown in Figure 4.2.27) reduced the size of the residuals although the pattern of reduced values from 1997 to 2002 persisted (Figure 4.2.28). Stronger shrinkage (0.5) using the power model increased the magnitude of the residuals (see WGNSDS, 2006 and the stock files for this assessment) and was rejected.

A comparison of the temporal trends in the survey indices at age with the trends in XSA population numbers-at-age, obtained with the power model at ages 1–3, is given in Figure 4.2.29. These plots show relatively low survey indices at ages 2–4 from around 1997 to the early 2000s compared with the XSA trends. This is the source of the low catchability values evident from the XSA runs. The reasons for this difference in trends are not clear.

The XSA run using the power model at ages 1–3 and shrinkage SE of 1.0 was accepted as the final assessment model (the same option was used in the 2006 assessment with a similar fit).

4.2.7.2 Final run XSA

Settings for the final XSA assessment are shown in the text table below. There were no changes in settings compared to the 2005 and 2006 assessments.

Assessment year	2005	2006	2007
Assessment model	XSA	XSA	XSA
Fleets			
SCOGFS	1991–2004 1–6	1991–2005 1–6	1991–2006 1–6
Time-series weights	none	none	none
Model	power	power	power
Catchability dependent for ages <	4	4	4
Regression type	C	C	C
Q plateau	5	5	5
Shk se	1.0	1.0	1.0
Shk age-yr	4 yrs 3 ages	4 yrs 3 ages	4 yrs 3 ages
Min se	0.3	0.3	0.3
Plus group	7	7	7
Fbar	2–5	2–5	2–5

The diagnostics file of the final XSA run is given in Table 4.2.21. The analysis of residuals and retrospective analysis (Figures 4.2.28 and 4.2.30) shows that applying the chosen parameters for XSA improves the residual and retrospective patterns. However, there are still some trends apparent in the log catchability residuals. The results of retrospective analysis conducted at the Working Group in 2002 and 2003 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. In this year's analysis, only 14 years data were available, but a good year-to-year consistency was obtained. Dynamics of fishing mortality-at-age are presented in Figure 4.2.31. Data show a peak in fishing mortality and effort for 2000 and 2004. The final XSA results are given in Tables 4.2.22–4.2.24. The final XSA and SURBA results are compared in Figure 4.2.32. The SURBA estimates are more variable, but there is a good overall consistency between estimates by the two methods.

Summary plots from the final XSA assessment are shown in Figure 4.2.33.

4.2.7.3 Estimation of recruit abundance

Individuals aged 1 were considered as recruits. The geometric mean for 1991–2004 derived from XSA was used to estimate recruit abundance at age 1 in 2007 (Table 4.2.23). The abundance of the 2005 year class of haddock was above the long-term mean and provisional results from the Scottish Autumn trawl survey showed abundance of the 2006 year class to be among the lowest during the whole survey period (Table 4.2.7).

4.2.7.4 Long-term trends

Recruitment in the early 1990s was high and resulted in an increase in SSB which peaked in 1995. Recruitment in the mid 1990s was around average but the 1998 and 1999 year classes were weak. A combination of these weak year classes and high fishing mortality resulted in SSB decreasing to the lowest in the time-series in 2001. In 2003 and 2004 SSB increased somewhat due to the 2000 and 2001 year classes which were slightly above average.

4.2.7.5 Short-term forecast

For forecasting recruitment (age 1), a geometric mean was used for 1991–2004.

The input data for the short-term forecast can be found in Table 4.2.25. *Status quo* fishing mortality is taken as the 3 year mean of the values over the period 2004–2006. Three year mean values were also used for stock weights and catch weights. The results obtained from the forecast are given in Tables 4.2.26 and 4.2.27.

The TAC for EU vessels in Divisions VIb, XII and XIV, which had a high proportion of discards, was increased from 597 t in 2006 to 4 615 t in 2007. For forecasting discards, the proportion of discards/landings at age in 1991–2006 was used (Tables 4.2.14–4.2.16 and 4.2.28). In recent years, the proportion of the total catch of haddock taken by vessels of nations which discard haddock has declined markedly. This has led to an overall reduction in the proportion of the total catch discarded. The results obtained from the forecast (including discards) are given in Tables 4.2.26 and 4.2.28. Short-term forecast is also shown in Figure 4.2.34.

The sensitivity analysis of forecast is shown in Figures 4.2.35–4.2.36. There is a small probability of SSB in 2009 being below Bpa and Fsq.

4.2.7.6 Yield-per-recruit

The stock-recruitment scatter plot is shown in Figure 4.2.37. Yield-per-recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Figure 4.2.38. *Status quo* F (0.34) is approximately 15% less than F_{max} (0.40) and nearly twice as great as $F_{0.1}$ (0.19).

4.2.7.7 Reference Points

Biological reference points for this stock are given below:

B_{lim}: 6,000 t (lowest observed SSB)

B_{pa}: 9,000 t ($B_{loss} \times 1.4$)

F_{pa}: 0.4 (by analogy with other haddock stocks).

Figure 4.2.39 shows the stock in 2006 to be above B_{pa} and below F_{pa}.

4.2.7.8 Quality of the Assessment

The WG considers that the long-term trends in the XSA assessment and survey biomass estimates/indices are probably indicative of the general stock trends. However, F is considered to be poorly estimated due to the following sources of uncertainty in the current assessment:

1) There are concerns over the accuracy of landings statistics from Rockall in earlier years.

2) Historically, there is poor agreement between survey and XSA estimates of population numbers during some periods. This may be related to potential inaccuracies in the landings statistics.

3) The method of estimating discards from survey data, although useful, is nonetheless another source of error.

4) In 1999 the gear and tow duration were changed on the Scottish survey. There were no calibrations done to assess possible impacts on catchability for this survey.

5) The XSA assessment shows trends in catchability, even if reduced by weak shrinkage.

6) The XSA assessment diagnostics give quite large standard errors on survivors estimates (0.3–0.4) and there are often quite different values given by ScoGFS, F-shrinkage and P-shrinkage.

The WG considers that a longer series of more accurate landings, discards (for non-Russian fleets) and survey data will be necessary to overcome these deficiencies.

There are concerns about the ability to forecast future catches and landings given substantial changes in national composition of the fleets operating at Rockall. The forecast presented predicts future catch, but this is not disaggregated into landings and discards components. A substantial change in TAC may lead to big changes in discarding practices. No attempts have been made in assessment to partition catches to landings and discards because of the uncertainty in the fleet composition. In conclusion, the forecast for haddock in VIb is considered highly uncertain and predicts only total removals from the fishing and not landings. This should be taken into consideration when determining future management advice for this stock.

4.2.7.9 Management Considerations

Historical perspectives of fishing mortality indicate that they have been high. The fishing mortality has decreased for small individuals (age 1 and 2) since 2001. Survey-based indices of SSB indicate that the stock was at a historical low in 2002, but have increased since.

In 2004, an ICES Expert Group met to deal with a request for advice from the EU and Russia concerning Rockall haddock management plans. They concluded that the lack of alternative assessment approaches precluded the identification of potential alternative limits to exploitation that may be useful to long-term management. In addressing this term of reference the Expert Group considered alternative approaches to management.

The Expert Group acknowledged that the Precautionary Approach requires that management be implemented in data poor situations. The Expert Group considered that the principles of the Precautionary Approach may have application to Rockall haddock provided the implementation considers the particular biology of the target species and the way it is exploited. For Rockall haddock the Expert Group considered that the fishing mortality should not be allowed to expand. Adoption of a TAC may actually allow increased fishing mortality if the stock is declining or there is significant unreported catch. Moreover, application of TACs implies that there is a simple relationship between a recorded landing of a species and the effort exerted on that species. Such an assumption is unlikely to be true for Rockall haddock. Furthermore, there are ways of evading TACs including misreporting, high grading and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. The Expert Group concluded that effort regulation rather than TACs may be a better means of controlling fishing mortality on Rockall haddock in the long-term but that TAC regulation could be used in the future if more objective and accurate biological and fishery information are routinely provided (ICES CM 2004/ACFM:33). In circumstances where population is dominated by small individuals and differences in length of older and younger age groups are not great, the effectiveness of using selective properties of trawl gear is very low. Comparison of the discard practices of the national fleets operating at Rockall indicate that an increase of minimum mesh size (as was the case in 1991) does not result in considerable reduction of the proportion of small individuals in catches (see Table 4.2.8), however catch rates are decreased.

In 2004–2007, the analytical methods of stock estimation were improved, the new data on biology and distribution were obtained, a trawl acoustic survey was carried out and the biomass of haddock from the Rockall Bank was estimated. The results from these investigations allow us to draw the following conclusions:

1) Due to the appearance of above-average year classes in 2000–2001, the haddock stock has increased. This is corroborated by Russian fishery statistics, biological research data, analytical calculations and Trawl Acoustic Survey in March 2005.

2) According to provisional survey data the 2005 year class is also a strong one that gives grounds to expect the fishable stock growth in the near future.

3) It would be beneficial to conduct the ground fish/trawl-acoustic survey annually.

4) Discarding and the use of small-mesh gear have historically resulted in significant mortality of small haddock.

5) It would be beneficial to develop and introduce into fisheries practice measures aimed at preventing discards of undersized haddock.

6) The forecast predicts future catch that is not disaggregated into landings and discards and is therefore highly uncertain. This should be taken into consideration in future management of this stock.

7) General management issues aimed at maintaining a healthy stock of Rockall haddock, such as decrease in landing size, changes in mesh size, use of square mesh and headline panels, licenses to fishing and closed areas, should be discussed between EU and the Russian Federation.

Table 4.2.1. Nominal catch (tonnes) of HADDOCK in Division VIb, 1989–2005, as officially reported to ICES.

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006[1]
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	n/a	n/a					2
France	…[2]	…[2]	…[2]	…[2]	…[2]	…[2]	…[2]	-	-	-[*]		5	2[*]	+	1			
Germany, Fed. Rep.	1	-	-	-	-	-	-	-	-	-	-	-	-					
Iceland	-	-	-	-	-	-	-	-	+	-	167	-	-	-				
Ireland	-	620	640	571	692	956	677	747	895	704	1 021	824	357	206	169	19[5]	105	41
Norway	47	38	69	47	68	75	29	24	24	40	61	152[*]	70[*]	49	60	32	33	123
Portugal	-	-	-	-	-	-	-	-	-	4	-	-	-					
Russian Federation	-	-	-	-	-	-	-	-	-	-	458	2 154	630	1 630	4 237	5 844	4 708	2 154
Spain	337	178	187	51	-	-	28	1	22	21	25	47	51	7	19			
UK (E, W & NI)	272	238	165	74	308	169	318	293	165	561	288	36	-	-	56			
UK (Scotland)	5 986	7 139	4 792	3 777	3 045	2,535	4 439	5,753	4 114	3 768	3 970	2 470	1 205	1 145[3]	1 606	411[3]	332[3]	440[3]
United Kingdom																		
Total	6 643	8 213	5 853	4 520	4 113	3,735	5 491	6 818	5 220	5 098	5 990	5 688	2 315	3 037	6 148	6 306	5 178	2 760
Unallocated catch	85	-4 329	-198	800	671	1,998	-379	-543	-591	-599	-851	-357	-279	299	94	139	1	290
WG estimate	6 728	3 884	5 655	5 320	4 784	5,733	5 112	6 275	4 629	4 499	5 139	5 331[4]	2 036[4]	3 336[4]	6 242[4]	6 445	5 179	3 050

[1]Preliminary.

2Included in Division VIa.

3Includes UK England, Wales and NI landings

4includes the total Russian catch

5 nonofficial

n/a = not available.

Table 4.2.2. Details of Russian fleet operations in fishery for the haddock on the Rockall Bank (Div. VIb) in 2005 (preliminary data).

Month	Tonnage Class	Haddock catch, t		
		Total	Per fishing day	Catch per trawling hour
March	9[1]	23	7.7	0.68
April	10[2]	205	8.2	0.76
	9[1]	592	7.8	0.58
May	10[2]	502	8.7	0.63
	9[1]	97	16.2	0.91
June	10[2]	464	10.5	0.82
August	10[2]	132	4.4	0.25
	9[1]	16	1.6	0.1
September	10[2]	92	7.1	0.39
	9[1]	31	3.4	0.23
Total		**2 154**		

[1]54m, 1000hp
[2]62m, 2400hp

Table 4.2.3. Species composition of Russian catch (t) taken with bottom trawls on the Rockall Bank (Div. VIb) in 2005 (preliminary data).

Fish species	March	April	May	June	July	August	September	October	November	December	Total
Haddock	23	797	599	464	-	148	123	-	-	-	**2 154**
Gray gurnard	-	10	6	2	-	109	11	-	-	-	**138**
Blue whiting	2	217	446	259	-	267	158	-	-	-	**1 349**
Saithe	-	<1	1	-	-	4	2	-	-	-	**7**
Blue ling	-	1	1	-	-	-	-	-	-	-	**2**
Ling	-	2	1	-	-	-	-	-	-	-	**3**
Redfish	-	11	10	2	-	3	22	-	-	-	**48**
Others	-	1	-	-	-	4	-	-	-	-	**5**
Total	**25**	**1 040**	**1 064**	**727**	**-**	**535**	**315**	**-**	**-**	**-**	**3 706**

Table 4.2.4. Details of UK fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2006 (preliminary data).

MONTH	COUNTRY	GEAR TYPE	CATCH IN TONNES	
			TOTAL	CATCH PER VESSEL/DAY
February	England and Wales	OTB	0.4	0.2
March	England and Wales	OTB	0.8	0.4
	Scotland	OTB	8.1	1.2
April	Scotland	OTB	27.0	2.5
	Scotland	PTB	2.3	1.1
May	Scotland	OTB	140.6	8.8
	Scotland	OTT	10.1	3.4
	Scotland	PTB	78.9	13.2
June	Scotland	OTB	82.6	6.4
	Scotland	OTT	7.3	3.6
	Scotland	PTB	36.5	18.2
July	Scotland	OTB	40.2	4.5
August	Scotland	OTB	4.1	4.1
December	England and Wales	OTB	0.0	0.0
Total			**439**	

OTB–bottom otter trawl, PTB–bottom pair trawl, OTT–otter twin trawl.

Table 4.2.5. Details of Irish fleet operations in fishery for the haddock on the Rockall Bank (Division VIb) in 2006 (preliminary data).

TIME INTERVAL	GEAR TYPE	CATCH IN TONNES
1 Quarter	OTB	0.6
2 Quarter	OTB	18.8
3 Quarter	OTB	11.3
4 Quarter	OTB	9.9
Total		**40.6**

OTB – bottom otter trawl

Table 4.2.6. Details of Scottish and Irish effort in 1985–2006 (preliminary data).

YEAR	SCOTTISH FLEET			IRISH FLEET
	SCOTRL*	SCOLTR*	SCOSEI*	IROTB*
1985	8 421	3 081	1 677	
1986	7 465	4 783	507	
1987	8 786	9 737	402	
1988	12 450	5 521	261	
1989	10 161	11 946	1 411	
1990	3 249	5 335	4 552	
1991	2 995	11 464	6 733	
1992	2 402	9 623	3 948	
1993	1 632	11 540	1 756	
1994	2 305	15 543	399	
1995	1 789	13 517	1 383	9 142
1996	1 627	17 324	952	7 219
1997	5 63	16 096	1 061	7 169
1998	1 332	12 263	456	7 461
1999	11 336	9 424	456	8 680
2000	12 951	8 586	80	9 883
2001	7 838	1 037	42	7 244
2002	8 304	1 100	0	2 626
2003	15 000	500	50	4 618
2004	15 200	300	50	2 070
2005	7 788	32	0	2 693
2006	9 990	231	0	5 903

SCOTRL*–Scottish Light Trawl, SCOLTR*–Scottish Heavy Trawl, SCOSEI*–Scottish Seine, IROTB*–Irish bottom otter trawl

Table 4.2.7. Haddock in VIb. Tuning data avaiable for Scottish groundfish survey in September.

HADDOCK WGNSDS 2007 ROCKALL
101
SCOGFS (Numbers per 10 hours fishing at Rockall)
1991 2006
1 1 0.66 0.75
0 6

1	14 458	16 398	4 431	683	315	228	37	64	3
1	20 336	44 912	14 631	6 135	647	127	200	4	32
1	15 220	37 959	15 689	3 716	1 104	183	38	73	21
1	23 474	13 287	11 399	4 314	696	203	30	12	4
1	16 293	16 971	6 648	5 993	1 935	483	200	1	6
1	33 578	19 420	5 903	1 940	1 317	325	69	6	1
1	28 897	10 693	2 384	538	292	281	71	9	1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	10 178	9 969	2 410	708	279	172	90	64	32
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	31 813	7 455	521	284	154	39	14	12	14
1	11 704	20 925	2 464	173	105	65	20	10	15
1	2 526	10 114	10 927	1 656	138	97	100	26	6
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	24 452	4 082	920	1 506	2 107	231	33	13	7
1	3 570	18 715	2 562	256	1 402	1 694	349	16	6

Table 4.2.8. Details of Scottish discard trips in the Rockall area (Newton *et al*., 2003).

TRIP NO.	DATE	GEAR	NO. OF HAULS	HOURS FISHED	% (BY WEIGHT) HADDOCK LANDED OF CATCH	% (BY WEIGHT) DISCARDED OF HADDOCK
1	May 85	Heavy Trawl	20	89.08	74	17.3
2	Jun 85	Heavy Trawl	28	127.17	74	18.6
3	Jun 99	Heavy Trawl	21	110.83	41	74.9
4	Apr 01	Heavy Trawl	11	47.33	96	12.4
5	Jun 01	Heavy Trawl	35	163.58	58	47.5
6	Aug 01	Heavy Trawl	26	130.08	31	69.7

Table 4.2.9. Landings and Discards haddock estimates at Rockall from discard observer trips conducted aboard Irish vessels between 1995 and 2001, and from an observer trip aboard the MFV (February–March 2000). (ICES CM 2004/ACFM:33).

	FAT/ KBG/ 00/4	FAT/ KBG/ 01/12	FAT/ KBG/ 95/1	FAT/ KBG/ 95/2	FAT/ KBG/ 97/7	FAT/ KBG/ 97/8	FAT/ KBG/ 98/4	FEB 2000	DISCARD RATE
Landing	3021	942	12727	6893	14258	25866	23805	4400	
Discards	1864	926	1146	1893	6625	17926	3687	6200	
% discarded	38.16	49.57	8.26	21.54	31.72	40.90	13.40	58.49	27%

Table 4.2.10. Scottish landings and raised discards of haddock in 1999 estimates at Rockall from discard observer trips conducted on Scottish vessels.

	AGE													
	0	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
Landing, N (*1000)	0	0	436.9	1 211.9	1 069.5	849.4	1 220.6	1 432.3	411.9	87.7	0.4	0	1.4	**6 722**
Landing, tonnes	0	0	135.8	432.5	420.7	383.9	646	760.7	245.5	49.6	0.5	0	4.3	**3 079.5**
Discards, N (*1000)[1]	22.4	14 420.8	15 276.9	6 844.7	2 534.8	1 516	734.3	219.4	39.6	0	0	0	0	**41 609.1**
Discards, tonnes[1]	1.5	2 284.1	3 658.2	1 936.2	799.1	515.4	248.8	86.2	17.6	0	0	0	0	**9 547.2**
Discards, N (*1000)[2]	12.5	13 306.1	15 895.9	7 168.1	2 588.9	1 555.7	772.5	247.9	48.6	12.2	0.7	0	0	**41 609.2**
Discards, tonnes[2]	0.3	2 241.2	3 791.3	2 035.1	821.7	538.7	268	103.8	22.7	6.3	0.5	0	0	**9 829.6**

[1] raised estimates from discard observer trips at Rockall

[2] estimates obtained from a logistic discard curve for 1999

Table 4.2.11. Scottish landings and raised discards of haddock in 2001 estimates at Rockall from discard observer trips conducted aboard Scottish.

	AGE													
	0	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
Landing, N (*1000)	0	0	326.5	489.1	132.9	774.3	326	223.9	113.5	22.4	3.8	0	0	**2 412.3**
Landing, tonnes	0	0	128.6	157	82.4	262.4	125.2	90.2	59.3	19.9	3	0	0	**928**
Discards, N (*1000)[1]	3.1	6 309.9	549.7	228.4	66.3	8.1	1	0.1	0.1	0.1	0	0	0	**7 166.8**
Discards, tonnes[1]	0.2	967.4	126.8	58.7	17.8	2.4	0.3	0.1	0	0	0	0	0	**1 173.8**
Discards, N (*1000)[2]	531	5 987.3	436.2	162.6	46.9	2.9	0.5	0.1	0	0	0	0	0	**7 167.6**
Discards, tonnes[2]	14.3	936.2	93	38.6	11.6	0.9	0.2	0.1	0	0	0	0	0	**1 094.9**

[1] raised estimates from discard observer trips at Rockall

[2] estimates from a logistic discard curve for 2001

Table 4.2.12. Values of DL_{50} by Scottish discard trips in the Rockall area.

YEAR	DL_{50}	B
1999	36.62	–0.5923
2001	31.20	–0.8238
Theoretical:	34.66	–1.2328

Table 4.2.13. Haddock in VIb International landings, discards and total catch.

Year	Num (*1000)			Weight, tonnes		
	Landings	Discards	Total Catch[1]	Landings	Discards	Total Catch[1]
1991	12 302	65 832	78 134	5 656	13 228	18 884
1992	11 418	55 964	67 383	5 321	11 871	17 192
1993	8 767	44 656	53 423	4 781	9 853	14 634
1994	11 400	46 628	58 028	5 732	11 023	16 755
1995	11 784	35 467	47 251	5 587	9 168	14 756
1996	14 066	41 506	55 572	7 072	9 356	16 428
1997	9 965	26 980	36 945	5 167	5 894	11 061
1998	9 034	47 831	56 865	4 986	10 862	15 848
1999	12 930	52 881	65 811	5 356	11 062	16 418
2000	15 999	26 033	42 031	5 444	6 609	12 053
2001	5 361	9 222	14 583	2 123	1 535	3 658
2002	11 167	21 899	33 066	3 117	4 152	7 270
2003	24 409	25 087	49 496	5 969	5 521	11 490
2004	22 705	3 989	2 6694	6 437	883	7 321
2005	19 505	1 877	21 382	5 191	505	5 696
2006	9 605	1 667	11 272	2 756	386	3 142

[1] **Landings and discards.**

Table 4.2.14. Haddock in VIb. International catch (landings and discards) numbers ($*10^3$) at age.

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 15/05/2006 16:55

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1991	1992	1993	1994	1995
	AGE					
	1	21186	16084	11178	8170	2749
	2	33847	24711	19375	20623	9831
	3	15189	18584	15494	17868	21584
	4	5341	5361	4938	8209	9756
	5	1704	1761	1617	2449	2464
	6	346	676	461	476	787
	+gp	522	206	359	232	79
0	TOTALNUM	78134	67383	53423	58028	47251

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	AGE											
	1	12096	9957	14224	17282	8222	7667	13363	6576	932	1061	2880
	2	18811	10535	19807	21949	12581	1961	11119	23606	4112	3723	1475
	3	10911	5388	10173	12203	10697	1815	4536	14559	10282	7420	1626
	4	9612	4098	4763	5499	4917	1018	2445	2063	9212	8124	2414
	5	3299	5002	3740	3419	2050	1038	898	1285	1386	753	2291
	6	751	1758	2767	2684	1498	484	260	925	296	109	436
	+gp	92	206	1391	2776	2066	601	444	483	474	193	151
0	TOTALNUM	55572	36945	56865	65811	42031	14583	33066	49496	26694	21382	11273

1

Table 4.2.15. Haddock in VIb. International landings numbers (*10^3) at age.

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 15/05/2006 16:55

Catch numbers at age Numbers*10**-3

	YEAR	1991	1992	1993	1994	1995
	AGE					
	1	87	86	28	30	1
	2	6807	3642	1919	1160	146
	3	3011	5624	4740	5299	5205
	4	1344	964	1157	3665	4791
	5	558	580	489	1040	1319
	6	32	364	144	66	279
	+gp	464	160	290	141	43
0	TOTALNU	12302	11418	8767	11400	11784

Catch numbers at age Numbers*10**-3

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	AGE											
	1	2	0	4	245	33	399	657	920	197	887	2344
	2	5149	319	392	2600	3445	941	2983	8103	1765	2835	768
	3	1861	2102	1815	2994	5081	1232	3998	11001	9502	6866	1290
	4	4149	2155	1340	1972	3006	752	2111	1846	9119	7913	2356
	5	2347	3658	1898	1228	1295	988	809	1188	1364	725	2269
	6	473	1540	2284	1600	1176	470	217	878	286	98	428
	+gp	85	192	1301	2291	1963	579	392	475	472	182	150
0	TOTALNU	14066	9965	9034	12930	15999	5361	11167	24409	22705	19505	9605

Table 4.2.16. Haddock in VIb. International discards numbers (*10^3) at age.

1

Run title : HADDOCK DISC 2007 ROCKALL

At 15/05/2006 16:55

Catch numbers at age Numbers*10**-3

	YEAR	1991	1992	1993	1994	**1995***
	AGE					
	1	21099	15998	11151	8140	**2748**
	2	27040	21069	17456	19464	**9685**
	3	12178	12961	10755	12570	**16379**
	4	3998	4397	3781	4545	**4965**
	5	1146	1181	1128	1409	**1145**
	6	313	312	317	410	**508**
	+gp	58	46	69	91	**36**
0	TOTALNU	65832	55964	44656	46628	**35467**

Catch numbers at age Numbers*10**-3

	YEAR	1996	**1997***	1998	**1999***	2000	**2001***	2002	2003	2004	2005	2006
	AGE											
	1	12094	**9957**	14220	**17037**	8189	**7268**	12706	5655	735	174	536
	2	13662	**10216**	19415	**19348**	9136	**1019**	8136	15503	2346	888	707
	3	9051	**3286**	8357	**9209**	5616	**583**	539	3558	781	554	336
	4	5463	**1944**	3423	**3526**	1912	**266**	334	217	93	210	58
	5	952	**1344**	1842	**2191**	755	**50**	89	97	22	28	22
	6	278	**218**	483	**1084**	322	**15**	43	48	10	11	8
	+gp	7	**15**	91	**485**	103	**21**	51	8	2	11	1
0	TOTALNU	41506	**26980**	47831	**52881**	26033	**9222**	21899	25087	3989	1877	1667

*** data calculated with use estimates at Rockall from discard observer trips**

Table 4.2.17. Haddock in VIb. International catch (landings and discards) weights-at-age (kg).

	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.235	0.311	0.459	0.600	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787

Table 4.2.18. Haddock in VIb. International landings weights-at-age (kg).

	1	2	3	4	5	6	7
1991	0.302	0.402	0.444	0.592	0.724	0.963	0.704
1992	0.136	0.366	0.455	0.658	0.612	0.759	0.954
1993	0.305	0.402	0.503	0.701	0.830	0.820	0.972
1994	0.314	0.356	0.452	0.558	0.638	1.224	0.890
1995	0.377	0.311	0.414	0.479	0.640	0.699	1.236
1996	0.327	0.436	0.501	0.487	0.627	0.709	0.783
1997	0.000	0.315	0.401	0.444	0.564	0.661	0.973
1998	0.256	0.344	0.494	0.517	0.542	0.591	0.678
1999	0.274	0.338	0.390	0.440	0.505	0.601	0.665
2000	0.272	0.404	0.379	0.407	0.473	0.513	0.740
2001	0.274	0.426	0.383	0.518	0.426	0.518	0.677
2002	0.240	0.422	0.416	0.541	0.565	0.649	0.818
2003	0.100	0.164	0.246	0.351	0.388	0.423	0.758
2004	0.142	0.172	0.241	0.293	0.446	0.617	0.754
2005	0.103	0.184	0.230	0.310	0.461	0.614	0.824
2006	0.084	0.167	0.223	0.327	0.440	0.598	0.789

Table 4.2.19. Haddock in VIb. International discards weights-at-age (kg).

	1	2	3	4	5	6	7
1991	0.142	0.199	0.253	0.306	0.345	0.358	0.478
1992	0.133	0.217	0.258	0.298	0.330	0.342	0.464
1993	0.137	0.220	0.260	0.307	0.346	0.359	0.462
1994	0.153	0.226	0.263	0.308	0.345	0.356	0.458
1995	0.118	0.220	0.276	0.325	0.341	0.329	0.379
1996	0.136	0.218	0.276	0.326	0.370	0.348	0.524
1997	0.136	0.238	0.272	0.312	0.372	0.442	0.568
1998	0.141	0.248	0.267	0.291	0.327	0.336	0.436
1999	0.139	0.212	0.255	0.288	0.313	0.318	0.410
2000	0.189	0.267	0.289	0.311	0.330	0.334	0.462
2001	0.135	0.247	0.294	0.344	0.412	0.440	0.495
2002	0.137	0.254	0.308	0.335	0.398	0.338	0.367
2003	0.161	0.223	0.287	0.342	0.337	0.440	0.510
2004	0.148	0.218	0.282	0.343	0.324	0.371	0.469
2005	0.171	0.240	0.298	0.357	0.387	0.473	0.506
2006	0.132	0.233	0.334	0.420	0.495	0.435	0.435

Table 4.2.20. Stock weights-at-age (kg). Haddock VIb.

	1	2	3	4	5	6	7
1991	0.142	0.240	0.291	0.378	0.469	0.414	0.679
1992	0.133	0.239	0.318	0.362	0.423	0.567	0.844
1993	0.137	0.238	0.334	0.400	0.493	0.503	0.874
1994	0.153	0.233	0.319	0.420	0.469	0.477	0.721
1995	0.118	0.222	0.309	0.401	0.501	0.460	0.843
1996	0.136	0.278	0.314	0.395	0.553	0.575	0.763
1997	0.136	0.240	0.322	0.382	0.512	0.634	0.944
1998	0.141	0.250	0.308	0.354	0.436	0.546	0.662
1999	0.138	0.208	0.272	0.334	0.379	0.483	0.618
2000	0.189	0.250	0.267	0.321	0.382	0.451	0.707
2001	0.133	0.257	0.320	0.416	0.432	0.521	0.713
2002	0.135	0.239	0.237	0.325	0.509	0.580	0.753
2003	0.153	0.203	0.256	0.350	0.384	0.424	0.753
2004	0.147	0.198	0.244	0.294	0.444	0.609	0.753
2005	0.114	0.197	0.235	0.311	0.459	0.600	0.806
2006	0.093	0.198	0.245	0.329	0.441	0.595	0.787

Table 4.2.21. XSA diagnostics in assessment of Haddock in VIb.

Lowestoft VPA Version 3.1

14/05/2007 0:44

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 16 years. 1991 to 2006. Ages 1 to 7.

Fleet	Firs year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2006	0	6	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 10 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 4 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 27 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.166	0.243	0.492	0.385	0.112	0.134	0.152	0.045	0.037	0.047
2	0.341	0.579	0.732	0.834	0.147	0.235	0.37	0.134	0.258	0.066
3	0.312	0.653	0.891	1.027	0.261	0.595	0.551	0.272	0.38	0.17
4	0.339	0.503	0.936	1.229	0.234	0.673	0.6	0.84	0.359	0.203
5	0.586	0.598	0.852	1.222	0.976	0.334	0.957	1.125	0.141	0.161
6	0.91	0.774	1.265	1.27	1.174	0.706	0.69	0.602	0.223	0.113

Table 4.2.21 cont.

1
XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
1997	7.19E+04	4.03E+04	2.22E+04	1.57E+04	1.25E+04	3.25E+03
1998	7.28E+04	4.98E+04	2.35E+04	1.33E+04	9.18E+03	5.68E+03
1999	4.91E+04	4.67E+04	2.29E+04	1.00E+04	6.59E+03	4.13E+03
2000	2.84E+04	2.46E+04	1.84E+04	7.68E+03	3.21E+03	2.30E+03
2001	8.01E+04	1.58E+04	8.75E+03	5.40E+03	1.84E+03	7.75E+02
2002	1.18E+05	5.87E+04	1.12E+04	5.52E+03	3.50E+03	5.68E+02
2003	5.16E+04	8.44E+04	3.80E+04	5.05E+03	2.30E+03	2.05E+03
2004	2.32E+04	3.63E+04	4.77E+04	1.79E+04	2.27E+03	7.24E+02
2005	3.25E+04	1.81E+04	2.60E+04	2.98E+04	6.33E+03	6.03E+02
2006	6.92E+04	2.57E+04	1.15E+04	1.45E+04	1.70E+04	4.50E+03

Estimated population abundance at 1st Jan 2007

0.00E+00	5.40E+04	1.97E+04	7.92E+03	9.73E+03	1.19E+04

Taper weighted geometric mean of the VPA populations:

6.37E+04	4.51E+04	2.56E+04	1.21E+04	4.97E+03	1.73E+03

Standard error of the weighted Log(VPA populations) :

0.4999	0.5475	0.5412	0.5394	0.6415	0.7895

1

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995	1996
1	-0.29	0.47	0.18	-0.04	0.21	0.41
2	-0.42	0.4	0.32	-0.06	0.21	0.3
3	-0.27	0.45	0.22	0.06	-0.02	0
4	-0.09	0.69	0.5	0.24	0.91	0.1
5	-0.15	0.24	0.67	-0.4	0.98	0.13
6	0.06	0.21	-0.02	-0.12	0.12	-0.16

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	-0.24	99.99	0.26	99.99	-0.66	-0.23	0.04	99.99	-0.28	0.17
2	-0.16	99.99	-0.14	99.99	-0.2	-0.56	0.01	99.99	0.05	0.22
3	-0.33	99.99	-0.03	99.99	0.29	-0.08	-0.25	99.99	0.03	-0.06
4	-1.04	99.99	-0.21	99.99	-0.68	-0.78	-0.47	99.99	0.31	0.51
5	-0.56	99.99	-0.22	99.99	-0.34	-0.93	0.33	99.99	-0.39	0.63
6	-0.36	99.99	-0.11	99.99	-0.36	-0.03	0.29	99.99	0.07	0.35

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6
Mean Log	-2.567	-2.6823	-2.6823
S.E(Log q)	0.6067	0.5531	0.2213

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.79	0.851	3.45	0.59	13	0.34	-1.34
2	0.59	2.703	5.64	0.8	13	0.31	-2.06
3	0.47	4.492	6.54	0.87	13	0.23	-2.53

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	0.64	2.102	5.03	0.76	13	0.34	-2.57
5	1	-0.005	2.67	0.57	13	0.58	-2.68
6	0.93	0.904	3.02	0.94	13	0.21	-2.69

1

This page was omitted in the draft report and has been added to the final report on Oct. 16, 2007.

```
Terminal year survivor and F summaries :,,,,,,,

Age  1   Catchability dependent on age and year class strength,,,,,,

Year class = 2005,,,,,,,

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SCOGFS              ,64098,          0.355,     0,     0,       1,   0.636,    0.04

  P shrinkage mean  ,45088,          0.55,       ,      ,        ,   0.28 ,    0.056

  F shrinkage mean  ,26950,          1   ,       ,      ,        ,   0.084,    0.092

Weighted prediction :,,,,,,,

Survivors,        Int,      Ext,    N,    Var,     F,,
at end of year,   s.e,      s.e,     ,   Ratio,     ,,
         54018,  0.29,     0.22,    3,   0.774,  0.047,,


1,,,,,,,
Age  2   Catchability dependent on age and year class strength,,,,,,

Year class = 2004,,,,,,,

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SCOGFS              ,20438,        0.253,     0.242,    0.95,   2,   0.766,    0.063

  P shrinkage mean  ,25618,        0.54 ,          ,        ,    ,   0.181,    0.051

  F shrinkage mean  ,4692,         1    ,          ,        ,    ,   0.053,    0.25

Weighted prediction :,,,,,,,

Survivors,        Int,      Ext,    N,    Var,     F,,
at end of year,   s.e,      s.e,     ,   Ratio,     ,,
         19693,  0.22,     0.24,    4,   1.061,  0.066,,


Age  3   Catchability dependent on age and year class strength,,,,,,

Year class = 2003,,,,,,,

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SCOGFS              ,       7751,  0.227,     0.053,    0.24,   2,   0.772,    0.174

  P shrinkage mean  ,      12059,   0.54,          ,        ,    ,   0.177,    0.115

  F shrinkage mean  ,       2570,      1,          ,        ,     ,  0.051,    0.453

Weighted prediction :,,,,,,,

Survivors,        Int,      Ext,    N,    Var,     F,,
at end of year,   s.e,      s.e,     ,   Ratio,     ,,
          7919,  0.21,     0.18,    4,   0.884,    0.17,,
```

Table 4.2.21 cont.

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	10932	0.221	0.13	0.59	3	0.92	0.182
F shrinka	2523	1				0.08	0.624

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
9725	0.22	0.26	4	1.188	0.203

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	14213	0.234	0.189	0.81	4	0.902	0.136
F shrinka	2288	1				0.098	0.645

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
11876	0.23	0.33	5	1.4	0.161

1

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2000

Fleet	I :	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	3388	0.2	0.195	0.97	5	0.944	0.11
F shrinka	2015	1				0.056	0.179

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
3292	0.2	0.18	6	0.902	0.113

1

Table 4.2.22. Haddock in VIb. Fishing mortality-at-age.

Run title : HADDOCK LANDISC 2007 ROCKALL

At 14/05/2007 0:46

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996
AGE						
1	0.2385	0.1763	0.106	0.1403	0.0506	0.2403
2	0.593	0.4842	0.3335	0.2902	0.2502	0.5688
3	0.8904	0.7826	0.6481	0.5905	0.5629	0.4868
4	0.9165	0.965	0.4866	0.892	0.7696	0.5294
5	0.387	0.9272	0.9129	0.4774	0.7506	0.6513
6	0.5697	0.2599	0.6709	0.7686	0.2747	0.5382
+gp	0.5697	0.2599	0.6709	0.7686	0.2747	0.5382
0 FBAR 2	0.6967	0.7897	0.5953	0.5625	0.5833	0.5591

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR
AGE											
1	0.1662	0.2432	0.4923	0.3853	0.1118	0.1339	0.1519	0.0455	0.0367	0.0471	0.0431
2	0.341	0.5786	0.7317	0.8337	0.1472	0.2351	0.3698	0.1339	0.2575	0.0656	0.1523
3	0.312	0.6526	0.8908	1.0273	0.2606	0.5948	0.5513	0.2718	0.3795	0.1704	0.2739
4	0.3393	0.5032	0.9357	1.2287	0.2337	0.673	0.6004	0.8402	0.3587	0.2026	0.4672
5	0.5864	0.5983	0.8519	1.2222	0.976	0.3336	0.9575	1.1247	0.1409	0.1609	0.4755
6	0.9103	0.774	1.265	1.2697	1.1743	0.706	0.6902	0.6017	0.2227	0.1132	0.3125
+gp	0.9103	0.774	1.265	1.2697	1.1743	0.706	0.6902	0.6017	0.2227	0.1132	
0 FBAR 2	0.3947	0.5832	0.8525	1.078	0.4044	0.4591	0.6197	0.5927	0.2842	0.1499	
1											

Table 4.2.23. Haddock in VIb. Stock number (*10^3) at age.

Run title : HADDOCK LANDISC 2007 ROCKALL

At 14/05/2007 0:46

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1991	1992	1993	1994	1995	1996
	AGE						
	1	110327	109990	122866	68975	61573	62582
	2	83624	71159	75498	90479	49079	47924
	3	28477	37840	35901	44282	55418	31288
	4	9836	9571	14165	15373	20087	25842
	5	5868	3220	2986	7129	5158	7618
	6	879	3262	1043	981	3621	1994
	+gp	1313	989	802	472	361	241
0	TOT/	240325	236031	253260	227691	195297	177488

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 91-'
	AGE												
	1	71859	72818	49129	28417	80124	117856	51554	23165	32541	69159	0	66438
	2	40293	49824	46748	24586	15826	58663	84400	36259	18122	25682	54018	50095
	3	22216	23457	22871	18414	8745	11183	37968	47742	25966	11469	19693	27105
	4	15743	13313	10000	7683	5397	5517	5051	17912	29784	14545	7919	11155
	5	12460	9181	6590	3212	1841	3498	2305	2269	6330	17034	9725	4474
	6	3252	5676	4132	2302	775	568	2051	724	603	4502	11876	1745
	+gp	376	2813	4180	3105	941	956	1057	1145	1063	1555	4429	
0	TOT/	166199	177081	143650	87718	113648	198240	184386	129216	114409	143946	107659	
	1												

Table 4.2.24. Haddock in VIb. Summary table.

Run title : HADDOCK LANDISC 2007 ROCKALL

At 14/05/2007 0:46

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RE Age 1	TOTALE	TOTSPE	LANDIN	YIELD/S	FBAR 2-
1991	110327	51749	16013	5655	0.3532	0.6967
1992	109990	51180	19545	5320	0.2722	0.7897
1993	122866	55156	20355	4784	0.235	0.5953
1994	68975	56369	24735	5733	0.2318	0.5625
1995	61573	47894	29733	5587	0.1879	0.5833
1996	62582	47409	25575	7075	0.2766	0.5591
1997	71859	41406	21963	5166	0.2352	0.3947
1998	72818	43625	20902	4984	0.2384	0.5832
1999	49129	33141	16638	5221	0.3138	0.8525
2000	28417	23361	11843	4558	0.3849	1.078
2001	80124	21637	6913	1918	0.2774	0.4044
2002	117856	37204	7273	2571	0.3535	0.4591
2003	51554	39059	14038	5961	0.4246	0.6197
2004	23165	29810	19226	6400	0.3329	0.5927
2005	32541	26777	19489	5191	0.2664	0.2842
2006	69159	30527	19010	2759	0.1451	0.1499
Arith. Mean	70808	39769	18328	4930	0.2831	0.5753
0 Units 1	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Table 4.2.25. Haddock in VIb. Input data for short-term catch forecasts.

MFDP version 1a
Run: 2007
Time and date: 14:09 14,05,2007
Fbar age range: 2-5

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	66438	0.2	0	0	0	0.118	0.0431	0.118
2	54018	0.2	0	0	0	0.198	0.1523	0.198
3	19693	0.2	1	0	0	0.241	0.2739	0.241
4	7919	0.2	1	0	0	0.311	0.4672	0.311
5	9725	0.2	1	0	0	0.448	0.4755	0.448
6	11876	0.2	1	0	0	0.601	0.3125	0.601
7	4429	0.2	1	0	0	0.782	0.3125	0.782

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	66438	0.2	0	0	0	0.118	0.0431	0.118
2	.	0.2	0	0	0	0.198	0.1523	0.198
3	.	0.2	1	0	0	0.241	0.2739	0.241
4	.	0.2	1	0	0	0.311	0.4672	0.311
5	.	0.2	1	0	0	0.448	0.4755	0.448
6	.	0.2	1	0	0	0.601	0.3125	0.601
7	.	0.2	1	0	0	0.782	0.3125	0.782

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	66438	0.2	0	0	0	0.118	0.0431	0.118
2	.	0.2	0	0	0	0.198	0.1523	0.198
3	.	0.2	1	0	0	0.241	0.2739	0.241
4	.	0.2	1	0	0	0.311	0.4672	0.311
5	.	0.2	1	0	0	0.448	0.4755	0.448
6	.	0.2	1	0	0	0.601	0.3125	0.601
7	.	0.2	1	0	0	0.782	0.3125	0.782

Input units are thousands and kg - output in tonnes

Table 4.2.26. Haddock in VIb. Short-term forecasts.

MFDP version 1a
Run: 2007
Had6b2007MFDP Index file 20,07,2005
Time and date: 14:09 14,05,2007
Fbar age range: 2-5

2007				
Biomass	SSB	FMult	FBar	**Catch***
40702	22167	1	0.3422	7646

2008					2009	
Biomass	SSB	FMult	FBar	**Catch***	Biomass	SSB
43554	25398	0	0	0	54478	35869
.	25398	0.1	0.0342	927	53427	34864
.	25398	0.2	0.0684	1826	52409	33891
.	25398	0.3	0.1027	2699	51421	32949
.	25398	0.4	0.1369	3547	50463	32038
.	25398	0.5	0.1711	4370	49535	31154
.	25398	0.6	0.2053	5170	48634	30299
.	25398	0.7	0.2396	5946	47760	29470
.	25398	0.8	0.2738	6700	46912	28667
.	25398	0.9	0.308	7433	46089	27889
.	25398	1	0.3422	8145	45291	27136
.	25398	1.1	0.3764	8837	44516	26405
	25398	1.16	0.4	9242	44062	25978
.	25398	1.2	0.4107	9509	43764	25697
.	25398	1.3	0.4449	10163	43034	25011
.	25398	1.4	0.4791	10798	42324	24345
.	25398	1.5	0.5133	11416	41636	23700
.	25398	1.6	0.5476	12017	40966	23074
.	25398	1.7	0.5818	12601	40316	22468
.	25398	1.8	0.616	13170	39685	21879
.	25398	1.9	0.6502	13723	39071	21308
.	25398	2	0.6845	14261	38475	20754

*** Catch=Landings+Discards**

Input units are thousands and kg - output in tonnes

Table 4.2.27. Haddock in VIb. Detailed short-term forecasts output.

MFDP version 1a
Run: 09
Time and date: 14:15 14,05,2007
Fbar age range: 2-5

Year:	2007	F multiplier	1	Fbar:	0.3422				
Age	F	**Catch*Nos**	**Catch*t**	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0431	2542	300	66438	7840	0	0	0	0
2	0.1523	6934	1373	54018	10696	0	0	0	0
3	0.2739	4296	1035	19693	4746	19693	4746	19693	4746
4	0.4672	2700	840	7919	2463	7919	2463	7919	2463
5	0.4755	3362	1506	9725	4357	9725	4357	9725	4357
6	0.3125	2904	1745	11876	7137	11876	7137	11876	7137
7	0.3125	1083	847	4429	3463	4429	3463	4429	3463
Total		23820	7646	174098	40702	53642	22167	53642	22167

Year:	2008	F multiplier	1.16	Fbar:	0.4				
Age	F	**Catch*Nos**	**Catch*t**	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.05	2939	347	66438	7840	0	0	0	0
2	0.1767	7670	1519	52100	10316	0	0	0	0
3	0.3177	9419	2270	37978	9153	37978	9153	37978	9153
4	0.542	4691	1459	12260	3813	12260	3813	12260	3813
5	0.5516	1576	706	4064	1820	4064	1820	4064	1820
6	0.3625	1372	825	4949	2974	4949	2974	4949	2974
7	0.3625	2708	2118	9767	7638	9767	7638	9767	7638
Total		30374	9242	187556	43554	69018	25398	69018	25398

Year:	2009	F multiplier	1.16	Fbar:	0.4				
Age	F	**Catch*Nos**	**Catch*t**	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.05	2939	347	66438	7840	0	0	0	0
2	0.1767	7617	1508	51742	10245	0	0	0	0
3	0.3177	8866	2137	35748	8615	35748	8615	35748	8615
4	0.542	8659	2693	22630	7038	22630	7038	22630	7038
5	0.5516	2264	1014	5838	2615	5838	2615	5838	2615
6	0.3625	531	319	1916	1152	1916	1152	1916	1152
7	0.3625	2325	1818	8385	6557	8385	6557	8385	6557
Total		33200	9836	192698	44062	74518	25978	74518	25978

*** Catch=Landings+Discards**
Input units are thousands and kg - output in tonnes

Table 4.2.28. Haddock in VIb. Detailed short-term forecasts output (including discards).

Year:	2007	F multiplie	1	Fbar:	0.3422								
Age	F	**CatchNos***	**Catch***	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	WtLand	**Discards Proportion**	**LandingNos**	**Landing (t)**
1	0.0431	2542	300	66438	7840	0	0	0	0	0.1097	**0.866**	**339**	**37**
2	0.1523	6934	1373	54018	10696	0	0	0	0	0.1745	**0.748**	**1750**	**305**
3	0.2739	4296	1035	19693	4746	19693	4746	19693	4746	0.2311	**0.515**	**2084**	**482**
4	0.4672	2700	840	7919	2463	7919	2463	7919	2463	0.31	**0.422**	**1561**	**484**
5	0.4755	3362	1506	9725	4357	9725	4357	9725	4357	0.4492	**0.339**	**2222**	**998**
6	0.3125	2904	1745	11876	7137	11876	7137	11876	7137	0.6098	**0.328**	**1951**	**1190**
7	0.3125	1083	847	4429	3463	4429	3463	4429	3463	0.7892	**0.128**	**944**	**745**
Total		23820	7646	174098	40702	53642	22167	53642	22167			**10852**	**4241**

Year:	2008	F multiplie	1.16	Fbar:	0.4								
Age	F	**CatchNos***	**Catch***	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	WtLand	**Discards Proportion**	**LandingNos**	**Landing (t)**
1	0.05	2939	347	66438	7840	0	0	0	0	0.1097	**0.866**	**392**	**43**
2	0.1767	7670	1519	52100	10316	0	0	0	0	0.1745	**0.748**	**1936**	**338**
3	0.3177	9419	2270	37978	9153	37978	9153	37978	9153	0.2311	**0.515**	**4569**	**1056**
4	0.542	4691	1459	12260	3813	12260	3813	12260	3813	0.31	**0.422**	**2712**	**841**
5	0.5516	1576	706	4064	1820	4064	1820	4064	1820	0.4492	**0.339**	**1042**	**468**
6	0.3625	1372	825	4949	2974	4949	2974	4949	2974	0.6098	**0.328**	**922**	**562**
7	0.3625	2708	2118	9767	7638	9767	7638	9767	7638	0.7892	**0.128**	**2361**	**1863**
Total		30374	9242	187556	43554	69018	25398	69018	25398			**13933**	**5170**

*** Catch=Landings+Discards**

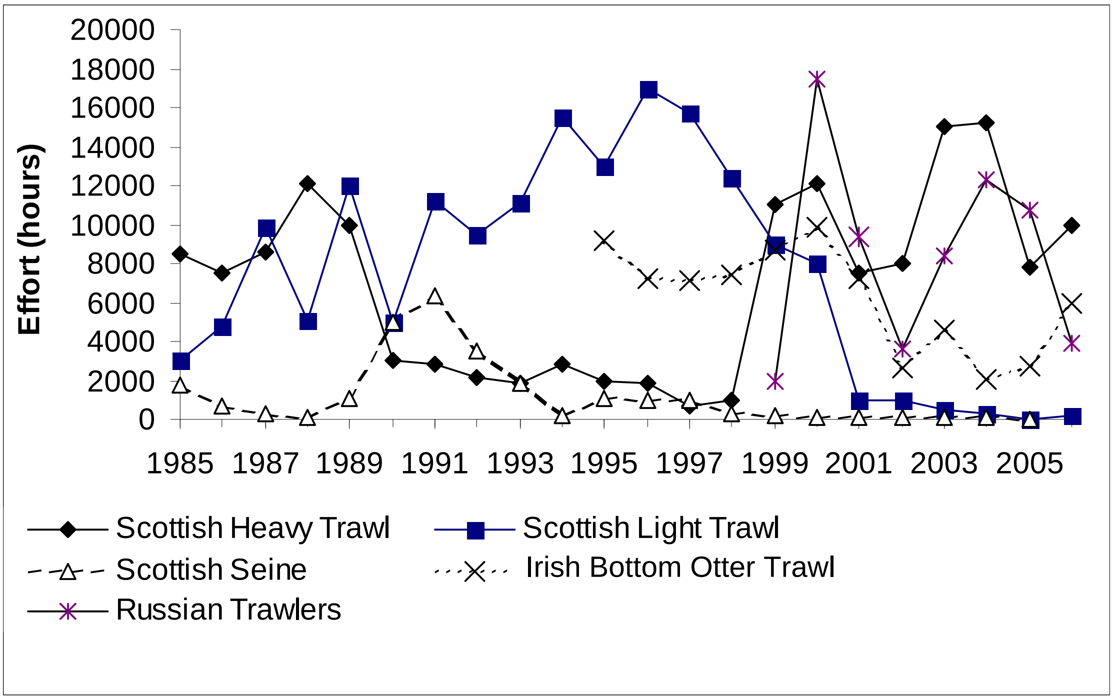
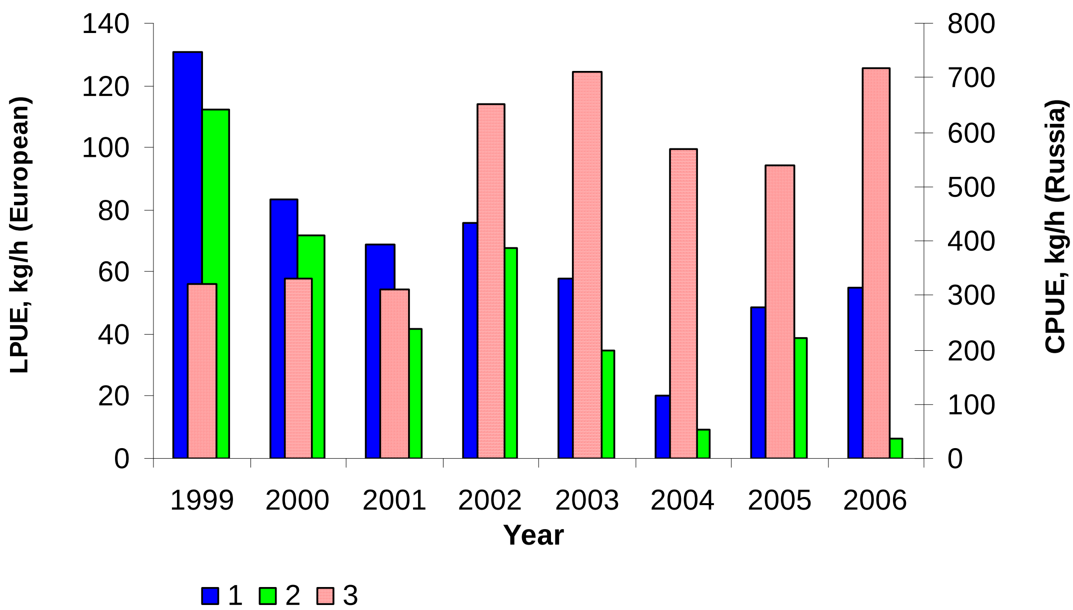


Figure 4.2.1. Rockall haddock in VIb. Scottish, Irish and Russian effort in 1985–2006.



1–Scottish lpue (all gears)

2–Irish trawlers lpue

3–cpue of Russian trawlers (BMRT type, tonnage class 10)

Figure 4.2.2. Lpue and cpue of the fleets fishing for Rockall haddock. Note that Scottish and Irish effort data are not reliable because reporting is not mandatory.

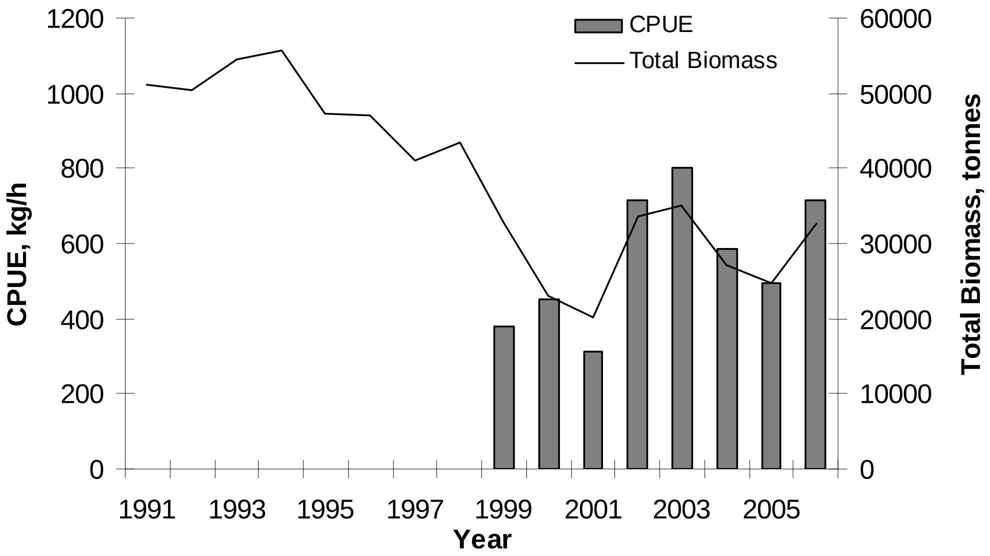


Figure 4.2.3. Dynamics of haddock total biomass (ICES, 2006a; ICES, 2006b) and directed fishing efficiency (t per a trawling hour) for tonnage class 10 vessels in 1999–2006.

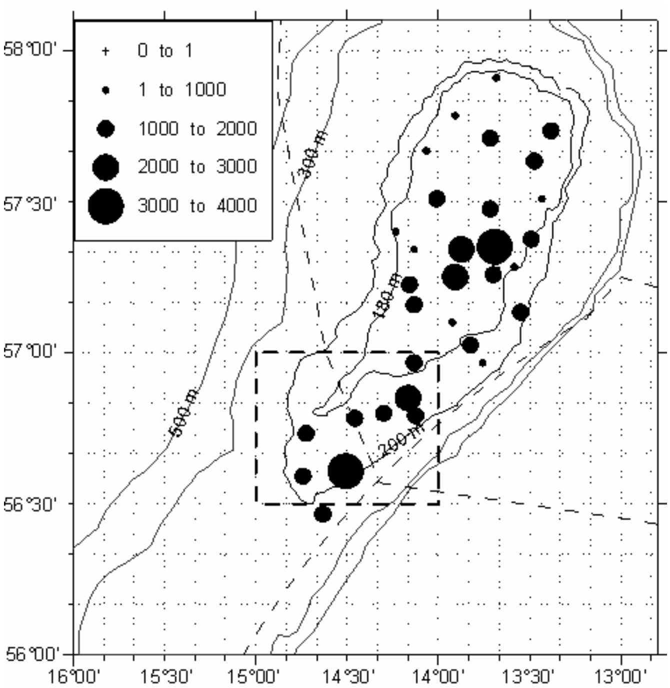


Figure 4.2.4. Distribution of haddock (catch per 30-min. haul) on the Rockall Bank in 2006 from data of the Scottish trawl survey.

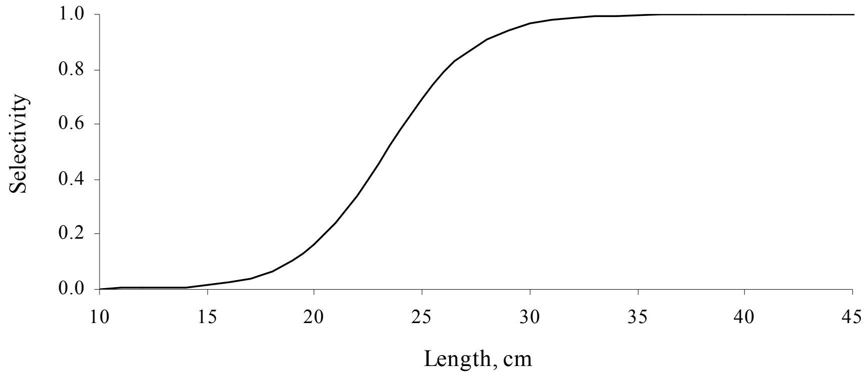


Figure 4.2.5. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted onboard Russian trawlers.

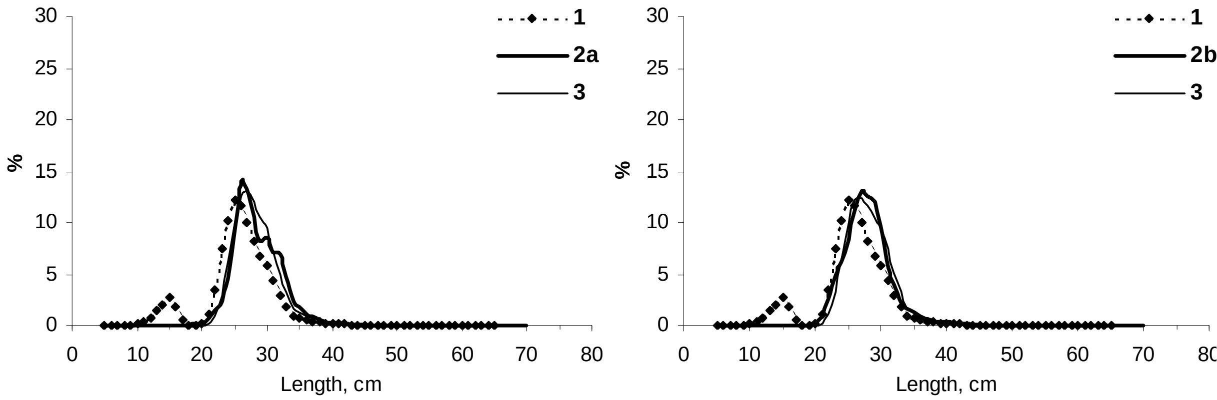


Figure 4.2.6. Length distribution of haddock in 2003: 1–by Scottish groundfish survey, 2a–by commercial Russian trawlers in June, 2b–by commercial Russian trawlers in July, 3–theoretically-derived.

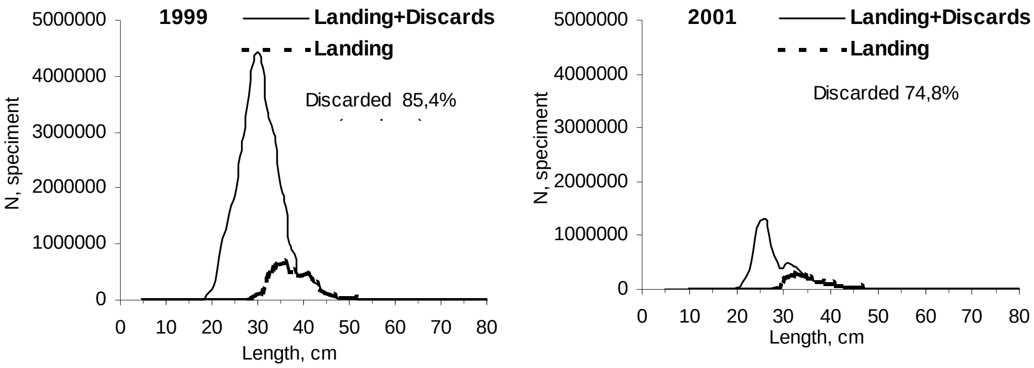


Figure 4.2.7. Length distribution and quantity of haddock lifted onboard and landings by Scottish trawlers in 1999 and 2001 (unpublished data, Newton, 2004).

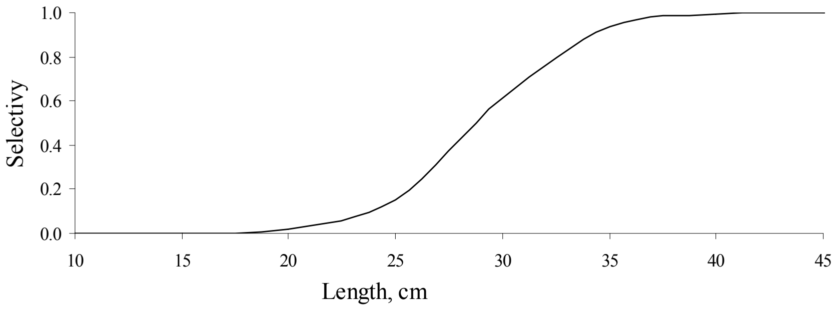


Figure 4.2.8. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted onboard Scottish trawlers.

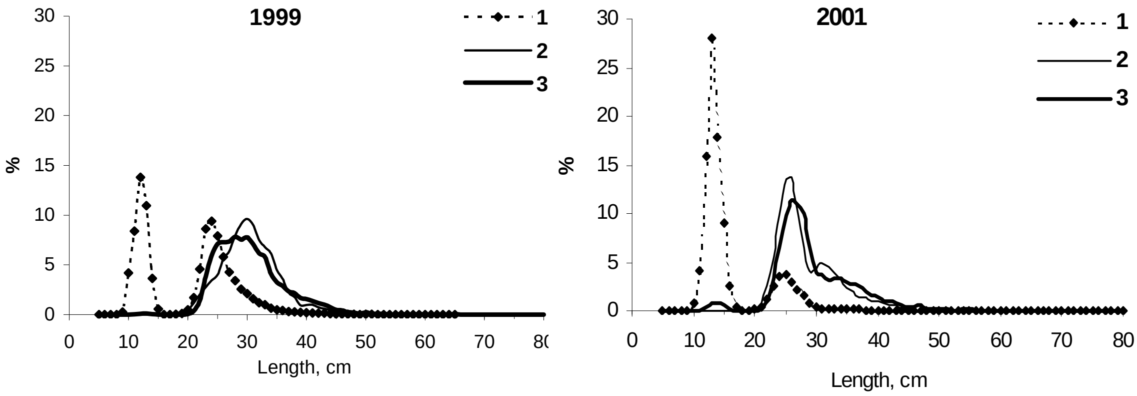


Figure 4.2.9. Length distribution of haddock in 1999 and 2001: 1–by Scottish groundfish survey, 2–by commercial Scottish trawlers, 3–theoretically-derived.

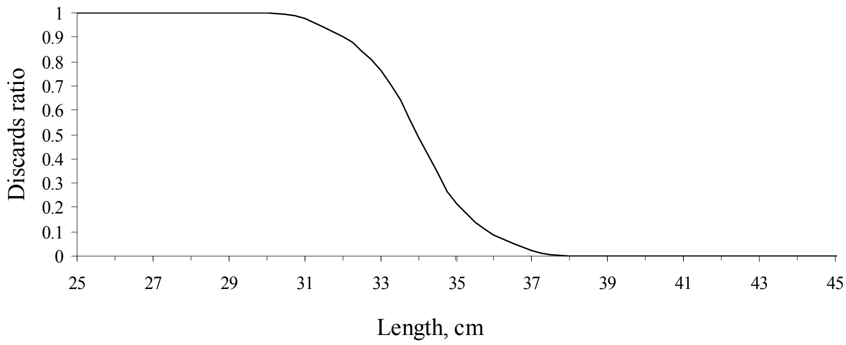


Figure 4.2.10. Selectivity curve used to estimate the proportion of discarded haddock in catches Scottish trawlers.

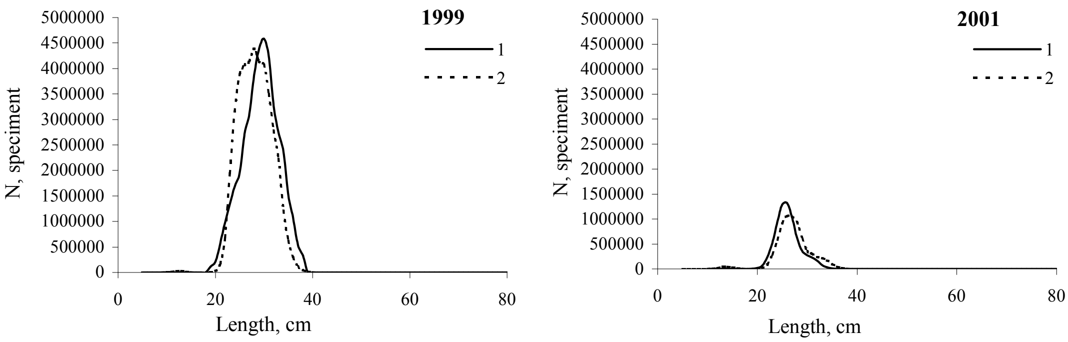


Figure 4.2.11. Length distribution of discarded haddock in catches Scottish trawlers in 1999 and 2001: 1–research data; 2–theoretically-derived.

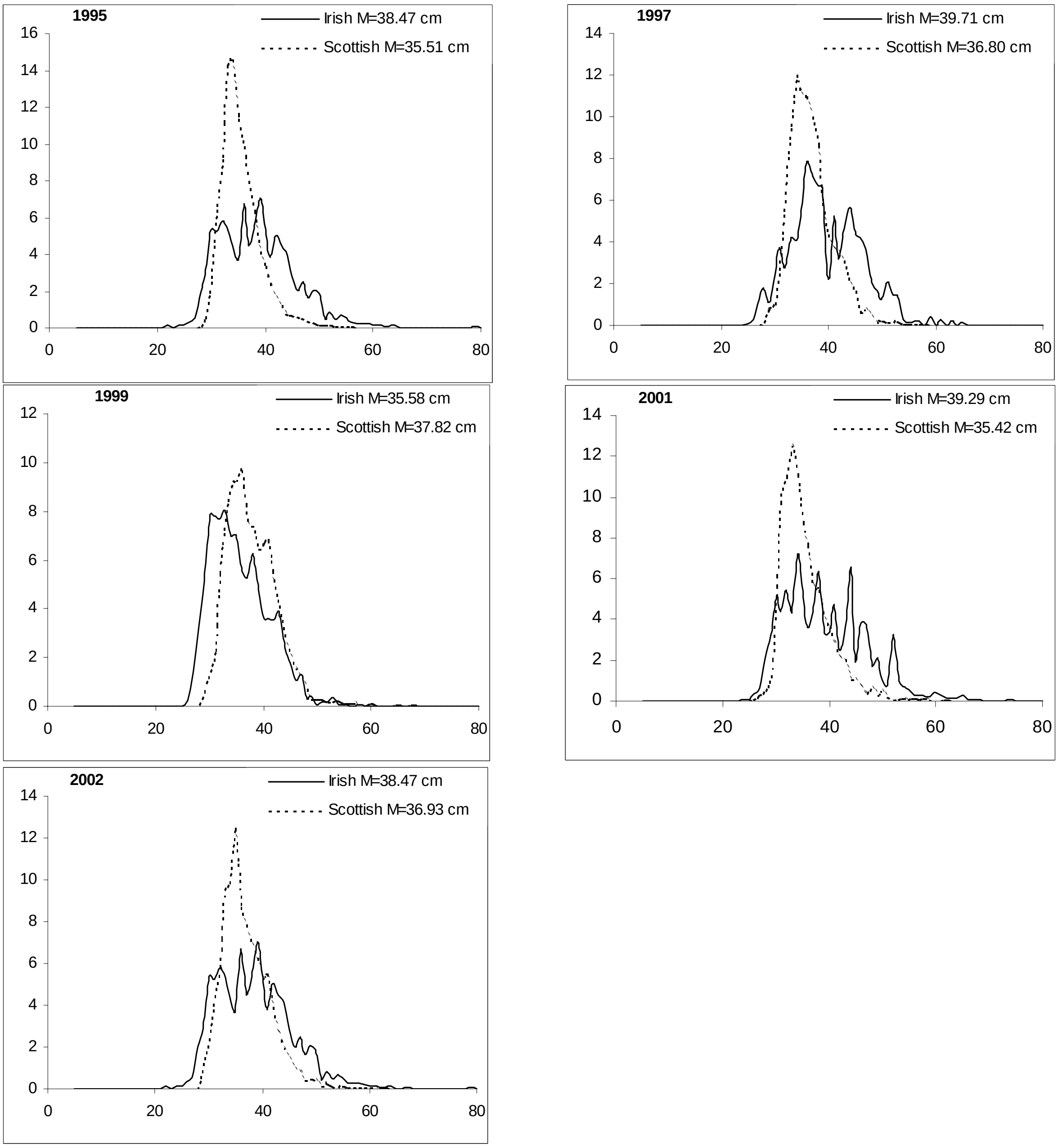


Figure 4.2.12. Length distribution of haddock landings in VI b (Scottish and Irish data).

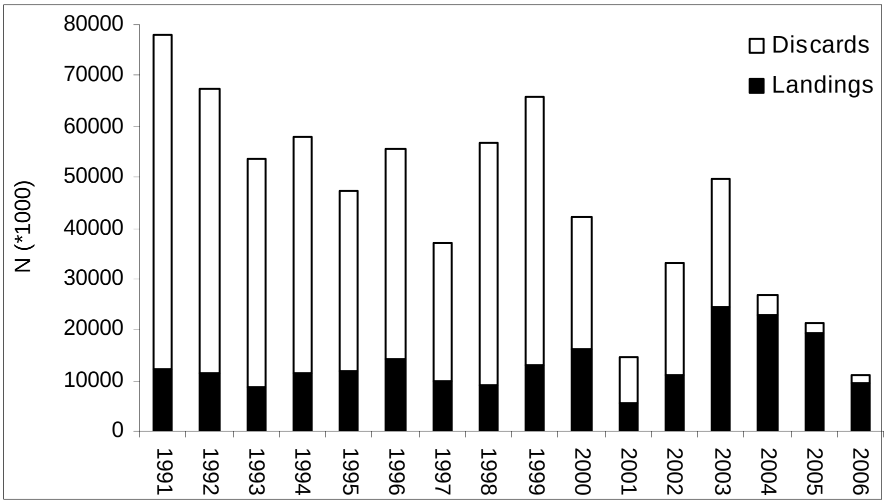


Figure 4.2.13. Total landings and discards of Rockall haddock ('000 individuals).

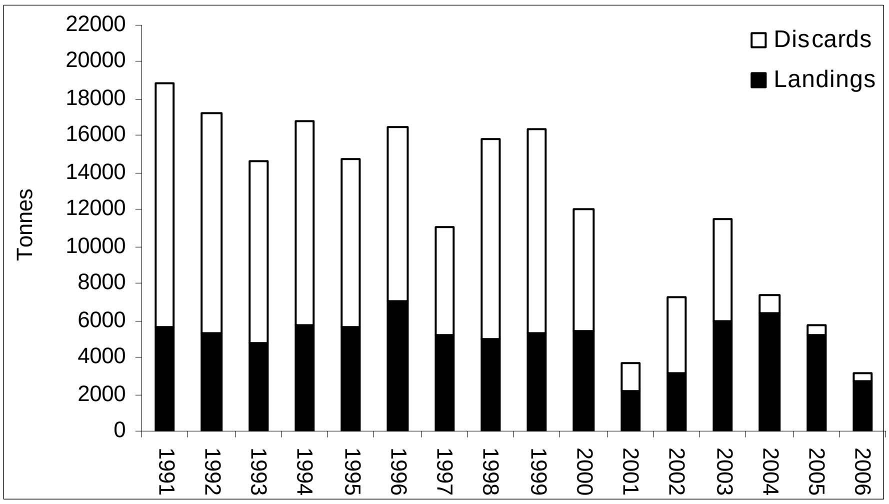
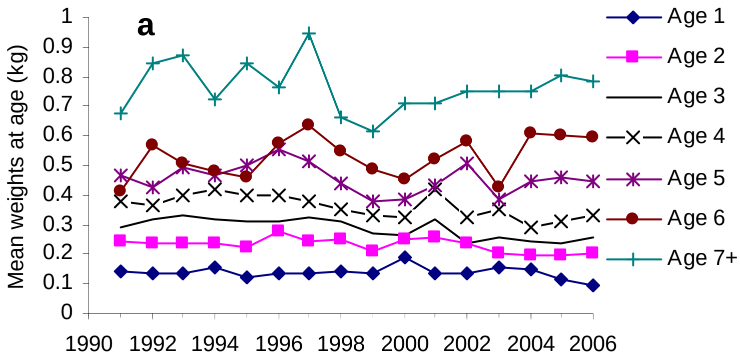


Figure 4.2.14. Total landings and discards of Rockall haddock (tonnes).



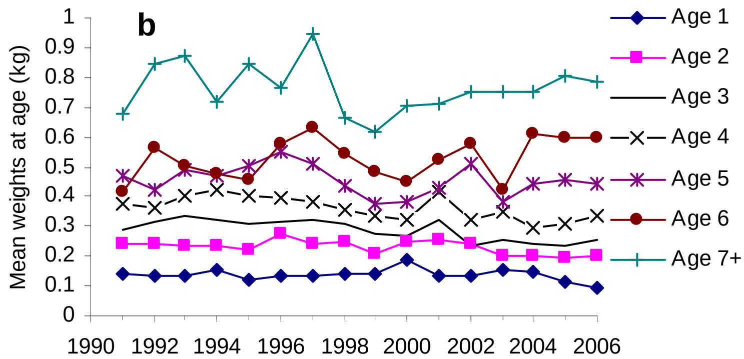


Figure 4.2.15. Haddock in VIb. Mean weights-at-age a) in catch and b) in stock.

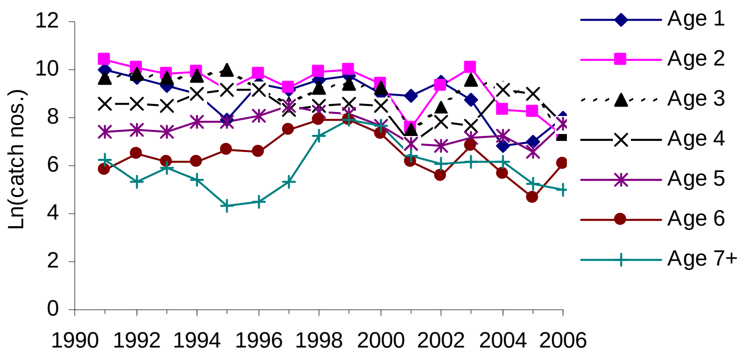


Figure 4.2.16. Haddock in VIb. Log catch (with discards in numbers) at age by year.

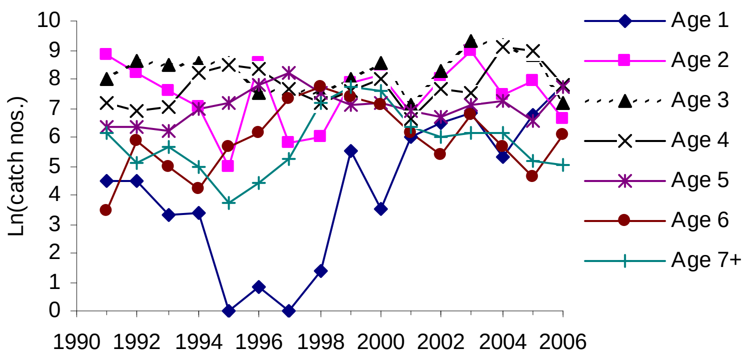


Figure 4.2.17. Haddock in VIb. Log landings (in numbers) at age by year.

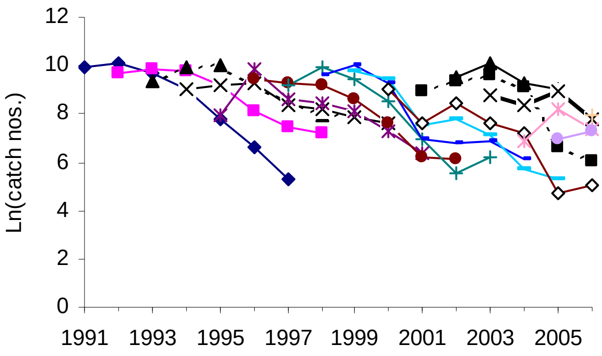


Figure 4.2.18. Haddock in VIb. Log catch (with discards, in numbers) at age by year class.

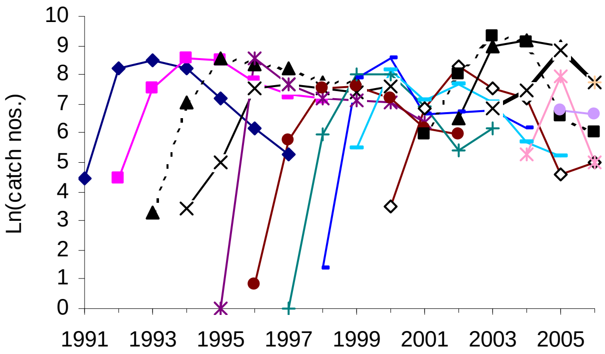


Figure 4.2.19. Haddock in VIb. Log landings (without registered discards, in numbers) at age by year class.

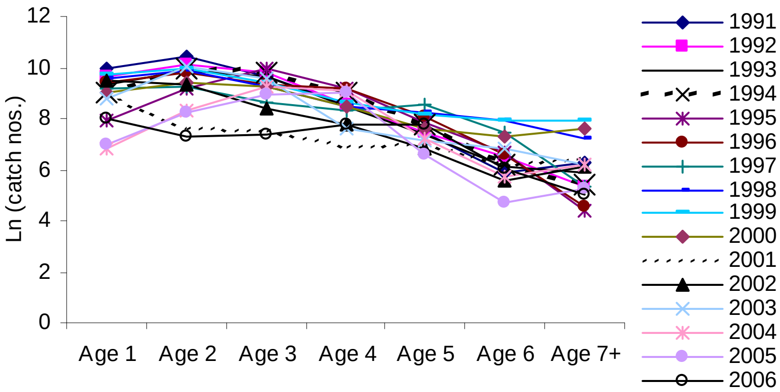


Figure 4.2.20. Haddock in VIb. Catch curves (with registered discards).

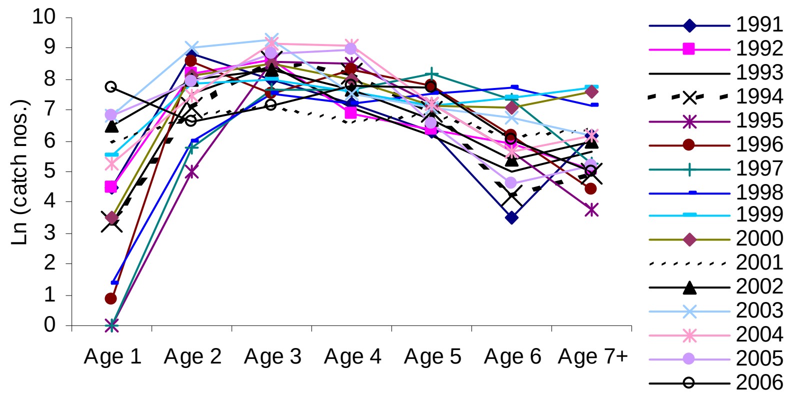


Figure 4.2.21. Haddock in VIb. Catch curves (landings without registered discards).

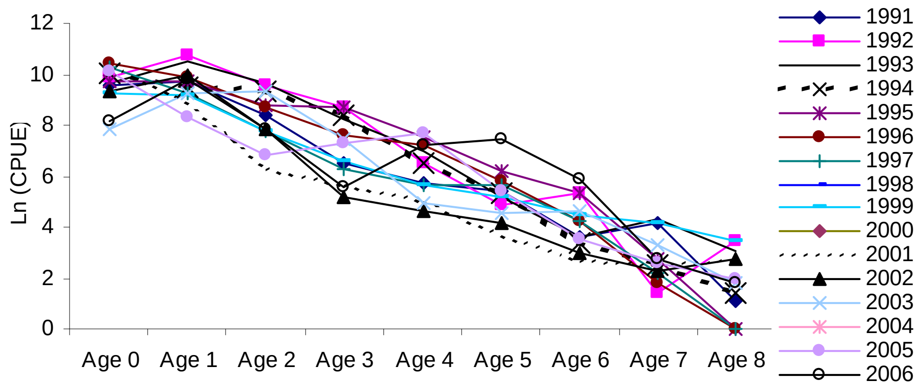


Figure 4.2.22. Haddock in VIb. Log survey cpue at age by year.

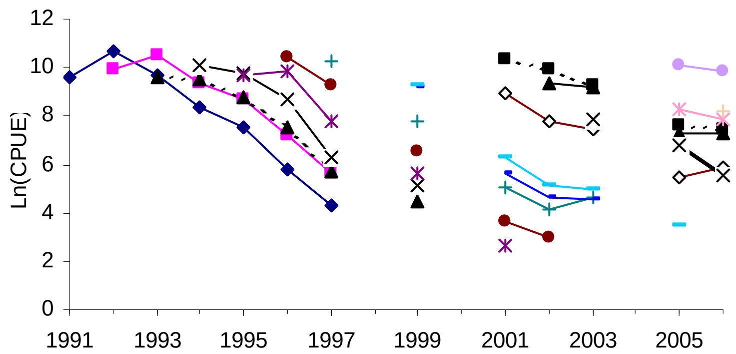


Figure 4.2.23. Haddock in VIb. Log survey cpue by year class.

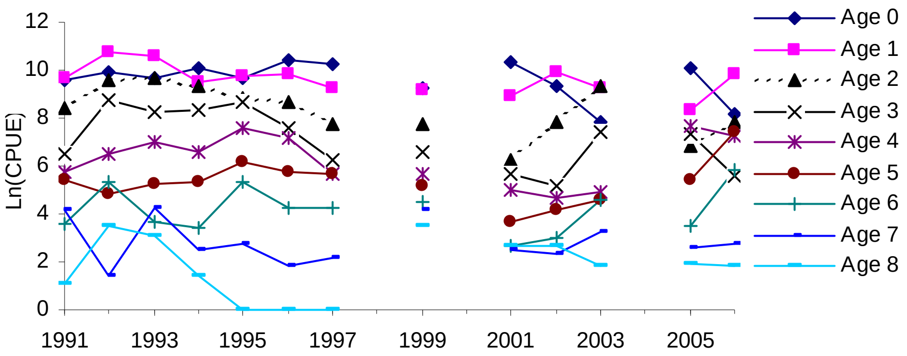


Figure 4.2.24. Haddock in VIb. Log survey cpue at age.

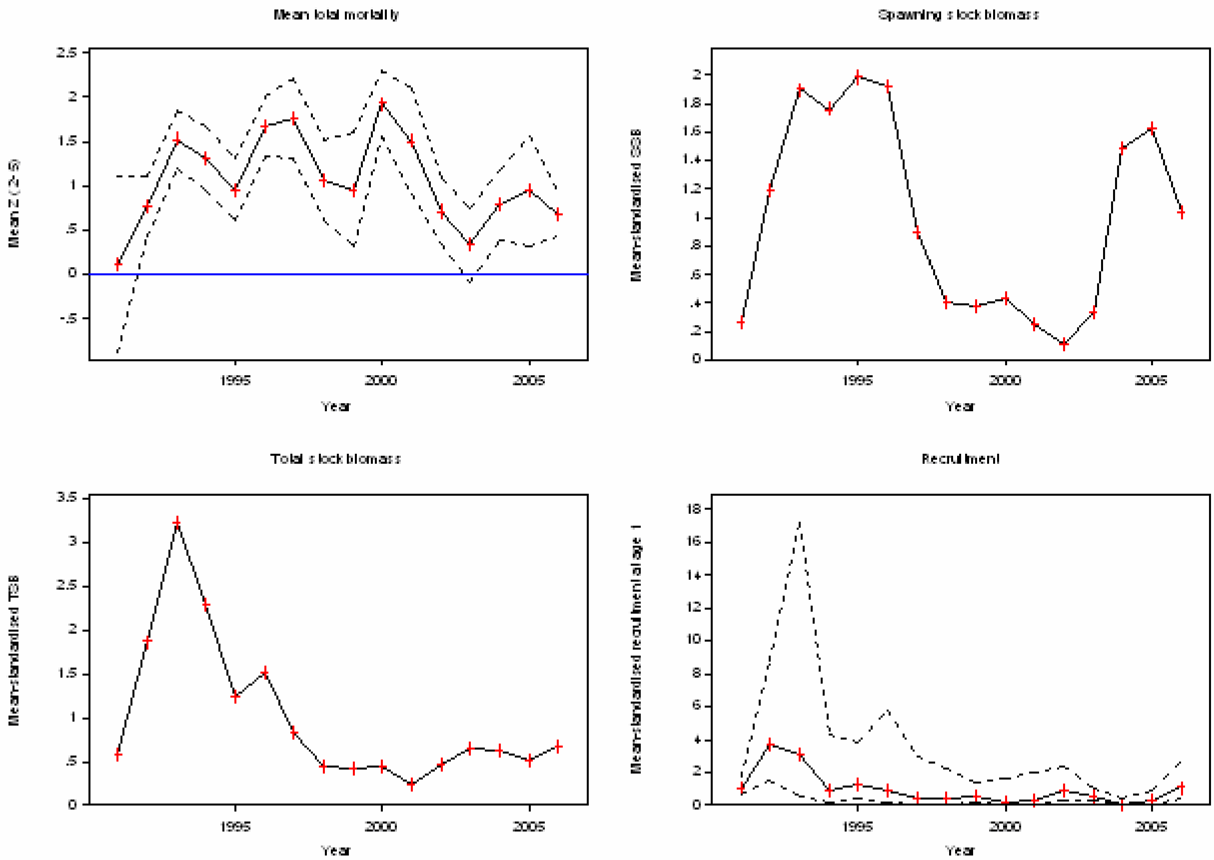


Figure 4.2.25. SURBA analysis for Rockall Haddock.

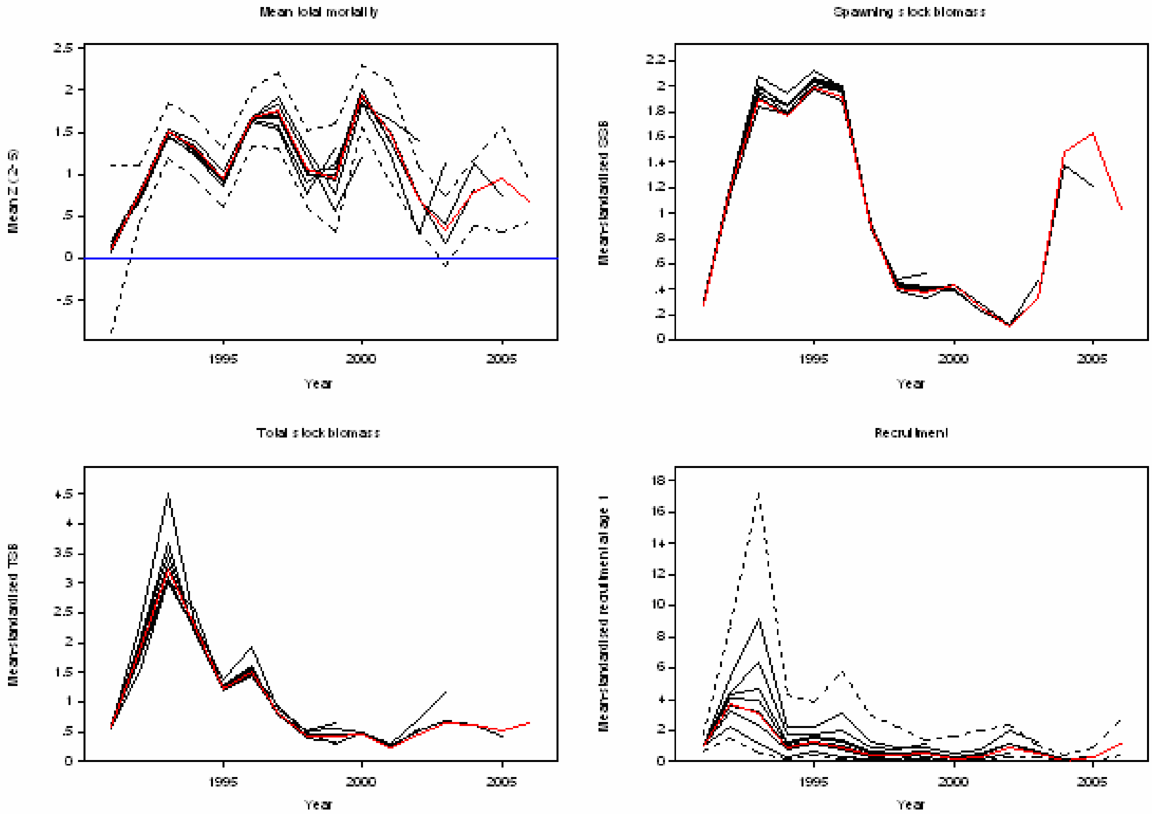


Figure 4.2.26a. SURBA analysis for Rockall Haddock. Retrospective plots.

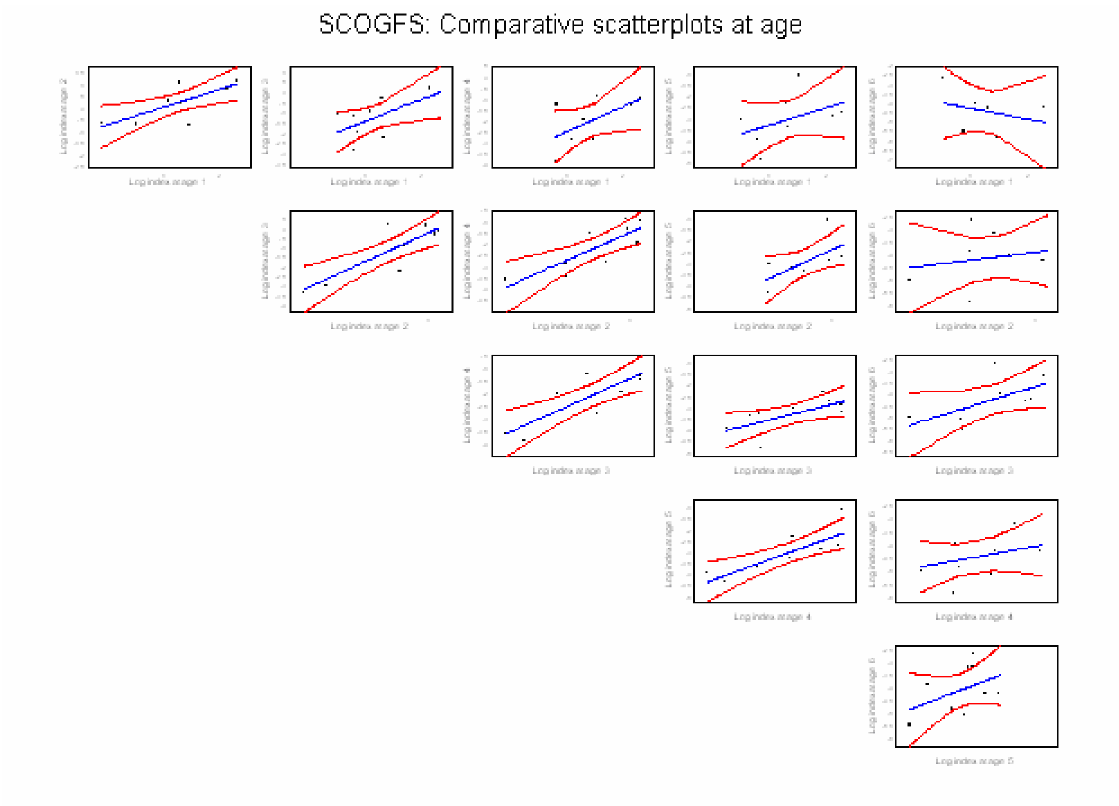


Figure 4.2.26b. SURBA analysis for Rockall Haddock. Pairwise plots of age.

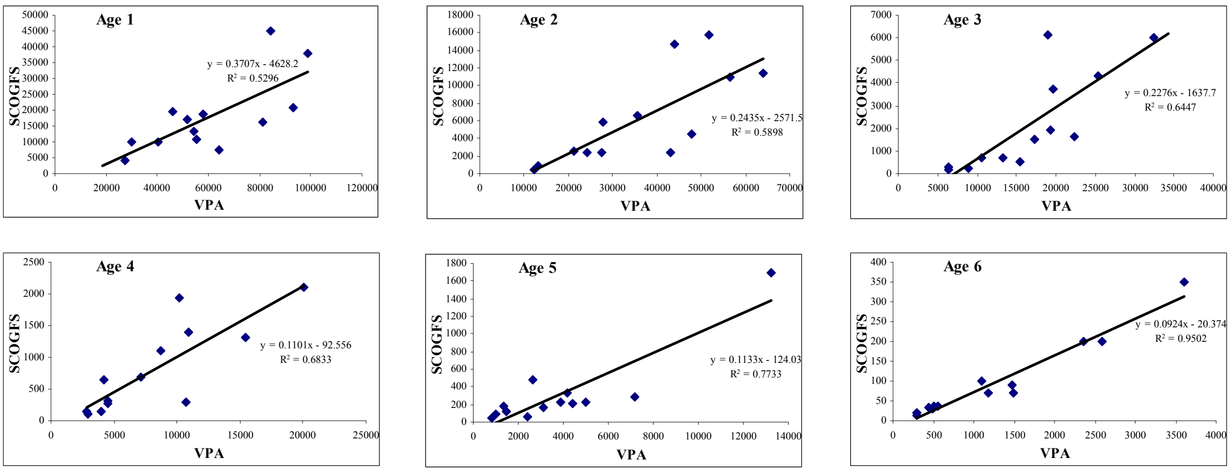


Figure 4.2.27. Haddock in VIb. Scotish groundfish survey adjusted cpue values from the final XSA run plotted against VPA numbers (shrinkage 1.0) at age. Catchability dependent on stock size at ages <4.

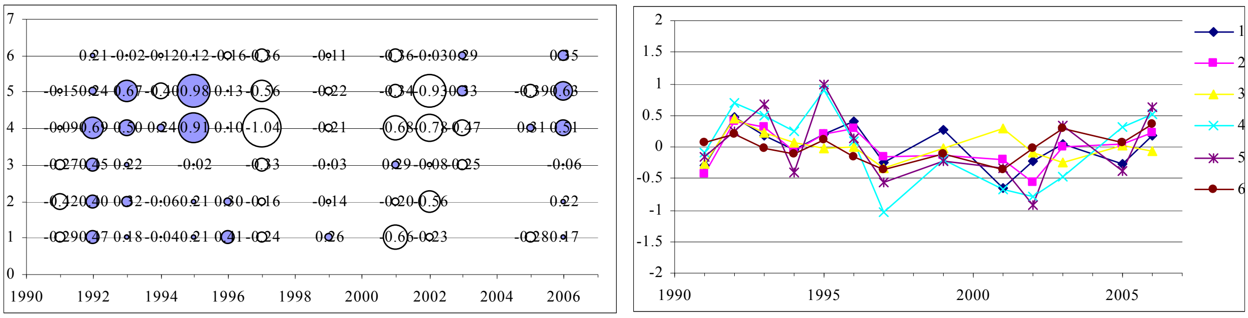


Figure 4.2.28. Haddock in VIb. Log catchability residual plots (shrinkage 1.0). Final XSA: catchability dependent on stock size at ages <4.

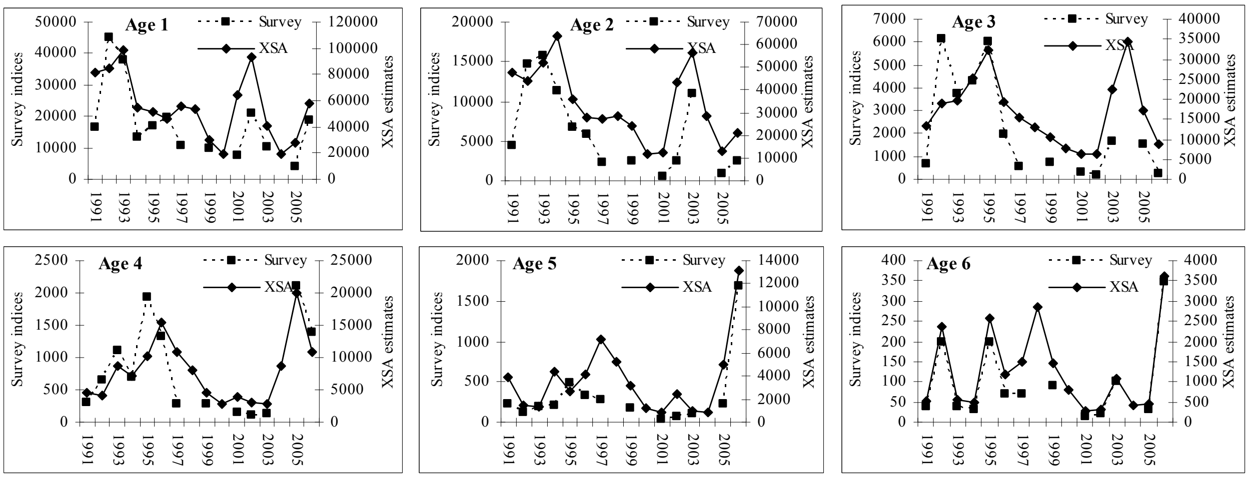


Figure 4.2.29. Haddock in VIb. Survey indices and XSA estimates (shrinkage 1.0) at age. Final XSA: catchability dependent on stock size at ages <4.

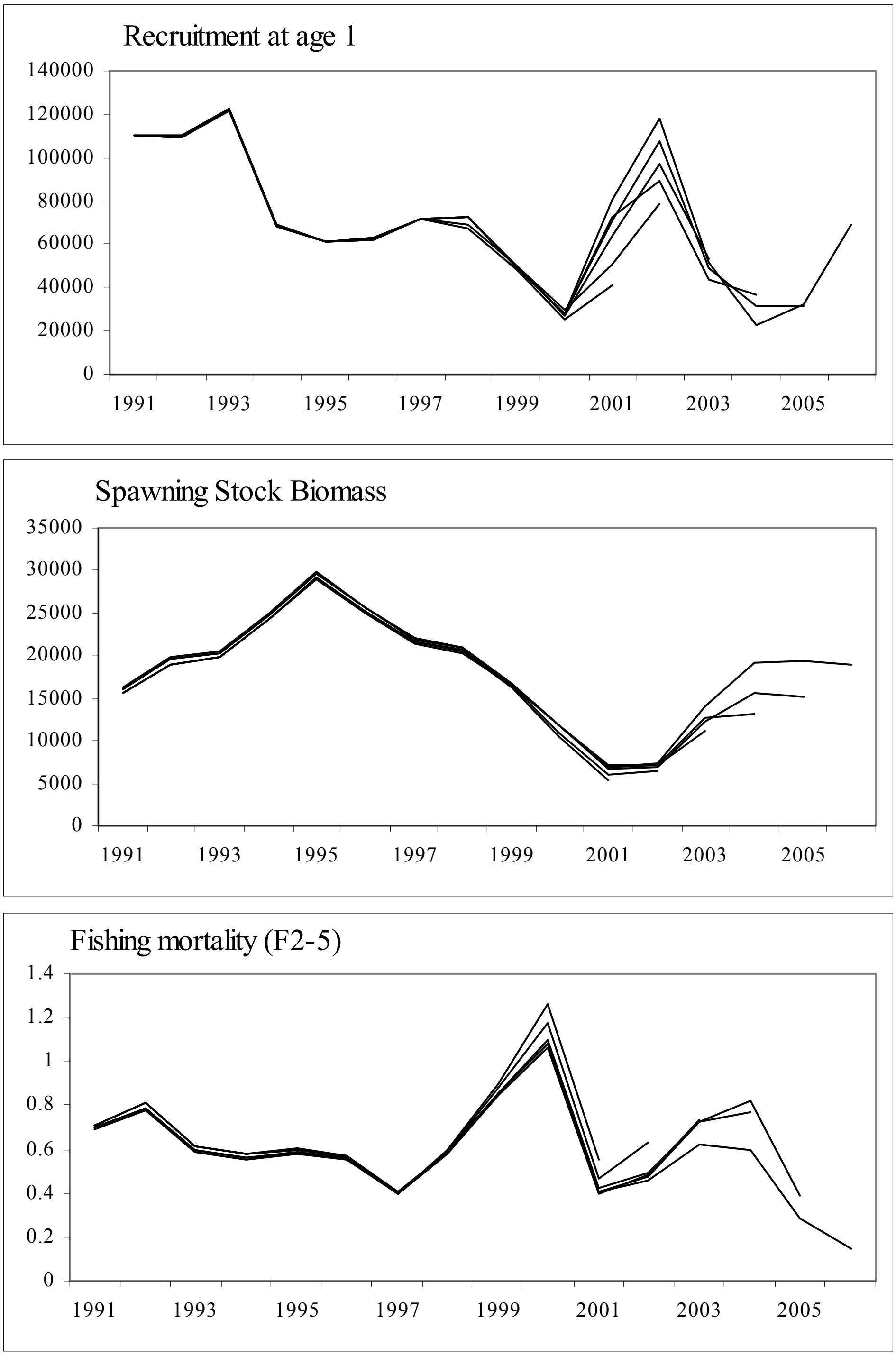


Figure 4.2.30. Haddock in VIb. Retrospective analyses (F shrinkage 1.0).

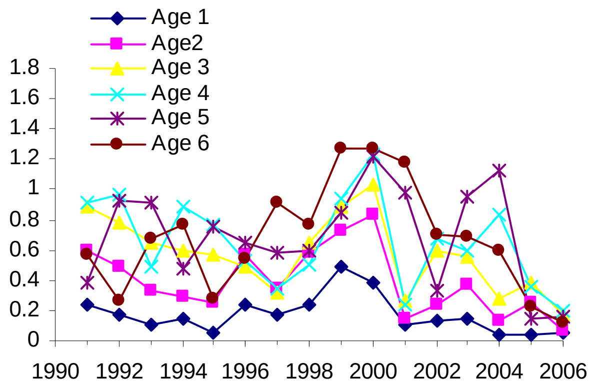


Figure 4.2.31. Haddock in VIb. F at age (F shrinkage 1.0).

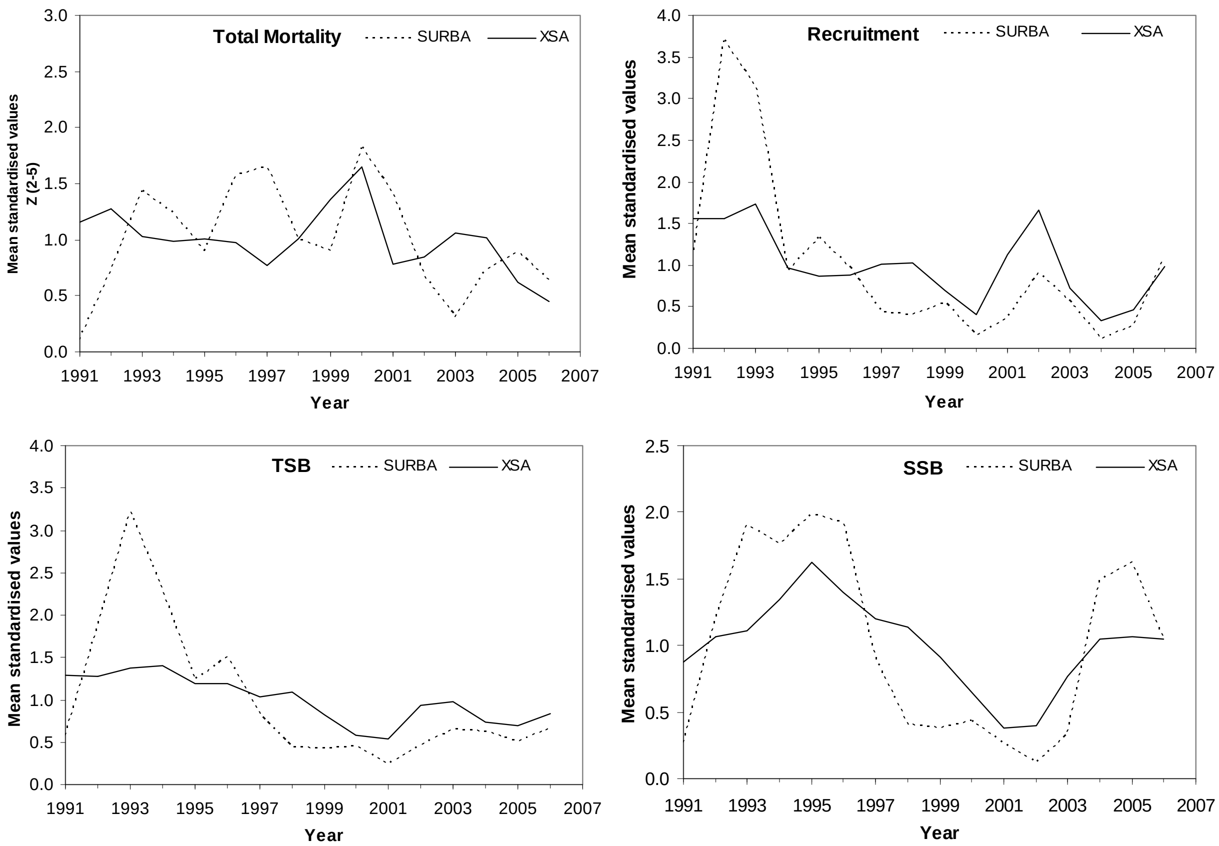


Figure 4.2.32. Haddock in VIb. XSA and SURBA analysis.

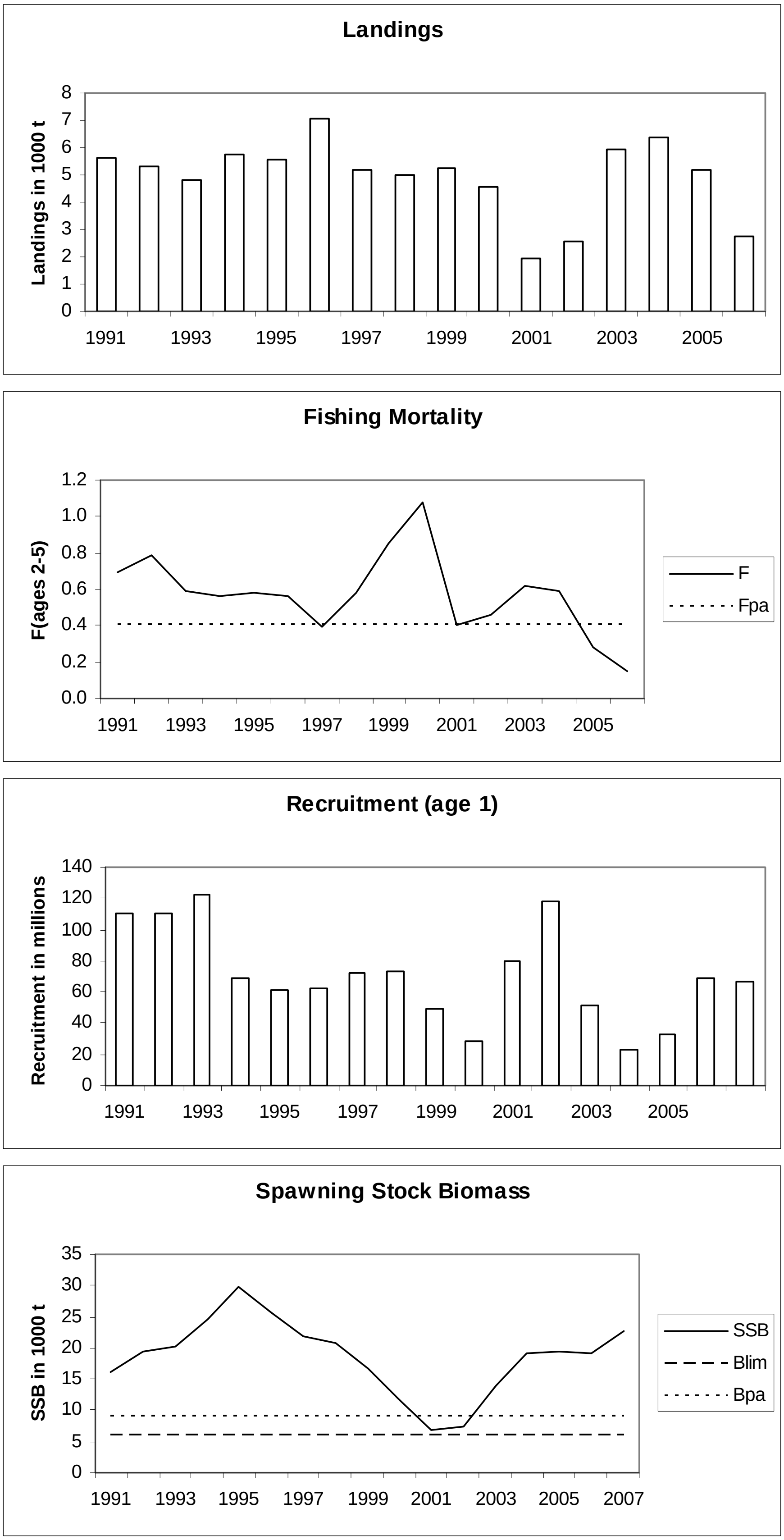
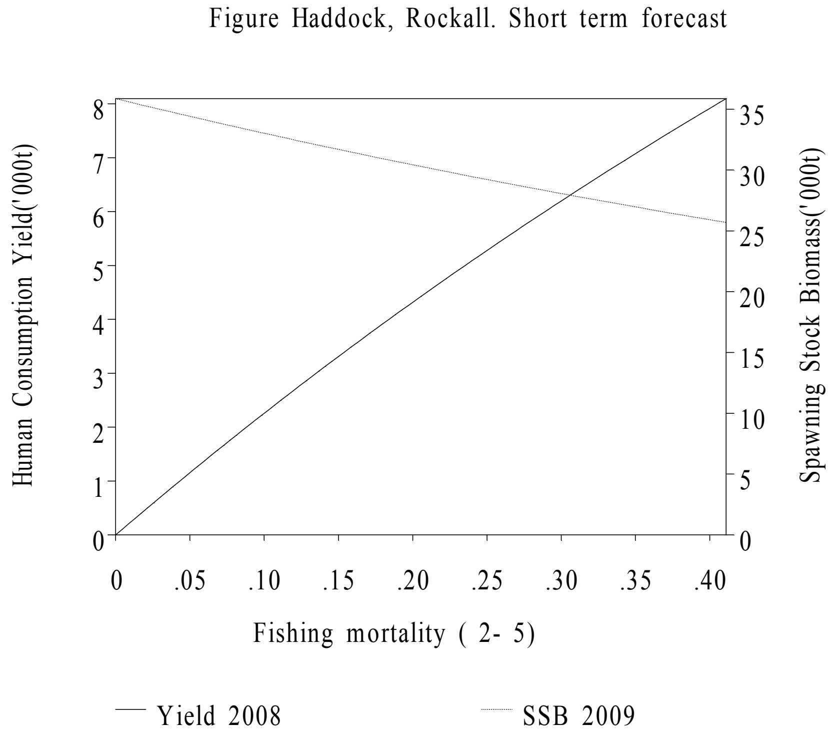


Figure 4.2.33. Haddock in VIb. Summary plots.



Data from file:C:\ïï\2007b\2007\ÎöâíêàÀ\ÎöâíêàÀ\MLA27\had6b.sen on 14/05/2007 at

Figure 4.2.34. Haddock in VIb. Short-term forecast.

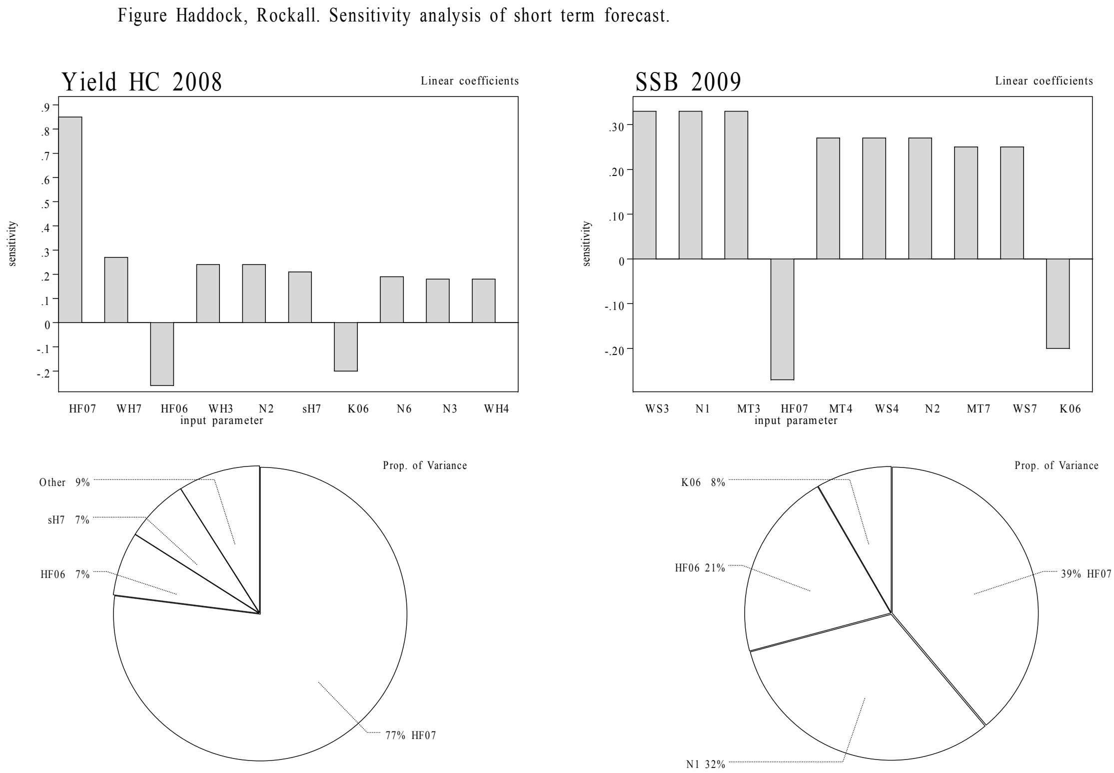


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Figure 4.2.35. Haddock in VIb. Delta plots from selectivity analysis.

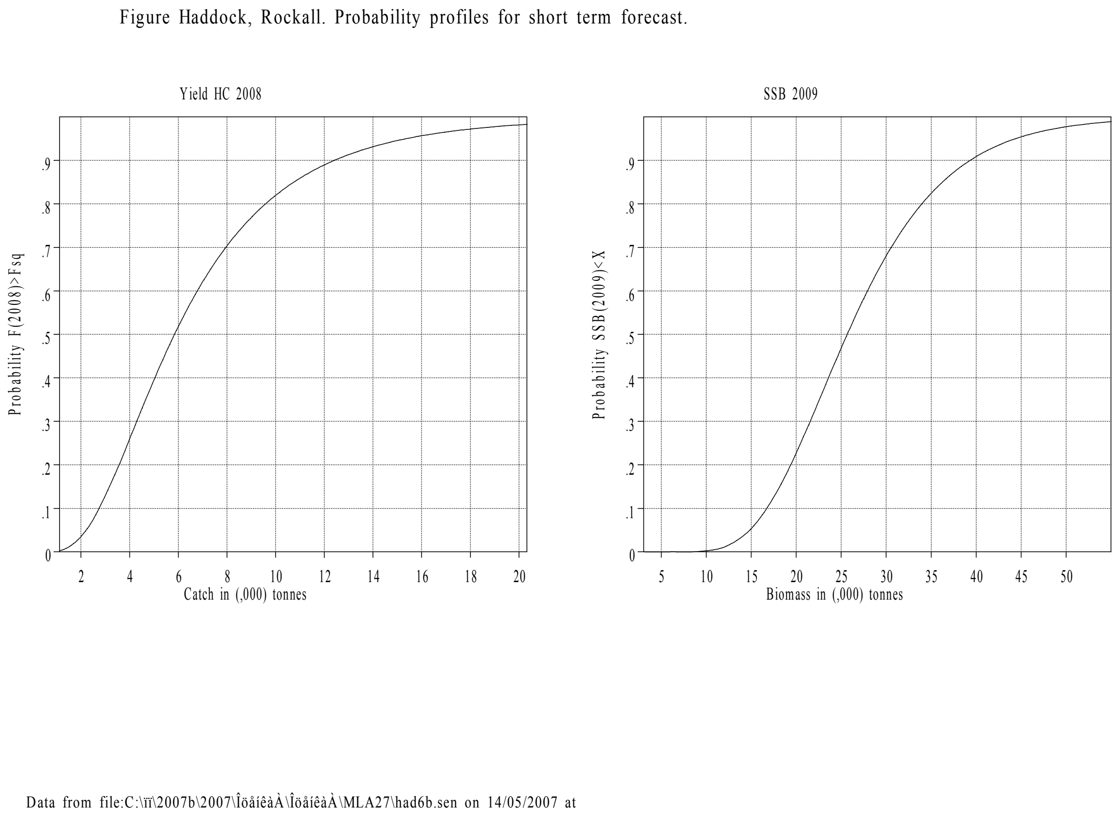


Figure 4.2.36. Haddock in VIb. Probability plots for yield in 2007 and SSB in 2008.

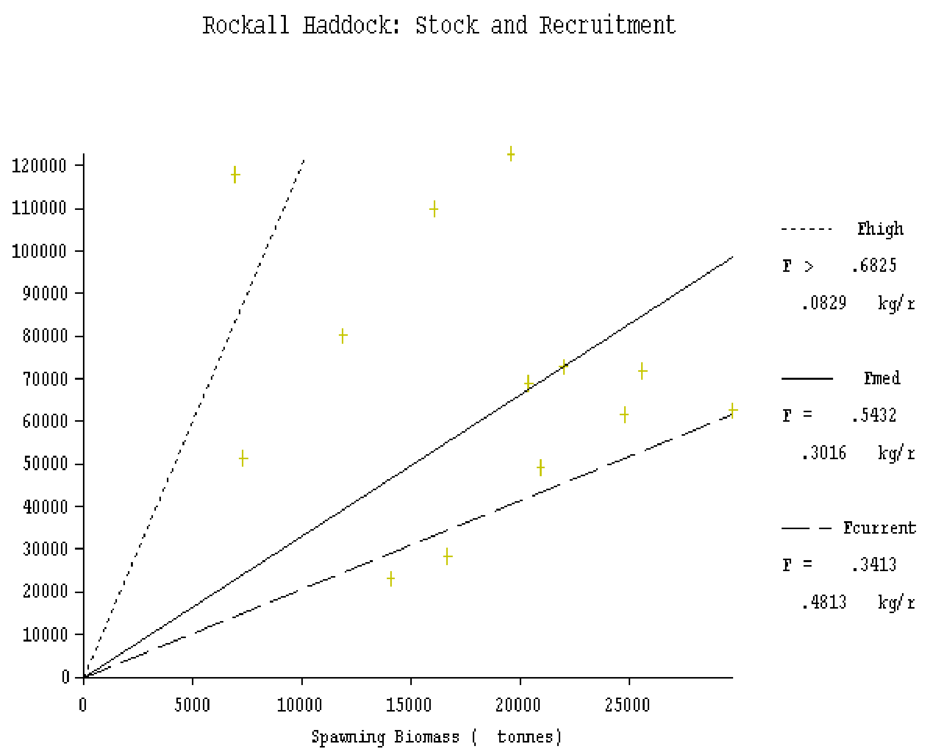


Figure 4.2.37. Haddock in VIb. SSB and recruitment.

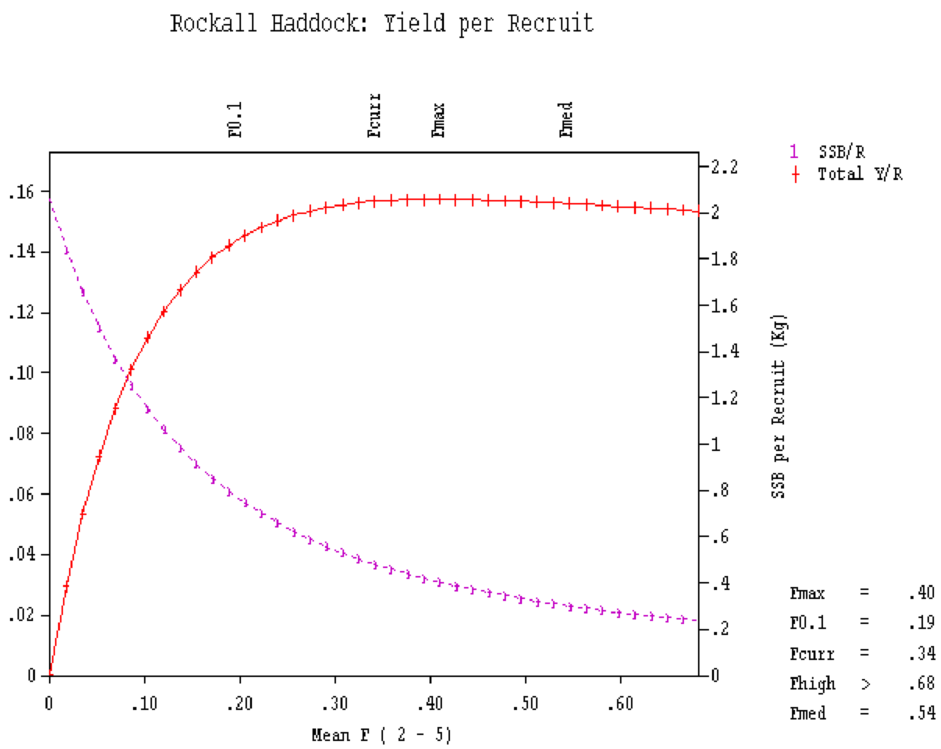


Figure 4.2.38. Haddock in VIb. Yield-per-recruit.

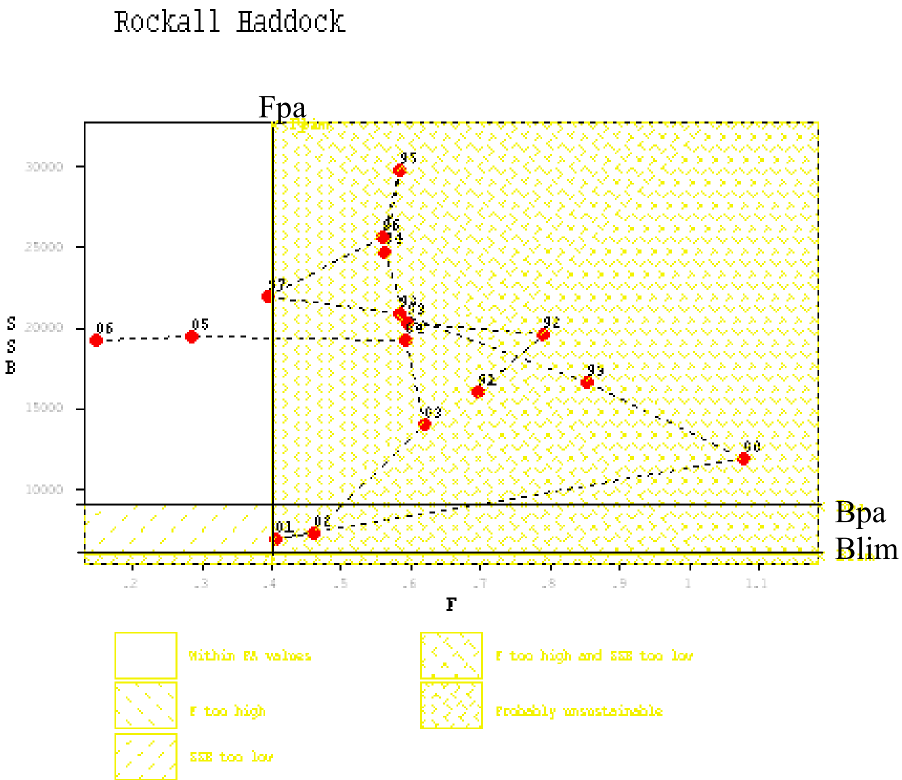


Figure 4.2.39. Haddock in VIb. Biological reference points.

5 Whiting in Sub-area VI

5.1 Whiting in Division VIa

Recent ACFM review groups (RGNSDS) have highlighted the various data problems associated with this stock: including noisy survey data and discard data which need to be re-worked. Their conclusion in 2006 was that:

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

The assessment presented by the WG this year is therefore based only on survey data which is the same approach as that adopted last year.

5.1.1 Stock definition and the fishery

General information is now located in the stock annex.

5.1.1.1 ICES advice applicable to 2006 and 2007

In 2005, the ICES advice for 2006 in terms of single stock exploitation boundaries was as follows:

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

"There will be no gain in the long-term yield by having fishing mortalities above $\mathbf{F}_{max}$ (0.23). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits."

Exploitation boundaries in relation to precautionary limits.

"Catches in 2006 should be reduced to the lowest possible level. Survey and catch-at-age data are inconsistent, indicating substantial unaccounted removals. Based on the survey data the stock is at a low level similar to the one in the early 1990s but official catches are now much lower than during this period; however, the exact catch level is not known."

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

Exploitation boundaries in relation to precautionary limits

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

Mixed fisheries advice for the West of Scotland can be found in Section 1.7.

5.1.1.2 Management applicable

The following table summarises ICES advice and actual management applicable for whiting in Division VIa during 2001–2007:

YEAR	SINGLE SPECIES EXPLOITATION	BASIS FOR SINGLE SPECIES	TAC FOR VB, VI, XII, XIV (TONNES)	% CHANGE IN F ASSOCIATED WITH TAC1
2001	< 4,200	Reduce F below Fpa	4,000	-40%
2002	< 2,000	SSB > Bpa in short term	3,500	-40%

YEAR	SINGLE SPECIES EXPLOITATION	BASIS FOR SINGLE SPECIES	TAC FOR VB, VI, XII, XIV (TONNES)	% CHANGE IN F ASSOCIATED WITH TAC1
2003	-	SSB > Bpa in short term	2,000	-60%
2004	-	SSB > Bpa in 2005	1,600	(no assessment)
2005	-	-	1,600	(assessment in relative trends only)
2006	-	-	1,360	(assessment in relative trends only)
2007	0	Reduce catches to lowest possible level	1,020	

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

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

5.1.1.3 The fishery in 2006

Tables and figures of total effort by the fleets operating in Division VIa can be found in Section 17.

The Scottish whiting fishery in Division VIa is part of the mixed whitefish fishery which catches varying proportions of other species depending on location and time of year. Following the major Scottish decommissioning scheme (prior to 2005) and implementation of days at sea restrictions, fishing activity of this fleet has reduced. However, the actual reduction in effort due to these measures is difficult to quantify. Additionally, a significant proportion of whiting landings are taken by Nephrops trawlers operating in more inshore waters to the west of Scotland. Anecdotal information from the fishing industry suggests that the number of vessels targeting whiting is very low, and in 2006, the quota uptake of UK vessels was less than 20%.

The draft report of the 2007 WG on Fish Technology and Fish Behaviour also highlights a number of issues relating to recent changes in fleet behaviour which are relevant to this stock

- *due to restrictive days at sea allocations for Scottish whitefish vessels operating in VIa, a number (up to 10) of larger Scottish vessels have switched to targeting Nephrops and have redistributed their effort in the Fladen fishery in IVa. While the number of vessels may be small, these are larger powered (typically in excess of 1 000hp) and will therefore result in a considerable reduction in Scottish effort in VIa and a significant increase in the Nephrops fishery of IVa which is fished by lower powered vessels. (Scotland; Implication -reduction in effort Via)*
- *A €45 million Decommissioning Scheme was launched in Ireland in October 2005 and continued in 2006. To date, a total of 36 (includes one in 2005) vessels have been decommissioned at a total expenditure of €15 967 million. This has resulted in the removal of 4 901 GTs and 15 392 kW's from the fleet from the Irish whitefish and scallop fleets. This has removed the few remaining vessels that traditionally target cod on the cape grounds (VIa). (Ireland; Implication - reduced effort through decommissioning associated with older vessels)*

5.1.2 Catch data

5.1.2.1 Official catch statistics

Total officially reported landings in 2006 were 379 t, 90 t greater than the landings in 2005 (Table 5.1), but still much lower than landings recorded in previous years. This increase in 2006 is due to an upturn in both Irish and UK official landings.

The total estimated international catch of ages 1–7+ (including discards) in 2006 was approximately 1 300 t of which almost 950 t were discards (Table 5.2). An additional 440 t of 0–gp fish were also estimated to be discarded. Although the catch in 2006 is estimated to be slightly higher than that in 2005, it is still the second lowest in the time series.

Mandatory increases in mesh size to 120 mm for vessels fishing in the mixed demersal fishery to the West of Scotland may account partly for the recent decline in landings of whiting.

5.1.2.2 Quality of catch data

There have been concerns that the quality of landings data is deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS) used in recent years, (see Section 5.1.6.1.3 in the 2005 WG report). The introduction of UK & Irish legislation requiring registration of all fish buyers and sellers (See Section 1.7) may mean that the reported landings in 2006 are more representative of actual landings.

5.1.3 Commercial catch-effort data and research vessel surveys

Four commercial catch-effort data series were available for the period to 2005, uncorrected for changes in fishing power and incorporating discard estimates from the Scottish sampling program. Data to update these time series were not available for 2006. As noted in the report of the WGNSSK for 2000 (ICES CM 2001/ACFM:07) the 1999 effort data for the Scottish commercial fleets are not consistent with the historical series. This problem persists through to 2006. Although the reporting and collation methodology was updated during 2001, future cpue indices from the Scottish commercial fleet may not be useable as effort reporting in terms of hours fished is still not mandatory. Therefore commercial cpue data are not used in this assessment. They are presented here for completeness:

Scottish light trawlers (ScoLTR): ages 1–7, years 1965–2005

Scottish seiners (ScoSEI): ages 1–6, years 1965–2005.

Scottish Nephrops trawlers (ScoNTR): ages 1–6, years 1965–2005.

Irish Otter Trawlers (IreOTB); ages1-7, years 1995–2005.

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

Scottish west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2007.

Irish west coast groundfish survey (IreGFS): ages 0–5, year 1993–2002.

Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2006.

Irish groundfish survey (IRGFS): ages 0-6; years 2003–2006

For the Scottish surveys, a new vessel and gear were used from 1999. The catch rates as presented are corrected for the change in vessel and gear. The basis for the correction is comparative trawl haul data (Zuur *et al.*, 2001). The Irish quarter four survey was discontinued in 2003 and has been replaced by a new survey. The replacement survey (IRGFS) has only been running for four years and is not yet long enough for tuning. The Scottish quarter four survey was presented for the first time to WGNSDS, 2005.

The survey series are described in Appendix 1 and the commercial fleets in Appendix 2 of the report for the 1999 meeting of the Working Group (ICES CM 2000/ACFM:1) and also in the Stock Annex. For all survey series, the oldest age given represents a true age, rather than a plus group. The effort series for both commercial and survey tuning fleets are shown in Table 5.3.

5.1.4 Age composition and mean weights-at-age

Annual numbers-at-age in the total catch are given in Table 5.6. Annual mean weights-at-age in the total catch are given in Table 5.9, As in previous meetings, the catch mean weights-at-age were also used as stock mean weights-at-age (see stock annex).

5.1.4.1 Landings age composition and mean weights-at-age

Details on nations which supply data are given in Table 2.2. Sampling levels are shown in Table 2.3. Age distributions were estimated from market samples. Annual numbers-at-age in the landings are given in Table 5.4, Annual mean weights-at-age in the landings are given in Table 5.7 and shown in Figure 5.1.

5.1.4.2 Discards age composition

Annual numbers-at-age in the discards are given in Table 5.5, Annual mean weights-at-age in the discards are given in Table 5.8 and shown in Figure 5.1.

This year, WG estimates of discards are based on data collected in the Scottish discard programme only (raised by weighted average to the level of the total international discards). Discard age compositions from Scottish sampling have been applied to unsampled fleets. No Irish discard data were available this year. Work is underway to revuse the Scottish discard estimates with an aim to reduce bias and increase precision. Such revisions are particularly important for the estimation of total catch for this stock which has very high discards across a wide age range. A working document set out the methodology of this work at the 2004 meeting of WGNSDS (Fryer and Millar, 2004).

5.1.5 Natural mortality and maturity-at-age

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

5.1.6 Data analyses

5.1.6.1 Data screening and exploratory runs

5.1.6.1.1 Commercial catch data

The year range previously used for catch-at-age analyses for this stock is from 1978 onwards, because independent discard estimates for the pre-1978 period are not available. Owing to uncertainties in catch at age data the WG only used commercial catch data to provide stock weights at age for this year’s assessment.

5.1.6.1.2 Survey data

Of the four survey series available, only the 2 Scottish surveys were considered further. The new Irish survey (IRGFS) is currently too short (4 years data) to give useful information on stock trends while the Irish west coast groundfish survey (IreGFS) has been discontinued. In addition, the sub-sampling protocol of the IreGFS was altered mid-way through the survey and therefore there are doubts about the consistency of this series. These two series were therefore not considered further.

A comparison of scaled survey indices (ScoGFSQ1 & ScoGFSQ4) at age show similar trends for some ages (Figure 5.2). For age 1 and age 4 there is relatively good correlation, but for some of the other age classes, particularly ages 2, 6 and 7, there is relativly poor correlation.

Log mean-standardised survey indices by year class and by year and scatter-plots of indices within year classes are shown in Figures 5.3, 5.4 and 5.5. the year-class plots for both surveys are quite noisy and the ability of these surveys to reliably track year-class strength is generally poor. There is some evidence that individual year classes have been picked up well by both surveys (for example 1999), but this does not occur consistently over the survey period. In addition, some of the correlations for the older ages in the ScoGFSQ1 scatterplot are negative, while the equivalent plots of the ScoGFSQ4 survey show very scattered data points with a large number of outliers. Age 0 in ScoGFSQ4 appears to be a particularly poor measure of year-class strength (little evidence of positive correlation) and is therefore excluded in further analysis of this survey. There are no marked year effects.

The log catch curves for these surveys are shown in Figure 5.6. The curves for both ScoGFSQ1 and ScoGFSQ4 are relatively linear and not very noisy, and show a fairly steep and consistent drop in abundance.

5.1.6.1.3 Exploratory assessment runs

The trawl survey data (ScoGFSQ1 and ScoGFSQ4) for West of Scotland whiting was extensively analysed at WGNSDS, 2005 and WGNSDS, 2006 using both SURBA 2.2 and SURBA 3.0 to look at consistency of output using a variety of age ranges, smoothing parameter values, relative catchabilities and weighting factors. Initial single fleet SURBA runs this year therefore used the model settings that were chosen in last year's final comparison runs which were:

- ScoGFSQ1: lambda=1, equal catchabilities at age, ages 1–6, all available years
- ScoGFSQ4: lambda=1, equal catchabilities at age, ages 1–5, all available years

FLSURBA was used to carry out these single fleet SURBA runs and results were checked for consistency with those from SURBA 3.0. More details of the assessment software can be found in Section 2.7.

The summary output of mean Z (2–4), recruitment and biomass from the FLSURBA run for ScoGRSQ1 is shown in Figure 5.8 with the residuals illustrated in Figure 5.8. Model residuals are large for some age classes in some years, but with the exception of age 1, do not show any particular trends or non-randomness. Little systematic retrospective bias is apparent in the stock trends although the estimates for recruitment show some variablity (Figure 5.9) and addtionally Z in the final year is not well estimated, although the peculiar estimates of total mortality in the final year are at least partly a result of the estmeation procedure used in SURBA: final year estimates of z are assumed to be equal to the mean of the previous 3 years. Therefore if there is an increasing trend in mortality, the final year value is always lower than the year before and vice-versa for decreasing trend in mortality.

The mean Z (2–4) estimates from this run shows significant fluctuations in recent years. Further runs were carried out to investigate the effect of different smoothing parameter (lambda) values. The results are shown in Figure 5.10. Only with very large values of lambda did the fluctuations in mean Z become more smoothed out. However, the runs with these very high values of lambda showed much worse retrospective patterns (see stock file) than the initial run with lambda=1.

Last year the WG had some difficulty in applying the SURBA model to the ScoGFSQ4 survey with all attempts to fit the model (using alternative catchability assumptions, weightings, lambdas) giving very poor convergence. However, with the addition of an extra year's data, the model seemed to perform better. The summary output for a run with the settings given above is shown in Figure 5.11 and the residuals in Figure 5.12. Model residuals are noisy, but show no particular trends or non-randomness. The retrospective plots are shown in Figre 5.13 and these indicate rather different stock trends with the exclusion of the final data point. The

ScoGFSQ4 survey is a relatively short time series (in comparison to ScoGSQ1), without particularly good internal consistency or strong year-class signals (See Section 5.1.6.2) and this may be the reason for the poor retrospective performance.

Since the two surveys appear to be implying consistent stock trends, a multifleet SURBA was also explored. The FLSURBA has not yet been fully tested for multifleet applications and therefore all runs with the two surveys were carried out using SURBA 3.0. The summary output is shown in Figure 5.14 and the model residuals in Figure 5.15. The residuals are noisy, and over the year range (1996–2006) when data are available from both surveys, there are some obvious problems with the model fit: virtually all residuals for the ScoGFSQ1 survey (except age 1) are negative while those for the ScoGFSQ4 survey are positive. A number of alternative model runs were conducted to explore whether model fit improved with different assumed relative catchabilities on the younger ages of either survey. However, in all cases similar residual patterns were observed, suggesting that the two surveys are giving rather different signals in terms of age effects. The multifleet SURBA run was therefore not considered further.

5.1.6.2 Final assessment run

The FLSURBA run using ScoGFSQ1 data for ages 1–6 is presented as the final assessment run given that it shows less retrospective problems than the ScoGFSQ4 survey. The SURBA model settings for the final run are given below:

	ScoGFSQ1
Year range:	1985–2007
Age range:	1–6
Catchability at age:	1.0, 1.0, 1.0, 1.0, 1.0, 1.0
Age weighting:	1.0, 1.0, 1.0, 1.0, 1.0, 1.0
Lambda:	1.0

The settings are the same as last year. The output file from this run is given in Table 5.10 Trends in Z, recruitment and SSB from this run are shown in Figure 5.7 with empirical estimates from the surveys included for comparison on Figure 5.16 (See section 2.7 for details of how these estimates are calculated). The empirical results highlight the level of noise in the raw survey indices. For mean Z and SSB the general agreement between the empirical estimate and the model result is good. The level of SSB estimated in 2007 is the 2nd lowest in the time series and recruitment is also estimated to have been low in recent years following a short period of enhanced recruitment. The level of mean Z is higher in the second half of the time period than the first, but is estimated to have fluctuated a great deal in recent years.

The summary, residuals and retrospective plots from the final run are shown in Figures 5.7, 5.8 and 5.9 and are discussed in section 5.1.6.3.

5.1.6.3 Comparison with last year's assessment

The survey based assessment presented this year uses FLSURBA with a single survey fleet and has the same settings as the (SURBA 3.0) run presented last year. A comparison of this year and last year's assessments is available on the retrospective plot in Figure 5.9. In terms of biomass and recruitment this year's assessment is similar to that presented last year. However, with the addition of an extra year of data, the generally increasing mean Z pattern seen in the two previous assessments, has altered and mean Z is now estimated to be fluctuating at a high level.

5.1.6.4 Long-term trends in biomass, fishing mortality and recruitment

Considering Figure 5.7, the SSB for whiting in VIa appears to be at an all time low. During the time period over which the survey data are available there was an apparent period of higher abundance during the mid 1990s, since when SSB has gradually been declined and mortality increased. Recruitment for VIa whiting appears quite variable. There was a period from 1992–2000 showing higher recruitment values, but current estimates indicate that recruitment has been low in the three most recent years.

The total mortality plot shows mean Z to be higher in the last decade than in the preceding one.

5.1.7 Short-term stock predictions

No short-term predictions were made by this WG.

5.1.8 Medium-term predictions

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

5.1.9 Yield and biomass per recruit

No catch-based assessment was presented at the WG this year and the previous TSA assessment presented in 2004 was not accepted as the basis for advice. Therefore no yield and biomass per recruit analyses were conducted at this meeting.

5.1.10 Reference points

ICES's PA reference points are:

$\mathbf{F}_{lim}$ = 1.00; $\mathbf{F}_{pa}$ = 0.60; $\mathbf{B}_{lim}$ = 16,000t; $\mathbf{B}_{pa}$ = 22,000t

5.1.11 Quality of the assessment

Landings

In the recent past, the most significant problem with assessment of this stock is with commercial data. Incorrect reporting of landings - species and quantity-is known to occur and directly affects the perception of the stock. Furthermore, both TSA and XSA are strongly influenced by catch data. Thus a survey based assessment was used.

Effort

Commercial effort data for Division VIa in terms of hours fished is considered very uncertain and was not used in the assessment.

Discards

Discard estimates are available for use in the assessment of this stock, derived from Scottish and Irish sampling programmes. There are currently problems with the Scottish sampling design which is significantly over-stratified. Work on the development of a new Scottish estimate-collation scheme has been completed for Area VI and work is underway on Area IV. Once completed a full revision of the Scottish discard data will be carried out and consideration given to redesign of the sampling scheme.

Surveys

The survey used for this assessment changed vessel and tow duration in 1999. Although a correction has been made for this using comparative tows there will be an additional variance associated with this correction factor which will affect the survey series indices. The raw survey indices do not show good internal consistency as tracking of year classes is poor. Whether this is related to relatively limited dynamic range of year classes or simply a function of survey design or age estimation problems is worthy of further investigations.

Model formulation

Estimates of mean Z in this stock appear relatively uncertain and trends in Z alter quite markedly with the addition of a single year of data. This is due in part to the SURBA model assumptions, but also due to the rather noisy survey data used in this assessment. For this and other stocks, measures of mean SSB and recruitment have shown themselves to be robust to SURBA model assumptions.

5.1.12 Management considerations

Recruitment during the 1990’s appears to have been high while more recently recruitment has been below average.

This year’s assessment estimates SSB to be at its 2nd lowest value over the 20 years in the assessment, only marginally higher than the estimated 2006 SSB. The increasing trend in total mortality seen in last year’s assessment is not apparent this year and total mortality now appears to be fluctuating at a high level. The perception of the state of this stock (as estimated from this assessment) appears to have changed very little from last year.

Whiting are caught in mixed fisheries with cod and haddock in VIa. Management of whiting will be strongly linked to that for cod for which there is an ongoing recovery plan (see Section 15). There have also been several technical conservation measures introduced in the VIa gadoid fishery in recent years including the mandatory increases in mesh size to 120 mm.

Whiting are caught mainly as a by-catch species and there are no targeted fisheries for this stock, making direct management difficult. Whiting are caught and heavily discarded in small meshed fisheries for Nephrops. Any management measures which may result in a shift of vessels to these smaller mesh sizes will therefore result in a worse exploitation pattern and higher discards.

5.2 Whiting in Division VIb

Officially reported catches are given in Table 5.11.

Table 5.1. Nominal catch (t) of WHITING in Division VIa, 1989–2006, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006[*]
Belgium	1	-	+	-	+	+	+	-	1	1	+	-	-	-	-	+	-	-
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-	-	+	+	-	-
France	199[1]	180	352[1]	105	149	191	362	202	108	82	300	48	52	21	11	6	9	5
Germany	+	+	+	1	1	+	-	+	-	-	+	-	-	-	-	-	-	+
Ireland	1,315	977	1,200	1,377	1,192	1,213	1,448	1,182	977	952	1,121	793	764	577	568	356	172	194
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	-	-	-	-	-
UK (E&W)[3]	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	5	…
UK (N.I.)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
UK (Scot.)	6,109	4,819	5,135	4,330	5,224	4,149	4,263	5,021	4,638	3,369	3,046	2,258	1,654	1,064	751	444	103	
UK (total)																		180
Total landings	7,669	6,026	6,908	6,010	6,751	5,786	6278	6642	6178	4657	4677	3203	2543	1735	1365	819	289	379

[*] Preliminary.

[1] Includes Divisions Vb (EC) and VIb.

1989–2001 N. Ireland included with England and Wales.

n/a=Not available.

Table 5.2. Whiting in Division VIa. Annual weight and numbers caught, years 1978–2006.

Year	Weight (tonnes)			Numbers (thousands)		
	Total	Human consumption	Discards	Total	Human consumption	Discards
1978	20452	14677	5775	93932	54369	39563
1979	20163	17081	3082	77794	61393	16401
1980	15108	12816	2292	57131	44562	12569
1981	16439	12203	4236	72113	46067	26046
1982	20064	13871	6193	87481	47883	39598
1983	21980	15970	6010	79114	49359	29755
1984	24118	16458	7660	125708	50218	75490
1985	23560	12893	10667	124683	43166	81517
1986	13413	8454	4959	64495	31273	33222
1987	18666	11544	7122	103485	41221	62264
1988	23136	11352	11784	141314	40681	100633
1989	11599	7531	4068	54633	26876	27757
1990	10036	5643	4393	42927	19201	23726
1991	12006	6660	5346	63112	25103	38009
1992	15396	6004	9392	86903	22266	64637
1993	15373	6872	8501	68351	23246	45105
1994	14771	5901	8870	87881	20060	67821
1995	13657	6076	7581	77932	18763	59169
1996	14058	7156	6902	71396	22329	49067
1997	11192	6285	4907	50459	19250	31209
1998	10476	4631	5845	56583	14387	42196
1999	7734	4613	3121	38260	15970	22290
2000	9715	3010	6705	78815	10118	68697
2001	4850	2438	2412	20802	8477	12325
2002	3829	1709	2120	25179	5765	19414
2003	2936	1356	1580	15403	4124	11279
2004	3437	811	2626	21749	2571	19178
2005	1239	341	898	6154	1051	5103
2006	1326	380	946	12988	1049	11939
Min	1239	341	898	6154	1049	5103
GM	10469	5369	4493	53847	18030	31539
AM	13129	7750	5379	65751	26579	39172
Max	24118	17081	11784	141314	61393	100633

Table 5.3. Whiting in Division VIa. Available catch-effort and survey tuning series.

SCOLTR: Scottish Light Trawl - Effort in hours - Numbers at age (thousands)

1965	2005						
1	1	0	1				
1	7						
37387	2011.623	469.253	3512.923	393.473	14.925	5.445	0.909
40538	1036.117	926.485	162.985	5508.27	333.46	32.68	6.196

80916	2539.797	4967.604	1637.023	101.256	2456.915	133.979	12.466
65348	1931.014	3404.448	1868.458	677.298	51.295	844.125	58.939
106856	46.897	8823.442	2211.584	578.006	278.879	28.188	516.892
129741	94.958	5275.823	8514.611	712.848	143.241	35.554	3.428
137728	1566.57	4472.064	1026.561	9818.08	337.772	63.477	25.237
154288	13450.885	4637.042	1716.159	334.786	5435.152	309.86	29.756
93992	4613.649	12778.492	680.372	148.997	42.975	478.522	39.083
88651	7452.711	15917.02	1773.837	159.241	17.112	6.477	78.812
132353	10597.964	6684.991	10431.537	837.283	79.71	12.155	2.811
139225	10858.324	15481.895	3550.826	5483.438	412.525	13.045	4.668
143574	18222.115	4276.619	5983.177	773.244	1126.782	74.579	1.916
127387	9805.191	5887.935	1561.61	1814.903	127.832	244.126	3.76
99803	1846.163	9530.148	2446.896	368.018	290.896	31.887	57.01
121211	1856.938	4385.272	4359.469	1052.873	170.989	172.29	10.997
165002	983.137	13544.1	4617.56	1330.75	504.711	152.752	62.619
135280	8248.806	2593.129	10934.792	1899.759	316.934	74.891	62.409
112332	4809.036	4322.894	2548.597	8292.216	1696.241	253.9	54.475
132217	29865.064	4084.418	2582.188	1149.781	5206.862	592.972	221.473
142815	9243.535	11577.551	2515.313	663.96	360.662	917.939	82.73
126533	3187.288	6006.487	2693.592	621.738	98.497	50.635	93.945
131720	12328.429	6004.925	2767.12	1229.144	147.776	43.178	32.132
158191	5358.52	15325.219	2988.119	1334.433	316.668	46.956	2.997
217443	3161.234	1640.767	5226.339	1473.139	434.728	129.89	14.252
169667	4110.42	4152.38	972.043	1380.502	386.872	51.478	6.092
209901	7018.52	2968.053	3981.784	336.752	423.153	73.429	5.829
189288	9761.596	6548.587	1727.049	2100.437	113.974	102.439	10.66
189925	2623.886	10105.623	4392.988	1169.932	1701.769	51.678	46.841
174879	3251.43	6503.608	5363.793	1739.967	333.927	291.821	13.881
175631	1775.509	5661.947	5310.813	1995.375	569.453	114.177	107.935
214159	2738.034	8043.865	4647.63	2543.265	833.461	213.15	24.196
179605	3107.284	3973.701	5098.515	1858.52	532.696	95.153	39.379
142457	3997.939	3171.019	2547.76	2327.54	654.589	149.808	79.812
98993	559.916	3273.961	1709.217	814.593	793.265	122.037	34.883
76157	4363.101	2324.771	2202.561	627.094	169.833	201.883	8.678
35698	575.281	2603.626	1358.595	783.414	117.804	37.996	5.442
15174	389.652	848.153	1566.132	374.617	166.509	16.845	5.038
9357	565.293	207.507	273.115	578.307	100.052	41.916	0.206
7116	1769.901	1215.938	242.922	199.9	221.001	27.997	3.138
3063	217.522	400.094	268.966	23.085	27.158	14.318	2.462

(cont) Whiting in VIa. Available catch-effort and survey tuning series.

SCOSEI: SCOTTISH SEINE - EFFORT IN HOURS - NUMBERS AT AGE (THOUSANDS)

1965	2005					
1	1	0	1			
1	6					
153103	8570.938	4534.63	19453.707	1412.984	62.399	15.334
156511	2872.249	12671.39	1491.149	13027.566	736.15	68.22
158208	7058.77	23604.969	5804.573	363.182	5528.921	304.951

150094	11817.932	14128.65	4897.227	1409.535	134.705	1651.222
140718	1314.237	19167.426	4024.433	1038.908	420.643	45.006
95629	979.255	2065.056	9177.95	815.703	176.987	51.144
98748	3280.938	6459.36	2466.983	14808.06	484.003	73.488
70741	20563.777	7286.501	1143.727	588.902	3139.349	112.588
59596	16428.303	16410.354	1995.231	373.15	97.243	886.47
56448	8764.309	28089.33	3578.12	289.184	22.105	9.317
56420	15931.473	9161.576	13093.543	585.337	37.682	9.127
57090	7559.305	30718.529	6226.15	4887.683	283.504	18.081
41920	14522.98	4873.693	6783.85	584.118	1035.664	43.296
33599	9880.994	4708.252	812.33	1086.089	65.835	152.233
38465	3779.036	13497.126	3739.924	473.079	392.189	16.481
38700	2222.899	3686.353	4277.55	1081.223	273.049	118.803
37208	789.787	9229.84	3128.155	1025.456	426.614	90.387
36689	1146.222	1977.49	9664.041	1183.655	229.857	68.248
38080	3803.96	3110.436	1942.945	5805.497	1181.95	138.395
29561	3965.733	2170.117	1220.296	382.107	2024.552	218.843
26365	18813.885	6473.455	1248.851	327.561	171.234	557.447
19960	1423.965	4902.12	1815.778	359.211	53.845	24.911
26332	8664.831	3706.126	2068.674	916.903	142.281	19.137
21383	7392.194	8210.657	1658.022	1078.674	218.449	22.005
39350	2182.008	1845.431	4488.746	1282.547	272.354	186.923
27664	2699.332	2964.297	687.892	940.682	279.68	34.508
25787	4160.412	2318.718	3285.513	305.785	290.789	53.282
20273	7513.958	5370.645	1341.721	1622.613	102.037	101.204
24315	1509.725	6046.03	2291.531	675.422	789.292	22.916
21305	1725.208	3310.909	2498.717	701.186	108.245	140.133
21950	721.806	2616.333	2260.832	970.329	298.966	83.208
15205	1270.19	2353.781	1371.875	819.771	297.3	67.732
11449	1096.1	1273.361	1933.262	696.409	187.498	33.748
11166	4251.142	1659.104	1010.394	614.297	265.65	62.355
8638	823.21	2152.386	706.708	294.599	179.097	43.194
6431	2601.077	887.944	755.637	152.896	66.565	19.536
5893	728.924	1007.442	454.373	240.788	40.285	22.082
3817	335.558	583.357	482.121	132.428	40.991	2.935
2370	3130.339	260.924	133.135	290.007	34.543	8.6
1173	7323.289	758.611	165.379	83.46	77.222	2.096
476	676.408	225.196	143.246	10.154	15.355	3.048

(cont) Whiting in VIa. Available catch-effort and survey tuning series.

SCONTR: SCOTTISH NEPHROPS TRAWL - EFFORT IN HOURS - NUMBERS AT AGE (THOUSANDS)

1965	2005					
1	1	0	1			
1	6					
101975	1659.715	453.604	1101.02	102.448	4.875	0.947
116972	613.623	951.561	154.546	785.807	44.575	4.319
135811	1788.967	2002.916	444.377	15.668	322.969	18.182

166713	1761.346	1850.07	637.399	159.199	12.641	190.783
155131	736.536	2706.572	437.098	155.072	44.263	4.378
144704	439.172	645.419	1379.363	127.922	31.719	12.912
127638	1072.488	444.198	235.897	1405.7	60.499	10.787
185397	3744.591	1908.742	232.266	70.731	730.108	46.028
186342	3462.89	5445.012	486.932	168.428	24.824	351.356
186342	1933.55	5427.964	650.405	87.286	11.605	3.757
203053	5916.971	2730.363	2846.712	319.449	35.425	9.045
224347	4061.224	4343.339	893.637	1142.92	125.278	3.601
196403	3573.612	1393.724	1431.401	168.241	289.689	17.117
219562	6053.242	2596.492	417.688	570.766	110.339	108.757
273713	659.614	3413.303	934.795	207.461	216.936	38.758
254147	1439.22	1529.161	1377.826	281.539	44.696	46.021
286461	1090.91	5250.686	1199.303	430.934	105.108	20.647
288902	2882.413	422	2552.725	439.981	95.697	55.05
293396	2702.936	1289.896	464.524	1258.148	205.504	48.013
312947	15763.118	731.211	414.638	132.72	870.58	84.641
384215	14885.186	3109.454	505.209	225.601	91.132	274.925
368971	2231.072	1259.03	707.734	246.405	8.838	22.587
395355	12048.819	1562.25	799.307	375.73	43.994	3.069
397682	19926.506	12751.985	539.705	138.471	31.741	1.001
379169	9854.602	485.161	443.582	152.424	71.883	13.451
390391	7434.593	1407.942	58.831	63.502	8.758	1.297
414817	13745.576	1280.079	294.651	27.112	43.958	5.263
391325	15245.132	3122.017	453.21	211.635	19.575	30.04
406753	6063.665	2833.312	611.27	159.111	112.856	2.336
380688	22785.318	4821.332	2174.707	613.104	18.004	26.177
333756	14759.284	5645.468	494.013	362.773	33.499	45.261
345007	14700.369	1316.965	633.638	192.741	44.427	25.493
354884	7854.017	1893.631	387.294	176.713	17.444	1.276
350882	13268.769	1926.434	620.474	116.935	63.417	3.41
337585	7208.116	1905.577	475.713	92.945	80.71	24.242
332659	31208.406	934.503	360.23	101.447	28.855	11.379
305743	1743.097	1271.809	189.3	80.436	14.844	15.496
258169	7281.766	1291.392	483.271	29.948	8.517	0.753
255729	4468.485	586.213	191.646	197.557	41.643	3.198
232356	3881.27	1310.954	239.992	157.625	102.126	6.493
220936	1738.881	829.542	258.178	41.47	16.707	7.849

(cont) Whiting in VIa. Available catch-effort and survey tuning series. For ScoGFSQ1, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising. For IreGFS, effort is given as minutes towed, numbers are in units.

SCOGFSQ1: SCOTTISH GROUNDFISH SRUVEY - EFFORT IN HOURS - NUMBERS AT AGE

1985	2007		
1	1	0	0.25
1	7		

10	3140	1792	380	85	23	156	18
10	1456	1526	403	68	10	9	10
10	6938	1054	584	143	36	2	1
10	567	3469	653	189	42	5	1
10	910	505	586	237	48	3	0
10	1818	572	122	216	61	4	1
10	3203	277	298	22	39	9	1
10	4777	1597	410	517	56	18	0
10	5532	6829	644	91	30	11	2
10	6614	2443	1487	174	56	15	6
10	5598	2831	1160	370	70	17	32
10	9384	2238	635	341	135	30	5
10	5663	2444	1531	355	102	17	4
10	9851	1352	294	195	50	14	1
10	6125	4952	489	103	16	1	0.4
10	12862	471	152	34	10	11	0
10	4653	1954	242	41	8	1	1
10	5542	1028	964	86	15	1	1
10	6934	746	436	300	32	2	4
10	5888	1566	189	131	44	9	1
10	1308	723	183	35	8	11	2
10	1441	466	282	77	+	3	+
10	614	522	127	75	16	3	2

IR-WCGFS : IRISH WEST COAST GFS (VIA) - EFFORT (MIN. TOWED) - WHITING NUMBER AT AGE

1993	2002					
1	1	0.75	0.79			
0	5					
2130	14403	32643	11419	1464	231	13
1865	264	11969	4817	2812	78	57
2026	34584	5609	6406	734	186	80
2008	376	7457	3551	374	232	5
1879	1550	13865	8207	1022	524	50
1936	1829	4077	3361	663	121	5
1914	3337	3059	1965	322	11	12
1878	682	10102	2126	109	109	4
965	1118	5201	2903	149	70	3
796	594	8247	9348	820	280	0

IRGFS: IRISH GROUNDFISH SURVEY - EFFORT IN MINUTES - NUMBERS AT AGE

2003	2006					
1	1	0.79	0.92			
0	6					
1127	1101	12886	2894	512	290	102
1200	6924	3114	1312	104	35	16
960	910	2228	1126	91	5	4

1510	99	1055	921	214	27	3

IreOTB: Irish otter trawl - Effort in hours - numbers at age (thousands)

1995	2005						
1	1	0	1				
1	7						
56335	222	298	530	461	92	28	98
60709	165	531	670	281	175	33	12
62698	99	358	515	282	339	133	89
57403	51	1092	552	312	186	218	232
53192	98	315	437	266	198	109	123
46913	50	131	188	303	158	76	65
48358	14	304	144	101	126	100	44
37231	31	162	388	27	65	97	47
39803	90	294	604	492	131	30	0
35140	33	387	266	245	200	28	21
30941	23	159	188	78	41	19	2

(cont). Whiting in VIa. Available catch-effort and survey tuning series. For ScoGFSQ4, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising.

ScoGFSQ4 : Quarter four Scottish groundfish survey - Effort in hours - numbers at age

1996	2006								
1	1	0.75	1						
0	8								
10	5154	1908	1116	570	188	51	6	1	0
10	8001	2869	951	323	160	46	12	1	0
10	1852	2713	1124	149	100	20	1	0	+
10	8203	2338	582	141	33	24	1	1	0
10	4434	4055	789	160	9	7	1	0	0
10	9615	1957	1420	155	40	12	2	0	0
10	14658	1591	621	479	30	9	5	0	0
10	9932	3446	567	338	83	27	4	0	0
10	5923	1758	940	83	57	62	1	0	0
10	2297	308	318	76	9	4	0	0	0
10	415	296	140	101	35	8	3	0	0

Table 5.4. Whiting in Division VIa. Landings at age (thousands).

	1	2	3	4	5	6	7+
1965	6938	6085	43530	4803	388	103	22
1966	1685	10544	2229	28185	1861	186	52
1967	5169	26023	10619	697	14574	789	143
1968	7265	16484	9239	3656	324	5036	368
1969	873	25174	8644	2566	1206	118	2333
1970	730	6423	28065	3241	670	214	550

1971	2387	8617	4122	34784	1338	240	223
1972	16777	12028	4013	1363	14796	793	148
1973	14078	36142	5592	1461	357	4292	310
1974	9083	51036	10049	1166	180	52	849
1975	14917	16778	36318	2819	281	57	245
1976	8500	46421	15757	17423	1508	66	57
1977	16120	13376	25144	3127	4719	292	24
1978	17670	18175	6682	9400	941	1433	68
1979	6334	34221	13282	3407	3488	276	384
1980	11650	11378	14860	4155	1244	1085	190
1981	3593	24395	11297	4611	1518	452	201
1982	2991	5783	29094	6821	2043	803	348
1983	3418	7094	8040	22757	6070	1439	540
1984	7209	12765	8221	4387	14825	1953	858
1985	4139	19520	8574	3351	1997	4764	822
1986	2674	14824	9770	2653	532	291	529
1987	6430	13935	13988	5442	837	330	259
1988	1842	20587	9638	6168	1949	290	207
1989	2529	5887	11889	4767	1266	468	71
1990	3203	8028	2393	4009	1326	204	37
1991	3294	8826	10046	1208	1391	286	51
1992	2695	9440	4473	4782	396	373	106
1993	1051	10179	6293	2673	2738	163	147
1994	909	4889	9158	3607	712	715	69
1995	215	4322	6516	5654	1397	376	282
1996	990	5410	7675	5052	2461	583	157
1997	877	3658	8514	4316	1441	338	106
1998	840	3504	4277	3698	1442	338	288
1999	1013	6131	4546	2040	1774	355	112
2000	484	2952	4211	1570	485	328	89
2001	461	3271	2630	1567	401	131	16
2002	62	1624	3018	799	227	23	13
2003	170	710	1111	1673	347	111	2
2004	54	724	543	521	622	78	29
2005	28	276	455	140	99	45	7
2006	82	139	369	260	61	113	24

Table 5.5. Whiting in Division VIa. Discards at age (thousands).

	1	2	3	4	5	6	7+
1965	17205	4968	11437	531	14	2	0
1966	4322	8946	515	3317	79	3	0
1967	12237	20791	2674	84	629	12	1
1968	16394	12612	2137	377	13	82	3
1969	1983	20494	2093	292	51	2	26
1970	1776	6704	7494	382	33	4	0

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

Table 5.6. Whiting in Division VIa. Total catch at age (thousands).

	1	2	3	4	5	6	7+
1965	24143	11054	54967	5334	402	105	22
1966	6007	19490	2744	31502	1940	189	53
1967	17406	46814	13293	781	15204	801	144
1968	23659	29096	11376	4034	337	5118	372
1969	2856	45668	10737	2858	1257	120	2358
1970	2506	13128	35559	3623	703	218	550

1971	7891	15336	5090	38690	1395	245	224
1972	55969	20958	4863	1514	15406	807	149
1973	44599	63137	6817	1608	371	4369	313
1974	32185	91625	12412	1289	188	53	856
1975	52213	30319	44804	3129	293	58	245
1976	33392	82233	19117	19363	1571	67	57
1977	64268	22051	30576	3428	4931	297	24
1978	45612	28680	7571	9606	942	1452	68
1979	9784	44943	14901	3940	3565	276	384
1980	14026	17551	18065	4806	1400	1093	190
1981	4610	46409	14060	4758	1618	456	201
1982	20829	10360	45032	8010	2098	804	348
1983	18487	15266	10004	27029	6246	1541	540
1984	75450	16716	9306	4959	16403	2011	863
1985	63922	36946	11708	4014	2058	5210	825
1986	13133	34909	12260	2770	539	293	591
1987	53305	27624	15506	5621	839	330	259
1988	48263	71982	12110	6460	2002	290	207
1989	20307	9547	17685	5168	1377	479	71
1990	19609	13819	3252	4580	1421	208	37
1991	33648	11700	14478	1381	1531	322	51
1992	49158	24481	6697	5691	396	373	106
1993	15669	32460	12259	3594	4055	163	149
1994	40606	23292	16933	5241	896	840	73
1995	28772	25243	14999	6615	1643	377	283
1996	29611	20027	12073	6447	2479	584	175
1997	19059	12695	11946	4782	1534	338	106
1998	32023	10808	6695	4689	1626	389	352
1999	14636	13387	5479	2408	1853	384	112
2000	64273	6508	5417	1687	500	343	89
2001	5975	9132	3368	1775	405	131	17
2002	14228	4859	4767	929	351	32	13
2003	9501	1817	1538	2044	381	119	4
2004	14721	4281	1079	825	730	82	31
2005	2951	1854	988	178	118	53	11
2006	9865	991	1369	516	97	124	26

Table 5.7. Whiting in Division VIa. Landings weights-at-age (kg).

	1	**2**	**3**	**4**	**5**	**6**	**7+**
1965	0.218	0.249	0.308	0.452	1.208	0.72	0.778
1966	0.238	0.243	0.325	0.374	0.61	0.72	0.828
1967	0.204	0.24	0.319	0.424	0.412	0.639	0.821
1968	0.206	0.263	0.366	0.444	0.554	0.538	0.735
1969	0.178	0.223	0.335	0.5	0.57	0.649	0.63
1970	0.205	0.203	0.274	0.382	0.519	0.619	0.683

1971	0.209	0.247	0.276	0.316	0.426	0.551	0.712
1972	0.211	0.258	0.345	0.368	0.426	0.494	0.638
1973	0.196	0.235	0.362	0.479	0.485	0.532	0.666
1974	0.193	0.215	0.317	0.444	0.591	0.641	0.584
1975	0.209	0.245	0.305	0.471	0.651	0.615	0.717
1976	0.201	0.242	0.309	0.361	0.497	0.687	0.856
1977	0.2	0.244	0.296	0.392	0.431	0.629	0.819
1978	0.199	0.235	0.286	0.389	0.516	0.549	0.612
1979	0.218	0.232	0.306	0.404	0.536	0.678	0.693
1980	0.172	0.242	0.33	0.42	0.492	0.595	0.817
1981	0.192	0.228	0.289	0.382	0.409	0.409	0.547
1982	0.184	0.22	0.276	0.352	0.505	0.513	0.526
1983	0.216	0.249	0.28	0.34	0.409	0.494	0.51
1984	0.216	0.259	0.313	0.371	0.412	0.458	0.458
1985	0.185	0.238	0.306	0.402	0.43	0.461	0.538
1986	0.174	0.236	0.294	0.365	0.468	0.482	0.499
1987	0.188	0.237	0.304	0.373	0.511	0.52	0.576
1988	0.176	0.215	0.301	0.4	0.483	0.567	0.6
1989	0.171	0.22	0.279	0.348	0.459	0.425	0.555
1990	0.225	0.251	0.324	0.359	0.417	0.582	0.543
1991	0.199	0.22	0.291	0.354	0.391	0.442	0.761
1992	0.193	0.23	0.288	0.349	0.388	0.397	0.51
1993	0.186	0.242	0.314	0.361	0.412	0.452	0.474
1994	0.161	0.217	0.29	0.371	0.451	0.482	0.483
1995	0.19	0.225	0.296	0.381	0.469	0.473	0.528
1996	0.195	0.245	0.288	0.365	0.483	0.526	0.569
1997	0.198	0.245	0.297	0.384	0.522	0.629	0.661
1998	0.215	0.236	0.301	0.364	0.438	0.5	0.646
1999	0.181	0.225	0.28	0.365	0.44	0.524	0.594
2000	0.205	0.241	0.298	0.336	0.419	0.488	0.617
2001	0.173	0.234	0.303	0.37	0.395	0.376	0.595
2002	0.213	0.257	0.304	0.363	0.464	0.65	0.707
2003	0.228	0.264	0.309	0.362	0.374	0.436	0.717
2004	0.193	0.251	0.295	0.345	0.382	0.403	0.342
2005	0.189	0.261	0.313	0.378	0.44	0.482	0.356
2006	0.221	0.292	0.319	0.394	0.455	0.528	0.567

Table 5.8. Whiting in Division VIa. Discard weights-at-age (kg).

	1	**2**	**3**	**4**	**5**	**6**	**7+**
1965	0.122	0.177	0.213	0.249	0.287	0.303	0.287
1966	0.122	0.178	0.212	0.248	0.29	0.297	0.286
1967	0.122	0.178	0.213	0.248	0.29	0.295	0.289
1968	0.128	0.179	0.213	0.249	0.291	0.298	0.287
1969	0.121	0.178	0.214	0.249	0.29	0.295	0.285
1970	0.121	0.175	0.213	0.249	0.29	0.299	0.284

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

Table 5.9. Whiting in Division VIa. Total catch weights-at-age (kg).

	1	**2**	**3**	**4**	**5**	**6**	**7+**
1965	0.15	0.217	0.288	0.432	1.177	0.712	0.776
1966	0.155	0.213	0.304	0.361	0.597	0.713	0.824
1967	0.146	0.212	0.298	0.405	0.407	0.634	0.817
1968	0.152	0.227	0.337	0.426	0.544	0.534	0.731
1969	0.138	0.203	0.311	0.474	0.559	0.643	0.626
1970	0.145	0.189	0.261	0.368	0.508	0.613	0.683

1971	0.147	0.216	0.264	0.309	0.42	0.547	0.71
1972	0.148	0.223	0.322	0.356	0.421	0.491	0.636
1973	0.146	0.21	0.336	0.458	0.477	0.528	0.663
1974	0.14	0.198	0.297	0.426	0.579	0.636	0.581
1975	0.145	0.214	0.288	0.449	0.636	0.61	0.717
1976	0.138	0.214	0.292	0.35	0.489	0.679	0.854
1977	0.139	0.218	0.281	0.379	0.425	0.624	0.816
1978	0.16	0.21	0.276	0.387	0.516	0.545	0.612
1979	0.202	0.222	0.295	0.378	0.531	0.678	0.693
1980	0.167	0.22	0.308	0.393	0.467	0.593	0.817
1981	0.173	0.196	0.271	0.379	0.401	0.408	0.547
1982	0.109	0.202	0.252	0.336	0.499	0.513	0.526
1983	0.155	0.215	0.27	0.324	0.405	0.479	0.51
1984	0.099	0.245	0.305	0.358	0.397	0.453	0.457
1985	0.107	0.216	0.288	0.383	0.427	0.448	0.537
1986	0.109	0.198	0.274	0.36	0.466	0.481	0.474
1987	0.097	0.21	0.297	0.369	0.51	0.52	0.576
1988	0.08	0.164	0.281	0.392	0.477	0.567	0.6
1989	0.108	0.204	0.255	0.337	0.446	0.422	0.555
1990	0.14	0.217	0.295	0.342	0.405	0.577	0.543
1991	0.096	0.207	0.265	0.338	0.376	0.424	0.761
1992	0.114	0.195	0.265	0.33	0.388	0.397	0.51
1993	0.123	0.211	0.271	0.331	0.361	0.452	0.474
1994	0.089	0.17	0.258	0.344	0.419	0.448	0.474
1995	0.076	0.166	0.235	0.361	0.44	0.473	0.528
1996	0.098	0.198	0.257	0.336	0.482	0.526	0.537
1997	0.116	0.2	0.275	0.369	0.505	0.629	0.661
1998	0.101	0.197	0.274	0.341	0.42	0.469	0.573
1999	0.084	0.194	0.269	0.34	0.433	0.504	0.593
2000	0.076	0.199	0.277	0.329	0.415	0.478	0.617
2001	0.1	0.183	0.28	0.35	0.395	0.376	0.589
2002	0.074	0.194	0.27	0.346	0.385	0.554	0.685
2003	0.08	0.211	0.287	0.34	0.36	0.427	0.526
2004	0.086	0.197	0.266	0.308	0.371	0.4	0.34
2005	0.089	0.166	0.264	0.344	0.42	0.455	0.362
2006	0.047	0.21	0.258	0.345	0.406	0.527	0.551

Table 5.10. Whiting in Division VIa.: Summary of SURBA indices of abundance at age, SSB and total mortality Z, based on data from ScoGFSQ1.

ABUNDANCE AT AGE

	Age					
Year	**1**	**2**	**3**	**4**	**5**	**6**
1985	3.8770	1.2817	0.3368	0.0526	0.0305	0.1542
1986	3.4741	1.2998	0.3600	0.0877	0.0104	0.0064

1987	4.9379	1.3911	0.4487	0.1166	0.0226	0.0028
1988	1.0080	1.9614	0.4758	0.1439	0.0297	0.0061
1989	1.5683	0.3526	0.5787	0.1305	0.0304	0.0067
1990	1.1140	0.5892	0.1130	0.1733	0.0306	0.0075
1991	2.1415	0.4825	0.2229	0.0403	0.0502	0.0093
1992	5.7031	1.4009	0.2947	0.1321	0.0215	0.0275
1993	5.8484	2.9083	0.6405	0.1286	0.0488	0.0083
1994	4.6396	2.6938	1.1815	0.2466	0.0408	0.0162
1995	8.6710	2.0496	1.0425	0.4320	0.0736	0.0128
1996	6.2100	3.6284	0.7448	0.3565	0.1190	0.0213
1997	5.7722	2.3020	1.1453	0.2194	0.0821	0.0290
1998	7.3536	1.5725	0.5080	0.2309	0.0320	0.0129
1999	6.0412	1.6754	0.2819	0.0822	0.0259	0.0039
2000	11.2880	1.3459	0.2927	0.0444	0.0089	0.0031
2001	3.6348	2.9349	0.2813	0.0557	0.0060	0.0013
2002	1.6319	1.3224	0.9065	0.0810	0.0125	0.0014
2003	5.1541	0.6513	0.4548	0.2925	0.0208	0.0034
2004	4.7086	1.6768	0.1767	0.1141	0.0555	0.0042
2005	1.4209	1.0740	0.3010	0.0286	0.0128	0.0068
2006	1.2439	0.3575	0.2161	0.0550	0.0037	0.0018
2007	0.5831	0.5328	0.1335	0.0761	0.0157	0.0011

Table 5.10. (continued)

STOCK SUMMARY

YEAR	**REC**		**SSB**	**TSB**	**MEAN Z (2-4)**	
	EST	**SE LOG**	**EST**	**EST**	**EST**	**SE LOG**
1985	3.877	0.359	0.476	0.891	1.411	0.08
1986	3.474	0.322	0.396	0.774	1.182	0.05
1987	4.938	0.319	0.481	0.965	1.192	0.048
1988	1.008	0.325	0.529	0.61	1.356	0.047
1989	1.568	0.323	0.28	0.449	1.264	0.047
1990	1.114	0.322	0.237	0.393	1.08	0.048
1991	2.141	0.306	0.195	0.403	0.548	0.05
1992	5.703	0.312	0.414	1.058	0.87	0.049
1993	5.848	0.315	0.851	1.565	1.001	0.048
1994	4.64	0.316	0.872	1.285	1.055	0.048
1995	8.671	0.317	0.782	1.441	1.125	0.048
1996	6.21	0.32	1.094	1.703	1.281	0.047
1997	5.772	0.334	0.916	1.586	1.679	0.044
1998	7.354	0.344	0.547	1.29	1.91	0.043
1999	6.041	0.346	0.442	0.956	1.939	0.043
2000	11.288	0.339	0.369	1.227	1.739	0.044
2001	3.635	0.321	0.635	0.999	1.305	0.047
2002	1.632	0.317	0.535	0.656	1.186	0.047
2003	5.154	0.337	0.377	0.789	1.45	0.046
2004	4.709	0.372	0.435	0.84	1.908	0.044
2005	1.421	0.398	0.276	0.403	1.782	0.044
2006	1.244	0.436	0.152	0.211	1.095	0.068

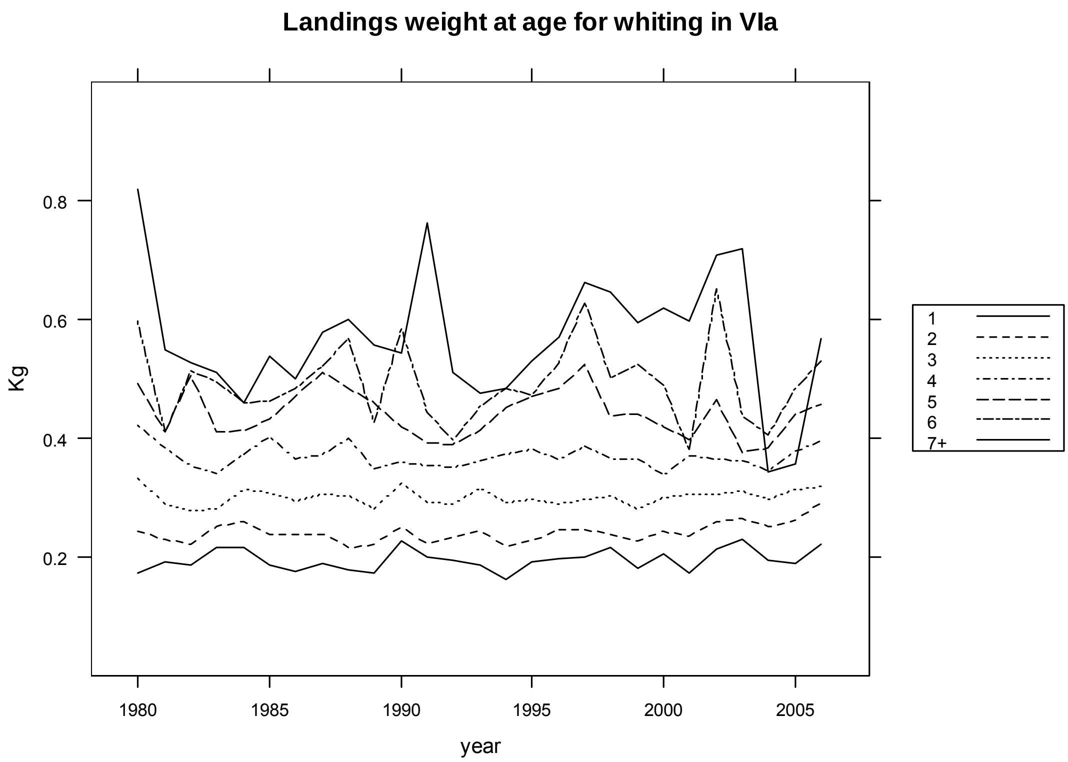
STOCK SUMMARY

YEAR	REC		SSB	TSB	MEAN Z (2-4)	
	EST	SE LOG	EST	EST	EST	SE LOG
2007	0.583	0.581	0.169	0.212	1.595	0.015

Table 5.11. Nominal catch (t) of WHITING in Division VIb, 1988–2006, as officially reported to ICES.

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10		2	3	3	104
Spain	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
UK (E.& W)[3]	16	6	1	5	10	2	5	26	49	20	+	+	-	-	-	-	…	…
UK (N.Ireland)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	18	482	459	283	86	68	53	36	65	23	44	58	4	7	11	1		
UK (all)																	1	1
Total	**34**	**488**	**460**	**288**	**128**	**80**	**62**	**85**	**117**	**44**	**44**	**58**	**14**	**7**	**13**	**4**	**4**	**105**

***Preliminary.**



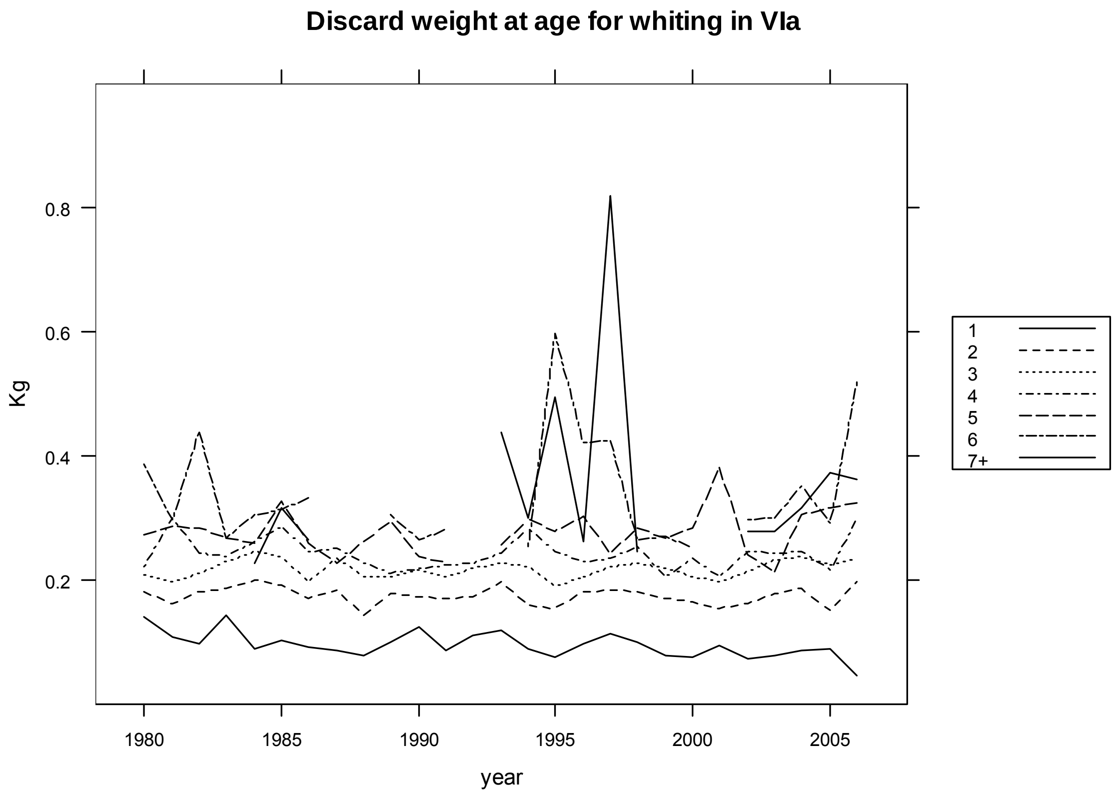


Figure 5.1. Whiting in Division VIa. Mean weights at age in the landings and discards.

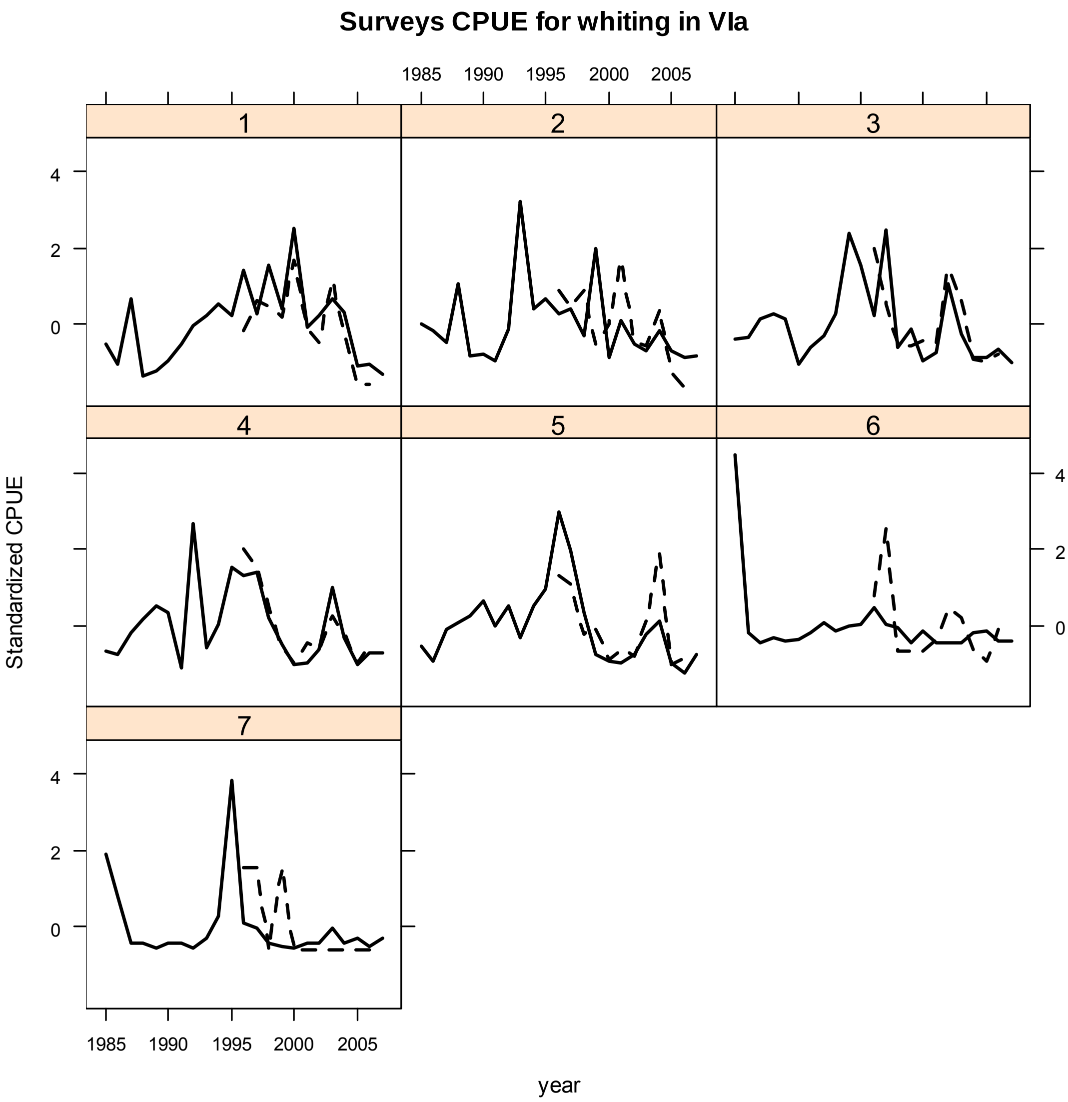
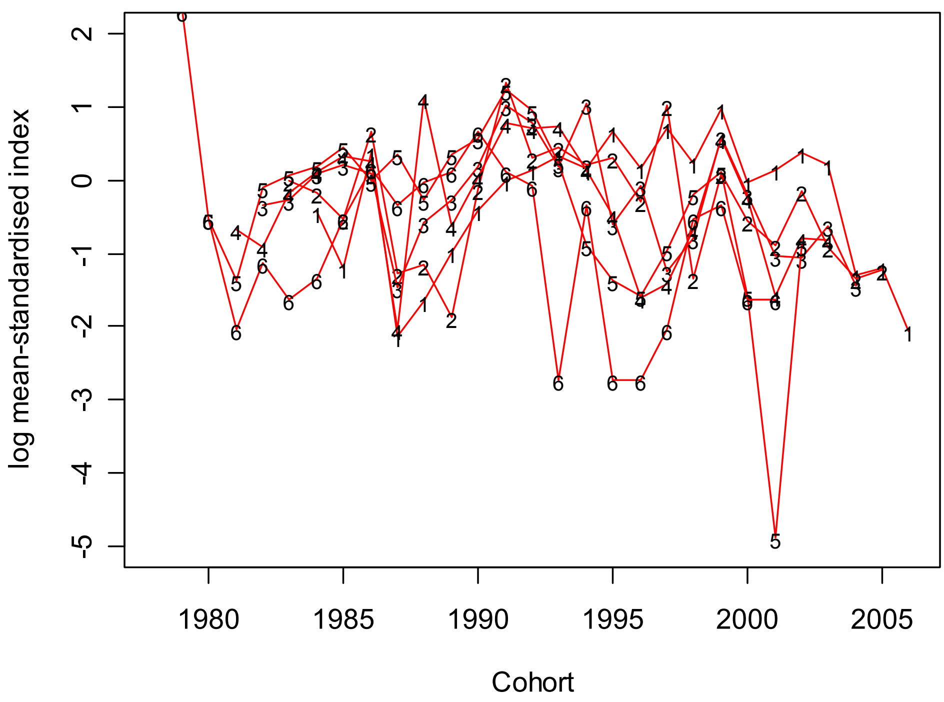


Figure 5.2. Whiting in Division VIa. Comparison of scaled survey indices from ScoGFSQ1(solid line) and ScoGFSQ4 (dashed line) by age.



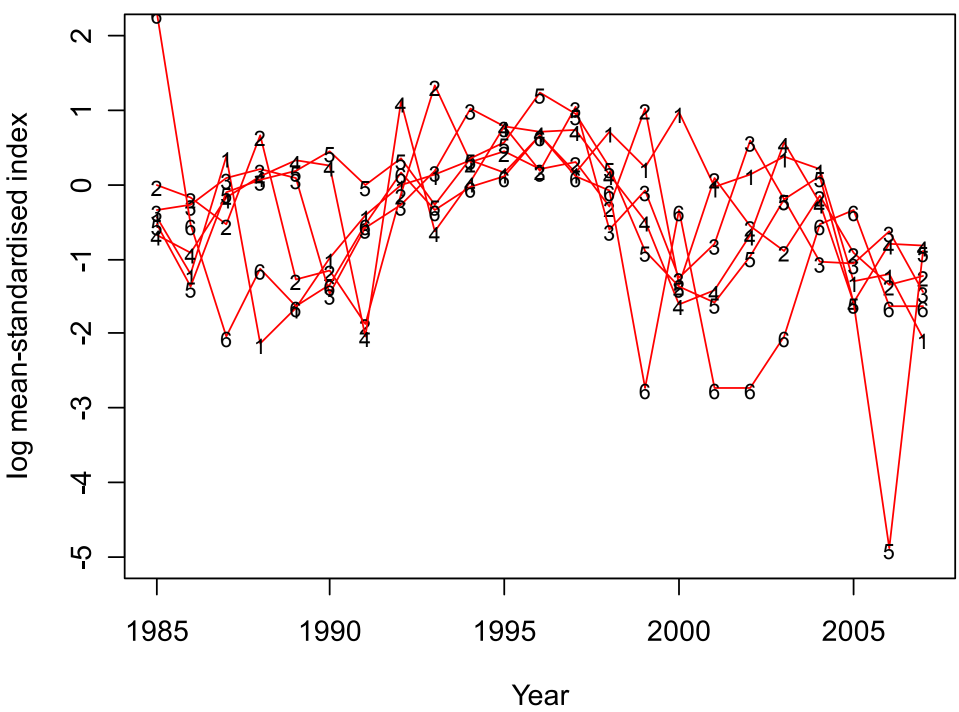
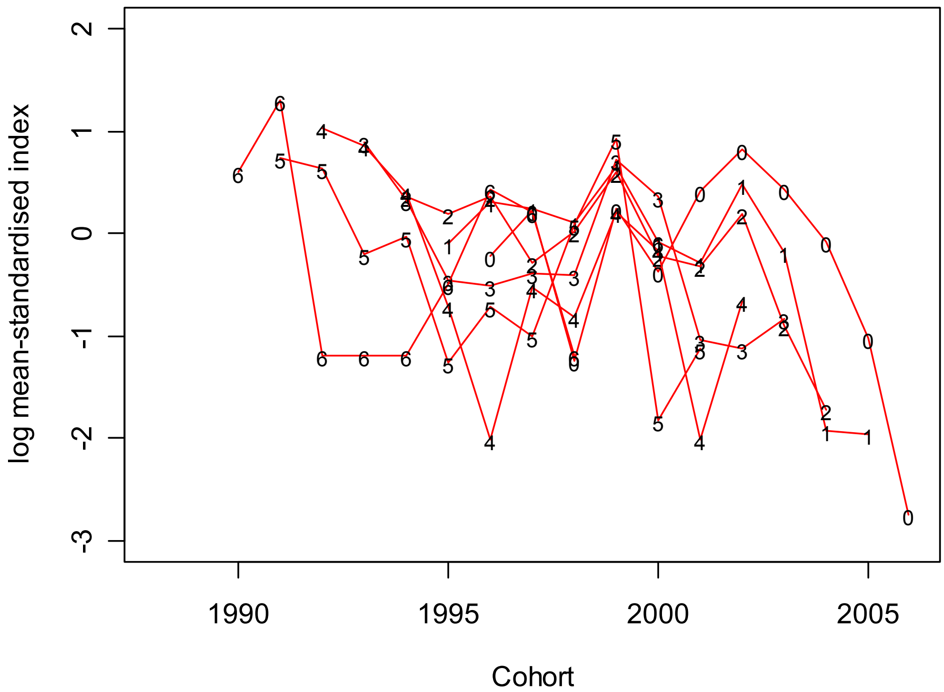
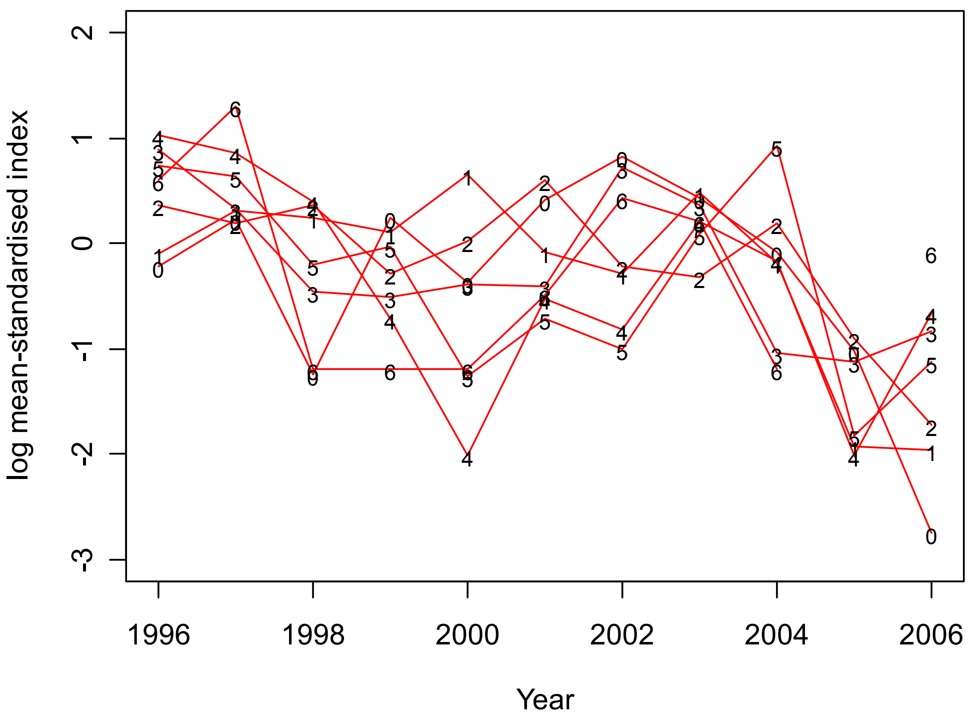


Figure 5.3. Whiting in Division VIa. Log mean standardised survey index for each age by cohort and year. Scottish ground fish survey (ScoGFSQ1) and Scottish quarter four ground fish survey (ScoGFSQ4).





(cont): Whiting in Division VIa. Log mean standardised survey index across all available ages. Scottish ground fish survey (ScoGFSQ1) and Scottish quarter four ground fish survey (ScoGFSQ4).

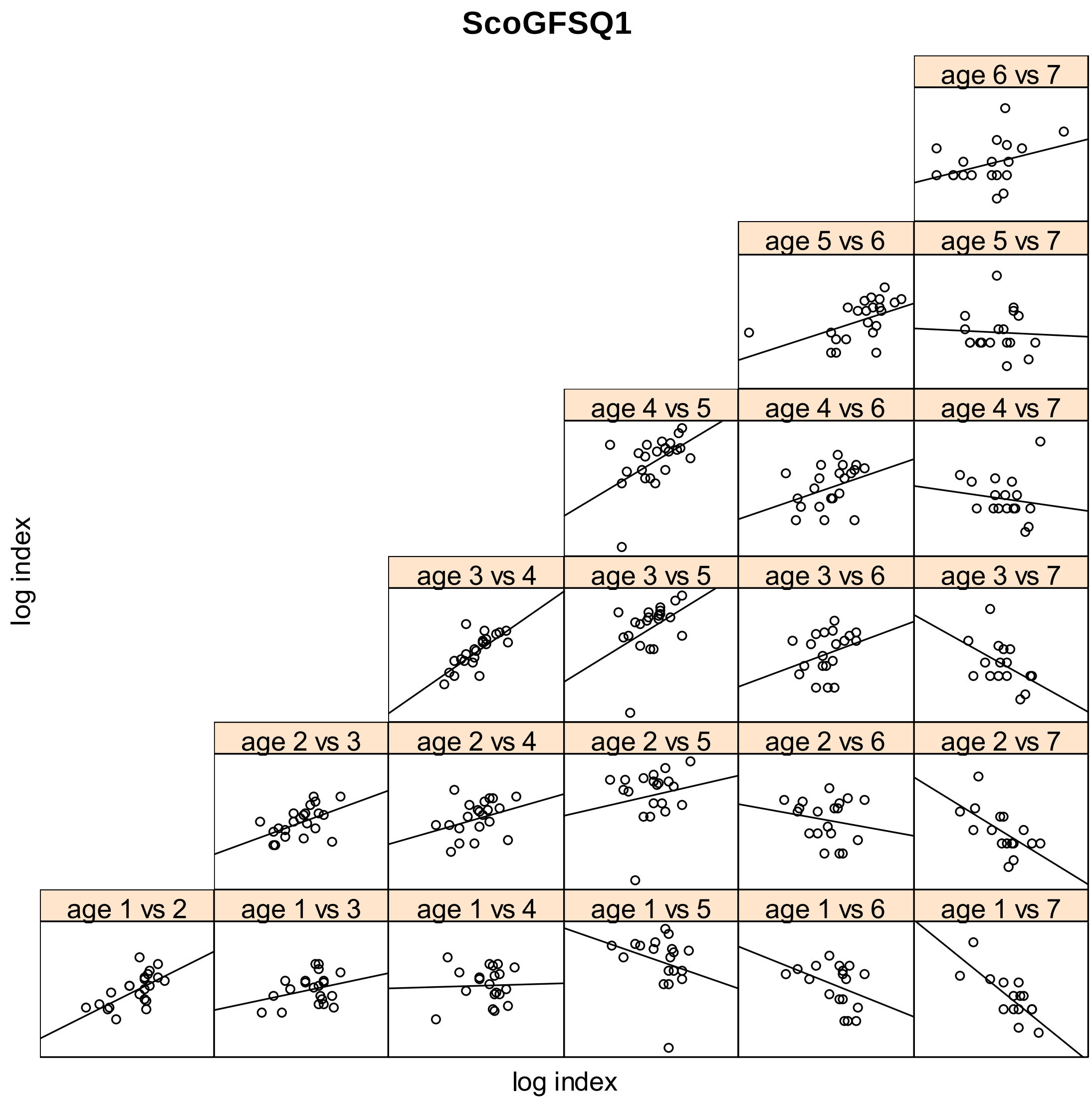


Figure 5.4. Whiting in Division VIa. Comparative scatterplots at age for Scottish ground fish survey (ScoGFSQ1).

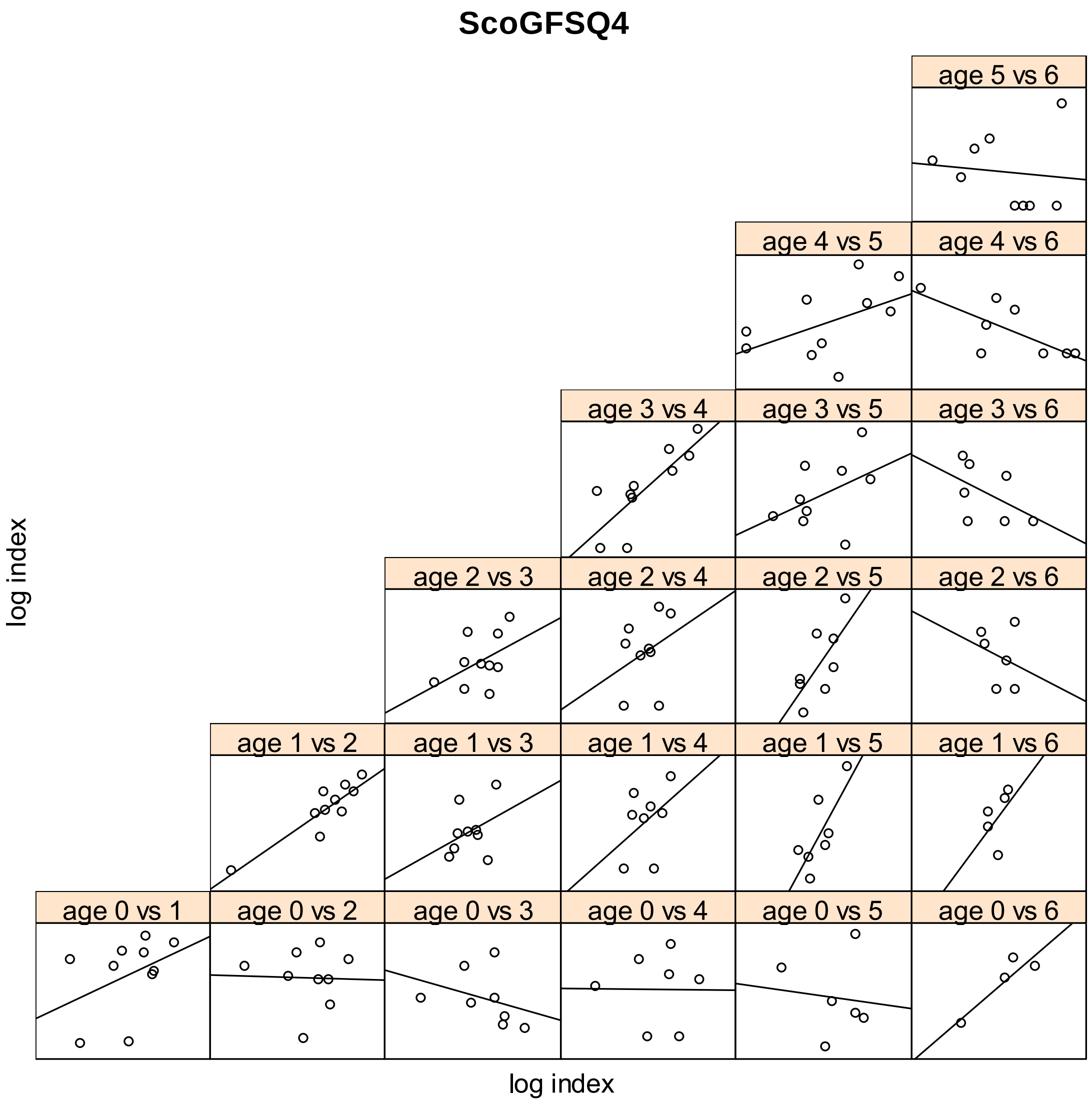


Figure 5.5. Whiting in Division VIa. Comparative scatterplots at age for Scottish quarter four ground fish survey (ScoGFSQ4).

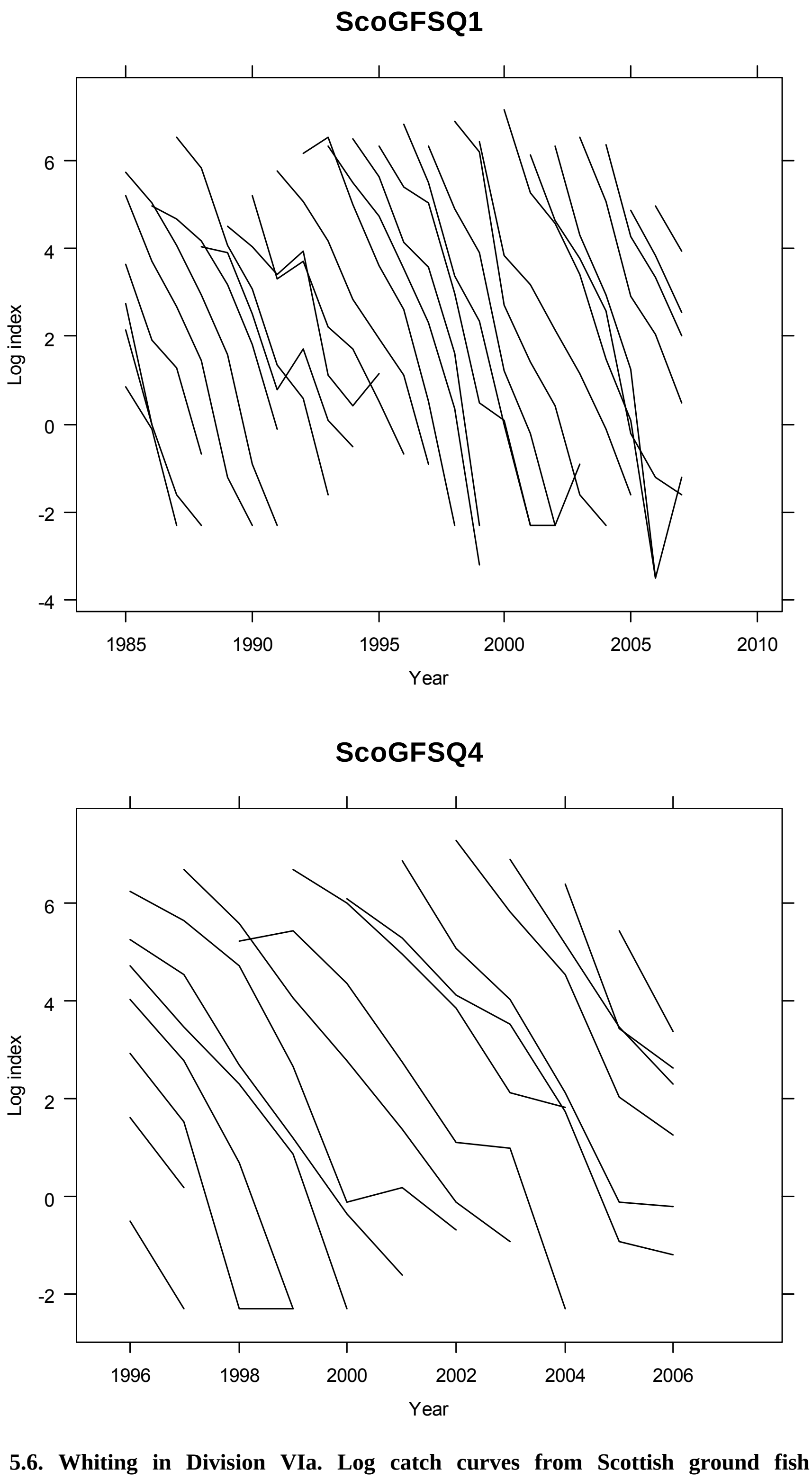


Figure 5.6. Whiting in Division VIa. Log catch curves from Scottish ground fish survey (ScoGFSQ1, ages 1–7) and scottish quarter four ground fish survey (ScoGFSQ4, ages 0–7).

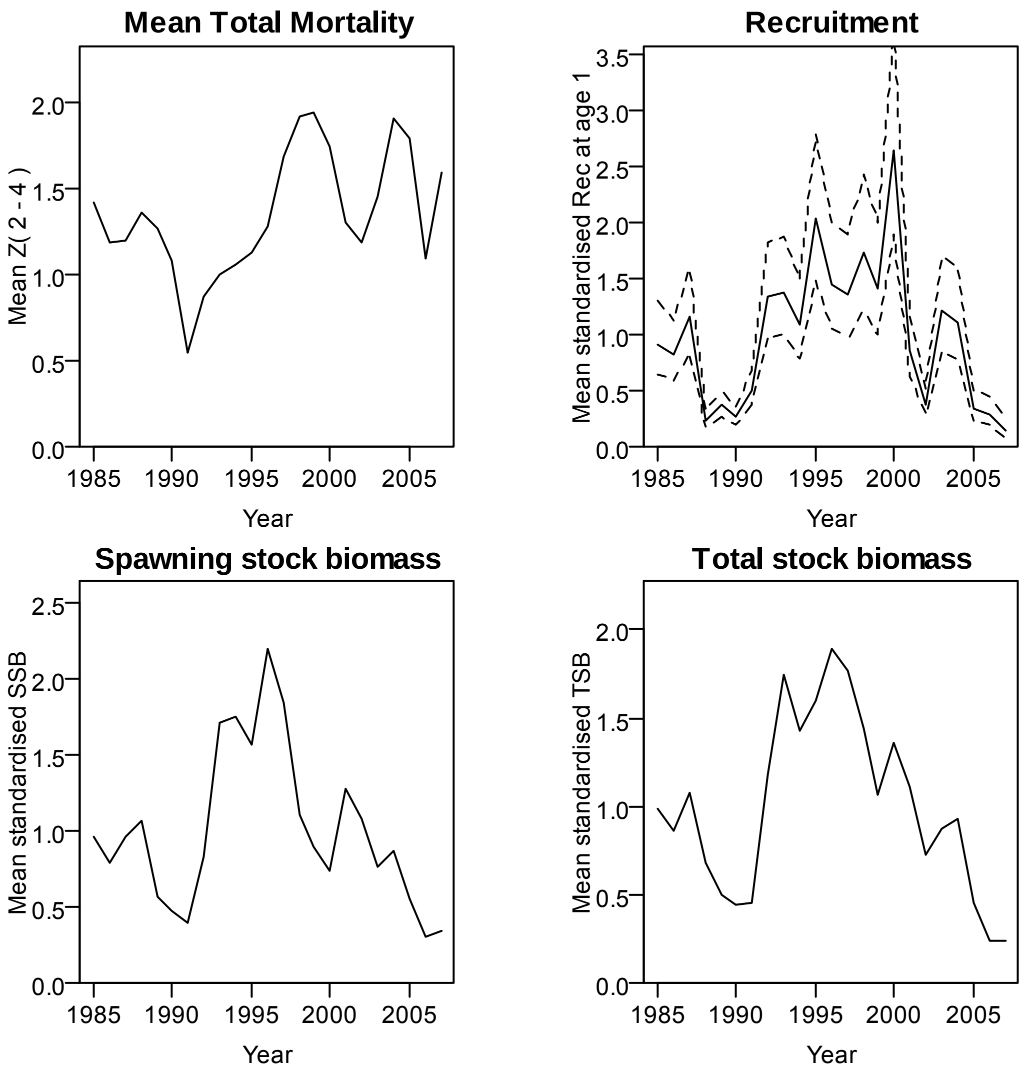


Figure 5.7. Whiting in Division VIa. Results of FLSURBA run using ScoGFSQ1 data. Z estimates are given as absolute; biomass and recruitment are mean-standardised. Recruitment is shown with +/-1 standard errors.

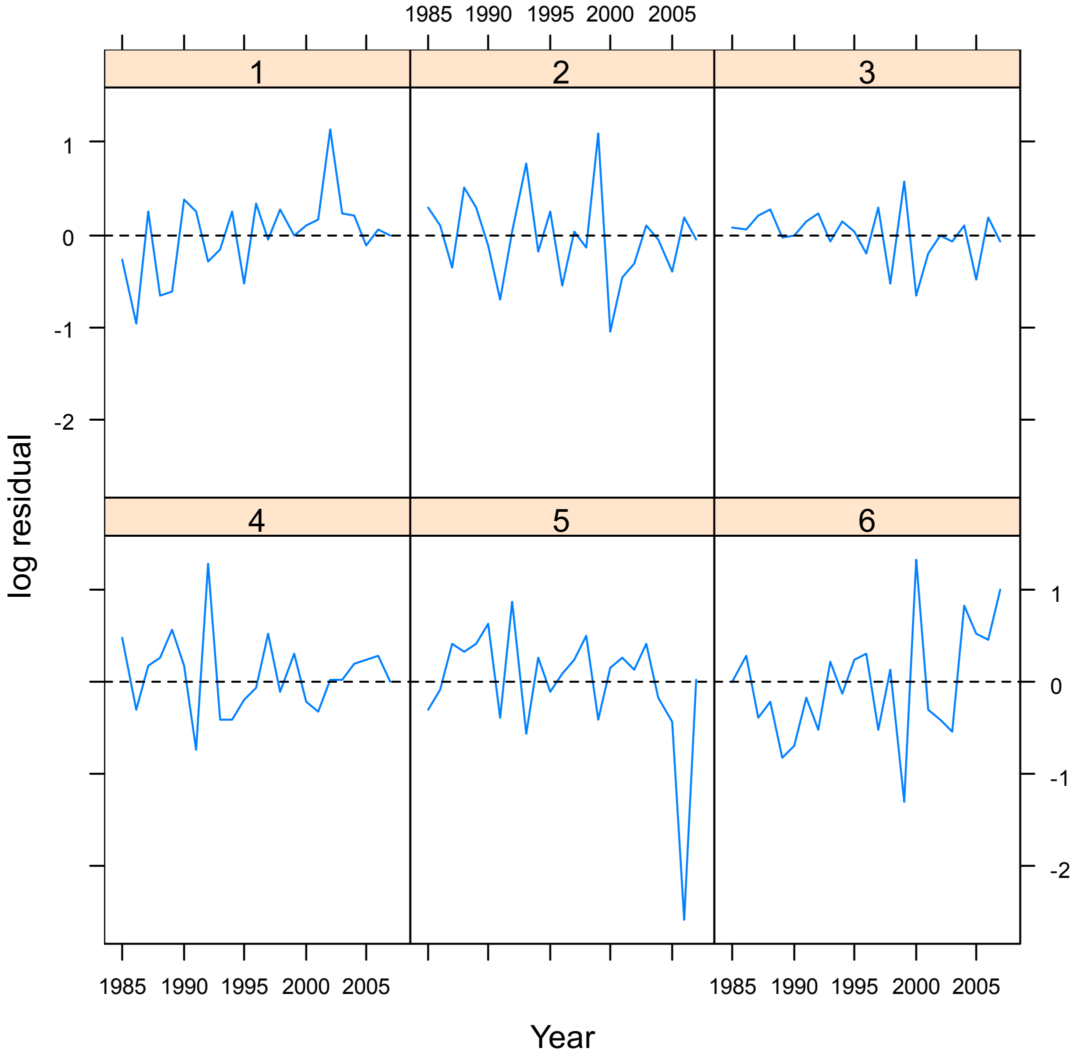


Figure 5.8. Whiting in Division VIa. Residuals by age from FLSURBA run using ScoGFSQ1.

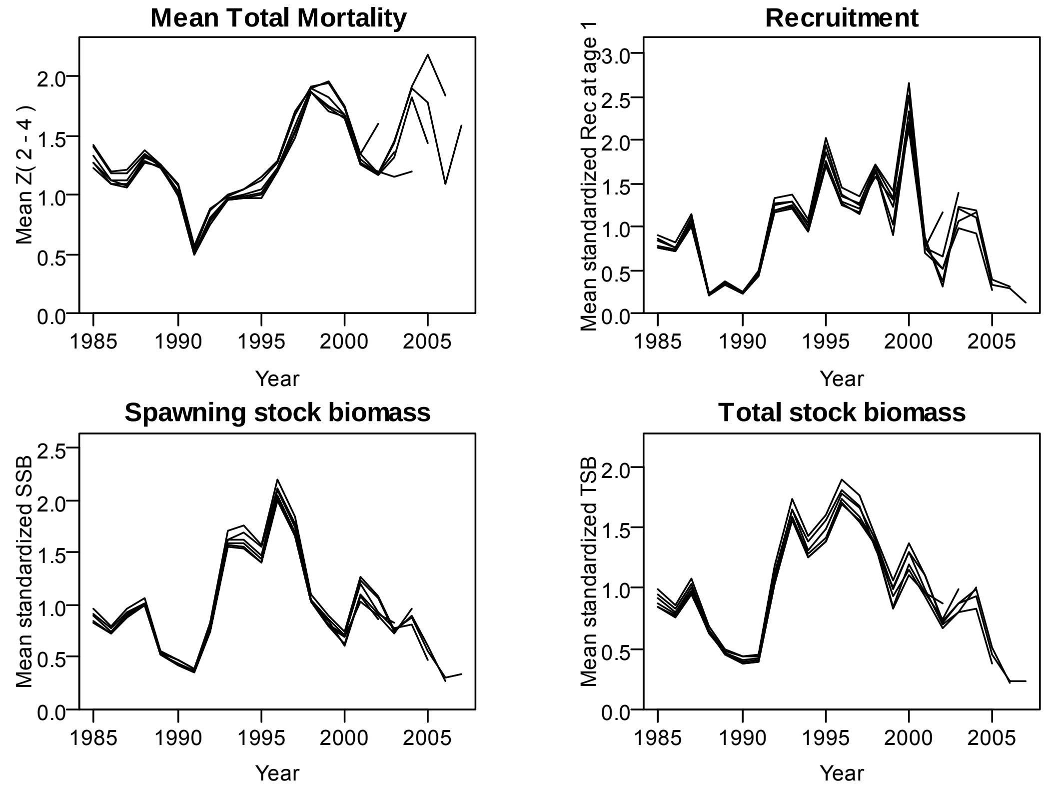


Figure 5.9. Whiting in Division VIa. Retrospective plots of SURBA run using ScoGFSQ1.

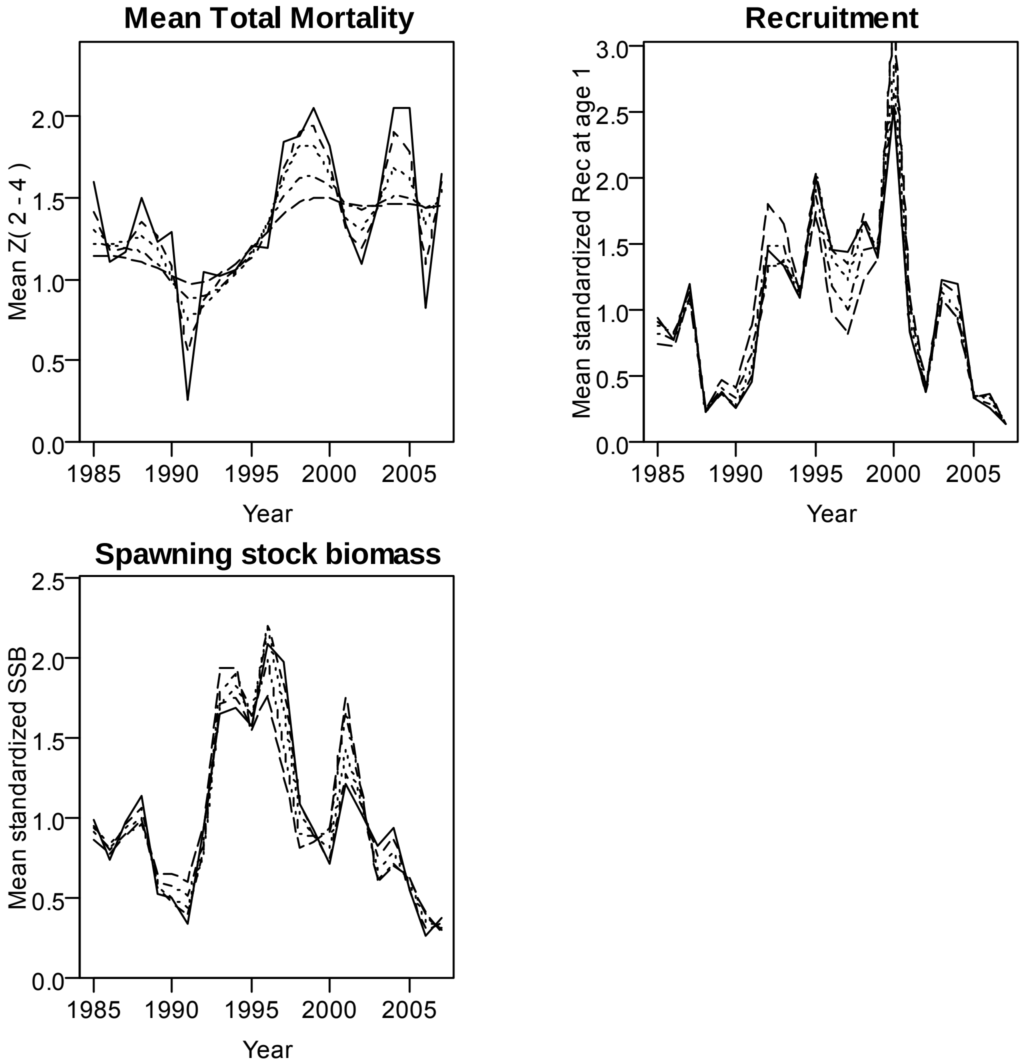


Figure 5.10. Whiting in Division VIa. Comparison of SURBA runs using ScoGFSQ1 with different values of the lambda smoother parameter (0.5, 1, 2, 5 & 10)

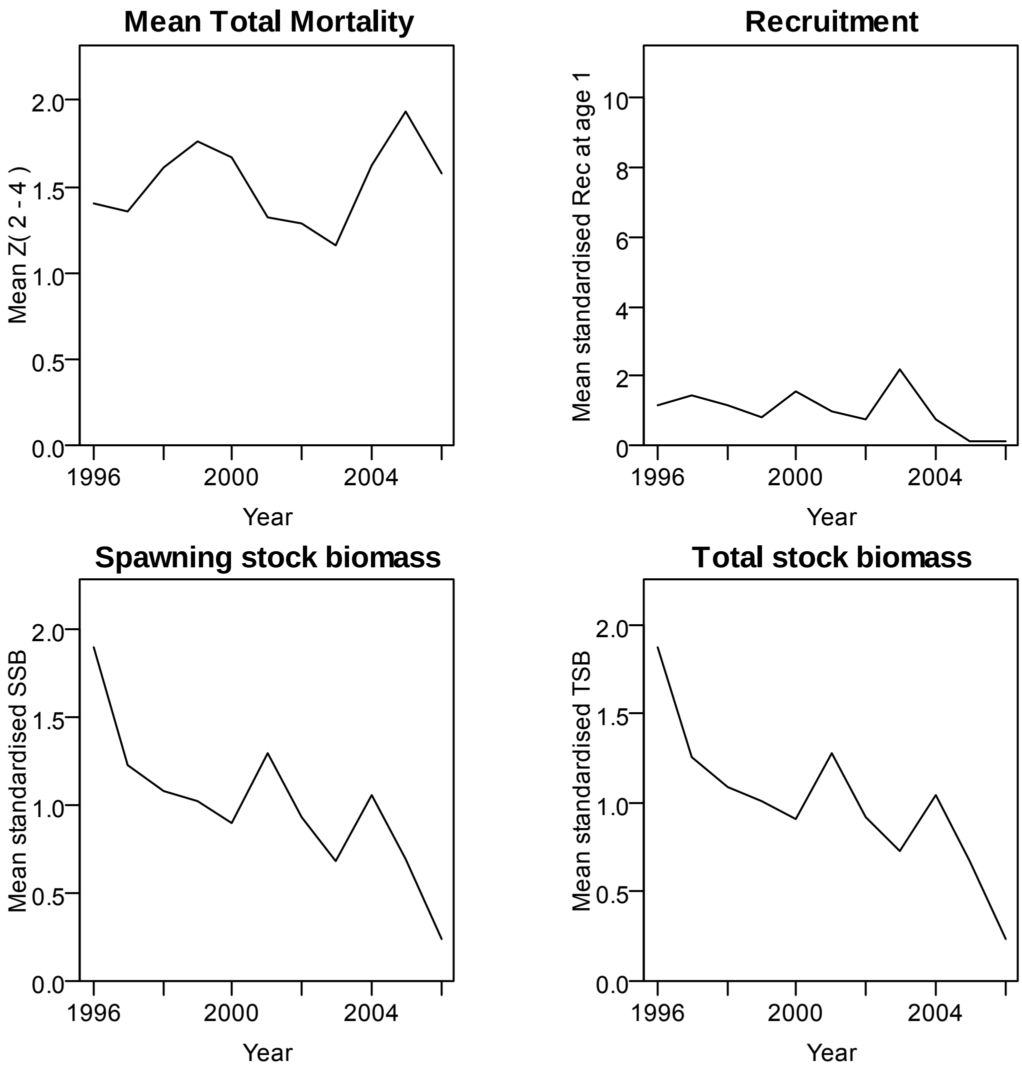


Figure 5.11. Whiting in Division VIa. Results of FLSURBA run using ScoGFSQ4 data. Z estimates are given as absolute; biomass and recruitment are mean-standardised. Recruitment standard errors too large to be shown on figure.

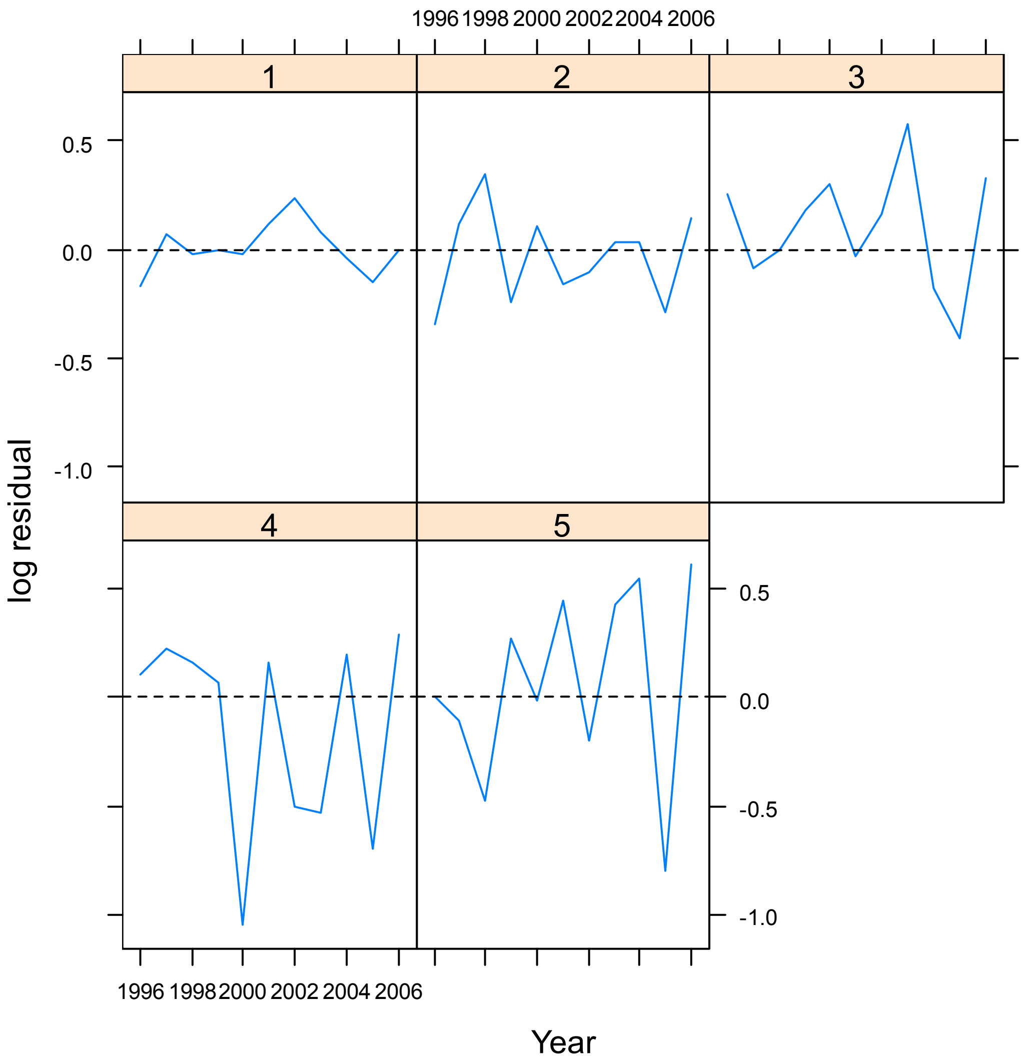


Figure 5.12. Whiting in Division VIa. Residuals by age from FLSURBA run using ScoGFSQ4.

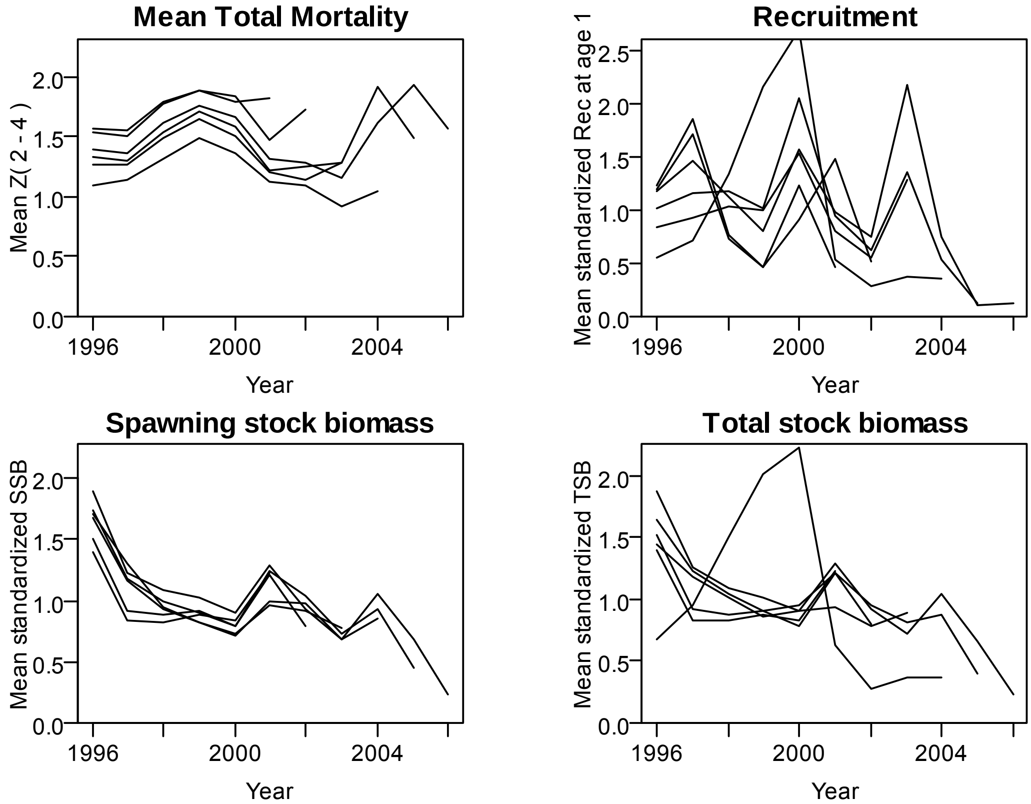


Figure 5.13. Whiting in Division VIa. Retrospective plots of SURBA run using ScoGFSQ4.

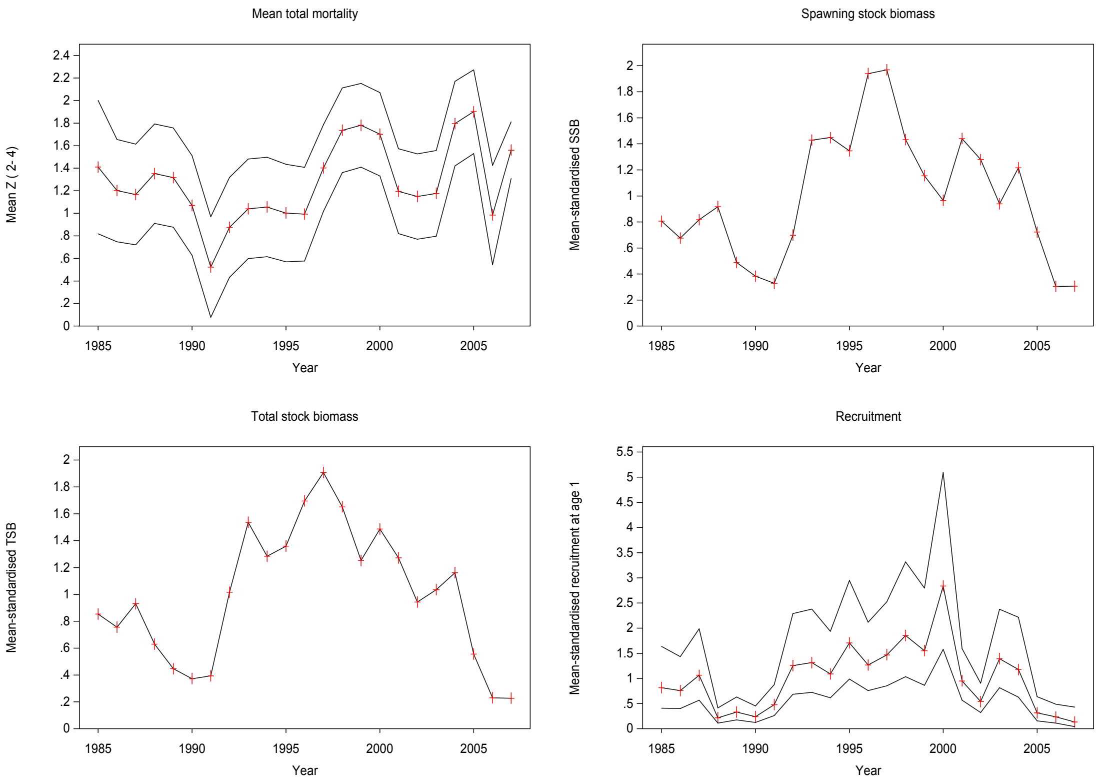


Figure 5.14. Whiting in Division VIa. Results of multifleet SURBA run using ScoGFSQ1 and ScoGFSQ4 data. Z estimates are given as absolute; biomass and recruitment are mean-standardised. Mean Z and recruitment are shown with +/-1 standard errors.

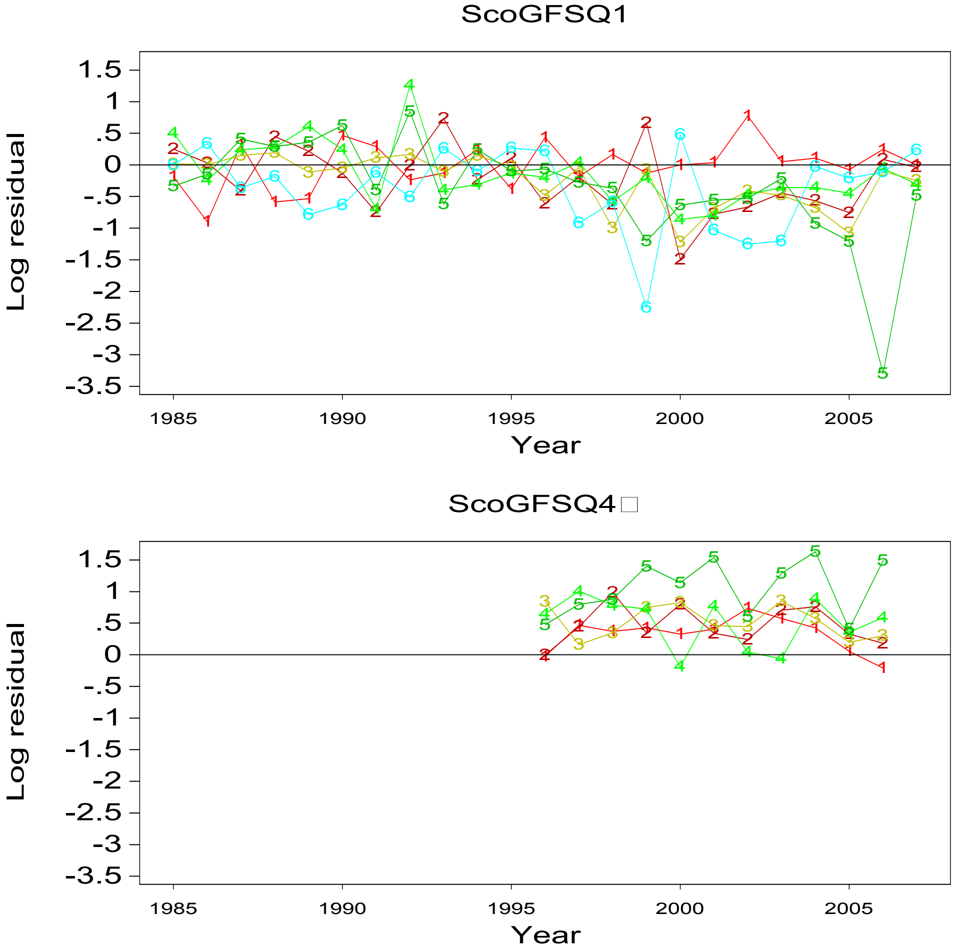


Figure 5.15. Whiting in Division VIa. Residuals from multifleet SURBA run for a) ScoGFSQ1 and b) ScoGFSQ4.

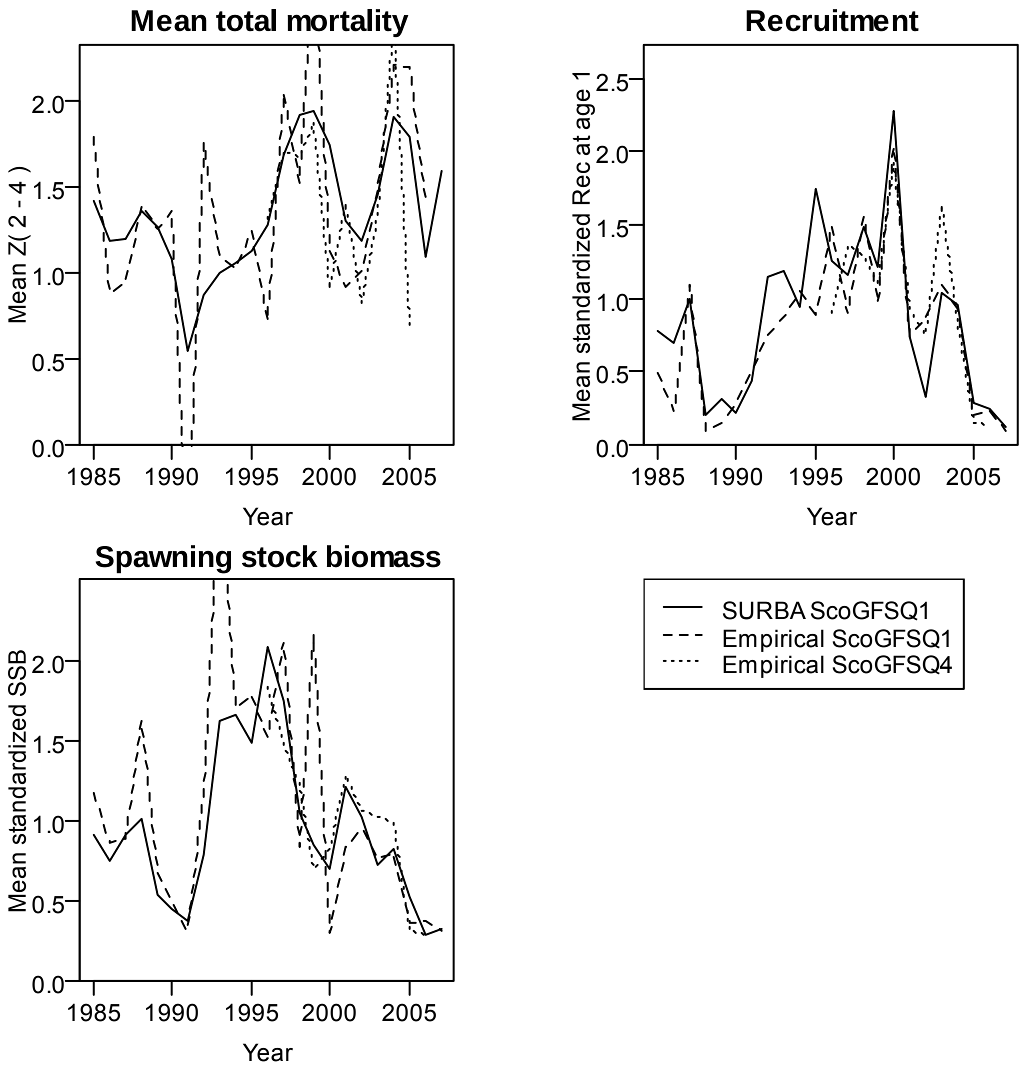


Figure 5.16. Whiting in Division VIa. Comparison of SURBA final run outputs with empirical estimates from the 2 Scottish surveys. Biomass and recruitment are mean standardized over 1996–2006 (the length of the shortest survey).

6 Anglerfish (on the Northern Shelf & IIa)

For the purposes of this section, the Northern Shelf is considered to comprise Division IIIa (Skagerrak & Kattegat), Sub-area IV (the North Sea) and Sub-area VI (West of Scotland plus Rockall). Anglerfish in the North Sea and Skagerrak/Kattegat were considered by this Working Group for the first time in 1999. In 2004, the WG was asked to consider the stock structure of anglerfish on a wider Northern European scale and despite a lack of conclusive evidence to indicate a single stock, anglerfish in IIa has been included in the ToR for this WG since then.

Management of Northern Shelf anglerfish is based on separate TACs for the North Sea area and West of Scotland area. Therefore, descriptions of the particular fisheries and management advice applicable to the individual Northern Shelf areas are given in Sections 6.1 and 6.2, while Section 6.3 contains details applicable to the combined Northern Shelf. Division IIa is considered in Section 6.4.

The decision to include descriptions of each area separately and then consider a combined Northern Shelf area assessment means that this chapter contains extensive text. Consequently, the WG wishes to highlight four specific issues at an early point:

The rapid development of the fishery in Divisions VIa and IVa in terms of the increase in reported landings from 1991 to 1996, was matched by an equally rapid decline in the following years (Figures 6.1.1) although the continued decline in reported landings may have been due to restrictive TACs and is not necessarily representative of actual catches.

It has previously been hypothesised that the deeper waters of the shelf edge to the west of Scotland may provide a refuge for mature female anglerfish. However, very few have been observed by scientific observers on commercial vessels fishing in this area in 1999 and 2000, or by targeted research vessel surveys undertaken during the same years, as part of an EU-funded research project entitled 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' (EC study contract 98/096, Anon 2001). More recent surveys (see section 6.3.2) have also failed to observe any large spawning locations.

The *status quo* catch forecast for the Northern Shelf for 2003 was 16 300 t, but there was a reduction of the TAC for this area for 2003 to 10 180 t (2/3 of that in 2002) based on the advice that F should be below $\mathbf{F}_{pa}$. This involved a large reduction in fishing mortality and anecdotal evidence from the fishery indicates that this, and the subsequent 2004 and 2005 TACs have been particularly restrictive, implying that reported landings are unlikely to reflect actual catches in these years.

Previous analyses using models based on dynamic pool assumptions highlight that fishing mortality on anglerfish in this area has been well above what may be considered sustainable.

Recent ACFM review groups have highlighted the generally poor data for this stock and the need to continue with the recently instigated data collection schemes (both survey & commercial data) in order to obtain time series of sufficient length. Updates to these data and some preliminary analyses of trends are therefore presented this year.

6.1 Anglerfish in Sub-Area VI

6.1.1 The fishery

General information can now be found in Section A.2 of the Stock Annex.

6.1.1.1 ICES advice applicable to 2006 and 2007

The ICES advice for 2006 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa

> "The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish."

The ICES advice for 2007 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa:

> "The available information is inadequate to evaluate spawning stock or fishing mortality relative to precautionary reference points. The effort in fisheries that catch anglerfish should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish."

Mixed fisheries advice for the West of Scotland can be found in Section 1.7.

6.1.1.2 Management applicable

YEAR	SINGLE STOCK EXPLOITATION BOUNDARY (VB(EC), VI, XII AND XIV)	BASIS	TAC (VB(EC), VI, XII AND XIV)	% CHANGE IN F ASSOCIATED WITH TAC	WG LANDINGS
2003	<67001)	Reduce F below Fpa	3180	49% reduction	4126
2004	<88002)	Reduce F below Fpa2)	3180	48% reduction	3296
2005	-	No effort increase2)	4686	-	n/a
2006	-	No effort increase2)	4686	-	n/a
2007		No effort increase2)	5155	-	

All values in tonnes.

1) Advice for Division IIIa, Subarea IV and Subarea VIa combined.

2) Advice for Division IIIa, Subarea IV and Subarea VI combined.

There is no minimum landing size for this species.

6.1.1.3 The fishery in 2006

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed round-fish. The Scottish Light Trawl Fleet (SCOLTR) takes around 45% of the Scottish anglerfish landings and the Scottish Heavy Trawl Fleet (SCOTRL) over 30%. The majority of these landings come from the shelf edge area to the north and west of the Outer Hebrides, with a smaller proportion of the reported landings (around 20%) being by-catch from the *Nephrops* trawlers operating on the shelf. In recent years there has been decommissioning of Scottish boats exploiting anglerfish in Division VIa: out of a total of 298 demersal trawlers (mesh size >=100 mm) active in 2001, 96 were decommissioned by the end of 2004. This is likely to have reduced fishing effort, however, it is not known to what extent effort has actually been reduced as this clearly depends on the size and the power of the boats which have been decommissioned. The Scottish fleet operating in VIb consists mainly of large otter trawlers (SCOTRL) targeting haddock and anglerfish at Rockall.

The landings of anglerfish by Irish vessels in VIa are primarily taken by the otter trawl fleet. Reported landings in 2006 were mainly taken on the slope in the southern part of VIa with some landings also reported from the Stanton Bank area. The number of vessels participating in the fishery has declined substantially in recent years. Similarly, the Irish fleet fishing at Rockall declined substantially between the late 1990s and 2006, as have reported landings.

The draft report of the 2007 WG on Fish Technology and Fish Behaviour also highlights a number of issues relating to recent changes in fishing technology and fleet behaviour which are relevant to the anglerfish fishery in Sub-area VI:

Due to restrictive days at sea allocations for Scottish whitefish vessels operating in VIa and lack of Rockall Haddock quota (VIb) a number (up to 10) of larger Scottish vessels have switched to targeting Nephrops and have redistributed their effort in the Fladen fishery in IVa. While the number of vessels may be small, these are larger powered (typically in excess of 1000hp) and will therefore result in a considerable reduction in Scottish effort in VIa and a significant increase in the Nephrops fishery of IVa which is fished by lower powered vessels. (Scotland; Implication -reduction in effort VIa)

The number of Irish whitefish vessels participating in the targeted monkfish fisheries in VIa has reduced during 2006 and in the first quarter of 2007. (Only 8-10 vessels from upwards of 20 vessels in 2005). This is due mainly to restrictive quotas and tighter enforcement including the introduction in Ireland of a new Sales Notes management regime. The remaining vessels have moved to the Porcupine Bank Nephrops fishery (see below) or targeted “mixed” demersal fisheries with single trawls for megrim, monkfish, Nephrops and hake. (Ireland; Implications - Reduction in effort in VIa and increase in VIIc-k)

Two of the largest Irish whitefish vessels (34m/2000hp) have shifted effort from deepwater species (black scabbard, orange roughy, grenadier) in VIa and VIIb-k to the mixed demersal species (megrim. monkfish, haddock, saithe) at Rockall (VIb). In addition 4–5 other vessels (all 24m+vessels) have also increased effort in the Rockall fishery in 2006, moving from the monkfish and mixed monkfish, megrim, hake fisheries in Areas VIIb-k. The Rockall fishery has now becoming increasingly important to the larger Irish whitefish vessels and quotas will become restrictive in 2007. (Ireland; Implication-increased effort in VIb)

Both pair trawl and pair seine teams have been exploring the potential to use paired gear for targeting Rockall haddock (VIb). This has been encouraged due to restrictive days at sea in IV and their absence from VIb. This is a significant development, as up until now this type of method was considered inappropriate in VIb due to topography conditions. If successful this could result in a significant switch in effort from IVa to VIb (Scotland; Implication - Increase in Effort VIb)

Vessels that have continued to target monkfish are now discarding 0–500g and 500–1kg fish to meet quota restrictions as it is increasing difficulty to sell “black fish” due to the registration of buyers and sellers. This discarding is reportedly at quite a high level. (Ireland; Implications-unaccounted removals of monkfish)

French demersal trawlers also take a considerable proportion of the total landings from this area. The vessels catching anglerfish may be targeting saithe and other demersal species or fishing in deep water for roundnose grenadier, blue ling or orange roughy. It is not known to what extent the increased restrictions to deepwater fisheries have affected the French fishery for anglerfish.

In addition to these demersal trawl fisheries, a deepwater gillnet fleet also operates on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. These vessels, though mostly based in Spain, are registered in the UK, Germany and other countries outside the EU such as Panama. The fishery is conducted in depths between 200 and 1200 metres, with the main target species being anglerfish and deepwater sharks. Gear loss and discarding of damaged catch are thought to be substantial in this fishery. Until recently these fisheries have not been well documented or understood and have been largely unregulated, with little or no information on catch composition, discards and a high degree of suspected misreporting (Hareide *et al.*, 2006). In 2005, there were around 16 vessels participating in the fishery, 12 UK registered and 4 German registered.

In response to the concerns with these gillnet fisheries for deep-water sharks and anglerfish in Sub-area VI, the EC banned the setting of gillnets in waters greater than 200m in 2006 (Council Regulation 51/2006). However, this regulation was reviewed in July 2006 & a new regulation put in place which is a permanent ban, but allows a derogation for entangling nets in waters less than 600 m, not exceeding 100 km in total length with a maximum soak time of 72 hours. (EC Regulation No 41/2006 Annex III, article 9). NEAFC have also introduced an indefinite ban.

In addition, the EU has recently funded a ghost net retrieval programme, DEEPCLEAN, (coordinated by the Marine Institute, Ireland) which is due to commence in Autumn 2007. The intention of this programme is to a) maximize the recovery of lost or abandoned gillnets and b) to quantify the scale and biological consequences.

6.1.2 Catch data

6.1.2.1 Official catch statistics and revisions to catch data

The official landings for each country are shown in Table 6.1.1. The data have been updated to incorporate revised landings for France, Ireland and the UK in 2005. Total landings (Sub-area VI) as reported to ICES in 2006 were approximately 3 200 t, which is about 700 t lower than the value for 2005. This is due to a reduction in French reported landings in VIa and VIb and in UK landings from VIa. In 2006, the official landings from Division VIa accounted for more than 75% of the total for Sub-area VI. The official landings for 2006 are still preliminary. Minor updates have been made to the officially reported landings for the years prior to 2005.

6.1.2.2 Quality of the catch data

For a number of years, anglerfish in Sub-areas VI, XII, XIV and Division Vb (EU zone) were subjected to a precautionary TAC (8 600 t), based on average landings in earlier years. In 2002 the TAC was set at 4 770 t and was further reduced to 3 180 t in 2003 and 2004. The TAC was increased in 2005 to 4 686 t and to 5 155 t for 2007. At the Working Group in 2003, it was highlighted that the reduction of the TAC in 2003 to just two-thirds of that in 2002 would likely imply an increased incentive to misreport landings and increase discarding unless fishing effort was reduced accordingly (Section 6.4.6, ICES WGNSDS, 2003). Anecdotal information from the fishery in 2003 to 2005 appeared to suggest that the TAC was particularly restrictive in these years. The official statistics for these years are, therefore, likely to be particularly unrepresentative of actual landings.

The absence of a TAC for the adjacent Sub-area IV prior to 1998, means that before then, landings in excess of the TAC in other areas were likely to be misreported into the North Sea. In 1999, a precautionary TAC was introduced for North Sea anglerfish, but unfortunately for current and future reporting purposes, the TAC was set in accord with recent catch levels from the North Sea which includes a substantial amount misreported from Sub-area VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4^{o}W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish. This is illustrated in the spatial distribution of officially reported Scottish landings shown in Figure 6.1.2.

The Working Group historically (prior to 2005) provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. The correction has been applied by first estimating a value for the true catch in each E6 square and then allocating the remainder of the catch into VIa squares in proportion to the reported catches in those squares. The ‘true’ catches in the E6 squares are estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean is calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares. Such a re-allocation of catches may still inadvertently include some landings taken legally in Division IVa on the shelf-edge to the west of Shetland, but these are likely to comprise fish within the distribution of the Division VIa stock component. Scottish officially reported landings adjusted for area misreporting are shown in Figure 6.1.3. Due to technical problems associated with changes to the Scottish Executive database and lack of landings data provided to the Working Group by some of the major nations exploiting the fishery, WG estimates of the actual Division VIa landings have not been calculated for recent years (2005 & 2006).

6.1.3 Commercial catch-effort data

Reliable effort data (in terms of hours fished) are not available from the Scottish trawl fleets due to changes in the practices of effort recording and non-mandatory effort recording in recent years. Further details can be found in Section B4 of the Stock Annex and the report of the 2000 WGNSSK (ICES, 2001). Effort data in terms of days fished is thought to be more reliable and these data are presented by gear in last year's WG report. However, given the uncertainties associated with the official landings no attempt has been made to use these data to calculate an LPUE series and they have not been updated this year.

Trends in official landings, effort in hours fished and lpue by gear from the Irish fleets are shown in Table 6.1.2. The majority of effort and landings is from the OTB fleet. The effort declines over the time series while the landings decline to 2004 but then increase in 2005 and 2006.

No effort data were available for the Spanish and French fleets operating in Sub-area VI.

Attempts have recently been made to obtain more reliable data on catch and effort from the Scottish anglerfish fishery. In 2005, an analysis of data collated from the personal diaries of Scottish skippers operating across the Northern Shelf was presented to this WG (ICES, 2006 and Bailey *et al.*, 2004). Following recommendations made by ACFM that this data collection scheme should be continued and extended, FRS (in consultation with the fishing industry) have recently established a new monkfish tally book project. A fuller description of these data can be found in Section 6.3.1 which covers anglerfish on the whole Northern Shelf.

Ahead of last year's STECF review group meeting on Northern Shelf anglerfish (SGRST-06–03), an enhanced Scottish observer scheme for anglerfish was put into operation and collated additional information on commercial catch rates in the Scottish anglerfish fisheries. Further details can be found in Section 6.3.1 which covers the whole Northern Shelf.

6.1.4 Research vessel surveys

At previous meetings of this WG it has been concluded that the traditional groundfish surveys are ineffective at catching anglerfish and do not provide a reliable indication of stock size. As a result of this conclusion, and the urgent requirement for fishery independent data, FRS, Scotland began a new joint science/industry survey in 2005. The survey was conducted in Sub-area VI and sub-area IV and further description and illustration of the preliminary results can be found in Section 6.3.2 which considers anglerfish across the whole Northern Shelf.

In 2006, Ireland extended the anglerfish survey to cover the remaining part of VIa (from $54^0$30' to $56^0$39') and into ICES areas VIIb, c, j. Survey stations for the entire survey (Irish and Scottish combined) are shown in Fig. 6.1.4. The Irish survey was conducted by three commercial vessels with similar characteristics e.g. tonnage, power etc, using gear configurations identical to that of the Scottish survey. The survey trawls were supplied by the same net manufacturer, and door sizes, sweep lengths etc to the same specification as used by Scotland. The same randomised station selection procedure for each of the three strata was used and the same operational procedures e.g. tow duration etc. (See WD 3 for further details).

In addition, 750 were double tagged using ribbon flags. To date no tag returns have been recorded. The data from the Irish survey is currently being analysed and a joint WD will be submitted to WGNSDS in 2008.

6.1.5 Commercial length compositions

Scotland provided landings length frequency data for 2006 for VIa and VIb while Ireland provided data for VIb. National sampling levels can be found in Table 2.3. In the past these data have not been particularly useful in helping identify strong year classes although it is not known to what extent these landings length frequencies are representative of the length frequencies of the actual catch due to lack of discard information and possible misreporting by size category. Furthermore, the coarse spatial resolution of these data may mean that if recruits congregate in particular locations then pulses of recruitment may not be picked up in the overall length frequency distribution. The data are therefore not presented in this report but can be found in the stock file. Mean lengths from the Scottish market sampling length frequency data are shown in Figures 6.1.5 and 6.1.6. There do not appear to have been any significant changes in the average size of large and small individuals being caught (officially landed) over the time series of data available.

Scottish discard estimates from an EU funded study of the fishery (Kunzlik *et al.*, 1995) were available for two complete years during 1992 QII to 1994 QI. Assessments both including and excluding the discard data were presented in ICES CM 1998/Assess:1. Due to a constant discard ogive being applied to each year's data, the difference in assessments was essentially a scaling factor on population and yield per recruit estimates.

More recent observer trips aboard Scottish vessels fishing for anglerfish (Anon, 2001) and records obtained from the current Scottish tally book scheme indicate generally very low levels of discarding. However, there are suggestions that vessels that have continued to target monkfish are now discarding smaller fish to meet quota restrictions as it is increasing difficulty to sell "black fish" due to the registration of buyers and sellers legislation introduced in the UK and Ireland. In some fisheries, this discarding is reportedly at quite a high level. (draft FTFB report*)*. Therefore sampled landings length frequency distributions are unlikely to be representative of the length frequency of the total catches.

6.1.6 Natural mortality and maturity

A value of 0.15 is assumed for natural mortality for all lengths and years. Length at 50% maturity is estimated to be 93 cm for females and 57 cm for males (Anon, 2001). More details can be found in Section B2 of the Stock Annex.

6.2 Anglerfish in the North Sea & Skagerrak

6.2.1 The fishery

Details can now be found in Section A.2 of the Stock Annex.

6.2.1.1 ICES advice applicable to 2006 and 2007

The ICES advice applicable to anglerfish in the North Sea in 2006 and 2007 has been the same as that for Sub-area VI.

The ICES advice for 2006 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa:

> "The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish."

The ICES advice for 2007 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa:

> "The available information is inadequate to evaluate spawning stock or fishing mortality relative to precautionary reference points. The effort in fisheries that catch anglerfish should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and by-catch fish."

Mixed fisheries advice relevant to the North Sea can be found in Section 1.7.

6.2.1.2 Management applicable

Year	Single stock exploitation boundaries (North Sea)	Basis	TAC IIa & IV (EC)	% change in F associated with TAC	WG landings
2002	5700	2/3 of the catches in 1973-1990	10500	-	10289
2003	<6700[1)]	Reduce F below $\mathbf{F}_{pa}$	7000	49% reduction	8268
2004	<8800[2)]	Reduce F below Fpa[2)]	7000	48% reduction	9027
2005	-	No effort increase	10,314		n/a
2006	-	No effort increase	10,314		n/a
2007		No effort increase	11,345[3)]		

All values in tonnes.

1) Advice for Division IIIa, Subarea IV and Subarea VIa combined.

2) Advice for Division IIIa, Subarea IV and Subarea VI combined.

3) An additional quota of 1,650 t is also available for EU vessels fishing in the Norwegian zone of Sub-area IV.

6.2.1.3 The fishery in 2006

Scottish vessels account for more than 70% of the reported anglerfish landings from the Northern North Sea. The Danish and Norwegian fleets are the next most important exploiters of this stock. A brief description of the recent fisheries of these three countries follows:

The U.K. (Scottish) fishery for Anglerfish in the North Sea

The Scottish fishery for anglerfish in the North Sea is located in two main areas: on the Shelf Edge to the north and west of Shetland and at the Fladen Ground. The fishery to the north and west of Shetland operates as an extension to that in Division VIa and mainly consists of light trawlers targeting mixed round-fish. The highest reported landings in 2006 come from the statistical rectangles around Shetland. The light-trawler fleet accounted for approximately 55% of Scottish reported landings in this area in 2006. The landings from the fishery at the Fladen are lower but still significant (almost 20% of total) with anglerfish caught as a by-catch in the *Nephrops* fishery which consists of approximately 200 vessels in 2006.

The Danish fishery for Anglerfish in the North Sea (IV) and Skagerrak (IIIa)

The geographical distribution of the Danish fishery for anglerfish in 2006 is shown in Fig. 6.2.1. This figure (quantity of landings by ICES rectangle) is based on logbook records. The majority of Danish anglerfish landings are taken in the north-eastern North Sea, in the part constituting the Norwegian Deeps, situated in the Norwegian EEZ of the North Sea. Other important fishing areas for anglerfish are the Fladen Ground (also in IVa) and in the Skagerrak

(IIIa). From Tables 6.2.1 and 6.2.2, it appears that more than 80% of the Danish landings come from ICES Divisions IVa and IIIa. The remaining part is from the most northern part of Division IVb.

The majority of the Danish vessels are taking anglerfish with demersal trawls. The trawlers can be distributed according to length group as shown in Figure 6.2.2.

Table 6.2.3 A and Fig. 6.2.3 shows the distribution of Danish landings in the North sea and IIIa according to fishery defined by gear type and mesh size as currently used by Danish Fisheries Directorate for the North Sea, see text table below.

FISHERY/GEAR	MESH SIZE, MM
Dem. Trawl	>= 100 mm
Nephrops trawl	70–99 mm
Shrimp trawl	33–69 mm
Industrial trawl	< = 32 mm
Beam trawl	>= 80 mm

Note that in the North Sea demersal trawls account for more than 90% of total Danish landings. However, it is necessary to further specify that at present the majority of the Danish catches of anglerfish are taken by fisheries in the Norwegian zone of IVa applying demersal trawls with mesh size >=120 mm. In 2006, the fishery with demersal trawl in the Norwegian Deeps (in the Norwegian zone) accounted for around 75% of total Danish landings by all gears from the entire North Sea. In the Skagerrak (IIIa) the 2 main fisheries taking anglerfish are the (mixed) *Nephrops* fishery and the demersal trawl fishery. In both areas minor landings are taken in gillnets and as by-catch in fisheries for shrimp (*Pandalus*).

Information on the species composition of the landings from Danish fisheries taking anglerfish is available from the Danish logbook records. Table 6.2.4 shows the species composition in landings from the Norwegian Deeps by the main gear used in this fishery (trawls with mesh size >=120 mm) for 2004, 2005 and 2006. The relative species composition appears to be rather similar over these 3 recent years. Anglerfish constitutes around 14% by weight of the landings, while the most important species by weight is saithe, see also Fig. 6.2.4.

In addition to logbook information, more detailed information of the composition of the catch, including the discard component is available for 2005 and 2006 from the Danish at-sea-samples from observers on fishing trips for anglerfish, *Nephrops* and other demersal species (mesh size=122 mm). While anglerfish constituted 24% (by weight) in the 2005 samples it was less than 10% in 2006. The big difference in the anglerfish components in the samples may be ascribed to choice of target species within the same gear and fishing area. The logbook records include all trips using this gear in this area regardless of target. It is however, noted that the frequencies of the roundfish species (cod, haddock and saithe) and *Nephrops* are similar for the two years, see Figs.6.2.5. The at-sea-samples also provide data on corresponding discards as shown in Figure 6.2.6. Note here the dominating 'other species' component. A considerable part of this component is rays and sharks. Cod also appears to be a significant component of the discards. One must be cautious to extrapolate to total discards corresponding to total landings from these few samples (Table 2.3 contains an overview of sampling levels).

The Norwegian fishery for Anglerfish in the North Sea

This overview is based on Norwegian sale slips data. The majority of the Norwegian anglerfish landings from Division IVa are taken in the directed, coastal, gillnetting fishery (Figure 6.2.7). The remaining 30–40% of the Norwegian landings from IVa is mostly taken as by-catch in different trawl fisheries. A similar pattern is found for Skagerrak (IIIa) (Table

6.2.5). The third quarter has in recent years been the most important season for the directed fishery, while the second quarter seems to be more important for other gears.

The draft report of the 2007 WG on Fish Technology and Fish Behaviour also highlights a number of issues relating to recent changes in fishing technology and fleet behaviour which are of relevance to anglerfish in the North Sea:

Due to restrictive days at sea allocations for Scottish whitefish vessels operating in VIa and lack of Rockall Haddock quota (VIb) a number (up to 10) of larger Scottish vessels have switched to targeting Nephrops and have redistributed their effort in the Fladen fishery in IVa. While the number of vessels may be small, these are larger powered (typically in excess of 1000hp) and will therefore result in a considerable reduction in Scottish effort in VIa and a significant increase in the Nephrops fishery of IVa which is fished by lower powered vessels. (Scotland; Implication -increase in effort IVa)

Norwegian authorities have reported significant quantities of lost and abandoned ghost nets being retrieved by Norwegian trawlers operating in the northernmost part of IVa.

6.2.2 Catch data

The official landings for each country are shown in Table 6.2.1. Minor updates have been made to reported landings for the years prior to 2006. Landings in 2006 as reported to ICES for the total North Sea were around 10 800 t, which is about 1 600 t higher than those reported for 2005. This is largely due to increased UK officially reported landings in the northern North Sea. The official landings from the Northern North Sea account for almost 95% of the total North Sea figure. The UK is still by far the largest exploiter of the Northern North Sea fishery accounting for more than 75% of official landings in 2006 in this ICES division. Denmark and Norway are the next most important exploiters of this stock, with landings of approximately 15% and 10% respectively, of the total reported to ICES. Reported landings in the southern North Sea have fallen from a peak of over 400 t in 1995 to just a few tonnes in 2006.

There has been substantial misreporting of catches into the North Sea in recent years, due to the existence of a restrictive precautionary TAC in the adjacent VIa fishery (See Sections 6.1.2.2 and 2.1.2 for further details). A precautionary TAC was first set for the North Sea and Division IIa (EU) in 1999 and by 2002 had been reduced to 10 500 t. The TAC for 2003 & 2004 was set at 7 000 t (a substantial reduction on 2002), but was increased in 2005 to 10 314 t and subsequently to 11 345 t in 2007. WG estimates of landings in the North Sea are not available for 2005 and 2006 (See 6.1.2.2 for further discussion).

Landings of Anglerfish in Division IIIa as officially reported to ICES are given in Table 6.2.2, with landings figures for a longer time period given in Table 6.3.1. Over 1975–1990, annual landings were close to 550 t. After this period there was a sharp increase to a peak of 938 t in 1992, since when landings gradually declined to 500 t in 2004. The officially reported landings in 2006 are 411 t. Denmark usually takes the highest proportion of the landings (over 50%), followed by Norway. The post–1990 increase in landings is attributable to increases in the landings by both of these nations. Landings from Division IIIa represent only a small proportion of the total Northern Shelf landings, with the proportion varying between 1% and 9% over 1973–2005.

6.2.3 Commercial catch-effort data

U.K. (Scotland)

Reliable logbook based effort data (in terms of hours fished) were not available from the Scottish trawl fleets due to changes in the practices of effort recording and non-mandatory effort recording in recent years. Further details can be found in Section B4 of the Stock Annex and the report of the WGNSSK, 2000 (ICES, 2001). Effort data in terms of days fished is thought to be more reliable and these data are presented by gear in last year's WG report. However, given the uncertainties associated with the official landings no attempt has been made to use these data to calculate an lpue series.

The catch rate information from the Scottish tallybook and observer schemes is further discussed in section 6.3.1 which covers the whole of the Northern Shelf.

Denmark

Danish logbook data for anglerfish landings and corresponding effort by main fishery in the North Sea and IIIA for the period 1996–2006 are shown in Table 6.2.3 B. Figure 6.2.8 and table 6.2.6 show the fluctuations in lpue for anglerfish for various fisheries defined by gear and by area. These are further discussed in Section 6.2.7.

Norway

Available logbook data from Norwegian trawlers have been examined for the possibility of establishing a cpue time series for anglerfish. However, several problems were encountered in the data set, and it is still considered insufficient for providing any reliable information on trends in stock abundance.

Six gillnetters have been included in a self-sampling scheme established along the Norwegian coast within IVa and IIIa. Detailed information about effort and catch will be provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

6.2.4 Research vessel surveys

See Section 6.3.2.

6.2.5 Length compositions

The countries supplying relevant data this year are shown in Table 2.2, with levels of sampling in Table 2.3. North Sea Scottish market sampling data by gear category have previously been presented to the WG, but are not considered useful in identifying any population trends (see section 6.1.5) and are not presented here, but retained in the stock file. Mean lengths over various size-ranges from the Scottish market sampling length frequency data are shown in Figures 6.2.9. There do not appear to have been any significant changes in the average size of large and small individuals being caught (officially landed) over the time series of data available.

Danish samples of landed catch in the port of Hirtshals for size (length) measurements are available for 2002–2006 and shown in Figure 6.2.10. It seems that the 2002 samples indicate more large individuals in the landings, However, sample size is small and the samples do not indicate any significant changes in size composition of the landings during this period.

Data on the size composition in the catch are available for the 4 years 2003–2006. The data include both Danish samples and Norwegian at-sea-samples of Danish bottom trawlers fishing in the Norwegian Deep (Figure 6.2.11). Note the recruiting size-(age-) group in 2005. Recruiting size groups can also be distinguished in 2003, but not as marked as in 2005. The size composition of the catch in these years could indicate a large recruiting size (age) groups in the stock. The middle mode of the size composition in 2006 is likely to represent the (large) incoming size class in 2005. This interpretation is qualitatively confirmed by the fishing industry's information of large amounts of small specimens in the catches in 2005 and 2006. Additional data on size composition in offshore fisheries in the eastern part of Div. IVa are provided from the Norwegian at-sea-sampling during 2006 (Figure 6.2.12). The main

Norwegian fishery in IVa, coastal gillnetting, was not sampled during 2006, but qualitative information from the fisheries indicates a similar size composition in terms of landings of different market categories as seen in IIa (see section 6.4). Sampling for length distribution of anglerfish caught by coastal gillnetting through the self-sampling scheme started during the autumn of 2006, but only two small samples were taken in IIIa.

6.2.6 Natural mortality and maturity

A value of 0.15 is assumed for natural mortality for all lengths and years. Length at 50% maturity is set to 93 cm for females and 57 cm for males. More details can be found in Section B2 of the Stock Annex.

6.2.7 Analysis of lpue data

The Danish lpues are based on logbook records. Figure 6.2.8 shows the fluctuations in lpues for the main fisheries as mentioned in Sect. 6.2.3. Of relevance is the series for the demersal trawl fishery in the North Sea and in particular the series for this fishery in the Norwegian Deep as this is the fishery where most anglerfish is taken. Note the upwards trend, especially from 2003 to 2004 for all fisheries and the subsequent stabilisation or even slight decline of the lpue level in 2005. In 2006 an upward was again seen in most fisheries except for shrimp trawl. The recorded overall effort seems to have declined in recent years, see Table 6.2.3.

The lpue in a number of the fisheries had shown an increase in 2002-2004. However, this trend seems to have levelled off in 2005. Anecdotal information from Danish fishermen suggests that this apparent levelling off is due to the TAC constraints on the Danish fishery in the Norwegian EEZ since 2005, which was not in evidence in previous years. The TAC constraints in the Norwegian zone may also have some influence in an upward direction on the log-book recorded landings in IIIa seen in 2006. The TAC constraints and possible misallocation of landings render it problematic to use these log-book based lpues as indicators of stock abundance. However, the figures do not suggest any decline in stock abundance.

Scottish lpue as estimated from officially reported landings and effort are not considered to be a good indicator of trend in stock abundance due to the inaccuracy of the official statistics. However attempts have been made in recent years to obtain more reliable fishery data directly from the fishing industry and this is discussed in further detail in Section 6.3.1.

6.3 Anglerfish on the Northern Shelf (combined IIIa, IV and VI)

The fishery

Total officially reported landings of anglerfish from the Northern Shelf are given in Table 6.3.1. During the 1970s landings were fairly stable at around 9 000 t, but from about 1983 they increased steadily to a peak of over 35 000 t in 1996, since when there has been a sharp drop to the 2006 landings of 14 400 t. This overall trend is driven by the catches in the Northern North Sea and West of Scotland. Together these two areas account on average for 75% of the total landings over 1973–2006. A more detailed description of the fishery and management advice for the separate Sub-areas can be found in sections 6.1 & 6.2 and Section A.2 of the Stock Annex.

The main fleets catching anglerfish in Scotland consist of mixed demersal trawl fisheries operating along the shelf-edge in both Divisions VIa and IVa and a more inshore *Nephrops* fishery in which anglerfish is an important by-catch. Ahead of the anglerfish STECF review group meeting in 2006(SGRST-06–03) attempts were made to develop descriptions of the main Scottish anglerfish fisheries which were spatially more relevant to the stock distribution and activity of fishing vessels rather than by ICES area. The descriptions used data on catch rates from various sources, including research vessel surveys, observer trips on board commercial boats, consultation with skippers and analysis of individual fishing trip records. An ‘anglerfish fishery’ area was defined as the combined area of high abundance (catch-rates) from the FRS/industry survey (section 6.3.2) and observer data analysis. A ‘*Nephrops* fishery’ area was assumed to cover the *Nephrops* grounds which are well defined by soft substrate and are described the in ICES WGs. Figure 6.3.1 shows the distributions of the *Nephrops* areas in relation to the anglerfish area described above. The areas are mostly separate but where overlaps occur (usually statistical rectangles on the outer margins of *Nephrops* areas, shown in black) these are taken to be part of the anglerfish area. A third area is defined to include all other statistical rectangles.

In the Scottish ‘anglerfish’ area, large meshed otter trawlers have the largest contribution to the total landings associated with anglerfish. This metier has a mixed species catch composition with haddock being the most important species and anglerfish and cod the next most important. In the *Nephrops* area the largest overall landings associated with anglerfish come from the <100 mm gear category with the dominant species being *Nephrops*, followed by haddock and anglerfish.

Previous studies have found it difficult to identify a specific anglerfish fishery as catch composition can vary a great deal over a small spatial scale (i.e. less than a statistical rectangle). Further analysis of the main, large mesh trawl operating in the ‘anglerfish area’ is required to provide a more comprehensive picture of catch composition. This was beyond the scope of this WG.

6.3.1 Commercial cpue analysis

Given the recent concerns over the official fishery data (catch and effort) and a lack of reliable information from surveys, the WG was again unable to present an analytical assessment for anglerfish. Prior to the 2005 WG, information from Scottish fishermen’s diaries was collected in an attempt to improve the quality of available commercial information. An analysis was presented at that WG which indicated increasing catch rates across all areas of the Northern Shelf. Although the analysis proved useful, the diary data were provided by a relatively small number of vessels and it was not known to what extent these were representative of the fisheries as a whole.

Tally book data

In order to expand this information, FRS (in consultation with the fishing industry) have recently established a new monkfish tally book project. The project is being operated in conjunction with fisher’s organisations who are responsible for distributing the tally books, co-ordinating the returns and allocating a vessel code before the data are forwarded to FRS. The tally books are filled in on a haul-by-haul basis to give weight caught by size category and information on haul location, duration and depth in a standardized format as well as gear and mesh being used.

So far, the time series is relatively short, with the first returns from fishing trips at the end of December 2005 and the most recent from March 2007. Initial participation in the scheme was high with returns received from up to 37 vessels with a wide spatial coverage (Figure 6.3.2) and different target species. Of the 37 vessels which have so far supplied information, 2 are French and these are operating towards the southern end of the shelf edge in Division VIa northwest of Ireland. The depth distribution of the haul information collated so far is shown in Figure 6.3.3. Most hauls are taken in depths between 100 & 400 m although there are a significant number of hauls from depths between 600 & 800 m. The records from the deeper water are largely from the French vessels although it does appear that a number of the Scottish vessels make occasional trips into deeper water. Average catch rates are similar to those previously seen in the diary data and observer data and range from around 10 Kg/hr for boats targeting *Nephrops* to over 100 Kg/hr for some whitefish boats.

Despite the short time series, some preliminary analysis of the tally book data has been carried out. Clearly catch-rates are likely to differ significantly between vessels operating with different gear, so gear is categorized as either single or twin rig and mesh size as <100 or >=100 mm. Catch rates in Kg/hr are modelled with month, year, vessel, gear, mesh, depth and spatial effects. Month and depth were modelled as smooth terms and represented using penalized regression splines with smoothing parameters selected by cross validation while the other effects were modelled as factors. Results from the preliminary analysis are shown in Figure 6.3.4. The estimated temporal trends from the model are rather uncertain due to the short time series and incomplete data for 2 out of the 3 years. The estimated seasonal effects show the well documented seasonal pattern in the fishery whereby catch rates decrease during the summer months. Highest catch rates in terms of Kg/hr appear to occur at depths of around 400 m. The spatial effect (not illustrated but included in stock file) was modelled using ICES statistical rectangle and showed higher catch rates in the statistical rectangles enclosing the 200 m contour and in the statistical rectangles to the east of Rockall.

Some of the vessels which provided diary data (see report of 2005 WG for further details) are now participating in the tally book scheme and it has been possible with the help of the fisher's organisations involved, to combine the data from the two collection schemes for these vessels. This provides a longer time series of data but from only 8 vessels. However, the dataset still contains information on nearly 8 000 hauls. The diary data does not include information on the fishing depth or fishing gear, so a simpler statistical model has to be fitted to these data. Catch rates in Kg/hr were modelled with month, year, vessel and spatial effects. The smooth terms (month and year) are again represented using penalized regression splines with smoothing parameters selected by cross validation. The results of the fitted GAM are shown in Figure 6.3.5. The catch rates are estimated to have increased over the time period by approximately 30% (model estimates are shown on log-scale) although there seems to have been a levelling off in recent years, although the 2007 data are incomplete. Alternative models were investigated which include interaction terms between temporal trend and area, where area was a factor (e.g. N Sea, VIa and VIb). However, no significant differences in estimated temporal trend with area were found and therefore the results are presented for the whole Northern Shelf stock.

The tally book scheme has been implemented as a long-term approach to providing better information on the fishery. However, for the scheme to be of continued success, it is important that:

Participation levels remain high. In total, 37 boats have been involved in the scheme, but the number of vessels returning tally books has dwindled more recently to around 15. Continuing high participation would result in a much more valuable dataset which could be used to provide information on temporal & spatial changes in the fishery catch rates and potentially the state of the stock.

Discards are recorded. Although the analysis of lpue provides useful information on spatial and depth distribution of the fishery, knowledge of the development and dynamics of the stock would be enhanced by information on the level of discarding e.g. for identifying years with high recruitment.

Catches of other species are also recorded to assist with fishery definition.

Observer data

FRS Marine Laboratory has conducted an on-board commercial vessel observer programme for over 30 years and these data are regularly fed into the ICES assessment Working Groups. Data on anglerfish observed catches are available since 1999 and were included in analysis of catch rates for the 2006 STECF review group meeting. As part of the enhanced programme of work on anglerfish, additional sampling was begun in 2005 by the North Atlantic Fishery

College and continued in 2006 by NAFC and the Scottish Fishermen's Federation. Further details of the enhanced scheme can be found in last year's WG report.

Figure 6.3.6 shows the spatial distribution of all observer trips between 1999 and 2006 together with the catch rates. These suggest an increase in catch rate in recent years, particularly along the continental shelf edge although the inter-year spatial variability in sampling and the changing sampling numbers confounds the interpretation.

Last year at the STECF review group meeting on anglerfish, a preliminary statistical analysis of these data was carried out (SGRST-06–03) and this has been further explored this year. The data used in the analysis consist of mean landing per unit effort (lpue) by year, quarter, gear type (heavy trawl, light trawl, *Nephrops* trawl, pair trawl and seine) and ICES rectangle. Data by haul were already aggregated by rectangle, so the number of hauls per rectangle was used as a weighting factor in the analysis. A generalized additive model assuming a logistic link function was used to model lpue as a function of year, quarter, gear type and rectangle. The model explained more than 80% of the total deviance. The estimated temporal trends (on a log scale) are shown in Figure 6.3.7 while the estimated spatial distribution of the lpue (corrected for gear and temporal trends) is shown in Figure 6.3.8. The annual trends show an increase in catch rate over the period, although the continued increase in 2006 is rather uncertain and the estimates have very wide confidence intervals. The seasonal pattern estimated in this analysis seems much less clear than those estimated from the analysis of diary and tally book data which may be due to the fact that much more of observer data come from the North Sea where the seasonal pattern is less clear.

To conclude, after accounting for temporal and spatial changes in sampling intensity a doubling in catch rate remains (Figure 6.3.7). The predicted lpues from this analysis are similar to those observed in the main Danish fisheries in Division IIIa and the Norwegian Deeps for the years since 2000. (Compare Figures 6.2.8 and 6.3.7).

It should be noted that all the analysis presented here is based on data aggregated at the rectangle level. Furthermore, no account has been taken of fishing depth or changes in vessel size/power (although a vessel type effect has been modelled). Re-analysis using the more detailed haul by haul data may yield different results.

6.3.2 Research vessel surveys

This WG has previously concluded that the traditional groundfish surveys do not provide a reliable indication of anglerfish stock size and as a result, FRS Marine Laboratory began a series of specific anglerfish surveys in November 2005 in collaboration with the fishing industry. The survey protocol was drawn up by an industry-science planning group which means that fishermen's expertise has been incorporated in various aspects of the survey. Further details of the survey including information on design, sampling, gear and vessel is given in WD3.

Figure 6.3.9 shows the survey density both in terms of n/km^2 and Kg/km^2. The highest weight density in both years is located along the shelf edge to the north and west of Scotland, and at Rockall, although the number density at Rockall appears lower than that to the north and west of Scotland. Additionally there are likely to be other areas of high density further to the south in areas fished by Ireland and France but not covered in the Scottish survey.

The aim of the survey is to provide a swept area estimate of the total abundance of anglerfish on the Northern Shelf. The provisional results of the two surveys are presented by stratum in Table 6.3.2. In 2005, the total estimated biomass was almost 31 654 t (95% CI: 20 350–42 955) with the largest proportion of the biomass (~35%) coming from the eastern stratum (the northern North Sea). In 2006, the total estimate was 42 999 t (95% CI: 36 063–49 934). Again, the largest contributor to the biomass was the northern North Sea.

The estimates of numbers at age are shown in Figure 6.3.10 and indicate some reduced catchability for the younger ages. This may be due to the size selection pattern of the trawl gear which is currently being investigated, but may also be due to the different spatial distribution of the younger individuals which may be located at more inshore areas not covered by this survey.

These estimates of anglerfish abundance are of the same order of magnitude as estimates obtained in previously attempted analytical assessments of Northern Shelf anglerfish (WGNSDS, 2001 estimated stock biomass at ~ 50 000 t). However, the estimates should be considered highly provisional and there a number of issues still to be resolved:

More accurate estimates of anglerfish catchability incorporating an estimate of the proportion caught by the gear will be available from an associated project being carried out at FRS. The abundance estimates currently make a correction for herding due to the sweeps, but no correction for escapes under the footrope.

Any anglerfish located in midwater will also not be accounted for in the biomass estimates. During both surveys a number of anglerfish were tagged with DSTs which when recovered will provide information which will help determine if anglerfish rise off the seabed, as has been suspected.

It is also anticipated that the survey will provide further useful information on the biology and stock structure anglerfish. The next survey is scheduled for November 2007.

6.3.3 Reference points for Management evaluation

ICES has proposed $F_{35\%SPR}$ =0.3 be chosen as $\mathbf{F}_{pa}$ (derivation unknown). There are uncertainties in the calculation of F as it is not know to what extent models based on dynamic pool assumptions are appropriate for anglerfish.

6.3.4 Quality of the assessment

This WG has previously attempted assessments of the anglerfish stock(s) within its remit using a number of different approaches. As yet none have proved entirely satisfactory. The catch at length analysis used in previous years appears to have addressed a number of the suspected problems with the data due to the rapid development of the fishery, and has also provided a satisfactory fit to the catch-at-length distribution data. However, this year, as last year, the WG has been unable to present an assessment due to the lack of reliable fishery and insufficient survey information (i.e. only a 2–year time series), and in addition it is not known to what extent the dynamic pool assumptions of traditional assessment model are valid for anglerfish.

6.3.4.1 Commercial data

For a number of years the WG has expressed concerns over the quality of the commercial catch-at-length data because of:

Accuracy of landings statistics due to species and area misreporting.

Lack of French length distribution data for Division VIa in recent years. French vessels account for more than half of the officially reported landings from this area;

Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the north west of the British Isles (See Section 6.1.1.3), and,

As discussed in Section 6.1.2.2, the TAC across the Northern Shelf has apparently been very restrictive in the years 2003–2005, implying an increased incentive to misreport or discard catches. The TAC for 2005 was increased, but there are still problems in obtaining reliable effort information due to non-mandatory effort (in terms of hours fished) reporting in some of the main fleets in recent years. The introduction of legislation on buyers and sellers registration in the UK and Ireland in 2006 may mean that the reported landings for 2006 are more reliable, but may not be representative of the total catch due to increased discarding (See section 6.1.1.3).

The recent Scottish tally book has been implemented as part of a long term approach to provide better information on the fishery. Although the time series of data is currently short, the scheme has the potential to deliver relatively extensive information on spatial and depth distribution of catch rates provided that participation remains high. In addition to total catch rate information, the fishermen are also asked to provide information on landings by size category, discards, catches of mature females and by-catches of other species.

6.3.4.2 Survey data

In addition to obtaining estimates of abundance from swept area methods (and in future a times series of data for use in survey based assessments), it is hoped that on future FRS/industry anglerfish surveys, a visual count method will be developed to provide alternative estimates of anglerfish density. Initial trials with UWTV gear used in *Nephrops* surveys proved unsatisfactory because the current TV camera setup can only be towed at a very slow speed which means that only a very small area can be covered, making sightings of anglerfish very unlikely. In addition, the equipment needs to be modified so that it can be deployed in the often poor weather conditions encountered on surveys which take place during winter. It is also anticipated that the new FRS/industry survey will provide further useful information on the biology and stock structure of anglerfish. During the survey, 24 live anglerfish were tagged with data storage tags which when recovered will provide information on the vertical migration, depth distribution and temperature regime of individuals.

In 2006, Ireland extended the survey area to include the more southerly regions of the Northern Shelf stock of anglerfish area not covered by the Scottish survey. However the participation of other nations in a collaborative survey to include coverage of deepwaters and waters further east would also be valuable.

6.3.4.3 Biological information

Despite a recent EU funded report, the biology and distribution of anglerfish on the Northern Shelf is still not well understood. It has been highlighted at previous WGNSDS meetings that some of the basic biological parameters used in the assessments should be regarded as quite uncertain. New growth parameters obtained from a survey in Division VIa have been used in previous length-based assessments of this stock last year and although these should still be regarded as uncertain, the analysis showed that the outcome of the assessment was relatively insensitive to the changes. Recent growth studies by Laurenson *et al.* (2005) have obtained similar growth parameters to those previously used. A further discussion of the biology can be found in the sections below.

6.3.4.4 Stock Structure

Currently, anglerfish on the Northern Shelf are split into Sub-area VI (including Vb(EC), XII and XIV) and the North Sea (& IIa (EC)) for management purposes. However, recent genetic studies have found no evidence of separate stocks over these 2 regions (including Rockall) and particle-tracking studies have indicated interchange of larvae between the two areas (Hislop *et al.*, 2001). So, at previous WGs, assessments have been made for the whole Northern Shelf area combined. In fact, both microsatellite DNA analysis (O'Sullivan *et al.*, 2005) and particle tracking studies carried out as part of EC 98/096 (Anon, 2001) also suggested that anglerfish from further south (Sub-area VII) could also be part of the same stock.

Following the recent expansion of the anglerfish fishery in ICES Divs. IIa and V, in 2004 the WG group was asked to consider the stock structure on the wider Northern European scale

(Section 16 of the WGNSDS, 2004 report). It was concluded that there was currently insufficient information to conclusively define new stock areas for assessment and further co-ordinated work is still required. Given the request to also assess anglerfish in Division IIa and that there may be an extension to include ICES Division V in the near future, the likely spatial disaggregation of the stock (drift of larvae and possible migration of mature fish back into deeper water) means that any assessment model would need to be spatially structured, possibly supported by assessments for each of the stock units separately. Given the problems with data quality in the current Northern Shelf anglerfish assessment, the WG wishes to highlight fundamentals required for a wider area assessment:

Accurate information on the spatial distribution of catch and effort;

Data on movement and migration of mature and immature individuals; and,

An internationally co-ordinated, dedicated anglerfish survey over the wider Northern European area to include deeper waters, waters further east and previously unsurveyed areas in order to obtain information on spatial abundance.

6.3.4.5 Assessment model formulation

Although the catch-at-length analysis which has previously been used to assess anglerfish tackled a number of the problems associated with this stock (uncertainty in age-reading and rapid development of the fishery), it is still not known whether the dynamic pool assumptions made in this, and other more traditional assessment methods are appropriate for this stock.

In previous ('catch-at-length') assessments of this stock, the SSB was always estimated to be at a very low level. The length data have been based on the U.K. landings only (in sub-divs. IVa and VIa), where very few individuals over 80 cm appear in the catch and therefore the model predicts very few in the population. Since females do not mature until they are over 90 cm in length the SSB is estimated to be very low. The length data from the eastern part of the North Sea (Danish and Norwegian fisheries) for the recent years indicate a higher amount of larger individuals in the catches. Although the Danish and Norwegian landings are small in comparison to the U.K. landings, the inclusion of the Danish and Norwegian length frequencies in the data used for any future assessment may change the concept of the magnitude of the SSB.

The fact that mature female anglerfish are rarely observed either on scientific surveys or by observers on board commercial vessels supports a very low estimate of biomass, yet there is little evidence of reduction in spatial distribution as fish are still recruiting to relatively inshore areas. It has been hypothesized that females may become pelagic when spawning as they produce a buoyant, gelatinous ribbon of eggs, and would therefore not appear in the catch of trawlers. (Anglerfish have been caught near the surface, Hislop *et al*., 2000). This would imply different exploitation patterns for males and females: a dome-shaped pattern (decreased exploitation at larger sizes) for females and a logistic pattern for males. It is also not known whether anglerfish are an iteroparous or semelparous species. The latter would also account for the almost complete absence of spawning females in commercial catches or research vessel surveys.

The key features of the species' life history in relation to its exploitation are the location of the main spawning areas, and whether or not there is any systematic migration of younger fish back into the deeper waters to spawn. At present, despite the large increase in catches during the mid 1990s, there is no apparent contraction in distribution; fish are still recruiting to relatively inshore areas such as the Moray Firth in the northern North Sea. The fact that spawning may occur largely in deep water off the edge of the continental shelf may offer the stock some degree of refuge. However, this assumes that the spawning component of the stock is resident in the deep water, and is thus not subject to exploitation. It is not known to what extent this is true, but if such a reservoir exists then the currently used assessment methods which make dynamic pool assumptions about the population are likely to be inappropriate. Nevertheless, it is clear that further expansion of the fishery into deeper water is likely to have a negative effect on the SSB and given the spatial development of the fishery, it cannot be ruled out that the serial depletion of fishing grounds has been occurring. In addition, some life-history characteristics of anglerfish suggest that it may be particularly vulnerable to high exploitation. A detailed discussion of the fishery development and biology can be found in Sections 7.5.4 and 7.5.5 of the 2000 report of this Working Group (ICES, 2001).

6.3.5 Management considerations

TAC development

The reduction of the TAC for 2003 to almost two thirds of that in 2002 (15 270 t) was based on the advice that F should be below $\mathbf{F}_{pa}$ This TAC was retained in 2004 and anecdotal information suggests that these reduced TACs were highly restrictive, and resulted in high levels of misreporting. The TAC was increased in 2005 (although considered still to have been restrictive) and then again for 2007 (by 10%). These data deficiencies prevent reliable estimation of the current level of fishing mortality and appropriate TACs.

Perception of the state of the stock based on available information

The analysis presented this year and last (diary/tally book data, Danish lpue & observer data) indicate increased commercial catch rates in recent years. The combined diary/tally book data analysis is based on a rather limited number of vessels and the WG had reservations about concluding that this was a reflection of increasing stock size. However, these increased catch rates are also evident (although somewhat uncertain in the most recent years) in the analysis of Scottish observer data presented this year (and last), and the stock certainly does not appear to be exhibiting a decline. In addition, there is no sign of a reduction in mean size of the stock (calculated from landings length frequencies) and there are indications from the Danish fishery at least, that recruitment is still relatively strong although recruitment in 2006 appears to be at a lower level than that in 2005 (Fig 6.2.11).

2006 was the second year of the Scottish anglerfish survey and preliminary biomass estimates indicate an approximate 30% increase from 2005 to 2006.

Mixed fishery and technical considerations

The advice provided by ICES last year for this stock was that effort should not be allowed to increase in this fishery until more reliable information can be obtained about the level of catches. (Section 17 gives more details of fishery effort). However, recent attempts (SGRST-06–03 and this report) at actually defining anglerfish fisheries have shown that the vast majority of the catch of anglerfish stems from mixed fisheries, catching sole, saithe, plaice, megrim, *Nephrops*, haddock and cod, amongst others, with the landings of anglerfish actually being a relatively low percentage of the total. For instance, in the Danish trawl fishery in the Norwegian Deep, anglerfish have in recent years constituted approximately 14% (by weight) of the landings (Table 6.2.4 and Figures 6.2.5 & 6.2.6). However, although the landings by weight are a relatively low percentage of the total, the value will actually constitute a much higher percentage of the total. So, any classification of target species in mixed fisheries should also include consideration of the value.

Effort restrictions aiming at recovery of other species will have a side-effect for the anglerfish too, but a shift from anglerfish-poor areas to anglerfish-rich areas might annihilate this effect. However, the statistical analysis of Scottish observer data did not show evidence for such shifts in the recent past.

The length-distributions obtained from sampling the Scottish and Irish landings indicate that the fishery is mainly conducted on the immature part of the stock, and therefore any management should ensure that enough fish are left to contribute to spawning. The body shape of anglerfish means that even at small sizes, they are easily retained by minimum mesh sizes currently in operation.

Length-frequency samples obtained from Norwegian and Danish fisheries operating in the deeper waters of the North Sea (mainly in the Norwegian deeps)) contain a higher proportion of larger fish.

In addition, if the deep water off the edge of the continental shelf is acting as a refuge to the spawning component of the stock, then further expansion of the fishery into deeper water is undesirable. Although there was a rapid expansion of the fishery during the mid to late 1980s, there is currently no evidence from either diary or tally book data of further spatial development of the fishery into deeper water.

Largely as a result of the DEEPNET report, which raised concerns about the deepwater tangle net fisheries for monkfish (section 6.1.1.3) and deepwater sharks, EU Regulation 51/2006 has banned the use of gillnets outside 200 m depth. This ban may have caused a shift in effort to other areas. The ban is not considered permanent and the EU has indicated that they are willing to open the fisheries again if a management framework can be agreed.

Stock structure

As the fishery operates primarily across VI and the North Sea, and there is no evidence to indicate that these comprise separate stocks (see EC 98/096 and O'Sullivan *et al.*, 2005), the WG suggests that in the future it provides assessments based only on the combined area stock unit. This does not necessarily preclude the use of assessment methods which may take account of finer-scale spatial effects, or of the setting of separate area TACs.

Since there is also no evidence to suggest that the area to the south and west (Division VIIb) is part of a separate stock either (Section 6.3.4.4), the WG considers that it may be more appropriate to consider the assessment of Northern Shelf anglerfish within the remit of the WGHMM. Additionally, there are other areas adjacent to the defined Northern Shelf stock with substantial anglerfish fisheries (e.g. Sub-area V) that are not considered by any ICES assessment WG.

6.4 Anglerfish in Division IIa

6.4.1 The fishery

The fishery for anglerfish in Division IIa expanded during the 1990s, when a Norwegian gillnet fishery was developed in coastal areas which has normally been carried out by one-man vessels operating with 360 mm gillnet. Further descriptions of the fishery were given in WD 11 of the 2004 WGNSDS. The current Stock Annex for anglerfish only applies to anglerfish in IIIa, IV and VI. A separate Stock Annex could be included for anglerfish in IIa before the next WGNSDS.

6.4.1.1 ICES advice applicable to 2006 and 2007

There was no ICES advice applicable to anglerfish in Division IIa in 2006 and 2007.

6.4.1.2 Management applicable in 2006 and 2007

No TAC is given for Division IIa, Norwegian waters. Catches of anglerfish in Division IIa, EC waters are taken as a part of the TAC for Subarea IV. The Norwegian fishery is regulated through:

A prohibition against targeting anglerfish with other fishing gear than 360 mm gillnets.

A discard ban on anglerfish regardless of size.

A maximum of 10% by-catch of anglerfish in the shrimp trawl fishery, maximum 30% by-catch of anglerfish in the trawl and Danish seine fishery.

48 hours maximum soak time in the gillnet fishery.

500 gillnets (each net being 27.5 m) pr vessel.

A closure of the gillnet fishery from 1 March to 20 May. This closure period was expanded somewhat in the northernmost part of IIa in 2007.

6.4.1.3 The fishery in 2006

There has been an expansion of the fishery in recent years. This is largely due to a northward expansion of the Norwegian gillnet fishery (Figure 6.4.1). The official landings from the areas north of 64° account for approximately 50% of the total figure for Division IIa in 2006. Norway is by far the largest exploiter of the IIa fishery accounting for over 95% of official landings. Germany is the next most important exploiter in this area, with landings of approximately 2% of the total reported to ICES (Table 6.4.1). The coastal gillnetting accounts for 85–90% of the landings, while 4–6% is taken as by-catch in different offshore gillnet fisheries (Table 6.4.2).

6.4.2 Catch data

The official landings for each country are shown in Table 6.4.1. Landings in 2006 as reported to ICES for the total Division IIa were 4 341 t, which is 62% higher than the year before. No information suggests that the official landing figures from Norway give a biased estimate of the actual landings. The absence of a TAC in Norwegian waters probably reduces the incentive to underreport landings. Anecdotal evidence from the industry suggests that a small percentage of the catch (not marketable) might be discarded. This happens when the soaking time is too long, mostly due to bad weather.

6.4.3 Commercial catch-effort data

Reliable effort data are not available from the Norwegian gillnetters due to non-mandatory effort recording. In late 2006, ten gillnetters were included in a self-sampling scheme established along the Norwegian coast within Division IIa. Detailed information about effort and catch is provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

6.4.4 Research vessel surveys

Anglerfish appears in demersal trawl surveys along the Norwegian shelf, but in very low numbers. There has been a change in the surveys, going from single species- to multispecies surveys, during recent years. The procedures for data collection on anglerfish have varied and, at present, no time series from surveys in Division IIa yields reliable information on the abundance of anglerfish.

6.4.5 Length and age compositions and mean weights at age

Some length distributions are available from the directed gillnetting during the period 1992–2006, but data is lacking 1997–2001 (Figure 6.4.2). The length data indicates a decrease in mean length of 15–20 cm occurring during the period without length samples. The mean length has increased somewhat during the last three years, but is still well below the level seen during the 1990s (Figure 6.4.3). One third of the anglerfish measured during the 1990s were above 100 cm, this proportion is 3% for the 2000s. For 2006, some length data from anglerfish caught as by-catch in other fisheries are presented in Figure 6.4.4.

6.4.6 Natural mortality and maturity

Natural mortality and length at 50% maturity for anglerfish in Division IIa are believed to be similar to what has been used in the North Sea. Length at 50% maturity is probably around 90 cm for females and 57 cm for males (Dyb 2003, Woll *et al*., 1995).

6.4.7 Management considerations

The WG is concerned by the apparent changes in size composition in anglerfish caught in the gillnet fishery. If the selectivity in the gillnets has been stable, this could be interpreted as an altering of the size spectrum in the stock. As the information on trends in effort is lacking for the main fishery, it remains unclear whether the increased landings last year might reflect an increased abundance in the area. Time series on effort and catch by length should be established to facilitate future analytical assessments of this stock. The possibility of establishing a survey, similar to the one being carried out for the Northern Shelf area, should also be considered for Division IIa.

Table 6.1.1 Anglerfish in Sub-area VI. Nominal landings (t) as officially reported to ICES.

Anglerfish in Division VIa (West of Scotland)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	3	2	9	6	5	-	5	2	-	-	+	+	-	+	-	-
Denmark	1	3	4	5	10	4	1	2	1	+	+	.	+	+	-	-
Faroe Is.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	3
France	1,910	2,308	2,467	2,382	2,648	2,899	2,058	1,634	1,814	1,132	943	739	1,212	1,191	1,392	1,148
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	39	.
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	356	364
Netherlands	-	-	-	-	-	-	27	1	-	-	-	-	-	-	-	-
Norway	6	14	8	6	4	4	1	3	1	3	2	1	+	+	1	1
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	82	.
UK(E,W&NI)	270	351	223	370	320	201	156	119	60	44	40	32	30	30	20	…
UK(Scot.)	2,613	2,385	2,346	2,133	2533	2,515	2,322	1,773	1,688	1,496	1,119	1,100	705	862	1,127	…
UK (total)																986
Total	**5,061**	**5,479**	**5,553**	**5,273**	**6,354**	**6,408**	**5,330**	**4,506**	**4,284**	**3,311**	**2,660**	**2,280**	**2,492**	**2,453**	**3,019**	**2,502**
Unallocated	296	2,638	3,816	2,766	5,112	11,148	7,506	5,234	3,799	3,114	2,068	1,882	985	1,938		
As used by WG	5,357	8,117	9,369	8,039	11,466	17,556	12,836	9,740	8,083	6,425	4,728	4,162	3,477	4,391		

***Preliminary.**

1) Includes VIb.

Anglerfish in Division VIb (Rockall)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Estonia	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-

Faroe Is.	-	2	-	-	-	15	4	2	2	-	1	-	-	-	-	+
France	-	-	29	-	-	-	1	1	…[1]	48	192	43	191		293	91
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	77	-
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	35	53
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4	6
Portugal	-	-	-	-	-	-	-	+	429	20	18	8	4	19	63	-
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-	2	4	1
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	-	-
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	93	…
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	355	…
UK (total)																523
Total	923	1089	681	777	830	602	899	900	1401	1074	1309	718	643	496	924	674
Unallocated									-9	17	-178	-47	145	121		
As used by WG	923	1,089	681	777	830	602	899	900	1392	1091	1131	671	788	617		

[*]Preliminary.

[1)] **Included in VIa.**

Total Anglerfish in Sub-area VI (West of Scotland and Rockall)

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Total official	5,984	6,568	6,234	6,050	7,184	7,010	6,229	5,406	5,685	4,385	3,969	2,998	3,135	2,949	3,943	3,176
Total ICES	6,280	9,206	10,050	8,816	12,296	18,158	13,735	10,640	9,475	7,516	5,859	4,833	4,265	5,008		

***Preliminary.**

Table 6.1.2 Anglerfish in Sub-area VI. Landings, effort and lpue from the Irish OTB fleet.

	IR-OTB-4-6 IV-VI			IR-TBB-4-6 IV-VI			IR-SCC-4-6 IV-VI			IR-GN-4-6 IV-VI		
YEAR	LANDINGS (T)	EFFORT (HR)	LPUE (KG/H)	LANDINGS (T)	EFFORT (HR)	LPUE (KG/H)	LANDINGS (T)	EFFORT (HR)	LPUE (KG/H)	LANDINGS (T)	EFFORT (HR)	LPUE (KG/H)
1995	769.21	66.54	11.56		0.00		5.70	2.65	2.15	0.87	1.57	0.55
1996	698.93	68.90	10.14	16.54	1.23	13.45	4.91	2.94	1.67	1.91	2.25	0.85
1997	680.78	72.71	9.36	2.055	1.07	1.93	7.79	3.00	2.60	3.40	1.83	1.86
1998	656.23	66.40	9.88	10.381	2.36	4.41	12.72	2.95	4.32	0.95	1.22	0.77
1999	512.92	63.23	8.11	1.939	1.12	1.73	12.14	4.22	2.87	6.19	0.49	12.65
2000	471.95	63.33	7.45	0.045	0.13	0.35	4.64	3.86	1.20	0.87	0.11	7.60
2001	408.46	55.99	7.30	0.12	0.12	0.98	2.95	1.31	2.26	22.23	0.43	51.69
2002	317.13	40.00	7.93		0.00		5.06	1.58	3.20	4.94	0.23	21.48
2003	299.17	44.44	6.73		0.00		3.84	2.22	1.73	1.86	0.54	3.45
2004	197.89	37.50	5.28	0.176	0.35	0.50	2.15	0.98	2.20	2.46	0.54	4.57
2005	350.33	34.79	10.07		0.04	0.00	1.07	0.69	1.56	0.00	0.04	0.00
2006	423.39	34.62	12.23	0.12	0.07	1.71	1.18	0.49	2.40	0.02	0.24	0.07

Table 6.2.1. Nominal catch (t) of ANGLERFISH in the North Sea, 1991–2006, as officially reported to ICES.

Northern North Sea (IVa)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006[*]
Belgium	2	9	3	3	2	8	4	1	5	12	-	8	1	.	-	
Denmark	1,245	1265	946	1,157	732	1,239	1,155	1,024	1,128	1,087	1,289	1,308	1,523	1,538	1379	1311
Faroes	1	-	10	18	20	-	15	10	6	.	2	+	2	11	22	2
France	124	151	69	28	18	7	7	3[*]	18[1*]	8	9	8	8	8	4	5

Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	84	
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	13	
Norway	587	635	1,224	1,318	657	821	672	954	1,219	1,182	1,212	928	769	999	880	1005
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	5	5
UK(E, W&NI)	129	143	160	169	176	439	2,174	668	781	218	183	98	104	83	34	…
UK (Scotland)	7,039	7,887	9,712	11,683	15,658	22,344	18,783	13,319	9,710	9,559	10,024	8,539	6,033	6,284	6,003	…
UK (total)																7,821
Total	**9,235**	**10,209**	**12,309**	**14,505**	**17,891**	**25,176**	**23,425**	**16,857**	**13,326**	**12,338**	**12,861**	**11,048**	**8,522**	**8,987**	**8,424**	**10,149**

Preliminary.

[1)] **Includes IVb,c.**

Table 6.2.1 (continued)

Central North Sea (IVb)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006[*]
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	259	207	139
Denmark	345	421	347	350	295	225	334	432	368	260	251	255	191	274	237	276
Faroes	-	-	2	-	-	-	-	-	-	-	-	10	-	-	-	-
France	-	1	-	2	-	-	-	-[*]	…[2*]	-	-	-	-	+	-	-
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	9	-
Ireland													1	-		-
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	31	-
Norway	17	4	3	11	15	29	6	13	17	9	15	10	12	22	16	14
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	4	4
UK(E, W&NI)	669	998	1,285	1,277	919	662	664	603	364	423	475	236	167	120	96	…
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	88	…
UK (total)																205
Total	**2,522**	**3,053**	**3,144**	**3,445**	**2,627**	**1,847**	**2,172**	**2,088**	**1,517**	**1,617**	**1,832**	**1,244**	**847**	**850**	**688**	**638**

*** Preliminary.**

1) Includes 2 tonnes reported as Sub-area IV.

2) Included in IVa.

Table 6.2.1 (continued)

Southern North Sea (IVc)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4	3
Denmark	2	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+
France	-	-	-	-	-	-	-	10	-	+	-	+	-	-	-	+
Germany	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	1	-
Norway	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	-	-	10	3	-	…
UK (Scotland)	-	-	-	17	-	3	1	+	+	+	-	-	-	7	-	… +
Total	**26**	**39**	**66**	**210**	**402**	**304**	**160**	**78**	**24**	**31**	**21**	**21**	**20**	**15**	**5**	**3**

Preliminary.

1) Included in IVa.

Total North Sea

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Total	**11,783**	**13,301**	**15,519**	**18,162**	**20,920**	**27,327**	**25,757**	**19,023**	**14,867**	**13,986**	**14,714**	**12,313**	**9,389**	**9,852**	**9,117**	**10,790**
WG estimate	10,566	11,728	13,078	15,432	15,794	16,240	18,217	14,027	11,719	11,564	12,677	10,334	8,273	9,027		
Unallocated	-1,217	-1,573	-2,441	-2,730	-5,126	-11,087	-7,540	-4,996	-3,148	-2,422	-2,037	-1,979	-1,116	-825		

*** Preliminary.**

Table 6.2.2 Nominal catch (t) of Anglerfish in Division IIIa, 1991–2006, as officially reported to ICES.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	15	48	34	21	35	-	-	-	-	-	-	.	.	.		
Denmark	493	658	565	459	312	367	550	415	362	377	375	369	215	311	274	227
Germany	-	-	1	-	-	1	1	1	2	1	-	1	-	1		
Netherlands							-	-	-	-	-	.	3	4	4	
Norway	64	170	154	263	440	309	186	177	260	197	200	242	187	130	100	137
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	79	47
Total	**595**	**938**	**843**	**811**	**823**	**702**	**776**	**626**	**660**	**602**	**621**	**667**	**476**	**519**	**457**	**411**

***Preliminary.**

Tables 6.2.3 Total Danish Anglerfish landings (tons) and effort (days fishing) by fishery.

A. Landings by fishery (from log-book data)

Year	North Sea						North Sea	IIIa tons						IIIa	IIIa & IV
	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	total)
1997	47	64	1132	56	103	88	1489	58	137	183	139	8	25	550	2039
1998	76	153	996	40	91	100	1456	58	86	167	89	2	13	415	1871
1999	75	116	1106	39	84	76	1496	82	41	121	105	1	12	362	1858
2000	52	88	1066	16	68	56	1347	61	47	116	140	0	13	377	1724
2001	52	18	1343	7	67	53	1540	44	18	86	211	4	11	375	1915
2002	41	59	1269	86	53	55	1563	35	41	116	162	1	15	371	1934
2003	28	40	1508	59	30	42	1707	27	4	27	147	1	10	217	1924
2004	57	45	1525	91	42	50	1809	31	13	40	189	0	37	311	2120
2005	14	48	1412	96	26	17	1612	18	5	83	135	0	30	272	1884
2006	9	18	1454	96	10	9	1587	10	1	107	105	0	3	227	1814

B. Effort by fishery (from log-book data)

Year	Total Danish effort in IV (days)						North Sea	Total Danish effort in IIIa (days)						IIIa	IIIa & IV
	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	total
1997	636	268	4778	727	1535	1387	9332	520	980	1820	2207	106	473	6107	15438
1998	733	566	4413	376	1257	1636	8982	376	665	1446	1454	14	276	4231	13213
1999	748	687	5084	428	1043	1200	9190	621	475	1462	2304	23	237	5121	14311
2000	695	787	6297	285	808	1102	9974	437	567	1330	3004	6	314	5658	15632
2001	780	250	8164	182	1039	1137	11552	426	361	1047	3941	42	296	6112	17665
2002	676	537	7415	741	1155	1025	11548	362	434	1284	3131	22	256	5489	17037
2003	309	445	7917	711	528	810	10720	220	79	414	2505	9	237	3463	14183
2004	522	419	6212	448	517	606	8725	358	191	245	2762	5	458	4020	12744
2005	166	401	6077	436	240	268	7588	189	123	691	2344	4	526	3877	11465
2006	177	97	6004	551	127	156	7113	149	65	808	2104	3	78	3207	10319

Table 6.2.4 Species composition of Danish landings from the demersal trawl fishery in the Norwegian Deep, where anglerfish is taken. Log-book records.

Species	2004		2005		2006	
	Tons landed	% of total	Tons landed	% of total	Tons landed	% of total
Tusk	98	1.10	80	0.84	121	1.35
Nephrops	730	8.17	911	9.67	852	9.55
Anglerfish	1200	13.43	1254	13.32	1266	14.19
Hake	127	1.42	215	2.28	366	4.10
Haddock	616	6.89	545	5.79	347	3.89
Ling	447	5.00	542	5.76	556	6.24
Saithe	3444	38.55	2918	30.99	2584	28.96
Plaice	480	5.37	556	5.91	645	7.23
Lemon sole	161	1.80	217	2.31	233	2.61
Witch	333	3.73	424	4.50	405	4.54
Cod	794	8.88	1081	11.48	898	10.07
Others	505	5.66	673	7.15	649	7.27
Grand Total	**8934**	**100.00**	**9416**	**100.00**	**8922**	**100.00**

Table 6.2.5 Anglerfish in IV and IIIa. Norwegian landings (tonnes) by fishery in 2005 and 2006.

Fleet	2005 Div IIIa	2005 Div IVa	2006 Div IIIa	2006 Div IVa
Coastal gillnetting	61	526	103	696
Offshore gillnetting	1	16	+	19
Coastal shrimp trawling	22	50	25	46
Offshore dem trawling	5	102	+	142
Offshore shrimp trawling	3	68	5	66
Other gears	7	119	3	36
Total	**100**	**880**	**137**	**1,005**

Table 6.2.6 Danish lpue (Kg/day) for anglerfish. Logbook records

År	IV			Norwegian deeps (IVa east + northeast of IVb)	IIIa		
	Dem trawl	Neph trawl	Shrimp trawl	Dem trawl	Dem trawl	Neph trawl	Shrimp trawl
1996	264	139	99	304	99	51	49
1997	237	77	63	268	101	63	52
1998	226	107	61	259	115	61	48
1999	218	90	64	243	83	46	51
2000	169	57	51	198	88	46	40
2001	164	39	47	181	83	54	38

2002	171	116	54	195	91	52	59
2003	191	83	51	197	66	59	40
2004	245	204	82	273	162	69	82
2005	232	220	62	245	121	58	56
2006	246	177	56	245	158	60	49

Table 6.3.1 Anglerfish on the Northern Shelf (IIIa, IV & VI). Total official landings by area (tonnes).

	IIIa	IVa	IVb	IVc	VIa	VIb	Total
1973	140	2085	575	41	9221	127	12189
1974	202	2737	1171	39	3217	435	7801
1975	291	2887	1864	59	3122	76	8299
1976	641	3624	1252	49	3383	72	9021
1977	643	3264	1278	54	3457	78	8774
1978	509	3111	1260	72	3117	103	8172
1979	687	2972	1578	112	2745	29	8123
1980	652	3450	1374	175	2634	200	8485
1981	549	2472	752	132	1387	331	5623
1982	529	2214	654	99	3154	454	7104
1983	506	2465	1540	181	3417	433	8542
1984	568	3874	1803	188	3935	707	11075
1985	578	4569	1798	77	4043	1013	12078
1986	524	5594	1762	47	3090	1326	12343
1987	589	7705	1768	66	3955	1294	15377
1988	347	7737	2061	95	6003	1730	17973
1989	334	7868	2121	86	5729	313	16451
1990	570	8387	2177	34	5615	822	17605
1991	595	9097	2522	26	5061	923	18224
1992	938	10202	3053	39	5479	1089	20800
1993	843	12302	3143	66	5553	681	22588
1994	811	14505	3445	210	5273	777	25021
1995	823	17891	2627	402	6354	830	28927
1996	702	25176	1847	304	6408	602	35039
1997	776	23425	2172	160	5330	899	32762
1998	626	16860	2088	78	4506	900	25058
1999	660	13326	1517	24	2470	1401	19398
2000	602	12338	1617	31	3311	1074	18973
2001	621	12861	1832	21	2660	1309	19304
2002	667	11048	1244	21	2280	718	15978
2003	478	8523	847	20	2493	643	13004
2004	519	8987	851	15	2453	671	13496
2005	458	8424	688	5	3019	958	13552
2006	411	10149	638	3	2502	674	14377
Min	140	2085	575	3	1387	29	5623
Max	938	25176	3445	402	9221	1730	35039
Average	570	8592	1674	89	4011	697	15633.41

Table 6.3.2 Northern Shelf anglerfish. Results of the Scottish survey by stratum (2005 & 2006). RSE = relative standard error.

Region	Abundance millions	RSE	- 95% CI millions	+ 95% CI millions	Biomass tonnes	RSE	- 95% CI tonnes	+ 95% CI tonnes
Rockall	1.629	18%	1.050	2.209	6,087	27%	2,834	9,340
West	4.040	21%	2.380	5.699	5,767	21%	3,367	8,166
North	4.916	21%	2.819	7.012	8,669	20%	5,271	12,066
East	6.584	51%	0.000	13.331	11,131	45%	1,139	21,123
Total	**17.169**	**21%**	**9.888**	**24.449**	**31,654**	**18%**	**20,352**	**42,955**

Region	Abundance millions	RSE	- 95% CI millions	+ 95% CI millions	Biomass tonnes	RSE	- 95% CI tonnes	+ 95% CI tonnes
Rockall	2.780	13%	2.051	3.509	6,995	13%	5,144	8,847
West	5.410	20%	3.259	7.560	6,195	14%	4,419	7,972
North	5.135	13%	3.800	6.470	8,744	12%	6,720	10,767
East	9.922	11%	7.798	12.047	21,065	15%	14,948	27,182
Total	**23.247**	**7%**	**19.863**	**26.632**	**42,999**	**8%**	**36,064**	**49,934**

Table 6.4.1 Nominal catch (t) of Anglerfish in Division IIa, 1992–2006, as officially reported to ICES.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Denmark	+	+	+	+	+	+	+	+	2	+	-	1	-	N/a
Faroes	+	+	+	+	+	+	+	-	1	1	2	5	11	3
France	-	-	-	-	-	-	+	-	-	-	-	-	-	N/a
Germany	2	3	1	4	20	53	4	17	65	59	55	70	55	N/a
Norway	3,044	1,026	526	893	576	1,488	1,731	2,952	3,552	2,000	2,404	2,906	2,649*	4,252
Russia	-	-	-	-	-	-	-	-	-	-	-	-	1	N/a
Sweden	-	-	-	+	+	+	+	+	+	-	-	-	-	N/a
UK (total)	1	2	74	15	5	7	6	30	2	10	15	18	19	87
Total	**3,047**	**1,031**	**601**	**912**	**601**	**1,548**	**1,741**	**2,999**	**3,622**	**2,070**	**2,476**	**2,999**	**2,672**	**4,341**

***Preliminary**

Table 6.4.2 Anglerfish in IIa. Norwegian landings (tonnes) by fishery in 2005 and 2006.

FLEET	2005	2006
Coastal gillnetting	2,301	3,723
Offshore gillnetting	115	261
Offshore dem trawling	77	71
Coastal Danish seine	54	54
Other gears	102	144
Total	**2,649**	**4,252**

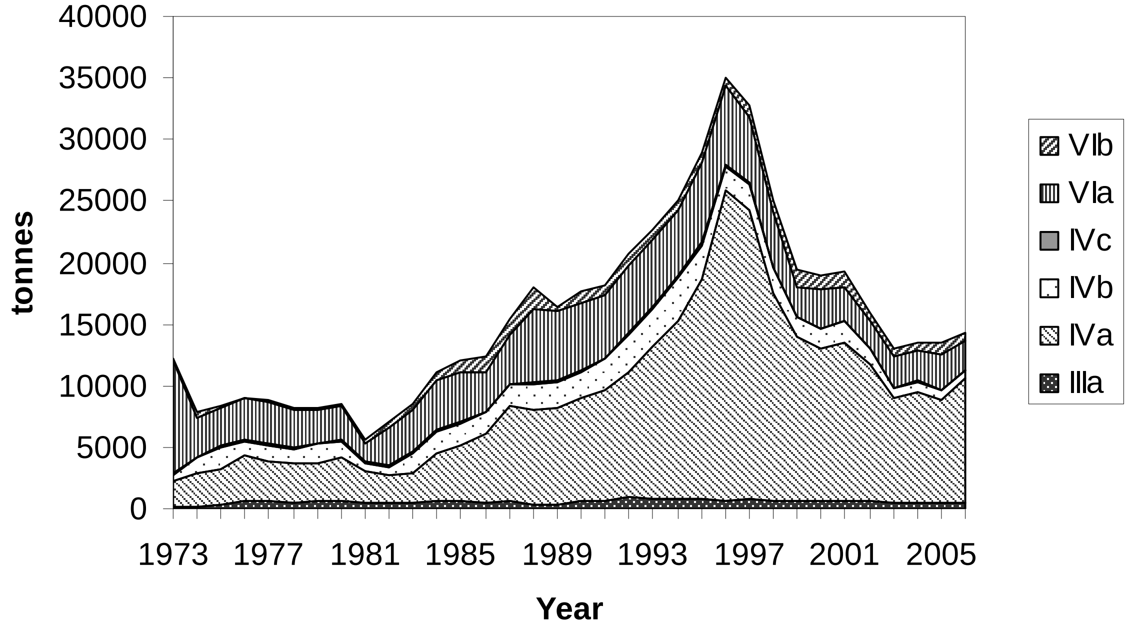


Figure 6.1.1. Northern Shelf anglerfish. Officially reported landings by ICES area.

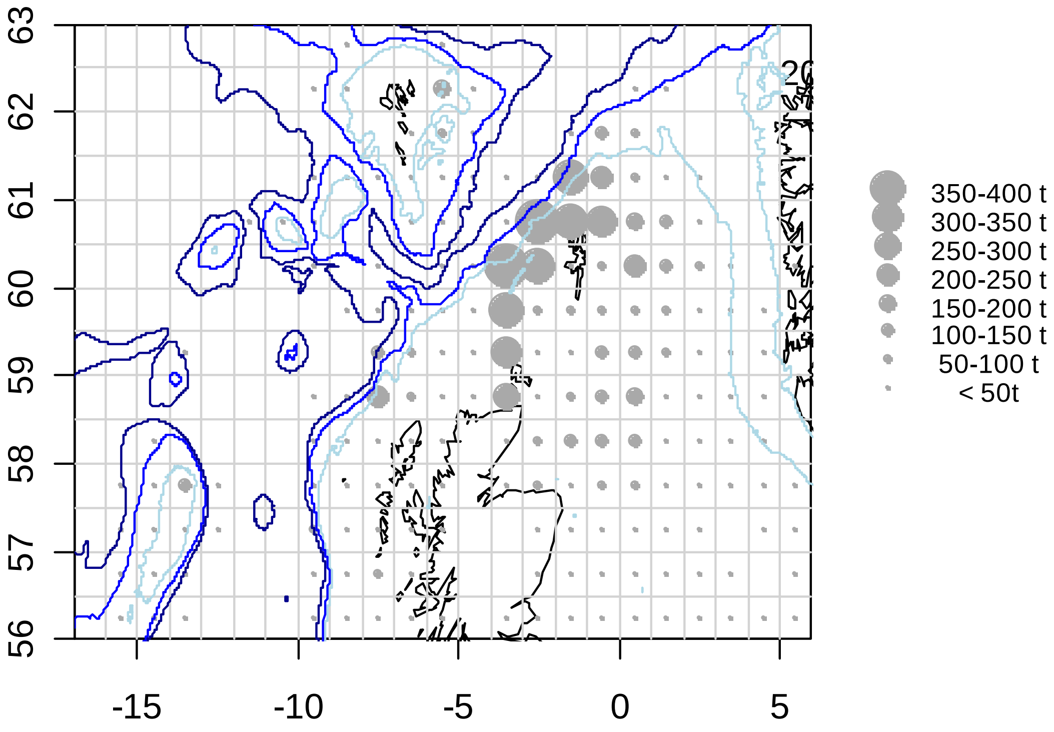


Figure 6.1.2. Northern Shelf anglerfish. Distribution of officially reported Scottish landings.

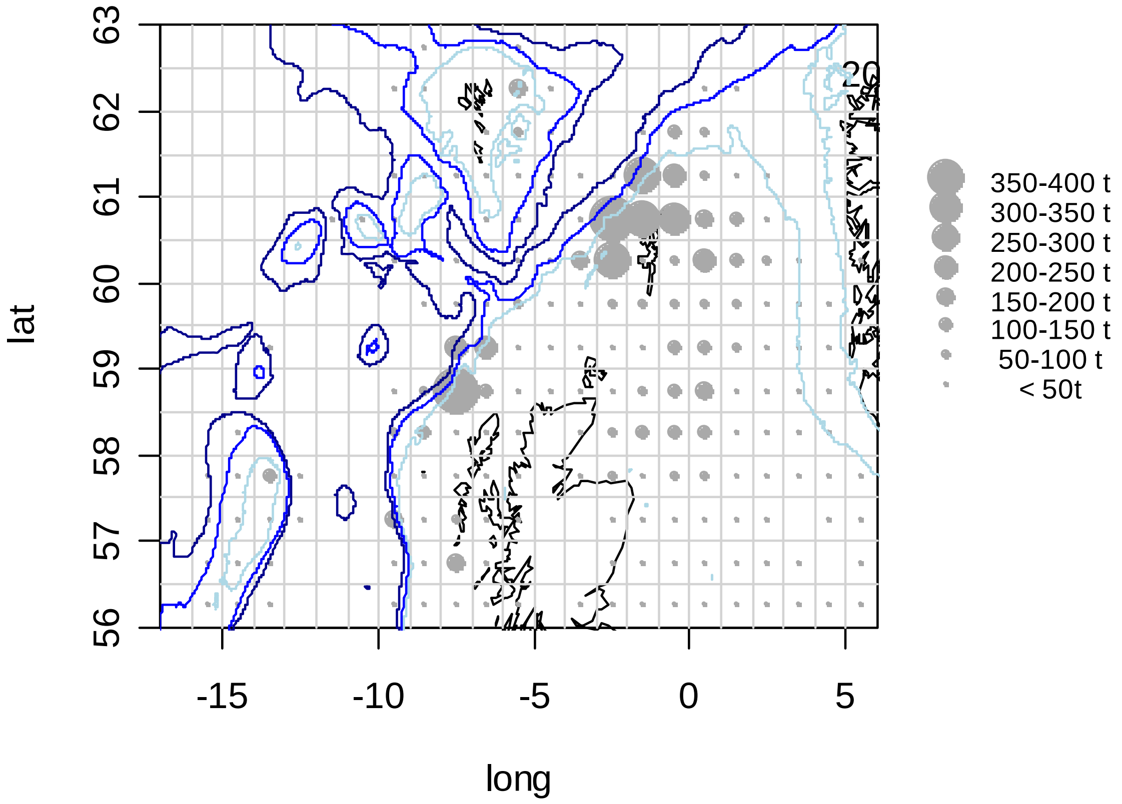


Figure 6.1.3. Northern Shelf anglerfish. Distribution of officially reported Scottish landings adjusted for area misreporting but not underreporting.

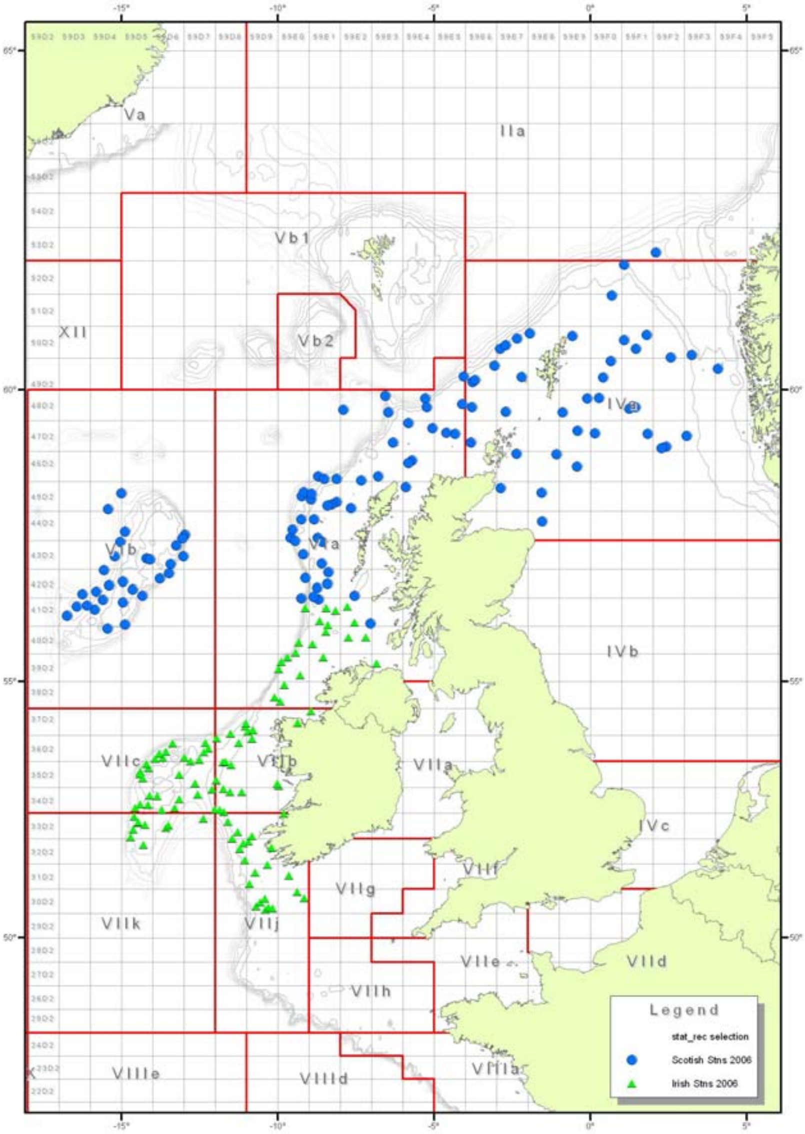


Figure 6.1.4. Northern Shelf anglerfish. Location of survey stations for 2006 industry-science partnership anglerfish survey (circles Scottish Stations; triangles Irish Stations).

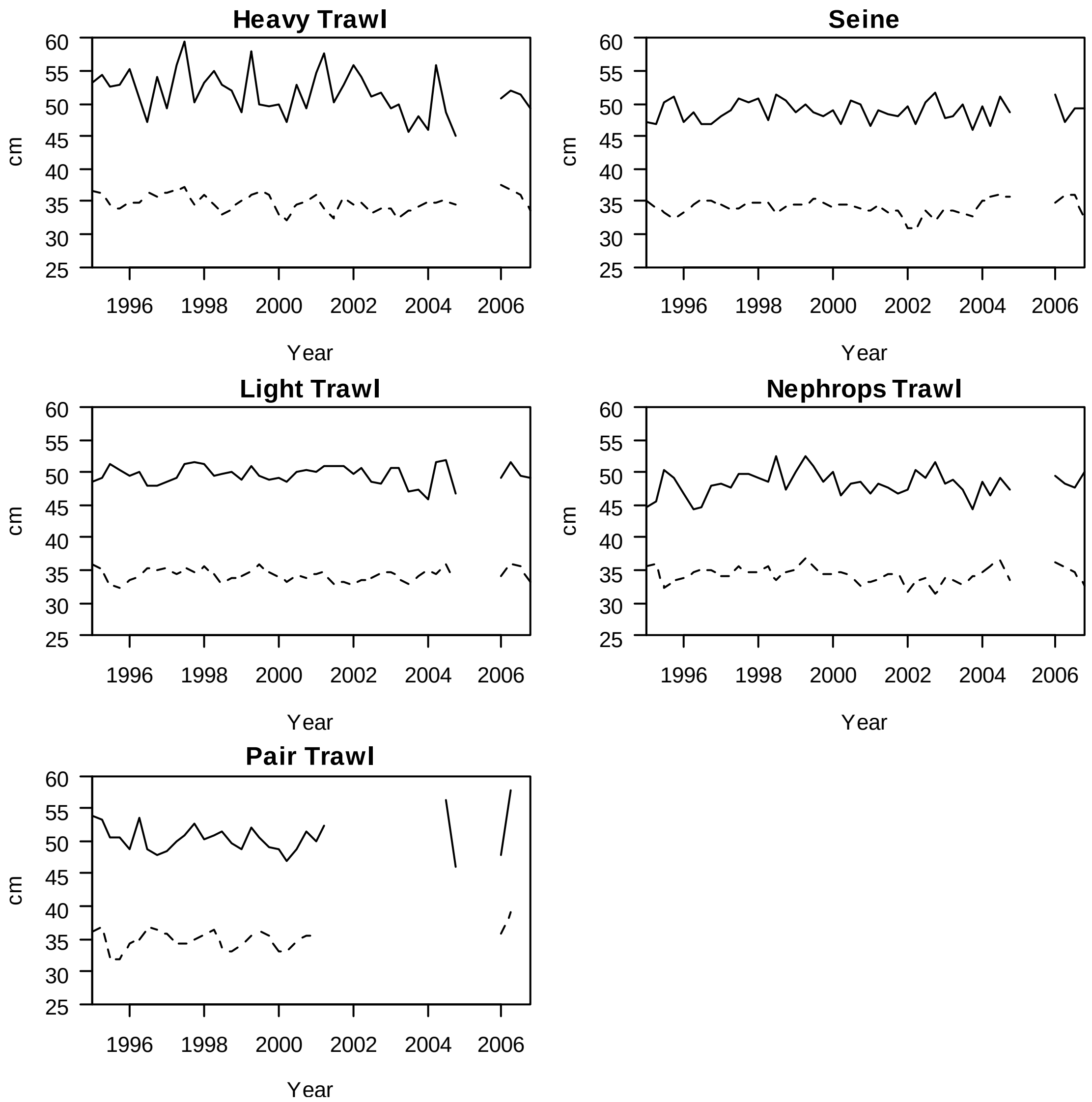


Figure 6.1.5. Anglerfish in Division VIa. Trends in mean length of small (<40 cm) and large (>=40 cm) anglerfish from the quarterly Scottish market sampling data by gear category. Data are currently unavailable for 2005 and pair trawl not sampled 2001–2004.

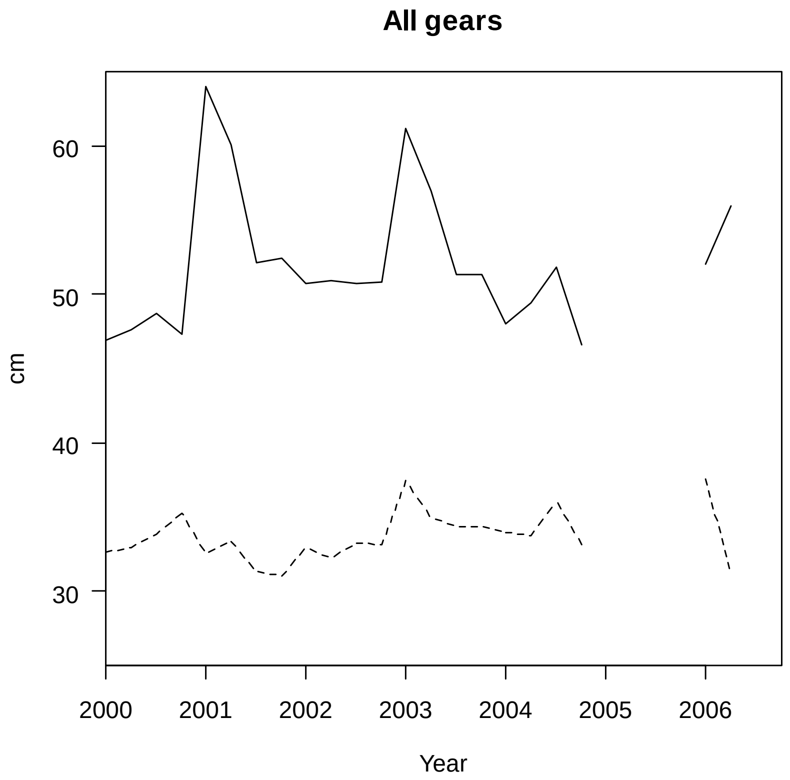


Figure 6.1.6. Anglerfish in Division VIb. Trends in mean length of small (<40 cm) and large (>=40 cm) anglerfish from the Scottish market sampling data by all gear categories combined (mainly light & heavy trawl). Data are currently unavailable for 2005.

2006

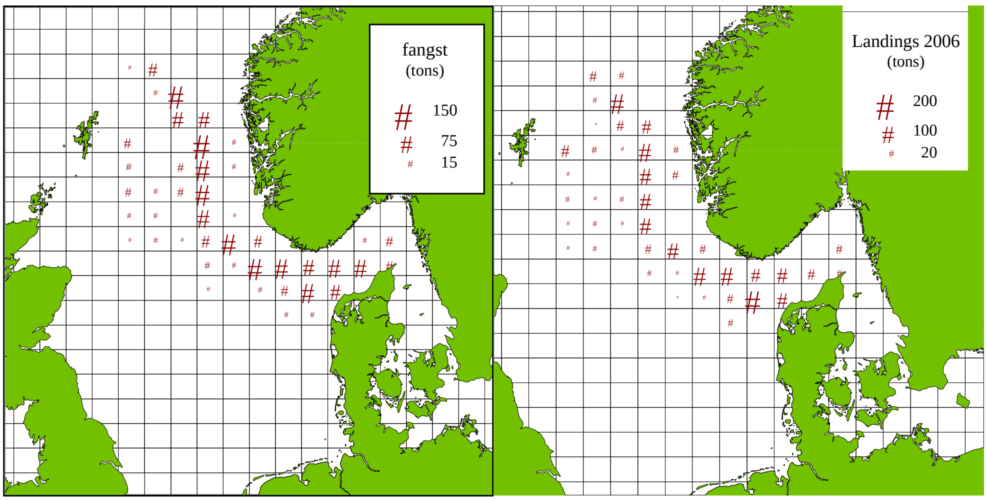


Figure 6.2.1. Anglerfish in the North Sea. Distribution of Danish landings (tonnes) by ICES square in 2005 and 2006.

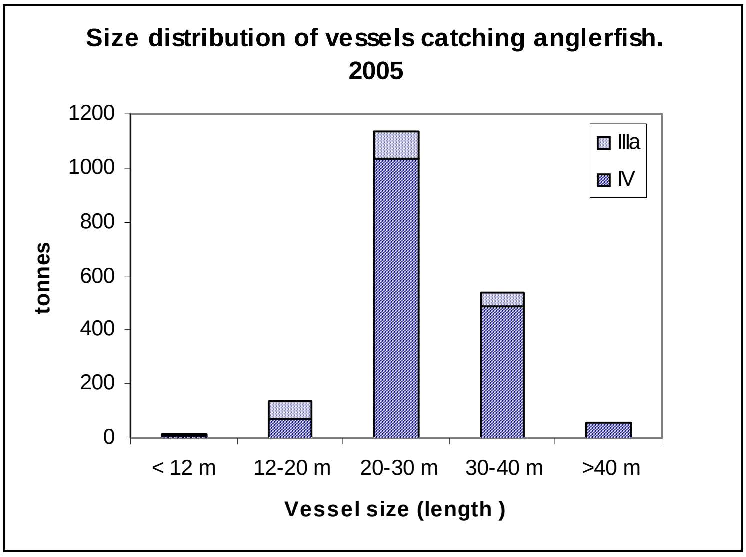
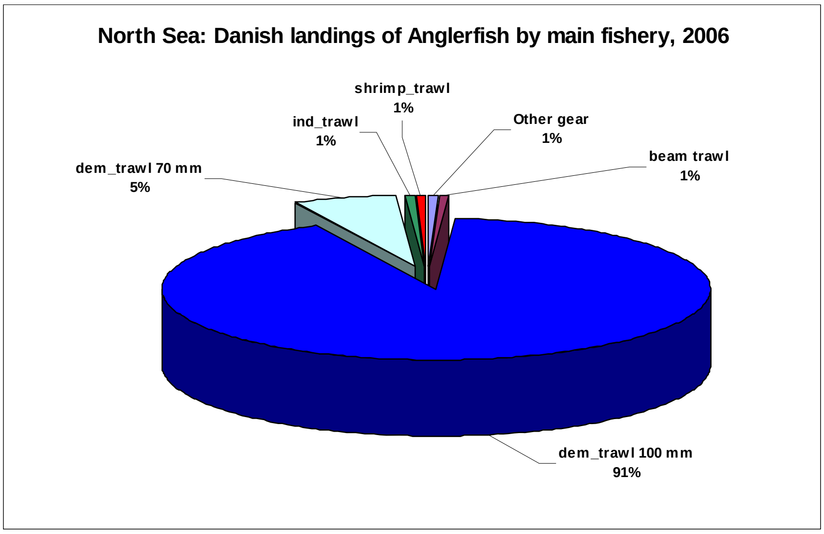


Figure 6.2.2. Anglerfish in the North Sea. Danish vessel categories (by size) catching anglerfish.



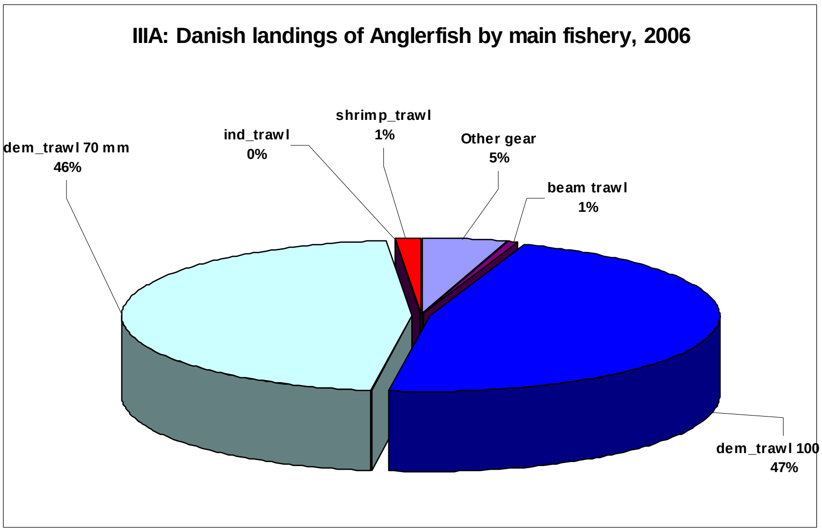


Figure 6.2.3. Anglerfish in the North Sea & Division IIIa. Danish landings by fishery.

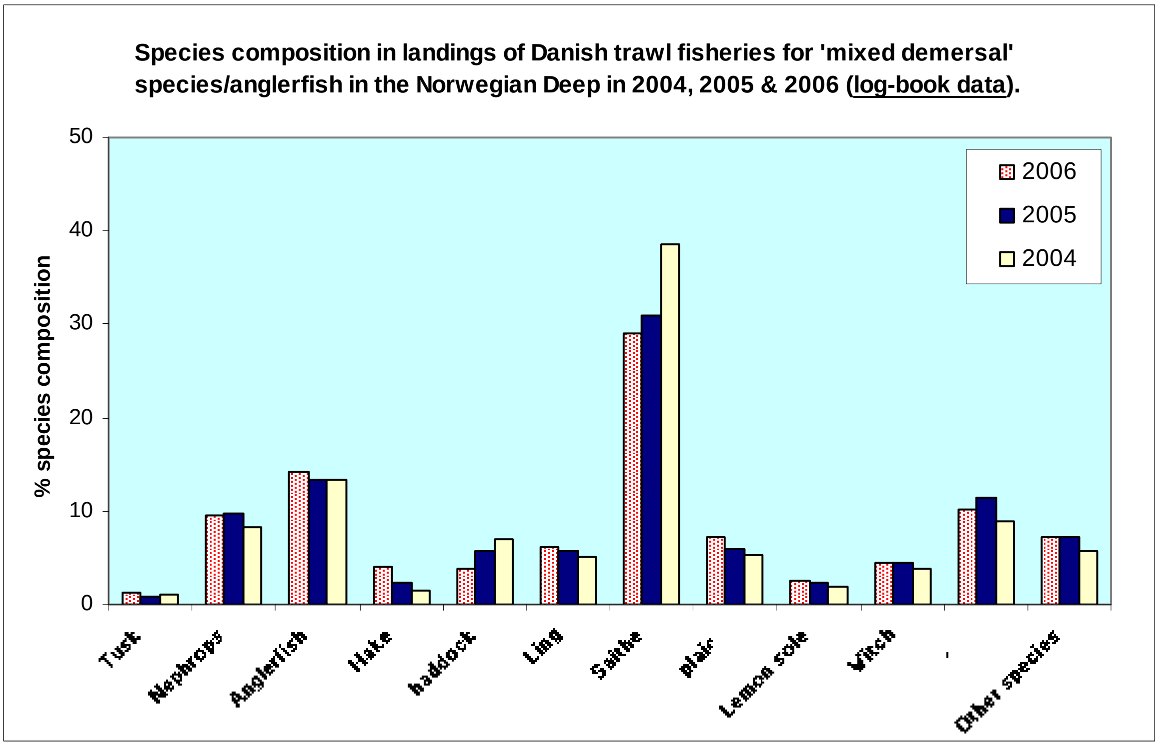


Figure 6.2.4. Anglerfish in the North Sea. Species composition in Danish landings with anglerfish. Data from logbooks (% by weight).

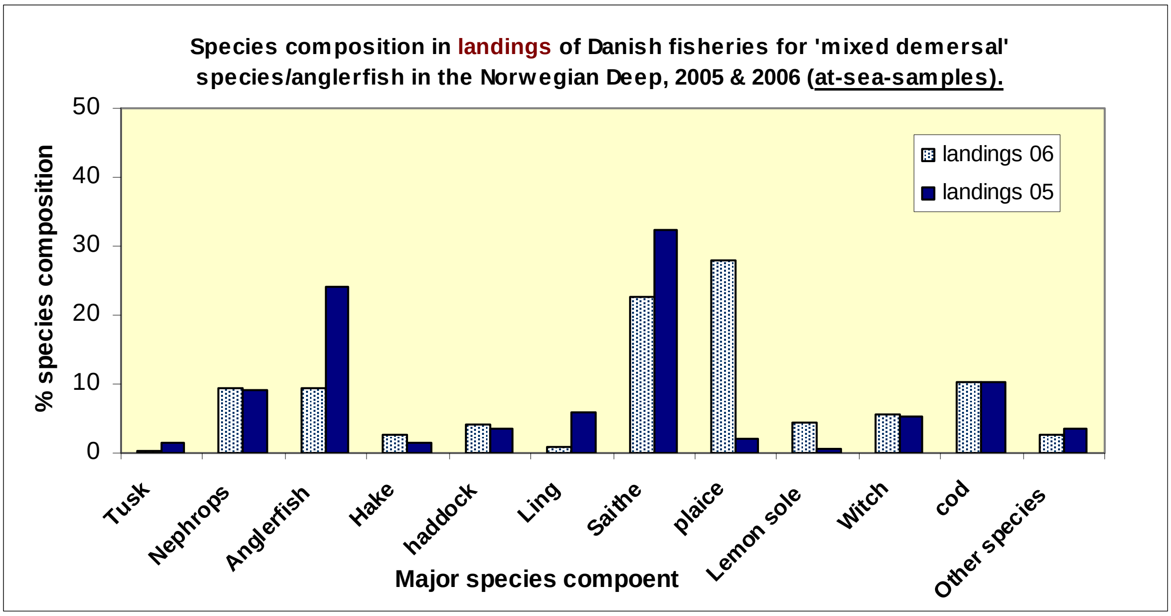


Figure 6.2.5. Anglerfish in the North Sea. Species composition (% by weight) in Danish landings with anglerfish. Data from observer programmes.

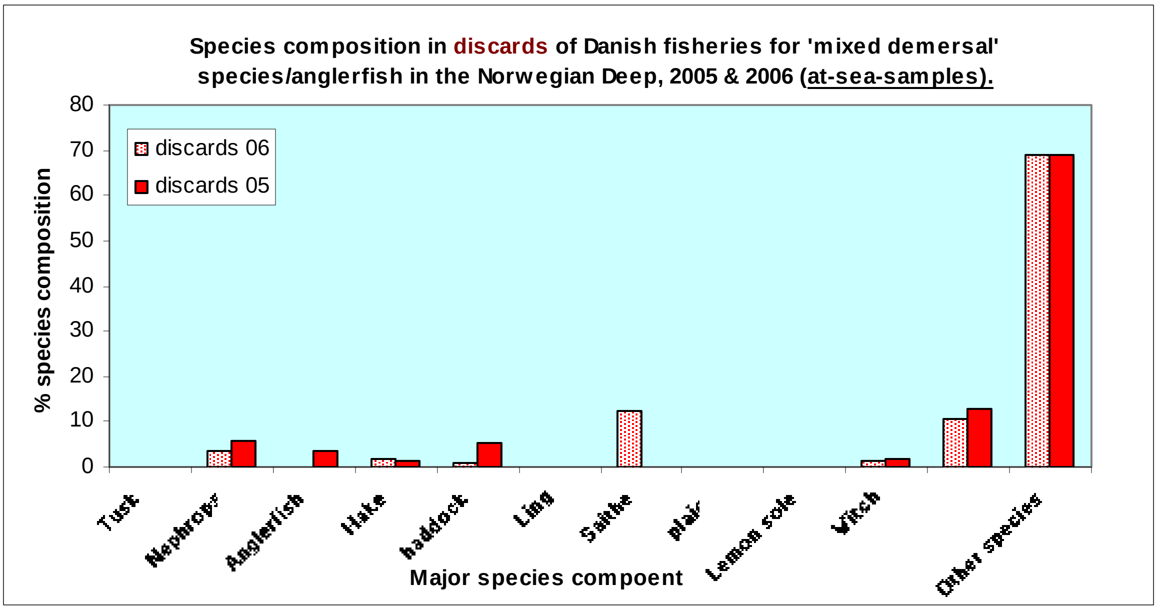


Figure 6.2.6. Anglerfish in the North Sea. Species composition (% by weight) of discards in fisheries for anglerfish. Data from observer programmes.

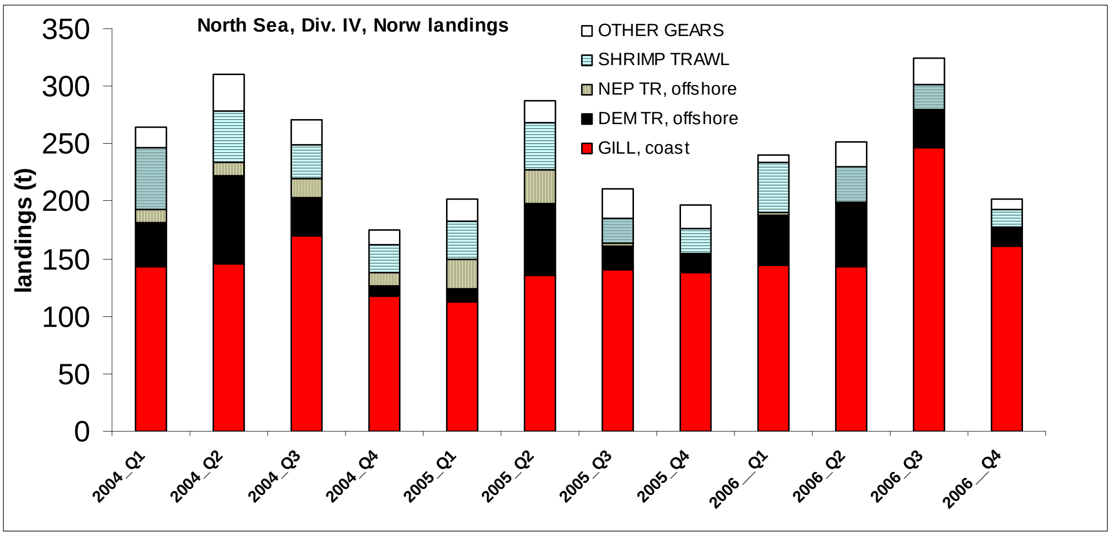


Figure 6.2.7. Anglerfish in Division IVa. Norwegian landings by quarter and fleet during 2004–2006.

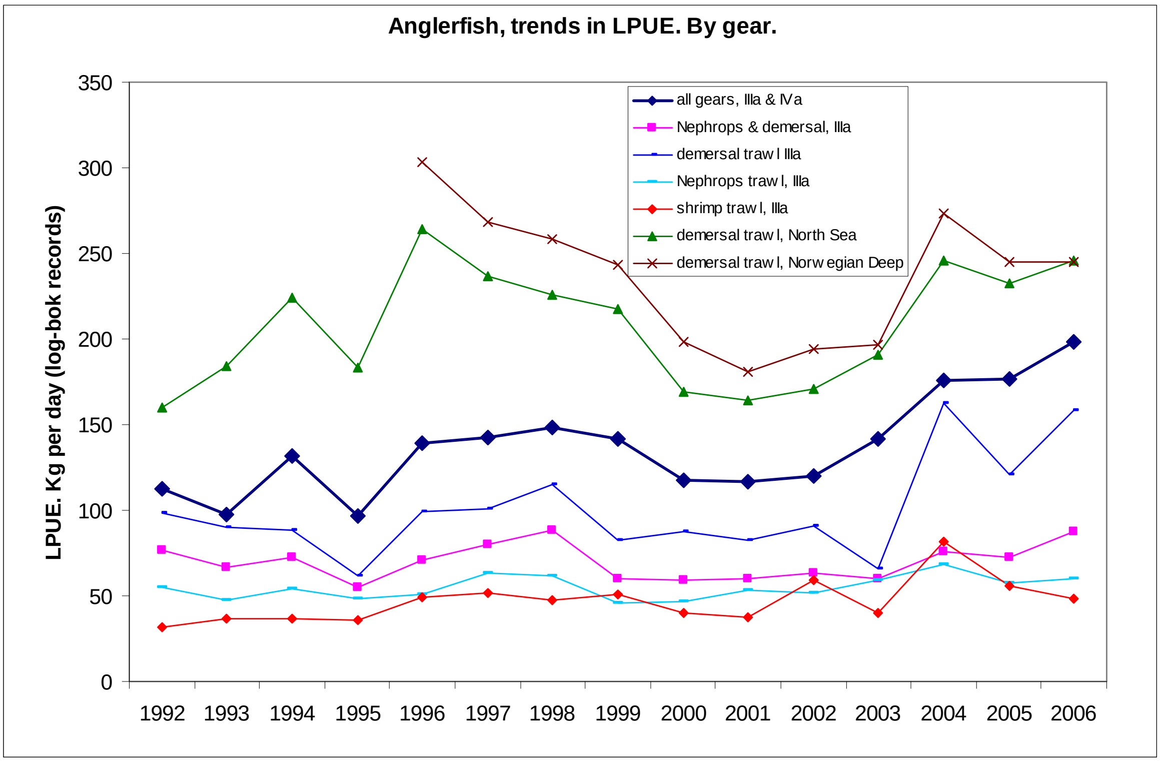


Figure 6.2.8. Anglerfish in the North Sea & Division IIIa. Estimates of Danish lpue by fishery. Based on log-book records.

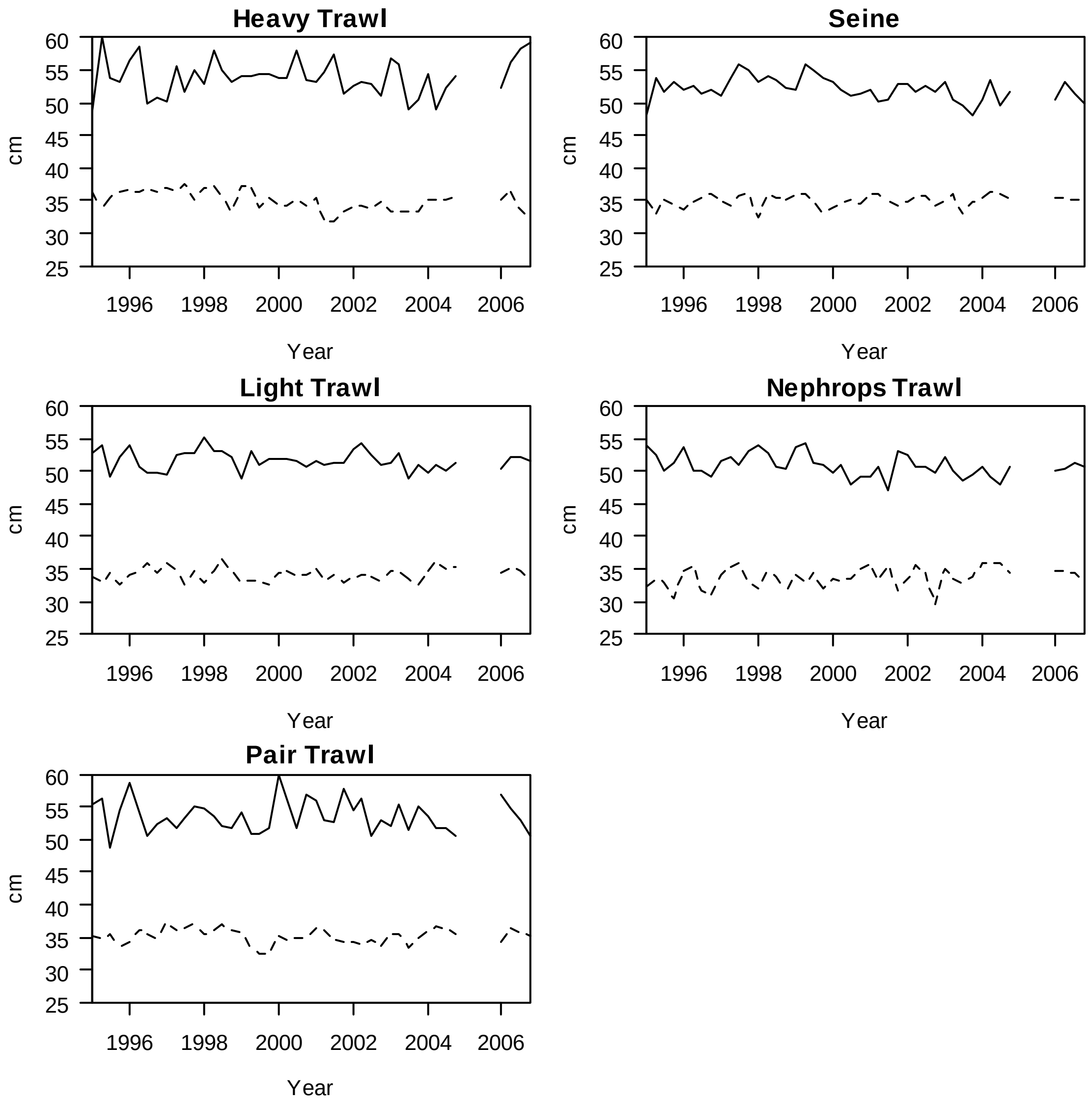


Figure 6.2.9. Trends in mean length of small (<40cm) and large (>=40cm) anglerfish from the quarterly Scottish market sampling data by gear category. No data available for 2005.

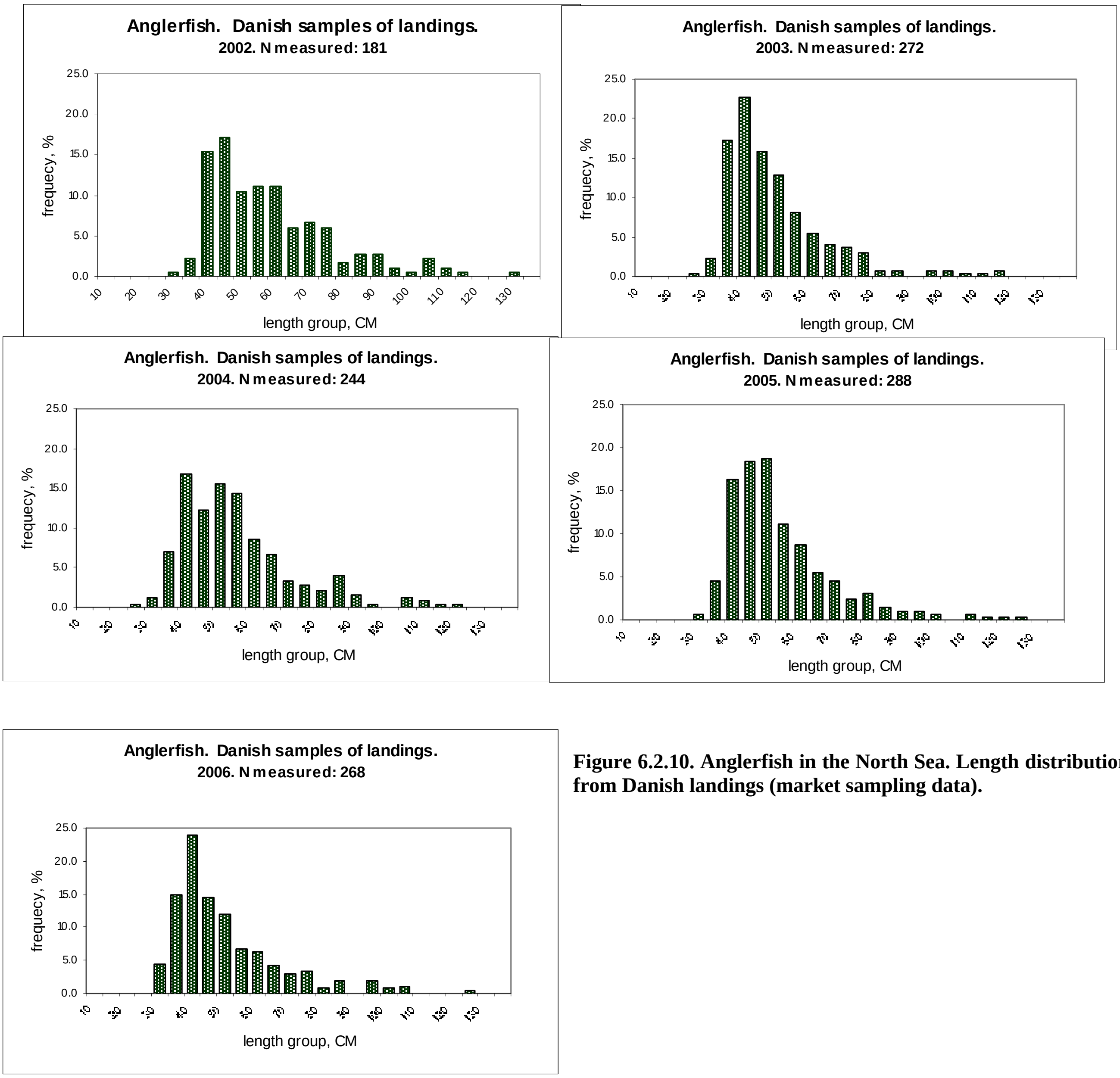


Figure 6.2.10. Anglerfish in the North Sea. Length distributions from Danish landings (market sampling data).

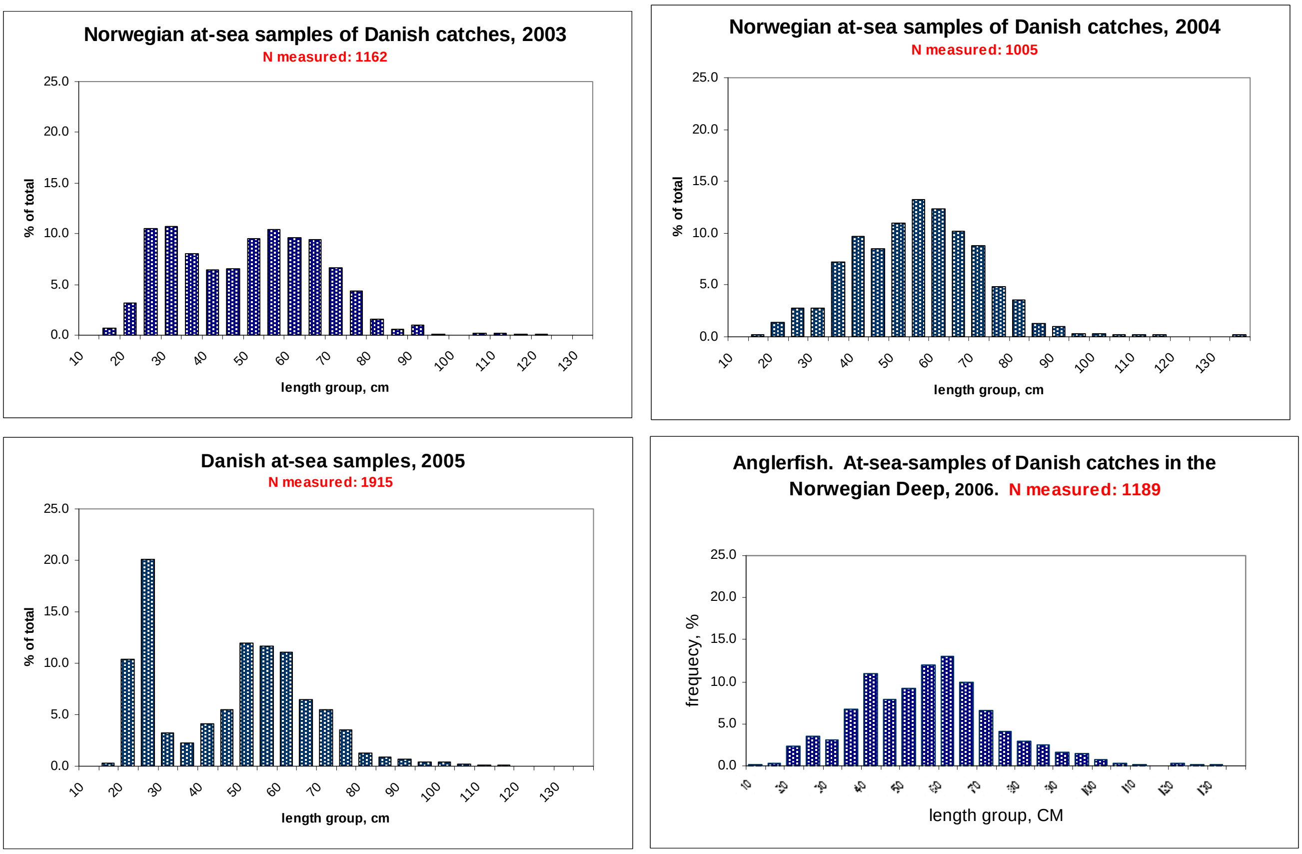


Figure 6.2.11. Anglerfish in the North Sea. At-sea samples from the Danish catches in the Norwegian Deeps.

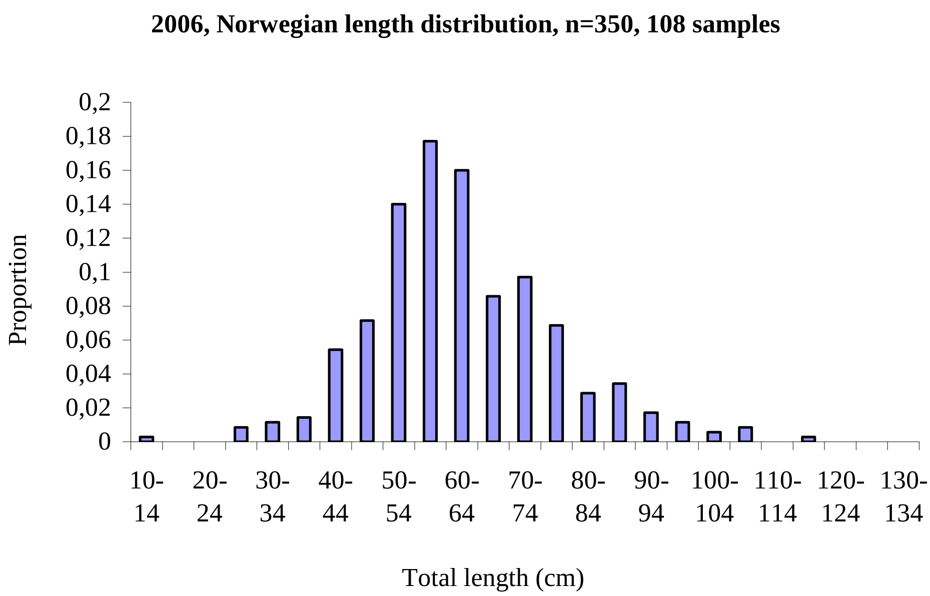


Figure 6.2.12. Anglerfish in Division IVa. Length distribution from Norwegian at-sea sampling of anglerfish caught as bycatch in offshore trawling for saithe and gillnetting for cod.

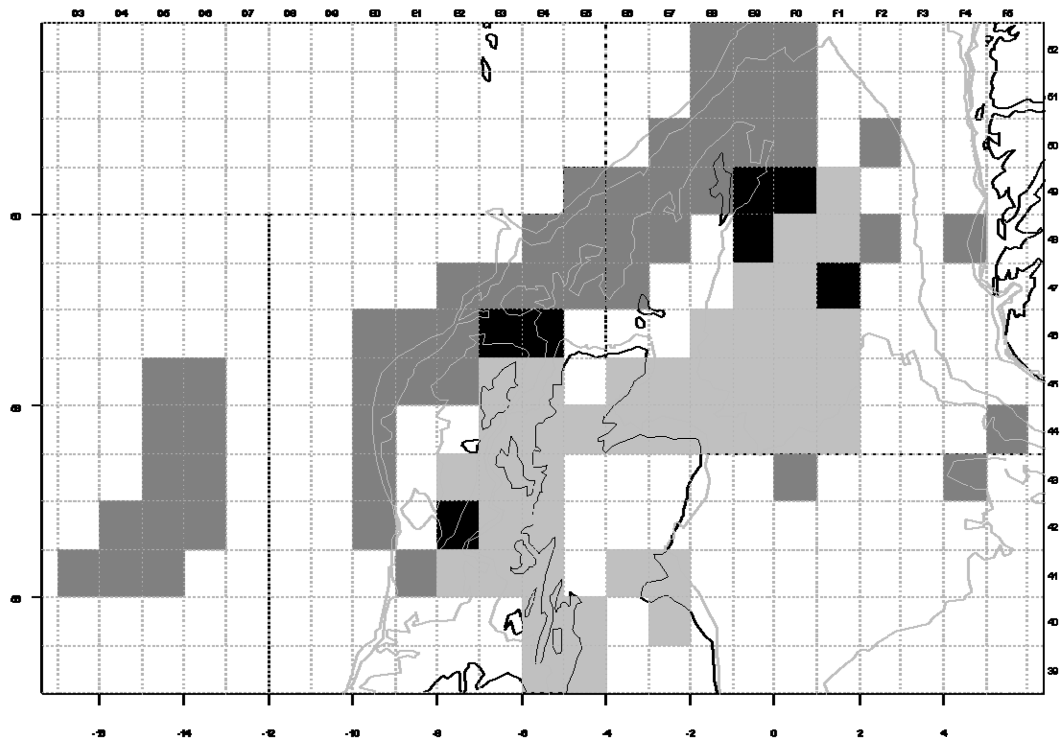


Figure 6.3.1. Anglerfish on the Northern ShelfStatistical rectangle definition of the Scottish anglerfish fishery areas: 'Anglerfish fishery area' (grey), 'Nephrops fishery area' (light grey) and 'other' (all other rectangles). Black rectangles indicate overlap between the anglerfish area and Nephrops area – these rectangles were subsequently included as part of the anglerfish area.

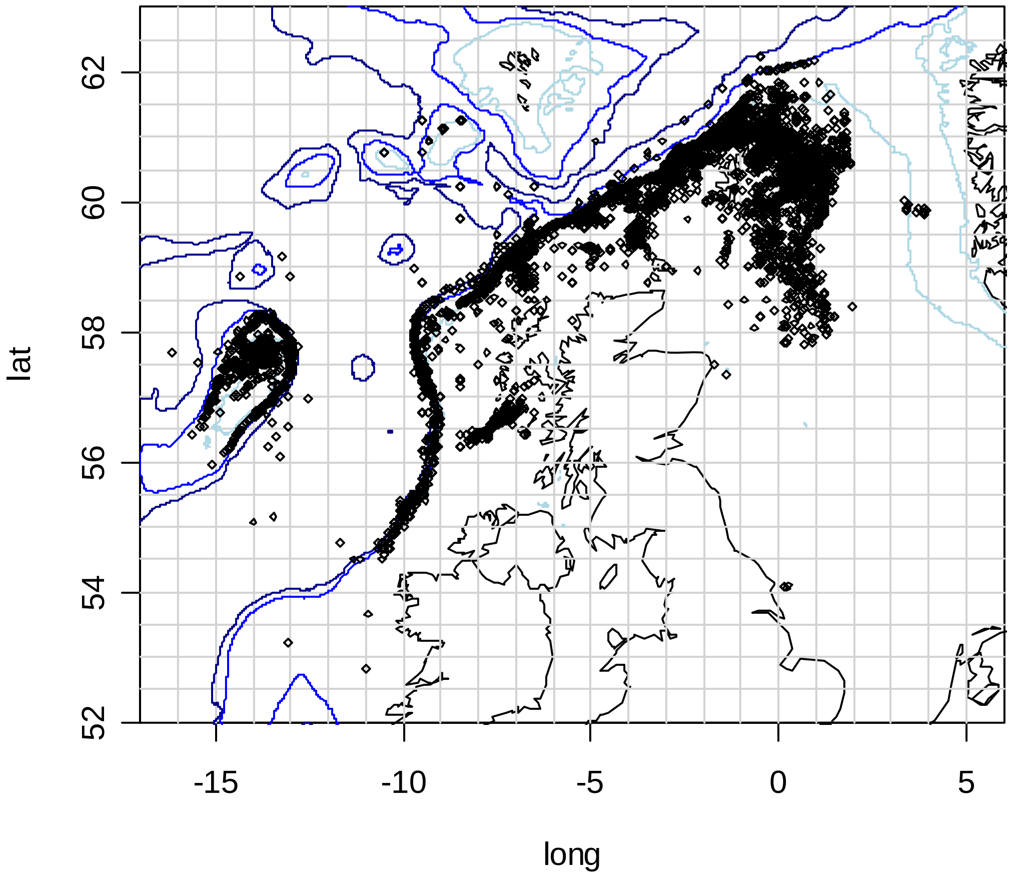


Figure 6.3.2. Northern Shelf anglerfish. Spatial distribution of haul information from Scottish tallybook data for Dec 2005–March 2007.

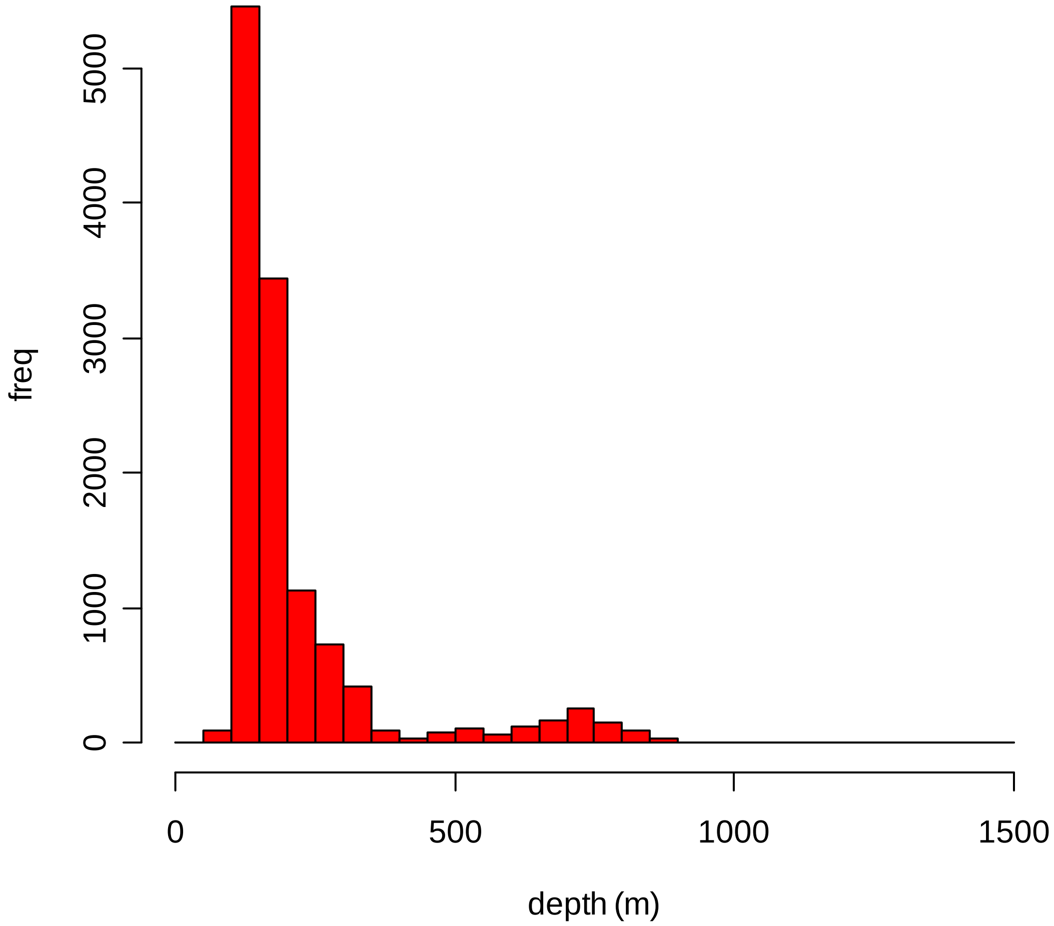


Figure 6.3.3. Northern Shelf anglerfish. Depth distribution of Scottish tallybook hauls.

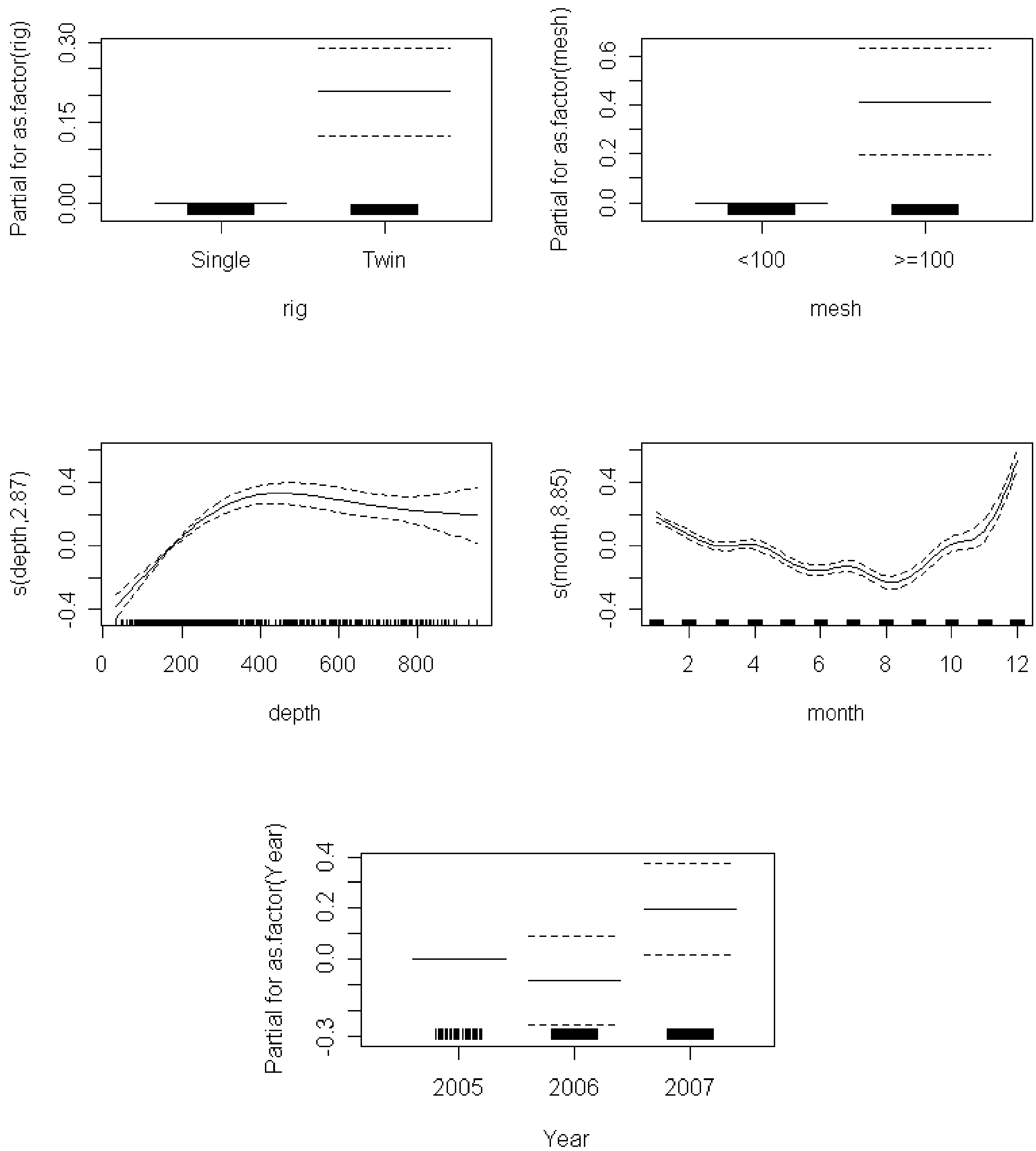
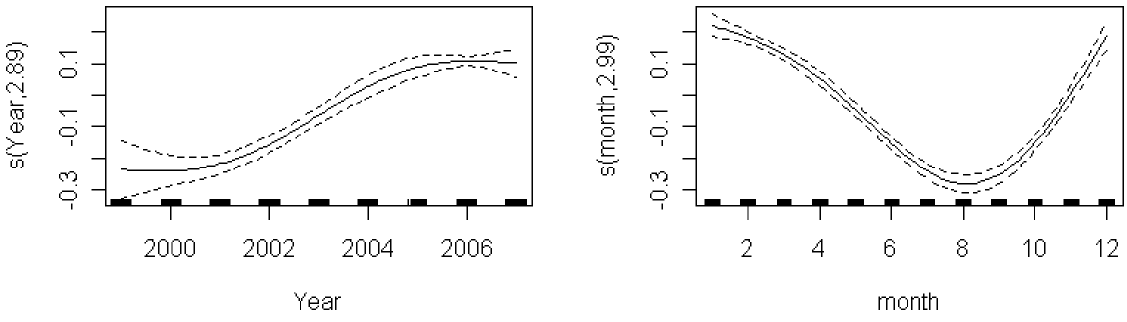
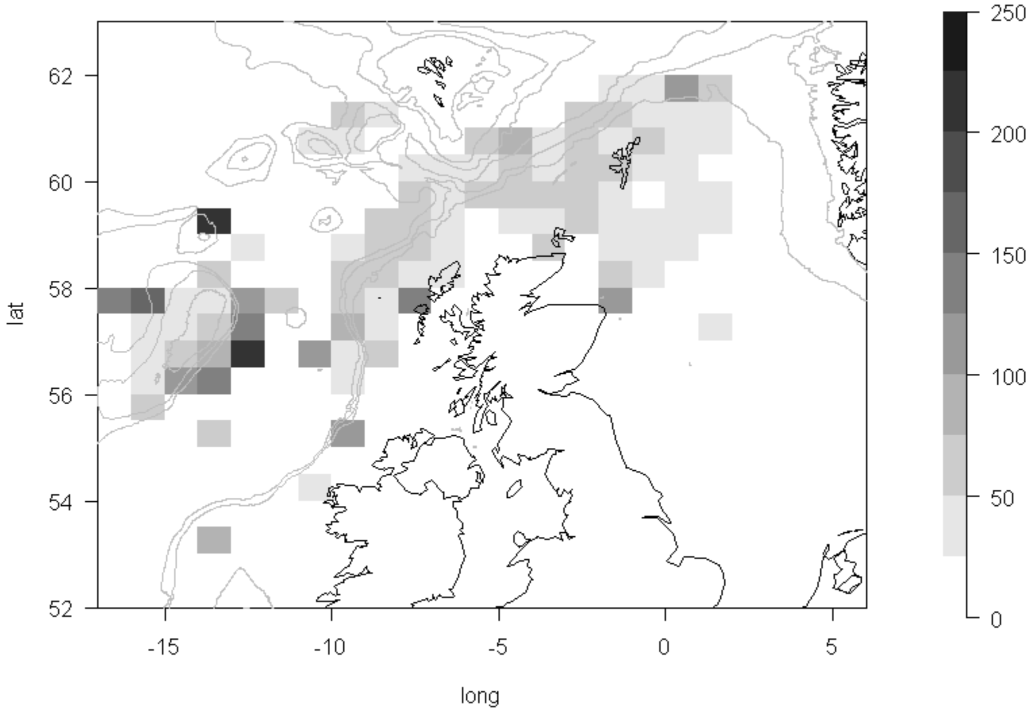


Figure 6.3.4. Northern Shelf anglerfish. Outputs from the preliminary GAM fitted to the Scottish tallyback data.



a) analysis of combined diary/tallybook data.



b) Estimated spatial distribution of diary/tallybook catch rates.

Figure 6.3.5. Anglerfish on the Northern Shelf.

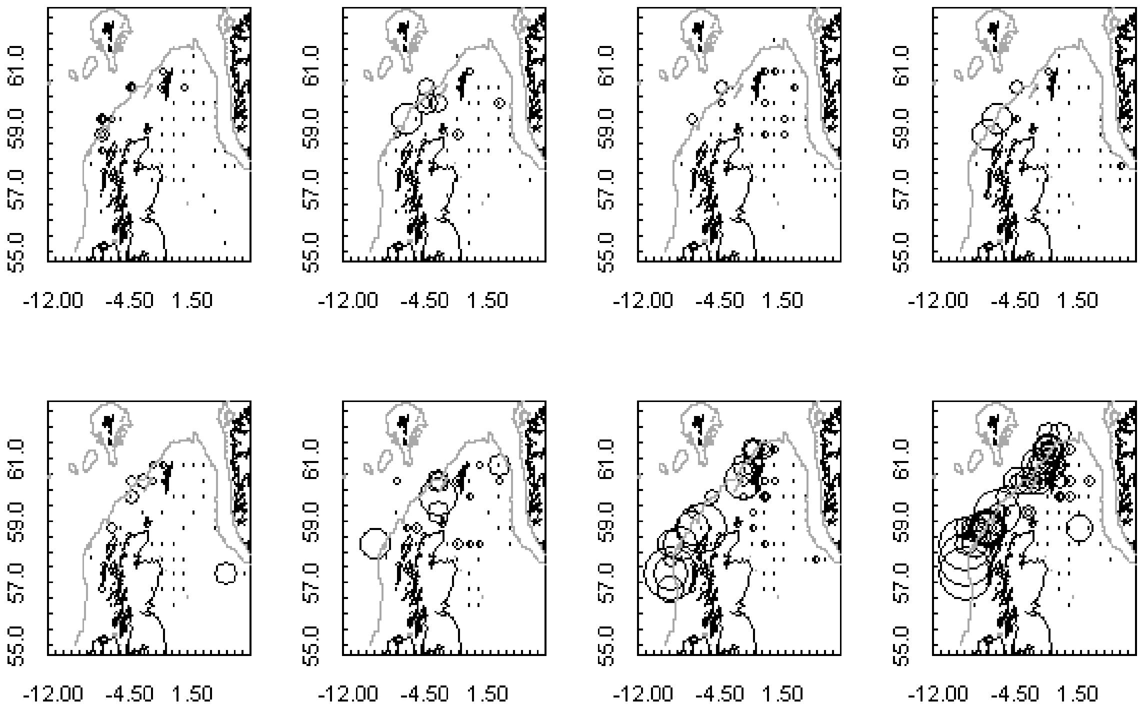


Figure 6.3.6. Anglerfish on the Northern Shelf. Distribution and catch rates of Anglerfish from observer trips conducted in Scotland between 1999 and 2006.

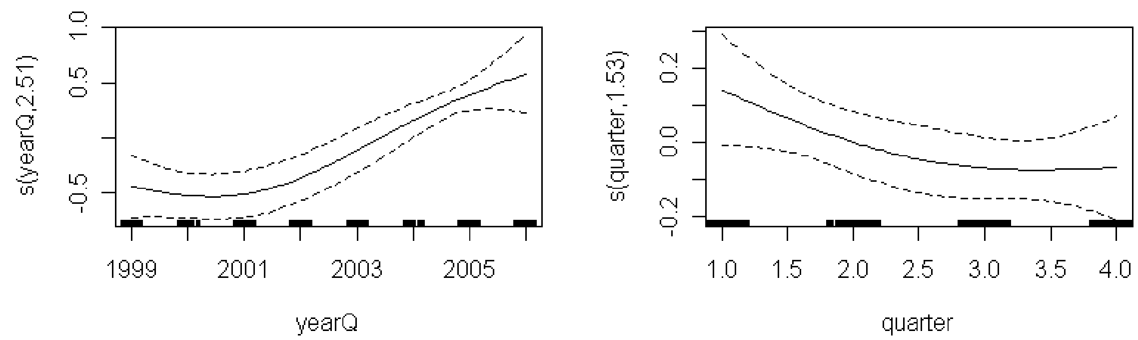


Figure 6.3.7. Northern Shelf anglerfish. Observer data GAM results (estimated effects on a log-scale).

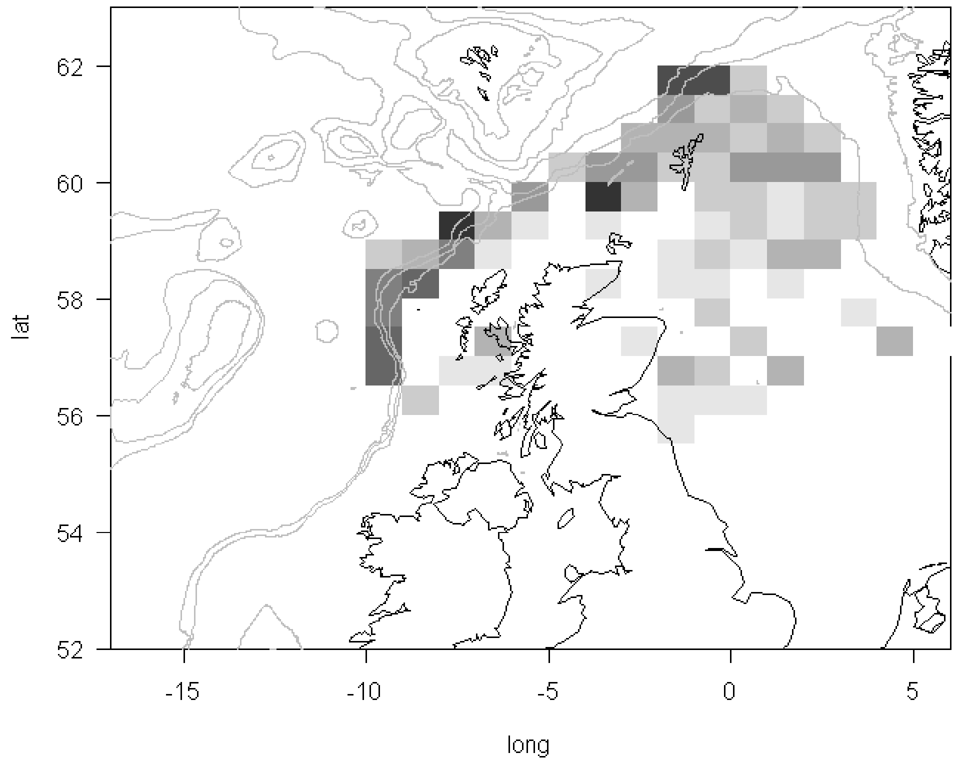


Figure 6.3.8. Predicted spatial distribution of the landings per unit of effort in the Scottish observer programme, following correction for gear and temporal trends.

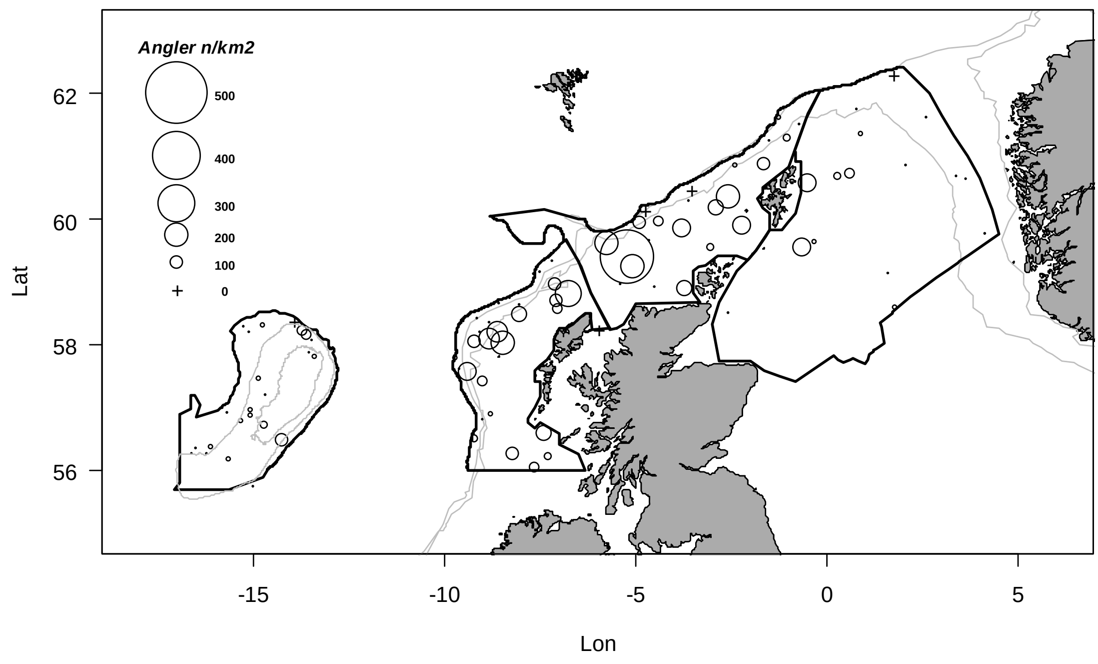
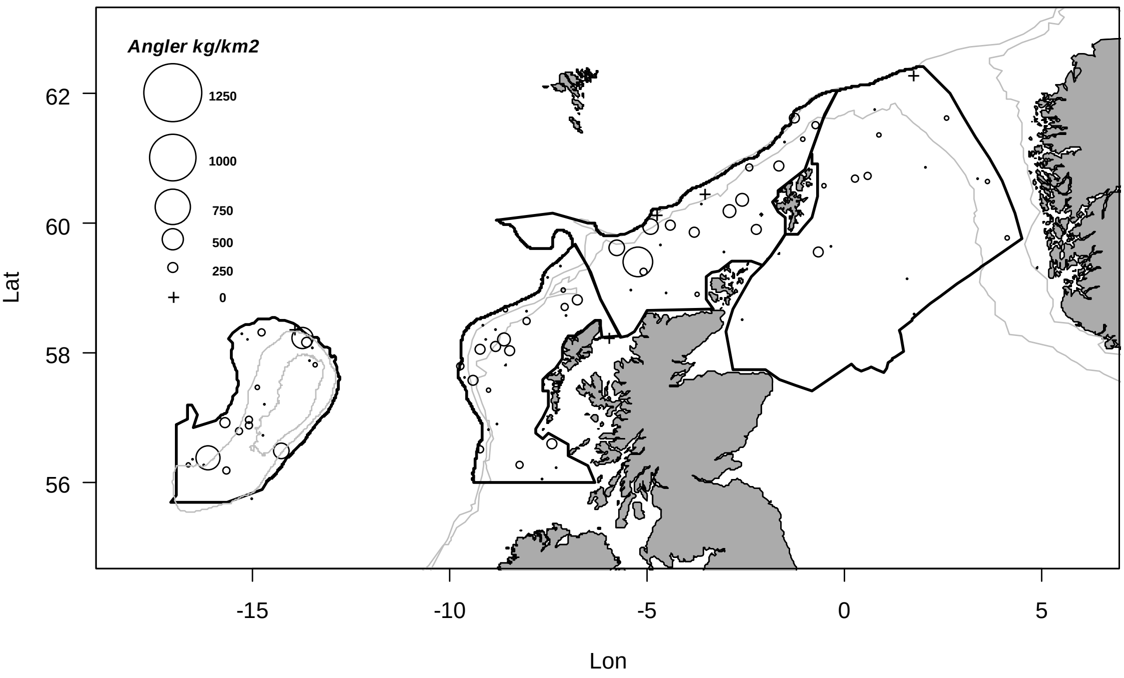


Figure 6.3.9.



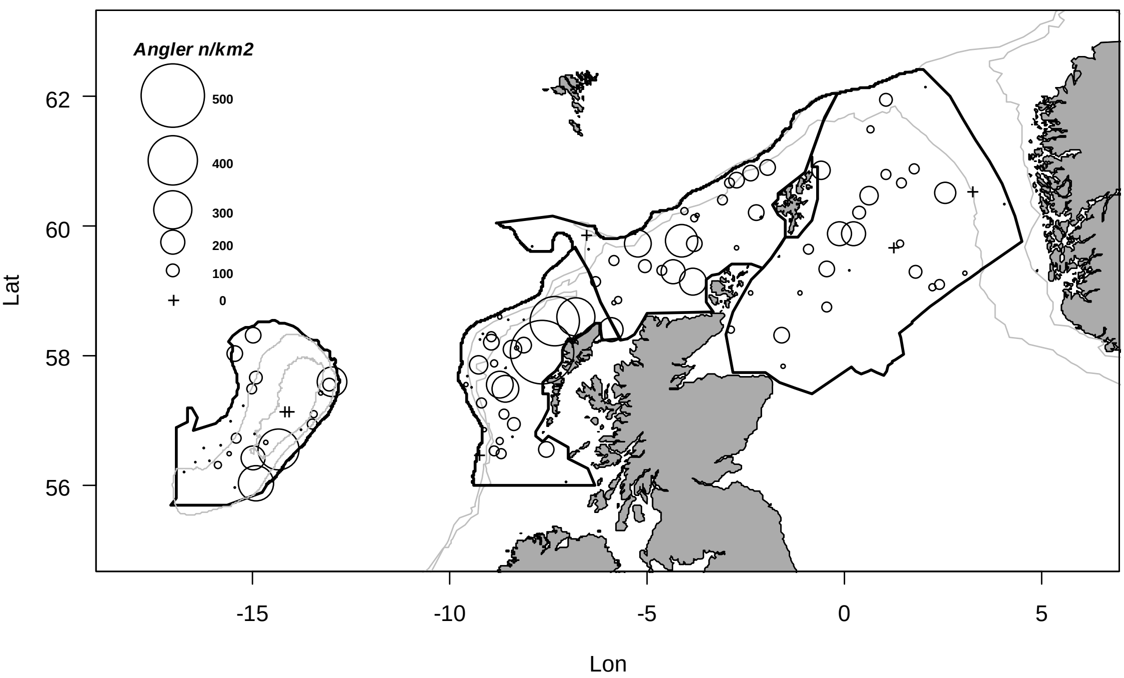


Figure 6.3.9 (continued) 2006

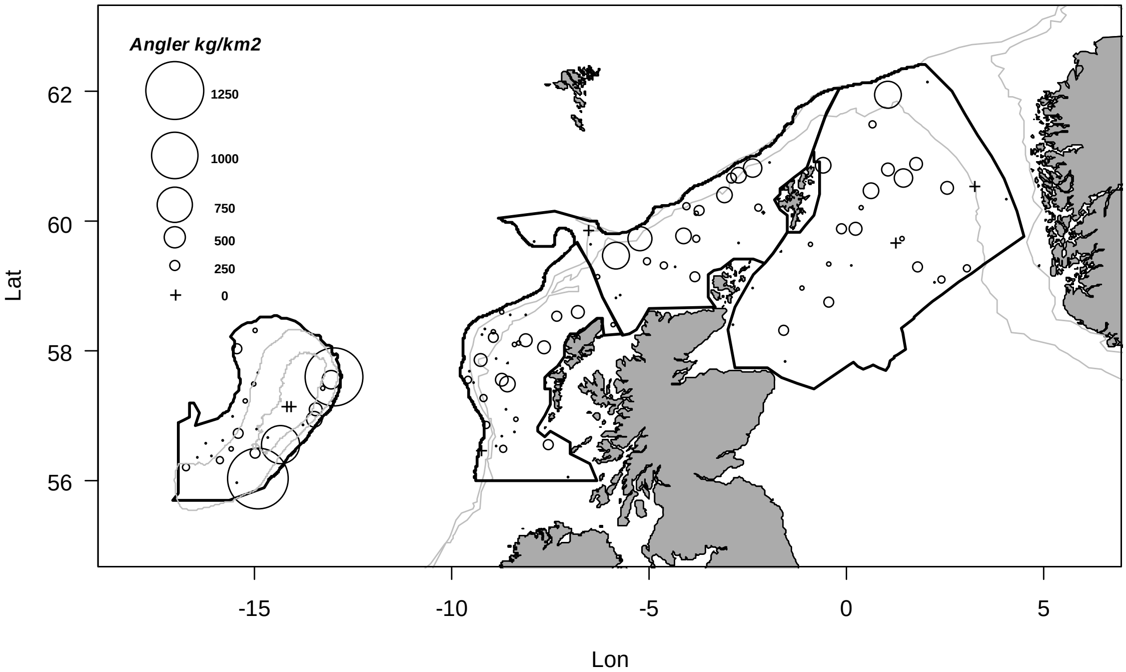


Figure 6.3.9. Anglerfish on the Northern Shelf. Distribution of sample stations and survey abundance in the Scottish Anglerfish survey (joint FRS/ industry) for 2005 and 2006. Catch rates expressed in both n/km^2 and Kg/ km^2. The irregular polygons signify the four strata used in the survey including Rockall, south west Scotland, north west Scotland and North Sea.

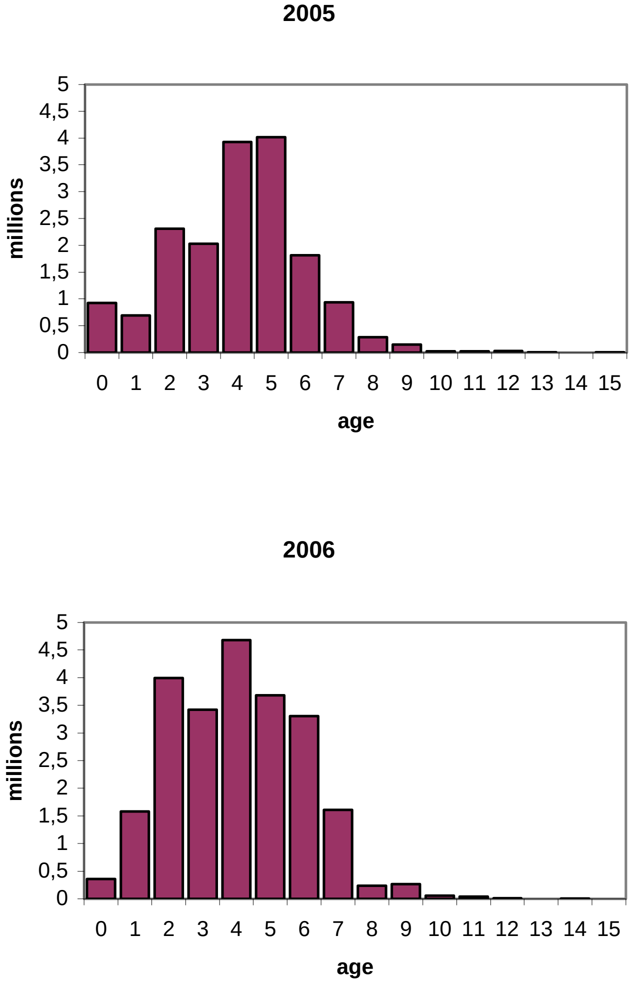


Figure 6.3.10. Northern Shelf anglerfish. Abundance at age as estimated from the Scottish anglerfish survey.

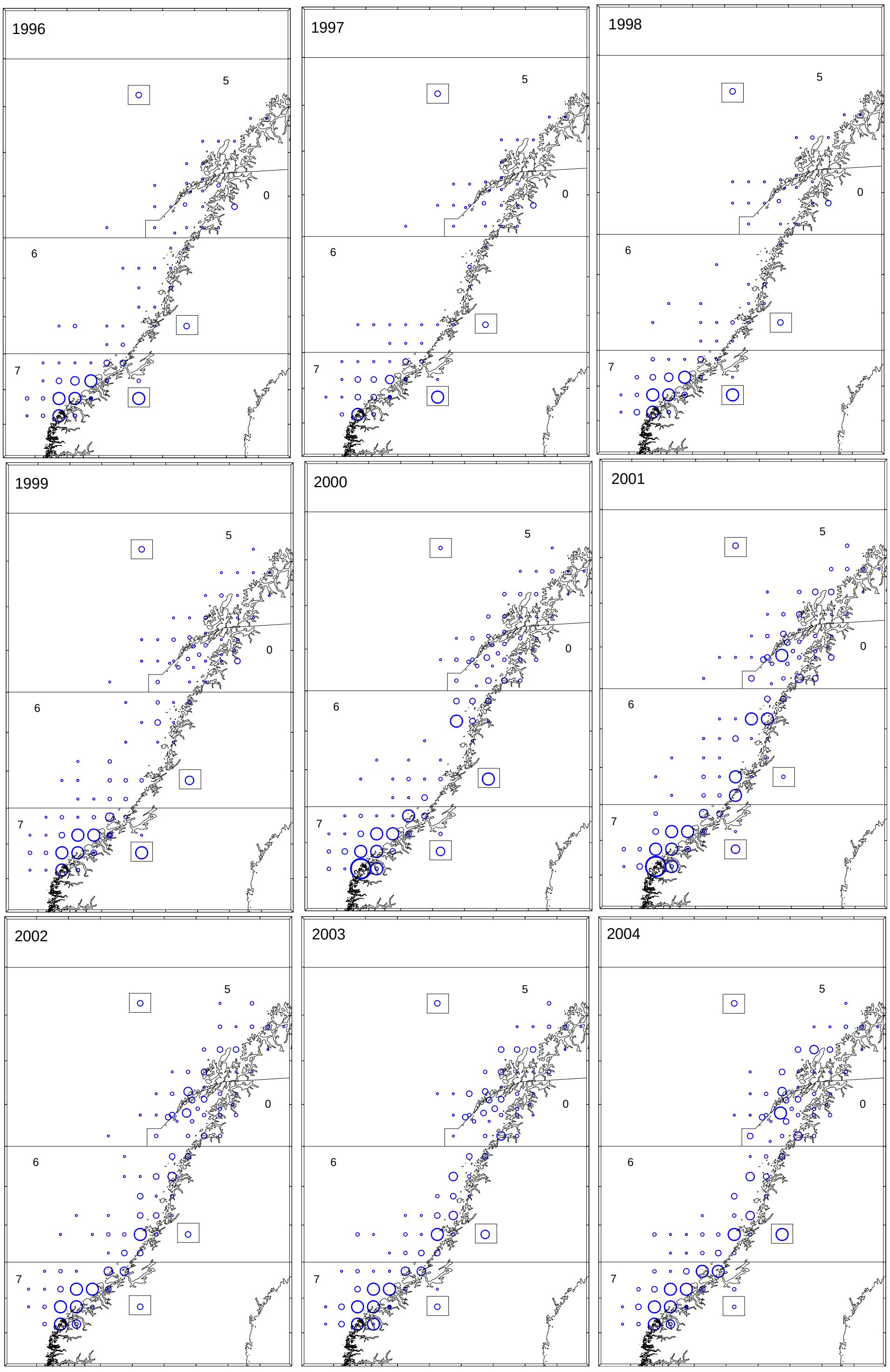


Figure 6.4.1. Anglerfish. Spatial distribution of official Norwegian landings within IIa for the period 1996–2004. Circles in the maps show proportional landings by statistical square in Norwegian statistical areas 5–7 from 1996-2004. Circles enclosed in squares denote landings unallocated to locations within the statistical areas.

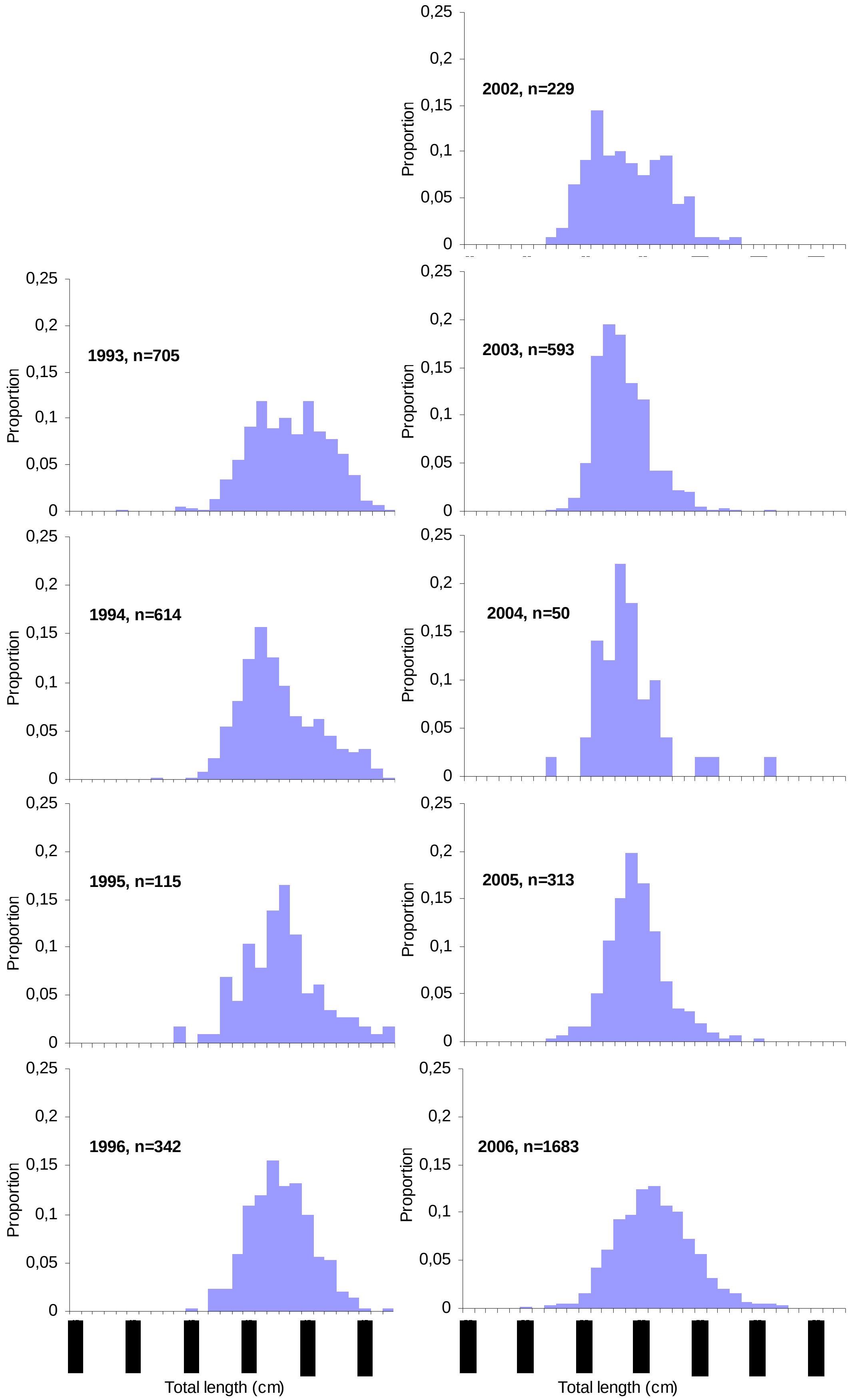


Figure 6.4.2. Anglerfish in IIa. Length distributions for anglerfish caught in the directed coastal gillnetting in Division IIa during 1993–2006. Note that data are lacking for 1997–2001.

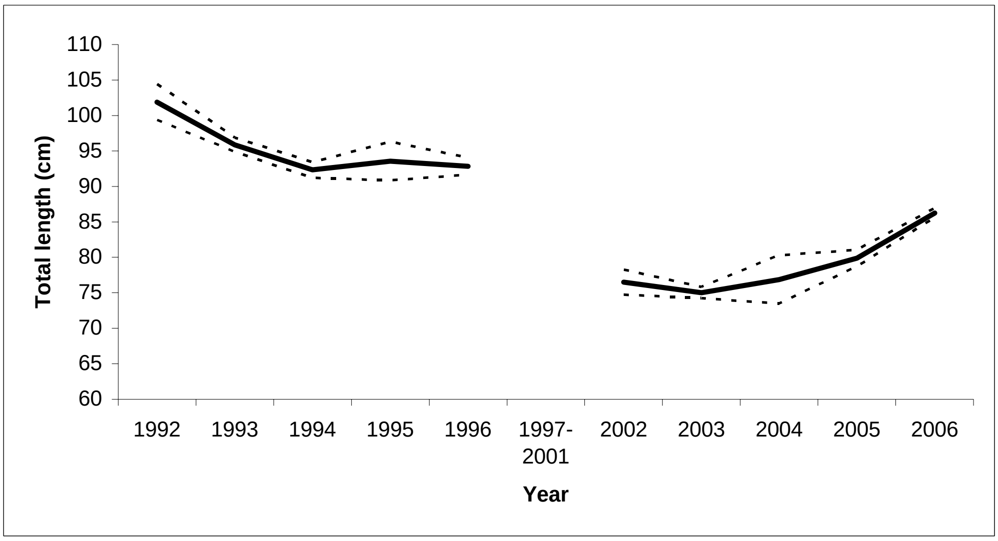


Figure 6.4.3. Anglerfish in IIa. Mean lengths for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992–2006, dotted lines represents ±2SE of the mean. Note that data are lacking for 1997–2001.

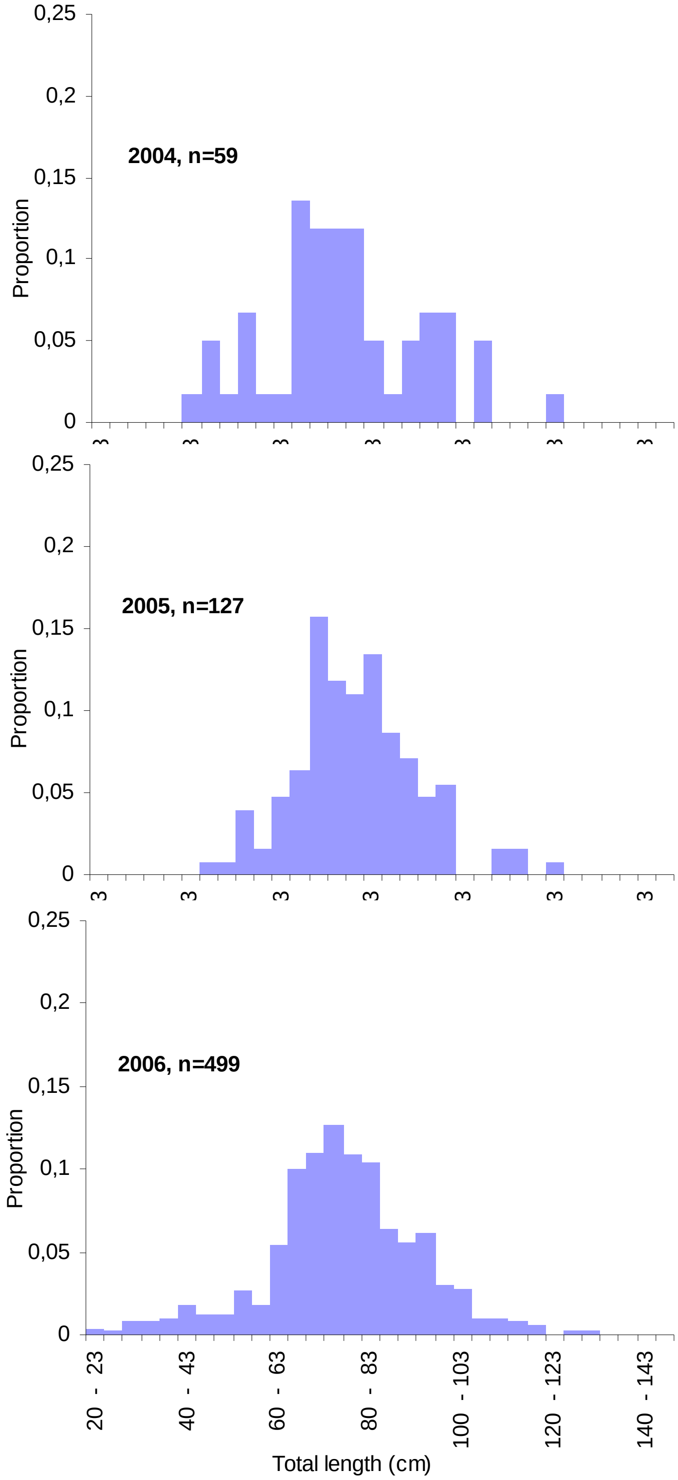


Figure 6.4.4. Anglerfish in IIa. Length distribution for anglerfish caught as by-catch by other gears (offshore gillnetting and longlining) in Division IIa in 2004–2006.

7 Megrim in Sub-area VI

Megrim in VIa continues to be a monitored stock. The category Monitoring allows for inter-sessional work to be done and signifies that the WGNSDS should continue compiling and presenting, for example, catch and survey data, but that it should not feel obliged to attempt an analytical assessment. The WG further investigated the range of available commercial catch data and potential candidate surveys for VIa and VIb megrim. There is evidence of substantial misreporting of commercial catch data which precludes any assessment based primarily on commercial catch data. Since 2005 several international surveys have been undertaken that have a better spatial coverage of megrim stocks in both VIa and VIb. These will potentially allow for survey based assessments of this stock in the future.

7.1 Megrim in Division VIa

7.1.1 ICES advice applicable from 2006 to 2007

Exploitation boundaries in relation to precautionary limits

Catches in 2007 should be no more than the recent (2002–2004) landings of about 2 100 t. This includes landings in Division VIa and VIb and unallocated landings in Subarea IV. **(See also Section 1.7).**

7.1.2 Management applicable from 2006 to 2007

For a number of years, megrim in Sub-areas VI, XII, XIV and Division Vb (EU zone) have been subjected to a precautionary TAC of 4 360 t. In 2004 this precautionary TAC was reduced to 3 600 t and in 2005 it was reduced further to 2 880 t where it remains for 2007.

YEAR	ICES ADVICE	BASIS	TAC[1]	% CHANGE IN F ASSOCIATED WITH TAC	WG LANDINGS
2002	4 360	Maintain current TAC	4 360	n/a	1 828
2003	4 360	Maintain current TAC	4 360	n/a	1 642
2004[2]	3 600	Reduce TAC to recent landings	3 600	n/a	1 328
2005	2 300	Reduce TAC to recent landings	2 880	n/a	561[2]
2006	2 300	Reduce TAC to recent landings	2 880	n/a	1 097
2007	2 100	Reduce TAC to recent landings	2 880	n/a	-

[1]Vb(EC), VI, XII and XIV. [2] Incomplete data. Weights in t.

Effort controls and technical measures enforced for the west of Scotland including those associated with the cod recovery plan are described in Section 1.7.

The minimum landings size of megrim was reduced in January 2000 to 20 cm EC Regulation No 850/98.

7.1.3 The Fishery

The Scottish fleets, targeting mixed finfish in area VIa, take around 70% of the Working Group estimates of landings in recent years. The development of the directed fishery for anglerfish has led to considerable changes in the way this fleet operates. Part of this was a change in the distribution of fishing effort into deeper waters. There have also been changes in the gear used by the heavy trawl fleet with twin rigs and >100 mm meshes being used in deeper water for anglerfish. Vessels using 80 mm mesh to target Nephrops and other species also catch megrims, but this activity is largely restricted to the Miniches and the Stanton Bank. Landings from the Scottish fleet come mainly from the Butt of Lewis, the slope North of the Hebrides and also include some landings from the Stanton Bank.

Between the mid–1970s and the late 1980s the French fleet landed large quantities (1 000–2 000 tonnes/year) of megrim from VIa (based on official landings statistics). During the early 1990s and up until 2003 French landings have declined continuously. This fleet alternated between the shelf and deepwater fisheries and targeted mixed roundfish. No information was available to the working group on the gear, discarding practices or changes to the composition of this fleet in recent years.

Megrim is caught by the Spanish (Basque) fleet targeting them in a mixed fishery for anglerfish, hake and *Nephrops* on the slope west of the Hebrides. In the past these fleets use 80 mm cod-end baka trawls. No information on discarding or recent changes to the composition or gears used by this fleet was available to the Working Group in 2006.

Since February 2003, a days at sea effort control regime was implemented in area VI as part of cod recovery measures. This allowed boats to fish a certain number of days per month, depending on the target species and gears used. This regime appears to have lead to considerable changes in fishing patterns, and may have been an incentive for vessels to switch to targeting anglerfish, megrim or Nephrops to avail of higher effort allocations.

7.1.4 The fishery in 2006

Recent decommissioning of vessels during 2005–2006 has substantially reduced Irish fishing activity in the southern part of VIa in 2006. The previous voluntary closure of the Cape grounds did not occur in 2006–2007 as the vessels that traditionally operate in the fishery have all been removed through decommissioning. During the spring of 2007 a significant fishery for shoaling cod in the Celtic Sea prompted the larger newer boats to switch their efforts away from VIa. Due to increasingly restrictive quotas for cod in VIa and the introduction of buyers and sellers legislation (see Section 1.7.2) both Ireland and Scotland report significant shifts in effort away from VIa which is being redistributed into the IVa *Nephrops* fishery to avail of increased effort allocations (Scotland) and into VIb (Ireland) due to the absence of effort restrictions and increased fishing opportunities, these tow factors are likely to have resulted in less catches of megrim.

7.1.5 Stock Structure

Megrim stock structure is uncertain and historically the Working Group has considered megrim populations in VIa and VIb as separate stocks. The review group questioned the basis for this in 2004. Data collected during an EC study contract (98/096) on the ‘Distribution and biology of anglerfish and megrim in the waters to the West of Scotland’ showed significantly different growth parameters and significant population structure difference between megrim sampled in VIa and VIb (Anon, 2001). Spawning fish occur in both areas but whether these populations are reproductively isolated is not clear.

Catches of megrim from Sub-area VI comprise two species, *Lepidorhombus whiffiagonis* and *L. boscii*. Information available to the Working Group indicates that *L. boscii*, are a negligible proportion of the Scottish and Irish megrim catch (Kunzlik *et al.* 1995 and Anon, 2001).

The migratory behaviour of megrim is poorly understood but commercial data does show clear seasonal patterns in catch rates (highest lpue’s in May each year) this is possibly related to some sort of post spawning migrations (Anon, 2001). The biology of megrim suggests that they are quite mobile when compared with other flatfish species in this area (e.g. plaice and sole). Indeed the WGHMM considers megrim in Divisions VIIb,c,e–k and VIIIa,b,d to be a stock. However, there is no evidence that megrim could migrate across the Rockall trough to such an extent as to consider both populations as continuous. The Rockall trough itself, with depths of in excess of 3 000 m, must present a significant barrier as it is significantly deeper than the normal bathymetric range of the species (max. depth ~800 m).

The stock structure is further complicated since the fishery along the NW coast of Ireland is continuous with the VIIb,c fishery. Megrim larval concentrations have also been found on the VIIb-VIa boundary (Dransfeld *et al.*, 2004) though these concentrations are much lower than observed along the shelf edge in VIIj. On the basis of this information the WG has previously concluded that the megrim population in southern VIa (on slope NW of Ireland) is probably more similar to VIIb than VIb.

Based on reported UK and Irish landings data there appear to be four distinct areas of megrim concentrations in VIa; the Butt of Lewis, the slope North of the Hebrides, Stanton Bank and the slope NW of Ireland (Anon, 2001). Quite how these relate to each other and to VIb requires further investigation. Since the stock structure of megrim on the northern shelf remains rather uncertain the WG has maintained its practice of considering VIb separately.

7.2 Catch Data

7.2.1 Official Catch statistics

Official landings data for each country together with Working Group best estimates of landings from VIa and VIb and are shown in Table 7.2.1. The WG best estimates of landings are those supplied by scientists of the various countries and differ from the official statistics in some years. These were supplied for VIa for some countries in 2006.

7.2.2 Revisions to the catch data

Official data became available for France, Ireland, and Spain as well as in disaggregated form for the UK for 2005 and these are given in Table 7.2.1.

7.2.3 Quality of the catch data

It is not clear to the WG whether landings of other countries are accurately partitioned into *Lepidorhombus whiffiagonis* and *L. boscii*. While Scottish and Irish landings of *L. boscii* are considered negligible, it is unclear whether the landings from other countries are accurately partitioned.

Megrim are caught in association with anglerfish by some fleets and are area misreported along with anglerfish (See Section 6.1.2.2). The official statistics differ substantially from Working Group estimates in recent years, although there appears to be little difference in 2005 which is likely to be a result of lack of information on area misreporting and unallocated landings presented to the WG rather than any improvement in official landing statistics. As with anglerfish, the reported Sub-area VI landings have been adjusted to the Working Groups estimate of catch by including landings declared from Sub-area IV in the ICES statistical rectangles immediately east of the 4 degree W line (see Section 6.1.2.2 for methodology). Area misreporting peaked in 1996 and 1997 when around 50% of the estimated Working Group landings for Division VIa were area misreported. 2006 Irish, French and Scottish landings by ICES statistical rectangle are given in Figure 7.2.3.1, including reported Scottish catches from ICES area IVa. This shows that there are significant differences in the magnitude of reported catches between the ICES rectangles to the east and west of the division between IVa and VIa. Similar patterns have historically been observed for anglerfish (see Section 6.1.2.2.).

There is some evidence that under reporting occurs in some fleets but the number of vessels examined is small and may not be representative of the entire fishery. The scale of misreporting at the individual vessel level for this species is large enough to make any future analysis based and official landings data highly uncertain. A historic analysis of observed cpue estimates obtained from sea going observers and comparing these with lpue estimates derived from official sources may be informative as to the potential scale of misreporting.

Discard data provided previously to the WG by Ireland have indicated that discarding is considerable. No discard data were available to the WG this year.

7.3 Catch-effort data

7.3.1 Commercial

Previously the Working Group investigated the Irish otter trawl commercial fleet as an age structure index for the stock. Due to recent changes in the fleet composition, WGNSDS (2006) had serious concerns about using this fleet 'uncorrected for fishing power' as a tuning index. In addition this fleet operates mainly in the southern part of VIa and may not be representative index for the whole stock. .In the latter half of the 1990's and early part of this decade, the Irish fleet was substantially modernised. This replaced older vessels, with a more modern fleet. In order to partially account for 'fishing power' Table 7.3.1.1 presents lpues based on both hours fished, as previously, but also includes lpues based on Kw.days, to provide a better proxy for effort. Figure 7.3.1.1 shows a comparison of historic lpues based on the two methods. Kw.days suggests a sharper overall decline in lpue for VIa in comparison to lpue based on hours only. While there was considerable declines in lpue from 2003 to 2005 for IVa megrim, lpue estimates for 2006 have increased. More detailed analysis of the relationship between vessel (and gear) characteristics is needed in order to correct for improvements in fleet catching power.

7.3.2 Research vessel surveys

WG investigations in 2004 on Scottish groundfish survey length frequencies concluded that they were of limited use due to low and variable catches as well as the fact that the distribution of the stock goes well beyond survey boundaries down the slope into deeper waters. This year no further investigations were made on these survey data and no updates were made to the time series. A new anglerfish survey started by Scotland in 2005 (WD3) and extended with the addition of Ireland in 2006 may offer a candidate survey for both VIa and VIb in the future as it covers both shelf and slope areas down to depths of 1 000 m (Fig. 7.3.2.1). No megrim data from the survey was made available for the WG this year but will be explored in more detail inter-sessionally and presented to next years WG.

The standard IBTS survey gear, the GOV, is not well suited for a flat fish species such as megrim. This is particularly true in its Rockhopper configuration (Groundgear type C) traditionally employed in area VI by the Irish and Scottish groundfish surveys. As well as utilising 200 mm meshes in the wings, the Rockhopper configuration uses 21" hoppers in the centre section of the trawl and has a 30 cm gap between footrope and fishing line. This is likely to result in significant escapes of flatfish species as well as cod. A number of study groups have (SGSTG) and are (SGSTS) addressing this and general survey trawl standardisation issues. A revised footrope configuration (Groundgear type D) was implemented for all of the Irish Groundfish Survey (IGFS) stations in VIa from 2004 onwards. Further, given the overlap of survey effort in the Irish Sea agreement was reached to re-allocate Irish Groundfish Survey days from VIIa to extend coverage along the shelf edge from 200 m down to 600 m in VIa and VIIb,j (Fig. 7.3.2.1). As a new survey stratum in 2005, this area will remain separate from the current survey until a time series is achieved.

A forth year of data was provided for the IGFS, which covers the southern part of VIa. Figure 7.3.2.2 maps the IGFS catches by sex to qualitatively illustrate the distribution of this species in the survey and the tendency for relatively more females to be caught in the shallower shelf area. This however, may be an artefact of sex specific selectivites of the survey trawl (GOV) which is constructed with large meshes (200 mm) in the lower wings, which may result in a higher escapement of males relative to females due to their smaller size. A comparison of the sex ratio data between the Spanish Baca (smaller wing mesh size) and the GOV from the Irish and Spanish Porcupine Intercalibration series will be explored during 2007 to provide information as to whether there are actual differences in sex ratios. Catch rates are still quite low, but when considering only the strata where megrim catches are highest (VIa Medium-Deep: 75–200 m), numbers of the abundant year classes in recent years range from 30–40/30 min tow for each sex (Table 7.3.2.1).

Raised length frequencies by sex and ICES division were also available for the Irish groundfish survey (Figure 7.3.2.3) illustrating the similarity in stock structure between VIa and VIIb (Section 7.1.4) indicated from length frequencies, as well as the median differences in length frequency between males and females for these areas.

7.4 Age compositions and mean weights at age

7.4.1 Landings age & length compositions and mean weights at age

Quarterly landings-at-age or length frequency data from VIa were only available from Ireland and only for quarter 2 no data was made available by France, UK, Spain. Therefore combined international landings-at-age are not updated for 2006 (Table 7.4.1.1).

Earlier investigation of French length-frequency data from 2002 indicated that the size structure of the French megrim landings was similar to that of the Scottish landings. The French vessels are known to mainly fish in deeper waters of VIa like many of the Scottish vessels and a Scottish ALK is therefore normally used to calculate CNAA for the French fleet. Most of the Spanish landings in recent years have been from VIb and no length-frequency data disaggregated by Division have been available to the Working Group, therefore these data cannot be used to calculate landings numbers-at-age for the Spanish fleet.

7.4.2 Discard age compositions and mean weights at age

No discard data were made available to the WG.

7.5 Natural mortality, maturity and stock weight at age

(This section will now appear in a stock annex being compiled for this stock).

7.6 Catch-at-age analysis

As previously stated WGNSDS did not conduct a catch at age analysis this year.

7.6.1 Data Screen Commercial Catch Data

The 2005 Working Group conducted a comparative investigation of the landings numbers-at-age from Scotland and Ireland prior to aggregation. These investigations indicated some differences between the age compositions for these countries with two strong years classes (1992 & 1993) apparent in Scottish data but not so evident in the Irish data. This might be explained by spatio-temporal differences in the catches coming from the fleets rather than mis-specification in the age estimations. However, there was also evidence that when strong year classes occurred in the catch-at-age matrix there were inflated numbers-at-age in surrounding cohorts so inaccurate age estimation may be a problem in this stock.

7.6.2 7.6.2 Comparison with last years assessment

As for last year no acceptable assessment could be carried out for this stock.

7.7 Reference points

There is insufficient information to estimate appropriate references points for this stock.

7.8 Quality of the assessment

7.8.1 Landings and lpue data

The quality of the available landings data, specifically the area misreporting and lack of effort and lpue data for the main fleet in the fishery, severely hampers the ability of the Working Group to carry out an assessment for this stock at present. It is likely that the spatial misallocation of megrim misreporting is simply driven by the problems identified with anglerfish quota allocations discussed in Section 6.1.2.2. In an attempt to provide a more ‘realistic’ view of catches by stats square, the reported data for VIa was adjusted to include a portion of the landings declared in IVa E6 statistical rectangles using the same approach as used to adjust anglerfish. The ‘adjusted’ catch by statistical rectangle is given in Figure 7.8.1.1.

For stocks like megrim and anglerfish on the northern shelf there is a general need for improved spatio-temporal resolution of commercial catch and effort data since dynamic pool assumptions may be invalidated by size related changes in distribution of the stock in relation to the fishery.

7.8.2 Discards

Historically, Irish data suggest that discarding may be substantial in this stock and that the discarding pattern may change over time although no data were available for the WG this year. Data sampling and access issues have precluded the provision of discard data to the WG this year. Efforts are underway to resolve these issues and it is anticipated that these will be resolved in the near future.

7.8.3 Surveys

There is no survey time series to adequately cover this stock. The traditional Scottish groundfish survey catches low numbers of megrim due to incompatible gear and survey coverage. The new Irish GFS survey series is attempting to address some of these issues through the various ICES coordinating and study groups by the inclusion of an additional stratum in 2005, but as a consequence requires at least another 3 years to produce a viable time series given the change of survey gear used in VIa (see Section 7.3).

As regards coordination and catchability of surveys overlap areas and station positions have been established in VIa between the Scottish and Irish Groundfish surveys, as well as in the eastern Porcupine Bank area of VIIb,c with the Spanish Porcupine Survey. The Spanish survey utilises a modified Baca trawl of 90 mm mesh. The baca is a scraper trawl that used commercially for this and other species. Parallel intercalibration tows have been initiated between all these surveys in recent years and should provide data on the relative efficacy of the gears.

7.9 Management considerations

Inaccurate landings and effort data for the main exploiters of the stock make an analytical assessment and the provision of management advice extremely difficult. Reported landings have declined continuously since 1996 and the 2005 estimates were around half the long-term average (Fig 7.9.1). These are considerably less than the TAC. This is because of poor quota uptake by the French and Spanish fleets. Other national quotas are very restrictive and this has probably led to under-reporting of landings by individual vessels. The recently introduced Buyers and Sellers legislation is likely to have reduced the scale of underreporting of megrim.

Area misreporting has also been prevalent (See Section 7.2.3) as megrim catches were misreported from Subarea VI into Subarea IV due to restrictive quotas for anglerfish and megrim (i.e. vessels targeting anglerfish misreported all landings including megrim from Subarea VI into Subarea IV).

In the past, management of the megrim stock has been linked to that for anglerfish on the assumption that landings were correlated in the fishery and it was thought that the anglerfish management would also constrain fishing mortality on megrim. However, this linkage may not be straightforward and may be fishery dependant. For the deep water slope fishery for anglerfish fishery the linkage may be less strong as the gear used typically has larger meshes and the fishery is beyond the depth distribution of megrim. However, anglerfish are also taken as a by-catch species in many of the shelf fisheries e.g. Stanton bank, the linkage in such cases may be somewhat stronger.

The minimum landings size of megrim was reduced in January 2000 to 20 cm EC Regulation No 850/98. Despite this extremely small size the catch is routinely high graded and large numbers of fish continue to be discarded above this MLS. The 20cm MLS is also coincident with the separation point between the length frequency modes for male and female megrim from the survey data presented in 7.3.3. indicating again a much higher F impacting on females.

Previous analysis (WGNSDS, 2006) of survey data has shown not only a strong spatial structuring in the sex ratio with depth, but also in mean length. While a sex ratio of 50:50 was observed between approximately 75–200 m, females accounted for only 30% of the catch at 300 m plus. As depth decreased females become relatively more abundant although overall catches decline, and females tend to become larger as one moves inshore.

7.10 Megrim in Division VIb

7.10.1 The fishery

Longer-term international landings from VIb are shown in Figure 7.9.1 (note: historical data based on official figures are incomplete in some years i.e. 1973–76 and 1979). Landings fluctuated around 1 000 t between 1986–1999 since then landings have declined.

Megrim are mainly caught by a Scottish heavy otter trawl fleet targeting haddock on the Rockall Bank. This fleet uses >110 mm mesh and twin-trawls have increasingly been used in recent years. Due to larger mesh sizes used in this fishery discarding of megrim by the fleet is not thought to be significant. No information was available to the working group on any recent changes to the composition of this fleet.

The Irish otter trawl fleet in Division VIb also take megrim as a by-catch in the mixed fishery on the Rockall Bank. The fleet targeting haddock uses >100 mm mesh. Discarding of megrim from the fleet targeting haddock in Division VIb is not thought to be significant (Anon, 2001).

Megrim are caught by Spanish fleets in a mixed fishery targeting anglerfish, hake, megrim and witch. Spain also catches four-spotted megrim (*Lepidorhombus boscii*) in VIb. In the past this fleet used 80 mm cod-end baka trawls. No information on current gears or recent changes to the composition this fleet were available to the Working Group.

7.10.2 The fishery in 2006

WGNSDS (2006) report that the number of vessels participating in the fishery has declined with only 2 vessels reporting significant megrim landings in 2004 but recent reports from WGFTFB (2007) suggest that there is likely to be a recent increase by both Scottish and Irish vessel activity in 2006/7 due to restrictive quotas in VIa and IVa and effort restrictions, increased fishing opportunities for haddock and lack of effort restrictions. At least 7 Irish vessels (>24 m, 1000 hp+) are reported to have shifted from targeting anglerfish and deepwater species and are now concentrating on the mixed fishery in VIb. The introduction of closed areas such as the 'Rockall box' and SACs to protect deepwater coral has resulted in a displacement and possible concentration of effort in 'open' areas.

7.10.3 Official Catch statistics

Official landings data are presented by country in 7.2.1.1 Note 2006 landings data are incomplete, only the UK and Ireland reported official landings data for this area.

7.10.4 Quality of the catch data

The catch data for VIb are very problematic. Firstly, estimates of catch were only available from Scotland, France and Ireland for VIb in 2006. Secondly, Spain also catches four-spotted megrim (*Lepidorhombus boscii*) in VIb and landings have not been supplied to the WG broken down by species. Finally, there is anecdotal evidence of underreporting and area mis-reporting in this fishery also.

7.10.5 Management applicable to 2006 and 2007

See Section 7.1.2

7.10.6 Commercial catch-effort data and research vessels survey

Catch and effort (days fished and kw.days) data were available for the Irish otter trawl fleets from 1995–2006.

	VIa				*VIb*			
Year	**Hours**	**LPUE (Hrs)**	**Kw.Days**	**LPUE (Kw.D)**	**Hours**	**LPUE (Hrs)**	**kw.Days**	**LPUE (Kw.D)**
1995	56863	9.01	1408312	0.36	9029.25	15.3	599053	0.23
1996	60960	7.19	1388902	0.32	7219	16.98	469212	0.26
1997	63159	6.35	1462368	0.27	7169	19.55	377836	0.37
1998	57398	6.63	1343782	0.28	7337	28.04	403310	0.51
1999	54075	6.5	1348480	0.26	8680	15.49	437920	0.31
2000	52847	6.83	1325585	0.27	9883	15.9	613229	0.26
2001	47224	8.91	1320179	0.32	7232	22.91	593467	0.28
2002	35016	6.83	1007965	0.24	2626	31.79	217918	0.38
2003	39665	8.16	1343881	0.24	4540	18	317048	0.26
2004	34973	7.36	1136725	0.23	2233	20.81	138178	0.34
2005	30950	4.8	916346.1	0.16	3844	17.16	163416	0.4
2006	28738	7.38	929199.4	0.23	5903.5	17.46	380350	0.27

Table 7.3.1.1. This fleet takes between 15–20% of the international landings in recent years. The Irish effort for the fleet in VIb increased until 2000. Effort since 2002 has declined substantially due to vessel decommissioning. Irish lpue in VIb is considerably higher than in VIa but it has fluctuated over the time series (Fig 7.10.5.1). The high lpues in some years (1998 and 2002) may simply reflect increased targeting of megrim by the fleet.

7.10.7 Catch age compositions and mean weights at age

Quarterly landings-at-age data for VIb were available to the Working Group for Ireland for 2006, but only data from Q2 was available and the sample size is small. However, since this country catches around 20% of the total landings relative to other fleets with more substantial landings the 2005 Working Group did not think it appropriate to use these data in even simple assessments. No further analytical assessment has been done.

7.10.8 Management considerations

Megrim is caught as part of a mixed species fisheries in VIb. Therefore management for haddock and other demersal species in VIb will impact on fleets catching megrim. WGFTFB (2007) note that both Irish and Scottish fleets have increased activity during 2006 in VIb this trend is likely to continue due to effort restrictions and restrictive quotas in other areas e.g. VIa and IVa and increased catching opportunities for haddock and lack of effort restrictions.

Table 7.2.1 **MEGRIM in Sub-area VI: Nominal catch (t) of Megrim West of Scotland and Rockall, as officially reported to ICES and WG best estimates of landings.**

COUNTRY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	-	-
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
France	398	455	504	517	408	618	462	192	172	0	135	252	79	92	50	48	45
Ireland	317	260	317	329	304	535	460	438	433	438	417	509	280	344	278	156	220
Netherlands	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	-
Spain	91	48	25	7	1	24	22	87	111	83	98	92	89	98	45	69	-
UK - Eng+Wales+N.Irl.	25	167	392	298	327	322	156	123	65	42	20	7	14	13	17	10	-
UK – Scotland	1093	1223	887	896	866	952	944	954	841	831	754	770	643	558	469	269	-
UK																	346
Offical Total	**1924**	**2154**	**2125**	**2047**	**1907**	**2451**	**2044**	**1795**	**1622**	**1394**	**1424**	**1630**	**1105**	**1105**	**859**	**552**	**611**
Unallocated	286	278	424	674	786	1047	2010	1477	1083	1254	823	843	723	537	n/a	n/a	212
As used by WG	2210	2432	2549	2721	2693	3498	4054	3272	2705	2648	2247	2473	1828	1642	1328	561	823
Area Mispreported landings	339	338	466	735	871	1126	2062	1556	1156	1066	868	829	731	544	421	n/a	212

Table 7.2.1 MEGRIM in Sub-area VI: Nominal catch (t) of Megrim West of Scotland and Rockall, as officially reported to ICES and WG best estimates of landings.

COUNTRY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	-	0.074
Ireland	196	240	139	128	176	117	124	141	218	127	167	176	87	83	43	-	94
Spain	363	587	683	594	574	520	515	628	549	404	427	370	120	93	71	68	-
UK - Eng+Wales+N.Irl.	19	14	53	56	38	27	92	76	116	57	57	42	41	74	42	88	-
UK - England & Wales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	-
UK – Scotland	226	204	198	147	258	152	112	164	208	278	309	236	207	382	372	207	-
UK																	190
Offical Total	**804**	**1045**	**1073**	**925**	**1046**	**816**	**843**	**1009**	**1091**	**866**	**964**	**824**	**455**	**632**	**528**	**382**	**284**
As used by WG	804	1045	1073	925	1046	816	843	1009	1091	866	964	825	456	632	457	n/a	253

Total Megrim in Sub-area VI (West of Scotland and Rockall)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Offical Total	**2728**	**3199**	**3198**	**2972**	**2953**	**3267**	**2887**	**2804**	**2713**	**2260**	**2388**	**2454**	**1560**	**1737**	**1387**	**934**	**895**
As used by WG	3014.1	3476.6	3621.7	3646	3739	4314.4	4896.7	4281	3796.4	3513.8	3211.1	3297.8	2283.7	2274.1	1785	n/a	1076

n/a = not available due to limited or absent data to allow calculation of the value.

Table 7.3.1.1. Megrim in Sub-area VI: Effort and lpue data for the Irish otter trawl fleet in Division VIa and Division VIb 1995–2006.

	VIa				VIb			
Year	Hours	LPUE (Hrs)	Kw.Days	LPUE (Kw.D)	Hours	LPUE (Hrs)	kw.Days	LPUE (Kw.D)
1995	56863	9.01	1408312	0.36	9029.25	15.3	599053	0.23
1996	60960	7.19	1388902	0.32	7219	16.98	469212	0.26
1997	63159	6.35	1462368	0.27	7169	19.55	377836	0.37
1998	57398	6.63	1343782	0.28	7337	28.04	403310	0.51
1999	54075	6.5	1348480	0.26	8680	15.49	437920	0.31
2000	52847	6.83	1325585	0.27	9883	15.9	613229	0.26
2001	47224	8.91	1320179	0.32	7232	22.91	593467	0.28
2002	35016	6.83	1007965	0.24	2626	31.79	217918	0.38
2003	39665	8.16	1343881	0.24	4540	18	317048	0.26
2004	34973	7.36	1136725	0.23	2233	20.81	138178	0.34
2005	30950	4.8	916346.1	0.16	3844	17.16	163416	0.4
2006	28738	7.38	929199.4	0.23	5903.5	17.46	380350	0.27

Table 7.3.2.1. Catch numbers at age for Via South for the Irish Grundfish Survey 2003–2005, disaggregated by sex and only including survey strata where catches are most abundant.

Male Megrim

	Effort(min)	0	1	2	3	4	5	6	7	8	9	10	Total
IGFS03	766	0	5	8	6	4	3	1	1	0	0	0	28
IGFS04	692	0	7	31	16	11	4	0	0	0	0	0	69
IGFS05	540	0	8	20	15	4	5	2	0	0	0	0	54
IGFS06	692	1	10	16	14	14	6	1	0	0	0	0	61

Female Megrim

	Effort(min)	0	1	2	3	4	5	6	7	8	9	10	Total
IGFS03	766	0	15	24	23	23	16	9	5	4	0	0	119
IGFS04	692	0	16	37	27	13	22	10	3	5	0	0	133
IGFS05	540	0	2	8	23	26	20	12	6	7	2	0	106
IGFS06	692	2	6	16	22	18	16	6	5	6	4	0	102

Table 7.4.1.1. Megrim in VIa. Landings numbers-at-age (‘000s) 1990–2004.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0
2	0	0	0	0	8	101	30	19	2	97	35	50	7	6	8
3	0	2	8	69	210	569	1,129	186	269	545	380	160	132	165	32
4	121	165	1,053	946	925	1,368	2,739	2,543	709	1,572	1,313	487	755	281	290
5	451	1,046	1,282	1,894	1,611	2,177	2,766	2,897	3,056	1,728	2,227	1,514	1,387	554	358
6	722	812	1,066	773	1,617	1,713	1,439	1,065	2,131	2,220	1,121	2,210	860	693	570
7	795	1,027	948	817	805	1,324	622	642	748	1,205	1,165	1,282	1,006	1,217	585
8	1,112	936	588	680	386	634	295	337	316	397	483	818	299	750	830
9	648	525	445	490	357	410	255	165	137	147	129	191	129	270	609
10	231	376	107	332	269	277	84	117	66	84	55	102	25	136	161
11	175	97	74	178	126	140	101	83	44	29	9	18	10	36	47
12	90	74	21	72	68	68	70	10	12	12	8	3	12	14	18
13	37	1	19	8	45	8	16	5	4	11	0	1	2	11	1
14	3	1	0	1	1	5	8	1	4	10	0	1	1	0	0
15	0	0	0	0	0	0	3	0	0	1	0	1	0	0	0
16	0	0	23	0	1	0	0	0	0	0	0	0	0	0	0

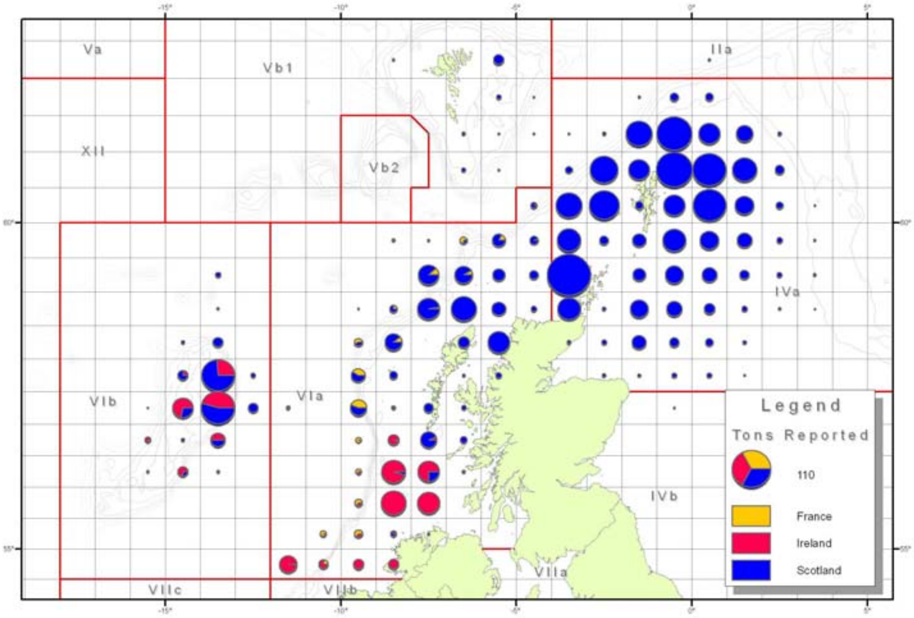


Figure 7.2.3.1 2006 reported landings of megrim by France, Ireland and Scotland by ICES stats square.

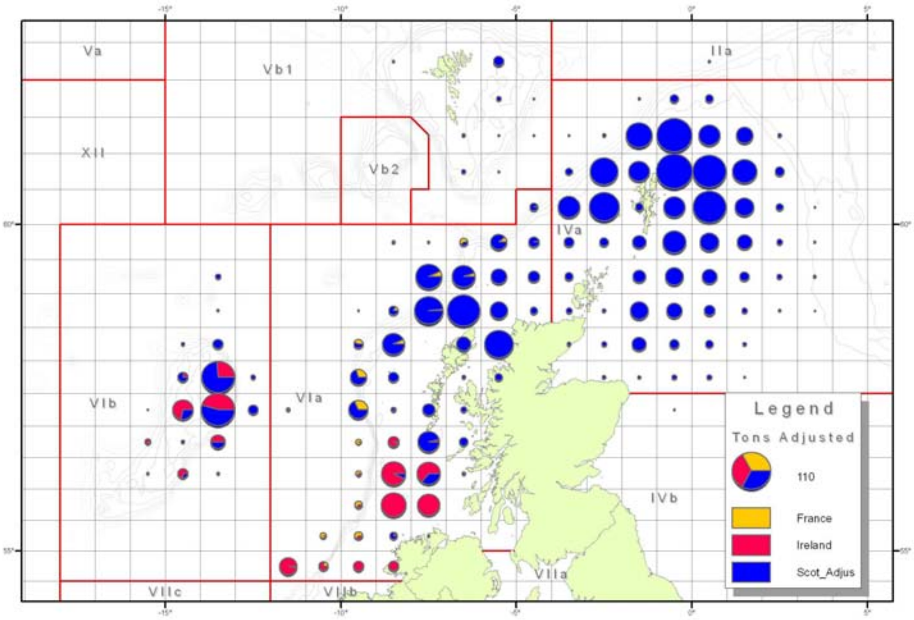


Figure 7.8.1.1. WG estimates of corrected megrim landings by ICES statistical square.

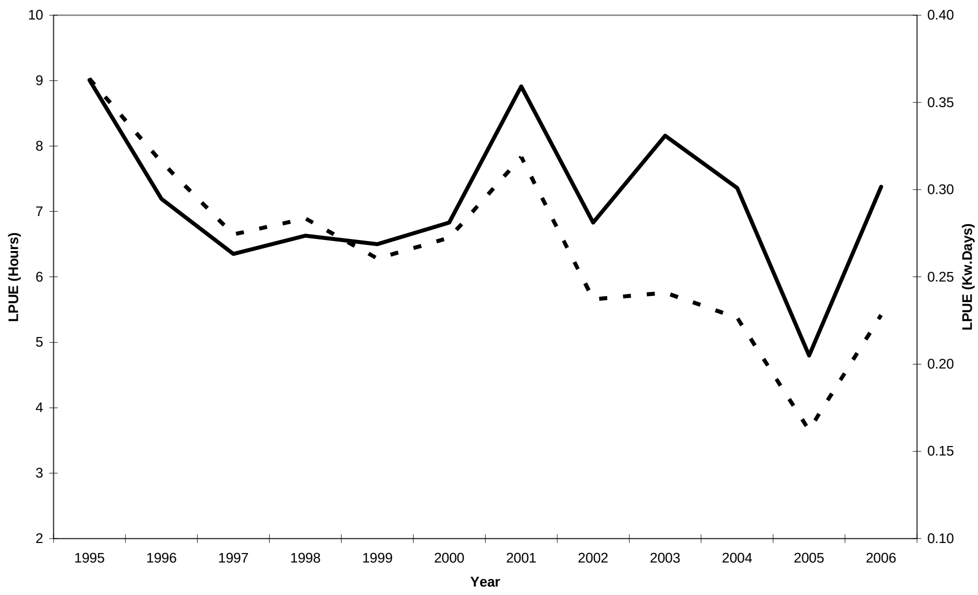


Figure 7.3.1.1. Megrim lpue estimates for VIa megrim based on hours fished (solid line) and Kw.Days (broken line) 1995–2006.

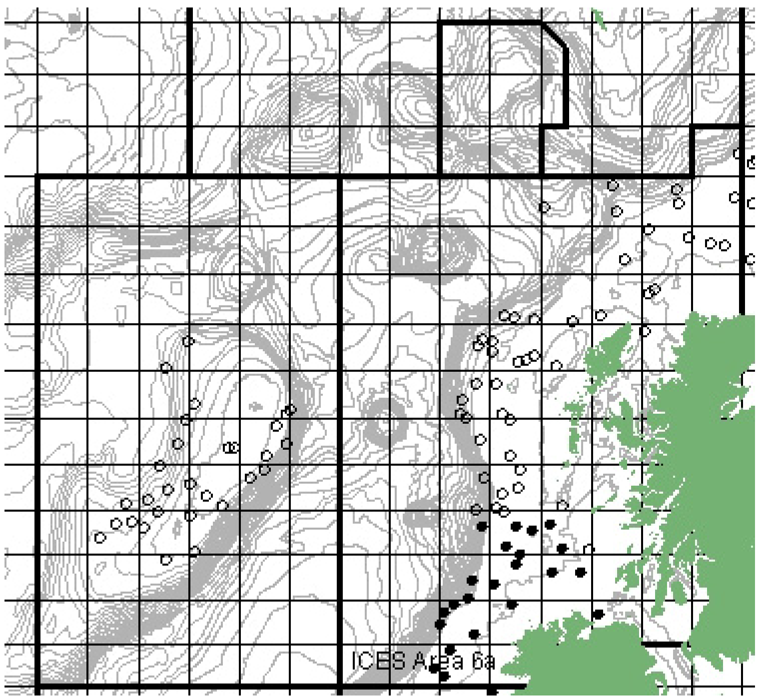


Figure 7.3.2.1. Position of Scottish (white circles) and Irish survey stations (black circles) for 2006 anglerfish survey.

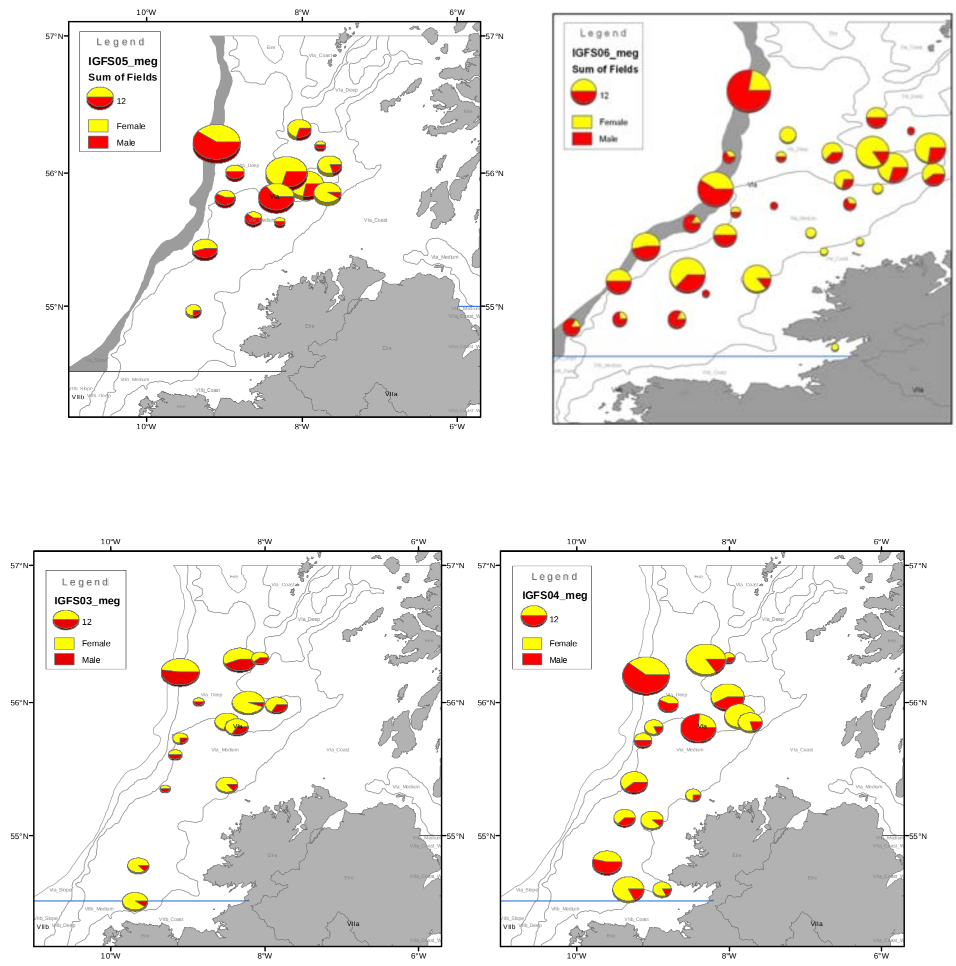


Fig 7.3.2.2. IGFS03–06 catches of male and female megrim for VIa in numbers per 30 min tow. Footrope toggle chains were shortened after 2003 and survey was extended in 2005 from 200–600 m, to effect more complete coverage of species on the slope such as megrim.

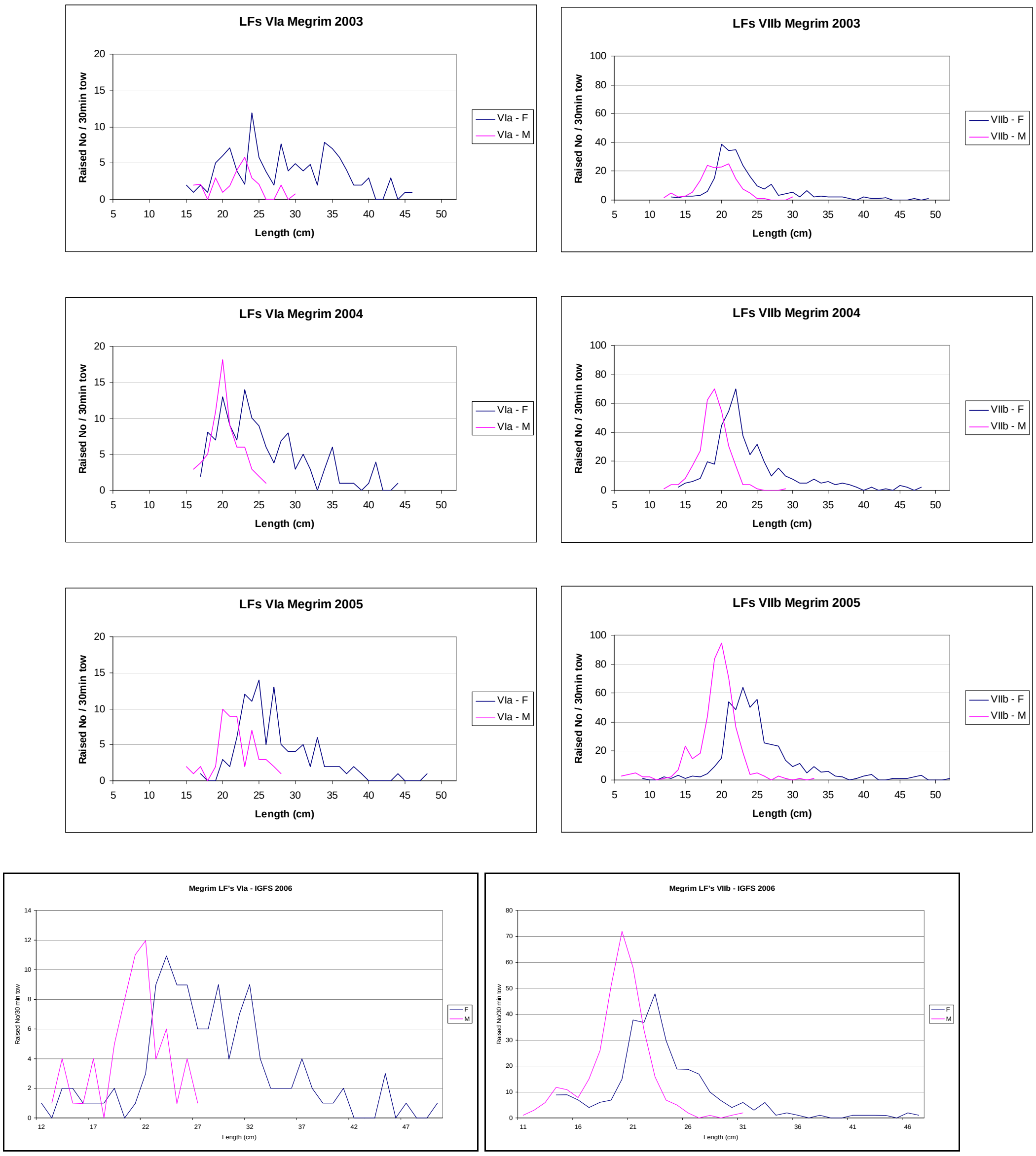


Fig 7.3.2.2. Length frequencies from the Irish Groundfish Survey (IGFS) from 2003–2006 for VIa and VIIb. Note that the increase in catches after 2003 is coincident with the introduction of a new trawl groundgear in VIa and shortening the gap between footrope and fishing line on the standard groundgear. Males are less abundant, and have a smaller average length, for all years in both areas.

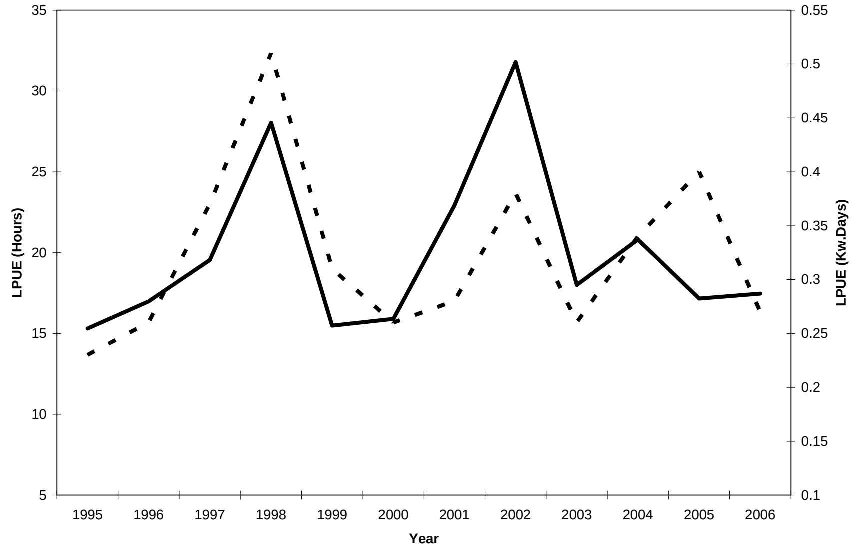


Figure 7.3.1.1. Megrim lpue estimates for VIa megrim based on hours fished (solid line) and Kw.Days (broken line) 1995–2006.

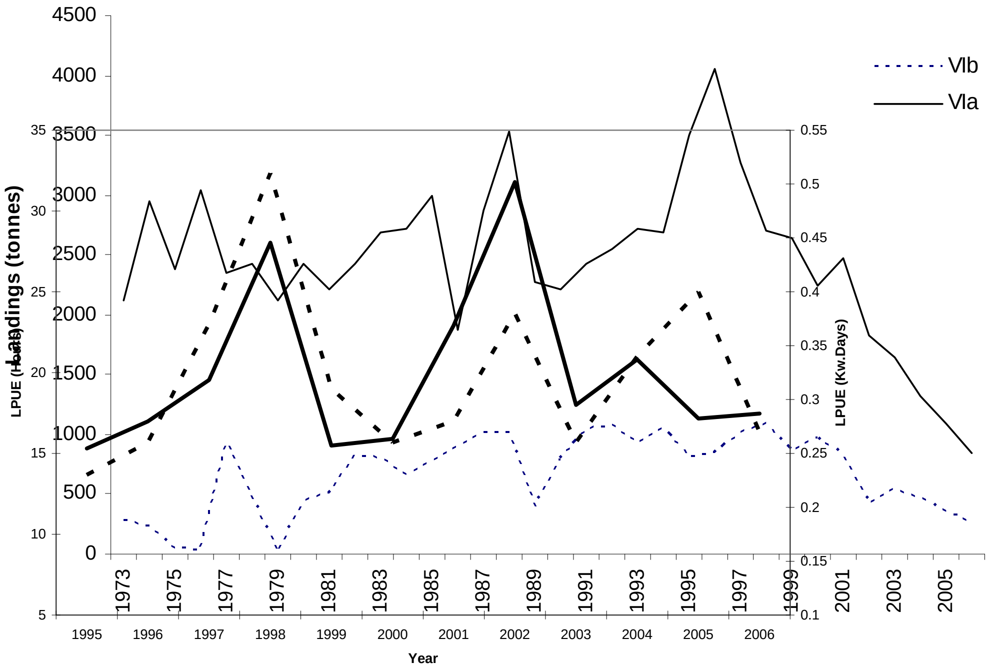


Figure 7.9.1. MEGRIM in Sub-area VI: Long term trends in landings. 1973–1989 data are based on official landings 1990–2004 are WGNSDS best estimates of landings. (2005 data are incomplete for VIa and VIb).

8 Cod in Division VIIa

The Irish Sea cod assessment in 2007 is classified as an observation assessment.

The primary assessment methods are SURBA (for evaluation of survey data) and B-Adapt (for combined analysis of survey and fishery data). Important issues identified by previous WGNSDS meetings are the accuracy of fishery removals data since the 1990s, continued high mortality rates implied by the steep age profile in the fishery and survey data, and very poor recruitment in recent years. Recommendations of the 2006 RGNSDS were for the WG to provide more information on the derivation of the sample-based estimates of landings, and to carry out simulation testing of the B-Adapt program.

All data available to the WG indicate that the Irish Sea cod stock has declined substantially over time, and is expected to decline further to a historic low value in 2008 due to a succession of very weak year classes since 2002 and continued poor survival of adult cod. Surveys provide consistent information on trends in recruitment and SSB, but estimates of current fishing mortality are very sensitive to assumptions regarding fishery removals.

8.1 The Fishery

The historical development of the fishery for cod in the Irish Sea is described in the Stock Annex. Fig. 8.1.1 shows the breakdown of the official cod landings in 2003–2006 by gear type, mesh band and country. Currently, the main fleets taking cod include 100mm+ mesh otter trawlers and mid-water demersal trawlers, otter trawlers using 70–99mm mesh gear for *Nephrops* and fish species such as plaice, and Irish vessels using gill nets in inshore waters. From 1 January 2000, there has been a requirement to use 100 mm cod-ends when targeting cod. Prior to that, many whitefish vessels used 80 mm cod-ends. By-catches of cod are taken in the *Nephrops* fisheries and in the beam trawl fisheries for flatfish, depending upon season, area fished and fishing practices. In a number of fisheries, the by-catch of cod reduces substantially during summer when adult cod have moved away from the spawning grounds.

Decommissioning at the end of 2003 permanently removed 19 out of 237 UK demersal vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that used demersal trawls with mesh size >=100 mm and had more than 5% cod in their reported landings. The previous round of decommissioning in 2001 removed 29 UK (NI) *Nephrops* and whitefish vessels and 4 UK (E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size >=100 mm and had more than 5% cod in their reported landings. Many remaining trawlers have moved into the *Nephrops* fishery, and effort in this fishery has been stable in recent years (see Section 17). However, the recorded effort (kW-days) of 100 mm+ mesh trawlers with >5% cod by catch declined by ~60% from 2003 to 2006. A decommissioning scheme launched by Ireland in October 2005 and continued in 2006 has so far removed 36 whitefish and scallop vessels (ICES WGFTFB, 2007), although this followed from the two Whitefish Renewal Schemes which introduced around 32 new vessels into the Irish fleet. The Irish decommissioning scheme removed 7 vessels with a significant track record of fishing in VIIa., and the recorded hours fished for Irish otter trawlers in VIIa declined by about 10% between 2004 and 2006 (see Section 10). A new Irish decommissioning programme is to be announced.

8.1.1 ICES advice applicable to 2006 and 2007

The advice from ICES for **2006**, in relation to single stock exploitation boundaries, was as follows:

In relation to agreed management plan: zero catch in 2006 provides only 50% probability of rebuilding SSB to B_{lim} in 2007.

In relation to precautionary limits: zero catch

In relation to target reference points: no advice

The advice from ICES for **2007**, in relation to single stock exploitation boundaries, was as follows:

In relation to agreed management plan: The most plausible forecast assumes a total removal in 2006 that is 55% greater than the agreed TAC. The forecast indicates that a zero catch in 2007 provides only 30% probability of rebuilding SSB to B_{lim} in 2007. The simulations indicate that a 30% increase in SSB during 2007 could be achieved with a reduction in fishing mortality to below 75% of the 2005 level.

In relation to precautionary limits: Given the low stock size, recent poor recruitment, continued substantial catch well above the TAC, the uncertainty in the assessment, and the inability to reliably forecast catch, it is not possible to identify any non-zero catch which would be compatible with the precautionary approach.

In relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: Fishing mortality between $F_{0.1}$ and F_{max} can be considered target reference points, which are consistent with taking high long term yields and achieving a low risk of depleting the reproductive potential. The present fishing mortality is well above this candidate reference point.

ICES mixed fishery advice for 2007 is given in Section 1.7.

8.1.2 Management applicable in 2006 and 2007

Management of cod is by TAC and technical measures. The ICES advice, and the agreed TACs and associated implications for cod in Division VIIa since 2002, have been as follows:

YEAR	SINGLE STOCK EXPLOITATION BOUNDARY (T)	BASIS FOR ICES ADVICE	TAC (T)	CHANGE IN F ASSOCIATED WITH TAC[1]
2002	-	Establish recovery plan	3 200	- 58%
2003	-	Closure of all fisheries for cod	1 950	- 64%
2004	0	Zero catch	2 150	- 65%
2005	0	Zero catch	2 150	-31%
2006	0	Zero catch	1 828	(no forecast)
2007	0	Zero catch	1 462	(no forecast)

[1] Calculated from F multipliers in status quo forecast.

Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 1.7.2.

8.1.3 The fishery in 2006

Technical measures in the Irish Sea fisheries in 2006 remained more or less the same as in 2005, with a western Irish Sea cod closure from mid February to the end of April (with derogations for *Nephrops* trawlers) and minimum mesh size of 100mm for vessels targeting whitefish.

The nominal catches of cod in division VIIa as reported to ICES are given in Table 8.1.3.1. The Working Group figure for total international landings in 2006 (838 t), based on official catch statistics, was the lowest recorded in the series since 1968, and only 46% of the TAC.

WGFTFB (2007) provided the following information on fleet activities in 2006:

- Information from Northern Ireland indicates that up to 20% of the Northern Irish *Nephrops* fleet now spend most of Q4 and Q1 engaged in the *Nephrops* fishery off the English east coast (Farne deeps). This will have resulted in a drop in effort in VIIa and a corresponding increase in IVb (UK; Implication – decrease in effort VIIa).
- There is evidence of mis-reporting of cod from Area VIIg into area VIIa by Irish vessels in 2007 due to good fishing in VIIg. The Irish authorities have indicated they will re-allocate approximately 100 tonnes of cod landings in VIIa into VIIg. This quota is now almost depleted and the industry has warned there will be widespread discarding of cod later in the year in the Celtic Sea. (Ireland; Implications - overestimation of VIIa cod catches).
- Two vessels (20 m/650 p) fishing in the Irish Sea are working inclined separator panels for the last 3 years in the restricted cod recovery area and also in certain other places e.g. Dundalk Bay when there are a lot of small fish on the grounds. They report them to be very effective. During the closure in 2007 4–5 vessels have fished in the restricted areas with inclined separator panels fitted. (Ireland; Implication–improved species selectivity but access to otherwise closed area).

8.2 Commercial catch-effort data and research vessel surveys

8.2.1 Commercial catch-effort data

Information on trends in fishing effort in the Irish Sea is provided in Section 17. This is based on kW days as compiled by the STECF Sub-group SGRST in May 2007, including preliminary data for 2006 (STECF, 2007). Effort data as kW-days at sea are more complete than hours-fished data which has not been a mandatory field on vessel log sheets. Commercial cpue data are no longer used in the assessment of Irish Sea cod.

Interpretation of kW-days effort trends by gear type is difficult prior to 2003 due to the absence of mesh size data for the Irish fleets. STECF (2007) noted a slow decline in total nominal effort of demersal gear types in the Irish Sea since 2003. This is the combined result of stable effort of towed gears with 70–89 mm mesh (predominantly *Nephrops* trawlers) and a substantial decline in effort of trawlers using 100 mm+ mesh. The effort of 100 mm+ vessels with track records showing >5% cod in their landings was 60% lower in 2006 than in 2003. Effort has remained high in the valuable *Nephrops* fishery despite decommissioning of vessels, due to vessels switching from whitefish trawling.

8.2.2 Surveys

Age-structured indices of abundance were available from the following surveys, and are given in Table 8.2.1:

- UK(NI) groundfish surveys: March 1992–2007 (NIGFS-Mar) and October 1992–2006 (NIGFS-Oct). (45 stations). A vessel change took place in 2005, although the previous trawl gear and towing practices were retained and no corrections for vessel power have been estimated.
- UK(Scotland) groundfish surveys: March 1996-2006 (ScoGFS-Q1; 9 stations in 1996 and 15–17 in 1997–2006) and autumn 1997–2005 (ScoGFS-Q4; 11–12 stations). The Irish Sea component of the surveys has now ceased.
- Irish groundfish survey, autumn 2003 and 2004 (Irish GFS). Survey now terminated and not used in assessment.
- UK(NI) MIK net surveys of 0-gp pelagic stage gadoids, 1994–2006 (NIMIKNET; 25 stations in the western Irish Sea).
- UK(E&W) 4–m beam trawl survey, 0–1 gp cod, 1988–2006 (BTS-Sept). Index is for eastern Irish Sea only.

A new IBTS-coordinated UK(E&W) trawl survey started in the Irish Sea in November/December 2004 using RV *Endeavour* to carry out approx. 30 tows with a GOV trawl in the Irish Sea and St George's Channel, and 50–60 tows in the Celtic Sea and Western Approaches (Ellis and Tidd, WD4; ICES IBTSWG report ICES CM 2006/RMC:03). The GOV trawl is rigged with standard or rockhopper ground gear depending on ground type.

UK Fishery Science Partnership Irish Sea roundfish survey, 2004–2007 (UKFSP-7a) (Armstrong *et al*., WD 2 and www.cefas.co.uk/fsp). A chartered commercial trawler carries out ~ 38 tows of approx. 6–7h duration in the western Irish Sea and North Channel, using a commercial semi-pelagic whitefish trawl with 100 mm mesh cod-end. The survey takes place in spring during the cod spawning period. A second chartered trawler carries out over 40 tows of approx. 4–h duration in the eastern Irish Sea at about the same time, using a rock-hopper otter trawl with 80 mm mesh cod-end.

Distribution maps for cod in the NIGFS-Mar and NIGFS-Oct surveys, showing catch rates (kg per 3–mile tow) for cod below and above the minimum landing size of 35 cm, are reproduced in Figures 8.2.1 and 8.2.2 for surveys up to March 2006. The NIGFS-Mar survey shows a widespread reduction in catch rates after 2003 (Figure 8.2.1), and occasional large individual catches (e.g. March 2002 cod > MLS). The March 1992 survey was disrupted by mechanical problems, and most of the stations in the northern half of the Irish coastal zone were not sampled.

The UK Fisheries-Science Partnership surveys in spring 2005–2007 showed a widespread distribution of cod with very low catch rates in many of the tows, with locally higher concentrations in some areas including the small area of the outer Firth of Clyde (VIa south) closed to commercial fishing in spring, the North Channel, off the Isle of Man and in the southerly region off the Irish Coast (Fig. 8.2.3).

8.3 Landings, age composition and mean weights-at-age

Landings estimates

Landings data provided to stock coordinators by national fishery scientists may differ from official statistics due to re-allocation between management areas. During the 1990s, TAC reductions without associated control of fishing effort caused deterioration in the accuracy of catch data of many stocks due to under-reporting. From 1991 to 2002, and again in 2005 and 2006, a routine sampling procedure was used to estimate landings of cod, haddock and whiting into three major Irish Sea ports independently from official landings statistics. The sample-based estimates for cod contributed ~40-80% of the resultant WG total international landings figures. The method was based on a stratified sampling scheme with ports and gear groupings as strata. The mean weight of each species landed per trip was calculated for each gear and port based on the observed number of boxes of fish offloaded on the market by each vessel and the expected or calculated weight per box. Observations were made during port-sampling visits throughout the year. Mean landings per trip were raised to fleet level using the total annual number of recorded trips per gear/port stratum after excluding trips not in VIIa. Estimates of total annual landings into the three ports for all gear types combined were obtained with relative standard errors of 10–15%.

Differences between the sample-based estimates of landings and reported landings in 1991 and 1992 were relatively small, and WGNSDS has assumed that reported landings prior to 1991 are accurate. The TAC for cod prior to 1991 was well above ICES recommendations and was unlikely to be limiting. A positive correlation is apparent between the annual TAC and the ratio of reported international landings to landings including the sample-based estimates, illustrating the effect of limiting quotas on the accuracy of official catch statistics (Fig. 8.3.1).

The series of sample-based landings estimates was interrupted in 2003 and 2004. A more limited resumption of the scheme in 2005 indicated a similar magnitude of under-reporting of cod to the estimates for the early 2000s. The introduction of the Buyers and Sellers scheme in 2006 is expected to have caused major improvements in the accuracy of catch statistics. Observations at the three ports in 2006 indicated that this was probably the case, although the sample coverage was less representative than in previous years.

Age compositions

Quarterly age compositions of landed catches were provided for 2006 by UK (E&W) (Q1-3 only) and UK (NI) for all sampled gears, and by Ireland for beam trawlers. Sampled countries took 94% of the reported international landings. Sampling details are given in Tables 2.2 and 2.3.

Age compositions and mean weights at age in the landings, incorporating the sample-based estimates of landings from 1991–1999, are given in Tables 8.3.1 and 8.3.2. Weights at age have fluctuated by up to ±20% of the mean for each age group but without any obvious trend over time (Fig. 8.3.2). Constant mean weights-at-age in the landings were assumed for years up to 1981 but in subsequent years weights-at-age were revised annually. It has still not been possible to revise the pre-1981 data, and SOP values differ from 100% in those years. The estimates of constant weight at age prior to 1981 would appear to be under-estimates and may alter the perception of the stock's dynamics during this period. The very variable mean weights for age 7+ cod in recent years probably reflect small numbers measured and aged.

The weights-at-age in the landings (Table 8.3.2) were also assumed to represent weights-at-age in the stock. As a result, stock weights for 1–year olds are over-estimated as cod of this age are mostly landed in the second half of the year. This does not influence estimates of spawning stock biomass (SSB) as all 1–year olds are assumed to be immature.

Discards estimates

There are no sufficiently complete time-series of discards estimates for inclusion in the VIIa cod assessment. Previous assessments have been based on landings only. The potential magnitude of discarding was investigated using the available data from 1996 onwards (Tables 8.3.3–8.3.5; Fig. 8.3.3). Discarding since 1996 took place at age groups 0–2. Although the data are limited there is some indication that fishing mortality on 1–year-old cod may be significantly under-estimated by variable amounts by omitting discards from a catch-at-age stock assessment. Numbers of cod discarded per trip have been very small in recent years.

Until a time series of more rigorous estimates of discards are assembled, the WG will be restricted to basing any catch-at-age assessment on landings at age only.

8.4 Natural mortality and maturity at age

As in previous assessments, natural mortality was assumed at M=0.2 over all age classes. Proportions of M and F before spawning were set to zero. Proportion mature at age was assumed constant over the full time-series, based on mean values from NIGFS-Mar surveys in the 1990s (see Stock Annex). More recent analysis of the survey data indicates an increase in proportion of 2–year-olds reaching maturity. The majority of 2–year-old males have been mature since the 1990s, and approximately 60% of 2–year-old females taken in the trawl surveys have been mature since the late 1990s. Almost all 3–year-old females have been mature each year since the early 1990s. The historical maturity ogive used by the WG therefore underestimates the proportion mature at age 2 in recent years.

Age:	**1**	**2**	**3**	**4+**
Proportion mature:	0	0.38	1.0	1.0

8.5 Stock assessment and prediction

8.5.1 Survey and catch-at-age analyses

8.5.1.1 Commercial catch-at-age data

The commercial fishery landings of VIIa cod show a progressively steeper age profile since the 1960s (Fig. 8.5.1.1). The contribution of older, mature cod to the catches has fallen substantially below what would be expected if the fishery had operated historically at $\mathbf{F}_{max}$ or $\mathbf{F}_{0.1}$. Since 2000, the numbers of cod older than four years of age in the landing have fallen below 1% of the total. All sources of data available to the Working Group, from port sampling and surveys, show a highly contracted age composition in recent years. This has required a reduction in the plus-group to 5+ in the B-Adapt assessment.

A Separable VPA was carried out on the international catch-at-age data, using reference age = 3, terminal F= 1.5, terminal S = 1.0, separable period 6 years, age 0/1 down-weighted, to check for anomalous values or trends. No anomalies were apparent that might indicate severe data errors, but the residuals for ages 1 / 2 showed persistently lower values since the 1990s, whilst ages 3 / 4 and 4 / 5 had the opposite trend. Age 5 / 6 residuals were very noisy for recent years. The trends are difficult to interpret due to the exclusion of sample-based estimates of landings from 2000 onwards, however the selectivity characteristics of the international fleet appeared to change in the early 1990s, a feature noted in previous WGNSDS reports.

8.5.1.2 Survey data

The survey series used in previous assessments give similar signals at age 0 and ages 2 to 4 (Figs 8.5.1.2.1 and 8.5.1.2.2). Correspondence between survey series was poorer for 1–year-old cod. The BTS-Sept 1-gp index and the ScoGFS-Q4 survey series are not used in the assessment due to poor consistency internally and with other surveys.

The international landings at age show similar patterns of year-class variation to the surveys; particularly at age 1 for the NIGFS-Mar and at ages 2–3 for the two spring surveys (Fig. 8.5.1.2.1). Correspondence is particularly close up to 1999, then the catch and survey trends diverge partly due to the exclusion or absence of sample-based landings estimates for 2000–2006.

Mean-standardised survey indices by year class and by year, year-class curves, and scatter-plots of indices within year classes, show good internal consistency of the NIGFS-Mar survey at ages 1–4 with no marked year-effects (Figs 8.5.1.2.3–5). NIGFS-Mar indices for 5–year-olds are poorly correlated with indices from younger ages (Fig. 8.5.1.2.5), and this age class was excluded from the assessment. The ScoGFS-Q1 survey showed strongly domed catch-curves and poor consistency at age 1 with other age classes (Figure 8.5.1.2.3–5). Internal consistency was generally poorer than in the NIGFS-Mar survey. Age 2 in the NIGFS-Oct survey was poorly correlated with younger age classes due to very low numbers caught in some years (Fig. 8.5.1.2.6), and there were strong year-effects in recent years.

Plots of empirical SSB from the NIGFS-Mar and ScoGFS-Q1 surveys, calculated using data from all age classes recorded, are shown in Figure 8.5.1.2.7. Both surveys show low SSB in 2000 and 2001, and from 2005 onwards, due to weak recruitment. The ScoGFS-Q1 survey does not show as marked an increase in SSB in 2003 and 2004 as indicated by the NIGFS-Mar survey.

8.5.1.3 Exploratory assessment runs

Survey analyses using SURBA v.3.0

Model settings for SURBA runs are given in Table 8.5.1.3.1. Survey catchability at age was inferred from the pattern across ages in ratios of survey indices to population estimates from this year's final B-Adapt run. The marked differences in the selectivity patterns of the NIGFS and ScoGFS surveys may reflect trawl design, towing speed and fishing locations.

Weighting factors for the NIGFS-Mar survey were derived from the approximate standard errors of the survey indices (see Table 8.2.1).

Single-fleet SURBA (v.3.0) runs show that NIGFS-Mar residuals at age 1 are strongly positive in the early years of the survey (Fig. 8.5.1.3.1), reflecting the more linear year-class curves during this period (Fig. 8.5.1.2.4). Age–1 residuals for the ScoGFS Q1 survey are also very noisy (Fig. 8.5.1.3.2), and there are some year effects at older ages. No retrospective bias is apparent in biomass and recruitment estimates from the two survey runs (Figs. 8.5.1.3.1–2).

The SURBA-derived trends in recruitment from the NIGFS-Mar and ScoGFS-Q1 surveys are very similar (Fig. 8.5.1.4.2). The large discrepancies in empirical SSB values for the two surveys in 2002-2003 (Fig. 8.5.1.2.6) are reduced in the SURBA runs. Trends in Z are generally upwards. Both surveys indicate very weak 2002–2005 year-classes. Surveys of 0–group cod (NIMIKNET, BTS-Sept and NIGFS-Oct) also indicate very weak 2002–2003 year-classes, but consistently show an increased abundance of 0-gp fish in 2004 and 2005 (Fig. 8.5.1.2.1).

Catch-at-age analysis

The B-Adapt method is described in Section 2.7. Software versions B-Adapt-F.exe (13/5/06) and Adapt_cod_09_06.exe (13/9/06) were used at the WG this year to allow examination of the effect of estimating the removals bias for 2006 or treating the 2006 landings data as exact. The Adapt_cod_09_06.exe was a version produced for the North Sea WG in 2006 to evaluate a scenario of more accurate catch reporting in 2006. A more recent version Adapt_16_04_07 was made available after the WG meeting to carry out medium-term forecasts, as version 09_06 had certain recruitment options for North Sea cod hard-wired into the forecast code (which was unavailable to the WG).

The objective functions for minimising are given below:

$$SSQvpa = \Sigma_{a,y,f} \{ Ln(u_{(a,y,f)}) - [Ln(q_{(a,f)}) + Ln(N_{(a,y)})]\}^2 \quad \text{(basic SSQ function)}$$
$$SSQf = \lambda\, \Sigma_{a,y} \{Ln(F_{(a,y)}) - Ln(F_{(a+1,y+1)})\}^2 \quad \text{(F-smoothing)}$$

where $u_{(a,y,f)}$ is the survey CPUE for age *a*, year *y*, fleet *f*; C and CW are catch numbers and catch weights at age and λ are the smoothing weights. A λ value of 1.0 was adopted last year following sensitivity tests, and was used for most of the exploratory runs this year. However, the effect of reducing λ to 0.10 was examined.

Model settings for the exploratory runs are given in Table 8.5.1.3.2. The runs group into those in which the removals bias is estimated for 2006, and those in which there was assumed to be no bias in 2006. Options examined within the first group (bias estimated in 2006) were the plus group setting (5+ or 6+), the method of calculating F on the oldest true age in each year; the range of tuning series and ages included, and the degree of F-smoothing (λ).

A replication of last year's run with updated catch and survey data (SPALY; run 1) indicated a sharp increase both in F(2-4) and in the removals bias estimate in 2006 (Figs 8.5.1.3.3–4). This feature remained to varying extents in all exploratory runs where the bias was estimated for 2006. The plus group setting and method of estimating oldest-age F (runs 2 and 4) had minimal effect on the bias or population estimates. Reducing λ to 0.1 (run 3) resulted in more noisy estimates as expected, but F in 2006 remained very high.

It was noted with reference to Fig. 8.5.1.2.1 that 0–gp indices tend to indicate stronger 2004–2005 year classes than is apparent in the spring surveys at age 1 and over. Running B-Adapt with only the NIGFS-Mar (run 6) or a combination of the NIGFS-Mar and ScoGFS-Q1 surveys (run 6b) resulted in overall increased bias estimates over the 2000–2005 period. However, run 6b had the lowest bias estimate for 2006. This suggests that the 0–gp indices have a significant influence on the population and bias estimates.

The SPALY run 1 showed anomalous year-effects in the NIGFS-Oct survey towards the end of the series, reflecting the obvious year effects in the raw survey data (Fig. 8.5.1.2.6). Reducing the survey data to 0–group only (run 5) had the effect of reducing the F in 2006 from the very high value in the SPALY run, with a corresponding reduction in the bias estimate. A more detailed examination of the 1–gp and 2–gp data from this survey indicated extremely low numbers of 2–year-olds in some years, and that the indices in some recent years can be driven by a few stations with relatively high catch rates (Fig. 8.2.2).

All the SPALY sensitivity runs indicated a reduction in the removals bias estimate in 2005 towards the sample-based estimate for that year, followed by a sharp increase in 2006 (Fig. 8.5.1.3.4).

Runs where bias was not estimated for 2006 (landings assumed accurate) had the expected result of pulling the 2005 bias estimate much closer to the observed value for 2005 (Fig. 8.5.1.3.4), and F estimates declined substantially between 2005 and 2006 (Fig. 8.5.1.3.3). This effect was exacerbated when NIGFS-Oct indices at ages 1 and 2 were included (run 8), possibly the result of the large year-effect in these estimates.

From the two groups of runs including and excluding bias estimation for 2006, runs 9b and 9c were considered the most suitable candidates for final B-Adapt assessment. These runs excluded NIGFS-Oct data at ages 1 and 2, and set the plus group to 5+ with F(4)=F(3) in each year. This procedure avoids including the partially selected age class 2 in the estimation of F(4). These two runs give very different perception of the removals bias in 2006, but there are only weak statistical grounds for choosing between them. Residual plots (Fig. 8.5.1.3.5) provide no clear indication that one model is necessarily better than the other, as the differences in residual error between the two runs are well within the interannual variability in the time series. The most obvious differences between the runs are the residuals for the NIGFS-Mar and ScoGFS at age 2 in 2005 and the negative residuals at ages 3 and 4 in the NIGFS-Mar survey in 2007. The residuals for the 0–gp indices in 2004 and 2005 are also marginally smaller when bias is estimated for 2006.

A trend in catchability residuals for 2–4 year old cod exists in the first five years of the NIGFS-Mar survey series, becoming progressively more marked with increasing age (Fig. 8.5.1.3.5). This is not reflected in the SURBA residuals (Fig. 8.5.1.3.1). In contrast, the three positive values at age 1 in 1995-96 in NIGFS-Mar B-Adapt residuals are evident in the SURBA analysis, indicating a change in selectivity.

A retrospective analysis for Run 9c shows no retrospective bias (Fig. 8.5.1.3.6). The retrospective pattern for run 9b is similar except that F for the run up to 2006 dips sharply in 2006. Both runs show a decline in F at age 1 in 2006 (Fig. 8.5.1.3.7), but divergent F estimates at ages 2 and 3 in 2006. Although the larger bias estimates for run 9c result in additional population numbers at all ages in recent years up to 2006, point estimates of survivors at ages 1, 2 and 4 in 2007 are very similar in the two runs, with slightly smaller numbers at age 3 in 2007 in run 9b (Fig. 8.5.1.3.7).

Conclusions regarding exploratory analyses

The principal evidence for an assessment result tending towards the “no bias” scenario for 2006 is the direct observation that landings records have been more accurate in 2006 in several major ports than in previous years. The assumption of no bias in 2006 also brings the B-Adapt estimates of total landings in 2000–2003 and 2005 closer to the WG estimates including the sample-based estimates. Furthermore, the reduction in the F(2–4) estimate for 2006 is also more in line with the observation of further reductions in fishing effort of the main fleets catching cod (see section 8.2.1). However, the Working Group considered the port sampling scheme to have had insufficient coverage in 2006 to allow a confident statement that official landings statistics were completely accurate in 2006, and there may also have been unaccounted-for removals other than under-reporting of landings at the ports where observations were made. The results of the B-Adapt runs 9b (no bias in 2006) and 9c (bias estimated in 2006) are therefore presented as bounding the possible recent dynamics of the stock, as there is presently insufficient information to evaluate statistically which is the more likely scenario. Although the recent fishing mortality is very poorly estimated and very sensitive to assumptions regarding accuracy of removals figures, the SSB and recruitment trends appear well estimated. The B-Adapt point estimates of SSB for 2007 are similar for the two final runs (2 057 t for run 9b and 2 075 t for 9c). The median bootstrap SSB estimates were 1 751 t for run 9b and 2 280 t for 9c.

8.5.1.4 Final assessment run

The data and model settings for run 9c with bias estimated in 2006 are given in Table 8.5.1.3.3. The run fixing the 2006 bias at 1.0 (run 9b) uses the same model settings other than the final-year bias option. The diagnostics from run 9c are given in Table 8.5.1.4.1, and the long-term trends in landings, F, SSB and recruitment are given in Fig. 8.5.1.4.1. The 5th and 95th percentiles are shown from 1 000 boot-strap runs selecting randomly from the survey catchability residuals. The equivalent trends for run 9b are also shown in Fig. 8.5.1.4.1 (see stock folder for diagnostics).

The landings values in Figure 8.5.1.4.1 show the reported landings, the landings including sample-based estimates from 1991–2002 and 2005 (only the 1991-1999 estimates are included in the landings for the B-Adapt run), and the B-Adapt estimates of total removals since 2000. The total removals may represent unallocated discards and landings, and losses due to additional natural mortality in excess of M=0.2. The error bars on total removals span the 5th and 95th percentiles from the bootstrap runs. The B-Adapt estimates of total removals (including unallocated removals) were close to the WG landings figures including sample-based estimates for 2000 and 2001, but in excess of the values for 2002 and 2005. The latter fall outside the confidence limits of the B-Adapt estimates from run 9c but are within the confidence intervals for run 9b (no bias estimated for 2006).

The recruitment trends from B-Adapt are very similar to the indices from SURBA for the NIGFS-Mar and ScoGFS surveys (Fig. 8.5.1.4.2).

The SURBA and B-Adapt indices of SSB indicate very low SSB in 2005 and 2006. B-Adapt SSB estimates from runs 9b and 9c diverge in 2006 but are very similar in 2007. The estimates of Z from the SURBA runs are of similar magnitude to the B-Adapt estimates. All estimates are, however, very high for adult cod. Given the highly truncated age composition in the stock, and the internal procedure in SURBA for estimating recent Z, the SURBA trends in Z are probably poorly estimated. The UK Fisheries Science Partnership surveys (Armstrong *et al.*, WD2; Table 8.2.1) also indicate a rapid decline in catch rates within year classes during 2004–2007, giving an approximate total mortality of Z=1.4 for the western Irish Sea spawning stock at ages 3 and over, which is in line with the assessment results.

8.5.1.5 Comparison with last years assessment

This year's B-Adapt estimates of bias (with SE of log estimates in parenthesis), and the estimates of SSB, F(2-4) and recruitment at age 0 in 2004 and 2005, are compared below with the results given by last year's WG.

	Bias 2000	**Bias 2001**	**Bias 2002**	**Bias 2003**	**Bias 2004**	**Bias 2005**	**SSB 2005**	**F 2005**	**R 2004**	**R 2005**
WG06	1.70 (0.21)	1.49 (0.23)	2.14 (0.21)	3.43 (0.22)	3.23 (0.23)	2.94 (0.22)	2 680	1.39	1 380	2 210
WG07 Run 9b	1.67 (0.24)	1.61 (0.25)	2.18 (0.23)	3.46 (0.24)	2.97 (0.24)	1.99 (0.23)	1 680	1.49	910	1 170
WG07 Run 9c	1.89 (0.22)	1.86 (0.24)	2.46 (0.22)	3.77 (0.23)	3.23 (0.24)	2.92 (0.24)	2 520	1.09	1 310	1 600

For run 9c (bias estimated for 2006), the addition of another year of data, together with smoothing of the F's, has resulted in some changes to the bias estimates for 2000-2003, but the SSB and R estimates are not changed substantially, and the perception of the state of the stock remains the same. For run 9b, forcing a bias value of 1.0 in 2006 brings down the bias estimates for 2004 and 2005 compared with last year's run, and gives smaller estimates of SSB and recruitment.

8.5.2 Estimating recruiting year class abundance

Working group estimates of year-class strength at age 0 are summarised below. The equivalent point estimates for the bootstrap values in the stochastic forecasts are shown in bold. The B-Adapt point estimate for the 2006 year-class is less than half the 1992–05 GM but was retained for forecasts as it is estimated from three surveys in 2006 and two in 2007. The log SE of the survivors for this year class from B-Adapt was 0.36 -0.38 for the two B-Adapt runs.

Number at age 0		**Run 9c (bias in 2006)**		**Run 9b (no bias**	
Year	**Year class**	**B-Adapt**	**GM(92-05)**	**B-Adapt**	**GM(92-05)**
2004	2004	**1 308**	2 567	**909**	2 264
2005	2005	**1 597**	2 567	**1 171**	2 264
2006	2006	**1 080**	2 567	**947**	2 264
2007	2007	**Bootstrap 92-06 y.classes**	2 567	**Bootstrap 92-06 y.classes**	2 264

8.5.3 Long-term trends in biomass, fishing mortality and recruitment

Long-term estimates from the final B-Adapt runs excluding and including removals bias in 2006 are given in Fig. 8.5.1.4.1. The decline in SSB to a very low value in 2000, following the production of weak year classes in 1997 and 1998, follows the pattern observed in previous WG assessments using analysis of commercial catches at age and survey data. An increase in SSB occurred in 2002 and 2003 following improved recruitment. However, recruitment has been extremely weak since 2002, with the year classes 2002–2006 being five of the six weakest in the series. This has caused a further reduction in SSB to around the value observed in 2000.

All SSB estimates from 1995 onwards are below the $\mathbf{B}_{\mathrm{lim}}$ of 6kt, and all estimates of F(2–4) from 1988 onwards are above the $\mathbf{F}_{\mathrm{lim}}$ of 1.0.

The stock-recruit estimates from the final B-Adapt run 9c exhibit an inflection point at 10 400 t, close to the Bpa value of 10 000 t, when a segmented regression with log-normal error distribution is fitted (Fig. 8.5.3.1). The majority of SSB values below Bpa have been recorded from 1990 onwards, and most are associated with below-average recruitment. An analysis of cod recruitment and sea surface temperature carried out by WGNSDS in 2006 showed that the residuals from the fitted stock recruit curve were negatively correlated with annual anomalies from a longer term trend fitted to sea surface temperature in the Irish Sea. The poor recruitment in recent years appears to result from a combination of unfavourable environmental conditions together with reduced SSB.

8.5.4 Stock predictions

Stock predictions were carried out using the B-Adapt bootstrap option, as described in Section 8.5.5. Where the assessment generates estimates of "unaccounted removals" in excess of reported or observed landings up to the final year (e.g. B-Adapt run 9c), the forecasts will also represent a mixture of catches and unaccounted removals and these cannot be separated.

8.5.5 Medium-term predictions

Stochastic projections were run forward using each of 1 000 non-parametric bootstrap iterations from B-Adapt run 9c (bias estimated in 2006).

As the extent to which the removals estimates from B-Adapt for recent years represent fishing mortality is not known, the term "fishing mortality" is used loosely in the following text as the value of Z due to removals in excess of the natural mortality rate M=0.2. This is indicated by superscripting the F as F^* to avoid confusion. The scenarios explored were constant status quo mortality (F^*_{sq}), 0.75, 0.5, 0.25, 0.10 and 0.0 multipliers of F^*_{sq}, and F^* equivalent to F_{pa} (F-multiplier of 0.43 for run 9c).

Starting populations in 2007 were taken from each bootstrap iteration. Status quo fishing mortality at age was the 2004–2006 average scaled to $F^*(2–4)$ in 2006. The use of a 3–year mean without re-scaling was not available in the B-Adapt bootstrap routine. Intermediate-year fishing mortality in 2006 was taken as F^*_{sq}. Stock and catch weights were the average of the final three years of assessment data. Recruitment was re-sampled from the 1992–2006 year-classes, representing the period of reduced recruitment at low SSB. This was considered appropriate as median SSB in most projections tended to remain below B_{pa} except at very low F^* towards the end of the forecast period. Historical recruitment has been reduced since SSB declined below B_{pa} in the early 1990s.

Figures 8.5.5.1–8.5.5.6 present the results of the stochastic projections using B-Adapt run 9c (bias estimated in 2006) to provide the starting populations and F^*-vector. In each case $F^*(2–4)$, catch, SSB and recruitment (5th, 25th, median 75th and 95th percentiles from the bootstrap distributions) are plotted. Percentiles of F^*, SSB and removals in 2007, 2008 and 2009 are tabulated, together with the probability of SSB > B_{lim} in each year and the probability of $\geq$30% SSB growth during the specified year. Figures 8.5.5.7 and 8.5.5.9 summarise the results as probability profiles for SSB>B_{pa} or B_{lim} for different F^*-multipliers and $F^*(2–4)$ values. The results of medium-term forecasts based on run 9b (no bias estimated for 2006) are given in Figs 8.5.5.8 and 8.5.5.9. The salient points are:

- In each of the stock projections, median SSB continues to decline to a historic low value in 2008, and can then begin to rebuild according to the mortality rate from 2008 onwards.
- There are no non-zero options for median $F^*(2–4)$ that allow rebuilding of SSB above B_{lim} by 2009 with a probability greater than about 20%.
- For run 9c, a 64% reduction in removals mortality $F^*(2–4)$ to about 0.60 is needed for a 50% probability of SSB exceeding the B_{lim} of 6 000 t by 2010 (Fig. 8.5.5.8). For run 9b, a 50% reduction in $F^*(2–4)$ to about 0.47 is needed due to the different starting conditions and lower F^*_{sq}.

- Reductions in F^* to around the F_{max} value of ~0.3 or below are required for SSB to exceed B_{pa} with high probability by 2016, assuming continued recruitment similar to the 1992-2006 estimates.
- The probability of sustained SSB growth in the next few years is quite uncertain, and highly dependent on the extent to which the recent run of recruitment failures will continue. The very poor estimates of fishing mortality from the B-Adapt model are also a large source of error in both the outcome and interpretation of the forecasts.

Simulating a 15% annual decrease in TAC from 2007 onwards.

Bootstrap forecast were made using runs 9b and 9c, applying a TAC constraint of 1,462 t in 2007 (the TAC currently imposed) followed by a 15% reduction to 1 243 t in 2008 and a further 15% reduction to 1 056 t in 2009. Initial runs using assessment run 9c indicated this generated F(2–4) values in 2009 close to the $F_{0.1}$ of 0.18, hence an F-multiplier was applied in years 2010–2016 to give median F close to $F_{0.1}$ in those years. This allowed variability in F in these years rather than an exact value at $F_{0.1}$. This scenario assumes accurate information on fishery removals in the future, with no increase in discard rates.

The 2007 TAC generates a higher F in run 9b than in 9c due to the lower median population size in 2007 when removals bias was not estimated for 2006. The declining TACs in 2008 and 2009, together with the assumed increase in recruitment to around the 1992–2006 GM (following on from extremely weak 2002–2006 year classes), generate a rapid decline in F (Figs. 8.5.5.10 and 8.5.5.11). The SSB increases sharply and exceeds B_{lim} with high probability (>80%) by 2010 (run 9c) or 2011 (run 9b). This forecast is likely to represent a very optimistic scenario, as it assumes that mortality is being effectively controlled by the TAC from 2007 onwards, and that the recent run of very poor recruitment will come to an end after 2006, albeit replaced by the relatively low 1992–06 GM. Recovery rates will be reduced by any increases in discarding or other sources of mortality other than fishing.

The large upper 95th percentile for F^* in 2007 in run 9b (Fig. 8.5.5.11) indicates that in ~5% of the runs the TAC approached the stock size causing extreme F values. As the GM recruitment assumption also continues to apply at very small SSB values, the stock recovers in these runs despite the very low SSB, which is unrealistic.

8.5.6 Yield and biomass per recruit

The WG did not update the yield-per-recruit and spawning biomass per recruit carried out by the 2004 WGNSDS, as the B-Adapt assessment uses a reduced plus-group (5+) which will constrain the estimates of landings and SSB at low values of F. The 2004 analysis, conditional on the exploitation pattern obtained by the 2004 WGNSDS from TSA, and long term (1982–2003) weights at age, is shown in Table 8.5.6.2 and Figure 8.5.6.1, with inputs listed in Table 8.5.6.1. $\mathbf{F}_{max}$ is estimated to be 0.32 and $\mathbf{F}_{0.1}$ is estimated to be 0.18. These estimates are well below any historical estimates of fishing mortality obtained by previous WGs.

8.5.7 Reference points

Previous assessment Working Groups have explored appropriate reference points for this stock based on stock-recruitment dynamics. The PA reference points proposed by ACFM for Irish Sea cod are:

$\mathbf{F}_{pa}$ = 0.72; $\mathbf{B}_{pa}$ = 10,000 t

$\mathbf{F}_{lim}$ = 1.0; $\mathbf{B}_{lim}$ = 6,000 t

The stochastic bootstrap forecasts presented in Section 8.5.5 (Fig. 8.5.5.9) indicate that the current **F**pa of 0.72 has an approximately 70–80% probability of recovering SSB to $\mathbf{B}_{lim}$ in the medium term, if recruitment in the foreseeable future varies around the low average level estimated for the 1992–2006 year classes. However, there was insufficient time at the WG to adequately review the reference points for this stock.

8.5.8 Quality of the assessment

Landings data

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The Working Group has, since the 1990s, attempted to overcome this problem by incorporating sample-based estimates of landings from three major ports in the WG landings figures. The data for this method have become more limited since 2003, and increasing restrictions on fishing could have resulted in more widespread under-reporting and discarding of over-quota fish since 2000. The WG therefore incorporates the sample-based landings estimates up to 1999 only, and uses the B-Adapt modelling approach to estimate subsequent landings. The unallocated removals figures given by B-Adapt could potentially include components due to increased natural mortality and discarding as well as misreported landings, albeit distributed according to the age composition in the landings. The estimates of bias can also be influenced by any remaining non-randomness of survey catchability or outlying values, or if the bias since 2000 varies with age of the fish. For this reason, the absolute values of the estimated unallocated removals should not be over-interpreted.

Discarding

Estimates of discards are patchy for Irish Sea cod, although more comprehensive sampling is now required through the EU Data Collection Regulation. Discarding is mainly at age 1. The absence of raised estimates of discarding for all fleets will result in under-estimation of F at age 1 in any catch-based assessments.

Surveys

The Irish Sea has relatively good survey coverage up to 2007. Good consistency is observed between surveys at age 0, and at ages 2–4, but poorer consistency is observed at age 1, and at ages 5 and above where catch numbers are small.

The indication that SSB in 2006–2007 has declined close to the very low value of 2000 is supported by SURBA analyses and trends in raw survey indices for adult cod during the surveys in spring. Evidence for recent weak year-classes is also provided by other surveys used in the assessment model although there are currently conflicting estimates of the 2005 year class between the 0–group and 1–group indices.

Model formulation

The final B-Adapt assessment runs estimated removals in 2003 and 2004 exceeding three times the reported fishery landings. Although the removals estimates then decreased towards the sample-based landings estimate for 2005, the subsequent increase in the bias estimate for 2006 in run 9c was unexpected given the introduction of the Buyers and Sellers scheme and the limited observations at the ports indicating improved accuracy of catch reporting in 2006. The B-Adapt run assuming no landings bias in 2006 (run 9b) resulted in removals estimates for 2000–2003 and 2005 more in line with the sample-based estimates not included in the assessment. However, this run generated a sharp decline in F in 2006 of magnitude typical of more conventional VPA assessments subject to retrospective bias. Given that the differences in model residuals were at best subtle, the WG could not evaluate which of the runs was the most appropriate on statistical grounds.

The application of B-Adapt to Irish Sea haddock (Section 9) also indicates continued high bias estimates despite reduced sample-based estimates of landings. Both the cod and the haddock stocks have very steep age profiles and noisy survey catchability, with only a few age classes being tuned by the surveys. It is possible that the highly truncated age composition renders the model over-sensitive to the random component of survey catchability. Auxiliary information may be needed to fix the removals bias or fishing mortality in the final year; however, the absence of sufficiently comprehensive observations precludes this at present.

The WG did not have time to carry out further simulation testing of the B-Adapt model applied to data similar to those from the Irish Sea cod and haddock. However, although recent F estimates are very sensitive to how the model is formulated, the recruitment and SSB trends appear to be quite robust, and the general stock trends appear well estimated.

8.5.9 Management considerations

ICES in 2006 classified the VIIa cod stock as having reduced reproductive capacity and being harvested unsustainably. Based on last year's assessment, SSB was projected to remain below $\mathbf{B}_{\mathrm{lim}}$ in 2006. The current assessment indicates that SSB of Irish Sea cod in 2007 is close to the lowest in the time series due to a combination of high mortality and very poor recruitment since 2002. Recruitment has been below average for the past nineteen years, and eight of the most recent 15 year classes have been well below any of the weakest year classes observed prior to 1990. This is likely due to a combination of low SSB and adverse environmental conditions for early-stage survival.

Although recent recruitment patterns appear well estimated, the problem of inaccurate landings and discards estimates makes it difficult to estimate the absolute value and recent trends in fishing mortality. However, all sources of information on age composition in the stock, from the fishery as well as surveys using research vessels and chartered commercial vessels, indicates a continued paucity of cod older than four years of age in the Irish Sea.

The time-series of kW-days fishing effort available to the Working Group (Section 17) indicates a substantial reduction in effort of whitefish vessels using gears designed for targeting demersal species such as cod, particularly those vessels with >5% cod in their landings. Effort of *Nephrops* trawlers has however remained high, and as there is some cod by-catch in this fishery, the overall effort generating cod mortality may have declined more slowly over time. It is difficult however to reconcile the large increase in F and catch bias in 2006 from the B-Adapt run in which removals bias is estimated for 2006, with the continued reduction in fishing effort in 2006 and the very low abundance of cod.

Poor information on the sources of mortality or other losses of cod from the Irish Sea that may be preventing recovery of the age composition is a major obstacle to the assessment of the stock and evaluation of management options. Current improvements in data collection may help resolve this issue. The EU-wide Buyers and Sellers scheme (see Section 1.7.2) has led to improved accuracy of landings statistics. A newly established Enhanced Data Collection Scheme in the Irish Sea involving self-sampling and additional observer coverage, is due to commence in 2007 and will provide more accurate data on discarding. Ongoing tagging programmes around Ireland (O Cuaig and Officer, 2007), together with a new UK(NI) programme planned for the Irish Sea, will help establish the possible effects of stock mixing on the composition of cod catches in the Irish Sea and the potential for mortality on the Irish Sea stock caused by fisheries outside the Irish Sea during seasonal migrations.

The VIIa commercial fishery for cod extends into the North Channel, particularly for vessels using mid-water trawls. It is not clear if the cod in this region belong to the Irish Sea stock, the nearby Clyde stock which exhibits dense aggregations of adult fish during spring in the area covered by the Clyde closure (see Fig. 8.2.3), or to other VIa cod populations. Recent tagging of cod off Greencastle on the north coast of Ireland (O Cuaig and Officer, 2007), and more limited tagging on UK Fisheries Science Partnership surveys (Armstrong *et al*. WD2), have demonstrated movements of cod between Division VIa and VIIa. Most recaptures in

VIIa from cod tagged in VIa have come from the North Channel and in or near the deep basin in the western Irish Sea that is a southward extension of the North Channel. The research surveys used for tuning the VIIa cod assessment cover only the western and eastern Irish Sea, and do not extend into the deeper water of the North Channel, where large catches of cod were made by midwater trawlers in the 1980s and 1990s. Historical tagging studies have also shown more limited movements of cod between spawning components in the western and eastern Irish Sea, for which the migrations tend to be in a north-south direction. STECF Sub-group SGRST (2005, Appendix 4) concluded that management of the Irish Sea stock on the basis of sub-stock assessment regions would be difficult in practice, particularly the separation of catches when the stock units are mixed. Further tagging and genetics studies are required to investigate stock structure, seasonal movements and mixing in VIIA and neighbouring areas.

The EU Cod Recovery Plan regulation implemented in the Irish Sea from 2004 will continue to impact the management measures for 2008, which will be formulated with reference to the estimates and forecasts of SSB in relation to limit and precautionary reference points. For stocks above $\mathbf{B}_{\mathrm{lim}}$, the harvest control rule (HCR) requires:

- setting a TAC that achieves a 30% increase in the SSB from one year to the next,
- limiting annual changes in TAC to ± 15% (except in the first year of application), and,
- a rate of fishing mortality that does not exceed $\mathbf{F}_{\mathrm{pa}}$.

For stocks below $\mathbf{B}_{\mathrm{lim}}$ the Regulation specifies that:

- conditions 1–3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application,
- a TAC will be set lower than that calculated under conditions 1–3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application.

The present assessment using B-Adapt indicates that SSB is well below $\mathbf{B}_{\mathrm{lim}}$, and that the combination of conditions 1–3 is unlikely to result in SSB recovering above $\mathbf{B}_{\mathrm{lim}}$ by the end of 2008.

Table 8.1.3.1 Nominal landings (t) of COD in Division VIIa as officially reported to ICES, and figures used by ICES.

COUNTRY	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	129	187	142	183	316	150	60	283	318	183	104	115	60
France	208	166	148	268	269	n/a	53	74	116	151[2]	29	35[2]	13
Ireland	1 506	1 414	2 476	1 492	1 739	966	455	751	1 111	594	380	220	272
Netherlands	-	-	25	29	20	5	1	-	-	-			
Spain	-	-	-	-	-	-	-	-	-	14	-	-	
UK (England, Wales & NI)	2 274	2 330	2 359	2 370	2 517	1 665	799	885	1 134	505	646	594[2]	590
UK (Isle of Man)	26	22	27	19	34	9	11	1	7	7	5		
UK (Scotland)	326	414	126	80	67	80	38	32	29	23	15	3	
Total	4 469	4 533	5 303	4 441	4 962	2 875	1 417	2 026	2 715	1 477	1 179	967	935
Unallocated	933	54	-339	1 418	356	1 909	-143	226	-20	-192	-107	-57	-97
Total as used by WG	**5 402[3]**	**4 587[3]**	**4 964[3]**	**5 859[3]**	**5 318[3]**	**4 784[3]**	**1 274[4]**	**2 252[4]**	**2 695[4]**	**1 285[4]**	**1 072[4]**	**910[4]**	**838[4]**

[1]Preliminary. [2]Revised. n/a = not available [3] includes sample-based estimates of landings into three ports [4] based on official data only.

Table 8.2.1. Cod in VIIa: survey indices. Approximate CVs for age groups used in the assessment are given for UK(NI) groundfish surveys. Years/ages used in assessments are in bold.

ScoGFS :Scottish spring groundfish survey of the Irish Sea Numbers per 10 Hours Fishing
Feb-March

Survey	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
1996	**3**	**31**	**44**	**7**	9	0	0
1997	**22**	**29**	**15**	**13**	2	0	1
1998	**5**	**81**	**27**	**5**	1	0	0
1999	**7**	**33**	**93**	**15**	5	0	0
2000	**51**	**6**	**11**	**16**	0	1	0
2001	**28**	**56**	**1**	**1**	4	0	0
2002	**13**	**18**	**37**	**1**	1	0	0
2003	**8**	**69**	**18**	**9**	0	0	0
2004	**8**	**11**	**49**	**0**	3	0	0
2005	**1**	**25**	**8**	**9**	1	0	0
2006	**0**	**2**	**5**	**11**	0	2	0

ScoGFS :Scottish autumn groundfish survey of the Irish Sea Numbers per 10 Hours Fishing
October

Survey	0-gp	1-gp	2-gp	3-gp	4-gp
1997	3	28	19	1	2
1998	0	8	42	5	0
1999	164	2	24	6	2
2000	24	136	4	0	0
2001	0	0	7	0	0
2002	0	18	15	9	0
2003	2	0	27	0	0
2004	2	12	5	5	0
2005	3	8	25	2	0

NI-GFS March groundfish survey Numbers per 3-miles (approx. 1-h tow) CV = coefficient of variation

Survey	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	CV(1gp)	CV(2gp)	CV(3gp)	CV(4gp)
1992	**23.257**	**5.005**	**1.965**	**0.248**	0.000	0.031	0.017	0.58	0.36	0.26	0.40
1993	**1.381**	**6.488**	**0.446**	**0.104**	0.014	0.028	0.000	0.67	0.22	0.25	0.39
1994	**13.804**	**1.097**	**1.203**	**0.084**	0.014	0.000	0.000	0.48	0.35	0.21	0.35
1995	**7.007**	**3.862**	**0.200**	**0.108**	0.000	0.010	0.000	0.30	0.25	0.41	0.39
1996	**11.061**	**3.293**	**1.117**	**0.014**	0.088	0.000	0.013	0.62	0.18	0.21	1.00
1997	**5.373**	**4.158**	**0.667**	**0.214**	0.014	0.000	0.000	0.32	0.21	0.21	0.38
1998	**1.694**	**7.692**	**0.569**	**0.120**	0.000	0.000	0.000	0.21	0.16	0.30	0.53
1999	**0.495**	**2.531**	**2.419**	**0.153**	0.028	0.000	0.000	0.27	0.20	0.15	0.43
2000	**6.296**	**1.011**	**0.346**	**0.330**	0.000	0.023	0.000	0.36	0.13	0.31	0.44
2001	**4.067**	**5.614**	**0.184**	**0.058**	0.040	0.000	0.000	0.29	0.15	0.39	0.42
2002	**6.622**	**2.533**	**3.335**	**0.000**	0.000	0.011	0.000	0.59	0.19	0.38	-
2003	**0.739**	**10.792**	**1.041**	**0.327**	0.037	0.030	0.058	0.32	0.21	0.30	0.26
2004	**2.170**	**1.720**	**0.886**	**0.054**	0.044	0.000	0.000	0.57	0.30	0.21	0.40
2005	**0.635**	**2.251**	**0.294**	**0.280**	0.183	0.000	0.000	0.56	0.29	0.60	0.64
2006	**1.700**	**1.308**	**0.583**	**0.025**	0.000	0.000	0.011	0.52	0.26	0.37	0.71
2007	**1.644**	**1.244**	**0.306**	**0.051**	0.000	0.000	0.000	0.41	0.21	0.38	0.66

NI-GFS October groundfish survey Numbers per 3-miles (approx. 1-h tow) CV = coefficient of variation

Survey	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	CV(0gp)	CV(1gp)	CV(2gp)
1992	**0.579**	11.094	0.501	0.476	0.086	0.000	0.000	0.000	0.58	0.36	0.28
1993	**7.808**	5.532	1.464	0.008	0.000	0.000	0.000	0.034	0.43	0.84	0.34
1994	**19.962**	16.725	0.254	0.104	0.000	0.000	0.000	0.000	0.28	0.43	0.42
1995	**7.886**	12.068	0.333	0.000	0.000	0.000	0.000	0.000	0.55	0.91	0.38
1996	**14.813**	4.866	0.501	0.065	0.000	0.000	0.000	0.000	0.42	0.50	0.30
1997	**4.204**	13.222	0.972	0.000	0.000	0.000	0.000	0.000	0.45	0.41	0.40
1998	**0.370**	3.765	1.639	0.057	0.000	0.000	0.000	0.000	0.38	0.36	0.37
1999	**20.225**	0.585	0.325	0.095	0.000	0.000	0.000	0.000	0.34	0.68	0.43
2000	**7.242**	3.016	0.020	0.000	0.000	0.000	0.000	0.000	0.36	0.33	1.00
2001	**8.411**	5.068	1.099	0.000	0.000	0.000	0.000	0.000	0.45	0.35	0.35
2002	**0.897**	4.879	0.377	0.125	0.000	0.000	0.000	0.000	0.86	0.58	0.55
2003	**2.759**	1.614	0.294	0.000	0.000	0.000	0.000	0.000	0.48	0.66	0.63
2004	**4.437**	5.790	0.237	0.000	0.000	0.000	0.000	0.000	0.30	0.48	0.75
2005	**8.245**	7.061	1.077	0.173	0.029	0.000	0.000	0.000	0.52	0.89	0.62
2006	**1.170**	1.302	0.015	0.066	0.000	0.000	0.000	0.000	0.45	0.53	1.00

Table 8.2.1. Contd.

Irish GFS. Irish groundfish survey of the Irish Sea. RV Celtic Explorer Total nos. per survey
October

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2003	16	29	31	3	1	0		
2004	23	74	7	2	0			

UK Fishery Science Partnership western Irish Sea pelagic trawl survey (mean nos. per hour)
Feb-March

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2004		0	0.35	2.5	0.25	0.25	0.042	0
2005		0	0.92	2.65	1.25	0.09	0.08	0.02
2006		0	0.1	2.7	0.42	0.12	0.021	0.011
2007		0	0.7	1.78	0.73	0.07	0.08	0.04

UK Fishery Science Partnership eastern Irish Sea otter trawl survey (mean nos. per hour)
Feb-March

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2005		0.06	4.02	0.25	0.38	0.004	0.01	0
2006		0.83	0.77	0.67	0.007	0.042	0	0.001
2007		0.59	1.43	0.09	0.08	0	0	0

UK(EW) BTS beam trawl survey. No. per 100km
September

Survey	0-gp	1-gp
1988	19	8
1989	17	6
1990	190	6
1991	**70**	20
1992	**11**	55
1993	**38**	1
1994	**30**	3
1995	**40**	3
1996	**29**	4
1997	**30**	14
1998	**2**	0
1999	**59**	0
2000	**37**	29
2001	**24**	4
2002	**7**	8
2003	**8**	0
2004	**22**	7
2005	**31**	1
2006	**4**	1

NIMIKNET pelagic 0-gp index
May-June

Survey	0-gp
1994	**57.4**
1995	**6.9**
1996	**66.3**
1997	**5.7**
1998	**0.1**
1999	**26.2**
2000	**6.1**
2001	**9.6**
2002	**3.4**
2003	**3.2**
2004	**25.8**
2005	**11.4**
2006	**9.0**

Table 8.3.1. Cod in VIIa: Catch numbers at age (thousands). Note: sample-based estimates of landings from three ports are included in 1991–1999 data.

Run title : "IRISH SEA COD NSWG 2007 COMBSEX PLUSGROUP"

At 14/05/2007 22:55

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976
	AGE									
	0	0	0	0	0	0	0	0	0	0
	1	364	882	1317	2739	789	2263	530	1699	1135
	2	1563	1481	1385	2022	3267	1091	3559	642	3007
	3	1003	1050	352	904	824	1783	557	1407	363
	4	456	269	204	144	250	430	494	294	500
	+gp	207	299	234	118	117	254	205	366	165
0	TOTALNUM	3593	3981	3492	5927	5247	5821	5345	4408	5170
	TONSLAND	8541	7991	6426	9246	9234	11819	10251	9863	10247
	SOPCOF %	87	81	94	97	86	91	86	93	97

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	816	687	1762	2533	1299	345	814	1577	1218	974
	2	511	1092	1288	2797	3635	2284	932	1195	2105	2248
	3	1233	310	608	729	1448	1455	751	439	703	699
	4	163	311	127	243	244	557	499	240	158	203
	+gp	289	104	235	104	146	181	200	236	161	129
0	TOTALNUM	3012	2504	4020	6406	6772	4822	3196	3687	4345	4253
	TONSLAND	8054	6271	8371	10776	14907	13381	10015	8383	10483	9852
	SOPCOF %	99	113	113	102	108	99	98	101	100	100

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	4323	2792	582	710	1973	1375	223	749	498	318
	2	1793	4734	2163	1075	1408	1243	2907	569	1283	1113
	3	841	702	1886	545	442	664	403	848	180	700
	4	252	263	231	372	127	132	119	68	163	38
	+gp	118	109	123	100	120	91	29	30	13	45
0	TOTALNUM	7327	8600	4985	2802	4070	3505	3681	2264	2137	2214
	TONSLAND	12894	14168	12751	7379	7095	7735	7555	5402	4587	4964
	SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	523	204	70	289	338	196	45	68	42	14
	2	1149	1926	843	176	841	564	439	101	224	141
	3	501	335	871	107	53	405	93	158	62	112
	4	213	80	66	50	13	7	35	21	33	16
	+gp	33	36	28	5	11	5	1	9	6	11
0	TOTALNUM	2418	2581	1877	627	1256	1177	613	357	367	294
	TONSLAND	5859	5318	4784	1274	2252	2695	1285	1072	910	838
	SOPCOF %	100	100	100	100	100	100	100	100	100	101

Table 8.3.2. Cod in VIIa: mean weights at age in the international landings (also used as stock weights).

Table 2 Catch weights at age (kg)

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976	
	AGE										
	0	0	0	0	0	0	0	0	0	0	
	1	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	
	2	1.660	1.660	1.660	1.660	1.660	1.660	1.660	1.660	1.660	
	3	3.330	3.330	3.330	3.330	3.330	3.330	3.330	3.330	3.330	
	4	5.090	5.090	5.090	5.090	5.090	5.090	5.090	5.090	5.090	
	+gp	6.288	6.596	6.488	6.593	6.741	6.499	6.606	6.465	6.783	
0	SOPCOFAC	0.873	0.813	0.941	0.968	0.862	0.911	0.858	0.926	0.971	

Table 2 Catch weights at age (kg)

	YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	0.610	0.610	0.610	0.610	0.610	1.010	0.995	0.679	0.783	0.805
	2	1.660	1.660	1.660	1.660	1.660	1.524	1.842	1.813	2.023	1.825
	3	3.330	3.330	3.330	3.330	3.330	3.488	3.988	3.808	4.244	3.862
	4	5.090	5.090	5.090	5.090	5.090	5.573	5.964	5.865	5.825	5.855
	+gp	6.543	6.813	6.579	6.551	6.627	8.255	8.428	8.295	8.239	8.092
0	SOPCOFAC	0.986	1.129	1.127	1.023	1.076	0.991	0.984	1.013	1.004	1.003

Table 2 Catch weights at age (kg)

	YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	0.713	0.607	0.936	0.842	0.856	0.813	0.847	0.798	0.900	0.980
	2	2.161	1.563	1.846	1.938	1.637	1.964	1.706	1.923	1.840	1.625
	3	3.910	3.756	3.223	3.572	3.542	3.993	3.666	3.608	4.000	3.256
	4	6.410	5.668	5.408	5.277	5.419	5.975	5.675	6.080	5.791	5.298
	+gp	8.731	8.667	7.442	8.092	6.888	7.862	8.624	7.977	8.768	8.002
0	SOPCOFAC	1.000	1.000	0.998	0.997	1.003	1.003	1.001	1.000	1.000	1.000

Table 2 Catch weights at age (kg)

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	AGE										
	0	0	0	0	0	0	0	0	0	0	0
	1	0.846	0.925	0.853	0.851	0.990	0.942	1.205	1.112	0.913	0.828
	2	1.937	1.647	1.624	1.985	1.823	1.836	1.662	2.202	1.938	1.842
	3	3.624	3.729	3.179	3.573	4.149	3.439	3.287	3.634	3.514	3.665
	4	5.291	5.371	5.505	5.138	5.606	5.727	5.425	6.505	5.318	4.708
	+gp	7.733	7.533	8.159	7.434	7.776	9.091	10.301	7.924	7.915	6.811
0	SOPCOFAC	1.000	1.002	1.000	1.001	1.002	0.999	0.995	0.996	0.997	1.006

Table 8.3.3. Cod in VIIa. (a) Proportion of catch by number discarded by sampled UK (NI) fleets, based on limited observer trips. (b) Information from UK (EW) observer trips from 2000-2005.

(a) UK(NI) fleets

			Proportion discarded			
Gear type	No. trips	Period	Age 0	Age 1	Age 2	Age 3
Midwater trawl	n/a	Q2-Q4 1997		0.40	0.00	0.00
Midwater trawl	n/a	Q1-Q3 1998		0.26	0.00	0.00
Midwater trawl	5	Q3-Q4 1999	1.00	0.00	0.00	0.00
Midwater trawl	4	Q1 2000		0.90	0.00	0.00
Single Nephrops	4	Q3-Q4 1999		0.00	0.00	
Single Nephrops	6	Q1-Q3 2000		0.75	0.00	0.00
Twin Nep. Trawl	n/a	Q2-Q4 1997	1.00	0.94	0.01	0.00
Twin Nep. Trawl	n/a	Q1-Q3 1998		0.94	0.08	0.00
Twin Nep. Trawl	1	Q4 1999	1.00	0.29	0.00	
Twin Nep. Trawl	10	Q1–Q4 2000	1.00	0.78	0.00	0.00

(b) UK (E&W) fleets

Gear type	No. trips	Period	Proportion discarded Age 0	Age 1	Age 2	Age 3
Beam trawl	1	Q2 2000		0.99	0.03	0.00
Beam trawl	1	Q1 2002		0.63	0.00	0.00
Beam trawl	2	Q4 2005		0.00	0.00	0.00
Demersal otter trawl	21	Q1&2 2000		0.91	0.05	0.00
Demersal otter trawl	8	Q1,2,4 2001		0.16	0.04	0.00
Demersal otter trawl	4	Q1,3,4 2002		0.32	0.00	0.00
Demersal otter trawl	4	Q1,2,4 2003		0.16	0.01	0.00
Demersal otter trawl	7	Q1-4 2004		0.60	0.02	0.00
Demersal otter trawl	4	Q1,2 2005		0.28	0.02	0.00
Nephrops trawls	8	Q1&2 2001		0.68	0.24	0.00
Nephrops trawls	3	Q3&4 2002		0.38	0.00	0.00
Nephrops trawls	2	Q2 2003		0.00	0.00	0.00
Nephrops trawls	7	Q1-3 2004	1.00	0.69	0.00	0.00
Nephrops trawls	1	Q2 2005		0.00	0.00	0.00
Danish anchor seine	2	Q2 2001		0.00	0.00	0.00

Table 8.3.4. Cod in VIIa. Estimates of numbers discarded in 1996–2005. Data are numbers (‘000 fish) discarded by each fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Tables (b) and (d) represent estimates from limited observer sampling of N.Ireland vessels also included within the self-sampling estimates for N.Ireland trawlers catching Nephrops (Table (a)). Tables (e)-(i) all use observer data.

(a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching Nephrops (single and twin trawl) (approx 40 trips sampled per year).

Age	1996 Q1-4	1997 Q1-4	1998 Q1-4	1999 Q1-4	2000 Q1-4	2001 Q1-4	2002 Q1-4
0	56	3	0	70	32	4	0
1	82	63	14	83	397	31	22

(b) Observer scheme: N.Ireland vessels catching Nephrops (single trawl only).

	1999 Q3-4	2000 Q1-3	2001 Q1
Age	4 trips	6 trips	1 trip
0	0	0	0
1	0	53	0

(c) Observer scheme: N.Ireland midwater trawl.

	1997 Q2-4	1998 Q1-3	1999 Q3-4	2000 Q1	2001 Q1
Age			5 trips	4 trips	2 trips
0	0	0	1.6	0	0
1	17	4	0	0.8	0
2	0.5	2	0	0	0

(d) Observer scheme: N.Ireland twin Nephrops trawl.

	1997 Q2-4	1998 Q1-3	1999 Q4	2000 Q1-4	2001 Q1
Age			1 trip	10 trips	2 trips
0	12	0	12	33	0
1	19	38	1	45	0

2	0.2	13	0	0	0

(e) UK(E&W) Beam trawl.

	2000 Q2	2002 Q1	2005 Q4
Age	**1 trip**	**1 trip**	**2 trips**
0	0	0	0
1	4.34	0.54	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00

(f) UK(E&W) Demersal otter trawl.

	2000 Q1&2	2001 Q1,2,4	2002Q1,3,4	2003 Q1,2,4	2004 Q1-4	2005 Q1,2
Age	**21 trips**	**8 trips**	**4 trips**	**4 trips**	**7 trips**	**4 trips**
0	0	0	0	0	0	0
1	38.91	9.21	3.43	0.60	17.71	1.26
2	0.05	4.46	0.00	0.62	0.81	0.36
3	0.00	0.00	0.00	0.00	0.00	0.00

(g) UK(E&W) Nephrops trawl.

	2001Q1,2	2002 Q3,4	2003 Q2	2004 Q1-3	2005 Q2
AGE	8 TRIPS	3 TRIPS	2 TRIPS	7 TRIPS	1 TRIP
0	0.00	0.00	0.00	0.03	0.00
1	3.09	0.03	0.00	0.24	0.00
2	0.70	0.00	0.00	0.00	0.00

(h) UK (E&W) Danish anchor seine.

	2001 Q2	2002 Q3	2003	2004 Q3	2005
AGE	2 TRIPS	1 TRIP	0	1 TRIP	0
0	0	0		0	
1	0.00	0.00		0.00	
2	0.00	0.00		0.00	
3	0.00	0.00		0.00	

Table 8.3.4. contd. Discards estimates for Irish fleets in VIIa, raised to trip level. Note very low numbers of trips sampled in some years.

Age	1996 Numbers	1996 Weight (kg)	1997 Numbers	1997 Weight (kg)	1998 Numbers	1998 Weight (kg)	1999 Numbers	1999 Weight (kg)	2000 Numbers	2000 Weight (kg)	2001 Numbers	2001 Weight (kg)
0	52	0.038	301	0.009	0	0.009	8	0.084	2320	0.159	58	0.010
1	374	0.217	333	0.127	202	0.127	16	0.184	798	0.237		
2	6	0.443	87	0.543	0	0.543	0		10	0.546		
3												
4												
5												
OTB Discards (tonnes, whole weight)		85.9		92.4		25.7		3.5		564.1		0.6

Sampling Information	1996	1997	1998	1999	2000	2001
Number of Trips	8	8	7	4	10	2
Number of Hauls	48	44	58	40	111	34

Age	2002 Numbers	2002 Weight	2003 Numbers	2003 Weight	2004 Numbers	2004 Weight (kg)	2005 Numbers	2005 Weight (kg)	2006 Numbers	2006 Weight (kg)
0	124	0.072	0	0.000	3213	0.008	8268	0.007	774	0.025
1	176	0.085	0	0.000	2577	0.078	632	0.180	150	0.128
2	0	0.000	0	0.000	598	0.635	0	0.000	0	0.000
3										
4										
5										
OTB Discards (tonnes, whole weight)		24.0		0.0		606.3		175.1		38.6

Sampling Information	2002	2003	2004	2005	2005
Number of Trips	1	9	11	8	5
Number of Hauls	7	60	122	96	56

Table 8.3.5. Numbers of cod discarded during observed trips on UK(NI) Nephrops trawlers in Q3 and Q4 2006 (raised to trip level).

NI observer discard sampling
Raised to trip level

Period:	Q3 & Q4 2006	
Area	7a	
Species	COD	
Fleet	*Nephops*	gear code 13&14
No. trips	9	
No. hauls	39	
Units	Numbers	

Length (cm)	Nos.	Age	Nos.
10	15	0	19
12	0	1	7
14	0	2	0
16	0	3	0
18	0	4	0
20	0	5	0
22	8	6	0
24	0	7	0
26	0		
28	3		
Total	26		26

Table 8.5.1.3.1. Settings for SURBA v3.0 analysis of NIGFS-Mar and ScoGFS-Q1 survey data.

	NIGFS-MAR	SCOGFS-Q1
YEAR RANGE	1993–2007	1996–2006
REFERENCE AGE	2	4
CATCHABILITY AT AGE	Age 1: 0.49; Age 2: 1.0; Age 3: 0.71; Age 4: 0.66	Age 1: 0.05; Age 2: 0.23; Age 3: 0.50; Age 4: 0.95; Age 5: 1.0
AGE WEIGHTING	Age 1: 0.3; Age 2: 1.0; Age 3: 0.6; Age 4: 0.3	Age 1: 0.1; Age 2: 1.0; Age 3: 1.0; Age 4: 1.0; Age 5: 1.0
LAMBDA	1.0	1.0

Table 8.5.1.3.2. Configuration of exploratory and final B-Adapt runs (run 9c = final B-Adapt run with bias estimate for 2006; run 9b = alternative final run with no bias estimated for 2006).

(a) catch bias estimated up to 2006

RUN NO.	SAMPLE-BASED LANDINGS	YEARS FOR BIAS ESTIMATES	TERMINAL F	SURVEYS USED	F-STIFFNESS WEIGHT λ	PLUS GP
1	1991–1999	2000–2006	F4=avg(F2,F3)	all	1	5+
2	1991–1999	2000–2006	F5=avg(F3,F4)	all	1	6+
3	1991–1999	2000–2006	F4=avg(F2,F3)	all	0.1	5+
4	1991–1999	2000–2006	F4=F3	all	1	5+
5	1991–1999	2000–2006	F4=avg(F2,F3)	NIGFSOct 1-2gp removed	1	5+
6	1991–1999	2000–2006	F4=avg(F2,F3)	NIGFS(mar) only	1	5+
6b	1991–1999	2000–2006	F4=avg(F2,F3)	Spring surveys only	1	5+
9c	1991–1999	2000–2006	F4=F3	NIGFSOct 1-2gp removed	1	5+

(b) reported landings in 2006 assumed correct

RUN NO.	SAMPLE-BASED LANDINGS	YEARS FOR BIAS ESTIMATES	TERMINAL F	SURVEYS USED	F-STIFFNESS WEIGHT λ	PLUS GP
8	1991–1999	2000–2005	F4=avg(F2,F3)	all	1	5+
9	1991–1999	2000–2005	F5=avg(F3,F4)	NIGFSOct 1-2gp removed	1	6+
9b	1991–1999	2000–2005	F4 = F3	NIGFSOct 1-2gp removed	1	5+
10	1991–2002	2003–2005	F5=avg(F3,F4)	NIGFSOct 1-2gp removed	1	6+

Table 8.5.1.3.3. B-Adapt model settings for final runs in 2006 and 2007. Changes other than adding another year of data are highlighted.

	2006 FINAL RUN	2007 FINAL RUN
Assessment model	B-ADAPT	B-ADAPT
Fishery data	1968–2005 landings at age including sample based estimates for 1991–1999; Catch-at-age and weight-at-age data 1968–2005	1968–2006 landings at age including sample based estimates for 1991–1999; Catch-at-age and weight-at-age data 1968–2006.
Bias estimates	2000–2005	2000–2006
Plus group	5-plus	5-plus
F on oldest true age *a*	F(4)=(F(4)+F(3))/2	F(4) = F(3)
Tuning Fleet1	E/W BTS (September); 1991–2005; age 0	E/W BTS (September); 1991–2005; age 0
Tuning Fleet 2	NIGFS–Oct; 1992–2005; age 0–2	NIGFS–Oct 1992-2006; **age 0 only**
Tuning Fleet 3	NIGFS-Mar; 1993–2006; age 1–4	NIGFS-Mar; 1993–2007; age 1–4
Tuning Fleet 4	NIMIK net; 1994–2005; age 0	NIMIK net; 1994–2006; age 0
Tuning Fleet 5	ScoGFS-Q1; 1996–2006, age 1–4	ScoGFS-Q1; 1996–2006, age 1–4
Time series weights	Not applied	Not applied
Power model applied to ages	Not applied	Not applied
F-smoothing weight λ	1.0	1.0
Prior weighting of fleets	None	None

Table 8.5.1.4.1. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Lowestoft VPA Program

14/05/2007 22:53

Adapt Analysis

"IRISH SEA COD NSWG 2007 COMBSEX PLUSGROUP"

CPUE data from file COD7TUN2.txt

Catch data for 39 years : 1968 to 2006. Ages 0 to 5+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BTS-Sept	1991	2006	0	0	0.75	0.79
NIGFSOCT(0 gp)	1992	2006	0	0	0.83	0.88
NIGFSMAR(1-4gp)	1993	2007	1	4	0.25	0.35
NIMIKNET	1994	2006	0	0	0.38	0.46
ScoGFS-Q1 Survey (No	1996	2006	1	4	0.25	0.35

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
BTS-Sept	0	3
NIGFSOCT(0 gp)	0	3
NIGFSMAR(1-4gp)	0	3
NIMIKNET	0	3
ScoGFS-Q1 Survey (No	0	3

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 7 years.

Oldest age F estimates in 1968 to 2007 calculated as 1.000 * the mean F of ages 3- 3

Total F penalty applied lambda = 1.000

Individual fleet weighting not applied

INITIAL SSQ = 1686.699
PARAMETERS = 11
OBSERVATIONS = 177

SSQ = 78.42704
QSSQ = 74.44889
CSSQ = 3.97815
IFAIL = 0
IFAILCV = 0

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0	0	0	0	0	0	0	0	0	0
1	0.13	0.14	0.113	0.14	0.238	0.151	0.211	0.164	0.116	0.035
2	1.167	0.951	1.36	1.168	0.731	1.251	1.125	0.793	0.816	0.853
3	1.613	1.533	1.994	1.861	1.585	1.744	1.458	1.508	1.232	2.039
4	1.613	1.533	1.994	1.861	1.585	1.744	1.458	1.508	1.232	2.039

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Population numbers (Thousands)

YEAR	AGE 0	1	2	3	4
1997	2.10E+03	4.74E+03	1.81E+03	6.72E+02	2.85E+02
1998	8.75E+02	1.72E+03	3.41E+03	4.60E+02	1.10E+02
1999	5.64E+03	7.17E+02	1.22E+03	1.08E+03	8.14E+01
2000	3.98E+03	4.62E+03	5.24E+02	2.57E+02	1.20E+02
2001	4.61E+03	3.26E+03	3.29E+03	1.33E+02	3.27E+01
2002	1.20E+03	3.78E+03	2.10E+03	1.30E+03	2.24E+01
2003	1.95E+03	9.80E+02	2.66E+03	4.93E+02	1.85E+02
2004	1.31E+03	1.60E+03	6.49E+02	7.06E+02	9.39E+01
2005	1.60E+03	1.07E+03	1.11E+03	2.40E+02	1.28E+02
2006	1.08E+03	1.31E+03	7.80E+02	4.02E+02	5.74E+01

Estimated population abundance at 1st Jan 2007

0.00E+00	8.84E+02	1.03E+03	2.72E+02	4.28E+01

Taper weighted geometric mean of the VPA populations:

4.71E+03	3.99E+03	2.67E+03	9.78E+02	2.67E+02

Standard error of the weighted Log(VPA populations) :

0.7663	0.7275	0.6744	0.74	0.9629

Log population residuals (unweighted).

Fleet : BTS-Sept

Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997
0	0.07	-0.15	-0.01	0.08	0.54	-0.4	0.65
1	No data for this fleet at this age						
2	No data for this fleet at this age						
3	No data for this fleet at this age						
4	No data for this fleet at this age						

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-1.19	0.33	0.24	-0.36	-0.25	-0.6	0.81	0.95	-0.7	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-4.7403
S.E(Log q)	0.5828

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	0.86	0.754	5.18	0.67	16	0.50813	-4.74

Fleet : NIGFSOCT(0 gp)

Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997
0	99.99	-1.63	-0.12	1.14	0.38	0.39	0.15
1	No data for this fleet at this age						
2	No data for this fleet at this age						
3	No data for this fleet at this age						
4	No data for this fleet at this age						

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-1.41	0.73	0.05	0.05	-0.83	-0.2	0.68	1.09	-0.47	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-1.5844
S.E(Log q)	0.8196

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	0.62	2.013	3.95	0.68	15	0.45913	-1.58

Fleet : NIGFSMAR(1-4gp)
Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997
0	No data for this fleet at this age						
1	99.99	99.99	-0.29	0.92	0.56	1.17	-0.17
2	99.99	99.99	-0.24	-0.45	-0.37	-0.17	0.27
3	99.99	99.99	-0.47	-0.32	-0.64	-0.37	-0.25
4	99.99	99.99	-0.76	-0.45	-1.13	-1.85	-0.55

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	No data for this fleet at this age									
1	-0.31	-0.68	0.01	-0.04	0.27	-0.56	0.02	-0.82	-0.07	99.99
2	0.18	0.21	0.09	-0.17	-0.36	0.82	0.29	0.03	-0.15	99.99
3	-0.05	0.68	0.14	0.05	0.74	0.46	-0.04	-0.17	0.25	99.99
4	-0.18	0.48	0.84	0.32	99.99	0.29	-0.83	0.42	-0.95	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-1.9042	-1.324	-1.5158	-1.5158
S.E(Log q)	0.5735	0.3413	0.4168	0.8509

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	2.866	4.01	0.84	14	0.29104	-1.9
2	1.04	-0.25	1.1	0.79	14	0.36759	-1.32
3	0.88	0.782	2.07	0.79	14	0.37381	-1.52
4	1.03	-0.064	1.78	0.37	13	0.83158	-1.85

Fleet : NIMIKNET

Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997
0	99.99	99.99	99.99	1.5	-0.45	1.2	-0.24
1	No data for this fleet at this age						
2	No data for this fleet at this age						
3	No data for this fleet at this age						
4	No data for this fleet at this age						

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-3.41	0.3	-0.81	-0.51	-0.19	-0.74	1.74	0.73	0.88	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0
Mean Log q	-5.585
S.E(Log q)	1.3388

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	0.65	0.914	6.35	0.38	13	0.87444	-5.58

Fleet : ScoGFS-Q1 Survey (No
Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997
0	No data for this fleet at this age						
1	99.99	99.99	99.99	99.99	99.99	-1.19	0.18
2	99.99	99.99	99.99	99.99	99.99	-0.07	0.06
3	99.99	99.99	99.99	99.99	99.99	-0.01	-0.45
4	99.99	99.99	99.99	99.99	99.99	1.06	0.27

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	No data for this fleet at this age									
1	-0.29	0.92	1.05	0.82	-0.12	0.77	0.26	-1.43	-0.96	99.99
2	0.38	0.63	-0.28	-0.02	-0.55	0.52	0	0.29	-0.96	99.99
3	0.5	1.02	0.28	-1.55	-0.16	0	0.66	-0.16	-0.12	99.99
4	0.24	1.78	1.41	-0.14	0.28	0.28	99.99	0.59	99.99	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log q	-5.4502	-3.7776	-2.8122	-2.8122
S.E(Log q)	0.8827	0.4699	0.667	0.931

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	0.83	0.451	5.81	0.45	11	0.76743	-5.45
2	0.79	1.174	4.51	0.78	11	0.36501	-3.78
3	0.66	2.037	3.99	0.8	11	0.38164	-2.81
4	0.92	0.284	2.35	0.66	9	0.62346	-2.17

Year	Est.Landin	Landings	Bias
2000	2412	1274	1.895
2001	4185	2252	1.861
2002	6638	2695	2.46
2003	4869	1285	3.772
2004	3479	1072	3.233
2005	2317	910	2.54
2006	2433	838	2.92

Parameters

Age	Survivors	s.e log est
0	884.2488	0.36063
1	1033.6235	0.29026
2	272.27154	0.39765
3	42.83078	0.46161

Year	Multiplier	s.e log est
33	1.89458	0.22293
34	1.86117	0.24038
35	2.45992	0.2249
36	3.77156	0.23242
37	3.23256	0.2383
38	2.53967	0.23632
39	2.91967	0.23684

Variance covariance matrix

0.13006	0.01096	0.00878	0.00395	0.00839	0.00956	0.00947	0.00904	0.00867	0.00888	0.00932
0.01096	0.08425	0.01129	0.00491	0.00867	0.00994	0.0099	0.00899	0.00693	0.00424	0.01874
0.00878	0.01129	0.15813	-0.00526	0.00849	0.00978	0.00996	0.0091	0.0055	0.01133	-0.00371
0.00395	0.00491	-0.00526	0.21308	0.00815	0.00947	0.00868	0.00748	0.00471	-0.00558	0.00298
0.00839	0.00867	0.00849	0.00815	0.0497	0.01569	0.00726	0.00712	0.00827	0.00889	0.00901
0.00956	0.00994	0.00978	0.00947	0.01569	0.05778	0.01579	0.00614	0.00727	0.00934	0.0102
0.00947	0.0099	0.00996	0.00868	0.00726	0.01579	0.05058	0.01662	0.00699	0.00725	0.0088
0.00904	0.00899	0.0091	0.00748	0.00712	0.00614	0.01662	0.05402	0.01542	0.00653	0.00632
0.00867	0.00693	0.0055	0.00471	0.00827	0.00727	0.00699	0.01542	0.05679	0.01775	0.00595
0.00888	0.00424	0.01133	-0.00558	0.00889	0.00934	0.00725	0.00653	0.01775	0.05585	0.0155
0.00932	0.01874	-0.00371	0.00298	0.00901	0.0102	0.0088	0.00632	0.00595	0.0155	0.05609

Table 8.5.1.4.2. Cod in VIIa. Estimates of fishing mortality from final B-ADAPT run.

Run title : "IRISH SEA COD NSWG 2007 COMBSEX PLUSGROUP"

At 14/05/2007 22:54

Table 8 Fishing mortality (F) at age

YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE									
0	0	0	0	0	0	0	0	0	0
1	0.1245	0.2008	0.233	0.2782	0.2259	0.2469	0.26	0.2311	0.5602
2	0.6164	1.0472	0.5517	0.6705	0.6247	0.5547	0.7623	0.5744	0.8133
3	1.1369	1.1811	0.7749	0.8767	0.6456	0.8585	0.6196	0.8021	0.7642
4	1.1369	1.1811	0.7749	0.8767	0.6456	0.8585	0.6196	0.8021	0.7642
+gp	1.1369	1.1811	0.7749	0.8767	0.6456	0.8585	0.6196	0.8021	0.7642
0 FBAR 2- 4	0.9634	1.1365	0.7005	0.808	0.6386	0.7572	0.6671	0.7262	0.7806

Table 8 Fishing mortality (F) at age

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.2416	0.1826	0.2179	0.2736	0.2485	0.1439	0.2327	0.3124	0.2312	0.2306
2	0.5331	0.5873	0.6082	0.6328	0.7917	0.9146	0.7052	0.6286	0.8971	0.868
3	0.9863	0.734	0.7804	0.859	0.8135	0.8898	0.9181	0.8856	0.9813	0.8895
4	0.9863	0.734	0.7804	0.859	0.8135	0.8898	0.9181	0.8856	0.9813	0.8895
+gp	0.9863	0.734	0.7804	0.859	0.8135	0.8898	0.9181	0.8856	0.9813	0.8895
0 FBAR 2- 4	0.8352	0.6851	0.723	0.7836	0.8062	0.8981	0.8471	0.7999	0.9532	0.8823

Table 8 Fishing mortality (F) at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.3768	0.5559	0.23	0.2162	0.6272	0.2369	0.1927	0.2192	0.1995	0.1471
2	0.8607	0.9327	1.1921	0.8614	0.8635	1.0973	1.1402	1.0585	0.7104	0.9054
3	0.9951	1.0518	1.3668	1.223	1.1493	1.5234	1.5382	1.4063	1.2894	1.1554
4	0.9951	1.0518	1.3668	1.223	1.1493	1.5234	1.5382	1.4063	1.2894	1.1554
+gp	0.9951	1.0518	1.3668	1.223	1.1493	1.5234	1.5382	1.4063	1.2894	1.1554
0 FBAR 2- 4	0.9503	1.0121	1.3086	1.1025	1.0541	1.3814	1.4055	1.2903	1.0964	1.0721

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	FBAR
AGE											
0	0	0	0	0	0	0	0	0	0	0	0
1	0.1295	0.1402	0.1131	0.1398	0.2384	0.1515	0.2113	0.1641	0.1162	0.0351	0.1051
2	1.1672	0.9509	1.3599	1.1676	0.7314	1.2506	1.1246	0.7933	0.8161	0.8531	0.8208
3	1.6129	1.5328	1.9943	1.8614	1.585	1.7442	1.4579	1.5084	1.2321	2.039	1.5932
4	1.6129	1.5328	1.9943	1.8614	1.585	1.7442	1.4579	1.5084	1.2321	2.039	1.5932
+gp	1.6129	1.5328	1.9943	1.8614	1.585	1.7442	1.4579	1.5084	1.2321	2.039	
0 FBAR 2- 4	1.4643	1.3388	1.7828	1.6301	1.3005	1.5797	1.3468	1.2701	1.0934	1.6437	

Table 8.5.1.4.3. Cod in VIIa. Estimates of stock numbers from final B-ADAPT run.

Run title : "IRISH SEA COD NSWG 2007 COMBSEX PLUSGROUP"

At 14/05/2007 22:54

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975	1976
	AGE									
	0	6512	8506	15131	5239	13883	3107	11055	3533	5103
	1	3424	5332	6964	12388	4289	11366	2544	9051	2893
	2	3710	2475	3571	4516	7680	2802	7270	1606	5881
	3	1600	1640	711	1684	1891	3367	1317	2777	740
	4	727	420	412	268	574	812	1168	580	1020
	+gp	330	467	473	220	269	480	485	722	336
0	TOTAL	16303	18839	27261	24315	28585	21933	23839	18270	15973

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	AGE										
	0	5529	12082	14196	7923	3461	5264	7879	7922	6350	18442
	1	4178	4527	9892	11623	6487	2833	4310	6451	6486	5199
	2	1353	2686	3087	6513	7238	4142	2009	2796	3864	4214
	3	2135	650	1222	1376	2832	2685	1359	813	1221	1290
	4	282	652	255	459	477	1028	903	444	274	375
	+gp	500	218	472	196	286	334	362	437	280	238
0	TOTAL	13977	20815	29126	28089	20780	16287	16822	18863	18475	29758

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
	AGE										
	0	8743	3803	4904	5648	8751	1709	5110	3699	3121	5790
	1	15099	7158	3113	4015	4624	7165	1399	4184	3028	2555
	2	3380	8481	3361	2025	2648	2022	4629	945	2751	2031
	3	1448	1170	2732	835	701	914	553	1212	268	1107
	4	434	438	335	570	201	182	163	97	243	61
	+gp	203	182	178	153	190	125	40	43	19	71
0	TOTAL	29307	21232	14624	13248	17116	12117	11893	10179	9431	11615

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	GMST 68-**	AMST 68-**
	AGE													
	0	2101	875	5643	3980	4611	1196	1952	1308	1597	1080	0	5048	6326
	1	4741	1720	717	4620	3259	3775	980	1598	1071	1308	884	4265	5243
	2	1806	3410	1224	524	3289	2102	2657	649	1110	780	1034	2831	3388
	3	672	460	1079	257	133	1296	493	706	240	402	272	1040	1280
	4	285	110	81	120	33	22	185	94	128	57	43	284	400
	+gp	44	49	34	13	28	16	6	38	23	40	10		
0	TOTAL	9649	6624	8778	9514	11354	8408	6272	4393	4169	3668	2243		

Table 8.5.1.4.4. Cod in VIIa: Summary table from final B-ADAPT run. SSB value for 2007 is calculated from survivors at age in 2007 and mean weights at age from 2004–2006.

Run title : "IRISH SEA COD NSWG 2007 COMBSEX PLUSGROUP"

At 14/05/2007 22:54

Table 16 Summary (without SOP correction)

Year	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1968	6512	19351	13444	8541	0.6353	0.9634
1969	8506	18040	12241	7991	0.6528	1.1365
1970	15131	17709	9785	6426	0.6567	0.7005
1971	5239	23476	11271	9246	0.8203	0.808
1972	13883	26393	15873	9234	0.5818	0.6386
1973	3107	30044	20227	11819	0.5843	0.7572
1974	11055	27155	18121	10251	0.5657	0.6671
1975	3533	25060	17886	9863	0.5514	0.7262
1976	5103	21465	13647	10247	0.7509	0.7806
1977	5529	16614	12673	8054	0.6355	0.8352
1978	12082	14188	8662	6271	0.724	0.6851
1979	14196	19638	10426	8371	0.8029	0.723
1980	7923	26103	12310	10776	0.8754	0.7836
1981	3461	29723	18317	14907	0.8138	0.8062
1982	5264	27025	20249	13381	0.6608	0.8981
1983	7879	21842	15260	10015	0.6563	0.8471
1984	7922	18773	11249	8383	0.7452	0.7999
1985	6350	21980	12055	10483	0.8696	0.9532
1986	18442	20979	12026	9852	0.8192	0.8823
1987	8743	28289	12995	12894	0.9922	0.9503
1988	3803	26056	13492	14168	1.0501	1.0121
1989	4904	21061	14300	12751	0.8917	1.3086
1990	5648	14540	8725	7379	0.8457	1.1025
1991	8751	13177	6531	7095	1.0864	1.0541
1992	1709	15518	7231	7735	1.0696	1.3814
1993	5110	12376	6295	7555	1.2001	1.4055
1994	3699	10460	5995	5402	0.9011	1.2903
1995	3121	10439	4575	4587	1.0026	1.0964
1996	5790	10297	5747	4964	0.8637	1.0721
1997	2101	11793	5614	5859	1.0437	1.4643
1998	875	9882	4809	5318	1.1059	1.3388
1999	5643	6756	4912	4784	0.9739	1.7828
2000	3980	6602	2025	1274	0.6291	1.6301
2001	4611	10181	3237	2252	0.6956	1.3005
2002	1196	12146	6197	2695	0.4349	1.5797
2003	1952	8283	4365	1285	0.2944	1.3468
2004	1308	6686	4022	1072	0.2665	1.2701
2005	1597	4836	2524	910	0.3605	1.0934
2006	1080	4537	2563	838	0.3269	1.6437
2007			**2075**			
Arith. Mean	6070	17166	10048	7562	0.7548	1.0645
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 8.5.6.1. Cod in VIIa. Yield per recruit input data from 2004 WG assessment.

MFYPR version 2a
Run: cod7aypr
"IRISH SEA COD, NSWG 2003, COMBSEX,PLUSGROUP"
Time and date: 21:21 11/05/2004 input F are mean $F_{01\text{-}03}$ unscaled
Fbar age range: 2-4 Catch and stock weights are $\text{mean}_{82\text{-}02}$

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	0.2	0	0	0	0.874	0.192	0.874
2	0.2	0.38	0	0	1.811	0.792	1.811
3	0.2	1	0	0	3.662	1.326	3.662
4	0.2	1	0	0	5.629	0.965	5.629
5	0.2	1	0	0	7.490	0.939	7.490
6	0.2	1	0	0	8.981	0.921	8.981
7	0.2	1	0	0	10.817	0.973	10.817

Weights in kilograms

Table 8.5.6.2. Cod in VIIa. Results of yield per recruit analysis carried out by 2004 WG.

MFYPR version 2a
Run: cod7aypr
Time and date: 21:21 11/05/2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	32.5432	4.0090	30.7501	4.0090	30.7501
0.1000	0.1028	0.2822	1.5797	4.1125	19.1807	2.6145	17.4051	2.6145	17.4051
0.2000	0.2055	0.4247	2.0229	3.4070	13.0133	1.9185	11.2548	1.9185	11.2548
0.3000	0.3083	0.5104	2.1156	2.9848	9.6369	1.5055	7.8952	1.5055	7.8952
0.4000	0.4111	0.5677	2.0872	2.7047	7.5890	1.2345	5.8637	1.2345	5.8637
0.5000	0.5138	0.6088	2.0181	2.5054	6.2555	1.0442	4.5464	1.0442	4.5464
0.6000	0.6166	0.6397	1.9388	2.3564	5.3395	0.9039	3.6463	0.9039	3.6463
0.7000	0.7194	0.6640	1.8612	2.2404	4.6826	0.7965	3.0050	0.7965	3.0050
0.8000	0.8221	0.6836	1.7894	2.1473	4.1945	0.7118	2.5321	0.7118	2.5321
0.9000	0.9249	0.6999	1.7247	2.0706	3.8206	0.6434	2.1732	0.6434	2.1732
1.0000	1.0277	0.7136	1.6669	2.0061	3.5265	0.5870	1.8938	0.5870	1.8938
1.1000	1.1304	0.7255	1.6153	1.9508	3.2898	0.5397	1.6715	0.5397	1.6715
1.2000	1.2332	0.7359	1.5692	1.9027	3.0955	0.4994	1.4913	0.4994	1.4913
1.3000	1.3360	0.7451	1.5280	1.8604	2.9331	0.4647	1.3427	0.4647	1.3427
1.4000	1.4387	0.7533	1.4909	1.8227	2.7952	0.4345	1.2185	0.4345	1.2185
1.5000	1.5415	0.7608	1.4575	1.7887	2.6765	0.4080	1.1131	0.4080	1.1131
1.6000	1.6443	0.7675	1.4271	1.7580	2.5732	0.3844	1.0229	0.3844	1.0229
1.7000	1.7470	0.7737	1.3995	1.7298	2.4822	0.3634	0.9448	0.3634	0.9448
1.8000	1.8498	0.7795	1.3743	1.7040	2.4014	0.3445	0.8766	0.3445	0.8766
1.9000	1.9526	0.7848	1.3512	1.6801	2.3290	0.3274	0.8166	0.3274	0.8166
2.0000	2.0553	0.7897	1.3299	1.6579	2.2637	0.3119	0.7634	0.3119	0.7634

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	1.0277
FMax	0.3112	0.3198
F0.1	0.1786	0.1835
F35%SPR	0.2116	0.2175

Weights in kilograms

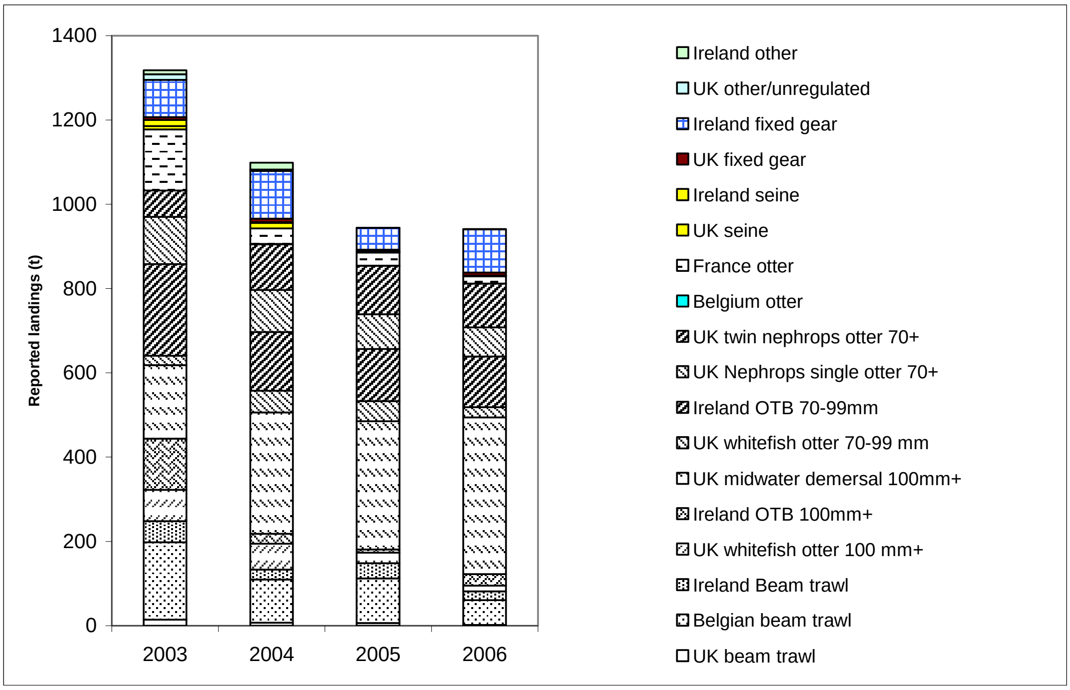


Fig. 8.1.1. Cod in VIIa. Official landings by fleet and mesh band, 2003–2006.

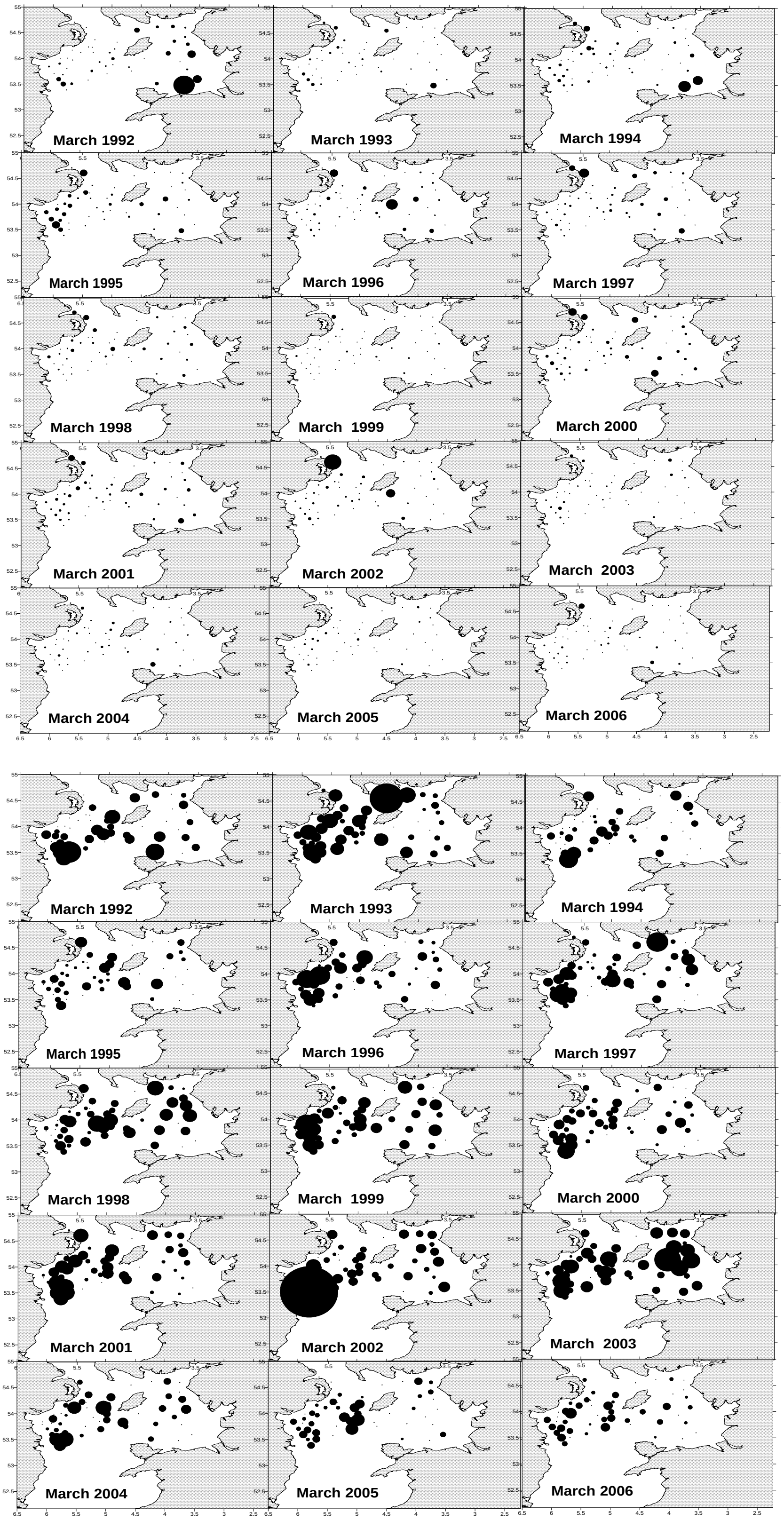


Figure 8.2.1. Cod in VIIa: NIGFS (March) survey distribution of cod. Areas of circles proportional to catch rate in kg per 3 mile tow. Top: cod < 35cm. Bottom: cod 35cm and over. Note: scale on top plot expanded by factor of 2.5.

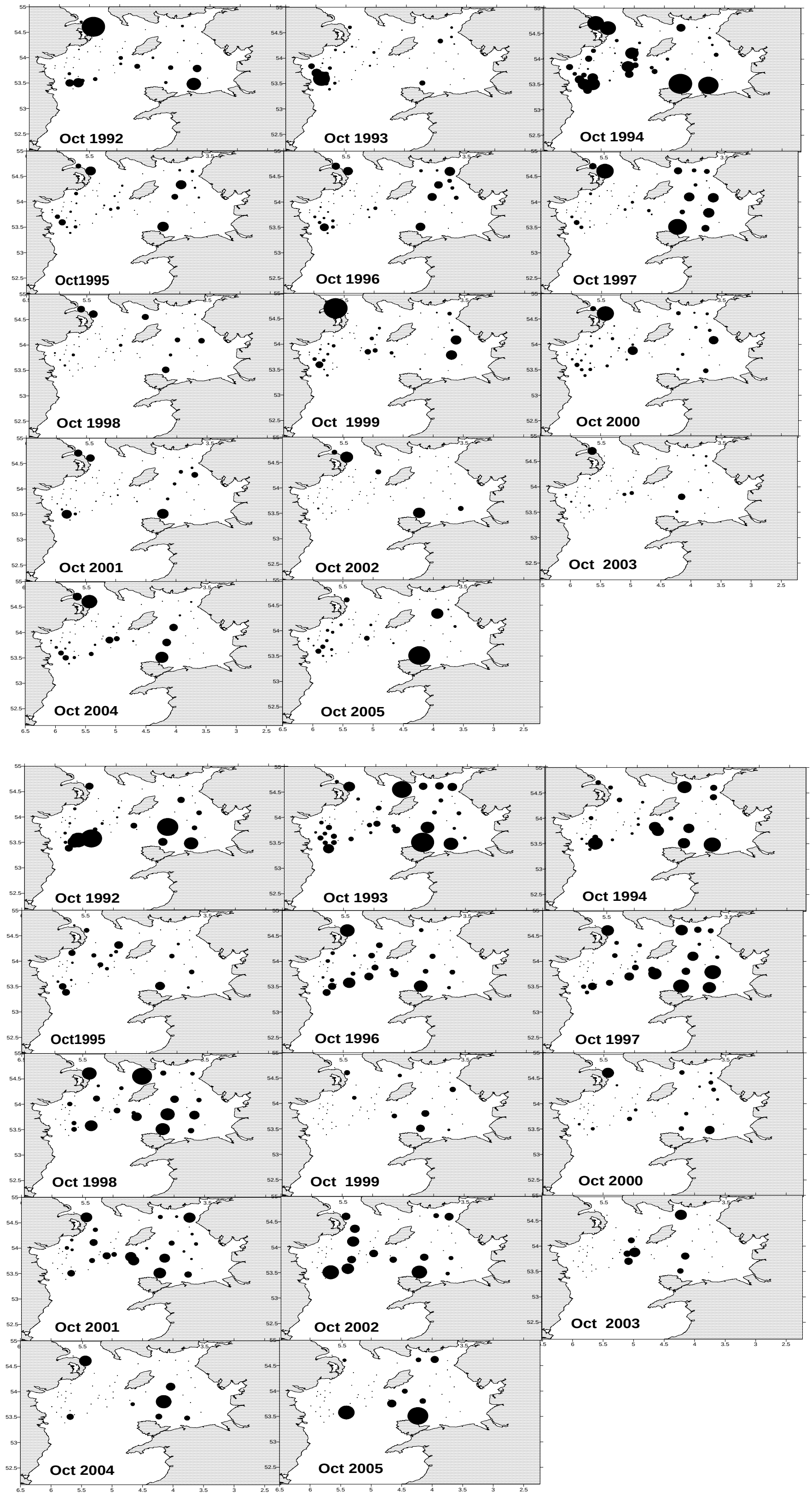


Figure 8.2.2. Cod in VIIa: NIGFS (Oct) survey distribution of cod. Areas of circles proportional to catch rate in kg per 3 mile tow. Top: cod < 35cm. Bottom: cod 35cm and over. Catch-rate scales same as for March survey in previous figure.

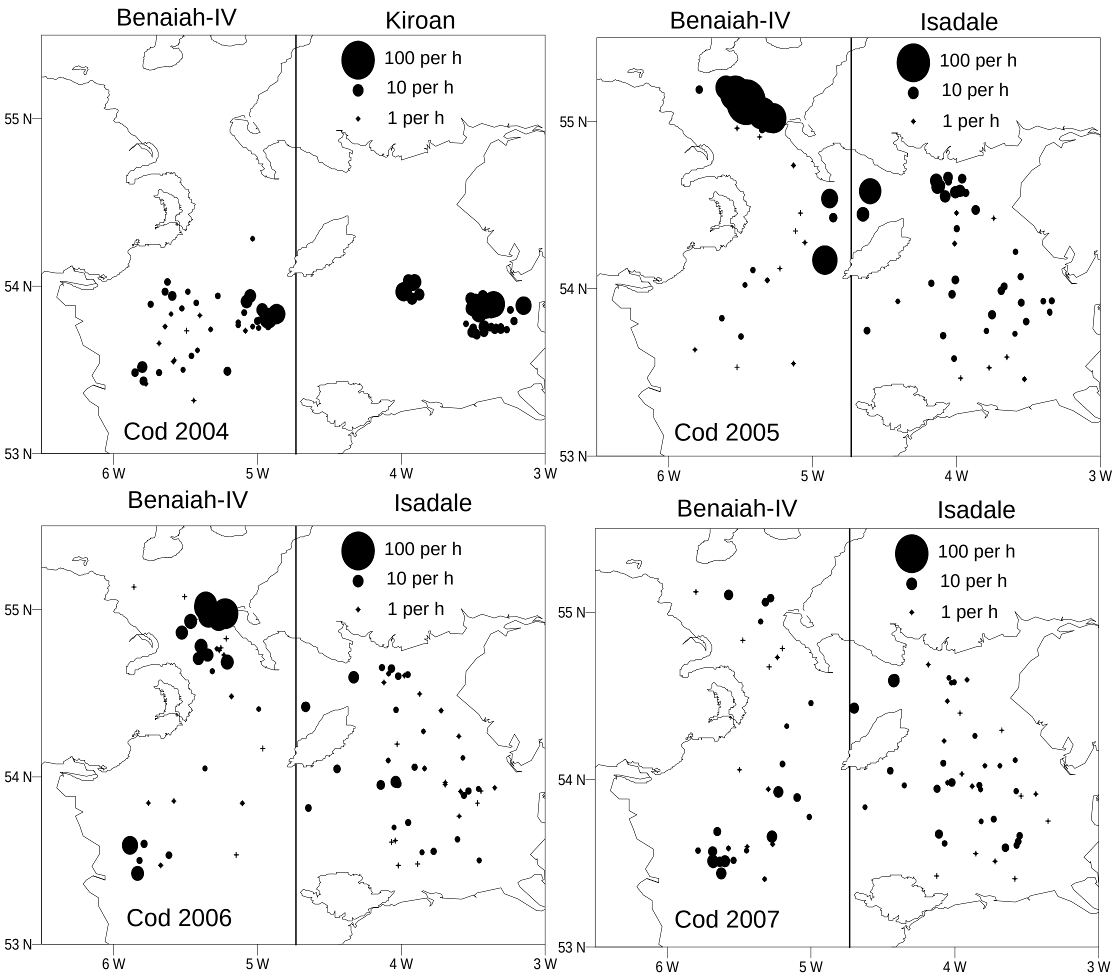


Figure 8.2.3. Cod in VIIa: Catch rates in UK Fisheries Science Partnership surveys using chartered commercial trawlers in spring 2004–2007. Tows to west of vertical line were carried out by a mid-water trawler; tows to the east by an otter trawler. Areas of spots are proportional to catch rate in <u>numbers</u> of fish per hour towed. Trawling in 2004 was exploratory; a more formal survey design was applied from 2005.

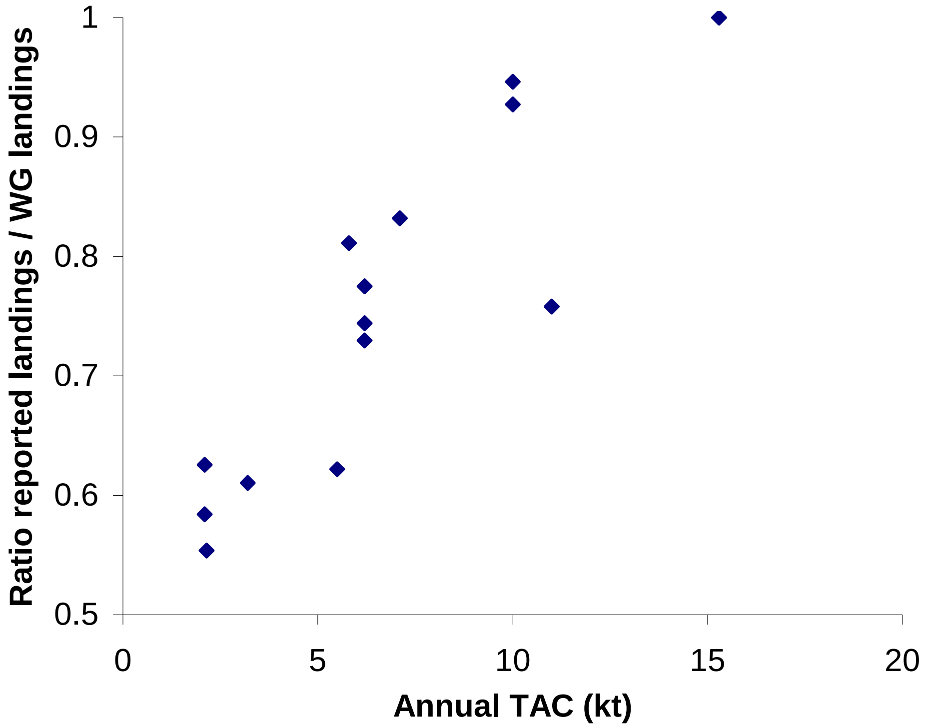


Figure 8.3.1. Cod in VIIa: ratio of reported international landings figures to Working Group landings estimates (including sample-based estimates for three ports) in relation to the annual TAC during 1990–2005 (2003&2004 data excluded due to absence of sample-based estimates).

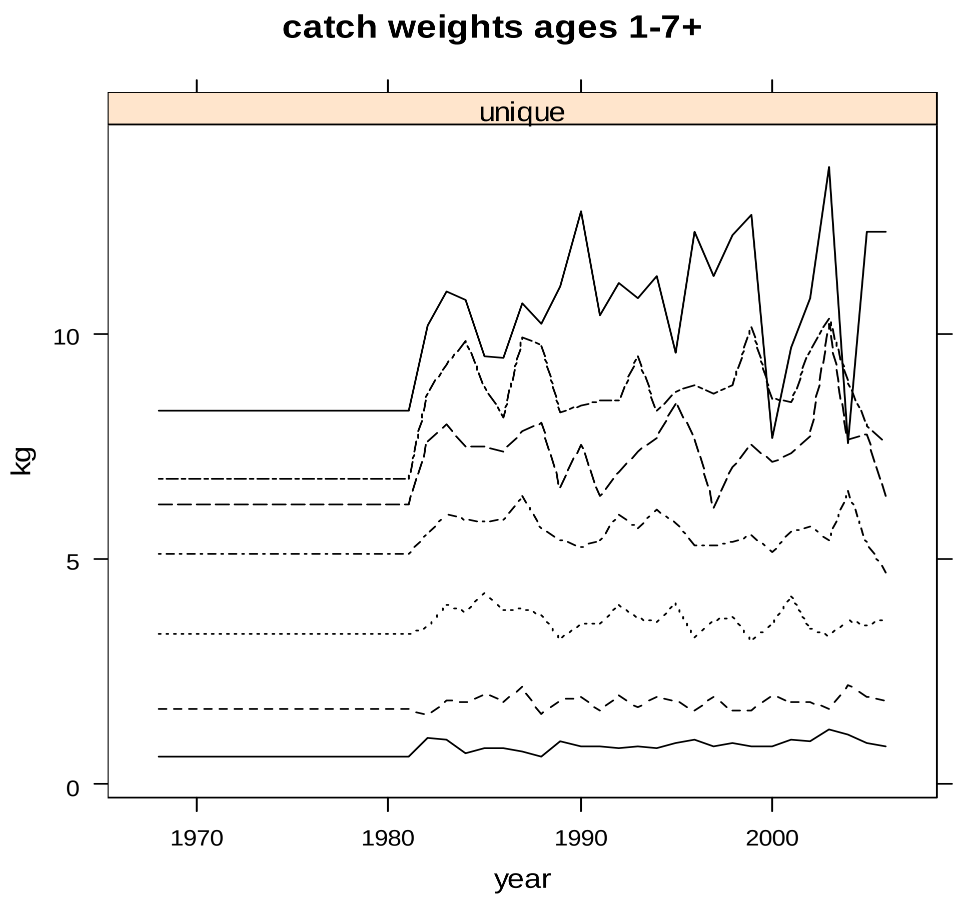
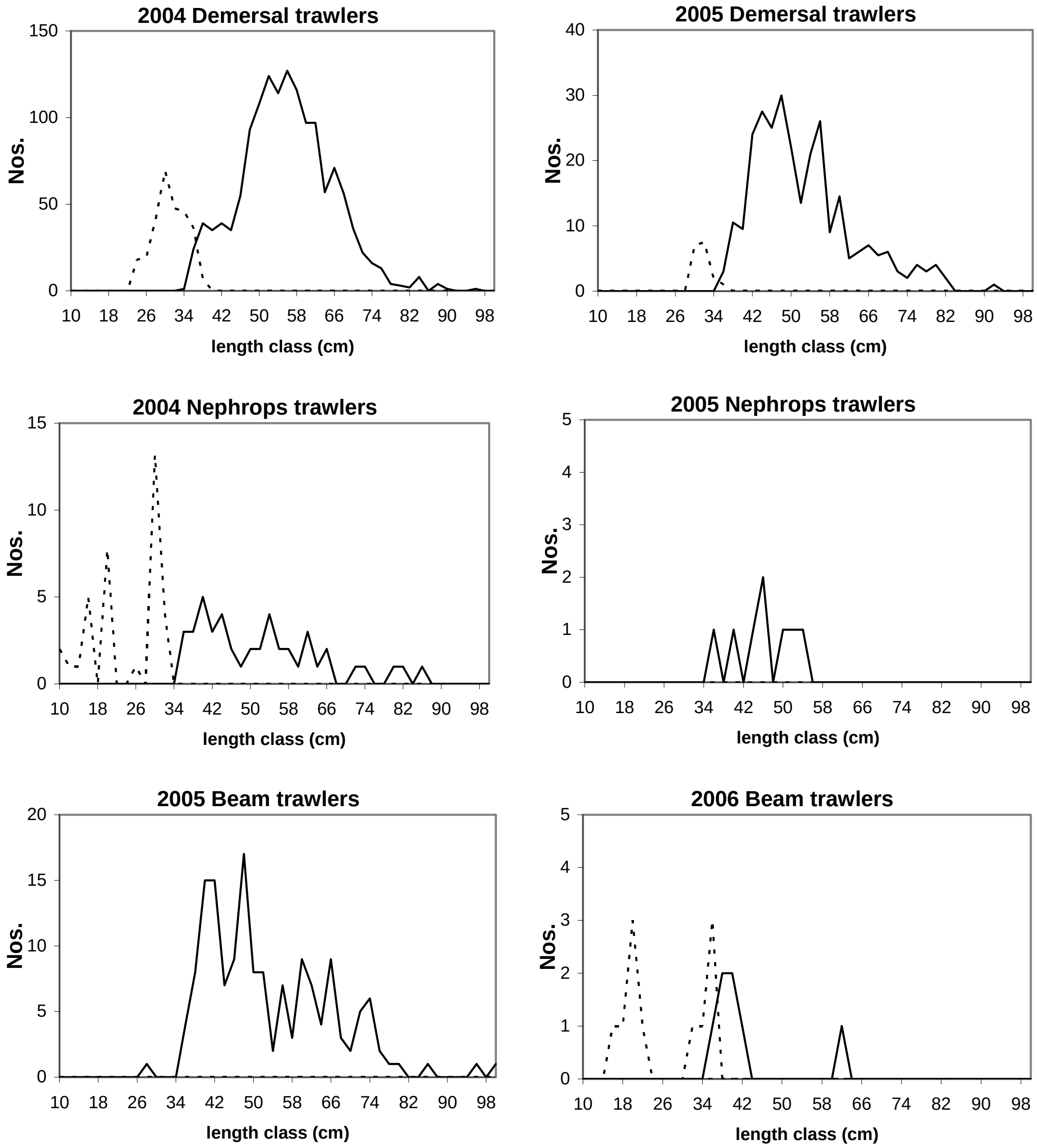


Figure 8.3.2. Cod in VIIa. Mean weight at age in the catch and stock.



	Demersal	Nephrops	Beam
2004	7	7	0
2005	4	2	2
2006	3	1	1

Figure 8.3.3. Length frequencies of discarded cod (dotted lines) and retained cod (solid lines) from observer trips on UK (E&W) vessels in 2004–2006. Total numbers are given for sampled hauls, not raised to fleet level. Nos. of trips sampled are given in the attached table.

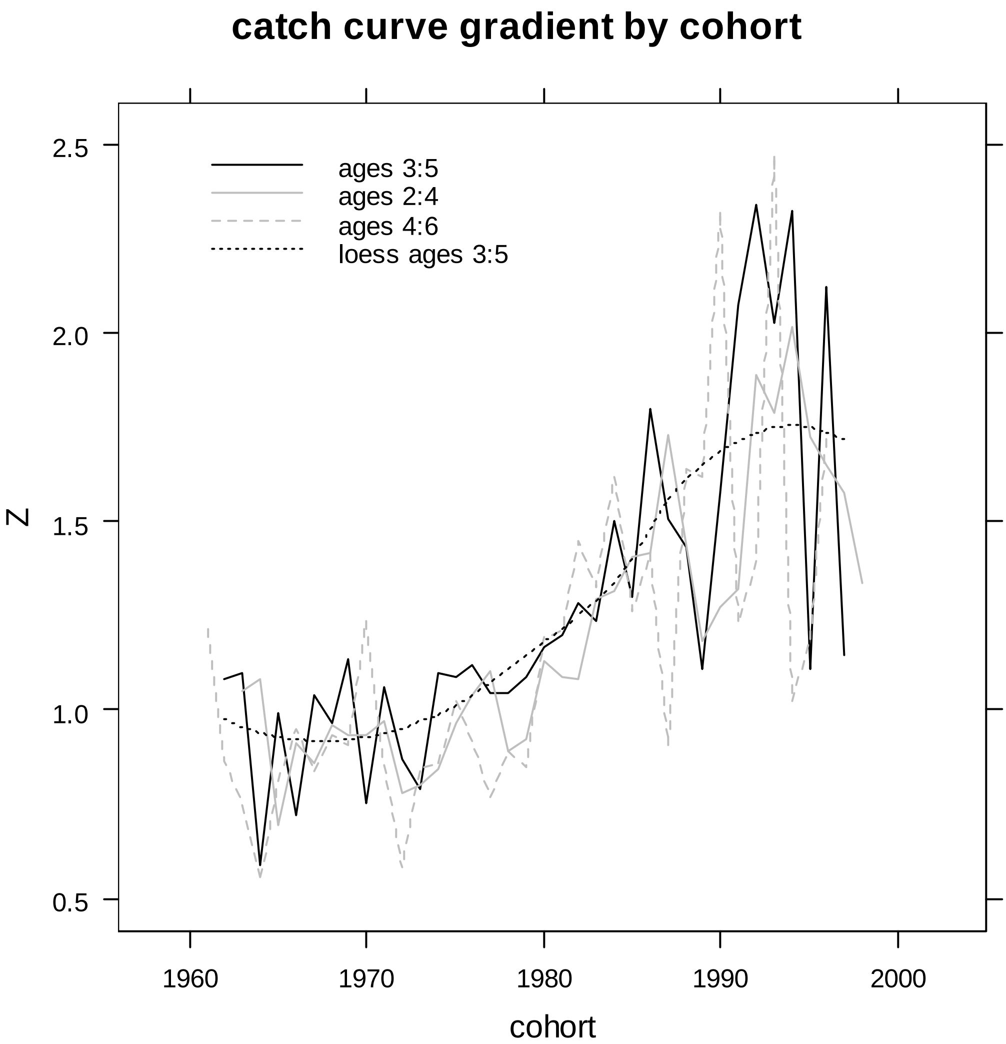


Fig. 8.5.1.1. Cod in VIIa: Z estimates calculated from the gradient of catch curves using total international fishery landings, over a range of age classes, together with a loess smoother fitted to the data for ages 3–5.

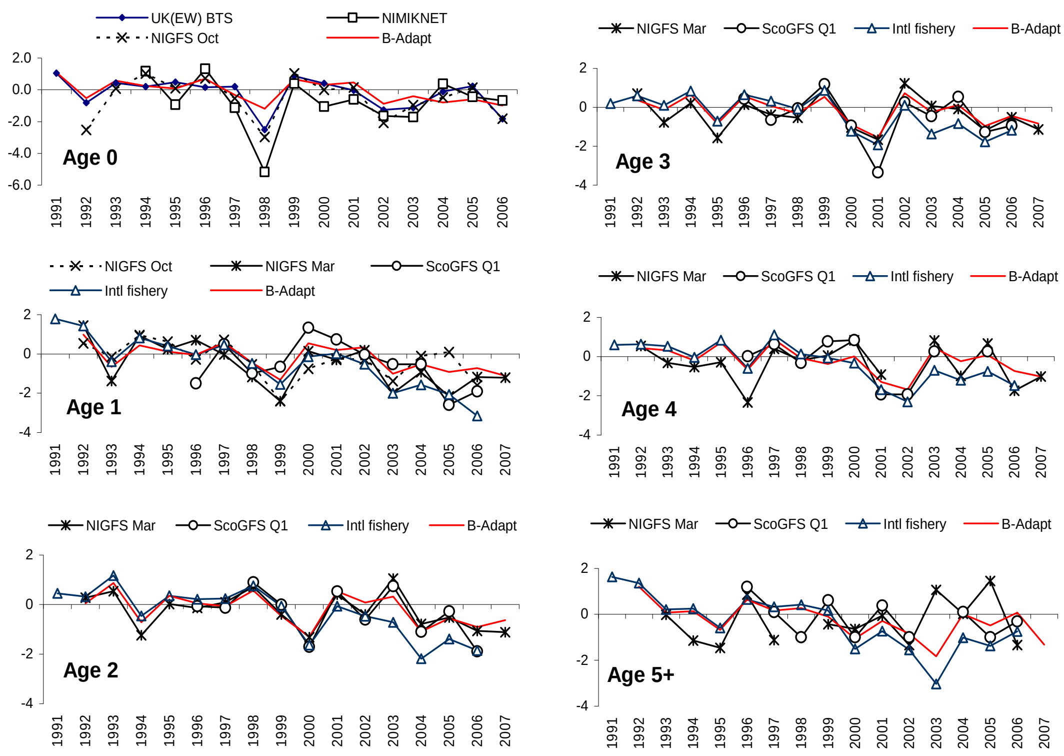


Figure 8.5.1.2.1. Cod in VIIa. Plots of log survey indices at age vs year of survey (standardised by dividing by the series means for years from 1992–1999). The international landings at age (Table 8.3.1) and the population estimates from the final B-Adapt run are also shown for comparison of year-class signals.

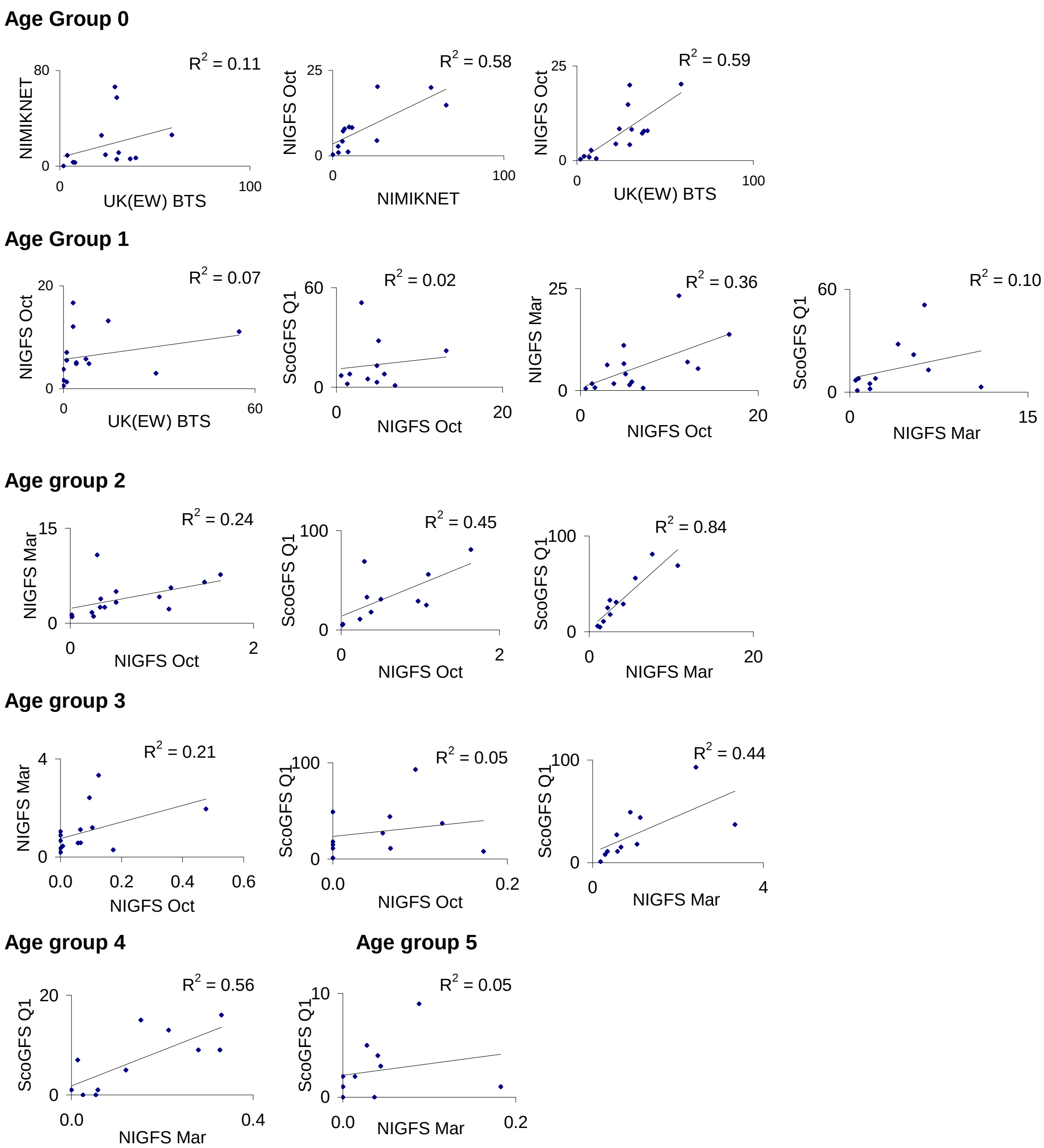


Figure 8.5.1.2.2. Cod in VIIa. Correlation between survey series, by age class.

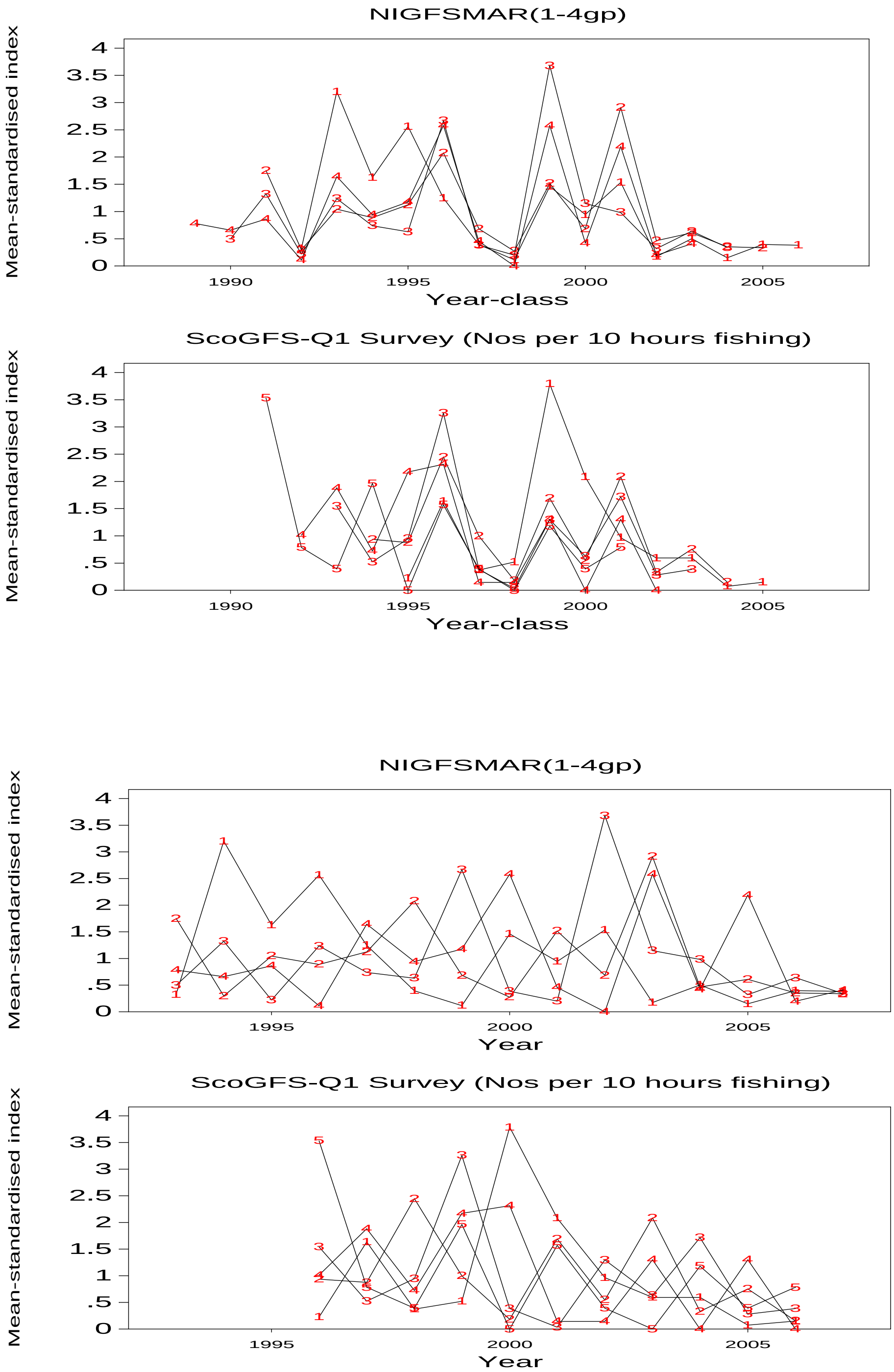
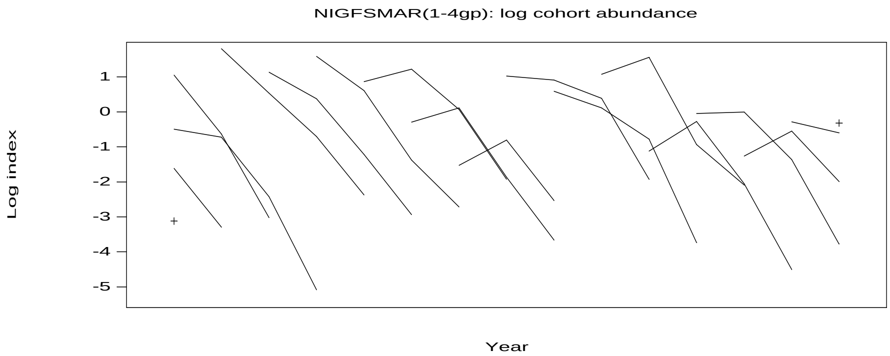


Figure 8.5.1.2.3. Cod in VIIa. Mean-standardised NIGFS-Mar and ScoGFS Q1 trawl surveys indices by year class and year, for ages 1–4 in NIGFS and 1-5 in ScoGFS.



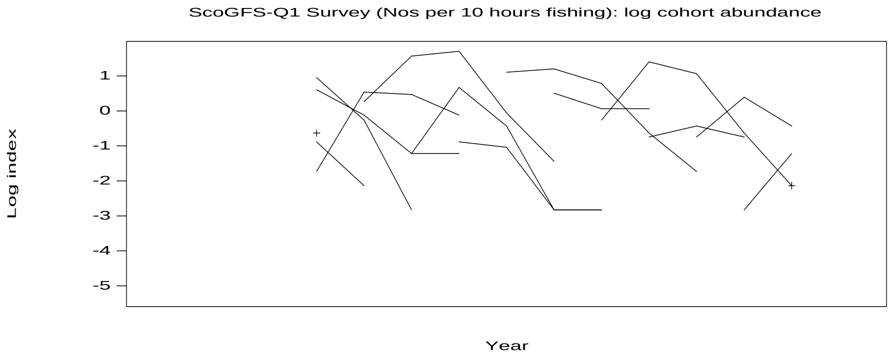
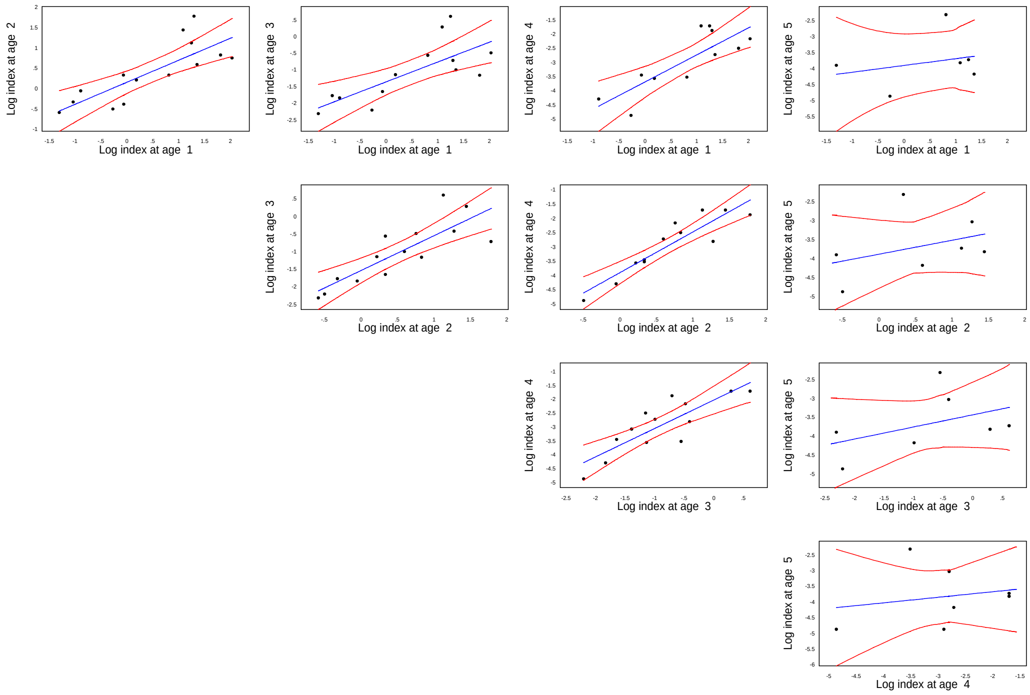


Figure 8.5.1.2.4. Cod in VIIa. Year class curves for NIGFS-Mar (ages 1–4) and ScoGFS Q1 (ages 1–5) trawl surveys.

NIGFSMAR(1-5gp): Comparative scatterplots at age



ScoGFS-Q1 Survey (Nos per 10 hours fishing): Comparative scatterplots at age

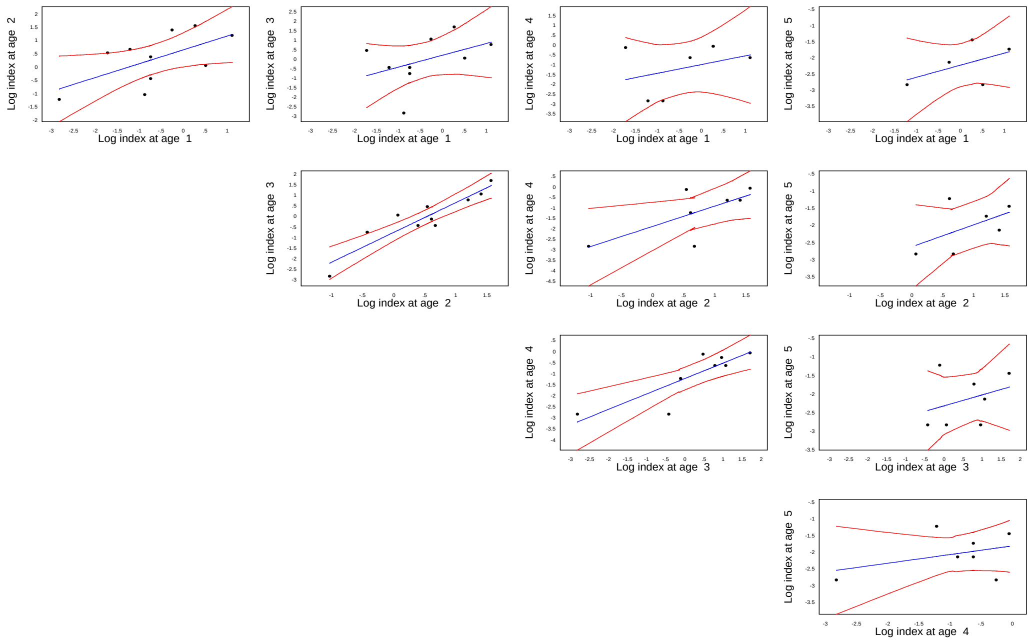
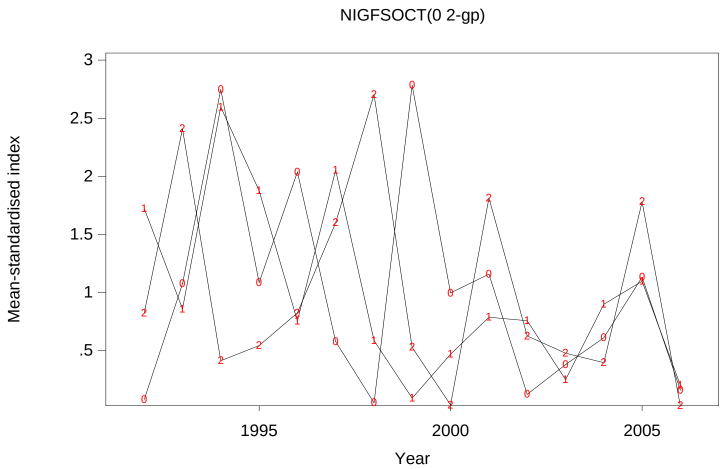
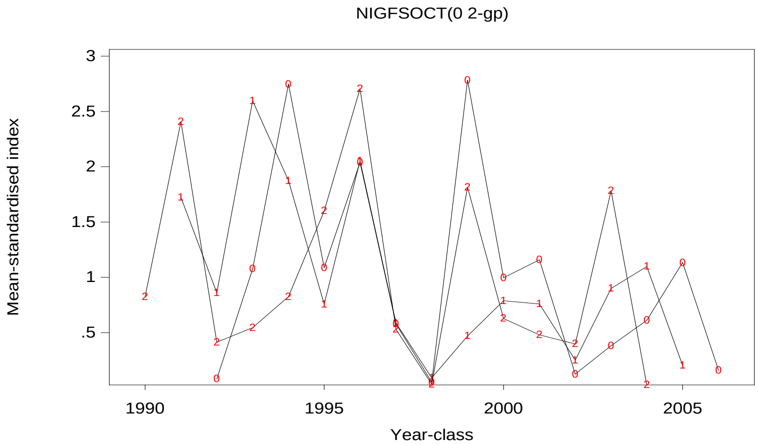


Figure 8.5.1.2.5. Cod in VIIa. Scatterplots and fitted regressions (plus 95% confidence limits) for adjacent ages within year classes, for NIGFS-Mar and ScoGFS Q1 surveys at ages 1–5.





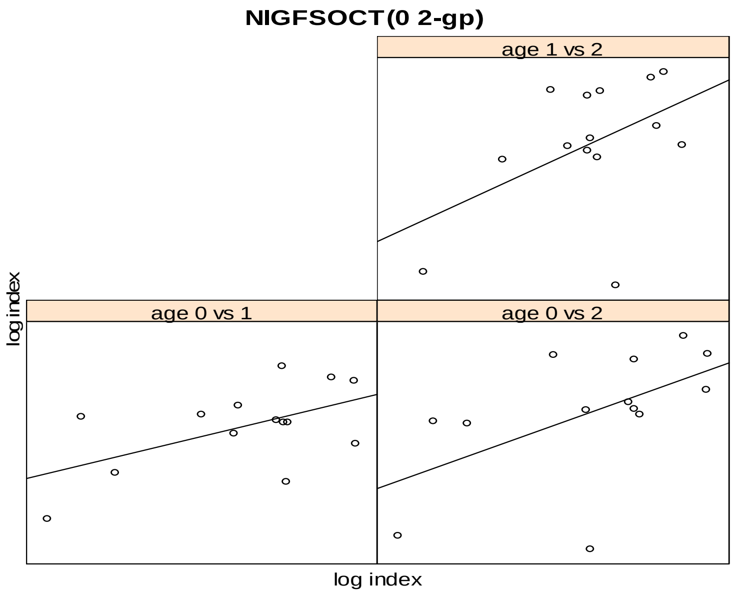


Figure 8.5.1.2.6. Cod in VIIa. Time series data and scatterplots with fitted regressions, for NIGFS-Oct survey at ages 0–2.

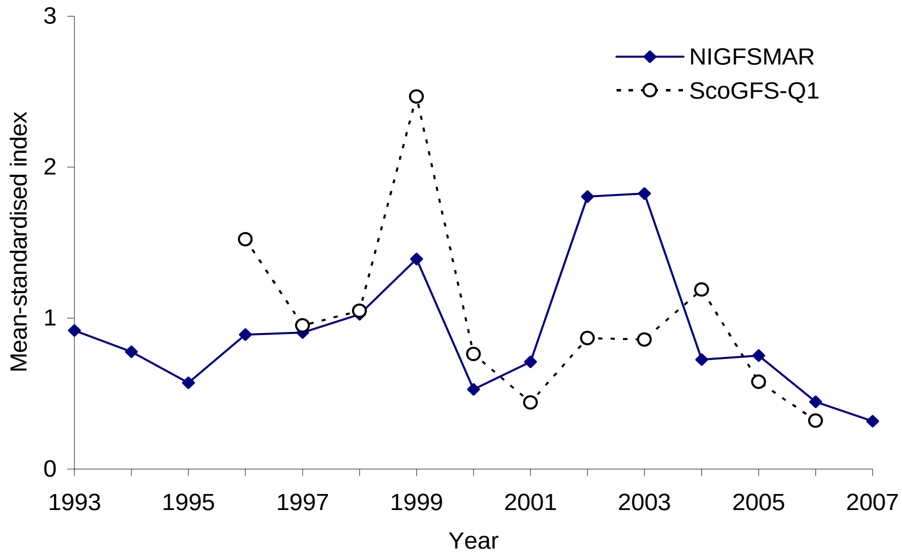


Figure 8.5.1.2.7. Cod in VIIa. Mean-standardised empirical SSB indices for NIGFS-Mar and ScoGFS-spring surveys, based on raw survey indices up to age 7, and stock weights as given in Table 8.3.2.

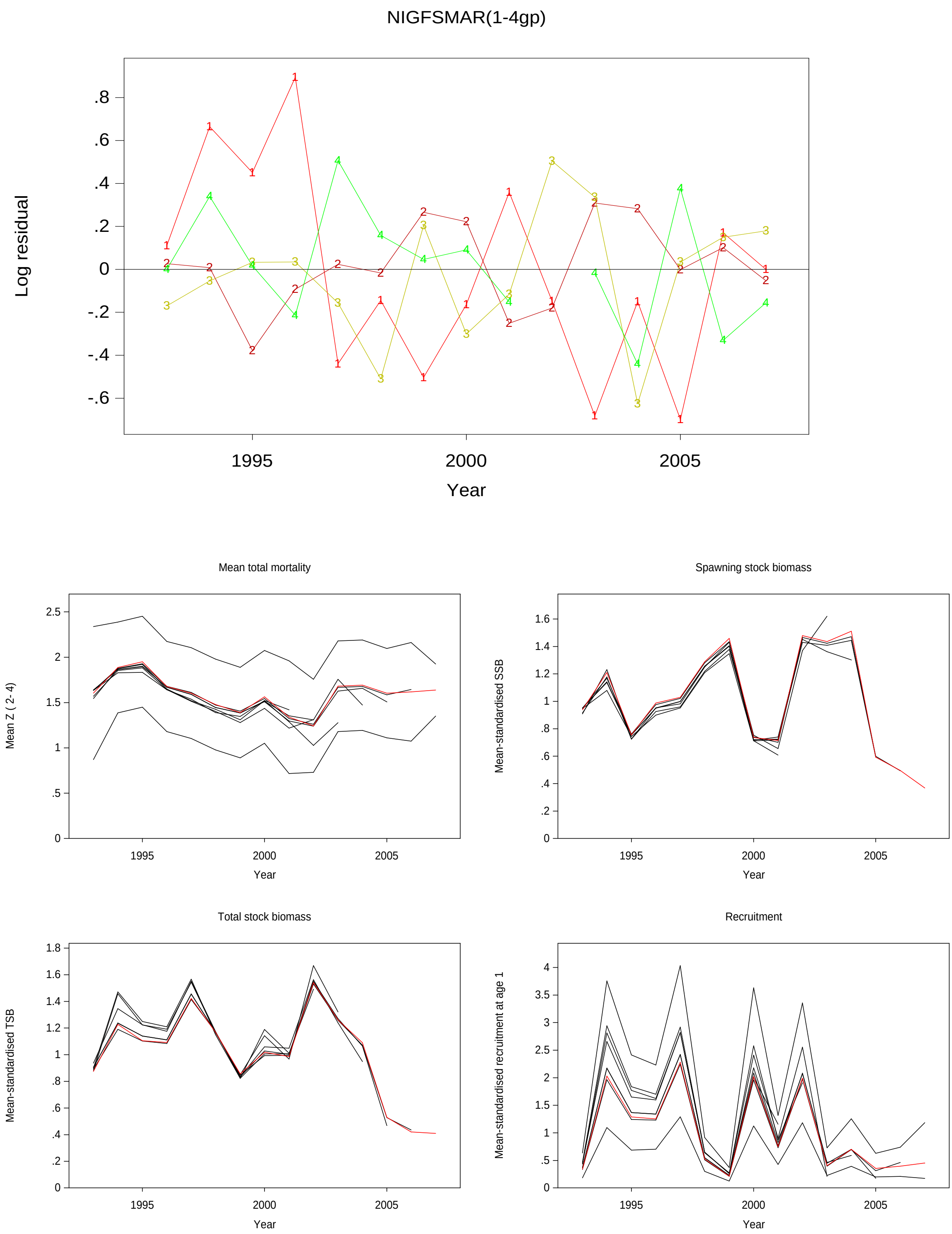
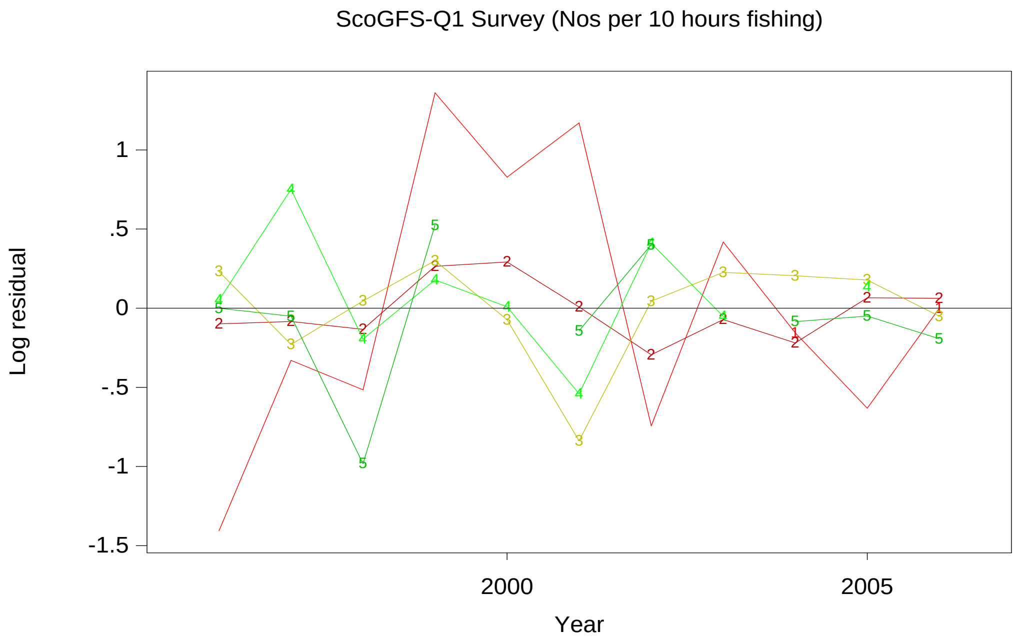


Figure 8.5.1.3.1. Cod in VIIa. Surba v3.0 plots for NIGFS-Mar trawl survey, age groups 1–4. Top: residual plots. Bottom: retrospective plots.



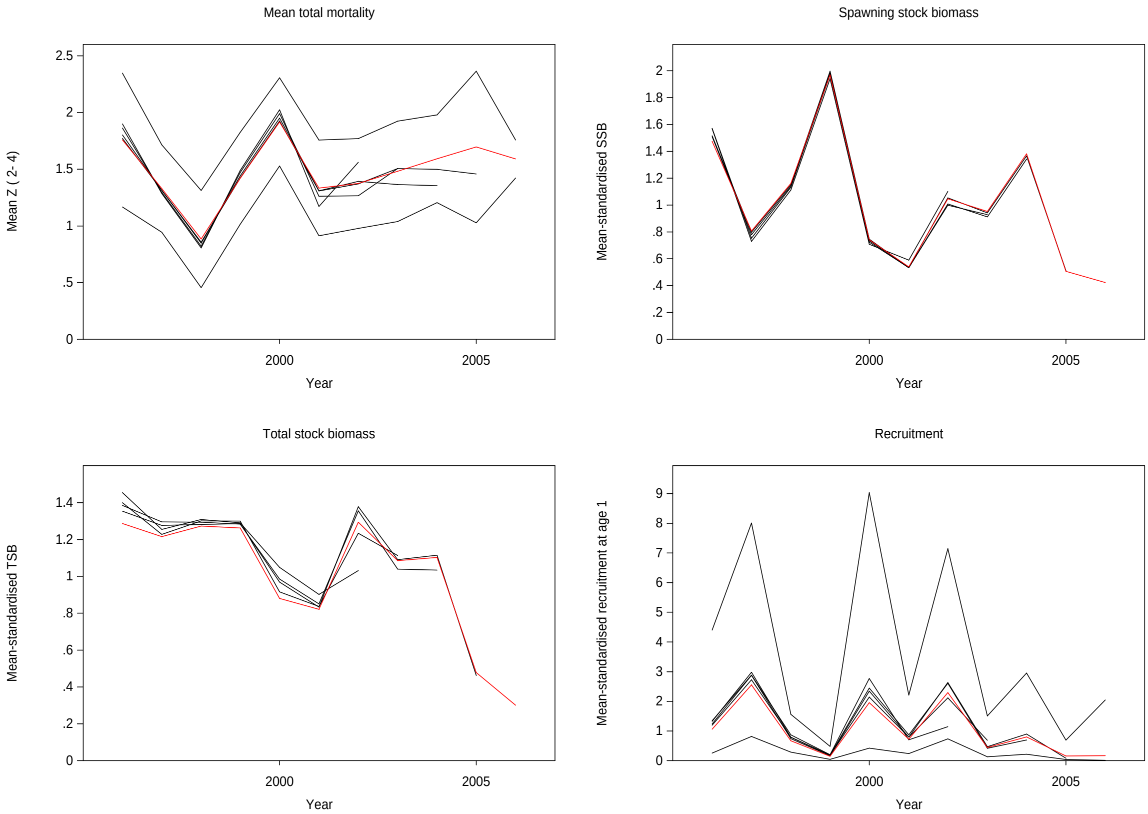


Figure 8.5.1.3.2. Cod in VIIa. Surba v3.0 plots for ScoGFS-Q1trawl survey, age groups 1–5. Residuals and retrospective plots.

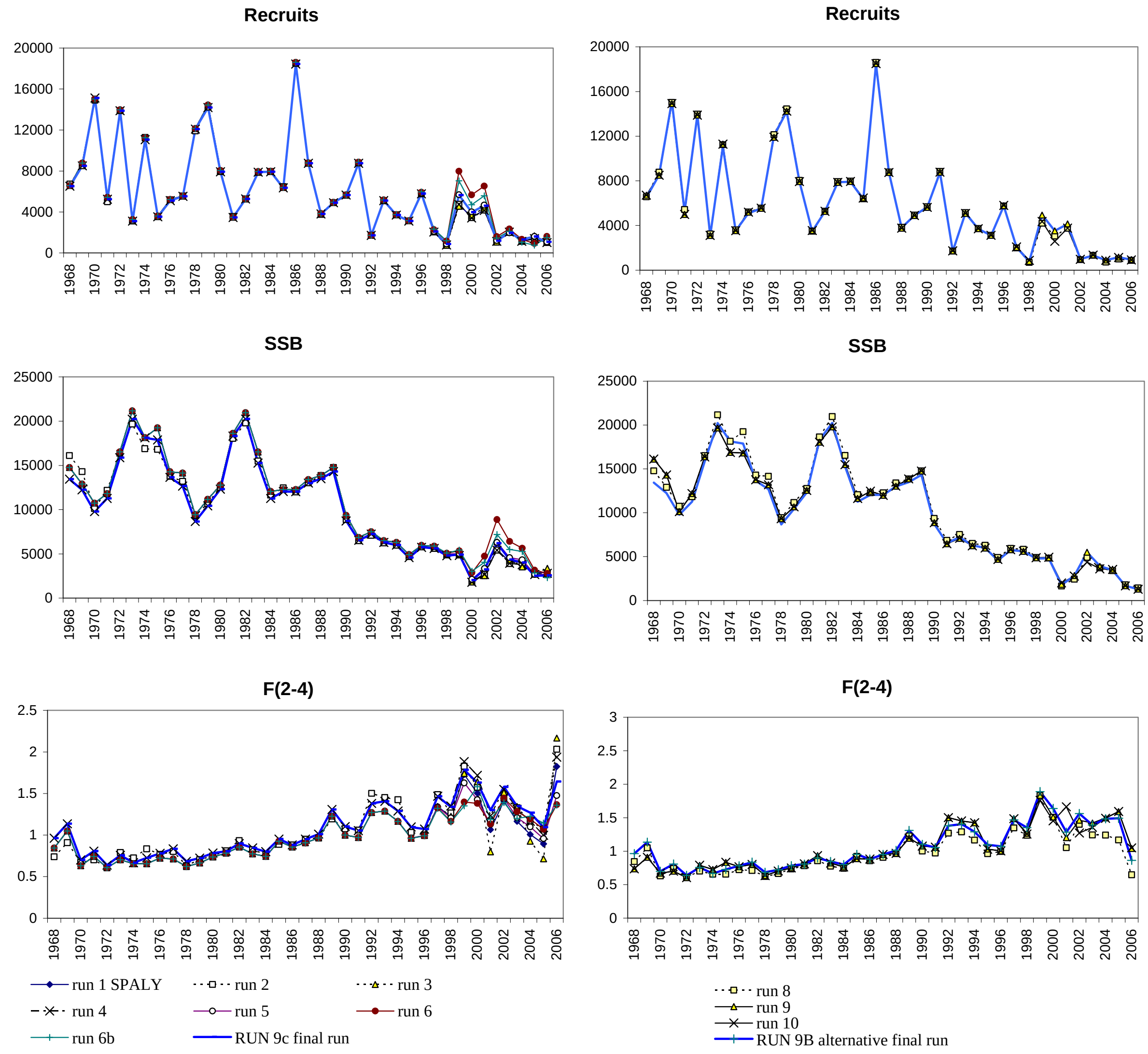
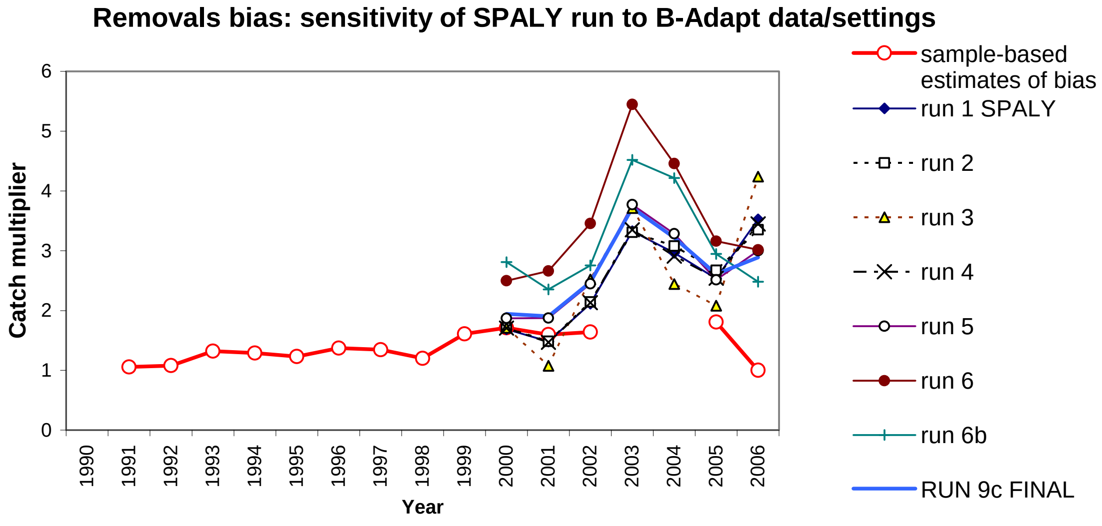


Fig 8.5.1.3.3. Cod in VIIa: trends in recruits, F (2–4) and SSB for a range of B-Adapt model settings as listed in Table 8.5.1.3.2. Left-hand plots are for B-Adapt run with bias estimated from 2000–2006. Right-hand plots are for runs assuming 2006 catch is accurate (no bias estimated).



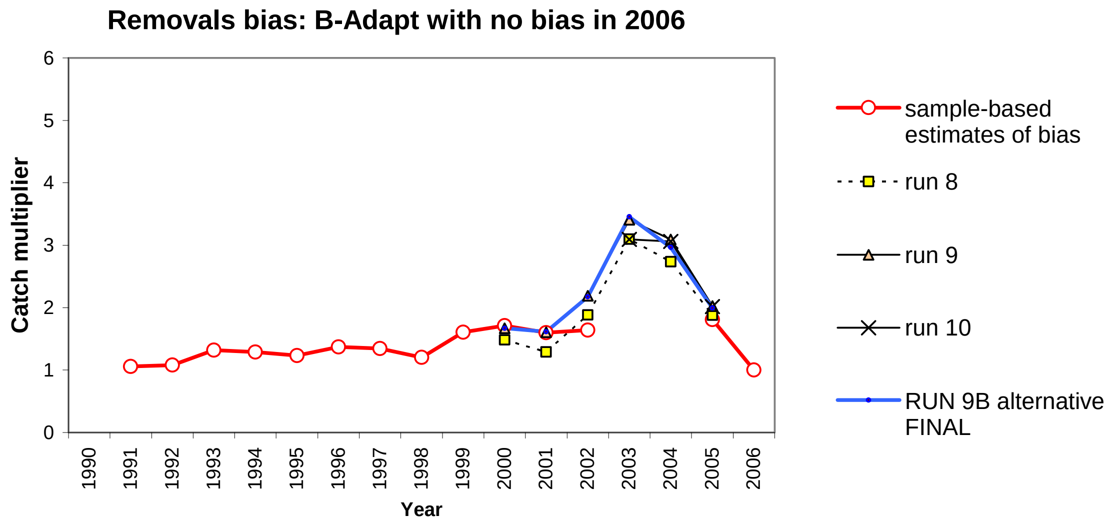


Figure 8.5.1.3.4. VIIa cod: removals bias from 1991 to 2006. Sample based estimates for 1991–2002 and 2005 landings are given together with B-Adapt estimates of bias for 2000–2006 (upper figure) and 2000–2005 (lower figure). Run 10 incorporates sample-based estimates up to 2002, and estimate the bias for 2003–2005. Sample based ratio of 1.0 for 2006 is inferred from limited sampling.

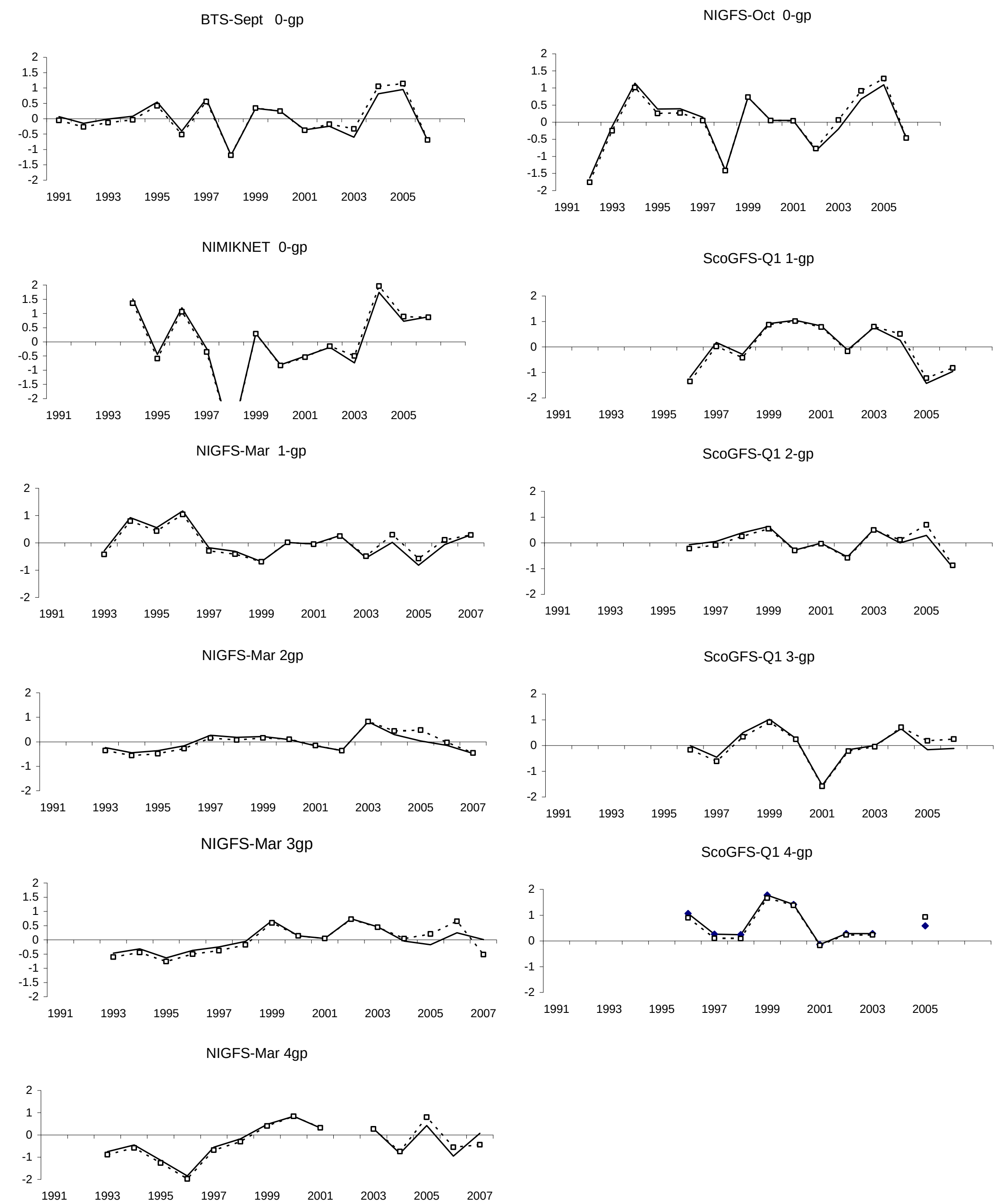


Fig. 8.5.1.3.5. Cod in VIIa: Catchability residuals from final B-Adapt runs. Solid line: removals bias estimated for 2006; dotted line: no bias estimated for 2006.

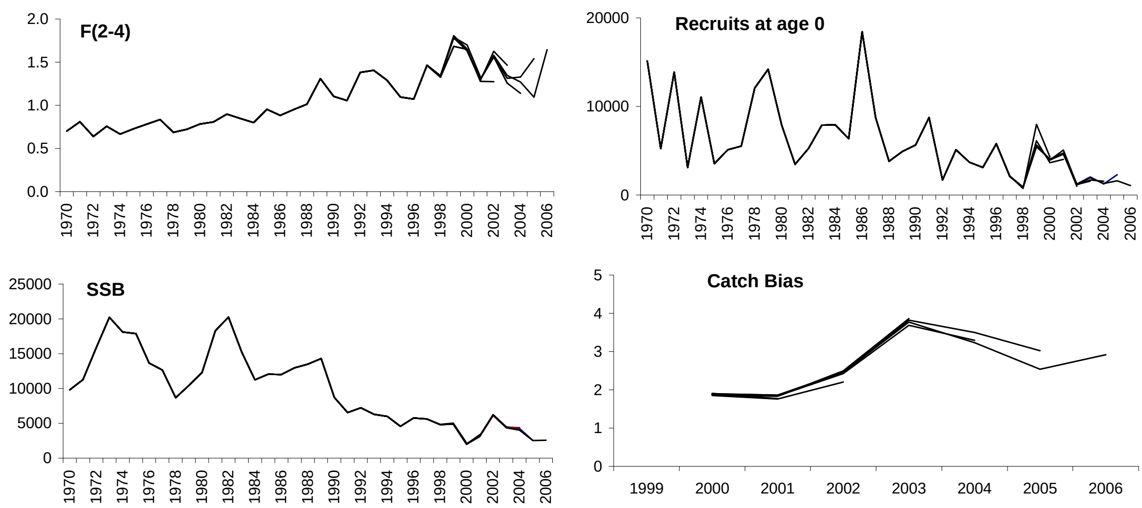


Fig 8.5.1.3.6. Cod in VIIa: Retrospective estimates of stock trends and catch bias from final B-Adapt assessment.

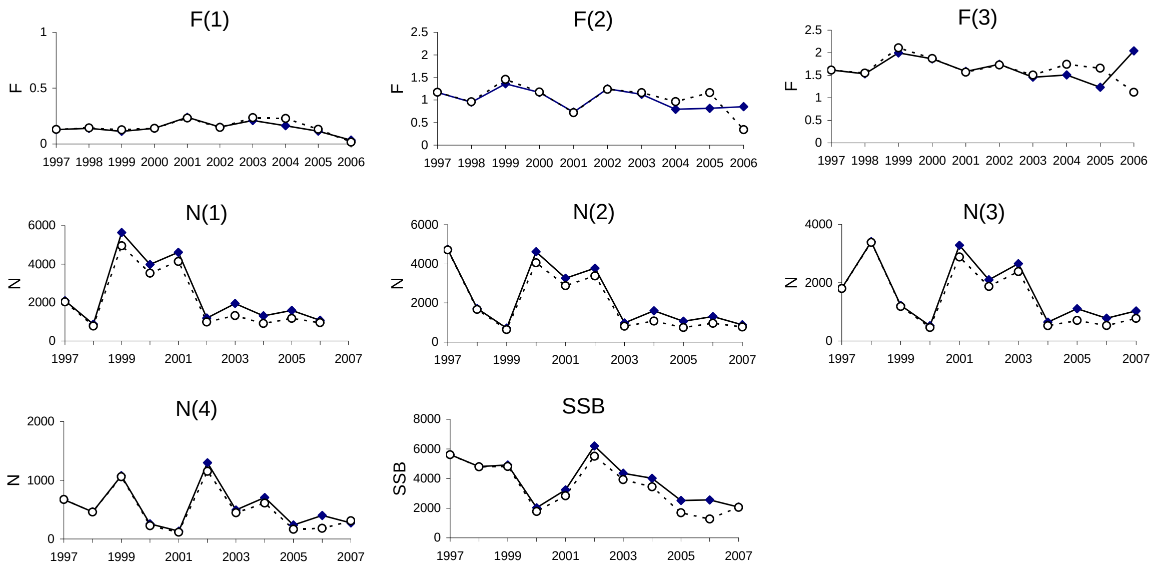


Fig. 8.5.1.3.7. Cod in VIIa: Trends in estimates of F at ages 1–3, stock numbers at ages 1–4, and SSB, for final B-Adapt runs. Solid line: removals bias estimated for 2006; dotted line: no bias estimated for 2006.

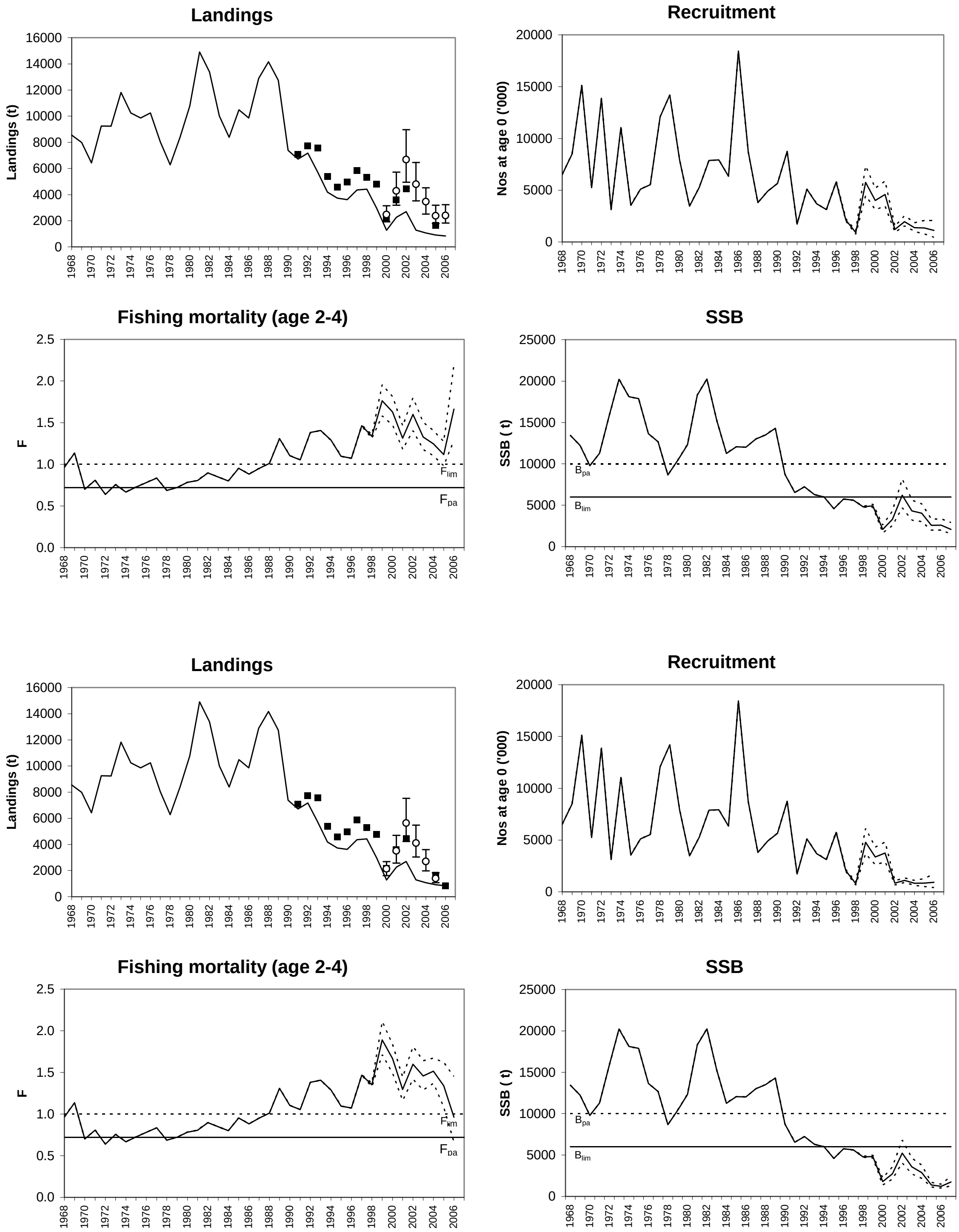


Fig 8.5.1.4.1. Cod in VIIa: landings and stock trends from final B-Adapt runs: top four plots are for run 9c including bias estimate for 2006; bottom four plots for run 9b with no bias estimate (2006 removals equal to reported landings). Continuous line on landings plot is the reported landings; filled squares are landings in 1991–2002 and 2005 including sample-based estimates at three ports; open circles with 90% confidence intervals are total removals estimates (in excess of assumed natural mortality) from B-Adapt. Dotted lines on plots are 5th and 95th bootstrap percentiles.

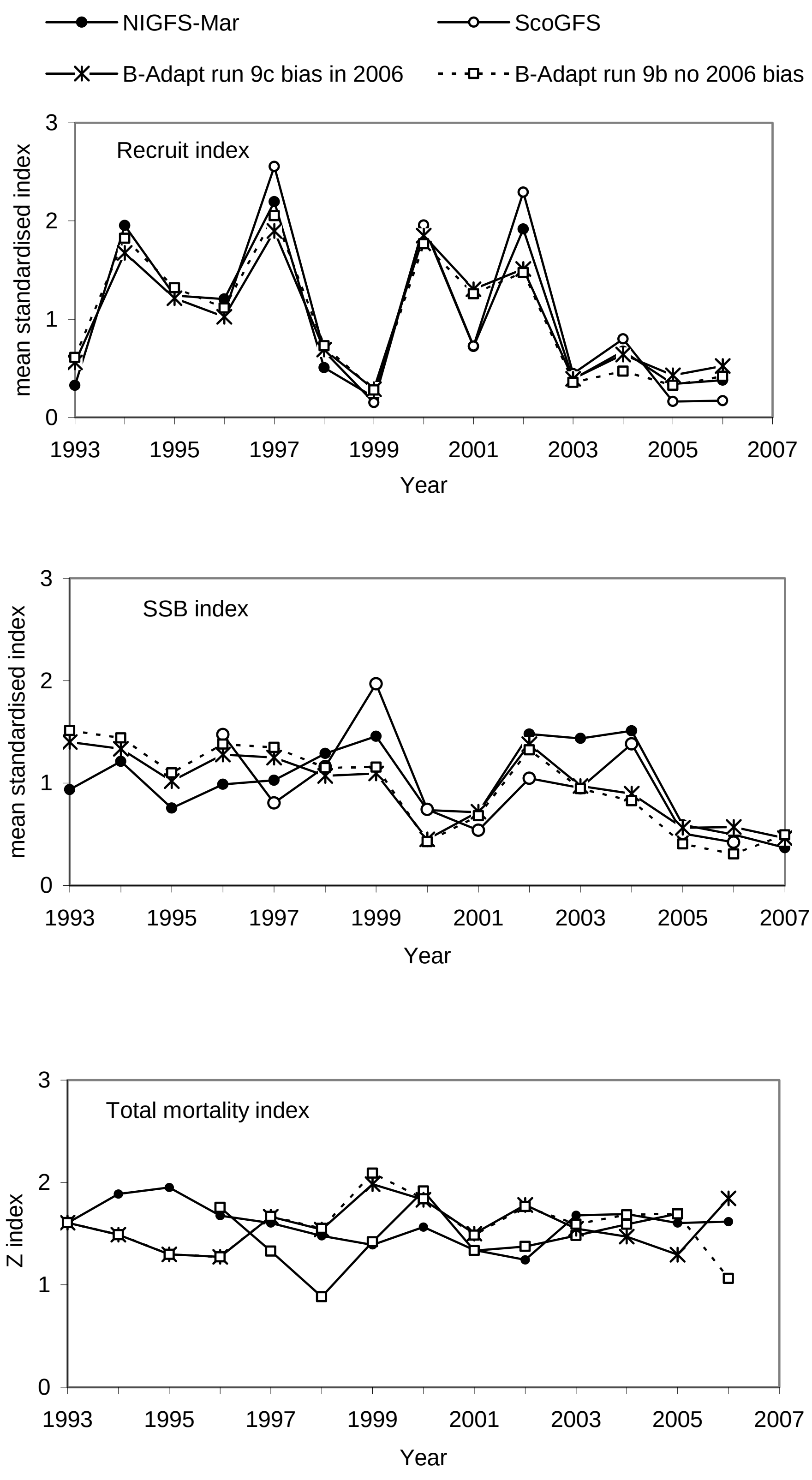


Fig 8.5.1.4.2. Cod in VIIa: comparison of final B-ADAPT run 9b and 9c (without and with bias estimate for 2006) stock trends with indices of recruitment, SSB and fishing mortality from SURBA runs with NIGFS-Mar and ScoGFS-Q1 surveys. The B-Adapt estimates of F have been increased by M=0.2 to give Z indices comparable with the SURBA values.

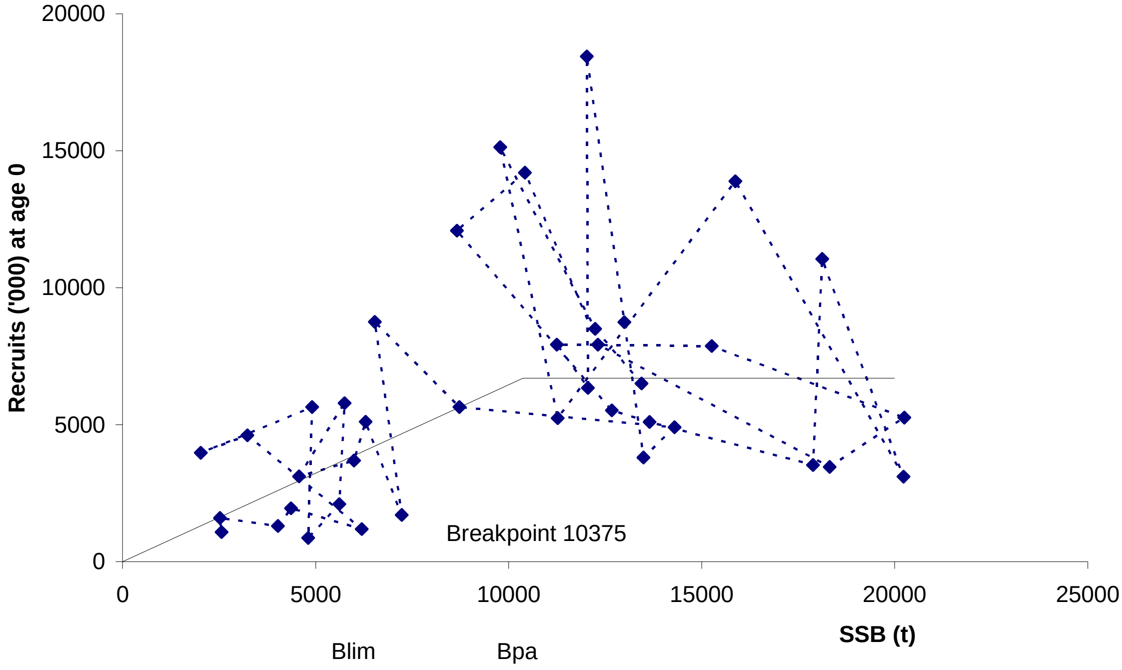


Fig. 8.5.3.1. Cod in VIIa. Stock and recruit data from final B-ADAPT model run, with segmented regression fit assuming log-normal errors in recruitment.

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	1.29	1.29
0.25	1.48	1.48	1.48
0.5	1.66	1.66	1.66
0.75	1.89	1.89	1.89
0.95	2.19	2.19	2.19

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	1008
0.25	1830	1442	1555
0.5	2080	1684	2128
0.75	2386	2010	2941
0.95	2903	2537	3887

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	1326	1376
0.25	1994	1710	1980
0.5	2268	1996	2657
0.75	2579	2298	4000
0.95	3111	2848	5203

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.00	0.05	0.07

Prob 30% SSB incr	
2007	2008
0.00	0.43

status quo F projection
Recruitment 1992 - 2006

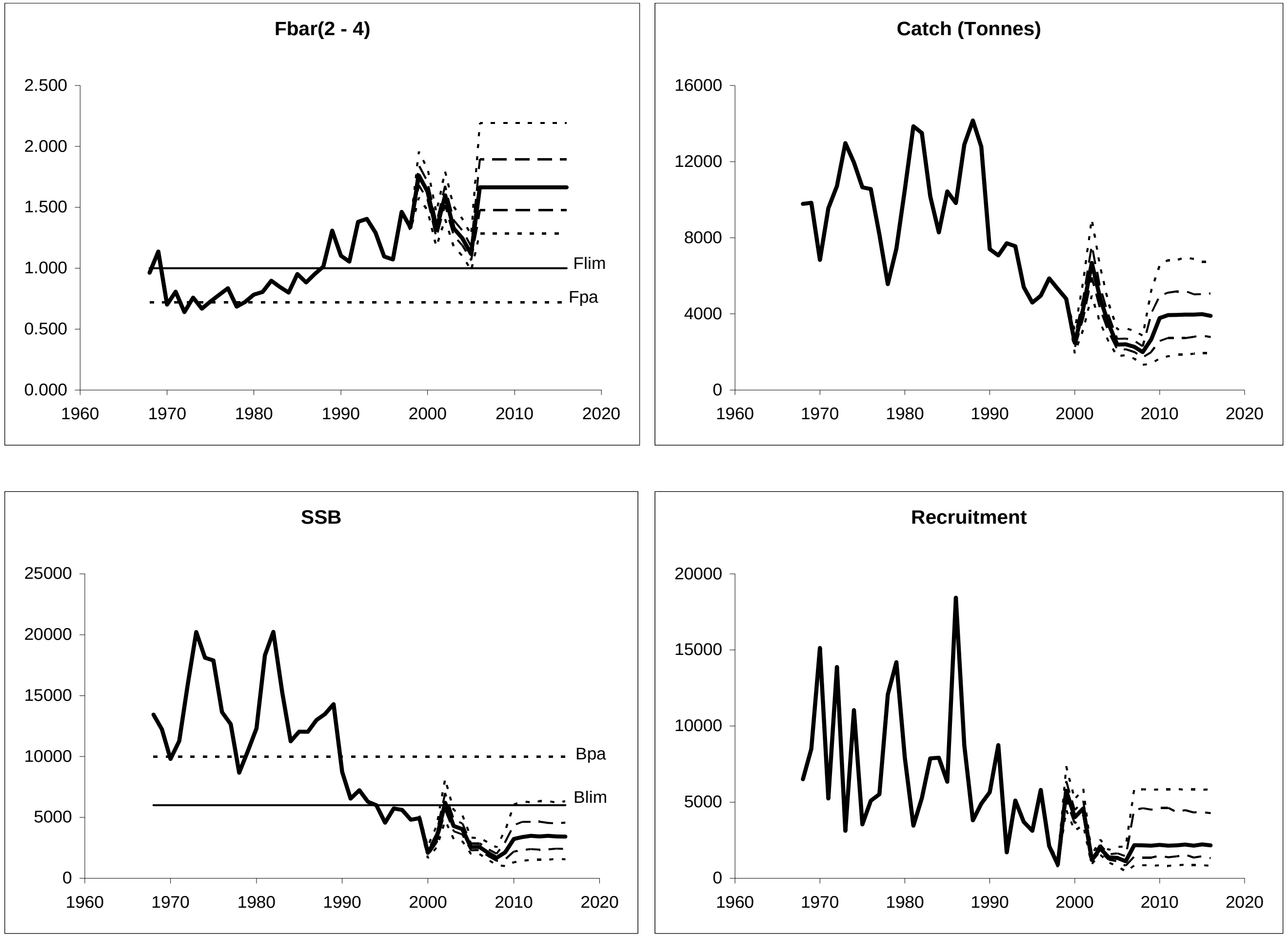


Figure 8.5.5.1. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for status-quo F, with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F(2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2006 period, and hence the catch in the forecast period also includes an expected unallocated removal.

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	0.96	0.96
0.25	1.48	1.11	1.11
0.5	1.66	1.25	1.25
0.75	1.89	1.42	1.42
0.95	2.19	1.64	1.64

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	1259
0.25	1830	1442	1885
0.5	2080	1684	2512
0.75	2386	2010	3341
0.95	2903	2537	4442

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	1146	1357
0.25	1994	1459	1942
0.5	2268	1697	2583
0.75	2579	1956	3678
0.95	3111	2423	4720

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.00	0.17	0.26

Prob 30% SSB incr	
2007	2008
0.00	0.57

0.75 * status quo F projection
Recruitment 1992 - 2006

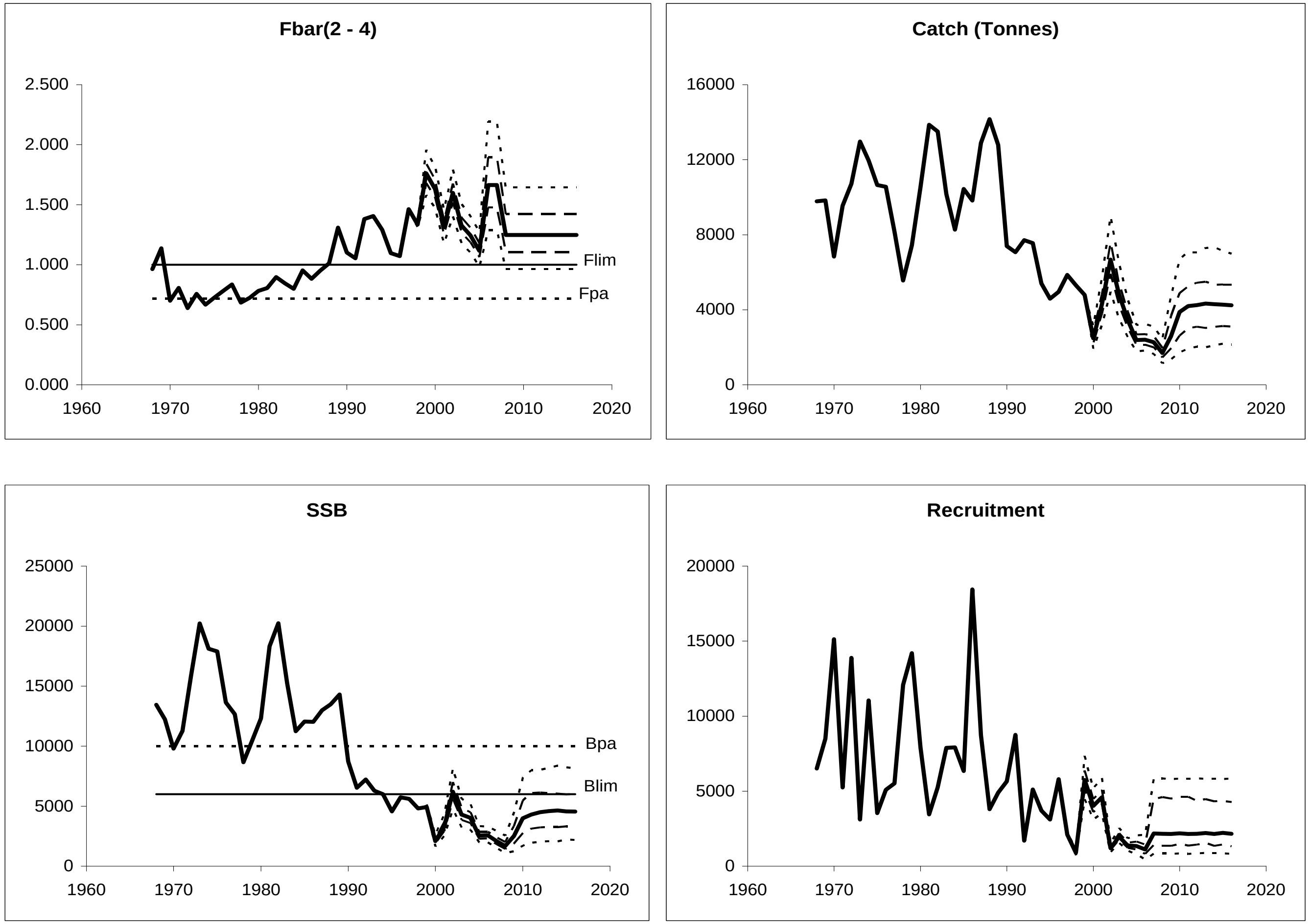


Figure 8.5.5.2. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.75* status-quo F, with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F(2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	0.64	0.64
0.25	1.48	0.74	0.74
0.5	1.66	0.83	0.83
0.75	1.89	0.95	0.95
0.95	2.19	1.10	1.10

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	1624
0.25	1830	1442	2364
0.5	2080	1684	3078
0.75	2386	2010	3926
0.95	2903	2537	5147

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	885	1251
0.25	1994	1120	1769
0.5	2268	1297	2310
0.75	2579	1498	3144
0.95	3111	1868	4012

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.01	0.37	0.52

Prob 30% SSB incr	
2007	2008
0.00	0.84

0.5* status quo F projection
Recruitment 1992 - 2006

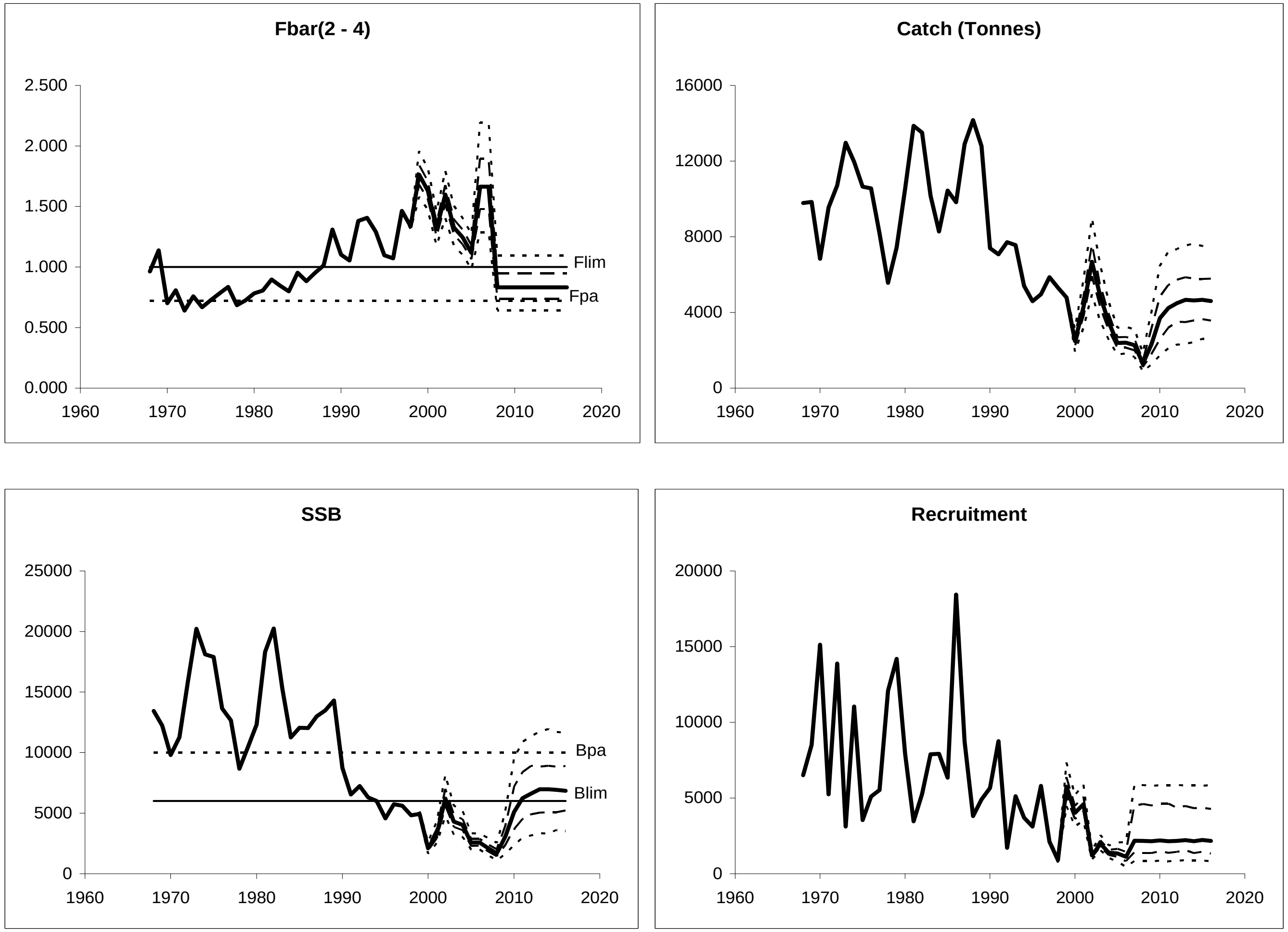


Figure 8.5.5.3. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.50* status-quo F, with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F (2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal.

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	0.56	0.56
0.25	1.48	0.64	0.64
0.5	1.66	0.72	0.72
0.75	1.89	0.82	0.82
0.95	2.19	0.95	0.95

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	1741
0.25	1830	1442	2511
0.5	2080	1684	3263
0.75	2386	2010	4111
0.95	2903	2537	5378

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	799	1201
0.25	1994	1009	1678
0.5	2268	1165	2172
0.75	2579	1350	2932
0.95	3111	1682	3739

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.01	0.44	0.62

Prob 30% SSB incr	
2007	2008
0.00	0.92

Fpa projection
Recruitment 1992 - 2006

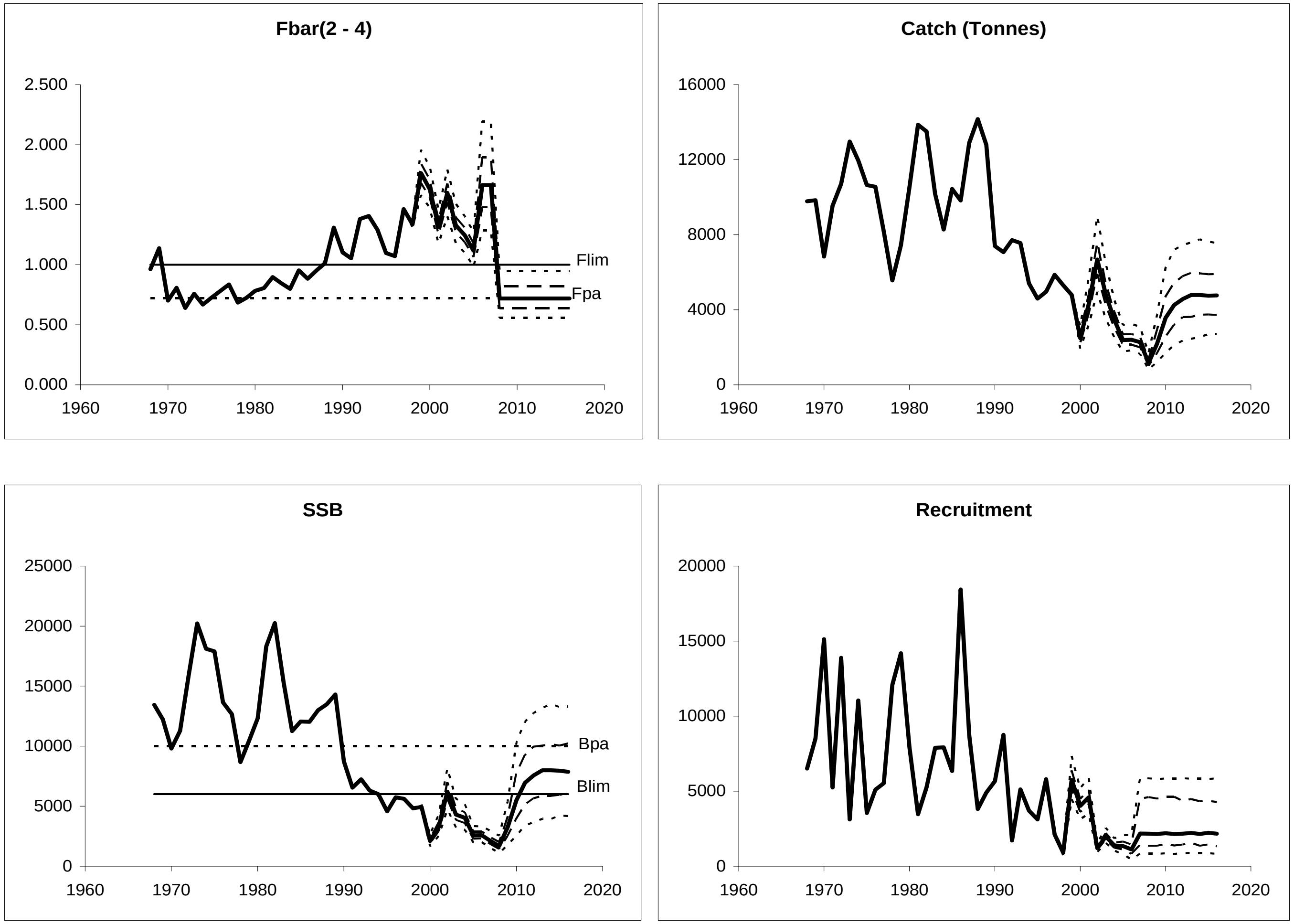


Figure 8.5.5.4. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for Fpa (0.72; fmult=0.43), with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F (2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal.

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	0.32	0.32
0.25	1.48	0.37	0.37
0.5	1.66	0.42	0.42
0.75	1.89	0.47	0.47
0.95	2.19	0.55	0.55

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	2129
0.25	1830	1442	3005
0.5	2080	1684	3824
0.75	2386	2010	4697
0.95	2903	2537	6100

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	521	928
0.25	1994	658	1283
0.5	2268	759	1638
0.75	2579	880	2107
0.95	3111	1098	2699

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.06	0.65	0.87

Prob 30% SSB incr	
2007	2008
0.00	1.00

0.25* status quo F projection
Recruitment 1992 - 2006

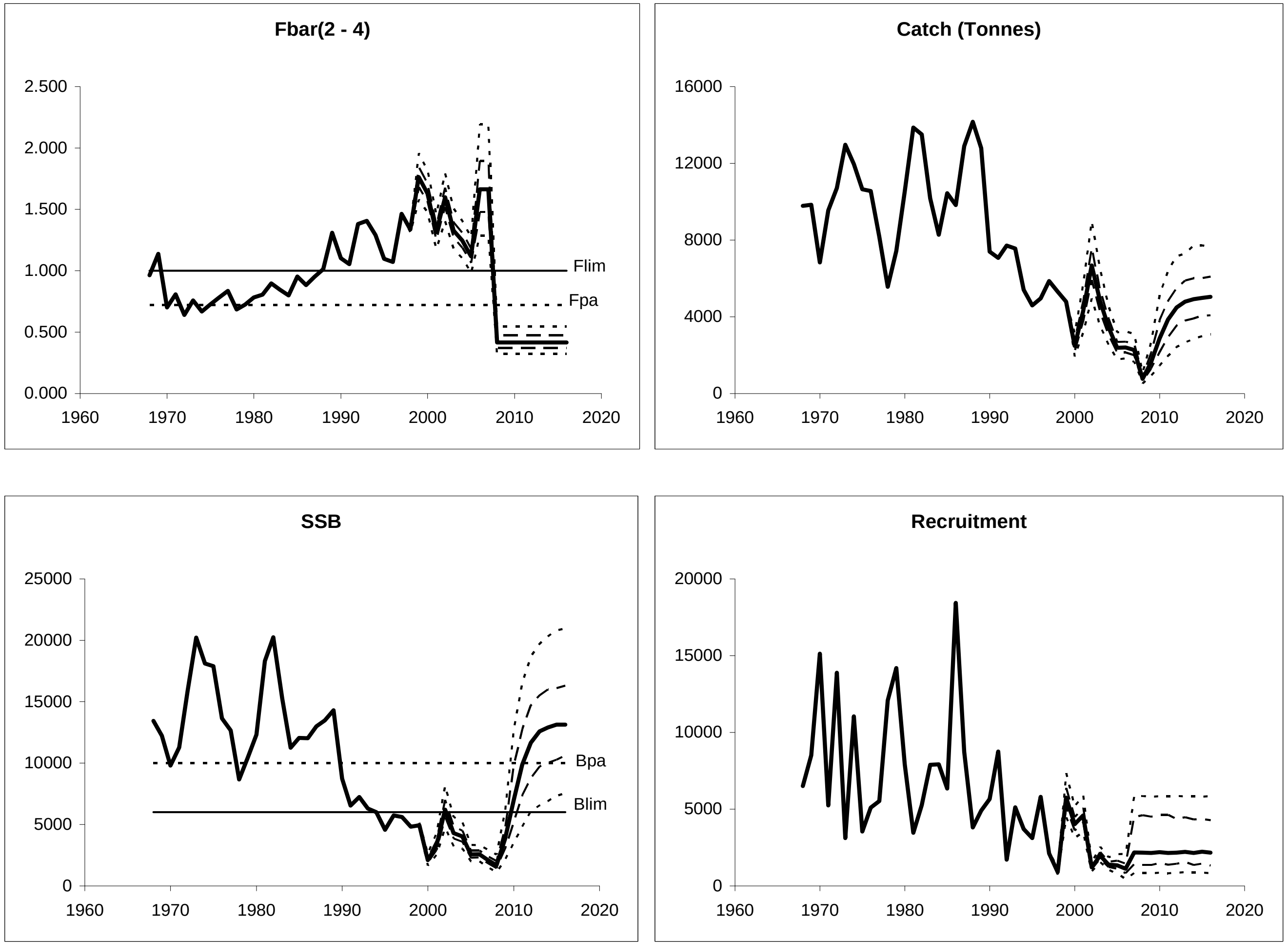


Figure 8.5.5.5. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.25* status-quo F, with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F (2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	1.29	0.13	0.13
0.25	1.48	0.15	0.15
0.5	1.66	0.17	0.17
0.75	1.89	0.19	0.19
0.95	2.19	0.22	0.22

SSB	Year		
Percentile	2007	2008	2009
0.05	1525	1092	2564
0.25	1830	1442	3539
0.5	2080	1684	4411
0.75	2386	2010	5315
0.95	2903	2537	6889

Catch	Year		
Percentile	2007	2008	2009
0.05	1635	231	483
0.25	1994	290	661
0.5	2268	338	838
0.75	2579	391	1040
0.95	3111	491	1350

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.12	0.85	0.99

Prob 30% SSB incr	
2007	2008
0.00	1.00

0.1 * status quo F projection
Recruitment 1992 - 2006

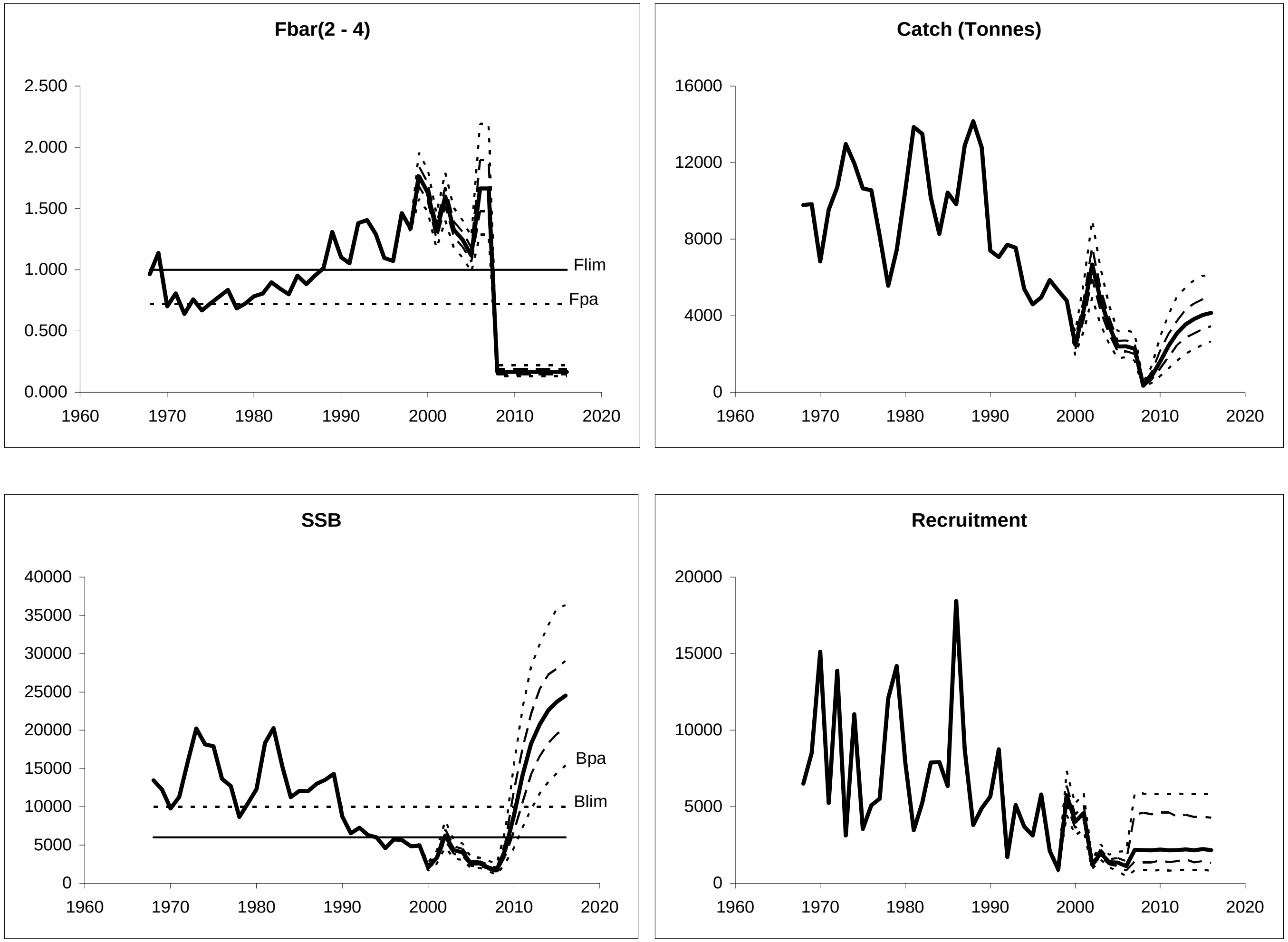
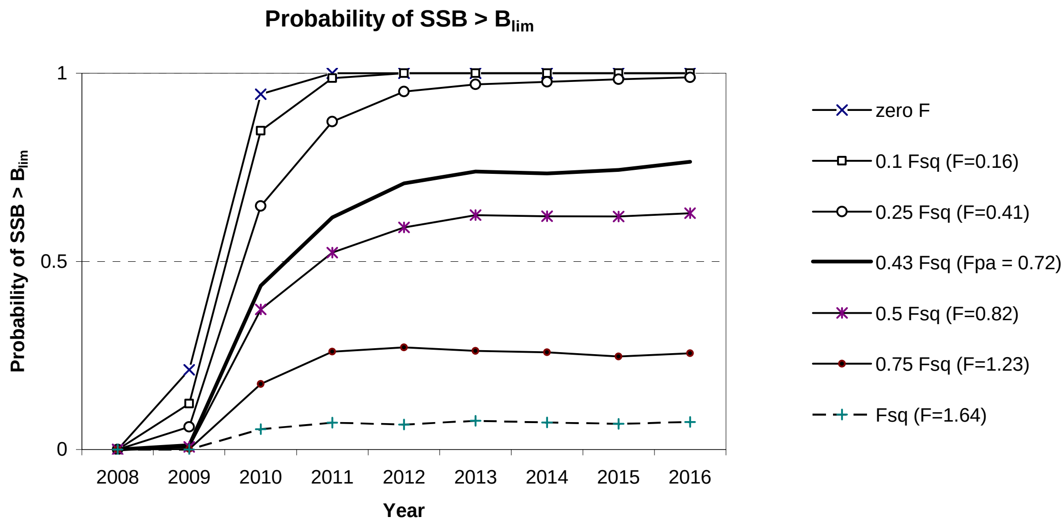


Figure 8.5.5.6. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.10* status-quo F, with recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. Note that F (2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal.



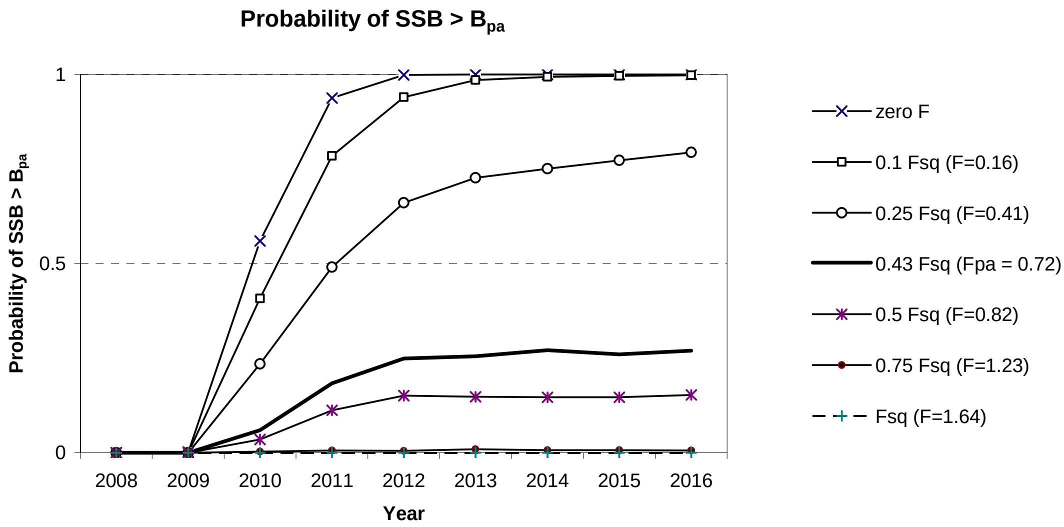


Figure 8.5.5.7. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast values of probability of SSB > B_{lim} and B_{pa} for different F-multipliers from 2008 onwards (with average selection pattern for 2004–2006). The equivalent F (2–4) values are given in the figure legend. Results are for B-Adapt run 9c (bias estimated for 2006).

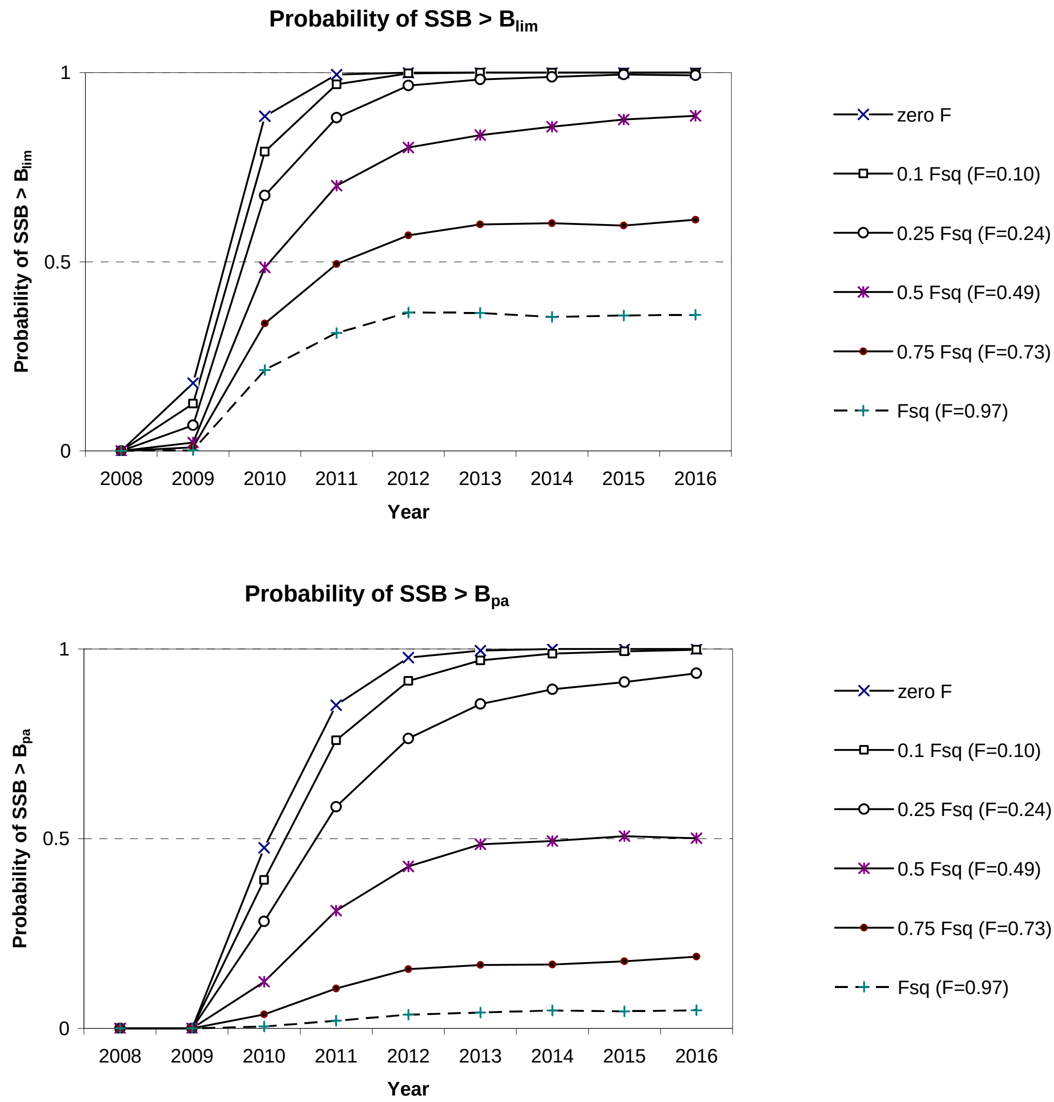
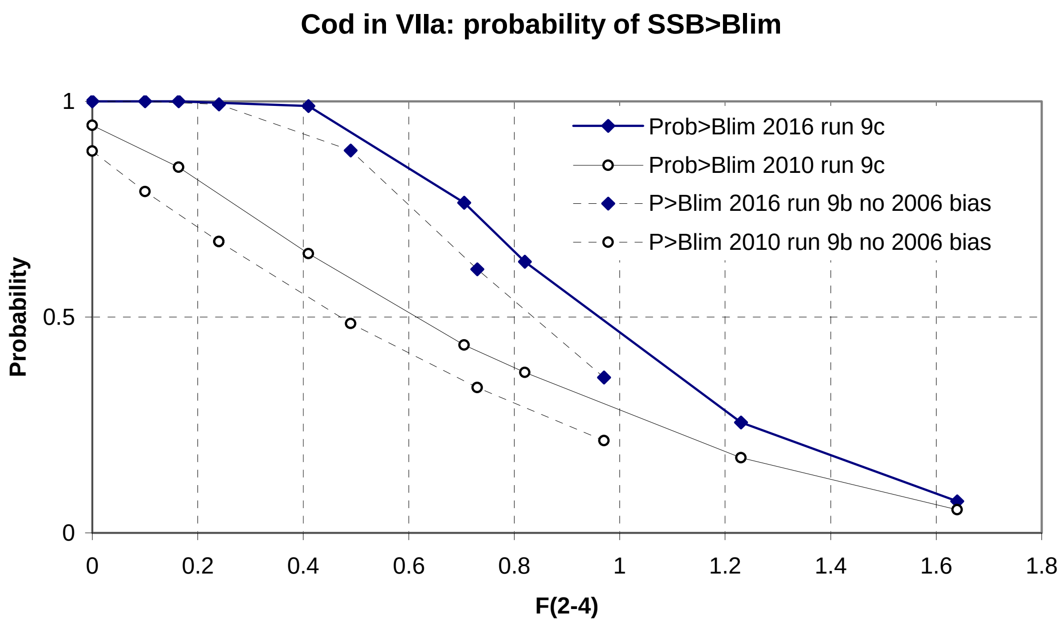


Figure 8.5.5.8. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast values of probability of SSB > B_{lim} and B_{pa} for different F-multipliers from 2008 onwards (with average selection pattern for 2004–2006). The equivalent F (2–4) values are given in the figure legend. . Results are for B-Adapt run 9b (no bias estimated for 2006).



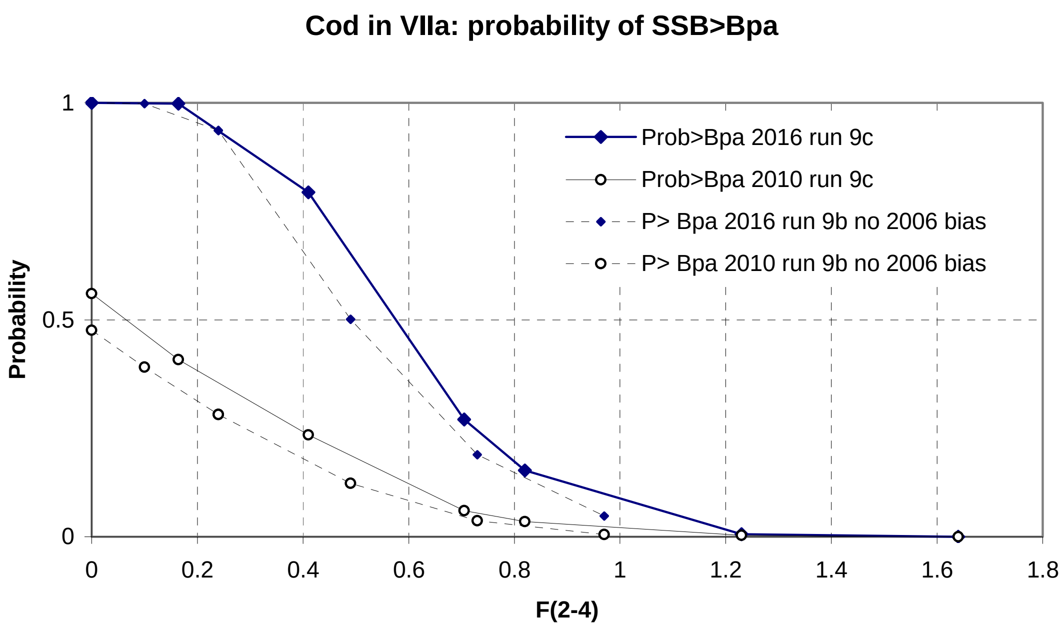


Figure 8.5.5.9. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast values of probability of SSB > B_{lim} and B_{pa} in 2010 and 2016 for different F (2–4)) values and 2004–2006 average selection pattern from 2008 onwards.

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	0.48	0.23	0.11
0.25	0.60	0.32	0.15
0.5	0.71	0.40	0.19
0.75	0.86	0.51	0.25
0.95	1.15	0.82	0.44

SSB	Year		
Percentile	2007	2008	2009
0.05	1669	1733	2330
0.25	2001	2513	3849
0.5	2280	3122	5101
0.75	2611	3839	6340
0.95	3136	5095	8431

Catch	Year		
Percentile	2007	2008	2009
0.05	1462	1243	1056
0.25	1462	1243	1056
0.5	1462	1243	1056
0.75	1462	1243	1056
0.95	1462	1243	1056

P(SSBYear > Blim)			
2008	2009	2010	2011
0.01	0.31	0.82	0.96

Prob 30% SSB incr	
2007	2008
0.59	0.78

Run 9c: Bias estimated in 2006
TAC constraint 2007-2009
2007 TAC reduced by 15% annually to
2009 then constant F at ~F0.1
Recruitment 1992 - 2006

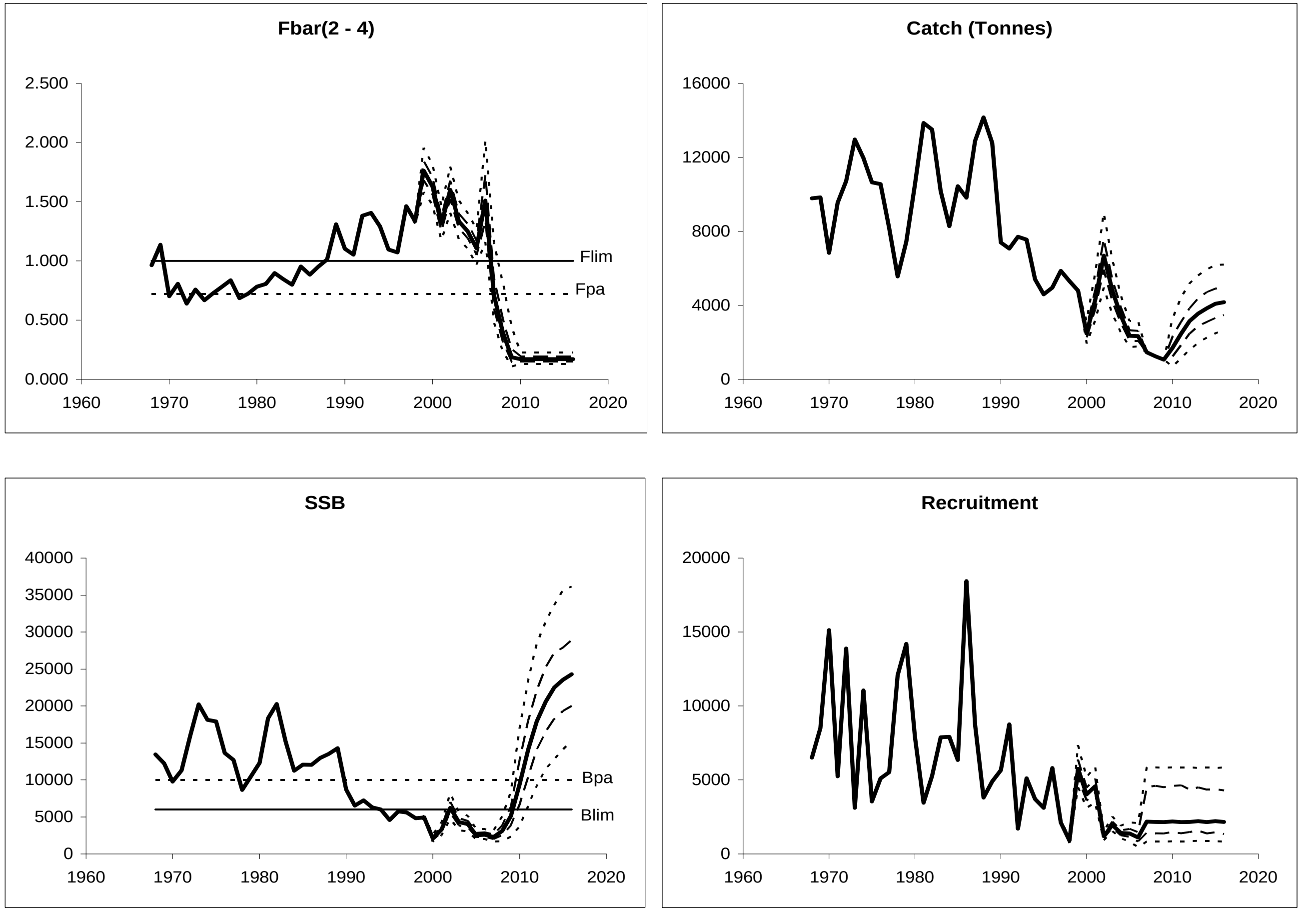


Figure 8.5.5.10. Cod in VIIa. Bootstrap B-Adapt run 9c medium-term forecast for TAC constraint in 2007, 15% reduction in TAC in 2008 and 2009, and F-multiplier of 0.11 to give F ~ $F_{0.1}$ of 0.18 from 2010. Recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. This forecast assumes that removals from 2007 onwards are as generated by the TAC and subsequent F-multipliers (i.e. no unallocated removals).

Fbar(2-4)	Year		
Percentile	2007	2008	2009
0.05	0.69	0.41	0.16
0.25	0.87	0.57	0.22
0.5	1.08	0.77	0.33
0.75	1.36	1.10	0.53
0.95	2.05	2.38	1.70

SSB	Year		
Percentile	2007	2008	2009
0.05	1264	741	705
0.25	1524	1295	1848
0.5	1751	1721	2865
0.75	2015	2232	3937
0.95	2398	2981	5684

Catch	Year		
Percentile	2007	2008	2009
0.05	1462	1243	1056
0.25	1462	1243	1056
0.5	1462	1243	1056
0.75	1462	1243	1056
0.95	1462	1243	1056

P(SSBYear > Blim)			
2008	2009	2010	2011
0.00	0.03	0.49	0.81

Prob 30% SSB incr	
2007	2008
0.09	0.65

Run 9b: No bias estimated in 2006
TAC constraint 2007-2009
2007 TAC reduced by 15% annually to
2009 then constant F at ~F0.1
Recruitment 1992 - 2006

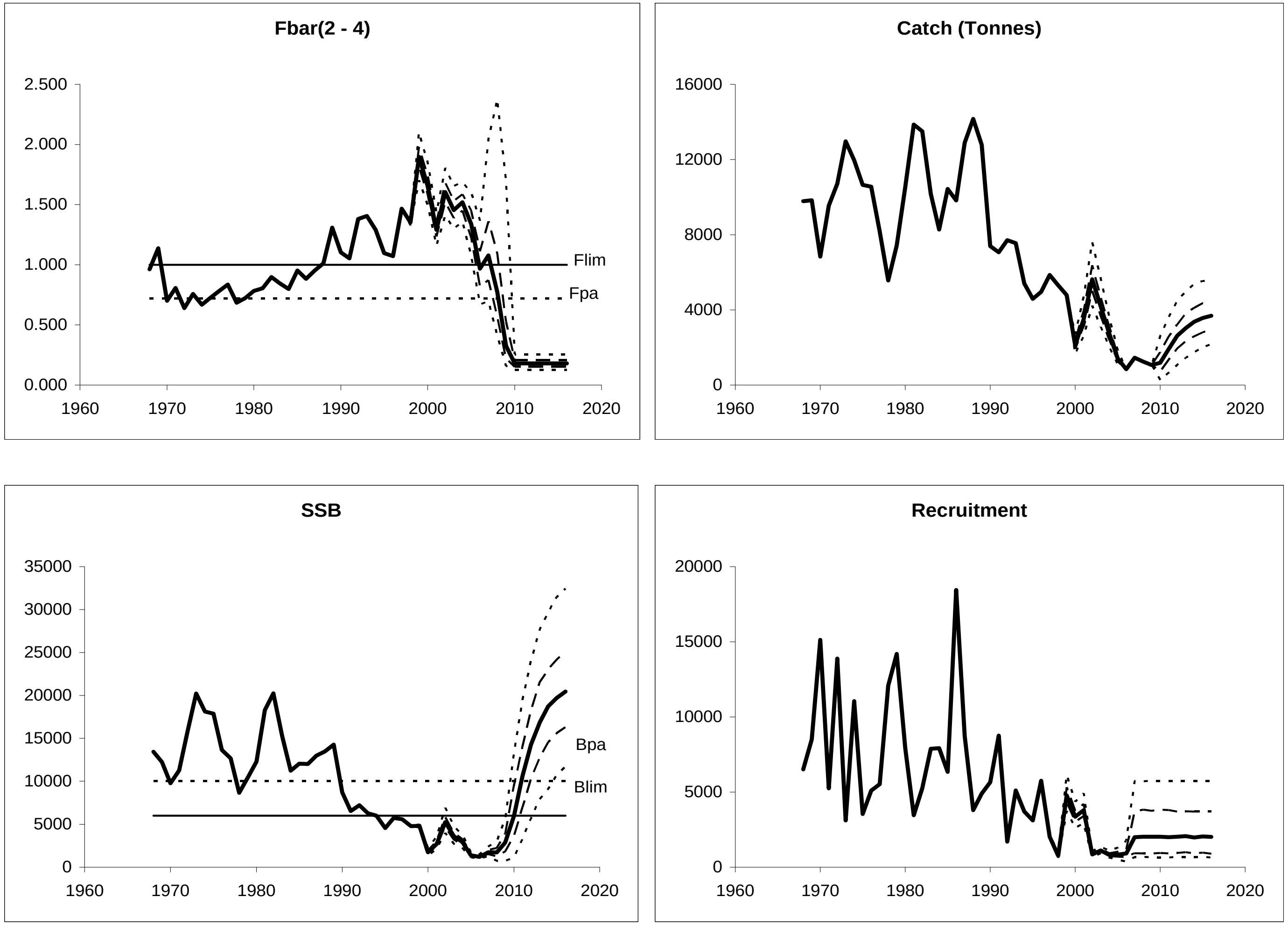
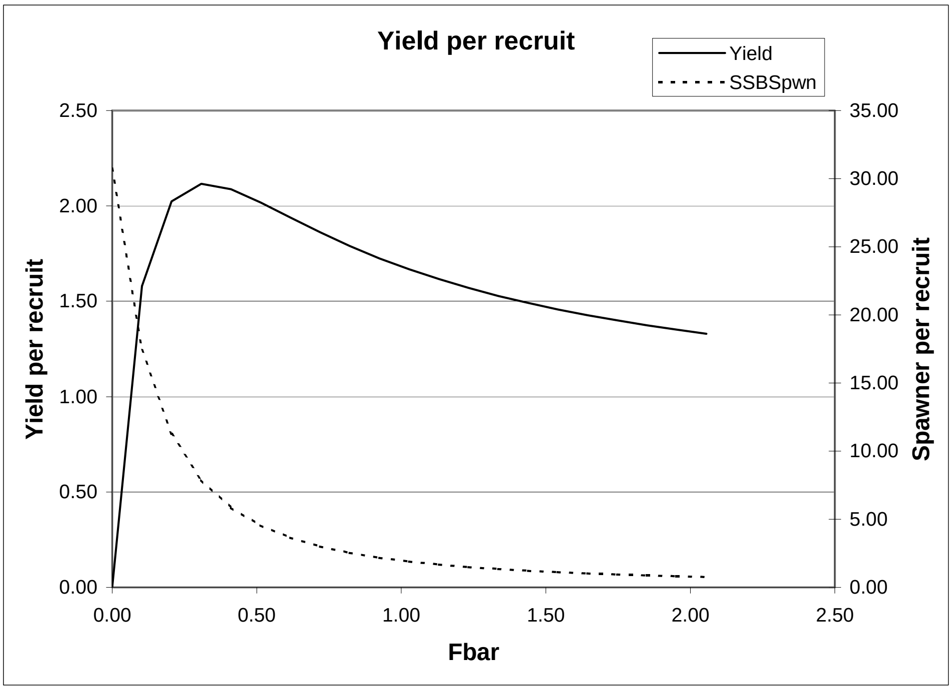


Figure 8.5.5.11. Cod in VIIa. Bootstrap B-Adapt run 9b medium-term forecast for TAC constraint in 2007, 15% reduction in TAC in 2008 and 2009, and F-multiplier of 0.19 to give F ~ $F_{0.1}$ of 0.18 from 2010. Recruitment from 2007 onwards re-sampled from 1992–2006 values in each projection. This forecast assumes that removals from 2007 onwards are as generated by the TAC and subsequent F-multipliers (i.e. no unallocated removals).



MFYPR version 2a
Run: cod7aypr
Time and date: 21:21 11/05/2004

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	1.0277
FMax	0.3112	0.3198
F0.1	0.1786	0.1835
F35%SPR	0.2116	0.2175

Weights in kilograms

Figure 8.5.6.1. Cod in VIIa. Results of yield per recruit analysis. (From 2004 WG assessment).

9 Haddock in Division VIIa

The Review Group suggested that the use of a TSA approach could be examined again to overcome the problems of incomplete/missing catch information in 2003–4. The 2006 Working Group performed an exploratory/benchmark assessment, again examining whether TSA or B-Adapt can be used to assess this stock.

The Working Group attempted a benchmark assessment for this stock in 2007. The VIIa haddock stock has been assessed prior to the 2004 WG using XSA. Due to unreliable landings estimates and no catch numbers-at-age for 2003, the 2004–2006 Working Group spend a considerable amount of time exploring the possibility to use TSA, ICA and B-Adapt (which allows the 2003 commercial catch data to be treated as missing). The results of these models were unsatisfactory. In the absence of reliable landing data and catch at age data based on official logbook data only, the 2006 WG performed a benchmark assessment of recent stock trends based on survey data only. The RGNSDS, 2006 considered SURBA to give a reliable picture of the status of the stock at least in terms of SSB and recruitment. The issue of how to provide advice was left unresolved, although the advice is driven to a large extent by linkages to cod in Division VIIa.

9.1 The fishery

The characteristics of the fishery are described in the Stock Annex.

9.1.1 ICES advice applicable in 2006 and 2007

The advice from ICES for 2006, under *Single-stock exploitation boundaries*, was as follows:

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: Recent estimates of fishing mortality have been in excess of 1.0 and there will be no gain to the long-term yield by having fishing mortalities above F_{max} (0.35). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits: The fishing mortality should be reduced in order to make the fishery less sensitive to variable recruitment. Recent estimates of fishing mortality have been in excess of 1.0, compared to an F_{pa} of 0.5. Effort and catches should be reduced considerably to approach F_{pa}. Given the poor information on the actual catches it is not possible to quantify this reduction.

ICES advice for 2007, under *Single-stock exploitation boundaries*, was as follows:

Exploitation boundaries in relation to precautionary limits: Although uncertain, recent estimates of total mortality are in excess of 1.0 which implies that F is above the F_{pa} of 0.5.

Fishing at F_{pa} requires a substantial reduction in effort and catches, but ICES cannot quantify the reduction.

No limit reference points have been set for this stock due to the short time-series of assessment data. ICES has adopted a precautionary F_{pa} of 0.5 as this is the value for the neighbouring stock in VIa.

Mixed fisheries advice for 2007 is given in Section 1.7.

9.1.2 Management applicable in 2006 and 2007

Management advice and WG landings in 2006 and 2007 are summarised below:

Year	Single species exploitation boundary[1]	Basis	TAC	F multiplier associated with TAC[2]	WG landings
2002	<1200	Reduce F below Fpa	1300	0.38	1972
2003	0	Linked to cod	585	<0.1	n/a
2004	<1500	Reduce F below Fpa	<1500	0.53	1278
2005	<1370	Reduce F below Fpa	<1370	0.50	699
2006	-	Substantial reduction in F	<1275	no forecast	647
2007	-	Substantial reduction in F	<1179	no forecast	-

1) VIIa allocation for VII, VIII, IX, X.

2) From short term forecast.

Due to the by-catch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the Irish Sea cod recovery plan. Technical measures and effort regulations are described in Section 1.7.

Limited sampling schemes since the 1990s have shown high rates of discarding of haddock less than 3 years old, and variable discarding of 3–year-olds in fisheries using 70–80 mm mesh nets. Data for whitefish vessels since the introduction of 100+ mm mesh and other recent technical measures are too few to form a basis for evaluation. However, any measures to reduce discards in the fishery will result in increased future yield.

The minimum landing size for haddock in the Irish Sea is 30 cm.

9.1.3 The fishery in 2006

The fishery in 2006 was prosecuted by the same fleets and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The shift of whitefish vessels to the Clyde was less marked since 2001 because of the Clyde closure.

9.2 Catch data

9.2.1 Official catch statistics

Table 9.1 gives nominal landings of haddock from the Irish Sea (Division VIIa) as reported by each country to ICES since 1984.

9.2.2 Revision of Catch data

Table 9.2 gives the long-term trend of nominal landings of haddock from the Irish Sea (Division VIIa) as reported to ICES since 1972, together with Working Group estimates. The 1993–2005 WG estimates (excl. 2003) include sampled-based estimates of landings into a number of Irish Sea ports. The 2006 WG estimates are equal to official reported landings. Similar to 2004 and 2005, the reported uptake of the TAC has been poor in 2006, with the estimated percentage uptake of UK, Irish and French vessels being 69% (estimated 422 t of 611 t quota), 33% (183 t of 552 t) and 21% (20 t of 92 t), respectively. For these figures, quota swaps have, however, not been taken into account. The Belgium fleet in contrary had 100% uptake of the TAC.

9.2.3 Quality of Catch data

Official logbook landings were partially corrected for by the WG for this stock from 1993–2002, based on a routine sampling procedure used to estimate landings in at ports in one country only. Sample-based estimates of landings were not available for 2003 and of poor quality in 2004. Estimates have been variable and have a substantial influence on the SSB and recruitment estimates for the stock. Landings and catch at age data based on official logbook reported landings, prior to 2006, are considered unreliable for an analytical catch-based assessment. Sampling of landings in 2006 indicate that the implementation of Article 9 of the EU Council Regulation 2847/93, relating to the designation of auction centres and registration of buyers and sellers, significantly reduced the bias between sample-based estimates of landings and official logbook reported landings for haddock in the Irish Sea.

9.3 Commercial catch-effort and research vessel surveys

9.3.1 Commericial catch-effort data

Recent trends in effort (kW.days) of various fleets are described in Section 17. Longer term trends in hours fished are given in the VIIa whiting section.

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB, 2006) provided information to WGNSDS concerning changes in fleets and practices in the Irish Sea that could influence the assessments or their interpretation. WGFTFB reported that up to 20% of the Northern Irish *Nephrops* fleet now spend most of Q4 and Q1 engaged in the *Nephrops* fishery off the English east coast (Farne deeps). This will have resulted in a drop in effort in VIIa and a corresponding increase in IVb. The Irish decommissioning scheme in 2005–2006 has removed a total of 36 whitefish and scallop vessels to date, 7 of which had a track record of fishing in the Irish Sea. A further decommissioning scheme will also be introduced in 2007.

9.3.2 Surveys

Survey series for haddock available to the Working Group are described in the stock Annex for 7a haddock (Section B.3).

Age-structured abundance indices are available from the following sources:

- UK(NI) groundfish survey (NIGFS) in March (age classes 1 to 5, years 1992–2007)
- UK(NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2006)
- Republic of Ireland Irish Sea–Celtic Sea groundfish survey (IR-ISCSGFS) in November (ages 0 to 5; years 1997–2002)
- Republic of Ireland groundfish survey (IR-GFS) in autumn (age classes 0 to 6, years 2003–2004)
- UK(NI) Methot-Isaacs Kidd (MIK) net survey in June (age 0; years 1994–2006)
- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 4, years 1996–2006)
- UK(Scotland) groundfish survey (SCOGFS) in autumn (age classes 0 to 3, years 1996–2005).
- UK Fishery Science Partnership Irish Sea roundfish survey, 2004–2007 (see Armstrong *et al*., WD 2 and www.cefas.co.uk/fsp)

Results from the UK Fishery Science Partnership Irish Sea roundfish survey have been presented to the Working Group. A chartered commercial trawler carries out ~ 38 tows of approx. 6–h duration using a commercial semi-pelagic whitefish trawl in the western Irish Sea and North Channel. The survey takes place in spring during the cod spawning period. A second chartered trawler carries out ~44 tows of approx. 4–h duration in the eastern Irish Sea at about the same time.

A new IBTS-coordinated UK trawl survey started in the Irish Sea in November/December 2004 using RV Endeavour to carry out approx. 30 tows with a GOV trawl in the Irish Sea and St George's Channel, and 50–60 tows in the Celtic Sea and Western Approaches. The GOV trawl is rigged with standard or rockhopper ground gear depending on ground type. A detailed description of the survey and catch rates of selected species were presented to the Working Group (Ellis and Tidd, WD4). Tuning data from this survey have not yet been provided to the Working Group.

The vessel used for the UK(NI) groundfish surveys has changed in 2005. No intercalibration trawls were carried out. No changes were made to the fishing gear, but the vessel effect is unknown. The two Irish groundfish surveys (IR-GFS and IR-ISCS GFS) in autumn were not considered because of the short series. Coverage of the Irish Sea in the IR-GFS survey (2003-2004) has been terminated. The IR-ISCS GFS is also excluded on the basis of changes in survey design and the method of calculating the indices not allowing for the changes in spatial coverage. The ScoGFS-Autumn survey was also excluded due to the small number of stations in the western Irish Sea where haddock are most abundant, and the poor internal consistency and consistency with other fleets. The ScoGFS-Spring was excluded due to the limited survey coverage in the western Iris Sea, where haddock is most abundance. Both ScoGFS-Autumn and ScoGFS-Sping surveys have been terminated in 2005 and 2006, respectively. The survey input files for the SURBA runs are given in Table 9.3.

The distribution of haddock from the NIGFS March and October surveys, showing catch rates in kg per 3 mile above and below the minimum landing size (30 cm), is shown in Figures 9.1 and 9.2. Distribution of haddock is patchy and concentrated in the western Irish Sea. The highest abundance of haddock above and below MLS during the NIGFS-Mar and NIGFS-Oct surveys is to the west and southwest of the Isle of Man and closer inshore off the east coast of Ireland (north and south of Dundalk Bay). Larger haddock are more dispersed during the NIGFS-Oct survey, but the highest concentrations are still found in the main areas mentioned in most years.

Distribution of haddock during the 2004–2007 UK Fisheries-Science Partnership surveys confirms the distribution pattern and patchiness observed in the research surveys. The 2005–2007 survey also showed relatively high catch rates of haddock in the North Channel (northern part of VIIa, north of 54^o 30’N), close to the Firth of Clyde cod closure (Figure 9.3).

9.4 Age composition and mean weights-at-age

9.4.1 Catch age composition and mean weights-at-age in the catch

The methods for estimating quantities and composition of haddock landings from VIIa, used in previous years, are described in the Stock Annex (Section B1.1). Data on quarterly age compositions of landings and associated mean weights-at-age were provided by UK (NI) and Ireland in 2005. Sampling covered the main fleets landing haddock in 2006. Following a poor period of sampling levels and coverage of landings in 2003–2004, sampling levels and coverage of landings for 2005 were satisfactory. Sampling levels and coverage deteriorated again in 2006 with scientist having restricted access to some Irish Sea landings ports and fleet segments. The landings of the fleets sampled by quarter comprise 60% of the international total in 2006 compared with 22% in 2003 and 85% in 2002. Numbers measured and aged are given in Table 2.2. The series of numbers-at-age in the international commercial landings is given in Table 9.4, and includes sampled-based estimates of unallocated landings in all years. Sampling levels were not considered adequate to derive catch age compositions in 2003.

The time-series mean weight-at-age in the landings is given Table 9.5. Since the large expansion of the haddock stock in the mid 1990s the mean weight-at-age has been variable (±40% of the mean for each age group). The general trend since 1996 indicate a slight decrease in mean weight-at-age for ages 2–4. The 2006 values are the lowest in the series.

9.4.2 Discard age composition

Methods for estimating quantities and composition of discards from UK(NI) and Irish *Nephrops* trawlers are described in the Stock Annex (Section B1.2). Previous analytical assessments have been based on landings only. The revised series of the Irish discard data, raised to the number of trips instead of landings, provided to the WG in 2005 was updated. Sampling levels has increased in recent years, but the highly variable and very large estimates of discarding for this fleet observed by previous WG are, however, still evident and raise concerns over their reliability.

UK(NI) observer sampling commenced again in 2006 and data have been provided to the WG for quarter 3 and 4 . Unfortunately, due to the poor temporal coverage of sampling from UK (NI) in 2006, the poor levels of discard sampling in 2003 and no sampling in 2004–2005, an estimate could not be provided for this fleet. Historically, discarding took place mainly at ages 0 to 2 in the otter trawl fisheries and at ages 1 to 2 in the mid-water trawl fishery (Table 9.6). The absence of 0–group discards in the mid-water trawl fishery reflects the mesh-size and deep-water distribution of fishing in this fishery. Discard rates could not be calculated from the *Nephrops* fishery self-sampling scheme as concomitant landings were not recorded or samples taken. Discarding in the mid-water trawl and twin trawl fishery was strongly influenced by the minimum landing size of 30 cm. Proportions discarded at age are given in Table 9.7. These results indicate that discarding may account for a significant and potentially variable fishing mortality on age classes 1 and 2 in particular.

A time-series of discard estimates for VIIa haddock was constructed by the 2003 WG for exploratory use only to determine if estimates of F (2–4) and SSB are sensitive to inclusion of discards data, and to investigate the magnitude of fishing mortality caused by discarding. This time-series was updated with the revised discard data series for the Irish *Nephrops* fleet. Table 9.8 gives the total catch at age for 1993–2006 including the estimates of discards. The discard data in its present form have poor precision due to a low number of sampling trips.

9.5 Natural mortality, maturity and stock weights-at-age

The derivation of these parameters and variables is described in the Stock Annex (Section B.2). The proportion of F and M before spawning were set to zero to reflect a SSB calculation date of 1 January. Natural mortality was assumed as 0.2 for all ages and years, and proportion mature knife-edged at age 2 for all years.

There is evidence for a decline in mean length of adult haddock over time (Figure 9.4), which needs to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights by fitting a Von Bertalanffy growth curve to all available survey estimates of mean length at age in March, described in the Stock Annex B.2. The procedure was updated this year using NIGFS-Mar data for 2007. The time-series of length weight parameters indicate a reduction in expected weight at length since 1996:

	Length-weight parameters		Expected weight at length	
Year	*a*	*B*	30 cm	40 cm
1993	0.01132	2.972	278	653
1994	0.00374	3.279	261	669
1995	0.00354	3.291	257	661
1996	0.00565	3.156	259	642
1997	0.00723	3.104	278	680
1998	0.00633	3.119	256	629
1999	0.00449	3.208	246	620
2000	0.00439	3.208	241	606
2001	0.00402	3.242	247	627
2002	0.00369	3.268	247	633
2003	0.00459	3.197	242	607
2004	0.00514	3.156	236	585
2005	0.00489	3.174	238	593
2006	0.00506	3.165	239	595
2007	0.00469	3.194	244	612

This decline coincides with the large growth in biomass of haddock in the Irish Sea.

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 79.9 cm (75.0); K = 0.202 (0. 232); t_0 = -0.356 (-0. 278)

Year class effects giving estimates of asymptotic length relative to the mean were as follows (2004 and 2005 data were combined as there is only one observation for the 2005 year-class):

Year class	Effect	Year class	Effect
1990	1.207	1998	0.980
1991	1.142	1999	0.935
1992	1.075	2000	0.954
1993	1.091	2001	0.964
1994	1.106	2002	0.948
1995	1.078	2003	0.874
1996	0.992	2004	0.828
1997	0.968	2005/2006	0.858

The year-class effects show a smooth decline from the mid-1990s coincident with the rapid growth of the stock, and may represent density-dependent growth effects. The close fit of the model to observed length-at-age data is shown by year class in Figure 9.4. The resultant stock weights-at-age are given in Table 9.9.

9.6 Survey and Catch-at-age analysis

9.6.1 Data screening and exploratory runs

9.6.1.1 Commercial catch data

The commercial catch data have only been partially corrected for unallocated estimates of landings and should be considered unreliable, especially in 2003–2004. The series of international landings at age and mean weight-at-age are given in Tables 9.4 and 9.5. A Separable VPA run (S=1.0; F=1.0, 1.2, 1.4; reference age = 3) showed no anomalies in the landings at age data for ages 2 and over. Residuals at age 1-2 were more variable, probably due to the absence of discards data (results on ICES system).

9.6.1.2 Survey data

The survey data for this stock are given in Table 9.3. The relative cpue data are plotted against time in Figure 9.5. Surveys give similar signals for all ages (0–4). Strong 1994, 1996, 1999, 2001, 2003 and 2004 year-classes are indicated by the 0–group indices from the NIGFS-Oct and MIK surveys. The two 0-group indices indicate different strengths for the 2006 year-class, but at worse still around the average for the survey time-series. The strong year classes were also evident for the older age groups in all surveys, indicating that the different surveys were capturing the prominent year-class signals in this stock (Figure 9.6). Correlation between survey indices by age (Figure 9.7) is positive for all surveys and show high consistency within each fleet, but patchy consistency between the fleets. However, it should be noted that the time-series are short. The NIGFS-Mar and ScoGFS-Spring survey series showed good correspondence in the past, but a deviation between the two surveys can be observed for indicating the strength of the 2004 and 2005 year-class. The indices from the UK Fishery Science Partnership survey in the western Irish Sea also show similar year class signals to the other survey series. The international landings at age (excl. 2003) show similar patterns of year-class variation to the surveys (Figure 9.5), giving confidence in the combined ability of the surveys to track year classes through time. Relative values for the landings at age in the last 3 years are well below the survey estimates.

Two tuning fleets, NIGFS-Mar and NIGFS-Oct, were screened using SURBA (ver. 3.0) to examine for year, age and cohort effects. Survey catchability and weighting factors by age were all entered manually as 1.0. The indices of the single fleet runs (Figure 9.8 to Figure 9.8) showed no obvious year-effects and were generally capturing the prominent year-class signals in this stock very well. Despite the vessel change in the NIGFS surveys in 2005, there is no evidence of a year-effect. The age scatter plots indicate good internal consistency in the NIGFS surveys. The survey data similar year-class patterns between fleets. Indices for age 5 in the NIGFS-Mar survey were previously excluded from further analysis due to small and variable catches evident from the raw data, but numbers in recent years have increased (Table 9.3) and have been retained since 2005. The catch curves from the two NIGFS surveys show similar steep profiles.

The ScoGFS-Spring survey was included from last year's assessment, due to inconsistency in trends between this fleet and the other survey indices. Survey coverage was considered inadequate in the western Irish Sea, where most of the haddock occurs (see Figures 9.1–9.3). The ScoGFS-Spring survey was subsequently terminated in 2006 and was excluded from any analysis.

The empirical trend in SSB from both the NIGFS series show the growth in SSB in the mid 1990s, a decline to 2000 and a subsequent variable trend (Figure 9.10). In recent years, both surveys show a increasing trend in SSB since 2005.

9.6.1.3 Exploratory assessment runs

SURBA

WGNSDS 2005 performed an extensive analysis of survey data for Irish Sea haddock. The effect of smoothing (lambda=1.0 and 0), fitting constant catchability (1.0 for all ages) or variable catchability at age and the choice of reference age were explored. The results indicated that the choice of catchability at age and using different values for the smoothing parameter had very little effect on the temporal trends in SSB or recruitment, and a lambda value of 1.0 reduces the noise in Z without over-smoothing the trends. Changing the reference age had very little effect on the results.

SURBA model residuals (log population indices) for the NIGFS-Mar and NIGFS-Oct surveys show noisy residuals (Figure 9.11 to Figure 9.12). Residuals from the NIGFS-Mar survey show some evidence of year effects in older ages in some years. The age 2 residual pattern from the NIGFS-Mar survey continue to show a better patterns than the other ages. The NIGFS-Mar survey model show quite large retrospective patterns in SSB, but less so for recruitment estimates. The retrospective pattern in SSB in recent years is probably related to an overestimation of the 2001 year-class. The SURBA run for the NIGFS-Oct show a poor fit with poor convergence (Figure 9.12). A better model fit is obtained when setting the reference age to 1, particularly relating the recruitment estimates. The retrospective analysis only runs when truncating the survey series by removing the 1991–92 data. The residual pattern for this survey is very noisy. The retrospective pattern in SSB is less pronounced for the NIGFS-Oct survey. Both surveys runs show large retrospective patterns in mortality estimates, highlighting the difficulty in estimating mortality for this stock.

Residuals and retrospective patterns for a SURBA multi-fleet run including both the NIGFS surveys are presented in Figure 9.13. Prior to 2007, no solution for this run has been found, with a failed retrospective analysis due to poor convergence. This was difficult to explain and reinforced the need for simulation testing of SURBA and more detailed diagnostic output. The model generate positive residuals for the spring survey and negative residuals for the autumn survey. This indicates that despite the similar empirical SSB trends (Figure 9.10) and strong correlation between survey indices by age (Figure 9.7), the two surveys show slightly different trends in abundance and the multifleet SURBA run is a compromise between these trends (Figure 9.14).

A comparison of the results of SURBA runs is given in Figures 9.14 and 9.15. A general tendency for the temporal trend in Z to increase up to 1999 is evident in the total mortality estimates for the NIGFS series. The NIGFS-Mar survey shows a slight increase in Z in 2003–2004, after a decreasing trend since 1999. Both the NIGFS surveys show a slight decrease in Z in 2006. The Z and SSB estimates from the NIGFS-Oct survey are more variable than the NIGFS-Mar surveys. The surveys give generally similar trends in SSB, with the exception of the NIGFS-Oct 1998, 2003 and 2006 estimate. These differences are related to the NIGFS-Oct having fewer age groups than the spring survey, which is reflected in the noisier Z trend and less ages being represented in the SSB. The historical trend in recruitment at age 0 is also similar, with a conflicting estimate in the terminal year. The surveys show similar trends in numbers-at-age for the time-series, but there are different estimates of numbers-at-age in the last year for all ages (Figure 9.15).

Figure 9.16 compares the trends in SSB, Z and recruitment from the 2006 final assessment with the SURBA run including an additional year of data. The comparison indicates slight differences in estimates of Z, SSB and recruitment in the last one to two years.

TSA

RGNSDS 2006 suggested that the Working Group should explore the use TSA to overcome problems of incomplete/missing catch. The Working Group attempted this approach and revisited the B-Adapt method, similar to last year.

The TSA model settings are given in Table 9.10. Both the NIGFS survey data were included in the analysis. The parameter estimates are given in Table 9.11. No catch estimate for 2003-2006 was included in the analyses. Summary plots for the TSA run are given in Figure 9.17 and the standardised prediction errors in Figure 9.18. The model is able to fit the historical landings estimate fairly accurately up to 2002. The standardised catch prediction errors is noisy, but show no obvious trends except for a negative trend at age 4 in latter part of time-series. Substantial error distributions are evident around estimates of catch, SSB and recruitment, with unrealistic estimates of catch and SSB towards the end of the time-series. The inability of the model to fit the data is probably due input data constraints. Input data were restrictive due to the short data series and narrow age range. The information in the data series appears insufficient before removing catch information to construct parameter estimates.

B-Adapt

WGNSDS, 2006 performed a series of exploratory B-Adapt runs to examine the influence of the degree of catch or F smoothing on the estimates of population abundance, fishing mortality and bias associated with unallocated removals of landings during 2000–2005. F-smoothing or catch-smoothing generated similar results. The degree of smoothing had very little influence on the results. The exploratory B-Adapt run used official reported landings 2000–2006, the landings including sample-based estimates from 1993–1999 and survey data from the NIGFS-Mar, NIGFS-Oct and MIK net surveys (F smoother of 1.0 applied). Figure 9.19 summarises the trends in SSB, recruitment and fishing mortality from the B-Adapt model and the catchability residuals are given by survey in Figure 9.20. The model, however, produced unsatisfactory results indicating unrealistically high estimates of bias in the 2000–2006 and very low Fs (Table 9.12 gives example output for model with F smoother of 1.0 applied, results from other runs are on the ICES network). Removal estimates for the 2004–2006 period were particularly high. The results reflect the relatively low catches compared to the survey indices (Figure 9.5) in recent years. This could not be explained by the Working Group.

Figure 9.21 present the results of the stochastic projections using the B-Adapt run to provide the starting populations and F-vector. In each case F (2–4), catch, SSB and recruitment (5th, 25th, median 75th and 95th percentiles from the bootstrap distributions) are plotted. Percentiles of F, SSB and removals in 2007, 2008 and 2009 are tabulated. The bootstrapping exercise was performed to explore SSB trends, in particular, under current removal rates. Due to the significant increase in the F in the terminal year the SSB projections show a decreasing trend after 2008, but remain at a relatively high level. The poor estimates of fishing mortality from the B-Adapt model are a large source of error in both the outcome and interpretation of the forecasts.

Conclusions

The Working Group spent considerable amount of time exploring the dynamics and characteristics of various assessment methods to resolve the issue of missing and incomplete catch at age information in recent years.

Figure 9.22 illustrate the landings bias from various sources and highlight the inability of the models, where catch data are excluded, to provide reliable estimates of mortality or catch. The stock trends of the TSA, B-Adapt and SURBA runs are also compared in Figure 9.23. Despite considerable differences in Z trends between the different models, the SSB and recruitment trends are generally consistent between the models (with the exception of the final year recruitment estimate), which hint towards a robust perception of current stock trends.

Model results from the TSA and B-Adapt runs were, however, unsatisfactory. Similar to the 2005–2006 assessment, WG performed a final assessment of recent stock trends based on survey data only.

9.6.1.4 Final assessment

The stock is characterised by highly variable recruitment, however, the NIGFS-Oct survey showed good internal consistency and gives similar trends to the other surveys, but showed variable trends in Z and SBB estimates. A multifleet SURBA run has been attempted in the past, but no convergence was found. This year the problem was not observed. Despite questionable SURBA outputs from a single fleet run using the NIGFS-Oct survey, a multifleet SURBA run including both NIGFS surveys was chosen as the final assessment model. There is reasonable consistency between the survey trends (Figure 9.5) and both surveys indicate similar trends in empirical SSB (Figure 9.10). The multifleet SURBA was thus preferred using all available information. The model settings are given below:

	WGNSDS 2005	WGNSDS 2006	WGNSDS 2007
Year range:	1992–2005	1992–2006	1992–2007
Age range:	1–4	1–5	0–5
Catchability:	1.0 at all ages	1.0 at all ages	1.0 at all ages
Age weighting	1.0 at all ages	1.0 at all ages	1.0 at all ages
Smoothing (Lambda):	1.0	1.0	1.0
Cohort weighting:	not applied	not applied	not applied
Survey used	NIGFS-Mar	NIGFS-Mar	NIGFS-Mar, NIGFS-Oct

The trends in Z, SSB and recruitment from this run, and the model residuals are given in Figures 9.24 and 9.25. The SURBA fitted numbers-at-age and total mortality-at-age given in Table 9.13. The SURBA index of Z follows the much noisier empirical estimates. Both the empirical and SURBA estimates of SSB give a similar increasing trend since 2005. The recruitment estimates at age 1 indicate a higher recruitment in 2007 than in 2006. In general, the SURBA results capture similar year-class dynamics than observed from the raw survey indices (Figure 9.5). The retrospectives for the multifleet SURBA run are given in Figure 9.13.

9.6.1.5 Comparison with 2006 WG assessment

Figure 9.26 compares the relative trends between the SURBA fitted estimates using the NIGFS-Mar survey data in 2006 and both the NIGFS-Mar and NIGFS-Oct surveys in 2007. The SSB estimates from the 2006 assessment were relatively higher since 2003 compared to this year's estimates, but the two series show similar trends. The recruitment estimates show similar signals of year class strength, but the relative strength of the 1999 and 2004 year-classes differ noticeably between the two sets of estimates. The trend in Z from the 2006 SURBA model is generally lower over the entire time-series compared to this year's assessment, which include an additional survey. Despite the different patterns in Z over the entire time-series for the two models, it has relatively little effect on the SSB trends.

9.6.2 Estimating recruiting year class abundance

The SURBA run give model estimates of relative abundance at age up to the 2006 year-class from NIGFS-Mar at age 1. Although only based on one observation, it agrees with the indication of strength of the 2006 year-class of average and similar strength than the 2005 year-class given by the NIGFS-Oct survey at age 0. The UK (NI) MIK net survey at age 0 gives dissimilar estimates, indicating a very strong 2006 year-class.

9.6.3 Long term trends of biomass, recruitment and fishing mortality

Detailed knowledge of the development of this stock is restricted to the recent period for which survey data are available. Figure 9.24 and Table 9.13 summarise the estimates of recruitment, spawning stock biomass, and total mortality Z (2–3) from the SURBA indices for the period 1991 to 2006. The spawning stock biomass increased substantially following entry of the strong 1994 and 1996 year-classes. High fishing mortality combined with weaker year classes in 1997 and 1998 resulted in a decline in abundance from 1999 to 2000. Stronger recruitment in 1999, 2001 and 2003–2004 resulted in an increase in biomass since 2001.

9.6.4 Short-term stock predictions

No short term forecast has been performed in 2007 for this stock.

9.6.5 Medium term predictions

Medium-term predictions were not carried out for this stock. The stock of haddock in the Irish Sea has historically exhibited short-lived periods of population growth, and the recruitment patterns over the time-series are may not represent the potential variability in the forthcoming decade.

9.6.6 Yield and biomass per recruit

Yield per recruit (YPR) and SSB per recruit (SPR) for the Irish Sea stock were calculated by the 2004 WGNSDS, conditional on the exploitation pattern for landings in 2000–2002 given for ages 0 to 5+ by XSA, using MFYPR software. Long-term (1993–2003) catch weights and stock weights-at-age were used. Input data are given in Table 9.14, and the summary output is given in Table 9.15. The YPR and SPR curves are plotted in Figure 9.27.

9.6.7 Reference points

The ACFM view on this stock is that there is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period (ACFM, October 2002). ACFM (2006) proposed that F_{pa} be set at 0.5 by association with other haddock stocks. The absolute level of F in this stock at present is poorly known.

9.6.8 Quality of the assessment

Sampling of landings for length and age appears adequate for years up to 2002 but was inadequate in 2003 to allow compilation of catch at age data. Sampling was improved in 2004 and sampling levels and coverage was adequate in 2005, but deteriorated again in 2006 with limited access to certain sectors of the fleet. The absence of reliable discard estimates is also a potentially serious deficiency that must be addressed if management is to be based on catch-at-age analysis. Landings data for this stock are uncertain because of evidence of a persistent difference between estimates of landings from a routine sampling procedure and official reported landings. Restrictive quotas for some countries caused extensive misreporting during the 1990s prior to the introduction of a separate TAC allocation for the Irish Sea. Whilst unallocated landings estimates appear to have declined since 2000, the recent attempts to reduce fishing mortality substantially through low TACs whilst the stock has continued to grow has coincided with anecdotal information for increased unreported landings. Sample-based estimates of landings suggest that the accuracy of officially reported landings has improved substantially in 2006. The recent reported landings and catch at age data are still considered too inaccurate to form the basis for a traditional analytical assessment based on catch-at-age data.

Survey indices in recent years indicate relatively high abundance of haddock compared to the commercial landings. Although the general trend in landings at age will differ from that of surveys if there are trends in misreporting and fishing mortality, it is currently not possible to reliably determine the relative contribution of these causes.

The narrow age range in the haddock stock and the resulting low numbers caught at older ages in the surveys restricted the number of age classes that could be used in the model. This and the differences in catchability at age between surveys make the total mortality difficult to estimate. The survey data used in the assessment are quite consistent both internally and between fleets, probably due to the very large data contrast between year class strengths as well as the restricted distribution of the stock. The recruitment pattern for this stock since the early 1990s is relatively well established and can be tracked fairly consistently through both the surveys and commercial catches. Hence it can be established with some confidence how, qualitatively, the catch and stock is likely to be impacted in the short term by recent year classes.

Knowledge of basic biology of Irish Sea haddock is expanding through data on growth, maturity and distribution obtained during trawl surveys. Patterns of movement within the Irish Sea and between the Irish Sea and surrounding areas are poorly understood, and it is assumed that the Irish Sea stock is essentially self-sustaining at present. Trends in length and weight-at-age in the stock over time are apparent and reduced growth appears to have coincided with the growth of the stock. This may represent density-dependent growth effects that will affect any forecast and lead to overoptimistic forecast estimates unless correctly predicted.

No forecast was possible using results from the SURBA-based assessment. The problem is with using Z-M as a proxy for F, when the survey Z is really only a measure of loss and not necessarily a measure of total mortality.

The perception of the stock from this year's assessment does not differ qualitatively from that obtained last year.

9.6.9 Management considerations

Following decades of very low recruitment and biomass as indicated by very low fishery catches, this stock grew substantially in the 1990s following sudden pulses of recruitment, and has gone from a minor by-catch species to one of the most economically valuable target species in the Irish Sea. The recruitment signals are clearly revealed by surveys, but the steep age profile in the catches and the resultant dependence of the fishery on highly variable recent year classes means that catch and SSB forecasts are highly uncertain. The WG landings for 2001 and 2002 were 20% and 16% below the status quo forecast. The TACs in those years were expected to reduce fishing mortality by 20% and 62% respectively, and by 52% and 50% in 2004 and 2005. The current assessment has insufficient accuracy to determine if F has reduced by these amounts in 2001–2002 and 2004–2005. The prevention of directed fishing for haddock during the cod closures in 2000–2006, other than during limited fishing experiments, should to have curtailed the directed fisheries on mature haddock that occur in spring.

Haddock in the Irish Sea are taken as both a by-catch in *Nephrops* and cod fisheries, and in a directed fishery using mid-water trawls and otter trawls. The latter fishery also takes a by-catch of cod, which has been a matter of some concern in drawing up the Irish Sea cod recovery programme. The distribution of the haddock stock is largely encompassed by the cod closure, and the closure has impacted directed haddock fishing at a time of year when fishermen claim that haddock are most available. Experimental haddock fishing took place during the 2000 and 2001 cod closure periods to determine the ability of mid-water trawl fishermen to target haddock shoals using echo sounders and hence to minimise the by-catch of cod. The results from 2000 were inconclusive in terms of the impact on cod, and the results from 2001 indicated a by-catch of cod of just over 15%. Hence the possibility of managing haddock fishing mortality in isolation from measures imposed for cod is not yet proven.

Whilst management of fishing mortality on this stock may not prevent it from declining again to low abundance due to natural causes, achieving a fishing mortality close to F_{max} would result in improved YPR and SPR and result in more persistent benefits from strong year classes. However, fishing patterns in the 1990s have shown that restrictive quotas for fleets fishing haddock in the Irish Sea have had little effect on actual landings, and have resulted in very uncertain data on quantities of fish caught by the fleet. The extent of discarding is also uncertain due to inadequate information. It is anticipated that the currently proposed "Irish Sea enhanced data collection programme" will improve the quality of input data into the assessment and aid identification of sources of unallocated removals.

ACFM (2006) proposed that F_{pa} be set at 0.5 by association with other haddock stocks. The assessment since 2004 has been indicative of SSB and recruitment trends only. F/Z is poorly estimated and currently unknown. The stock appears to be in a relatively healthy state with an increasing SSB trend and good recruitment. The use of F reference points are not a sound basis for management for this stock.

The EU Cod Recovery Plan regulation implemented in the Irish Sea from 2004 will impact the management measures for haddock in 2008 and the setting of a TAC for this stock.

Table 9.1. Nominal landings (t) of HADDOCK in Division VIIa, 1984–2006, as officially reported to ICES. (Working Group figures are given in Table 9.2).

COUNTRY	1984	1985	1986	1987	1988	1989	1990	1991	1992
Belgium	3	4	5	10	12	4	4	1	8
France	38	31	39	50	47	n/a	n/a	n/a	73
Ireland	199	341	275	797	363	215	80	254	251
Netherlands	-	-	-	-	-	-	-	-	-
UK (England & Wales)[1]	29	28	22	41	74	252	177	204	244
UK (Isle of Man)	2	5	4	3	3	3	5	14	13
UK (N. Ireland)	38	215	358	230	196	…	…	…	…
UK (Scotland)	78	104	23	156	52	86	316	143	114
Total	**387**	**728**	**726**	**1,287**	**747**	**560**	**582**	**616**	**703**

COUNTRY	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	18	22	32	34	55	104	53	22	68
France	41	22	58	105	74	86	n/a	49	184
Ireland	252	246	320	798	1,005	1,699	759	1,238	652
Netherlands	-	-	-	1	14	10	5	2	-
UK (England & Wales)[1]	260	301	294	463	717	1,023	1,479	1,061	1,238
UK (Isle of Man)	19	24	27	38	9	13	7	19	1
UK (N. Ireland)	…	…	…	…	…	…	…	…	…
UK (Scotland)	140	66	110	14	51	80	67	56	86
Total	**730**	**681**	**841**	**1,453**	**1,925**	**3,015**	**2,370**	**2,447**	**2,229**

COUNTRY	2002	2003	2004	2005	2006
Belgium	44	20	15	22	23
France	72	146	20	36	18
Ireland	401	229	296	139	183
Netherlands	-	-	-	-	
UK (England & Wales)[1]	551	248	421	344	
UK (Isle of Man)	-	-	-	-	
UK (N. Ireland)	…	…	…	…	…
UK (Scotland)	47	31	9	6	
United Kingdom					423*
Total	**1,115**	**674**	**761**	**547**	**647***

***Preliminary.**

[1]1989–2006 Northern Ireland included with England and Wales.

n/a = not available.

Table 9.2. Haddock in VIIa. Total international landings of haddock from the Irish Sea, 1972–2006, as officially reported to ICES. Working Group figures, assuming 1972–1992 official landings to be correct, are also given. The 1993–2005 WG estimates include sampled-based estimates of landings at a number of Irish Sea ports. (Landings in tonnes live weight).

YEAR	OFFICIAL LANDINGS	WG LANDINGS
1972	2204	2204
1973	2169	2169
1974	683	683
1975	276	276
1976	345	345
1977	188	188
1978	131	131
1979	146	146
1980	418	418
1981	445	445
1982	303	303
1983	299	299
1984	387	387
1985	728	728
1986	726	726
1987	1287	1287
1988	747	747
1989	560	560
1990	582	582
1991	616	616
1992	703	656
1993	730	813
1994	681	1043
1995	841	1753
1996	1453	3023
1997	1925	3391
1998	3015	4902
1999	2370	4129
2000	2447	1380
2001	2228	2498
2002	1115	1972
2003	674	n/a
2004	761	1278
2005	547	699
2006	n/a	647

Table 9.3. Haddock in VIIa: Available tuning data (file name: h7ani.tun). Ages used in assessment are in bold type.

```
IRISH SEA haddock, 2007 WG,ANON,COMBSEX,TUNING DATA(effort, nos
at age) 107
NIGFS March [Northern Ireland March Groundfish Survey – Effort:
numbers caught/3 nm]
1992 2007
1 1 0.21 0.25
```

1 5

1	**1525**	**23**	**0**	**0**	**0**	0
1	139	569	31	0	0	0
1	644	58	183	0	0	0
1	24823	437	0	43	0	0
1	1065	3743	67	3	1	0
1	25118	474	1457	44	0	2
1	3913	8694	70	105	1	0
1	6058	680	2072	16	11	0
1	14028	1853	64	147	2	3
1	3277	6990	770	40	20	0
1	28755	842	1059	78	1	0
1	6966	14162	341	356	26	0
1	19945	2379	2206	45	35	0
1	24488	6454	406	234	13	2
1	13444	12721	2194	91	33	0
1	20918	11325	3661	240	16	11

NIGFS Oct [Northern Ireland October Groundfish Survey – Effort: numbers caught/3 nm]

1991 2006

1 1 0.83 0.88

0 3

1	15780	70	0	0	0	0
1	**124**	**784**	**151**	**0**	0	0
1	4462	101	375	3	0	0
1	56683	1137	12	79	0	0
1	1661	10153	74	0	5	0
1	**143300**	**1167**	**1480**	**13**	0	0
1	**16400**	**39680**	**174**	**98**	1	0

1	**41820**	**1243**	**3778**	**22**	3	4
1	**80674**	**2835**	**71**	**145**	0	1
1	**6545**	**8598**	**763**	**31**	39	0
1	**75017**	**2003**	**2742**	**311**	0	20
1	**15116**	**10501**	**86**	**365**	0	0
1	**53922**	**7125**	**3008**	**59**	79	0
1	70337	14413	1261	649	0	0
1	47030	12962	1743	59	8	0
1	35748	10788	3607	392	52	0

MIK net May/June [Northern Ireland Methot-Isaacs Kidd net survey in May/June – Effort: numbers/km^2]

1994 2006

1 1 0.38 0.47

0 0

1	**47000**
1	**1700**
1	**47800**
1	**14500**
1	**2500**
1	**15400**
1	**1700**
1	**17100**
1	**1200**
1	**4250**
1	25970
1	**8250**
1	40240

Table 9.3 contd.

```
Fleets below not included in assessment

IRE OTB [Irish Otter trawl - Effort in hours numbers at age in 1000’s]

1995 2002

1 1 0 1

2 5

   80314   262     29      15    1

   64824  1257     33       1    1

   92178    96    191       7    1

   93533  1341     95     110    3

  110275    56    471       7    1

   82690   118     17      31    3

   77541   232    251      10    5

   77863    97    174      22    1

IR-GFS Autumn [Irish groundfish survey in Autumn (Celtic Explorer)]

2003  2004

1 1 0.89 0.91

0 6

    1170   5520  1069   406     3   4   0   1

    1030   8132  2062   131    46   7   0   0

SGFS Autumn [Scottish groundfish survey in Autumn – Effort: numbers caught/10 hr]

1997 2005

1 1 0.83  0.88

0 3

        1     104     437      4     27   1   0   0

        1     291      29     41      2   2   0   0
```

```
        1    4988     473      0     22   2   0   0
        1     790     332     38      2   4   0   0
        1    1647     389   1462     27  62  60   7
        1     178     189      2     13   2   0   0
        1     601      86    100      5   2   0   0
        1     394     416     39     18   2   0   0
        1    1399     526    171      9   3   0   0
```

SGFS Spring [Scottish groundfish survey in Spring – Effort: numbers caught/10 hr]

```
1997  2006
1 1 0.15 0.21
1 4
       1   6581    65   213     9   2   0
       1    564   472     4     9   0   0
       1    246    21   137     2   1   0
       1    819   338     8    15   0   0
       1     62   299    71     6   5   1
       1    944    72   111    16   0   0
       1    318  1420     7    16   3   0
       1   1591   242   355     0   3   0
       1    514   371    41    40   0   0
       1     97   252    91     0   3   0
```

Table 9.4. Haddock in VIIa: catch numbers-at-age (include partial estimates of misreporting).

TABLE 1 CATCH NUMBERS AT AGE NUMBERS*10-3**

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE														
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0
1	94	30	1341	109	1285	100	91	459	597	120	n/a	54	38	7
2	1250	123	1322	4619	700	6427	519	915	2263	632	n/a	203	523	340

3	18	861	107	735	2411	292	4462	238	1116	1853	n/a	751	133	631
4	1	3	222	16	203	539	49	374	80	196	n/a	76	219	74
+gp	1	2	5	30	16	35	72	28	127	28	n/a	97	43	78
0 TOTALNUM	1364	1019	2997	5509	4615	7393	5193	2014	4183	2829	n/a	1181	956	1130
TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971	n/a	1278	699	647
SOPCOF %	100	100	100	100	95	100	100	97	100	100	n/a	100	99	100

Table 9.5. Haddock in VIIa: catch weights-at-age.

CATCH WEIGHTS AT AGE (KG)														
YEAR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
AGE														
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0
1	0.351	0.346	0.361	0.346	0.348	0.19	0.325	0.329	0.3	0.279	n/a	0.401	0.273	0.244
2	0.596	0.56	0.545	0.474	0.592	0.53	0.416	0.474	0.452	0.357	n/a	0.519	0.417	0.354
3	1.688	1.103	0.898	0.917	1.002	1.13	0.802	0.786	0.859	0.749	n/a	1.007	0.697	0.505
4	2.52	2.73	1.983	2.034	1.349	2	2.064	1.573	1.243	1.361	n/a	1.940	1.256	0.872
+gp	2.52	2.522	2.178	2.682	1.955	2.55	2.854	2.365	1.869	2.107	n/a	2.544	2.268	1.841
SOPCOFAC	0.9995	1.0008	1.0007	1.0029	0.9465	0.9958	0.9996	0.9675	1.0002	0.9991				

Table 9.6. Haddock in VIIa: Estimates of Irish Sea haddock discards 1995–2006. Data are numbers ('000 fish) discarded by the fleet, estimated from numbers per sampled trip raised to total fishing effort by each fleet, for the range of quarters indicated. Tables (b) and (d) represent estimates from limited observer sampling of N.Ireland vessels also included within the self-sampling estimates for N.Ireland trawlers catching *Nephrops* (Table (a)). Table (f) is the total for sampled fleets and quarters, excluding missing quarters or fleets. Table (e) is the revised figures supplied to the 2005 WG.

(a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching *Nephrops* (single and twin trawl) (approx 40 trips sampled per year).

	1996 Q1-4	**1997 Q1-4**	**1998 Q1-4**	**1999 Q1-4**	**2000 Q1-4**	**2001 Q1-4**	**2002 Q1-4**	**2003 Q1**	**2004**	**2005**	**2006**
Age	43 trips	39 trips	48 trips	39 trips	44 trips	43 trips	35 trips	8 trips			
0	4485	100	1552	1274	110	1083	851	0	n/a	n/a	n/a
1	229	1209	318	342	2384	140	1073	62	n/a	n/a	n/a
2	179	88	210	69	253	199	37	28	n/a	n/a	n/a
3	0	0	0	0	0	0	11	0	n/a	n/a	n/a

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only) (*not raised to fleet level – no. of fish).

	1999 Q3-4	**2000 Q1-3**	**2001 Q1**	**2006 Q3-4***
Age	4 trips	6 trips	1 trip	9 trips
0	2185	210	0	8391
1	22	280	1677	809
2	0	57	1593	60
3	0	0	0	15

(c) Observer scheme: N.Ireland midwater trawl.

	1997	**1998**	**1999**	**2000 Q1**	**2001 Q1**

Age	n/a	n/a	5 trips	4 trips	2 trips
0	0	0	68	0	0
1	178	316	96	20	0.4
2	19	1342	35	83	19
3	4	0	2	5	0

(d) Observer scheme: N.Ireland twin trawl (*not raised to fleet level – no. of fish).

	1997	1998	1999 Q4	2000	2001 Q1	2006 Q3-
Age	n/a	n/a	1 trips	10 trips	2 trips	2 trip
0	34	4	26	10	0	363
1	284	205	3	13	3	59
2	6	382	0	10	19	9
3	0.5	0	0	0	0	0

(e) Observer scheme: Republic of Ireland otter trawlers.

	1996	1997 Q1-	1998	1999 Q1-	2000	2001	2002 Q1-	2003	2004 Q1-	2005 Q1-	2006
Age	8 trips	8 trips	7 trips	4 trips	10 trips	2 trips	1 trip	9 trips	11 trips	8 trips	5 trips
0	3808	165	565	87	182	5349	47	1169	5663	776	3966
1	713	11396	1973	58	2193	7354	31	1747	6566	2350	10140
2	297	303	3564	59	580	140	0	1178	2301	996	3856
3	0	0	0	0	0	15	0	10	225	120	132
4	0	0	0	0	0	0	0	0	0	0	0

(f) Total for sampled fleets and quarters: NI self sampling scheme (a); NI midwater trawl (c); ROI otter trawl (e).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age	51 trips	n/a	n/a	48 trips	58 trips	47 trips	36 trips	17 trips	n/a	n/a	n/a
0	8293	265	2117	1429	292	47	36	17	n/a	n/a	n/a
1	942	12783	2607	496	4597	6432	898	1169	n/a	n/a	n/a
2	476	410	5116	163	916	7494	1104	1809	n/a	n/a	n/a
3	0	4	0	2	5	358	37	1206	n/a	n/a	n/a
4	0	0	0	0	0	15	11	10	n/a	n/a	n/a

Table 9.7. Haddock in VIIa: Proportion by number-at-age discarded by sampled fleets.

		Proportion discarded			
Fleet	Period	Age 0	Age 1	Age 2	Age 3
Midwater trawl	Q2-Q4 1997		0.93	0.37	0.02
Midwater trawl	Q1-Q3 1998		0.99	0.16	0.00
Midwater trawl	Q3-Q4 1999	1.00	0.79	0.31	0.00
Midwater trawl	Q1 2000		1.00	0.44	0.04
Midwater trawl	Q1 2001		1.00	0.30	
Single Nephrops	Q3-Q4 1999	1.00	0.94		
Single Nephrops	Q1-Q3 2000	1.00	0.97	0.45	
Single Nephrops	Q1 2001		1.00	0.49	
Single Nephrops	Q3-Q4 2006	1.00	1.00	0.96	0.50
Twin trawl	Q2-Q4 1997	1.00	1.00	0.61	0.04
Twin trawl	Q1-Q3 1998	1.00	1.00	0.76	0.00
Twin trawl	Q4 1999	1.00	1.00		
Twin trawl	Q1 – Q4 2000	1.00	0.96	0.28	
Twin trawl	Q1 2001		1.00	0.12	

Twin trawl	Q3-Q4 2006	1.00	1.00	0.81	0.00

Table 9.8. Haddock in VIIa: total catch numbers-at-age.

CATCH NUMBERS AT AGE						NUMBERS*10**-3								
YEAR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
AGE														
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0
1	959	306	13676	1051	13890	2391	491	5036	8091	1224	n/a	8197	2952	12582
2	1645	162	1740	5095	1091	10201	647	1748	2602	669	n/a	2986	1728	5004
3	18	861	861	735	2411	292	4462	238	1131	1864	n/a	1147	344	863
4	1	3	3	16	203	539	49	374	80	196	n/a	76	219	74
+gp	1	2	2	30	16	35	72	28	127	28	n/a	97	43	78
TOTALNUM	2624	1334	16282	6927	17611	13458	5721	7424	12031	3981		12502	5286	18600
TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971		1278	699	647
SOPCOF %	60	90	26	85	41	67	96	41	51	86		20	33	12

Table 9.9. Haddock in VIIa: stock weights-at-age.

STOCK WEIGHTS AT AGE (KG)															
YEAR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
AGE															
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.090	0.079	0.081	0.079	0.067	0.056	0.054	0.046	0.049	0.048	0.047	0.036	0.033	0.039	0.038
2	0.433	0.349	0.363	0.378	0.370	0.265	0.234	0.237	0.210	0.225	0.219	0.204	0.159	0.149	0.172
3	1.153	0.999	0.810	0.822	0.905	0.769	0.586	0.527	0.565	0.493	0.505	0.485	0.470	0.364	0.344
4	1.893	2.168	1.712	1.321	1.454	1.412	1.301	0.979	0.935	0.984	0.810	0.826	0.835	0.800	0.629
+gp	2.665	3.160	3.229	2.444	2.096	1.986	2.111	1.920	1.586	1.448	1.387	1.174	1.242	1.241	1.225

Table 9.10. Haddock in VIIa: TSA parameter settings for exploratory TSA run.

PARAMETER	SETTING	JUSTIFICATION
Age of full selection.	$a_m = 3$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 1, 4 and 5+ $B_{survey}(a) = 2$ for age 4	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	$H(1) = 2$	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant q by 3)	not implemented	
Discards	No discards included	

Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean η_1 S exp($-\eta_2$ S), where S is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.
Large year classes.	The 1994 and 1996 year classes were large, and recruitment at age 1 in 1995 and 1997 are not well modelled by the Ricker recruitment model. Instead, N(1, 1995) and N(1, 1997) are taken to be normally distributed with mean 5η_1 S exp($-\eta_2$ S). The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966-1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is assumed to be constant.

Table 9.11. Haddock in VIIa. TSA parameter estimates for 2007 and 2004 TSA runs, including survey data (excluding 2003 catch at age data)

PARAMETER	NOTATION	DESCRIPTION	2004 WG	2007 WG	
Initial fishing mortality	F (1, 1993)	Fishing mortality at age *a* in year *y*	0.21	0.19	
	F (2, 1993)		0.77	0.79	
	F (4, 1993)		0.73	0.70	
			NIGFS-March	NIGFS-March	NIGFS-Oct
Survey selectivities	$\Phi(1)$	Survey selectivity at age *a*	0.28	0.11	0.07
	$\Phi(2)$		0.14	0.05	0.02
	$\Phi(4)$		0.08	0.02	0.01
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.00	0.005	
	σ_U	Persistent changes in selection (age effect in F)	0.22	0.48	
	σ_V	Transitory changes in the year effect in fishing mortality	0.00	0.002	
	σ_Y	Persistent changes in the year effect in fishing mortality	0.10	0.15	
				NIGFS-March	NIGFS-Oct
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.57	0.42	0.34
	σ_β	Persistent changes in survey catchability	0.00	0.00 (f)	0.00 (f)
Measurement standard deviations	σ_{landings}	Standard error of landings-at-age data	0.31	0.39	
				NIGFS-March	NIGFS-Oct
	σ_{survey}	Standard error of survey data	0.10	0.33	0.39
Recruitment	η_1	Ricker parameter (slope at the origin)	3.193	1.42	
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.023	0.004	
	cv_{rec}	Standard error of recruitment data	0.67	0.90	

Table 9.12. Haddock in VIIa: Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Lowestoft VPA Program

14/05/2007 17:44

Adapt Analysis

IRISH SE/ 2007 WG 01-May ANON COMBSEX PLUSGROUP

CPUE data from file h7Anitun.dat

Catch data for 14 years : 1993 to 2006. Ages 0 to 5+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
NIGFS Ma	1993	2007	1	4	0.21	0.25
NIGFS Oc	1993	2007	0	3	0.83	0.88
MIK net M	1994	2007	0	0	0.38	0.47

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
NIGFS	0	3
NIGFS	0	3
MIK ne	0	3

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 7 years.

Oldest age F estimates in 1993 to 2007 calculated as 1.000 * the mean F of ages 2- 3

Total F pe lambda = 1.000

Individual fleet weighting not applied

INITIAL S	1812.454
PARAMET	11
OBSERVA	157

SSQ :	79.74338
QSSQ	68.47179
CSSQ	11.27159
IFAIL :	3

IFAILCV = 0

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0	0	0	0	0	0	0	0	0	0
1	0.075	0.061	0.019	0.053	0.122	0.021	0.024	0.017	0.01	0.004
2	0.906	0.634	0.509	0.451	0.23	0.469	0.286	0.244	0.302	0.143
3	1.197	1.371	1.358	0.994	0.704	0.714	0.503	0.471	0.434	1.107
4	1.052	1.003	0.933	0.723	0.467	0.592	0.395	0.358	0.368	0.625

Table 9.12 contd. Haddock in VIIa: Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Population numbers (Thousands)

YEAR	AGE 0	1	2	3	4
1997	2.26E+03	1.97E+04	1.28E+03	3.74E+03	3.38E+02
1998	6.54E+03	1.85E+03	1.49E+04	4.22E+02	9.24E+02
1999	1.73E+04	5.35E+03	1.42E+03	6.49E+03	8.78E+01
2000	6.30E+03	1.42E+04	4.30E+03	7.01E+02	1.37E+03
2001	1.81E+04	5.16E+03	1.10E+04	2.24E+03	2.12E+02
2002	5.22E+03	1.48E+04	3.74E+03	7.14E+03	9.07E+02
2003	1.71E+04	4.27E+03	1.19E+04	1.91E+03	2.86E+03
2004	2.83E+04	1.40E+04	3.42E+03	7.30E+03	9.48E+02
2005	1.54E+04	2.32E+04	1.13E+04	2.19E+03	3.73E+03
2006	2.52E+04	1.26E+04	1.88E+04	6.83E+03	1.16E+03

Estimated population abundance at 1st Jan 2007

0.00E+00	2.06E+04	1.02E+04	1.33E+04	1.85E+03

Taper weighted geometric mean of the VPA populations:

1.00E+04	6.27E+03	4.43E+03	1.44E+03	2.67E+02

Standard error of the weighted Log(VPA populations) :

0.8887	1.1202	1.1436	1.6257	2.2927

Log population residuals (unweighted).

Fleet : NIGFS March

Log index residuals

Age	1993	1994	1995	1996	1997
0	No data for this fleet at this age				
1	-1.19	-1.7	0.68	-0.41	0.29
2	-0.77	-0.8	-0.97	0.01	-0.01
3	1.76	-0.46	99.99	-1.35	0.63
4	99.99	99.99	-0.6	-0.76	-0.5

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	No data for this fleet at this age									
1	0.79	0.15	0.03	-0.4	0.69	0.52	0.38	0.08	0.09	99.99
2	0.38	0.15	0.04	0.38	-0.61	1.02	0.47	0.29	0.42	99.99
3	-0.18	0.47	-0.86	0.39	-0.44	-0.31	0.21	-0.29	0.42	99.99
4	-0.64	-0.19	-0.76	-0.26	-1.02	-0.69	-1.67	-1.38	-1.1	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4
Mean Log	0.0222	-0.7301	-1.2545	-1.2545
S.E(Log q	0.7188	0.5795	0.7794	0.9396

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	0.75	2.05	2.14	0.85	14	0.48523	0.02
2	0.76	2.703	2.55	0.92	14	0.36248	-0.73
3	1.18	-1.049	0.15	0.76	13	0.91473	-1.25
4	1.2	-2.009	1.21	0.91	12	0.45895	-2.05

Table 9.12 contd. Haddock in VIIa: Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Fleet : NIGFS Oct

Log index residuals

Age	1993	1994	1995	1996	1997
0	-1.01	0.24	-1.23	0.77	0.96
1	-1.03	-0.79	0.19	0.05	1.12
2	0.15	-1.08	-1.36	0.5	0.52
3	1.25	0.39	99.99	-1.32	-0.32
4	No data for this fleet at this age				

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.84	0.52	-0.98	0.4	0.04	0.13	-0.11	0.1	-0.67	99.99
1	0.01	-0.27	-0.1	-0.49	0.03	0.89	0.4	-0.22	0.2	99.99
2	0.9	-0.83	0.39	0.55	-1.64	0.61	0.95	0.13	0.21	99.99
3	0.51	-0.35	0.03	0.92	-0.07	-0.76	0.28	-0.95	0.38	99.99
4	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0	1	2	3
Mean Log	1.1908	-0.183	-1.5648	-2.1235
S.E(Log q	0.7169	0.5771	0.8546	0.7357

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	0.83	0.909	0.58	0.7	14	0.59915	1.19
1	0.79	2.075	1.97	0.89	14	0.40749	-0.18
2	0.72	2.131	3.49	0.83	14	0.54446	-1.56
3	1.24	-1.461	0.87	0.78	13	0.86942	-2.12

Fleet : MIK net May/June

Log index residuals

Age	1993	1994	1995	1996	1997
0	99.99	1.23	-0.03	0.85	2.02
1	No data for this fleet at this age				
2	No data for this fleet at this age				
3	No data for this fleet at this age				
4	No data for this fleet at this age				

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-0.8	0.05	-1.15	0.11	-1.31	-1.23	0.08	-0.46	0.63	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	0
Mean Log	-0.0777
S.E(Log q	1.0057

Table 9.12 contd. Haddock in VIIa: Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
0	1	-0.006	0.06	0.44	13	1.05254	-0.08

Year	Est.Landir	Landings	Bias
1993	813	813	
1994	1042	1043	
1995	1752	1753	
1996	3014	3023	
1997	3583	3391	
1998	4923	4902	
1999	4131	4129	
2000	2363	1569	1.506
2001	2304	2226	1.035
2002	3882	1215	3.196
2003	3858	674	5.716
2004	4492	760	5.911
2005	3447	533	6.465
2006	4335	647	6.682

Fishing Mortality

YEAR	AGE				
	0	1	2	3	4
1993	0	0.23529	0.59282	1.32486	0.95884
1994	0	0.00924	0.54782	1.12381	0.83581
1995	0	0.11862	0.68097	1.44502	1.063
1996	0	0.0742	0.74325	1.07443	0.90884
1997	0	0.07474	0.9063	1.19749	1.05189
1998	0	0.06145	0.6344	1.37124	1.00282
1999	0	0.01893	0.50879	1.35767	0.93323
2000	0	0.05337	0.45146	0.99389	0.72268
2001	0	0.12202	0.2305	0.70449	0.46749
2002	0	0.02117	0.469	0.71413	0.59156
2003	0	0.02388	0.28637	0.50281	0.39459
2004	0	0.0169	0.24424	0.47143	0.35784
2005	0	0.00959	0.30189	0.43425	0.36807
2006	0	0.00411	0.14286	1.10661	0.62474
2007	0	0.00411	0.14286	1.10661	0.62474

Parameters

Age	Survivor:	s.e log est
0	20625.36	0.44851
1	10249.51	0.33309
2	13330.94	0.28689
3	1848.089	0.46152

Year	Multiplier	s.e log est
8	1.50619	0.2569
9	1.03497	0.28995
10	3.19604	0.27743
11	5.71571	0.29742
12	5.91093	0.30205
13	6.46481	0.30664
14	6.68161	0.29744

Variance covariance matrix

0.20116	0.0171	0.01449	0.00665	0.01174	0.01483	0.01543	0.01496	0.01474	0.01515	0.01541
0.0171	0.11095	0.02331	0.00408	0.01135	0.01421	0.01432	0.01209	0.00923	0.00704	0.02493
0.01449	0.02331	0.0823	0.00789	0.011	0.0134	0.01291	0.01065	0.00714	0.01854	0.01761
0.00665	0.00408	0.00789	0.213	0.01134	0.01357	0.01046	0.00175	-0.01317	-0.03881	-0.04679
0.01174	0.01135	0.011	0.01134	0.066	0.02876	0.01413	0.00844	0.00772	0.00857	0.00968
0.01483	0.01421	0.0134	0.01357	0.02876	0.08407	0.0356	0.01495	0.00804	0.00783	0.0096
0.01543	0.01432	0.01291	0.01046	0.01413	0.0356	0.07696	0.03394	0.01582	0.00925	0.00861
0.01496	0.01209	0.01065	0.00175	0.00844	0.01495	0.03394	0.08846	0.0412	0.01884	0.00869
0.01474	0.00923	0.00714	-0.01317	0.00772	0.00804	0.01582	0.0412	0.09123	0.04307	0.01813
0.01515	0.00704	0.01854	-0.03881	0.00857	0.00783	0.00925	0.01884	0.04307	0.09403	0.04081
0.01541	0.02493	0.01761	-0.04679	0.00968	0.0096	0.00861	0.00869	0.01813	0.04081	0.08847

Table 9.13. Haddock in VIIa: SURBA 3.0 fitted numbers-at-age, total mortality-at-age, SSB and Z using the NIGFS-Mar survey data.

NIGFS-March												
	Numbers at age						Total mortality at age					
	Age						Age					
Year	0	1	2	3	4	5	0	1	2	3	4	5
1991	0.134	0.030	0	0	0		-1.413	0.946	0.947	1.004	0.835	0.835
1992	0.006	0.551	0.012	0	0	0	-1.937	1.297	1.298	1.377	1.145	1.145
1993	0.044	0.040	0.151	0.003	0	0	-2.169	1.453	1.454	1.542	1.282	1.282
1994	0.536	0.386	0.009	0.035	0.001	0	-2.261	1.514	1.515	1.607	1.336	1.336
1995	0.033	5.138	0.085	0.002	0.007	0	-2.678	1.794	1.795	1.904	1.583	1.583
1996	1.450	0.479	0.855	0.014	0	0.001	-2.183	1.462	1.463	1.552	1.290	1.290
1997	0.080	12.863	0.111	0.198	0.003	0	-2.551	1.708	1.71	1.813	1.507	1.507
1998	0.209	1.020	2.331	0.020	0.032	0.001	-2.935	1.966	1.968	2.087	1.735	1.735
1999	0.261	3.927	0.143	0.326	0.003	0.006	-3.09	2.07	2.071	2.197	1.826	1.826
2000	0.091	5.728	0.496	0.018	0.036	0	-2.225	1.490	1.491	1.581	1.315	1.315
2001	0.807	0.844	1.291	0.112	0.004	0.010	-2.227	1.491	1.493	1.583	1.316	1.316
2002	0.205	7.481	0.190	0.290	0.023	0.001	-2.267	1.518	1.519	1.611	1.34	1.34
2003	0.855	1.975	1.639	0.042	0.058	0.006	-2.034	1.362	1.364	1.446	1.202	1.202
2004	0.881	6.535	0.506	0.419	0.010	0.017	-2.4	1.607	1.609	1.706	1.418	1.418
2005	0.477	9.713	1.310	0.101	0.076	0.002	-2.451	1.641	1.643	1.742	1.448	1.448
2006	0.929	5.527	1.882	0.253	0.018	0.018	-1.782	1.193	1.194	1.267	1.053	1.053
2007		5.518	1.676	0.570	0.071	0.006	-2.211	1.481	1.482	1.572	1.307	1.307

Stock summary

Year	Recruits (age 0)	log SE (rec)	SSB	TSB	Z(2-3)	SE (Z)
1991	0.134	1.473			0.975	0.776
1992	0.006	1.561	0.005	0.055	1.337	0.399
1993	0.044	1.682	0.069	0.073	1.498	0.303
1994	0.536	1.739	0.040	0.070	1.561	0.294
1995	0.033	2.025	0.045	0.461	1.849	0.306
1996	1.450	1.710	0.339	0.376	1.507	0.282
1997	0.080	1.94	0.225	1.086	1.761	0.283
1998	0.209	2.205	0.680	0.737	2.027	0.288
1999	0.261	2.329	0.240	0.452	2.134	0.300
2000	0.091	1.747	0.163	0.427	1.536	0.276
2001	0.807	1.719	0.353	0.394	1.538	0.28
2002	0.205	1.749	0.210	0.569	1.565	0.283
2003	0.855	1.595	0.435	0.528	1.405	0.274
2004	0.881	1.831	0.335	0.570	1.657	0.283
2005	0.477	1.875	0.322	0.643	1.692	0.289
2006	0.929	1.479	0.409	0.625	1.230	0.319

Table 9.14. Haddock in VIIa: Input for yield/Recruit.

MFYPR version 2a
Run: Had7a_2004WG_yield
Had7a_2004WG_yieldMFYPR Index file 11/05/2004
Time and date: 10:55 13/05/2004
Fbar age range: 2-4

Age	M	Mat	PF	PM	SWt	Sel	CWt
0	0.2	0	0	0	0.000	0.000	0.000
1	0.2	0	0	0	0.061	0.140	0.322
2	0.2	1	0	0	0.302	0.544	0.492
3	0.2	1	0	0	0.754	1.118	0.967
4	0.2	1	0	0	1.377	1.057	1.814
5	0.2	1	0	0	2.259	1.057	2.308

Weights in kilograms

Table 9.15. Haddock in VIIa: Yield per recruit output table.

MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	5.8695	3.6979	5.8200	3.6979	5.8200
0.1000	0.0906	0.2211	0.3492	4.4167	3.5229	2.5980	3.4733	2.5980	3.4733
0.2000	0.1813	0.3298	0.4658	3.8781	2.4296	2.0593	2.3801	2.0593	2.3801
0.3000	0.2719	0.3951	0.5037	3.5564	1.8139	1.7377	1.7644	1.7377	1.7644
0.4000	0.3626	0.4390	0.5098	3.3412	1.4279	1.5225	1.3783	1.5225	1.3783
0.5000	0.4532	0.4709	0.5022	3.1861	1.1681	1.3674	1.1186	1.3674	1.1186
0.6000	0.5439	0.4952	0.4888	3.0683	0.9843	1.2496	0.9347	1.2496	0.9347
0.7000	0.6345	0.5146	0.4735	2.9752	0.8490	1.1564	0.7995	1.1564	0.7995
0.8000	0.7252	0.5305	0.4580	2.8993	0.7464	1.0805	0.6969	1.0805	0.6969
0.9000	0.8158	0.5438	0.4431	2.8358	0.6666	1.0171	0.6170	1.0171	0.6170
1.0000	0.9065	0.5552	0.4293	2.7818	0.6030	0.9631	0.5535	0.9631	0.5535
1.1000	0.9971	0.5651	0.4167	2.7350	0.5515	0.9163	0.5019	0.9163	0.5019
1.2000	1.0878	0.5739	0.4052	2.6939	0.5090	0.8751	0.4594	0.8751	0.4594
1.3000	1.1784	0.5817	0.3947	2.6573	0.4733	0.8386	0.4238	0.8386	0.4238
1.4000	1.2691	0.5887	0.3853	2.6245	0.4431	0.8057	0.3936	0.8057	0.3936
1.5000	1.3597	0.5951	0.3768	2.5947	0.4172	0.7760	0.3676	0.7760	0.3676
1.6000	1.4503	0.6009	0.3692	2.5676	0.3946	0.7489	0.3451	0.7489	0.3451
1.7000	1.5410	0.6063	0.3622	2.5427	0.3749	0.7240	0.3253	0.7240	0.3253
1.8000	1.6316	0.6113	0.3559	2.5197	0.3574	0.7010	0.3079	0.7010	0.3079
1.9000	1.7223	0.6159	0.3501	2.4983	0.3418	0.6796	0.2923	0.6796	0.2923
2.0000	1.8129	0.6202	0.3449	2.4784	0.3278	0.6597	0.2783	0.6597	0.2783

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	0.9065
FMax	0.3811	0.3455
F0.1	0.2074	0.188
F35%SPR	0.2494	0.2261

Weights in kilograms

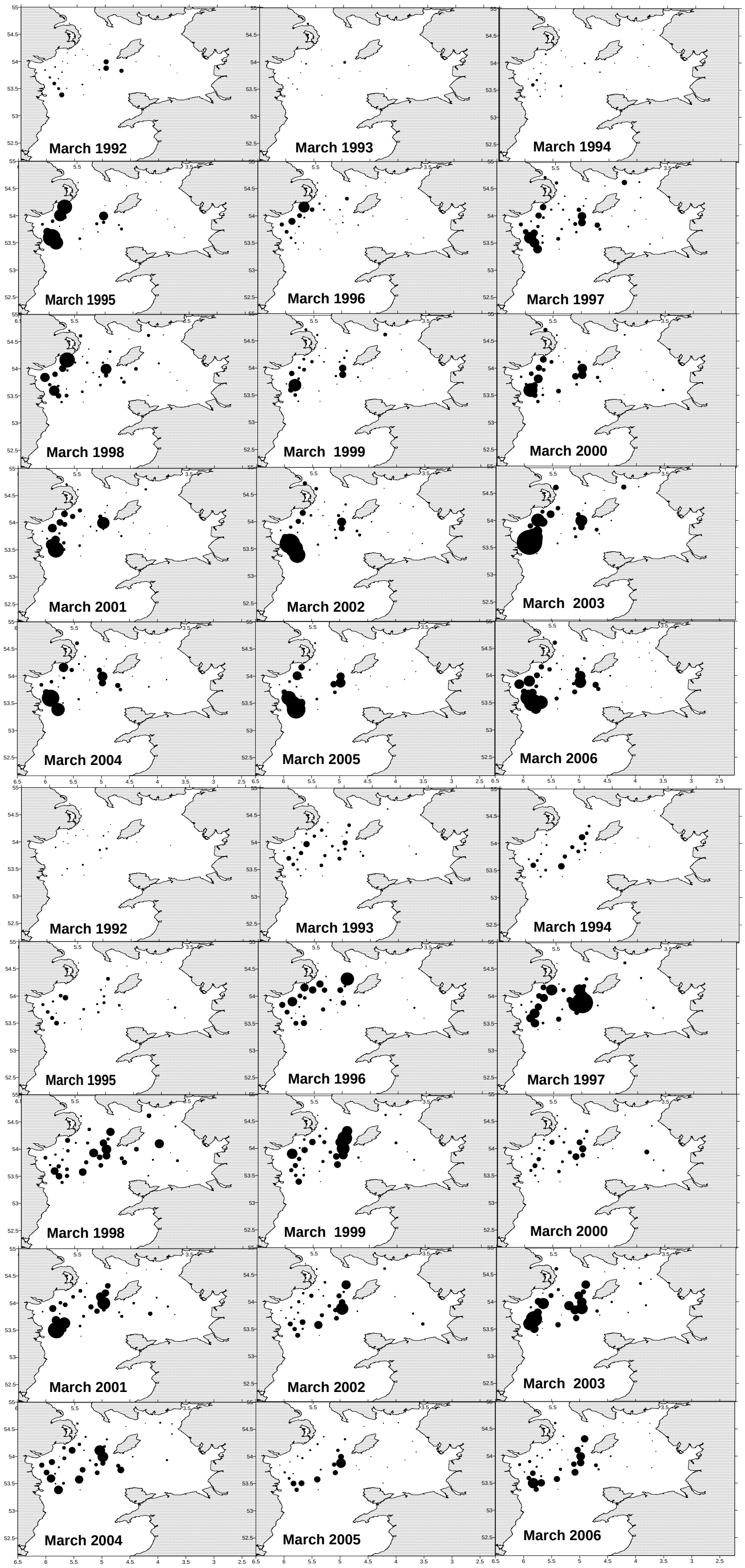


Figure 9.1. Haddock in VIIa: Distribution of haddock less than MLS (30 cm) (top plot) and above MLS (bottom plot) in spring, based on NIGFS March surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 665 (top) and 450 kg per 3 miles (bottom).

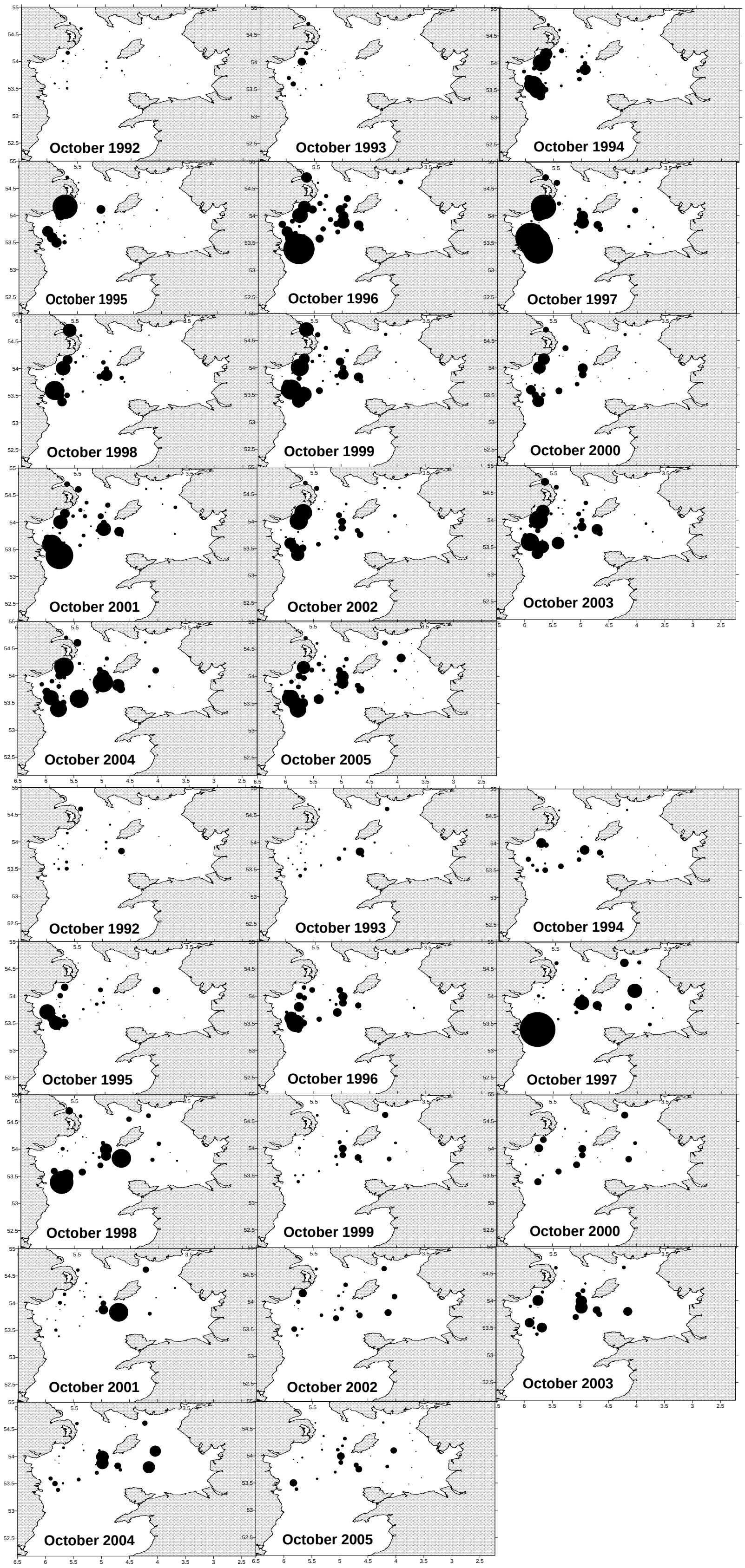


Figure 9.2. Haddock in VIIa: Distribution of haddock less than MLS (30 cm) (top plot) and above MLS (bottom plot) in autumn, based on NIGFS October surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 1 030 (top) and 880 kg per 3 miles (bottom).

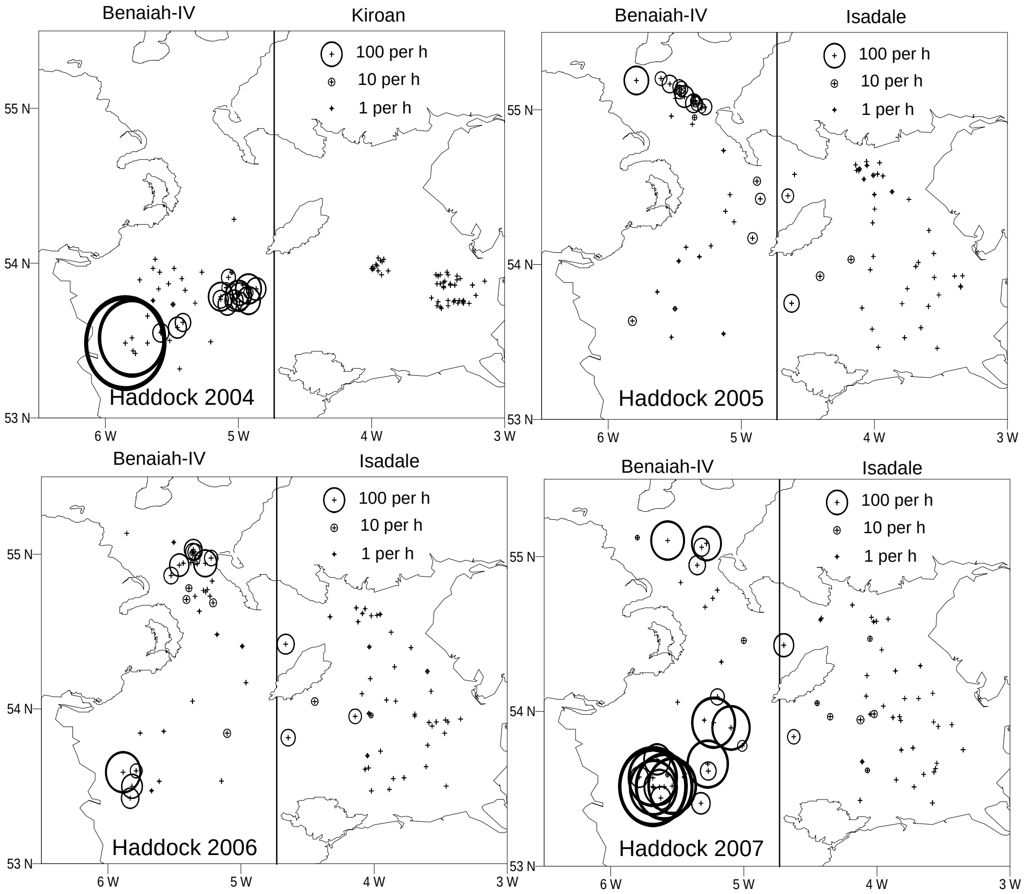


Figure 9.3. Distribution of haddock during the 2004–2007 Irish Sea roundfish FSP. The areas of the circles are proportional to numbers caught per hour (same scale for all plots).

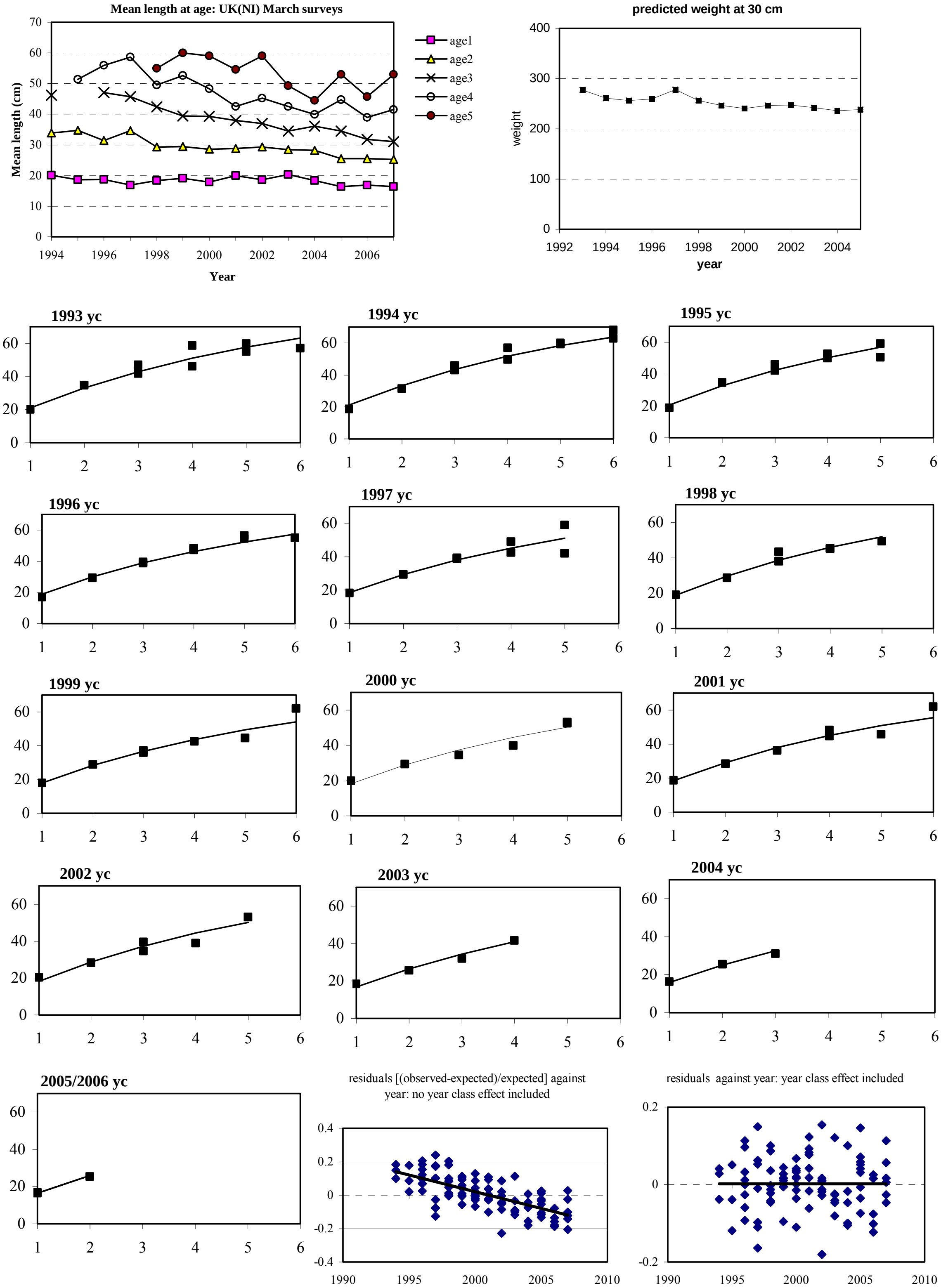


Figure 9.4. Growth of haddock in the Irish Sea. Top two panels: mean length-at-age in N.Ireland groundfish surveys in March, by year and age, and expected mean weight-at-length based on length-weight parameters from each survey. Lower panels: mean length-at-age from March surveys, and from Quarter 1 commercial landings at age 3 and over, by year class. Lines are Von Bertalanffy model fits with year class effect included. Model residuals are shown for the fit without year class effects, and for the fit with year class effects.

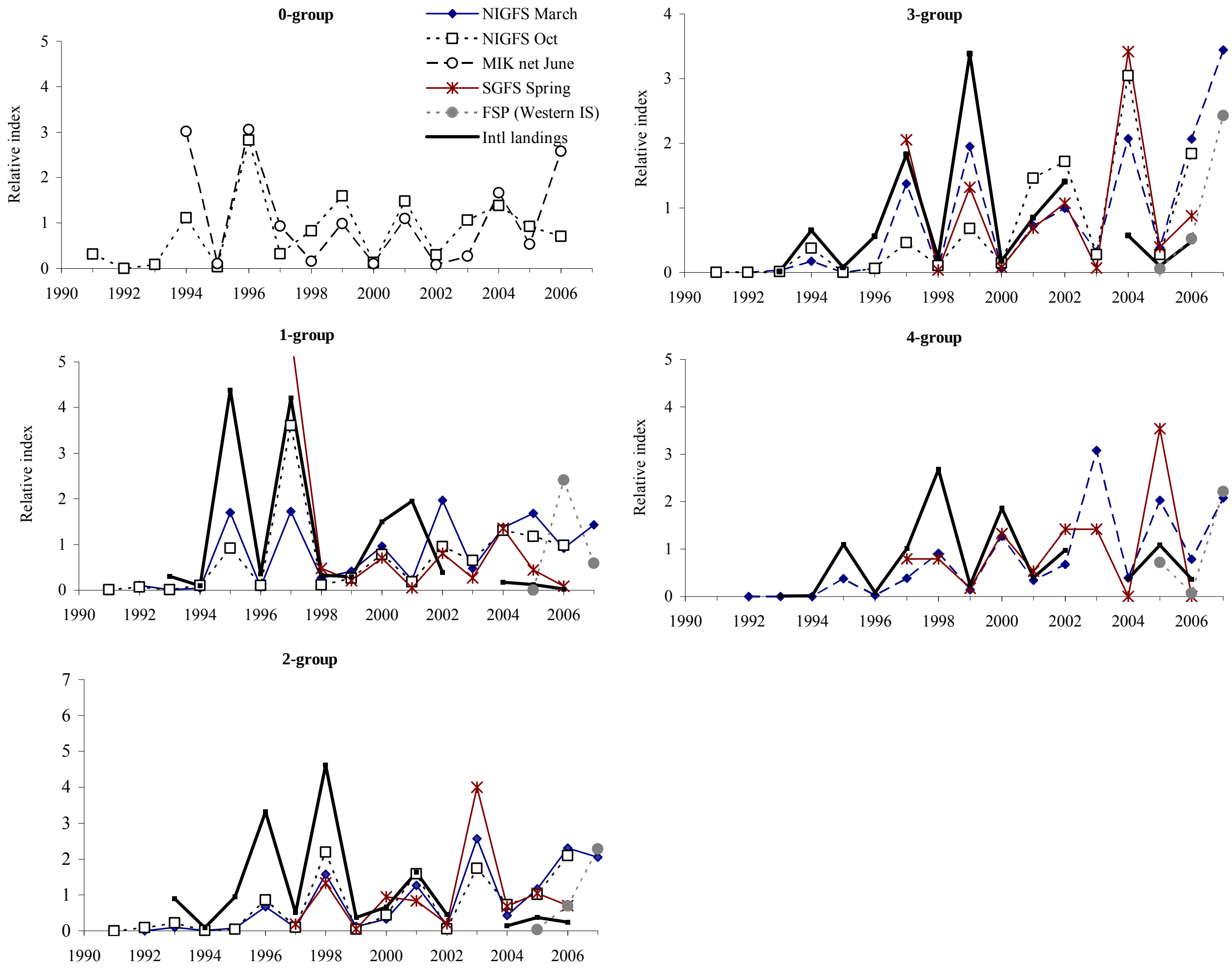


Figure 9.5. Haddock in VIIa: Trends in raw survey indices compared with international landings, by age class and year. All values are standardised to the mean for years common to all series in each plot (except for short FSP series).

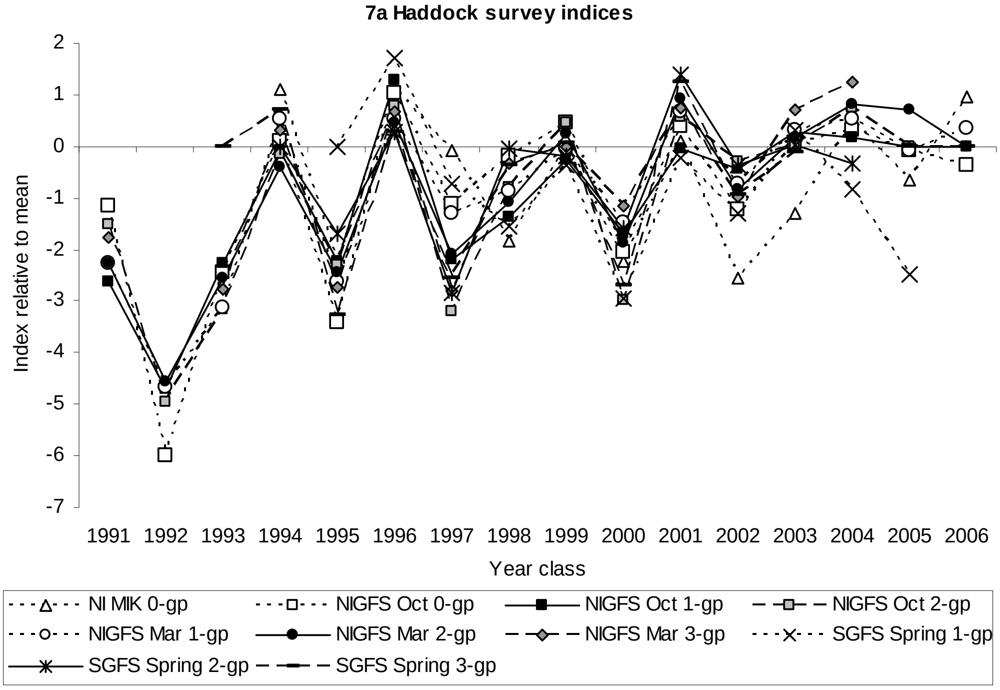


Figure 9.6. Haddock in VIIa: Time-series plots of the logarithms of survey indices at age by year class, after standardising by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year class signals.

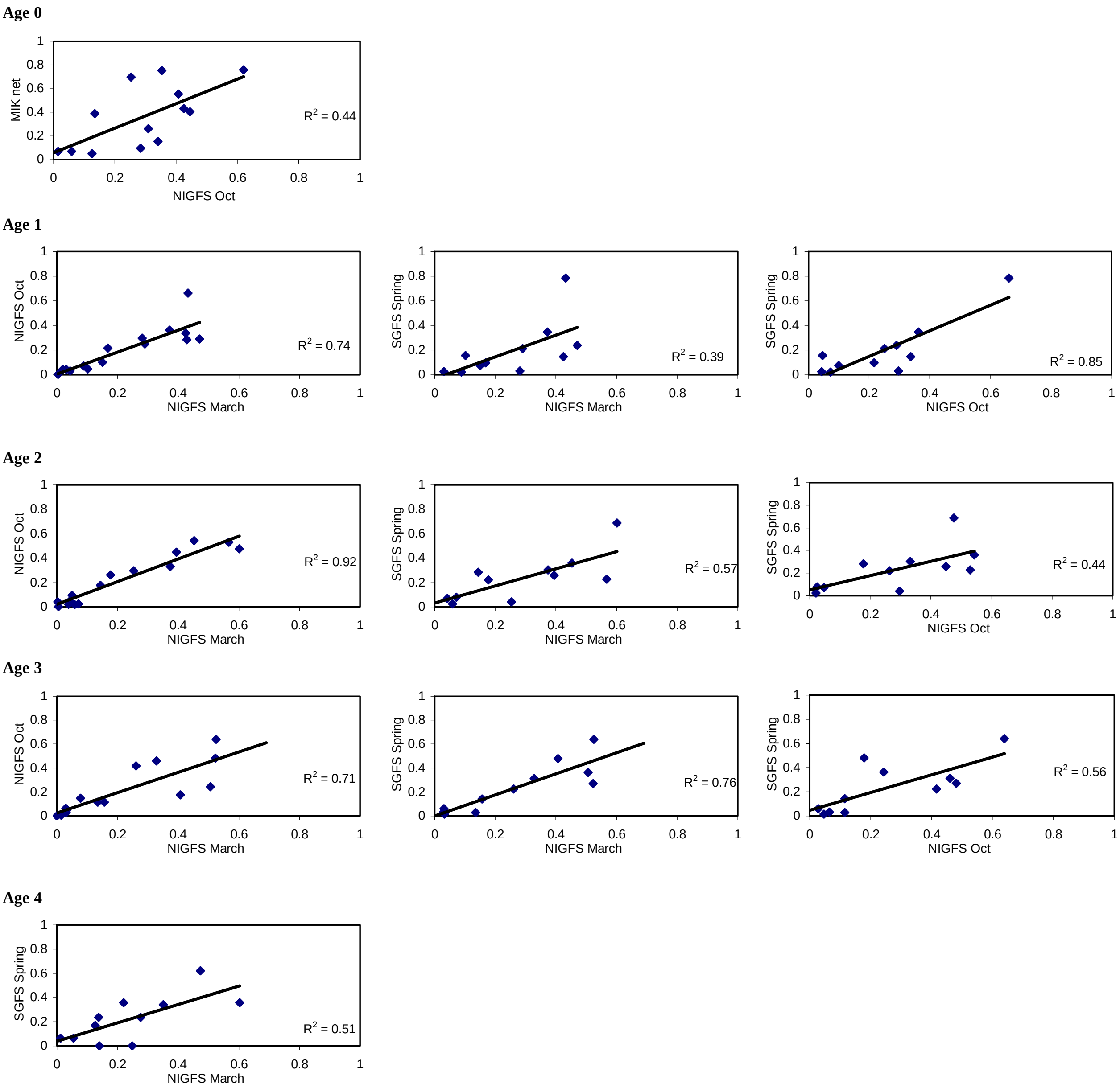


Figure 9.7. Haddock in VIIa: Correlation between survey series by age class.

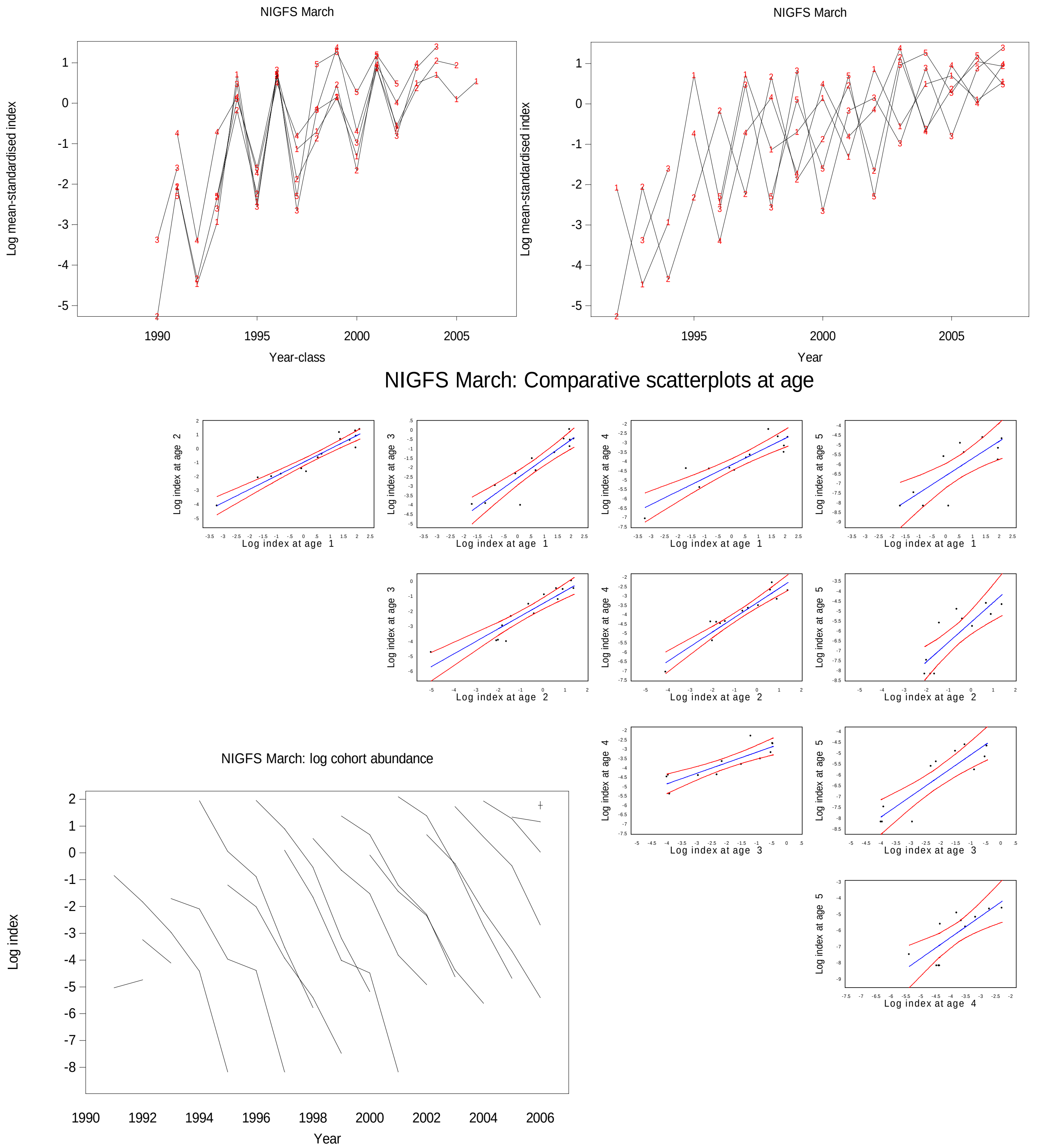


Figure 9.8. Haddock in VIIa: Output from SURBA (ver. 3.0) plots for NIGFS March survey (ages 1–5), showing log mean-standardised indices by year and age class, scatter plots and catch curves.

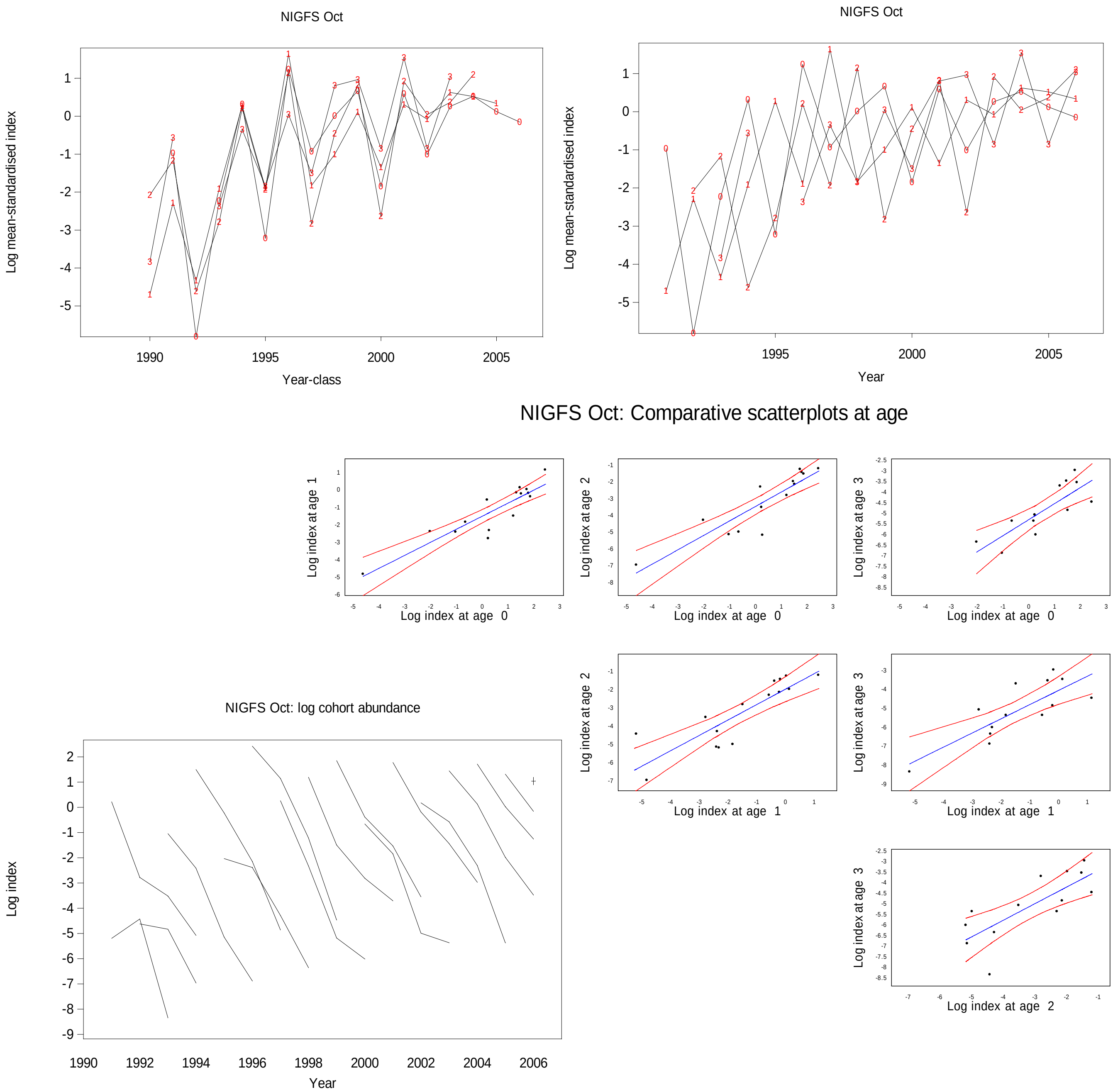


Figure 9.9. Haddock in VIIa: Output from SURBA (ver. 3.0) plots for NIGFS October survey (ages 0–3), showing log mean-standardised indices by year and age class, scatter plots and catch curves.

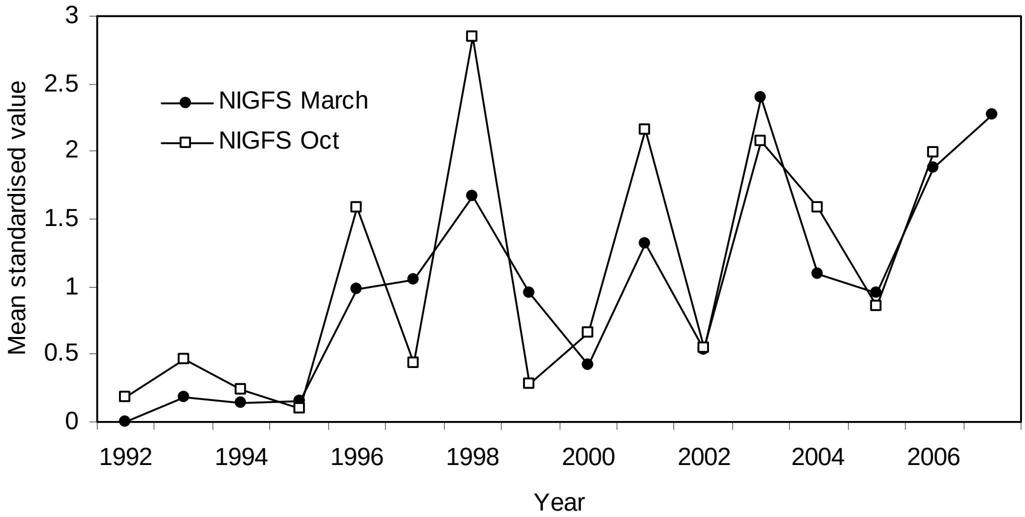


Figure 9.10. Haddock in VIIa: Mean Standardised empirical SSB indices from the NIGFS-Mar, NIGFS-Oct and ScoGFS-Spring surveys, based on raw indices up to age 6.

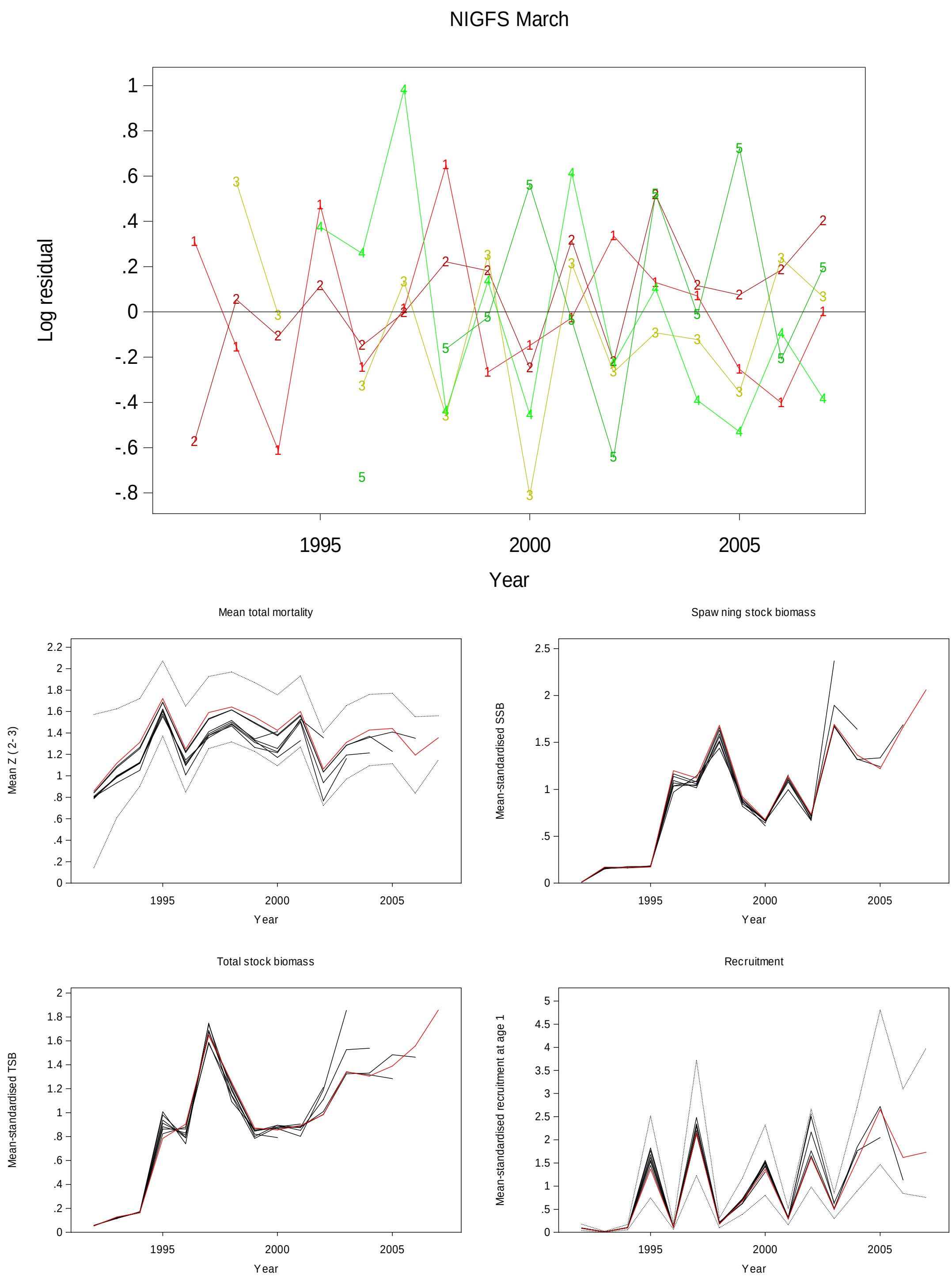


Figure 9.11. Haddock VIIa: SURBA 3.0 Residuals at age (top panel) and retrospective plots (bottom panel) for the NIGFS-Mar survey.

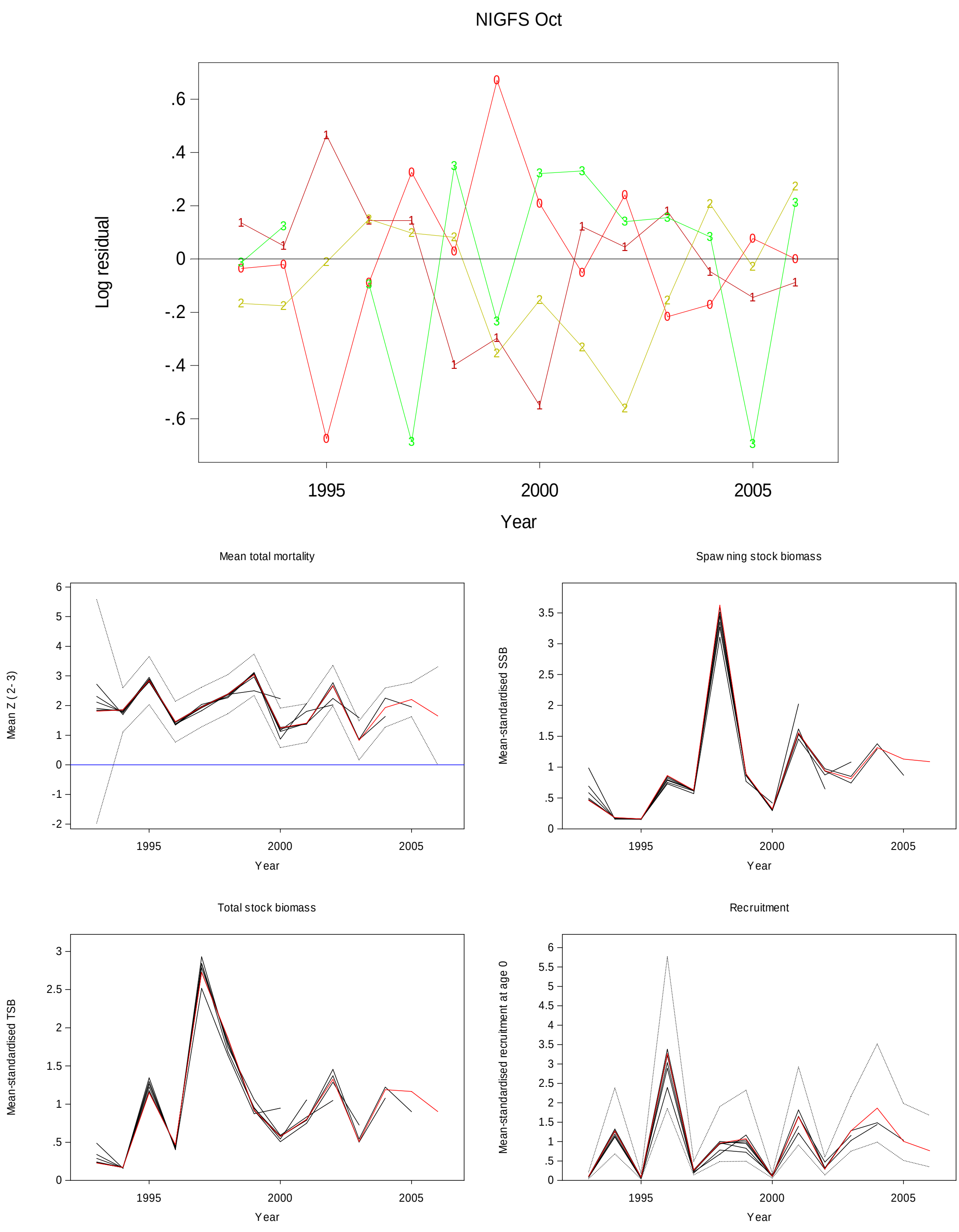


Figure 9.12. Haddock VIIa: SURBA 3.0 Residuals at age (top panel) and retrospective plots (bottom panel) for the NIGFS-Oct survey (poor convergence).

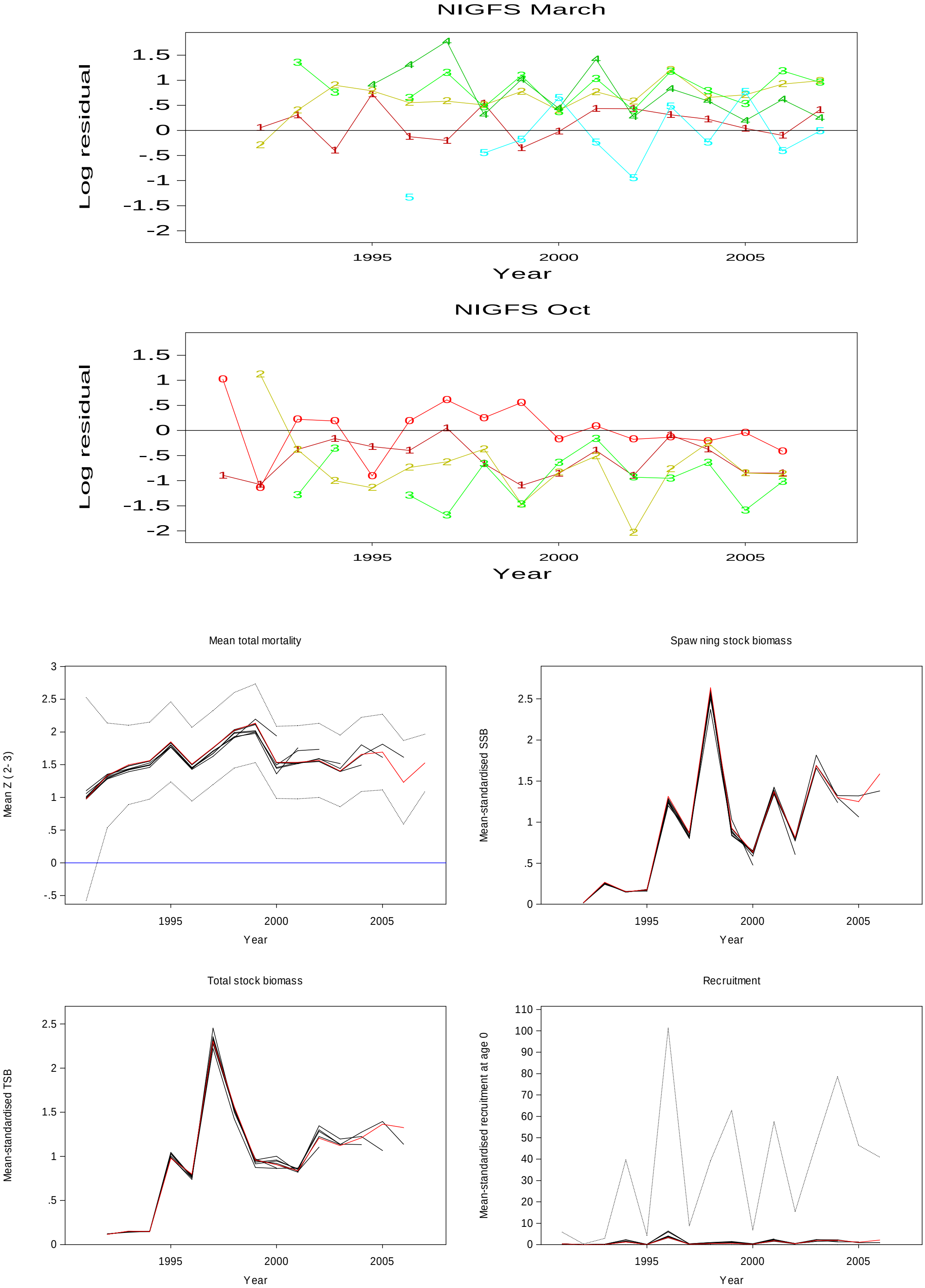


Figure 9.13. Haddock VIIa: SURBA 3.0 Residuals at age (top panel) and retrospective plots (bottom panel) for the combined SURBA run using both NIGFS surveys.

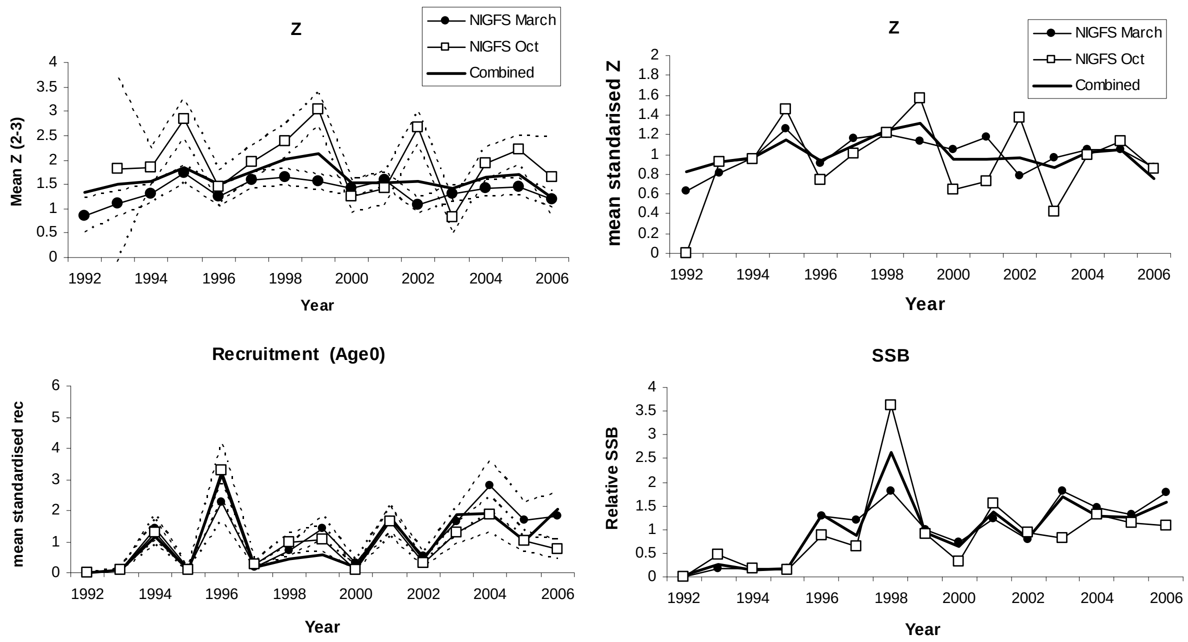


Figure 9.14. Haddock in VIIa: Comparison of SURBA runs using NIGFS-Mar and NIGFS-Oct survey data, individually and combined. Dotted lines are +/- 1SE. Z estimates given as absolute and relative.

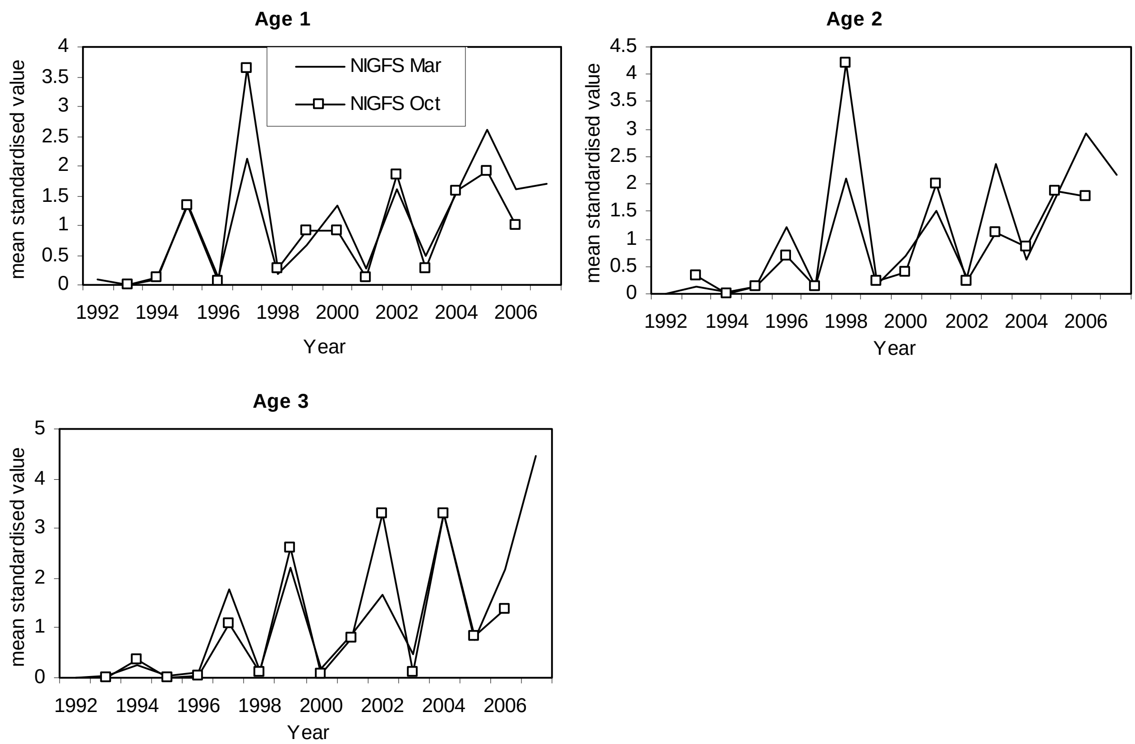


Figure 9.15. Haddock in VIIa: Comparison of SURBA estimates of numbers-at-age (mean standardised) using NIGFS-Mar and NIGFS-Oct survey data.

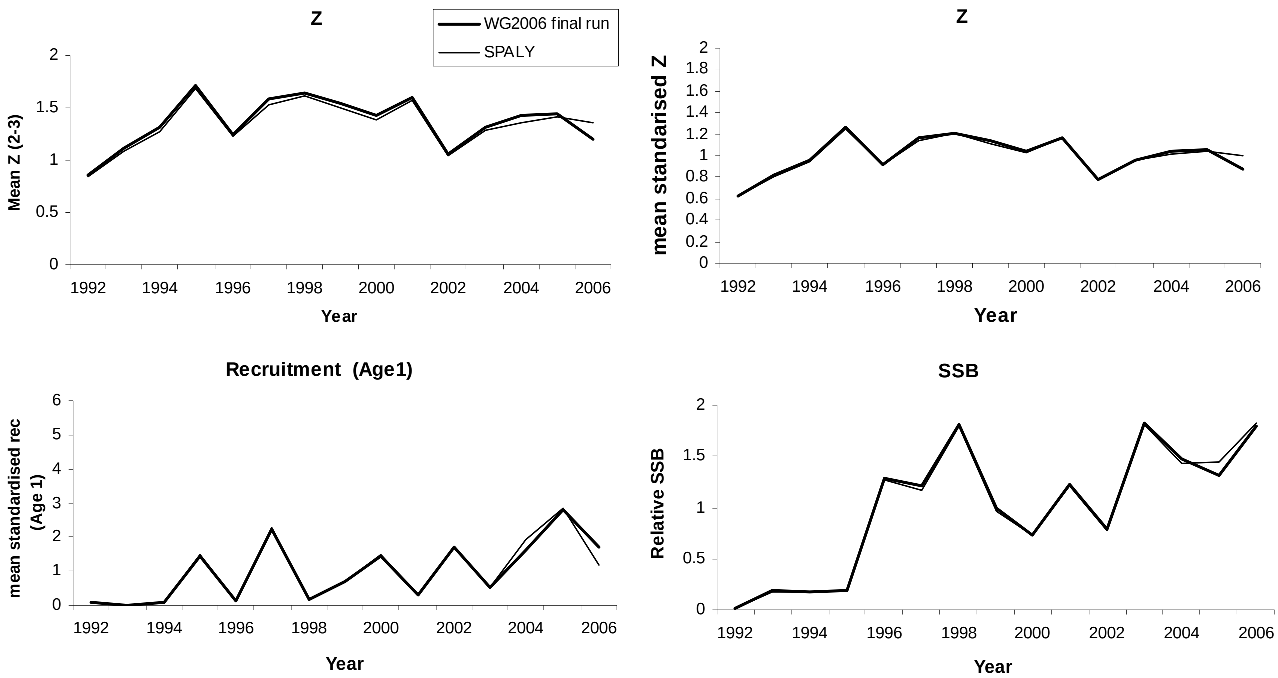


Figure 9.16. Haddock VIIa: Results of SPALY SURBA run using NIGFS-Mar survey data (ages 1–4).

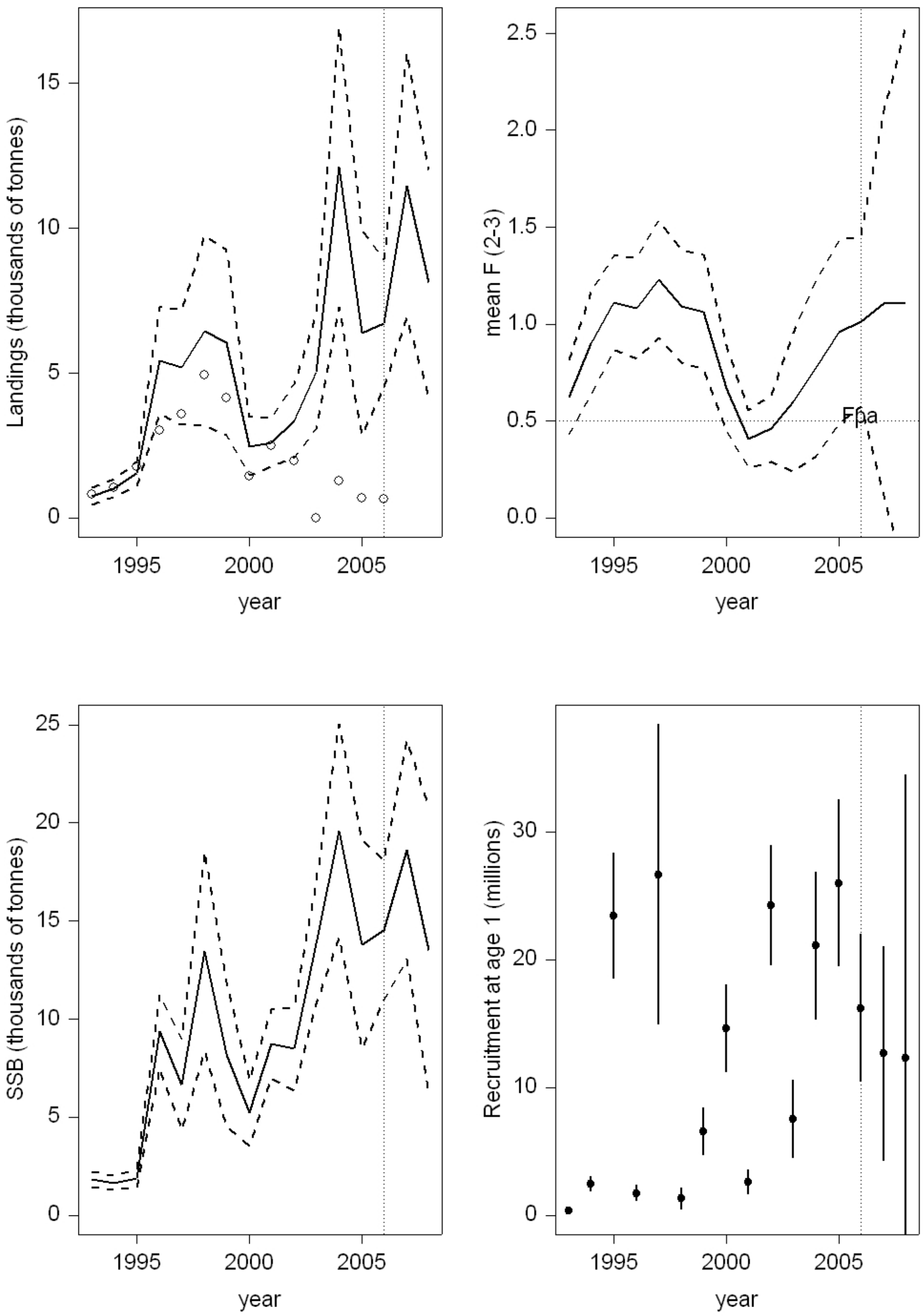


Figure 9.17. Haddock in VIIa: TSA summary plots of landings, F(2–3), SSB and recruitment for run excluding catch data from 2003–2006.

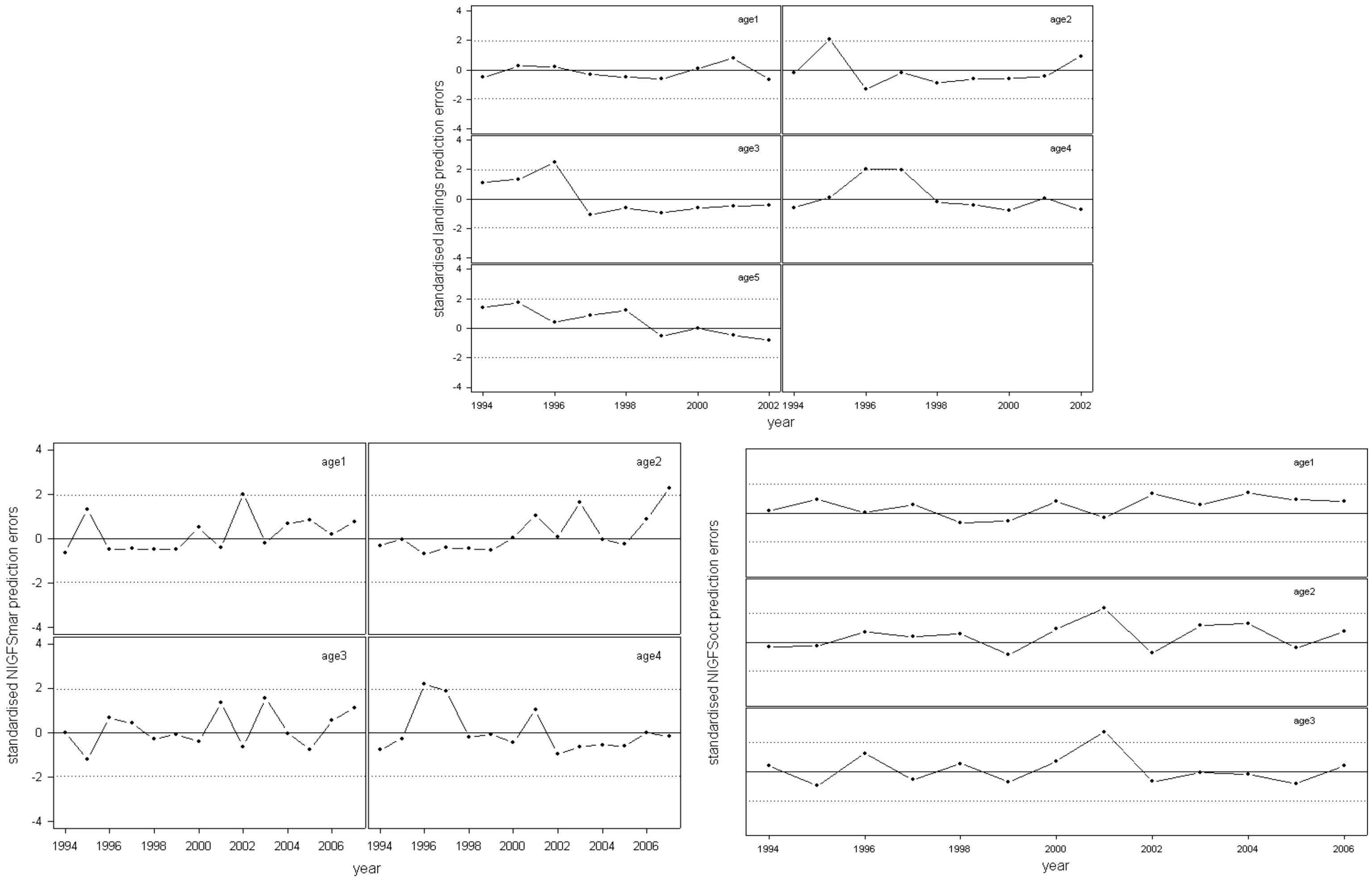


Figure 9.18. Haddock in VIIa: Standardised catch (top panel) and survey prediction errors (NIGFS-Mar – bottom left and NIGFS-Oct – bottom right) for TSA run.

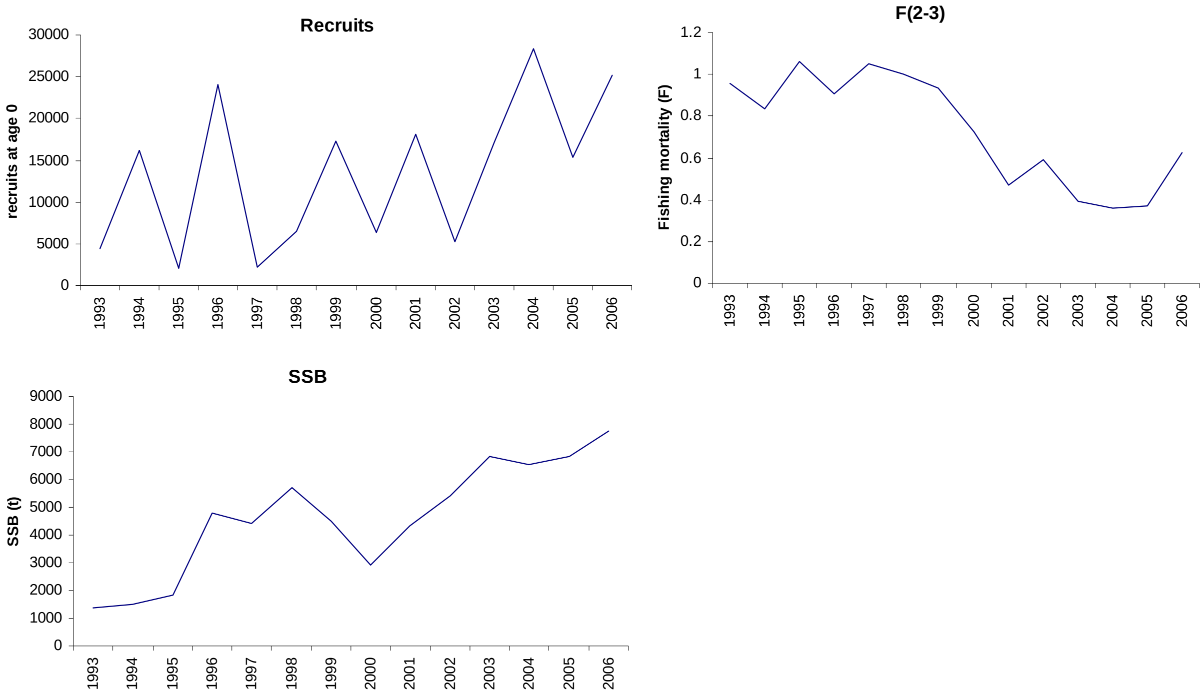


Figure 9.19. Haddock VIIa: Summary plots of F(2–3), SSB and recruitment from exploratory B-ADAPT run applying a F smoother of 1.0, using tuning data from the NIGFS-Mar, NIGFS-Oct and MIK-net surveys.

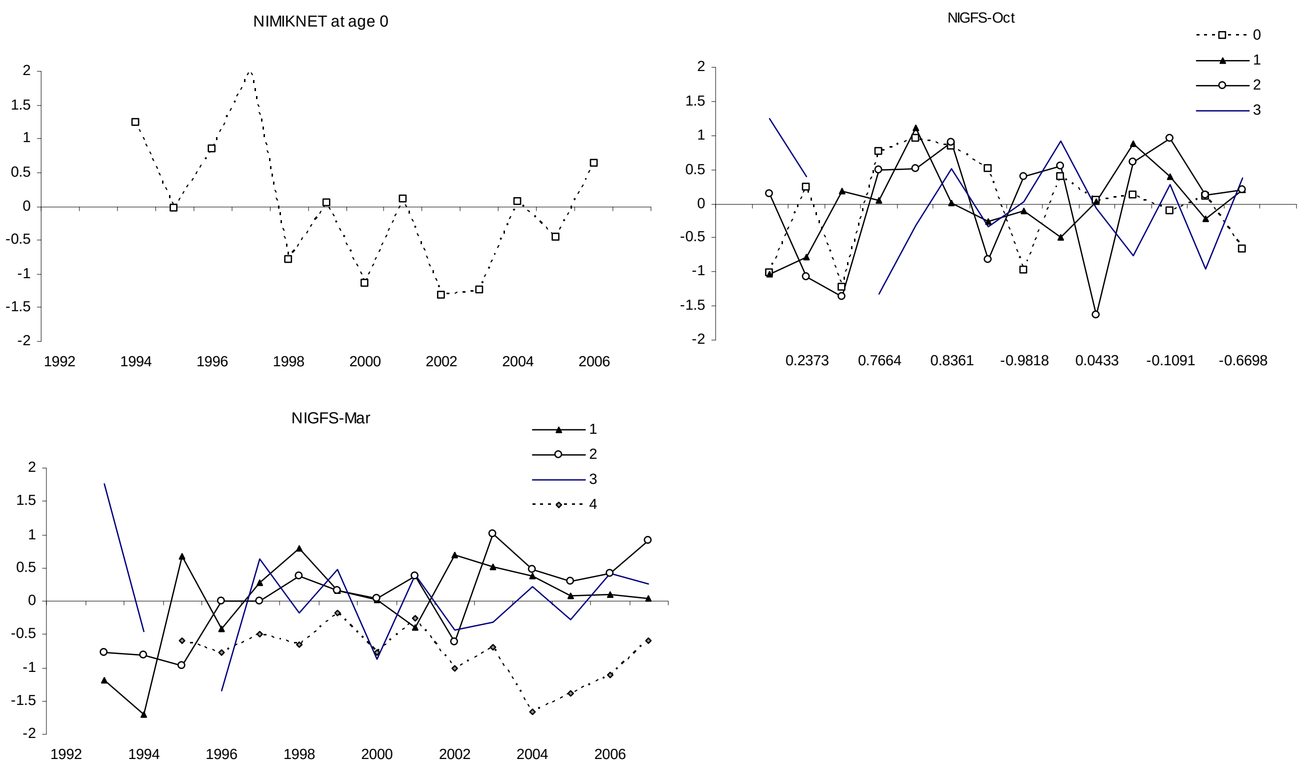
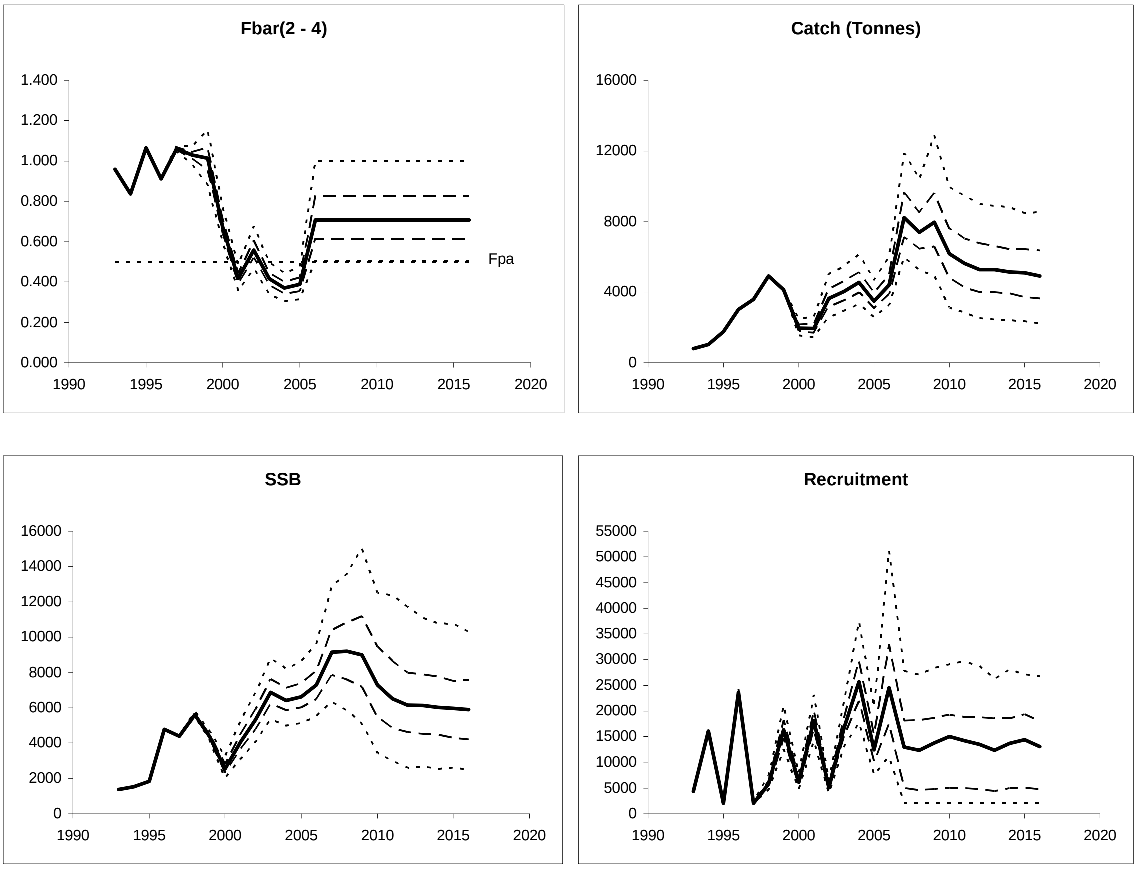


Figure 9.20. Haddock VIIa: Catchability residuals from the B-Adapt run using three surveys (F smoother 1.0).



Fbar(2-4)	Year			SSB	Year			Catch	Year		
Percentile	2007	2008	2009		2007	2008	2009		2007	2008	2009
0.05	0.51	0.51	0.51		6337	5840	5088		5972	5218	4946
0.25	0.62	0.62	0.62		7860	7610	7182		7104	6469	6591
0.5	0.71	0.71	0.71		9143	9199	8998		8232	7404	7964
0.75	0.83	0.83	0.83		10405	10823	11195		9642	8511	9619
0.95	1.00	1.00	1.00		12905	13566	15007		11872	10387	12879

Figure 9.21. Haddock VIIa: Bootstrap B-ADAPT medium-term forecast for status-quo F, with recruitment from 2007 onwards re-sampled from 1993–2006 values in each projection. Note that F(2–4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000–2006 period, and hence the catch in the forecast period also includes an expected unallocated removal.

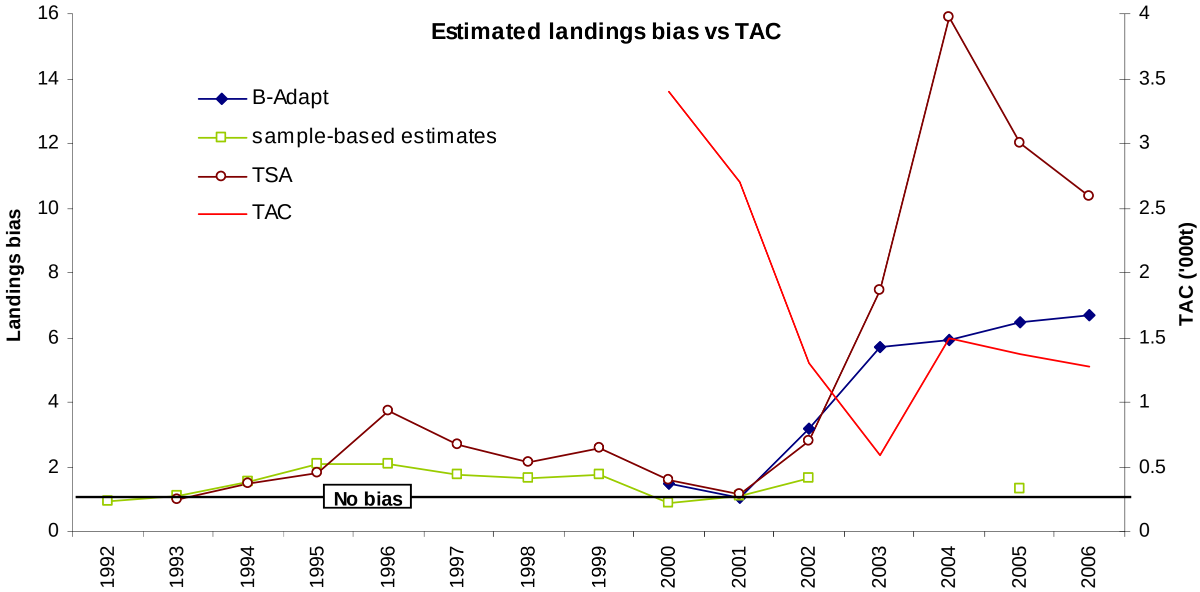


Figure 9.22. Haddock VIIa: Landings bias estimates from different methods. Trend in TAC is also illustrated.

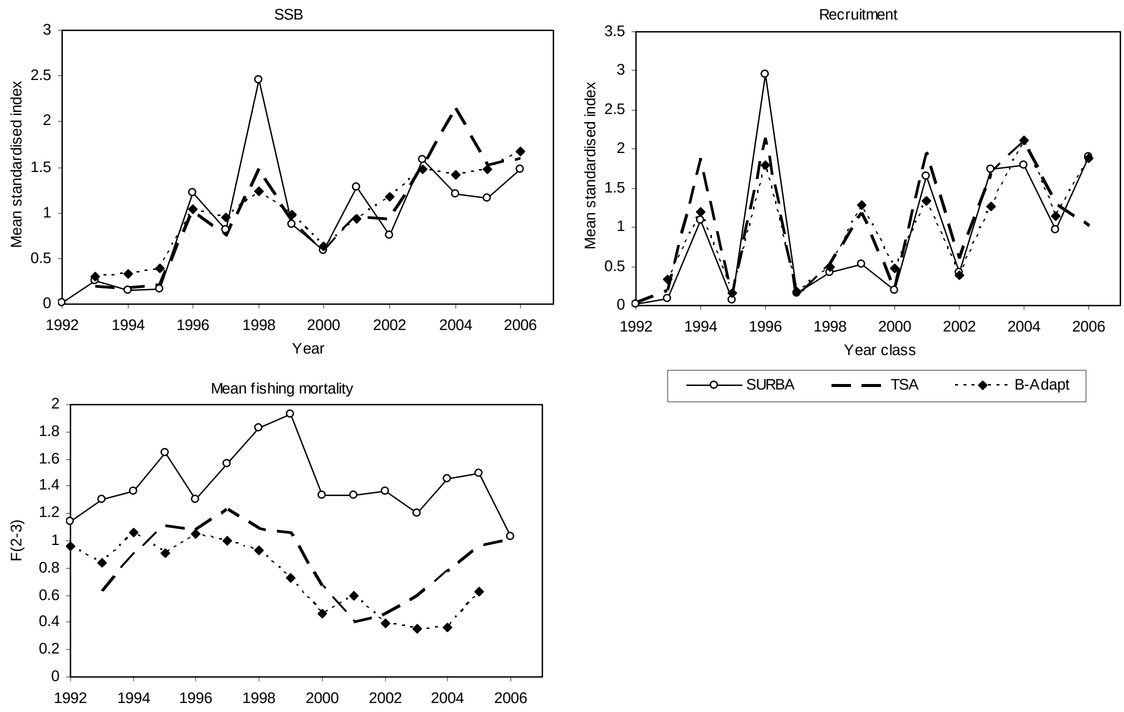


Figure 9.23. Haddock VIIa: Trends in SSB, recruitment and F(2–3) from SURBA, TSA and B-Adapt estimates. SSB and recruitment are standardised to the mean for years common to all series (1993–2006) in each plot.

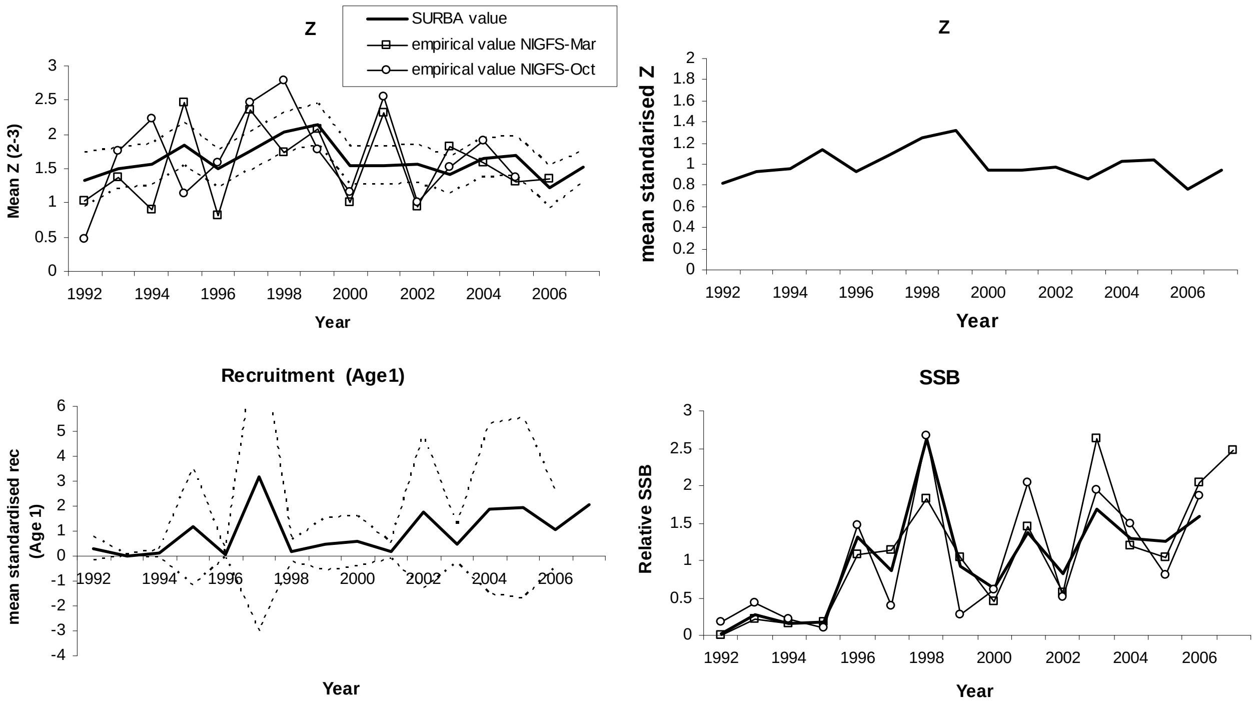


Figure 9.24. Haddock VIIa: Results of final SURBA 3.0 run using both NIGFS surveys data. Dotted lines are +/- 1SE. Z estimates given as absolute and relative. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.

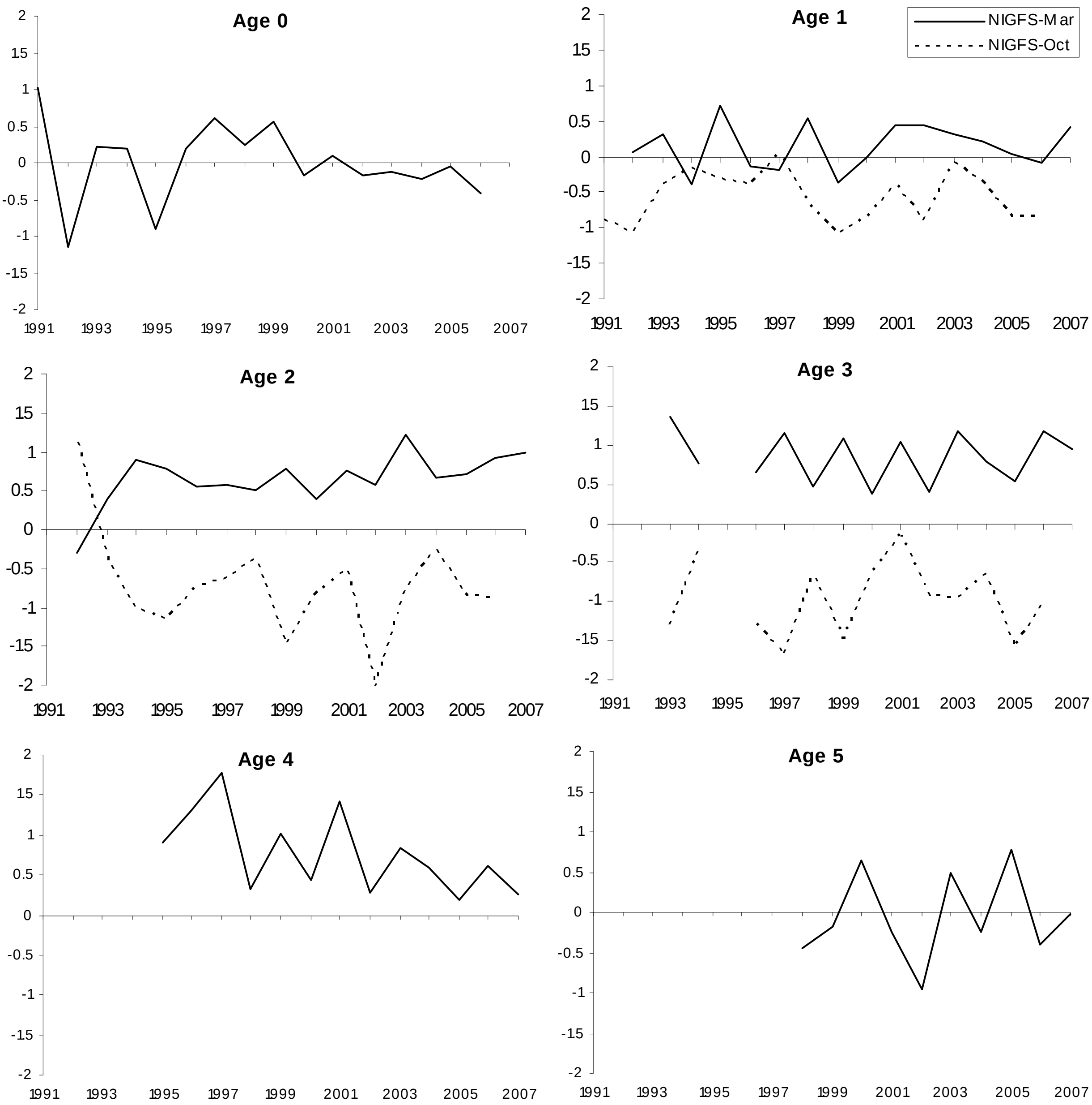


Figure 9.25. Haddock VIIa: SURBA 3.0 Residuals at age for final run using the NIGFS-Mar and NIGFS-Oct survey data.

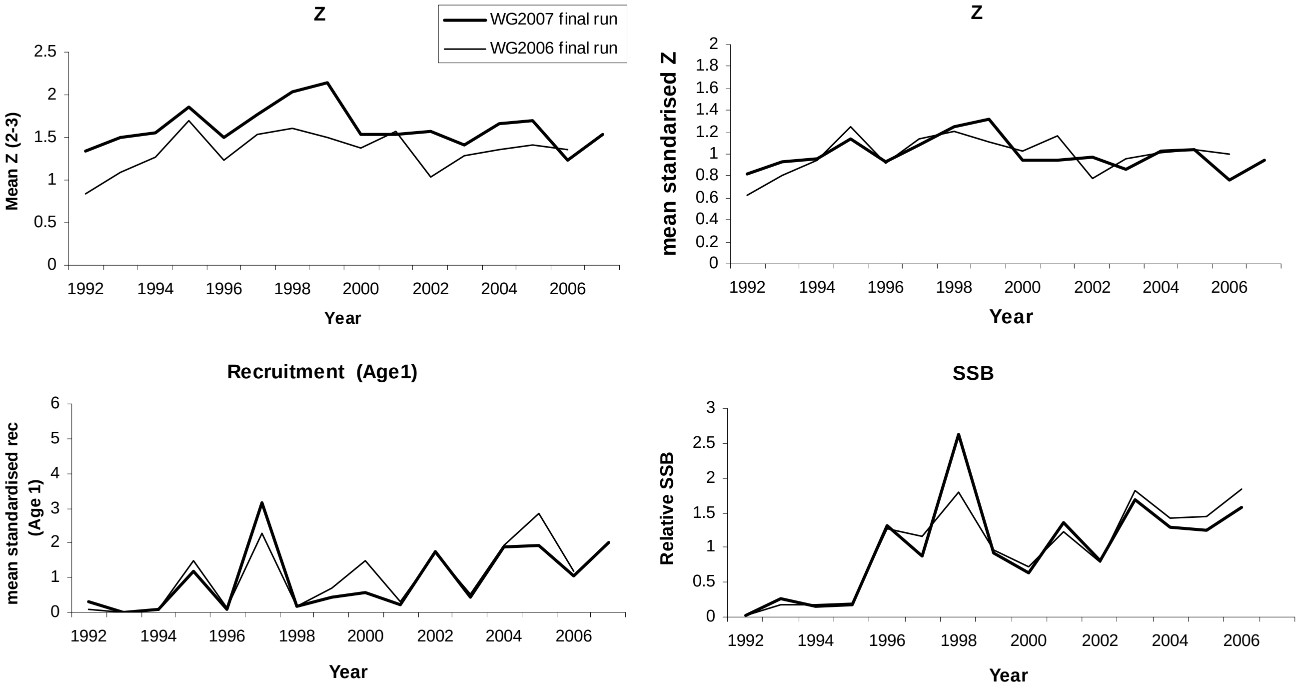
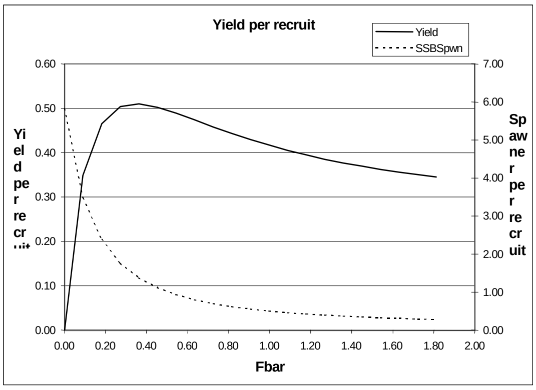


Figure 9.26. Haddock VIIa: Trends in SSB, recruitment and Z(2–3) from the 2006 and 20067 SURBA. SSB and recruitment are standardised to the mean for years common to all series (1993–2006) in each plot.



MFYPR version 2a
Run: Had7a_2004WG_yield
Time and date: 10:55 13/05/2004

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	0.9065
FMax	0.3811	0.3455
F0.1	0.2074	0.1880
F35%SPR	0.2494	0.2261

Weights in kilograms

Figure 9.27. Haddock VIIa: Yield per recruit based on analysis carried out in 2004.

10 Whiting in Division VIIa

No analytical assessment has been carried out for this stock since 2003. This year the assessment has been classified as exploratory. Single and multi fleet SURBA runs were carried out for two of the main surveys assessing this stock, the NIGFS March and NIGFS October. The multi-fleet run is presented as the final assessment. Overall it is clear that the stock is in a state of decline. Landings have been decreasing in recent years and are at their lowest level in 2006. The survey results indicate a decline in SSB to low levels in recent years, despite concurrent increases in recruitment. Total mortality has also been increasing over the time series.

No specific recommendations were made by RGNSDS 2006 for this stock.

10.1 The Fishery

The characteristics of the fishery are described in the Stock Annex.

10.1.1 ICES advice applicable to 2006 and 2007

Overall advice for this stock is given in Section 1.7.

The Single Stock Exploitation Boundary advised by ICES for 2006 was as follows:

- Exploitation boundaries in relation to precautionary limits

On the basis of the stock status ICES advises that catches of whiting in 2006 should be the lowest possible.

The Single Stock Exploitation Boundary advised by ICES for 2007 was as follows:

- Exploitation boundaries in relation to precautionary limits

On the basis of the stock status ICES advises that catches of whiting in 2007 should be the lowest possible.

10.1.2 Management applicable in 2006 and 2007

Recent management advice is summarised below:

YEAR	ACFM ADVICE	BASIS	TAC
2002	0	Lowest possible F	1 000
2003	0	Lowest possible F	500
2004	0	Zero catch	514
2005	0	Lowest catch	514
2006	0	Lowest catch	437
2007	0	Lowest catch	371

There are no specific recovery plans for whiting in VIIa, however, the technical measures for cod described in Section 1.7 will also impact of vessels catching whiting. The minimum landing size (MLS) for whiting is 27 cm. Section 1.7 summarises the technical measures in place in the Irish Sea. Technical measures remain unchanged for 2006 and 2007. Since 2000, there has been a move to using 100 mm mesh gear in the Irish Sea targeting cod and mixed demersal gadoids.

10.1.3 The Fishery in 2006

The closure of the western Irish Sea to whitefish fishing from mid February to the end of April, designed to protect cod, was continued in 2006 but is unlikely to have affected whiting catches which are mainly by-caught in the derogated *Nephrops* fishery. *Nephrops* vessels can obtain a derogation to fish in the closed area, providing they fit separator panels to their nets to allow escape of cod and other fish. As in previous years, the Irish and UK NI *Nephrops* fishery shows a peak in activity in the summer which is outside the time of the closed period for cod. In 2006, for the Irish fleet for the first time, *Nephrops* landings from the Smalls grounds (VIIg) have surpassed those from the Irish Sea grounds. This reflects the increasing amount of effort by East Coast vessels in 7g where in general, better prices are obtained for their catch. Two significant fleet movements occurred in 2006 for the Irish fleets. Firstly, there was a brief shift in effort by the *Nephrops* fleet towards the Aran Grounds around October due to reports of good fishing in the area. Also, some of the larger twin-riggers in the fleet switched to tuna fishing in the Bay of Biscay during the summer months. The number of older vessels in the Irish fleet has been reduced with the implementation of the Irish vessel-decommissioning scheme. Under the scheme, 7 vessels with a significant track record of fishing in VIIa were permanently removed between 2005 and 2006.

Information from Northern Ireland indicates that up to 20% of the Northern Irish *Nephrops* fleet now spend most of Q4 and Q1 engaged in the *Nephrops* fishery off the English east coast (Farne deeps). This will have resulted in a drop in effort in VIIa and a corresponding increase in IVb (WGFTFB, 2007).

10.2 Catch Data

10.2.1 Official Catch Statistics

Table 10.1.3.1 gives the nominal landings of VIIa whiting as reported by each country to ICES. The officially reported landings have declined since 1996. Figures supplied to the working group indicate landings of around 86 t in 2006. This is the lowest recorded in the time series. Discard estimates from the NI *Nephrops* fishery discards (based on the NI self sampling scheme), which have previously been used by the WG, have not been available since 2003. Working groups estimates of catch available since 1980 are illustrated in Figure 10.2.1.1 and indicate the declining trend since the start of the time series.

10.2.2 Revisions to Catch Data

No revisions to the previous years working group estimate of landings was made.

10.2.3 Quality of the Catch data

There is evidence that officially reported landings of whiting in the past (especially around the mid '90's) have been inaccurate due to misreporting. Landings data has previously been partially corrected for by using sample-based estimates of landings at a number of Irish Sea ports. Due to the low level of landings recently, this has not been carried out since 2003.

10.3 Commercial catch-effort and research vessel surveys

10.3.1 Commercial catch and effort data

Commercial catch and effort series available to the Working Group are described in the stock Annex for 7a whiting (Section B:4). Effort, presented as kw days at sea from different fleet sectors are reported in Section 17. The most important fleets for the whiting fishery are the UK (NI) and the IR-OTB *Nephrops* directed fleets.

Effort data in hours for the UK (England and Wales and Northern Ireland) fleets is presented in Table 10.3.1.1 and Figure 10.3.1.1. There is a marked decline in otter trawlers using 70–99 mm mesh since 1993 and in 2000 there was a shift in effort from the 100mm mesh to the 70-99 mm mesh in order to avail of greater days at sea allowances (WGFTFB, 2006). For *Nephrops* trawls there has been a decline in the use of single rigs with a concurrent increase in the effort for twin rig trawls. In 2000, there is a clear shift between the two metiers for the midwater demersal trawlers, with a decline in effort for midwater trawls using 70–99mm mesh to very low levels in recent years. Seine nets (70–99 mm) show a stable trend in effort apart from a peak in 1993 with a decline in recent years. Seine nets using 100 mm+ also exhibit a steady effort trend with two large peaks in 1995 and 2000.

The main Irish fleet that landed whiting in 2006 was the otter trawl fleet (73% of the total), with the Scottish seine fleet landing 25% and the remaining 2% landed by boats using other gears. Table 10.3.1.2 and Figure 10.3.1.2 shows landings, effort and lpue data for the Irish Otter board trawl (IR-OTB), Irish beam trawl (IR-TBB) and Scottish seine (IR-SSC) fleets for 1995–2006. Irish OTB effort has declined significantly since 1999 but has remained stable in 2006. The majority of OTB effort is concentrated in the western Irish Sea. Effort for Irish beam trawlers shows an overall increasing trend since 1996, for Irish Scottish seines effort has declined since 2003 and shows a slight increase in 2006. The majority (47%) of whiting landed by the Irish Scottish Seine fleet was landed in Quarter 4 as this fleet is fishing in area VIIg for most of the year.

10.3.2 Research vessel surveys

The following research surveys were available to the Working group:

- UK (NI) groundfish survey: March 1992–2007.
- UK (NI) groundfish survey: October 1992–2006.
- UK (Scotland) groundfish survey: March 1996–2006.
- UK (Scotland) groundfish survey: autumn 1997–2005.
- Irish groundfish survey: autumn 2003 and 2004.
- UK (NI) MIK net surveys of pelagic-stage 0-group cod, western Irish Sea 1994–2006.
- UK (E&W) beam trawl survey: 0-1 gp cod, 1988–2006.
- FSP surveys of Irish Sea round fish: 2004–2007.

Table 10.3.2.1 describes the survey data available.

In 2004 a UK(E&W) groundfish survey commenced in the Irish Sea using a GOV trawl and it is envisaged that this data will contribute to the future survey indices for this stock. Preliminary analysis shows Whiting was one of the most abundant species caught on this survey. No abundance indices were provided this year but indications are that Age 0 whiting was the dominant age group in the survey catch (WD 4).

Figure 10.3.2.1 shows the survey distribution of the NIGFS in March and October. Seasonal changes in the distribution of whiting are evident in the trawl surveys. The distribution of whiting below MLS of 27cm remains fairly consistent between spring and autumn, although there is a tendency for the fish in the eastern Irish Sea to be more aggregated off Cumbria in autumn and to be more dispersed in spring (Figure 10.3.2.1 (b) and (d). This may be indicative of movement of the mature fish in this size range towards spawning grounds. Whiting above

MLS ((Figure 10.3.2.1 (a) and (c)), which are all mature individuals, tend to be more abundant in the eastern Irish Sea than in the western Irish Sea. Catch-rates are quite patchy, with no obvious distinction between distributions in spring and autumn other than a tendency for higher catch-rates off North Wales in spring compared to autumn. This may reflect the movement of fish into spawning areas. Figure 10.3.2.2 shows the decline in mean catch rate of whiting in eastern Irish sea since 2003. Catch rates for the western Irish sea also show a decline since 2003 with a slight increase in abundance in 2007.

Further information on whiting distribution is detailed in the results of Fisheries Science Partnership surveys of Irish Sea round fish stocks (WD2). These surveys corroborate the findings of the UK (NI) trawl surveys showing much higher catch rates of adult whiting in the eastern Irish Sea than in the western Irish Sea. Catches of whiting showed broadly similar patterns of distribution in 2005, 2006 and 2007, with the highest catch rates in the southern part of the eastern Irish Sea. The dominant age group in 2005 was 3–year-olds, whereas 2–year-olds were predominant in 2006 and 2007 (Table 10.3.2.1). The large abundance index for 2–year-olds in 2006 was not followed by an increased catch rate of 3–year-olds in 2007, indicating that the year-class signals are not well captured by the FSP survey, even if the distribution patterns appear consistent from year to year. Few whiting more than four years old have been caught in any of the years (WD2).

The Scottish groundfish surveys in spring and autumn using a GOV trawl were ceased for the Irish Sea component in 2006 and 2005 respectively and were not explored further during WGNSDS 2007.

Survey series for whiting provided to the Working Group are further described in the stock Annex for 7a whiting (SectionB.3).

10.4 Age compositions and mean weights at age

10.4.1 1.4.1 Landings age composition and mean weights at age

Sampling and raising methods previously used are described in the stock Annex for 7a whiting. Methods for estimating quantities and composition of whiting landings from VIIa are described in the Stock Annex (Section B1.1).

Landings, discards and total catch numbers and weights at age for the period 1980 to 2002 as estimated by WGNSDS 2002 are given in Tables 10.4.1 to 10.4.6. The proportion of the total catch comprising discards from the *Nephrops* fleets increased over time at ages 1 and over (Table 10.4.7) although this will also reflect trends in catch of vessels not sampled for discards. While the proportion has increased it is largely due to the decline in abundance of marketable sized whiting and the total volume over time has declined as in Table 10.4.8. Mean weights at age for landings and discards are presented in Figure 10.4.1.1. There is an overall decline in mean weight at age for landings over the time series at some ages. This can also be seen in the discards though it is difficult to interpret for older ages due to the small numbers discarded.

Since 2003 it has not been possible to construct catch numbers at age for this stock. This is due to a number of factors including low levels of landings, leading to concurrently low levels of sampling and restricted access to some ports in some years. In 2006 limited landings sampling data was available consisting only of length data from the Irish beam trawl fleet.

10.4.2 1.4.2 Discards age composition

Discard Data available for Whiting VIIa include:

- Discard Numbers at age from 1980–2002 estimated from the NI *Nephrops* fishery and raised to the International Fleet-from the NI self sampling scheme

- Discard Numbers at age from the Irish Otterboard Trawl Fleet from 1996–2006, including length frequency data
- Discard Length Frequencies for the UK (E&W) fleet, 2004–2006, raised to trip
- Discard Numbers at age for the NI fleet for 1997–2001, and 2006, raised to trip, including length frequency data from the NI observer scheme.

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the Stock Annex section B1.2.A recent study on discarding in the demersal fishery in the waters around Ireland has been carried out by Borges *et al* (2005). Results indicate that there was high discarding (in number) for whiting in all Irish otter trawl fleets in 2000–2002 and that there was substantial discarding of smaller fish by the *Nephrops* fleets operating in VIIa. Revised Irish discard estimates (1996–2006) raised according to the methods described in Borges *et al* (2005) were available to the Working Group (Table 10.4.9). Ages 1 and 2 are predominantly discarded and although discard rates in this series were variable compared with previous estimates based on the UK NI self sampling scheme, they do show a decrease in total discard numbers at age for 2005 and 2006, although sampling levels are limited.(Figure 10.4.2.1(a).

Mean weights at age are also presented (Figure 10.4.2.1 (b) and show a slight decrease in mean weight for ages 1 and 2. Due to the small numbers at older ages mean weights are more variable over the years.

Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers at age can be made. It is expected that the industry-science initiative for an “Enhanced Data Collection Programme” for the Irish Sea will contribute to further estimates of discarding for this stock in the future.

The length frequency of discards of sampled fleets in 2006 is given in Figure 10.4.9. Irish Discard sampling in 2006 was based on 5 trips (56 hauls) and is raised to fleet level. The UK (E&W) supplied data on the raised length compositions of landed and discarded whiting from 5 trips and 68 hauls sampled in 2006, but not raised to the fleet. NI discard data is also supplied, based on 9 trips and 39 hauls sampled and raised to trip level. Both the Irish OTB and NI fleet show similar modes of distribution, indicating similar discarding patterns between these two fleets. For the UK (E&W) fleet, there is a bimodal length frequency distribution with a modal peak at 8cm indicating potentially different gear selectivity between the Irish, NI and E&W fleet or perhaps prosecution of a different part of the whiting stock.

10.5 Natural mortality, maturity and stock weight at age

The derivation of these parameters and variables is described in the Stock Annex B.2. Natural mortality was assumed as 0.2 for all ages and years, and proportion mature knife-edged at age 2 for all years. Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in VIIa are described in the Stock Annex. In most areas whiting were mature by age three and most were mature at age two.

The stock weights used in WGNSDS 2002 are shown in Table 10.5.1. These are calculated from commercial catch weights and smoothed using a three-year rolling average as described in the Stock Annex. There has been a marked downward trend in stock weights in all ages over the period 1988 to 2002. Weights at age for ages 5 and 6+ are poorly estimated in recent years as these ages now represent less than 1% of the catch in number.

10.6 Catch-at-age analysis

Section 2.7 outlines the general approach adopted at this year's Working Group. Catch at age data was not updated for 2006.

10.6.1 Data Screening and Exploratory Runs

10.6.1.1 Commercial Catch data

Commercial catch data was not explored for 2006.

10.6.1.2 Survey Data

Trends in log mean standardized survey indices are presented for the NIGFS, ScoGFS, UKNI-MIKnet and UK (E+W) beam trawl surveys in Figure 10.6.1.2.1. Most of the surveys show a slight increasing trend over the time series for age 0. For age 1, there are similar abundance indices for all surveys, despite the anomalous value in 2001 for the Scottish Autumn survey, however catch rates for this survey were unusually low in 2001 for all ages. Otherwise, there is no obvious coherence between surveys or tracking of year classes with the possible exception of 1995 and 1996 for age group 4 and 5. Surveys previously considered inappropriate for this stock have not been explored this year, nor have surveys where no data has been provided for 2006/2007. The abundance indices for the different surveys available to the WG are given in Table 10.3.2.1. This includes data for three different configurations of the NIGFS surveys; West, East and a combined East and West index. A decision was made at WGNSDS, 2005 that both the east and west components of the March and October NIGFS surveys should be considered as a combined East and West index. Conclusions drawn previously from a working document presented to WGNSDS 2005 have indicated that there is no strong evidence at present to justify keeping these indices separate.

The following survey series were updated for exploratory analysis this year:

- UK (Northern Ireland) Groundfish survey in March (NIGFS-March) East and West
- UK (Northern Ireland) Groundfish survey in October (NIGFS-Oct) East and West

Log-mean standardised indices and scatter plots of log index at age for the NIGFS-March are presented in Figure 10.6.1.2.2 (a) and Figure 10.6.1.2.3 (a), respectively. Both plots indicate poor internal consistency within the survey. The survey appears to track the 1991, 1994 and 1996 year classes but examination of the internal consistency via the scatter plots indicates a very poor correlation between the various age classes.

Corresponding figures for the NIGFS-Oct are plotted in Figures 10.6.1.2.2(b) and 10.6.1.2.3 (b) for the UK Northern Ireland October groundfish Survey. There is some indication of tracking for the 1991, 1994 and 1995 year class but scatter plots at age are noisy and don't show any strong positive correlations.

Catch curves for the NIGFS-Mar and NIGFS-Oct survey are plotted in Figure 10.6.1.2.4 (a) and (b). Both surveys show a steep decline in log numbers at age over time.

Empirical SSB estimates are presented in Figure 10.6.1.2.5 for the NIGFS March and the NIGFS Oct surveys. Both NIGFS surveys show a decline in SSB in the last two years.

10.6.1.3 Exploratory Assessment Runs

Single fleet runs were carried out on the NIGFS-Mar and NIGFS-Oct surveys using SURBA (version 2.2). Default values of 1 were used for both catchability and Lambda settings.

Figure 10.6.1.3 shows the residual plots by age for the NIGFS March, the model fits well for age one but for older ages residuals are quite noisy, especially in the latter part of the time series. Stock summary for the NIGFS March is shown in Figure 10.6.1.4. The temporal F trend is increasing but is variable in later years, there are no extreme age or cohort effects. The plot of empirical SSB with model fit (bottom, centre) shows good fit for most years. Figure 10.6.1.5 shows the retrospective summary plot for the NIGFS March. SSB is declining since 2002, and has reached low levels in most recent years; there is no apparent retrospective pattern. F shows an increasing trend over the time series. Recruitment is also variable but estimated to be low in recent years. There is no strong retrospective pattern for recruitment but there is a noisy period between 1995 and 2000.

Residual plots by age for the NIGFS-Oct are shown in Figure 10.6.1.6. Residuals are quite noisy for all ages apart from age 0. Figure 10.6.1.7 shows the stock summary plot for the NIGFS Oct. The temporal F trend is variable in the earlier part of the time series but has been increasing for the last 3 years. There appears to be an age effect for age 1 for this survey but no strong cohort effects. The plot of empirical SSB versus model estimates shows good fit for the latter part of the time series. Retrospective patterns for the summary plots (Figure 10.6.1.8) show a generally increasing F trend over the time series. SSB has been declining since 2003, as has recruitment, despite an increase in the last year. No retrospective bias is evident in F, SSB or recruitment.

A multi fleet SURBA (Version 3.0) was carried out for combined NIGFS March and NIGFS Oct surveys. Default values of 1 were used for both catchability and Lambda settings.

Log residuals for the multi-fleet SURBA run (Figure 10.6.1.9) tend to be more positive in the earlier part of the time series for the NIGFS March and there may be evidence of a slight year effect in 2004 for ages older than 1. For the NIGFS October the residuals are more random but with evidence of possible year effects in 2002 and 2003. No strong retrospective bias (Figure 10.6.8.1) is apparent in biomass and recruitment estimates. Summary results of the multi fleet runs are plotted in Figure 10.6.1.10. SSB appears to be stable until 2003 but has been decreasing since despite increases in recruitment. This is concurrent with steep catch curves seen in the surveys and the hike in total mortality in recent years.

10.6.1.4 Final Assessment run

Previously no final assessment was presented for this stock due to conflicting signals for final SSB and Z estimates between the NIGFS-Mar and NIGFS-Oct surveys. However in the last two years both these surveys have been indicating the same trends of declining SSB to low levels as well as increasing total mortality. This compounded with the fact that there are no reliable estimates of catch numbers at age since 2003 and the low landings levels of whiting in recent years, indicates that the multi fleet SURBA explored above is presented as the final assessment for this stock.

10.6.2 Estimating recruiting year class abundance

The general approach to estimating recruitment is described in Section 2.9.

10.6.3 Long-term trends in biomass, fishing mortality and recruitment

The decline in fishery landings to under 1 000 t since 2000 has been interpreted in all assessment models as a collapse in biomass, despite the absence of an analytical assessment. Generally, trends in biomass have been declining in recent years. Recruitment, albeit at low levels, shows a general increase over the time series. Long term trends of recruitment for this stock are difficult to interpret given the uncertainty in discard estimates for younger ages.

10.6.4 Short-term stock predictions

It was not possible to carry out short-term projections for this stock.

10.6.5 Medium Term Projections

It was not possible to carry out long-term equilibrium projections for this stock.

10.6.6 Yield and Biomass per Recruit

It was not possible to carry out medium term projections for this stock.

10.6.7 Reference Points

There is no basis for the evaluation of reference points for this stock.

10.6.8 Quality of the Assessment

Previously no final assessment was presented for this stock due to conflicting signals for final SSB and Z estimates between the NIGFS-Mar and NIGFS-Oct surveys. However in the last two years both these surveys have been indicating the same trends of declining SSB to low levels as well as increasing total mortality. The multi fleet SURBA run seems to perform reasonably well for this stock. There is no evidence of strong retrospective bias for biomass trends, apart from a slight tendency to underestimate biomass. Retrospective patterns for total mortality are more variable with strong tendency to underestimate Z (Figure 10.6.8.1).

As discard estimation and raising procedures are problematic and discard estimates may be imprecise discard data for this stock should be re-examined to look at discard patterns in space and time. Furthermore landings data from the *Nephrops* fishery as well as survey data could be examined to model seasonal and tidal catchability patterns. The main aim being to identify ways of minimise the collateral damage to the whiting stock by the *Nephrops* fishery.

10.6.9 Management considerations

Landings of whiting by all vessels, and discards of whiting estimated for *Nephrops* fisheries, have declined substantially since the 1990s and whiting is now a relatively minor by-catch in the demersal fisheries. Due to the small catches and low value of the catch, a high proportion of whiting are discarded. Age profiles observed on the surveys is very steep indicating either a continuing high mortality or some emigration effect.

Fishing mortality cannot be managed by a TAC on whiting, and measures restricting landings alone will not be sufficient to allow recovery of the stock. Various technical measures have been introduced in the past to mitigate by-catch of whiting in the *Nephrops* fishery, which operates on the whiting nursery grounds. It has proved difficult to evaluate the success of measures such as the mandatory use of square mesh panels in *Nephrops* trawls since 1994, as there have been very few direct observations of size and age compositions of catches prior to discarding (much of the discards data are from fisher self-sampling schemes that do not record total catch).

Acknowledgement of the discard problem in the *Nephrops* fishery by the Northern Ireland industry recently resulted in the Anglo-North Irish Fish Producers Organisation Ltd (ANIFPO) embarking upon a project to improve gear selectivity. The aim of the project, which commenced in 2005, was to examine the effectiveness of the technical conservation measures proposed as part of the Irish Sea Cod Recovery Programme, in an attempt to reduce discard levels in the *Nephrops* fishery. Phase 1 of the project was completed in 2006 and phase 2 is ongoing and due for completion in 2008. The study is co-funded by the Northern Ireland Building Sustainable Prosperity (BSP) programme. The BSP and in particular the Financial Instrument for Fisheries Guidance (FIFG) scheme aims to contribute to achieving a sustainable balance between fishery resources and their exploitation.

The Multi-national EC funded studies RECOVERY and NECESSITY were completed in 2006 and involved extensive trials with a range of net configurations and novel devices to exclude catches of unwanted by-catch species including whiting. Results provided viable measures that could be adopted to reduce whiting discards, though some configurations resulted in unacceptable losses of *Nephrops* catch.

A decommissioning scheme launched by Ireland in October 2005 and continued in 2006 has so far removed 36 whitefish and scallop vessels (WGFTFB, 2007), some (~7) of which operated in the Irish Sea, although this followed from the two Whitefish Renewal Schemes which introduced around 32 new vessels into the Irish fleet. A new decommissioning programme will be announced shortly under the EFF 2007-2013 but it is unclear which vessels will decommission given that the fleet structure has changed and improved over recent years (WGFTFB, 2007).

As the human consumption fishery has collapsed and mortality rates continue at high levels, the previous perception that whiting continues to be one of the most abundant species caught on ground fish surveys in the Irish sea may not be true. With the addition of 2006 and 2007 data evidence from the NIGFS survey distribution maps indicate that there has been a decline in catch rate of whiting since 2003 in both the eastern and western parts.

Due to the by-catch of cod in fisheries taking whiting, the regulations affecting Division VIIa whiting remain linked to those implemented under the Irish Sea cod recovery plan. The regulations implemented for cod are detailed in the single-species advice for cod (Section 4.6.1.a). The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, has been continued, but is unlikely to have affected whiting catches, which are mainly by-catch in the derogated *Nephrops* fishery.

The minimum landing size for whiting is 27 cm. Discarding data shows that individuals in excess of the MLS are discarded. In addition, the discard data indicates that very large numbers of whiting below this size are caught in the *Nephrops* fishery and discarded.

Table 10.1.3.1 Nominal catch (t) of WHITING in Division VIIa, 1988-2006, as officially reported to ICES and Working Group estimates of discards.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	90	92	142	53	78	50	80	92	80	47
France	1.063	533	528	611	509	255	163	169	78	86
Ireland	4.394	3.871	2.000	2.200	2.100	1.440	1.418	1.840	1.773	1.119
Netherlands									17	14
UK(Engl. & Wales)[a]	1.202	6.652	5.202	4.250	4.089	3.859	3.724	3.125	3.557	3.152
Spain										
UK (Isle of Man)	15	26	75	74	44	55	44	41	28	24
UK (N.Ireland)	4.621									
UK (Scotland)	107	154	236	223	274	318	208	198	48	30
UK										
Total human consumption	11.492	11.328	8.183	7.411	7.094	5.977	5.637	5.465	5.581	4.472
Estimated Nephrops fishery discards used by the WG[b]	1.611	2.103	2.444	2.598	4.203	2.707	1.173	2.151	3.631	1.928
Working Group Estimates	11.856	13.408	10.656	9.946	12.791	9.230	7.936	7.044	7.966	4.205

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	52	46	30	27	22	13	11	10	4,2
France	81	150	59	25	33	29	8	13	3,7
Ireland	1.260	509	353	482	347	265	96	94	55,3
Netherlands	7	6	1						
UK(Engl. & Wales)[a]	1.900	1.229	670	506	284	130	82	47	21,7
Spain						85			
UK (Isle of Man)	33	5	2	1	1	1	1		
UK (N.Ireland)									
UK (Scotland)	22	44	15	25	27	31	6		
UK									
Total human consumption	3.355	1.989	1.130	1.066	714	554	204	164	84,9
Estimated Nephrops fishery discards used by the WG[b]	1.304	1.092	2.118	1.012	740	n/a	n/a	n/a	n/a
Working Group Estimates	3.533	2.762	2.880	1.745	1.487	676	184	158	86

[a] 1989-onwards Northern Ireland included with England and Wales.
[b] Based on UK(N.Ireland) and Ireland data.
[*] Preliminary.

Table 10.3.1.1 Whiting VIIa (Irish Sea)
Effort (Hours fished) for UK (E & W and NI) trawlers in VIIa

	seine nets 70-99 mm	seine nets 100mm+	otter trawls 70-99	otter trawls 100mm+	Single Nephrops mainly 70-99	Twin-rig Nephrops mainly 70-99	Midwater demersal 70-99	Midwater demersal 100+
1985	2097	946	121903	2780			38227	0
1986	576	441	191207	3122			48852	0
1987	1194	207	256364	2821			70750	0
1988	1598	873	279135	2325			71886	0
1989	2268	20	300658	2371			86753	0
1990	833	0	289761	3665			98918	0
1991	586	231	292643	2309			90131	0
1992	2384	459	287509	2095			100584	12
1993	19063	912	289037	3764			76244	125
1994	1065	651	145356	3321	126475	5413	75915	0
1995	534	3695	87422	4010	157656	17187	54885	36
1996	497	797	86443	8178	142706	21465	55580	176
1997	829	2093	74270	11239	153086	24467	56096	106
1998	1098	1468	63786	11215	138682	36482	61759	133
1999	2874	723	60727	6842	133604	36530	71952	16
2000	443	4403	42431	12423	125252	47290	2764	44899
2001	24	2735	37504	23037	129421	40060	388	50708
2002	36	1350	24522	21242	100985	29216	191	56485
2003	30	1022	24197	26328	105923	39110	0	62029
2004	17	1062	37764	9307	101017	39214	608	35291
2005	0	645	34128	5354	96085	48450	0	27564
2006		804	23799	3687	109742	46155	9	23604

Table 10.3.1.2 Landings, Effort and LPUE data for Irish Otter Trawl Fleet (IR-OTB),beam trawl(IR-TBB) and Scottish seine (IR-SSC) for 1995-2006.

IR-OTB-7a VIIa			
Year	**Landings (t)**	**Effort (hr)**	**LPUE (kg/h)**
1995	268,45	80,31	3,34
1996	656,75	64,82	10,13
1997	326,89	92,18	3,55
1998	351,94	93,53	3,76
1999	294,99	110,28	2,68
2000	119,77	82,69	1,45
2001	286,15	77,54	3,69
2002	195,14	77,86	2,51
2003	170,42	73,85	2,31
2004	61,00	72,51	0,84
2005	58,05	68,34	0,85
2006	34,55	64,88	0,53

IR-TBB-7a VIIa			
Year	**Landings (t)**	**Effort (hr)**	**LPUE (kg/h)**
1995	11,56	8,64	1,34
1996	9,53	6,26	1,52
1997	8,16	9,86	0,83
1998	8,96	11,58	0,77
1999	8,91	14,67	0,61
2000	8,39	11,42	0,73
2001	9,85	13,13	0,75
2002	6,45	17,67	0,36
2003	3,28	18,70	0,18
2004	1,71	14,19	0,12
2005	2,13	14,67	0,15
2006	0,23	11,93	0,02

IR-SCC-7a VIIa			
Year	**Landings (t)**	**Effort (hr)**	**LPUE (kg/h)**
1995	0,1	0,0	3,5
1996	203,2	1,5	131,2
1997	46,5	2,2	21,0
1998	108,9	2,6	42,3
1999	21,0	1,5	14,5
2000	23,7	0,6	37,8
2001	12,6	0,7	18,7
2002	19,9	0,6	35,4
2003	61,4	1,3	48,1
2004	5,2	1,0	5,1
2005	8,9	0,6	14,9
2006	12,13	1,2	10,05

Table 10.3.2.1. Whiting in 7a. Survey data available to the WGNSDS 2007.

UKE&W-BTS : Corystes Irish Sea Beam Trawl Survey (Sept)-Prime stations only-Effort and numbers at age (per km towed)

1988	2006		
1	1	0.75	0.79
0	1		
1	205	84	1988
1	112	33	1989
1	157	120	1990
1	257	39	1991
1	227	300	1992
1	146	97	1993
1	157	106	1994
1	1570	60	1995
1	136	164	1996
1	306	208	1997
1	700	144	1998
1	464	122	1999
1	282	122	2000
1	468	155	2001
1	234	5	2002
1	438	154	2003
1	797	298	2004
1	706	245	2005
1	239	112	2006

NIGFS-Oct E&W: Northern Ireland October Groundfish Survey-Irish Sea East & West-Nos. per 3 nm

1992	2006						
1	1	0.83	0.88				
0	5						
1	1454	995	96	26.0	4.0	0.0	1992
1	1554	425	300	27.0	2.0	0.1	1993
1	2450	686	133	123.0	20.0	2.0	1994
1	3199	483	163	30.9	33.6	6.9	1995
1	2628	605	124	50.0	10.8	6.8	1996
1	3219	655	504	63.0	19.0	4.0	1997
1	3601	414	164	70.0	7.9	3.0	1998
1	3945	1060	191	70.0	54.1	1.7	1999
1	2631	1066	158	18.0	15.8	6.1	2000
1	6911	713	270	29.0	4.7	3.1	2001
1	3189	1421	274	55.4	6.1	1.5	2002
1	5284	1831	901	111.9	17.4	2.2	2003
1	4892	712	276	78.1	5.3	1.2	2004
1	2583	684	219	14.2	1.5	0.4	2005
1	3045	157	43	7.6	1.6	0.0	2006

Table 10.3.2.1. (cont'd) Whiting in 7a. Survey tuning data available to the WGNSDS 2007.

NIGFS-March E&W: Northern Ireland March Groundfish Survey-Irish Sea East & West-Nos. per 3 nm

1992	2007						
1	1	0.21	0.25				
1	5						
1	1477	456	94	29	5.0	0.0	1992
1	667	655	67	9	2.0	0.5	1993
1	1790	221	304	34	8.0	5.0	1994
1	1696	698	116	85	17.0	3.0	1995
1	1478	280	160	28	32.0	5.6	1996

1	1419	860	79	27	1.7	4.3	1997
1	1730	767	196	12	3.3	0.1	1998
1	1453	350	104	38	5.0	1.0	1999
1	2297	431	163	25	2.7	0.0	2000
1	1067	704	120	11	7	1.6	2001
1	1734	762	177	38	9	0.3	2002
1	1703	1163	129	18	4	0.0	2003
1	1837	261	59	3	1	0.1	2004
1	729	119	30	9	3	0.3	2005
1	1054	274	31	7	1	0.1	2006
1	1007	142	11	2	0.1	0.0	2007

UKNI-MIK : Northern Ireland MIK Net Survey

1994	2006		
1	1	0.46	0.50
0	0		
1	778	1994	
1	225	1995	
1	397	1996	
1	205	1997	
1	59	1998	
1	91	1999	
1	40	2000	
1	167	2001	
1	19	2002	
1	148	2003	
1	101	2004	
1	135	2005	
1	118	2006	

ScoGFS Spring: Scottish groundfish survey in Spring

1996	2006								
1	1	0.15	0.21						
1	8								
1	11610	4051	1898	362	229	59	3	4	1996
1	16322	16200	2953	964	250	105	39	1	1997
1	22145	8187	3817	137	110	0	5	0	1998
1	19815	6642	1706	282	11	0	27	0	1999
1	13019	1662	169	71	36	6	0	0	2000
1	9419	4541	407	40	2	0	0	0	2001
1	15605	3060	430	34	1	0	0	0	2002
1	14798	5404	375	45	0	4	0	0	2003
1	9199	2219	583	27	1	0	0	0	2004
1	3783	899	200	56	3	0	0	0	2005
1	7317	1040	319	32	2	0	0	0	2006

Table 10.3.2.1. (cont'd) Whiting in 7a. Survey tuning data available to the WGNSDS 2007.

ScoGFS Autumn: Scottish groundfish survey

1997	2005							
1	1	0.83	0.91					
0	6							
1								
1	30094	8827	2530	435	215	4	0	1997
1	18457	7166	1291	37	35	26	0	1998
1	73309	7357	2166	263	219	0	6	1999
1	16862	8677	503	242	25	12	0	2000
1	0	140	133	13	0	0	0	2001
1	30324	16655	1435	224	2	28	0	2002
1	26671	7170	1138	69	0	0	0	2003
1	42435	19333	3321	319	3	0	0	2004
1	16510	3382	97	4	2	3	0	2005

IR-ISCSGFS: Irish Sea Celtic Sea GFS 4th Qtr-Effort min. towed-No. at age

1997 2002

1 1 0.8 0.9

0 5

540	1566	3330		793	154	23	12	1997
1020	48396	6534		2249	170	15	0	1998
1170	208494	3302		624	24	28	2	1999
1128	97502	4402		25	1	0	0	2000
1221	28881	29577		3123	177	1	0	2001
1035	12112	10237		1497	225	33	5	2002

IR-Q4 IBTS: IRISH GFS RV Celtic Explorer: NUMBERS AT AGE

2003 2004

1 1 0.89 0.91

0 5

1	72340	19658	13391	1617	605	0	2003
1	75196	14563	1293	147	5	2	2004

FSP Survey of Irish Sea Roundfish-Whiting VIIa

FV *Isadale*: indices of abundance (nos. caught per hour) for cod, haddock and whiting, 2005 - 2007.

2005 2007

1 1

1 5

1	0.22	11.06	21.12	5.28	0.98	0.00	0.69
1	8.69	46.65	15.22	1.85	0.53	0.013	0.00
1	4.24	10.77	5.55	1.01	0.28	0.02	0.00

Table 10.4.1 Whiting in VIIa (Irish Sea)
International catch at age ('000) for human consumption
1980 to 2002.**Partially corrected for misreporting.**
No 2003 - 2006 estimates were possible.

Age	1980	1981
0	0	0
1	14520	11203
2	21811	29011
3	6468	16004
4	2548	2596
5	350	821
6+	621	339

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	41	0	0	0	0	0	0	0	0	102
1	5427	4886	18254	15540	6306	10149	6983	11645	9502	7426
2	18098	9943	12683	35324	16839	21563	25768	14029	17604	18406
3	19340	9100	5257	8687	10809	6968	6989	13011	4734	5829
4	6108	4530	2571	996	1877	1943	1513	3645	1477	993
5	813	1165	1045	675	285	242	396	490	318	311
6+	400	321	402	372	270	111	197	177	128	84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	38	0	0	129	0	0	1	0	0	0
1	8380	2742	3245	1124	1652	610	329	341	319	111	67
2	21907	21468	6983	10095	6162	4239	3287	2806	1364	1189	748
3	7959	7327	18509	3020	7432	2567	4727	2607	1002	1006	1480
4	1374	932	1801	4444	1263	1795	888	741	299	171	376
5	462	135	208	233	1082	87	261	160	115	53	48
6+	93	27	50	21	135	79	95	119	15	20	41

Table 10.4.2 Whiting in VIIa (Irish Sea)
International catch at age ('000) discarded, 1980 to 2002
No 2003 - 2006 estimates were possible.

Age	1980	1981
0	12786	9865
1	32318	24935
2	6888	9162
3	65	162
4	26	26
5	0	0
6+	0	0

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	4047	23847	26394	12380	28364	16594	6922	17247	4216	20349
1	8489	7328	33900	26461	21111	40598	17958	20701	31810	29334
2	560	2036	1568	1859	1464	1875	1940	2476	3353	3823
3	19	9	11	9	33	0	0	26	72	146
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6+	0	0	0	0	0	0	0	0	0	0

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	1497	12639	3731	7118	12732	8163	6096	20851	7321	16940	8538
1	61451	13979	12063	17613	39647	25497	27131	7677	38922	12631	13412
2	10404	17707	1812	7015	8168	5352	2293	2117	4395	3150	1588
3	97	426	1702	492	1976	689	550	228	564	102	231
4	0	5	29	234	81	141	44	34	55	10	33
5	0	0	0	0	0	0	0	2	1	0	0
6+	0	0	0	0	0	0	0	2	10	0	1

Table 10.4.3 Whiting in VIIa (Irish Sea)
International catch at age ('000) landed and discarded,
1980 to 2002

No 2003 - 2006 estimates were possible.

Age	1980	1981
0	12786	9865
1	46838	36138
2	28699	38173
3	6533	16166
4	2574	2622
5	350	821
6+	621	339

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	4088	23847	26394	12380	28364	16594	6922	17247	4216	20451
1	13916	12214	52154	42001	27417	50747	24941	32346	41312	36760
2	18658	11979	14251	37183	18303	23438	27708	16505	20957	22229
3	19359	9109	5268	8696	10842	6968	6989	13037	4806	5975
4	6108	4530	2571	996	1877	1943	1513	3645	1477	994
5	813	1165	1045	675	285	242	396	490	318	311
6+	400	321	402	372	270	111	197	177	128	84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	1497	12677	3731	7118	12861	8163	6096	20852	7321	16940	8538
1	69831	16721	15308	18737	41299	26107	27460	8018	39242	12742	13479
2	32311	39175	8795	17110	14330	9591	5580	4923	5758	4338	2336
3	8056	7753	20211	3512	9408	3256	5277	2835	1566	1108	1711
4	1374	937	1830	4678	1344	1936	932	776	354	181	409
5	462	135	208	233	1082	87	261	161	115	53	48
6+	93	27	50	21	135	79	95	121	25	20	42

Table 10.4.4 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the human consumption catch, 1980 to 2002.
No 2003 - 2006 estimates were possible.

Age	1980	1981
0	0,133	0,133
1	0,216	0,216
2	0,269	0,269
3	0,365	0,365
4	0,533	0,533
5	0,630	0,630
6+	0,772	0,888

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0,133	0	0,144	0	0,134	0	0	0	0	0,115
1	0,216	0,215	0,208	0,174	0,184	0,173	0,152	0,197	0,198	0,172
2	0,269	0,279	0,257	0,250	0,225	0,223	0,214	0,209	0,220	0,210
3	0,365	0,397	0,403	0,333	0,342	0,363	0,330	0,269	0,313	0,266
4	0,533	0,491	0,550	0,478	0,512	0,535	0,547	0,433	0,436	0,352
5	0,630	0,605	0,699	0,567	0,709	0,720	0,763	0,680	0,676	0,453
6+	0,736	0,655	0,745	0,642	0,940	0,933	1,005	1,079	0,800	0,692

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0,117	0	0	0	0	0	0,120	0,064	0	0
1	0,160	0,151	0,169	0,188	0,196	0,171	0,169	0,166	0,179	0,182	0,145
2	0,198	0,186	0,198	0,219	0,217	0,219	0,202	0,218	0,216	0,250	0,214
3	0,274	0,233	0,227	0,273	0,244	0,244	0,240	0,255	0,269	0,319	0,273
4	0,361	0,332	0,304	0,334	0,288	0,296	0,274	0,328	0,317	0,346	0,356
5	0,513	0,454	0,378	0,551	0,365	0,396	0,350	0,352	0,347	0,538	0,449
6+	1,007	0,892	0,496	1,320	0,415	0,537	0,421	0,328	0,412	0,337	0,428

Table 10.4.5 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the discarded catch, 1980 to 2002. **No 2003-2006 estimates were possible.**

Age	1980	1981
0	0,034	0,034
1	0,062	0,062
2	0,125	0,125
3	0,230	0,230
4	0	0
5	0	0
6+	0	0

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0,029	0,033	0,024	0,022	0,023	0,024	0,021	0,026	0,034	0,030
1	0,072	0,101	0,075	0,080	0,058	0,078	0,069	0,063	0,060	0,051
2	0,125	0,147	0,130	0,137	0,126	0,157	0,114	0,105	0,113	0,115
3	0,141	0,245	0	0	0,155	0	0,449	0,091	0,115	0,130
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6+	0	0	0	0	0	0	0	0	0	0

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0,014	0,029	0,029	0,031	0,026	0,026	0,017	0,028	0,024	0,017	0,016
1	0,050	0,050	0,048	0,055	0,051	0,041	0,034	0,038	0,036	0,034	0,033
2	0,110	0,089	0,123	0,120	0,111	0,101	0,090	0,086	0,100	0,088	0,082
3	0,137	0,143	0,154	0,153	0,161	0,141	0,130	0,147	0,128	0,119	0,127
4	0	0,175	0,149	0,179	0,186	0,170	0,145	0,237	0,150	0,194	0,141
5	0	0	0	0	0	0	0	0,218	0,213	0	0
6+	0	0	0	0	0	0	0	0,174	0,152	0	0,213

Table 10.4.6 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the total catch
(landings plus discards) 1980 to 2002.

No 2003 - 2006 estimates were possible.

Age	1980	1981
0	0,034	0,040
1	0,110	0,118
2	0,235	0,240
3	0,363	0,364
4	0,529	0,529
5	0,630	0,630
6+	0,772	0,888

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0,031	0,033	0,032	0,021	0,025	0,024	0,021	0,026	0,036	0,031
1	0,135	0,146	0,125	0,107	0,100	0,101	0,088	0,111	0,094	0,077
2	0,265	0,256	0,244	0,245	0,217	0,217	0,201	0,193	0,204	0,194
3	0,365	0,397	0,403	0,333	0,342	0,363	0,330	0,269	0,310	0,263
4	0,533	0,491	0,550	0,478	0,512	0,535	0,547	0,433	0,436	0,352
5	0,630	0,605	0,700	0,567	0,709	0,720	0,763	0,680	0,676	0,453
6+	0,736	0,655	0,745	0,642	0,940	0,933	1,005	1,079	0,800	0,692

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0,014	0,029	0,030	0,031	0,027	0,026	0,017	0,028	0,024	0,017	0,016
1	0,063	0,067	0,074	0,063	0,057	0,044	0,035	0,044	0,038	0,036	0,033
2	0,170	0,142	0,183	0,179	0,159	0,153	0,156	0,161	0,127	0,132	0,124
3	0,272	0,228	0,221	0,257	0,230	0,222	0,228	0,246	0,218	0,301	0,253
4	0,361	0,331	0,301	0,326	0,284	0,287	0,268	0,324	0,291	0,338	0,339
5	0,513	0,454	0,378	0,551	0,364	0,396	0,350	0,351	0,347	0,538	0,449
6+	1,007	0,892	0,496	1,320	0,715	0,679	0,421	0,325	0,310	0,337	0,425

Table 10.4.7 Whiting in VIIa (Irish Sea)
Estimate of Discarding from *Nephrops* fleet as proportion of total International Catch at age.
This does not include discards from the fleets other than the *Nephrops* fleet.

Age	0	1	2	3	4	5
1981	1,000	0,690	0,240	0,010	0,010	0
1982	0,990	0,610	0,030	0,001	0	0
1983	1,000	0,600	0,170	0,001	0	0
1984	1,000	0,650	0,110	0,002	0	0
1985	1,000	0,630	0,050	0,001	0	0
1986	1,000	0,770	0,080	0,003	0	0
1987	1,000	0,800	0,080	0	0	0
1988	1,000	0,720	0,070	0	0	0
1989	1,000	0,640	0,150	0,002	0	0
1990	1,000	0,770	0,160	0,015	0	0
1991	0,995	0,798	0,172	0,024	0,001	0
1992	1,000	0,880	0,322	0,012	0	0
1993	0,997	0,836	0,452	0,055	0,005	0
1994	1,000	0,788	0,206	0,084	0,016	0
1995	1,000	0,940	0,410	0,140	0,050	0
1996	0,990	0,960	0,570	0,210	0,060	0
1997	1,000	0,977	0,558	0,212	0,073	0
1998	1,000	0,988	0,411	0,104	0,047	0
1999	1,000	0,957	0,430	0,081	0,044	0,009
2000	1,000	0,992	0,763	0,360	0,154	0,005
2001	1,000	0,991	0,726	0,092	0,055	0
2002	1,000	0,995	0,680	0,135	0,081	0,000
Mean 81-02	0,999	0,817	0,311	0,070	0,027	0,001

Table 10.4.8 Whiting in VIIa (Irish Sea)
Estimated landed and discarded catch.
Partially corrected for misreporting

	Catch ('000 t)	
Year	Landed	Discarded
1980	13461	3324
1981	17646	2960
1982	17304	808
1983	10525	1820
1984	11802	3433
1985	15582	2654
1986	10300	2115
1987	10519	3899
1988	10245	1611
1989	11305	2103
1990	8212	2444
1991	7348	2598
1992	8588	4203
1993	6523	2707
1994	6763	1173
1995	4893	2151
1996	4335	3631
1997	2277	1928
1998	2229	1304
1999	1670	1092
2000	762	2118
2001	733	1012
2002	747	740
2003	401	n/a
Mean:	7990	2253

Table 10.4.9. Whiting VIIa Discard Numbers and Weights at Age of Irish otter trawl fleet 1996-2006

	1996		1997		1998		1999		2000		2001	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	5631,20	0,015	4110,63	0,027	5073,57	0,027	187,26	0,036	7850,12	0,033	20981,54	0,016
1	5925,33	0,035	8361,19	0,044	5939,53	0,064	276,50	0,102	3098,24	0,047	8883,11	0,054
2	1802,90	0,111	3243,45	0,120	3826,20	0,107	150,99	0,174	137,80	0,153	1413,48	0,126
3	144,34	0,217	696,18	0,200	440,05	0,185	43,70	0,235	30,31	0,229	479,38	0,133
4	6,02	0,206	68,71	0,241	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
5	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	22,95	0,136
6	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
7	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
8	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
9	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
10	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
11	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
12	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
13	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
14+	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
OTB Discards (tonnes, whole weight)		520,8		1024,1		1010,3		71,6		434,3		1054,5
Sampling Information	1996		1997		1998		1999		2000		2001	
Number of Trips		8		8		7		4		10		2
Number of Hauls		48		44		58		40		111		34

	2002		2003		2004		2005		2006	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	29017,16	0,021	1921,76	0,016	17091,56	0,018	442,07	0,010	1534,97	0,016
1	12097,93	0,033	2419,56	0,036	7347,29	0,034	2531,84	0,035	1483,43	0,060
2	576,17	0,112	1287,21	0,178	731,35	0,101	783,68	0,091	621,58	0,133
3	152,95	0,105	603,20	0,246	142,50	0,165	129,28	0,159	99,02	0,218
4	0,00	0,000	108,64	0,268	96,30	0,218	40,12	0,154	16,82	0,312
5	17,66	0,123	0,00	0,000	0,00	0,000	24,48	0,371	0,00	0,000
6	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
7	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
8	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
9	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
10	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
11	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
12	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
13	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
14+	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,00	0,000
OTB Discards (tonnes, whole weight)		1100,9		523,6		680,3		201,3		223,2
Sampling Information	2002		2003		2004		2005		2006	
Number of Trips		1		9		11		8		5
Number of Hauls		7		60		122		96		56

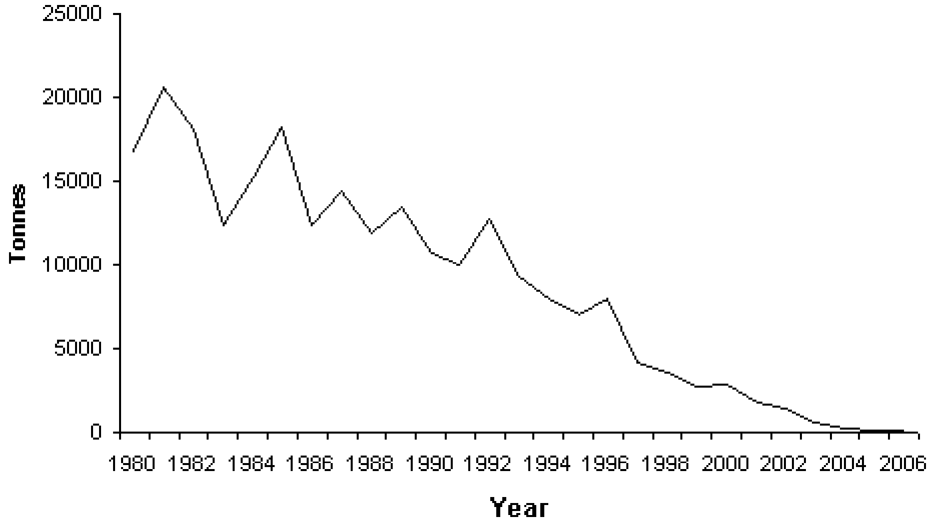
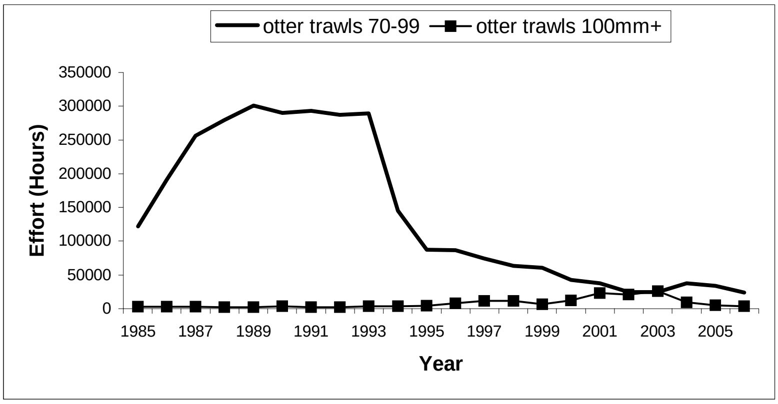
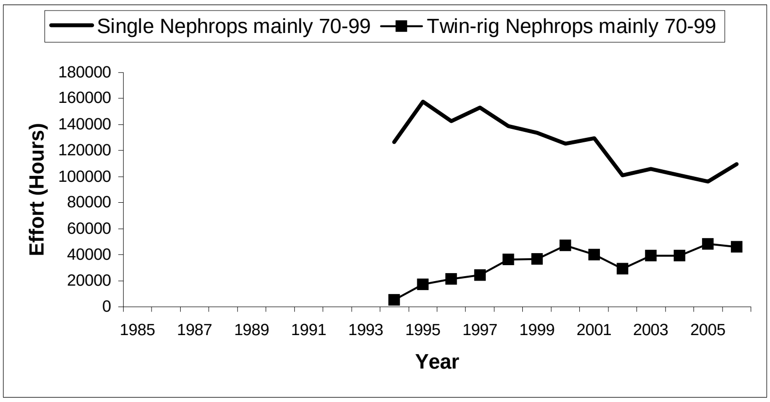
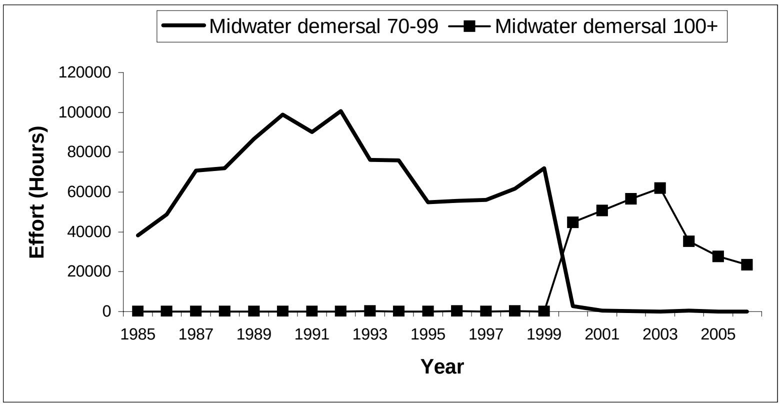


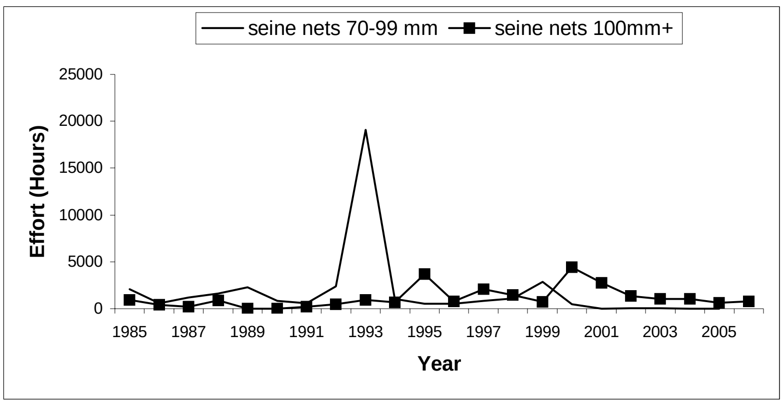
Figure 10.2.1.1 Whiting VIIa. Working group estimates of landings 1980-2006. Note landings data has prior to 2003 has been adjusted for misreporting and includes estimates of discards.

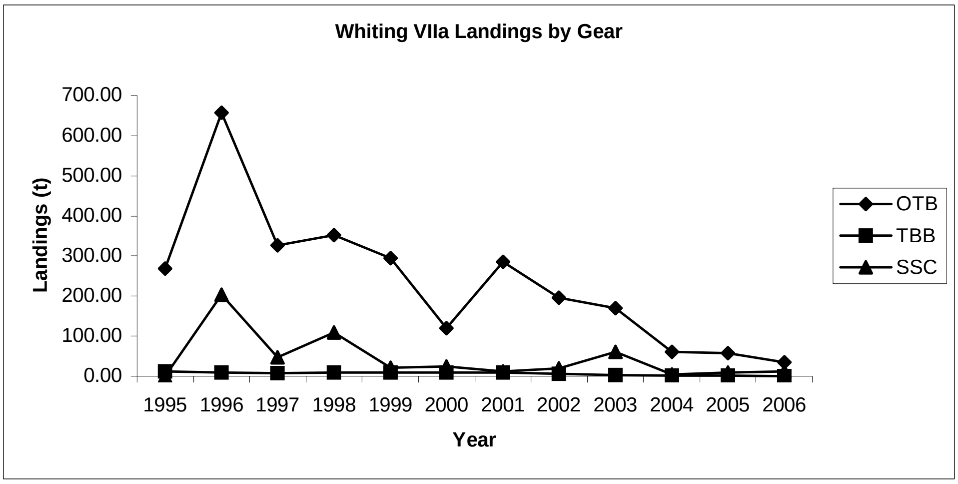
Figure 10.3.1.1 Whiting VIIa (Irish Sea)
Trends in effort (Hours) for UK(E&W) commercial tuning fleets.

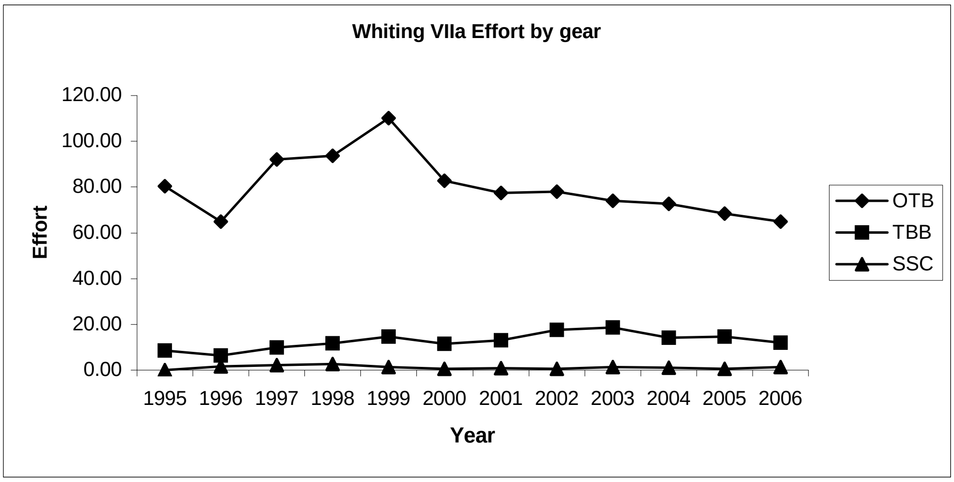












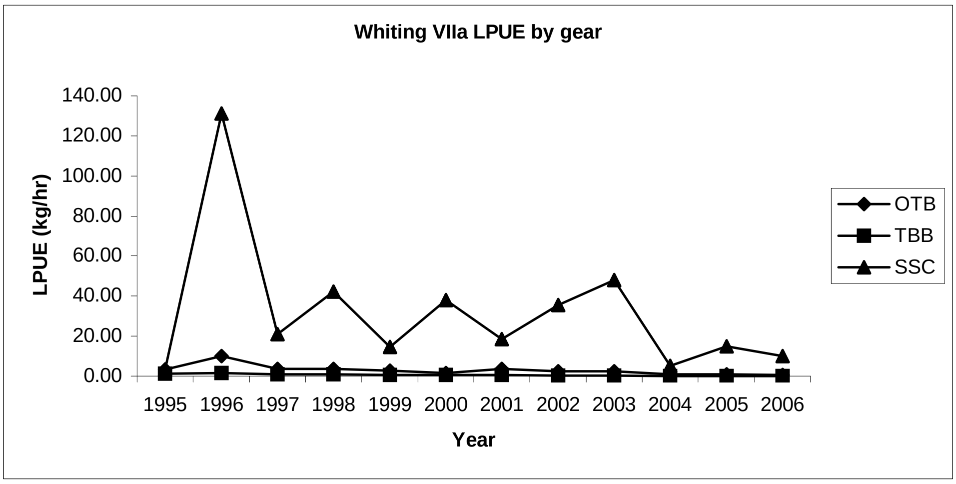


Figure 10.3.1.2 Landings, Effort and LPUE data for Irish Otter Trawl Fleet (IR-OTB),beam trawl(IR-TBB) and Scottish seine (IR-SSC) for 1995-2006.

Distribution of whiting above MLS in spring, based on NI groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 1090 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot. Stations in the St George s Channel have only been fished since autumn 2001).

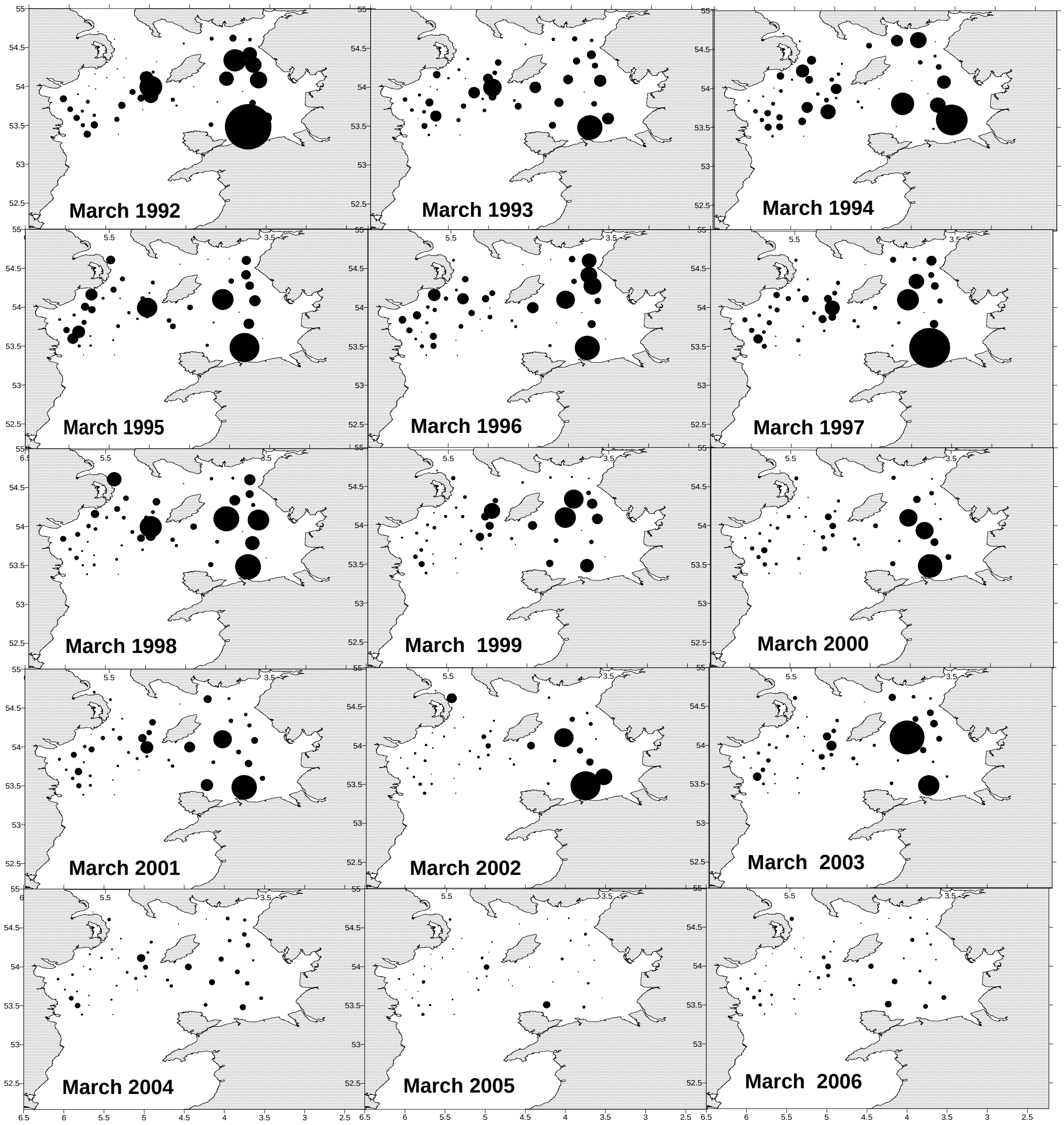


Figure 10.3.2.1 (a) Distribution of whiting less than MLS in spring, based on NI groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 2200 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot.)

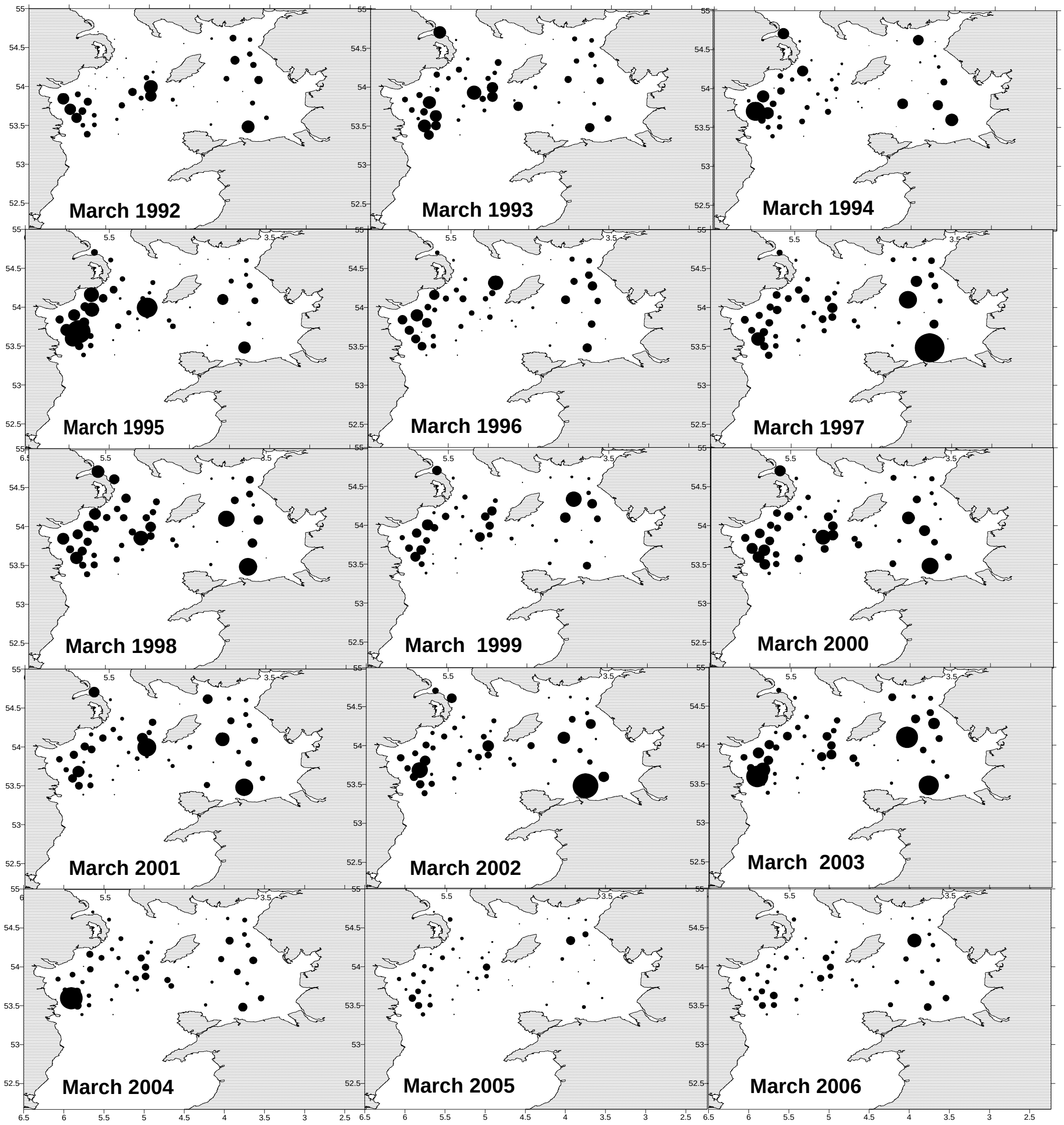


Figure 10.3.2.1 (b) Distribution of whiting above MLS in autumn, based on NI groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 375 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot.)

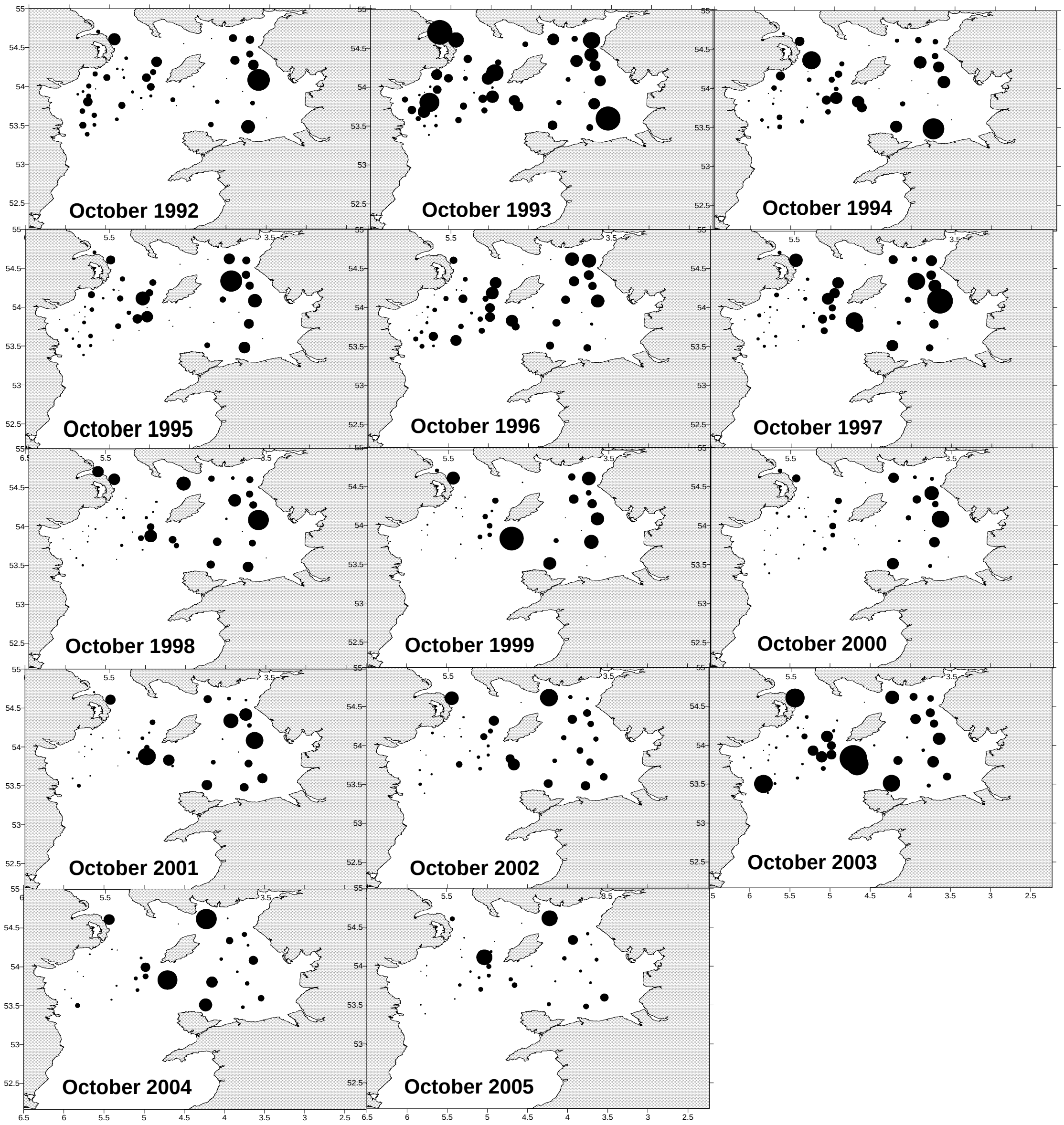


Figure 10.3.2.1 (c) Distribution of whiting less than MLS in autumn, based on NI groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 3140 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot).

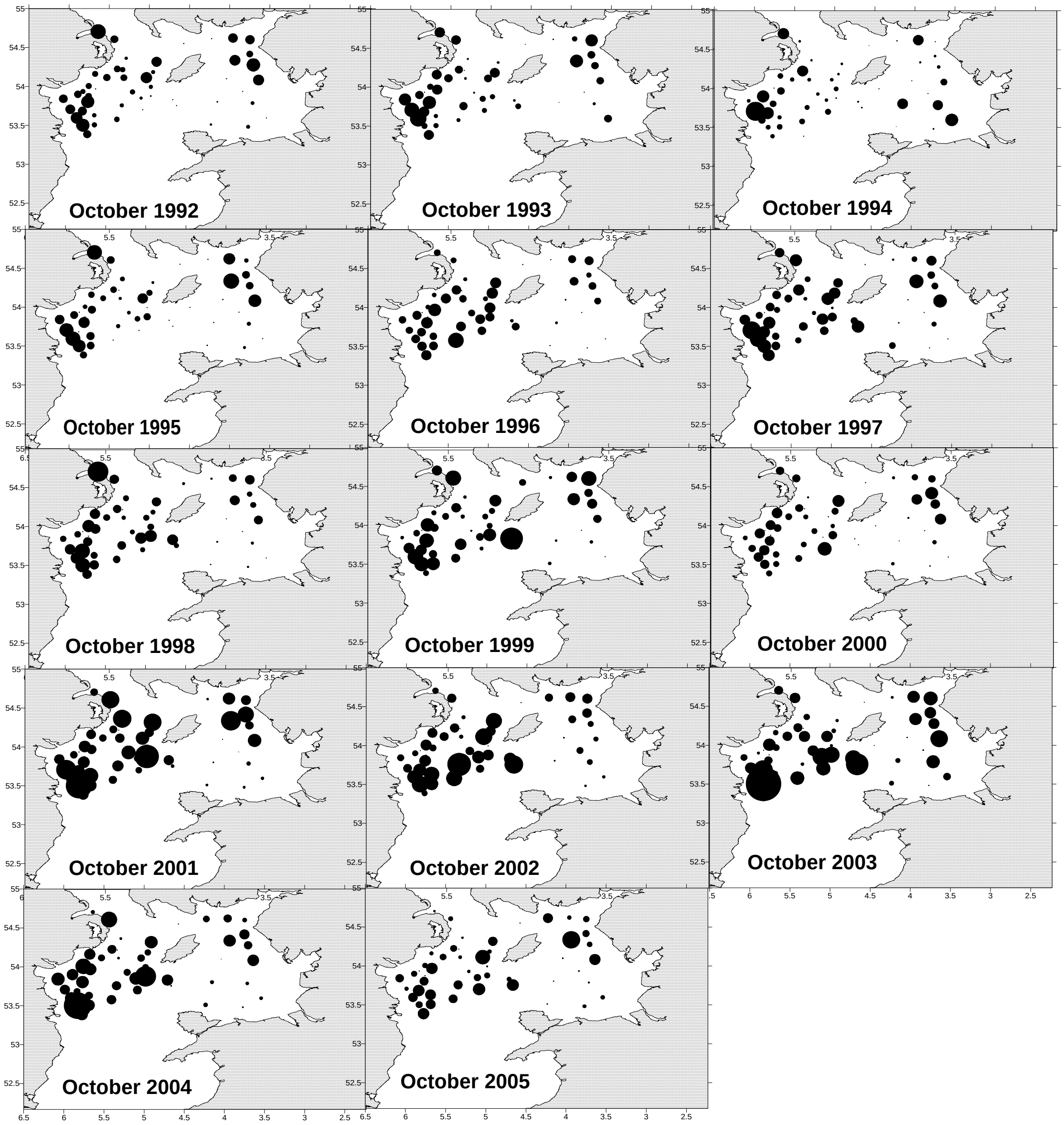


Figure 10.3.2.1 (d) Distribution of whiting less than MLS in autumn, based on NI groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 3140 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot).

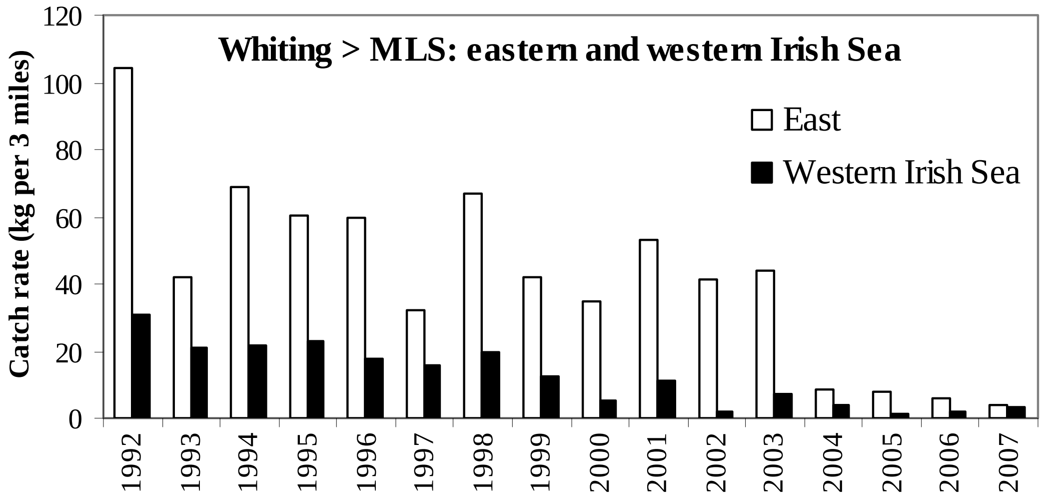
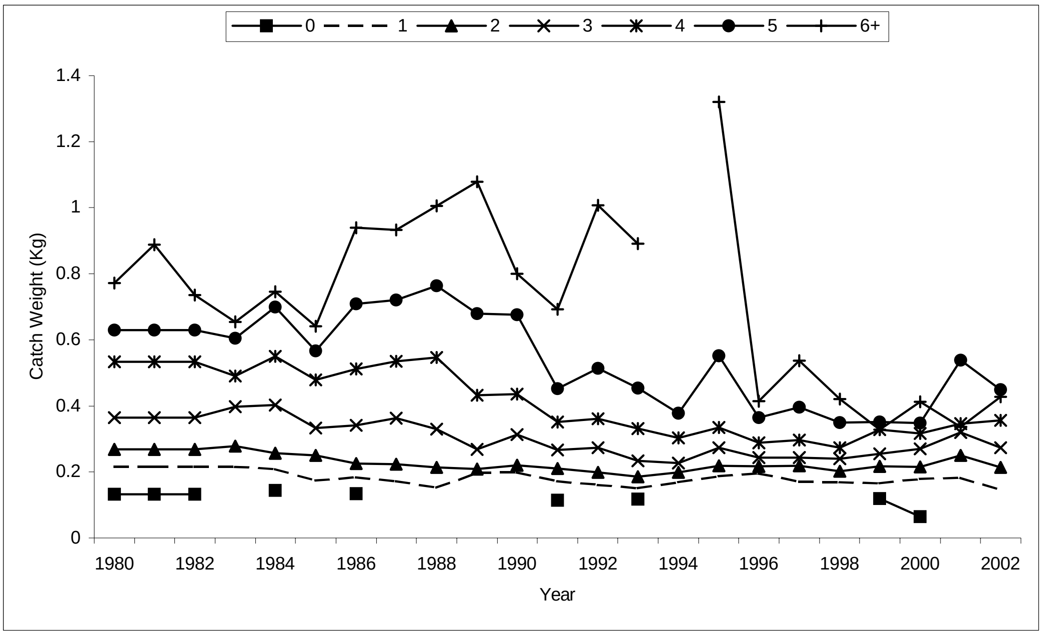


Fig. 10.3.2.2. Mean catch rates in eastern and western Irish Sea of whiting in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) for UK(NI) groundfish surveys in March 1992 - 2007.

a)



b)

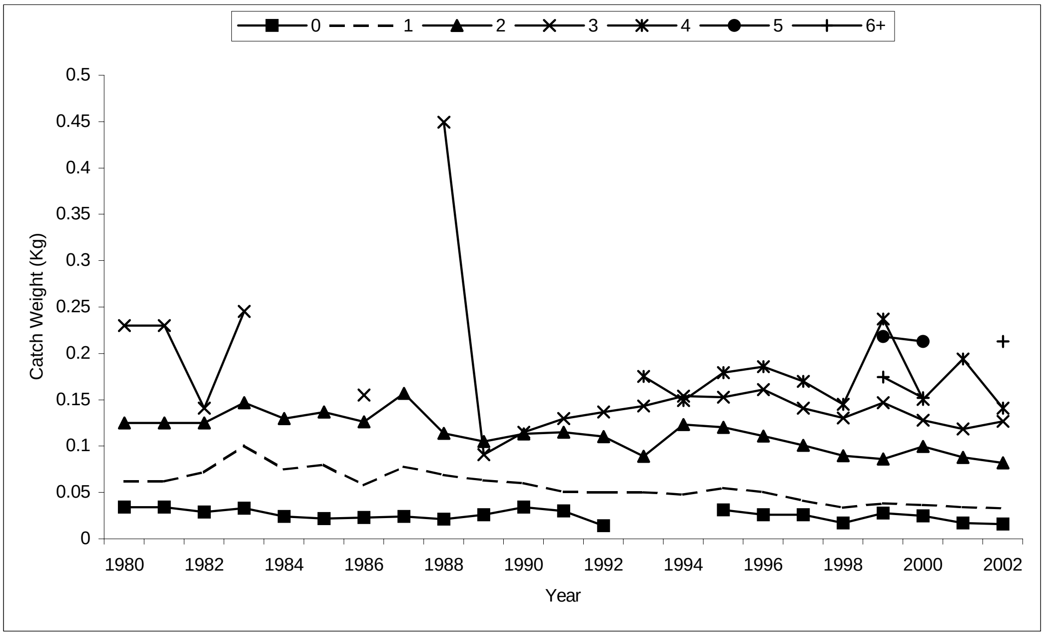
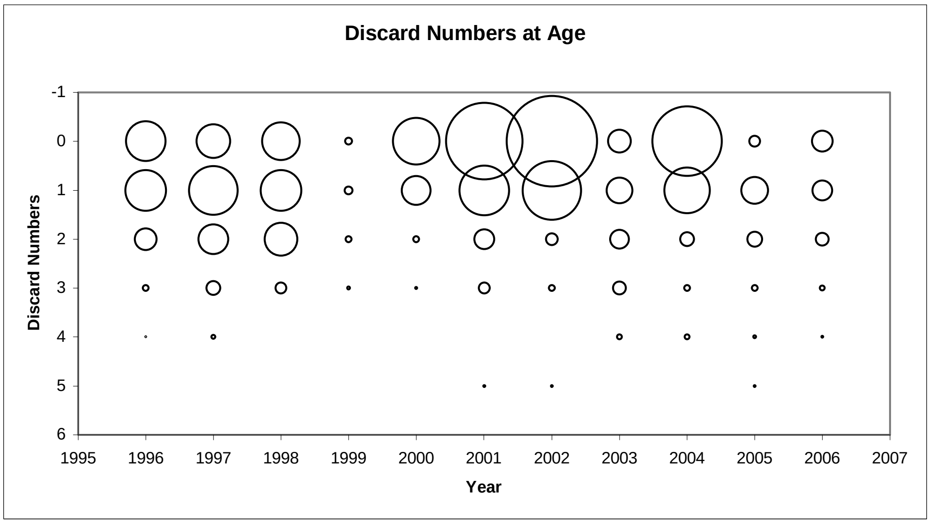


Figure 10.4.1.1 Mean weights at age in the Human Consumption Fishery (landings) (a) and in the Discards (b) for Whtiting in VIIa

a)



b)

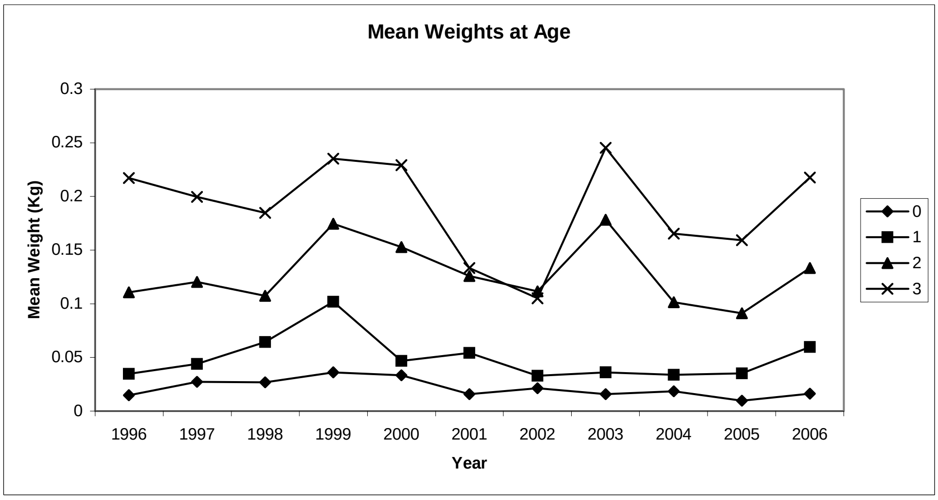
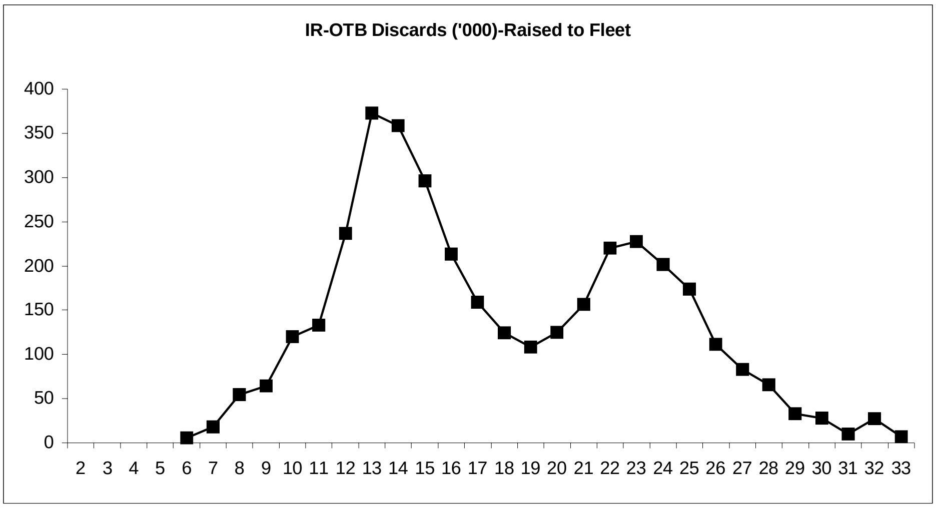
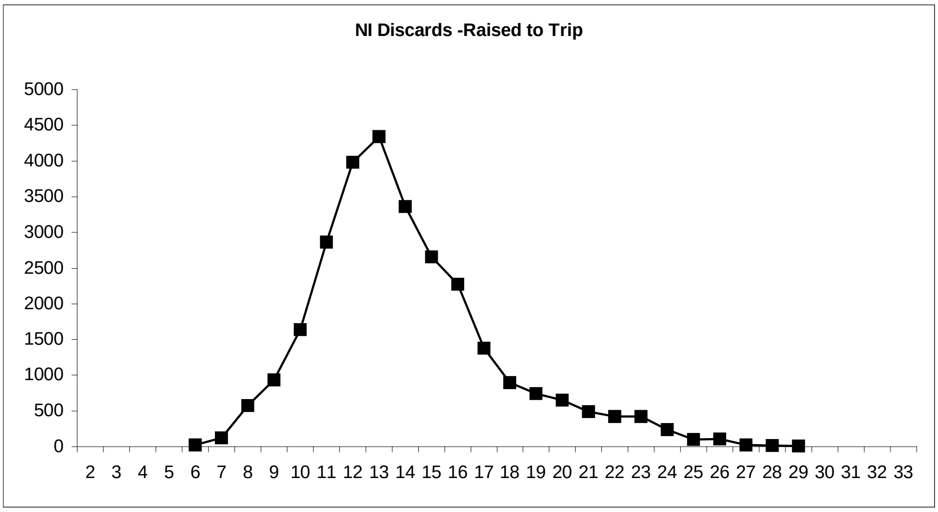


Figure 10.4.2.1 Whiting VIIa Discard Numbers (a) and Mean Weights at age (b)for the Irish Otterboard Trawl Fleet (1996-2006)





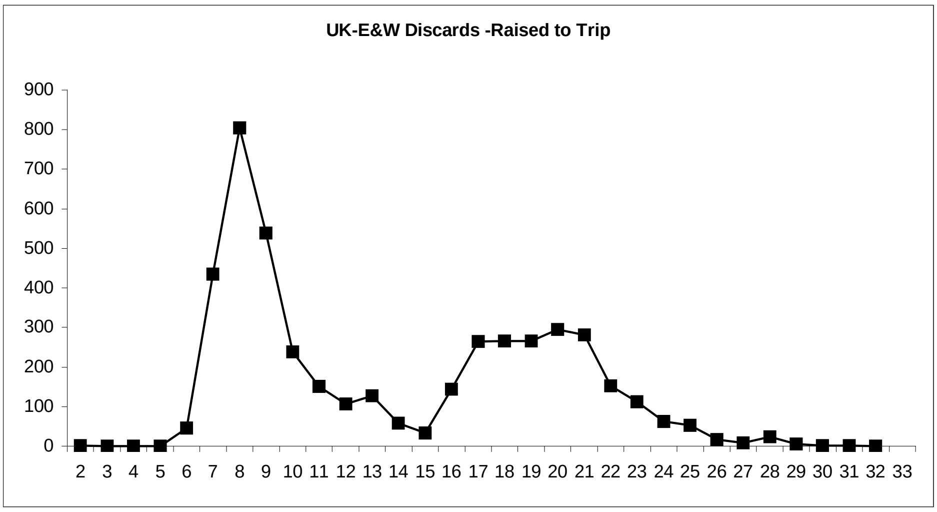
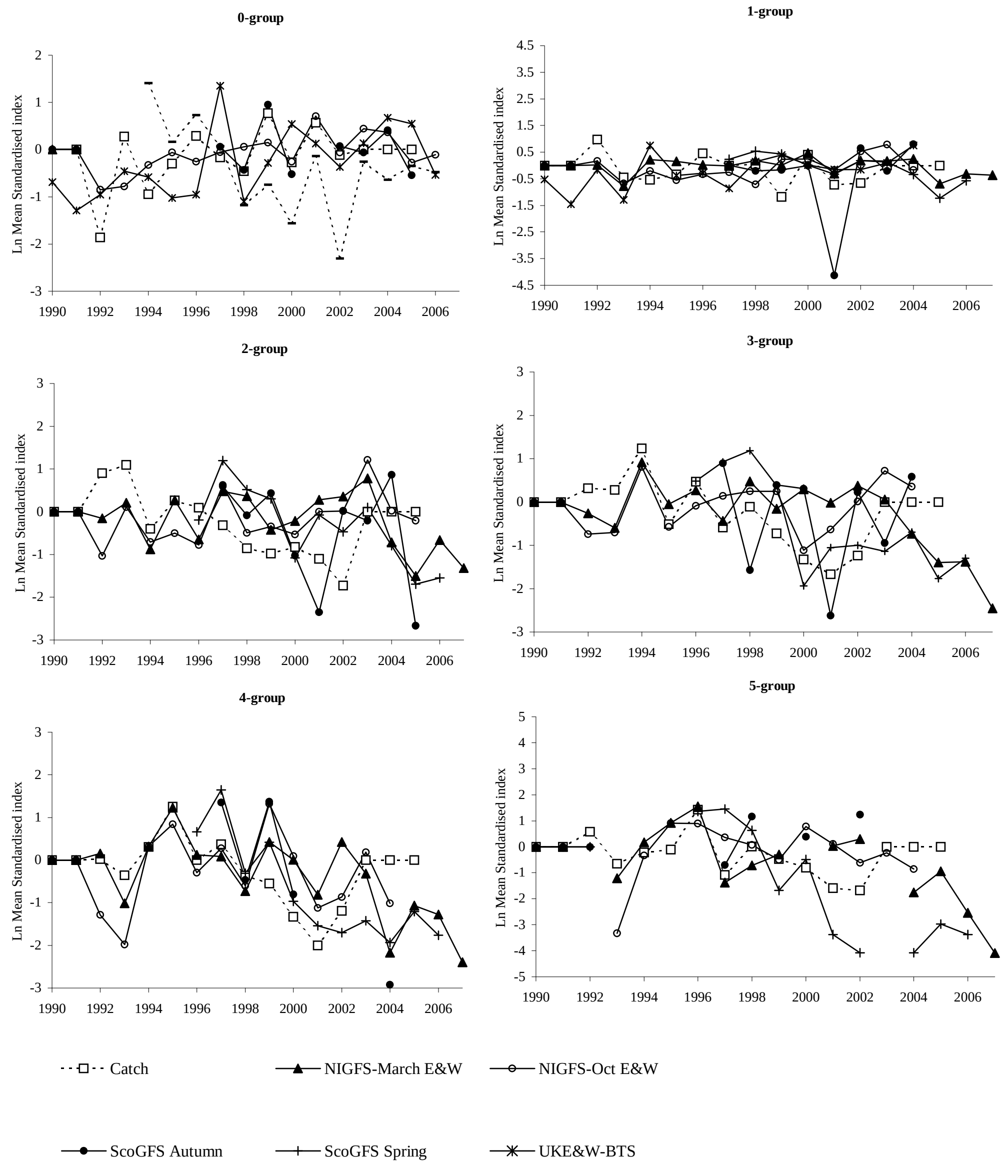
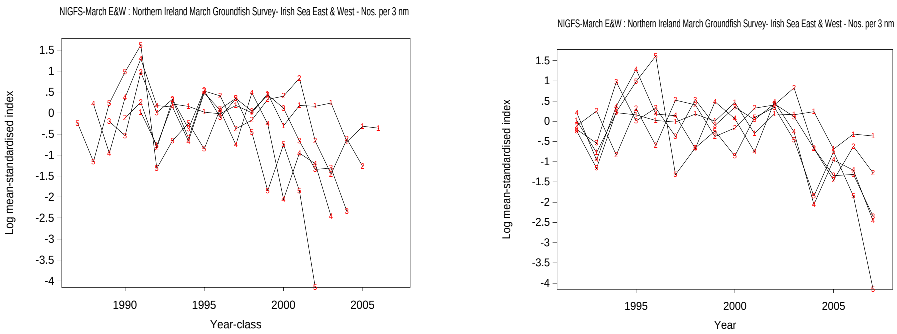


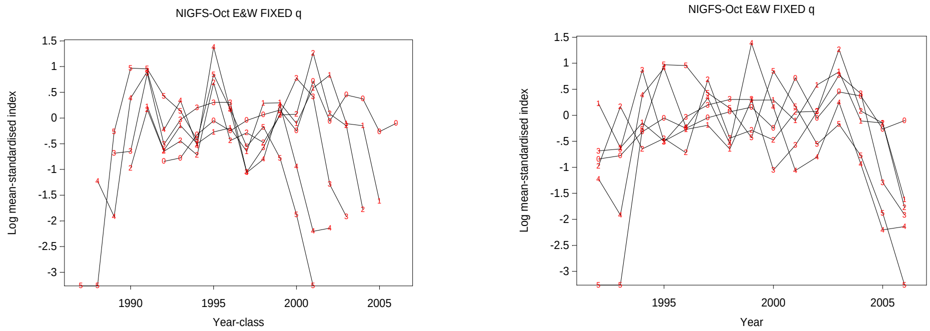
Figure 10.4.9 Discard Length Frequency of Whiting VIIa in 2006. Note due to low levels of retained catch, and hence low sampling, this data is not presented.

Figure 10.6.1.2.1 Whiting in VIIa (Irish Sea). Trends in log mean standardised abundance indices compared with total international catch at age. **Survey data for whole of northern Irish Sea**





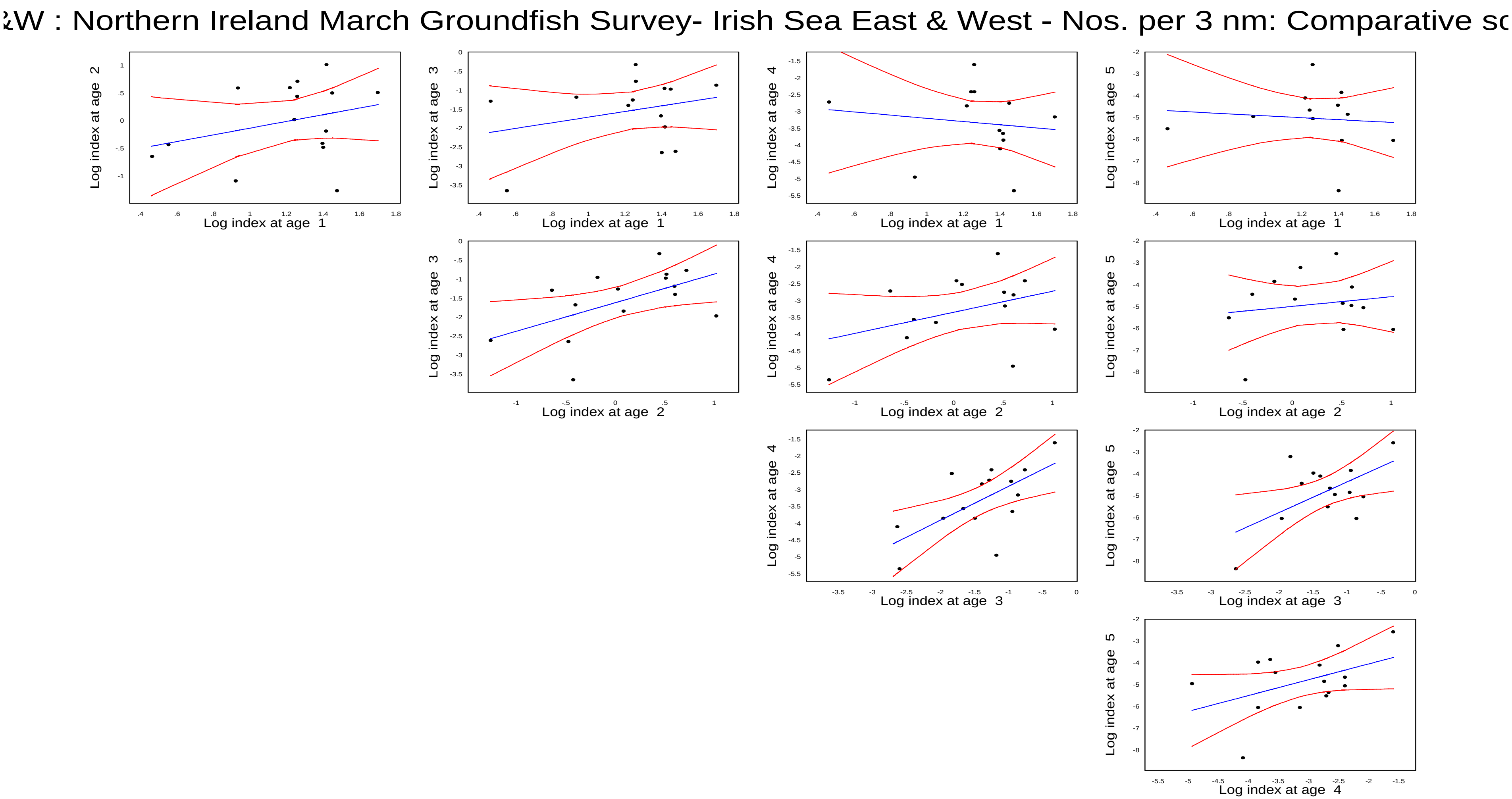
(a)



(b)

Figure 10.6.1.2.2 Log Mean Standardized Indices By Year-class and Year for NIGFS March (a), and NIGFS October (b).

(a)



ꝛW : Northern Ireland March Groundfish Survey- Irish Sea East & West - Nos. per 3 nm: Comparative sc
Log index at age 2
Log index at age 3
Log index at age 4
Log index at age 5
Log index at age 1
Log index at age 2
Log index at age 3
Log index at age 4

(b)

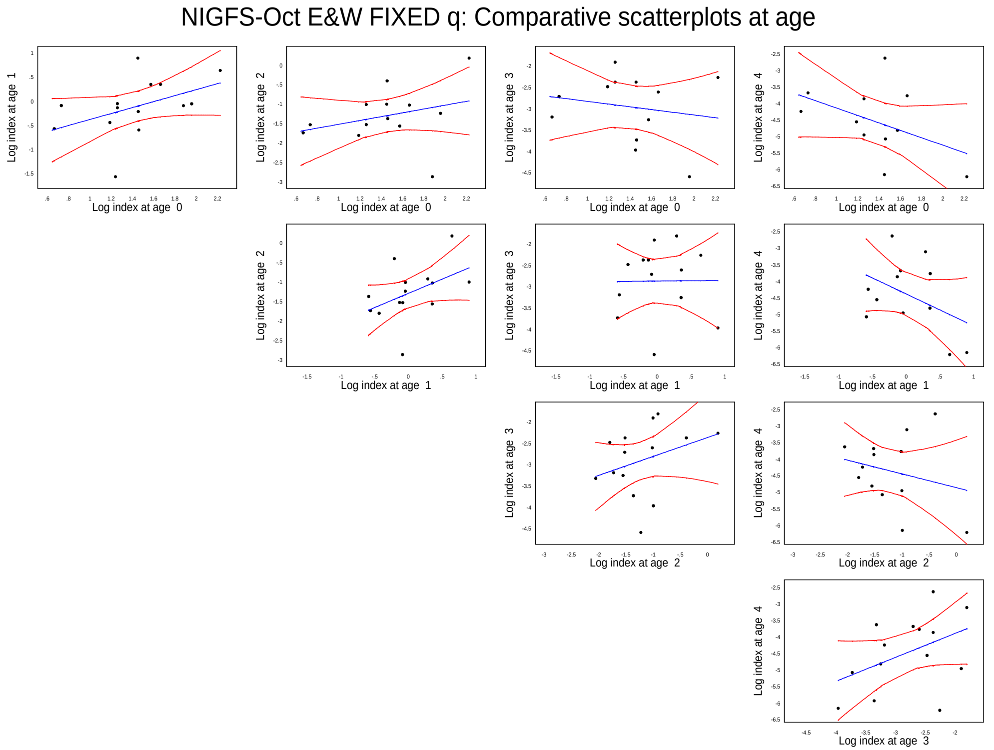
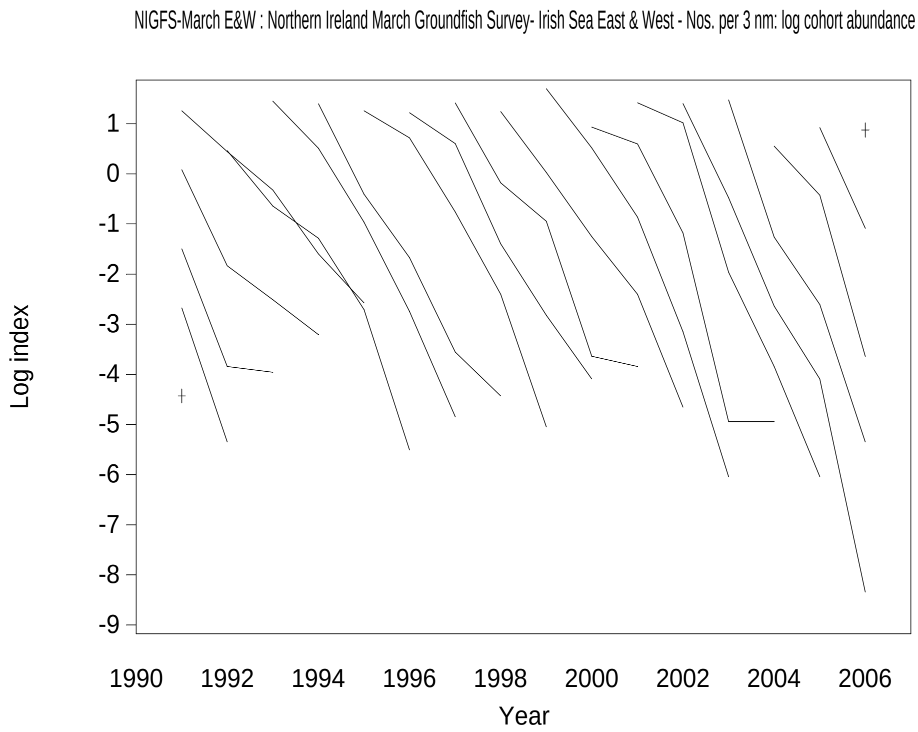


Figure 10.6.1.2.3 Scatter Plots of Log index at age for the NIGFS March (a) and NIGFS October (b).

(a)



(b)

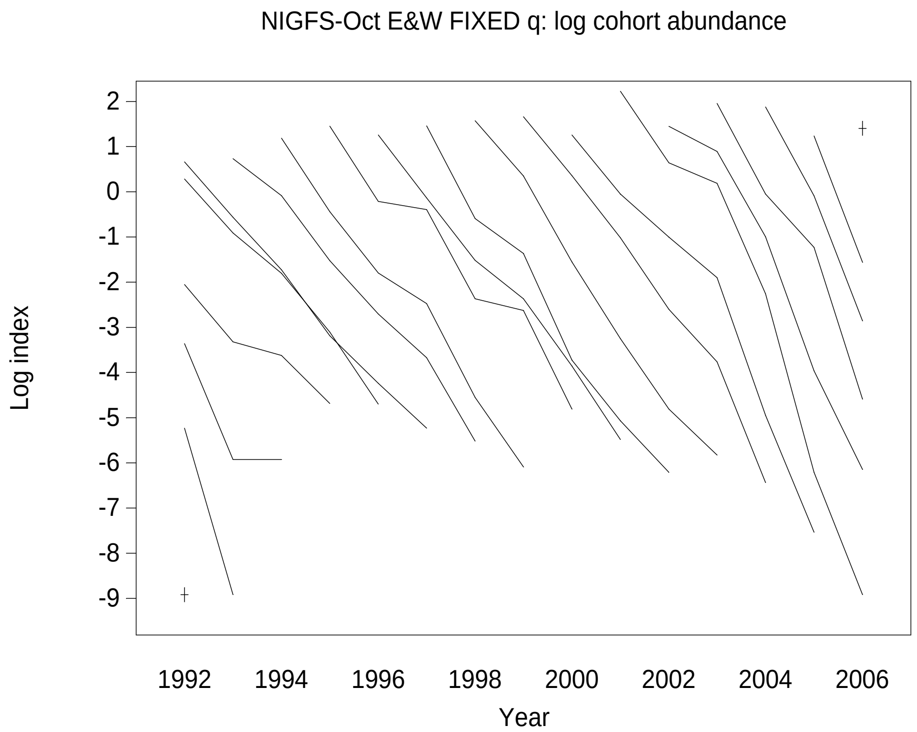
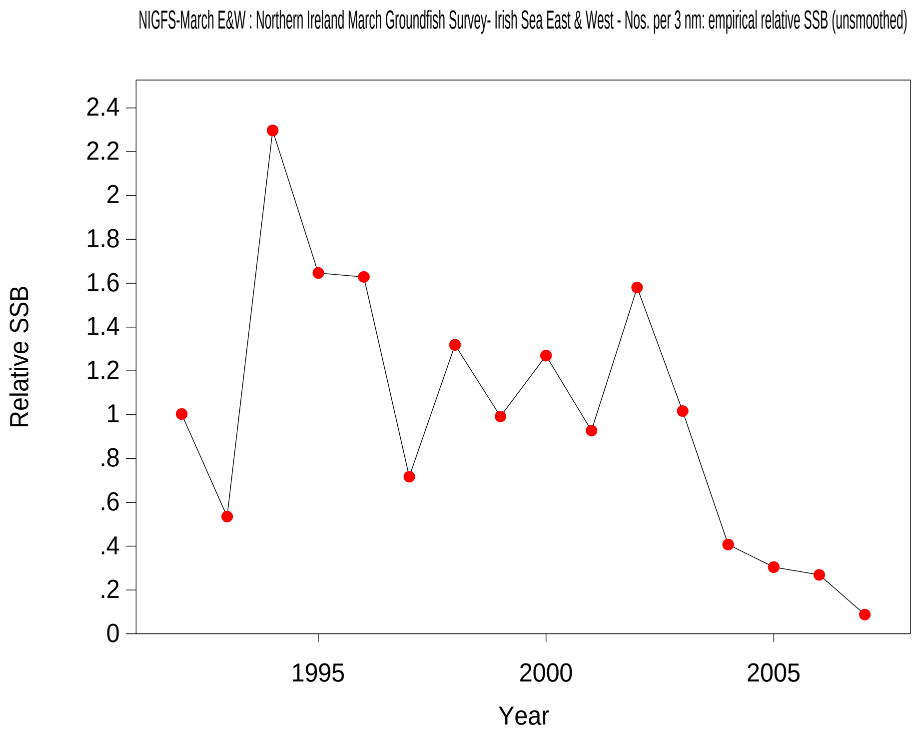


Figure 10.6.1.2.4 Catch Curves for NIGFS-March (a) and NIGFS-Oct (b)

a)



b)

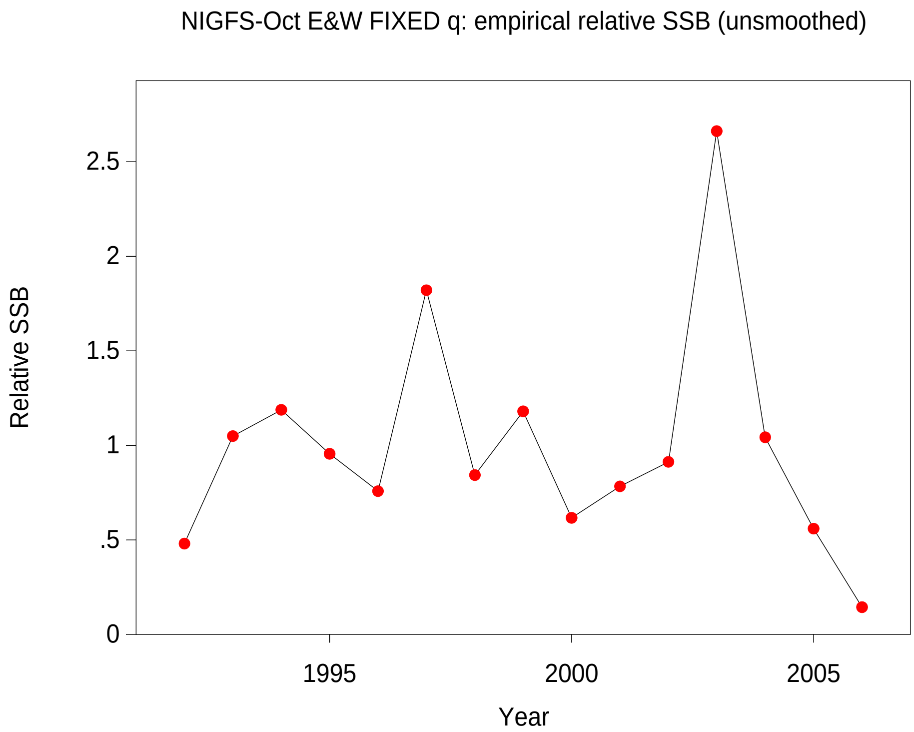


Figure 10.6.1.2.5 Empirical Estimates of SSB for NIGFS-March (a) and NIGFS-Oct (b)

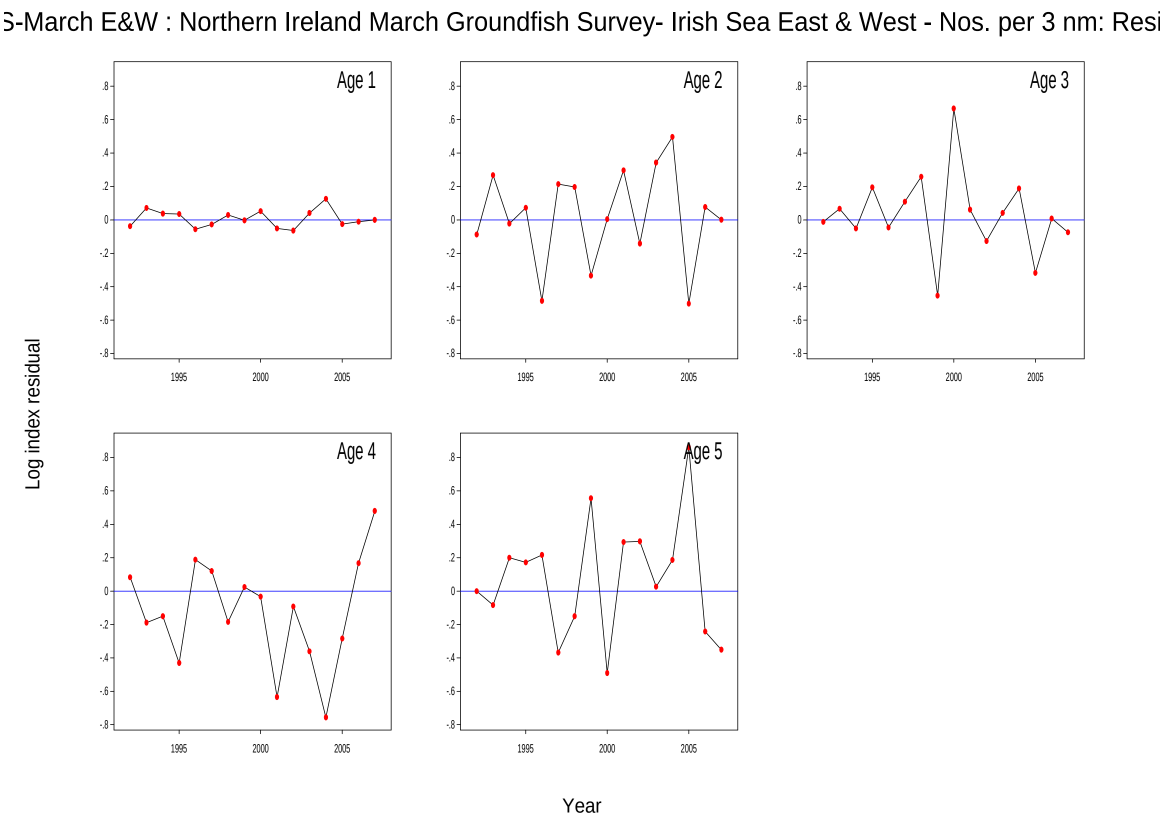


Figure 10.6.1.3 Residual Plots by Age of the NIGFS-March.

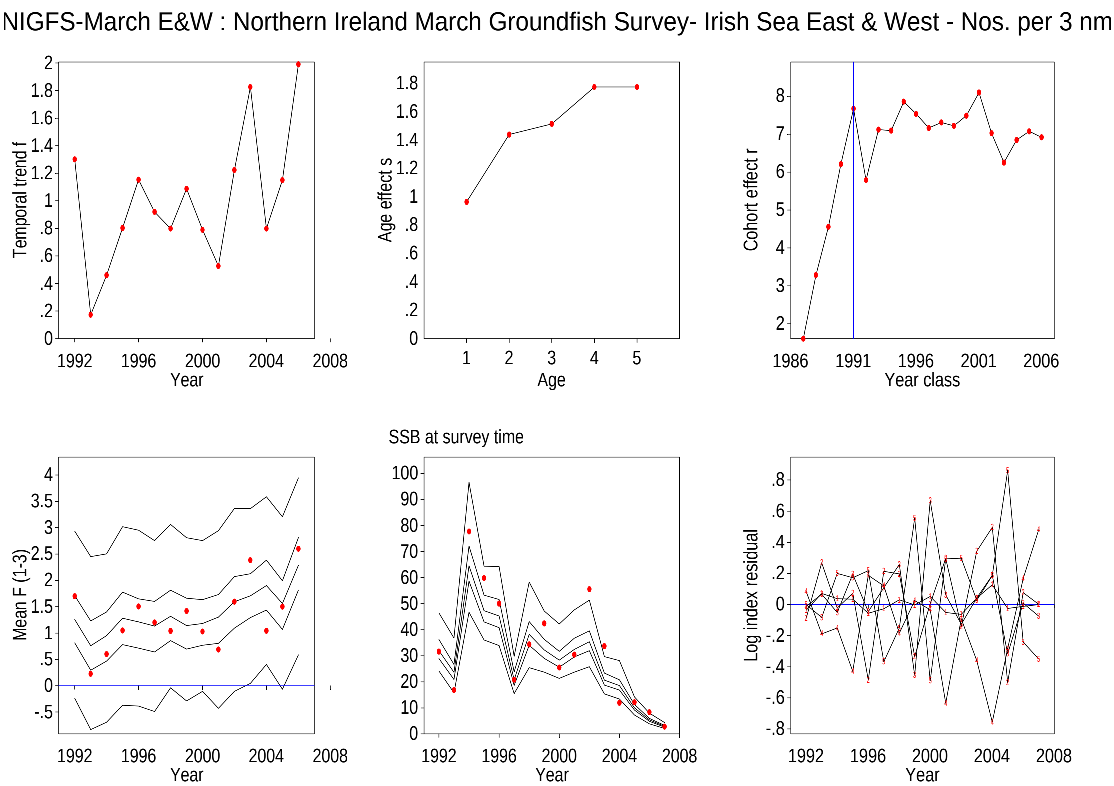


Figure 10.6.1.4 Stock Summary of the SURBA model fit for the NIGFS-March.-Empirical SSB (red dots) with model estimates of SSB(black line) are shown in bottom centre panel.

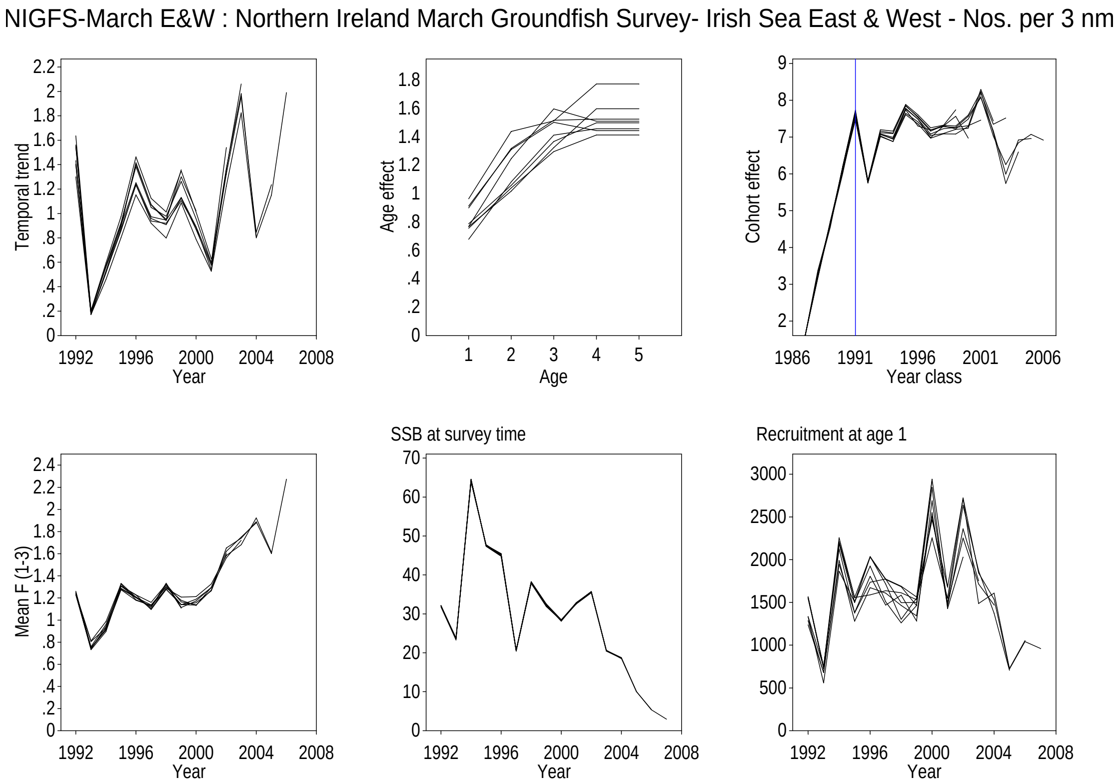


Figure 10.6.1.5 Retrospective pattern of Single fleet SURBA run for NIGFS March

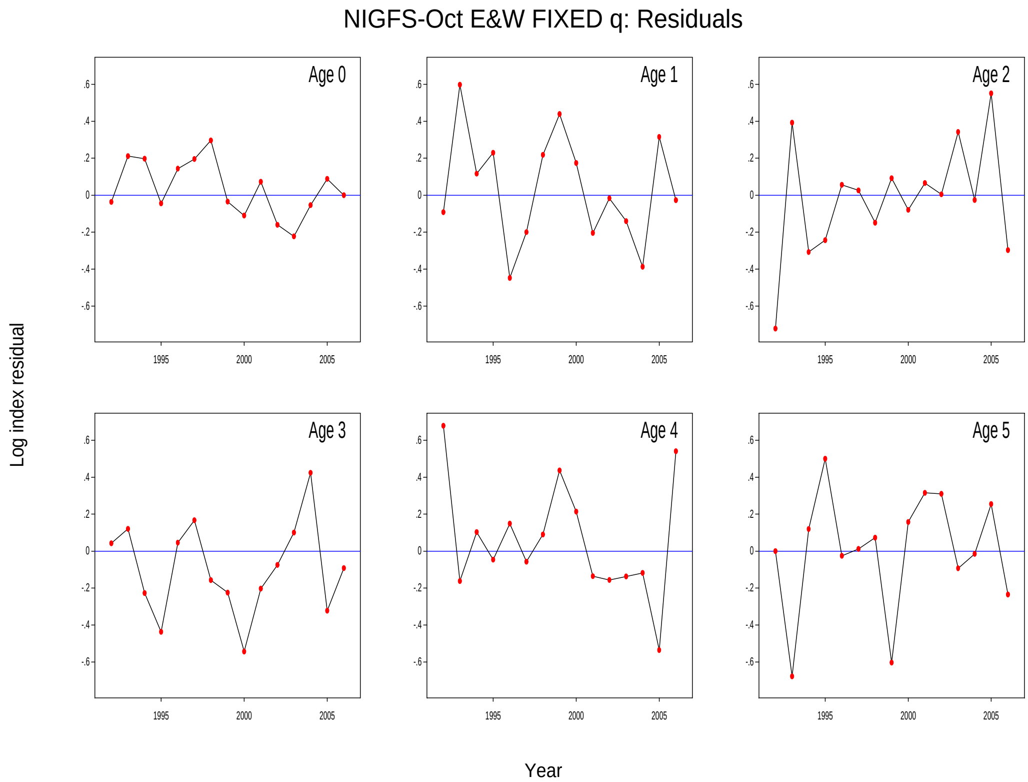


Figure 10.6.1.6 Residual Plots by Age of the NIGFS -October.

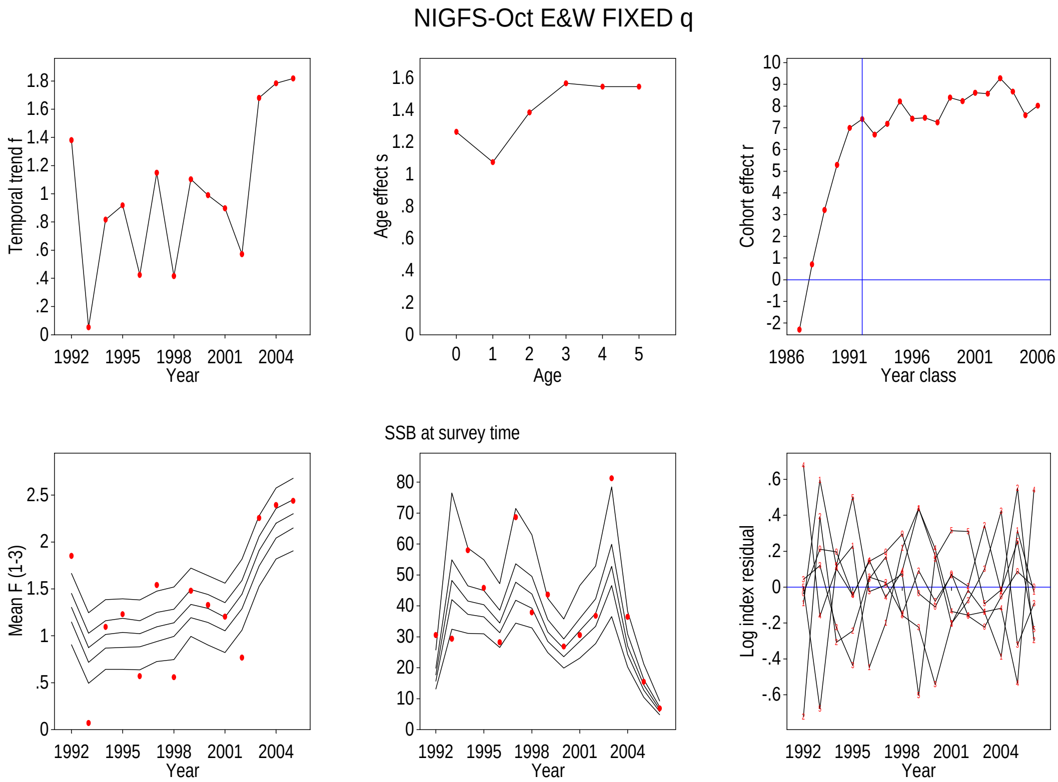


Figure 10.6.1.7 Stock Summary of the SURBA model fit for the NIGFS-October. Empirical SSB (red dots) with model estimates of SSB(black line) are shown in bottom centre panel.

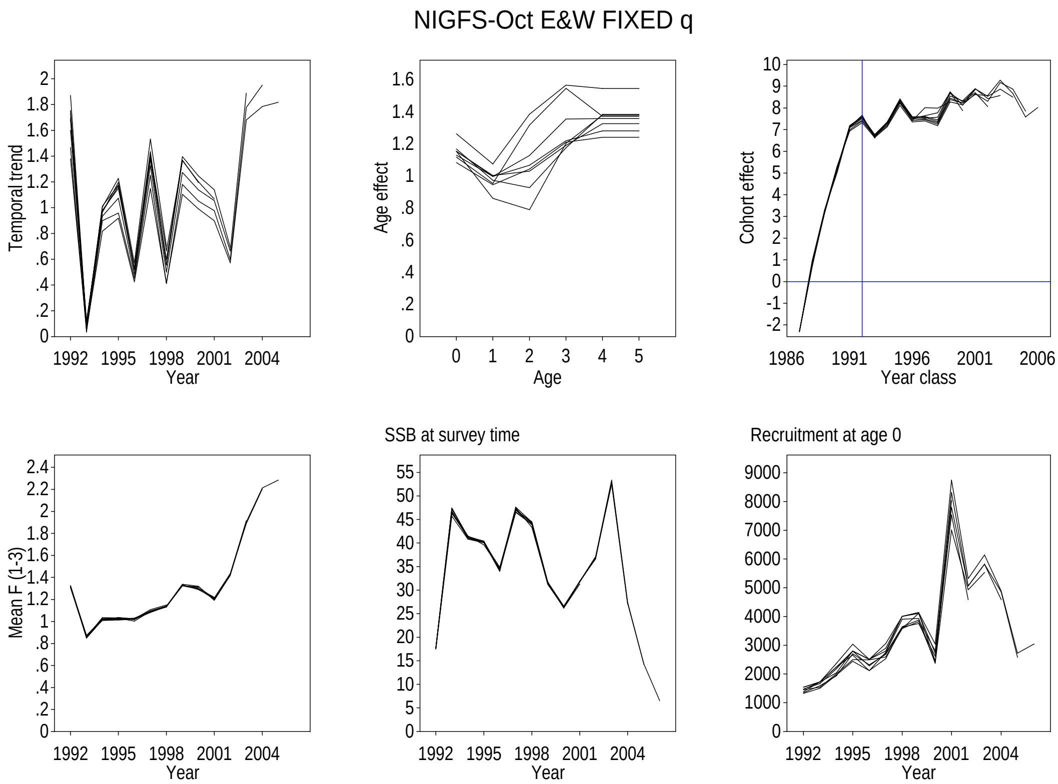


Figure 10.6.1.8 Retrospective pattern of Single fleet SURBA run for NIGFS October.

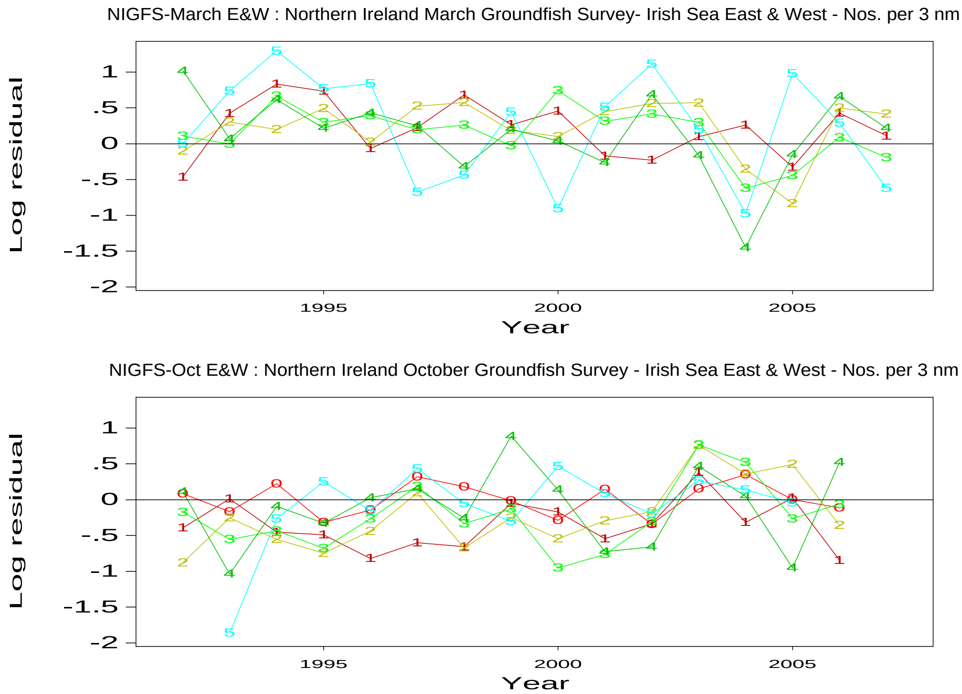


Figure 10.6.1.9 Residual Plots of Multi Fleet SURBA run for NIGFS-March and NIGFS-October.

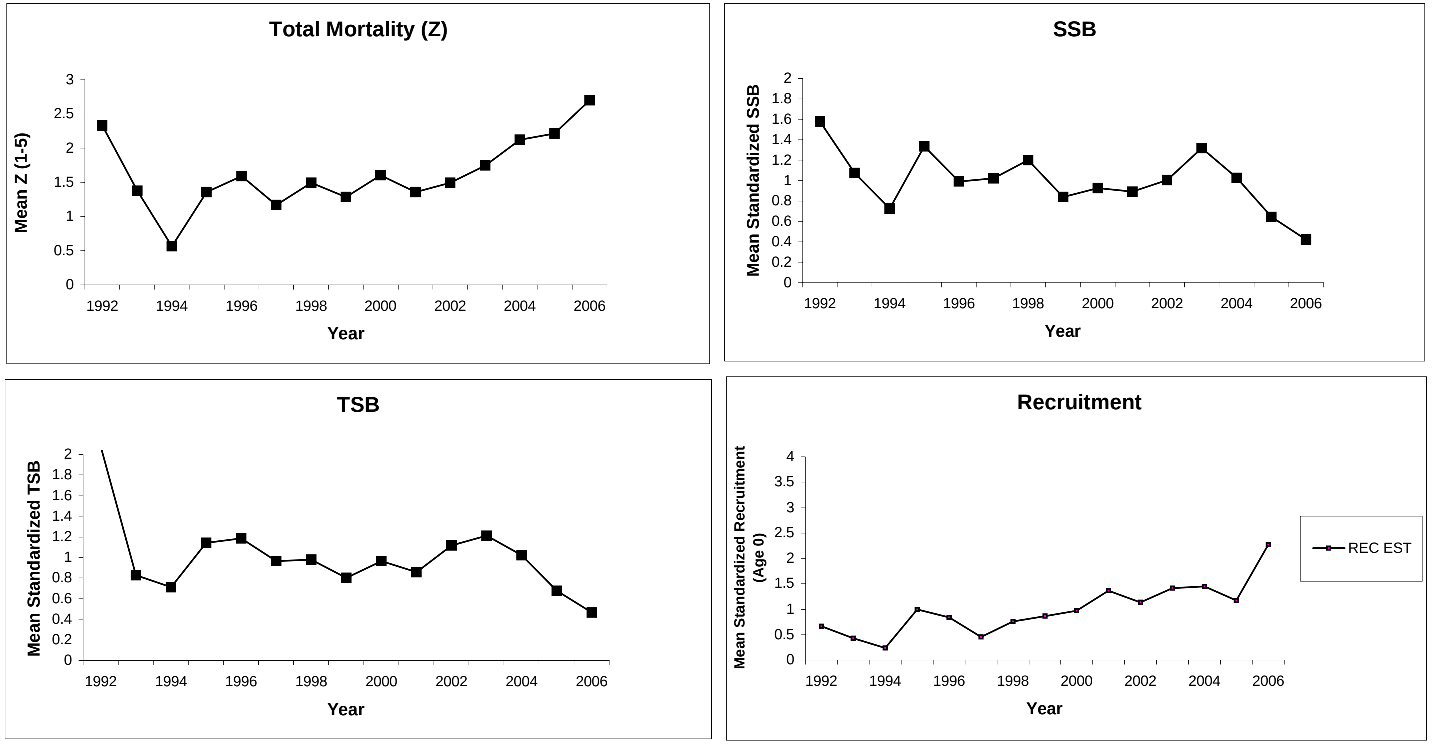


Figure 10.6.1.10 Multi-Fleet SURBA (ver 3.0) analysis using NIGFS March and NIGFS October.

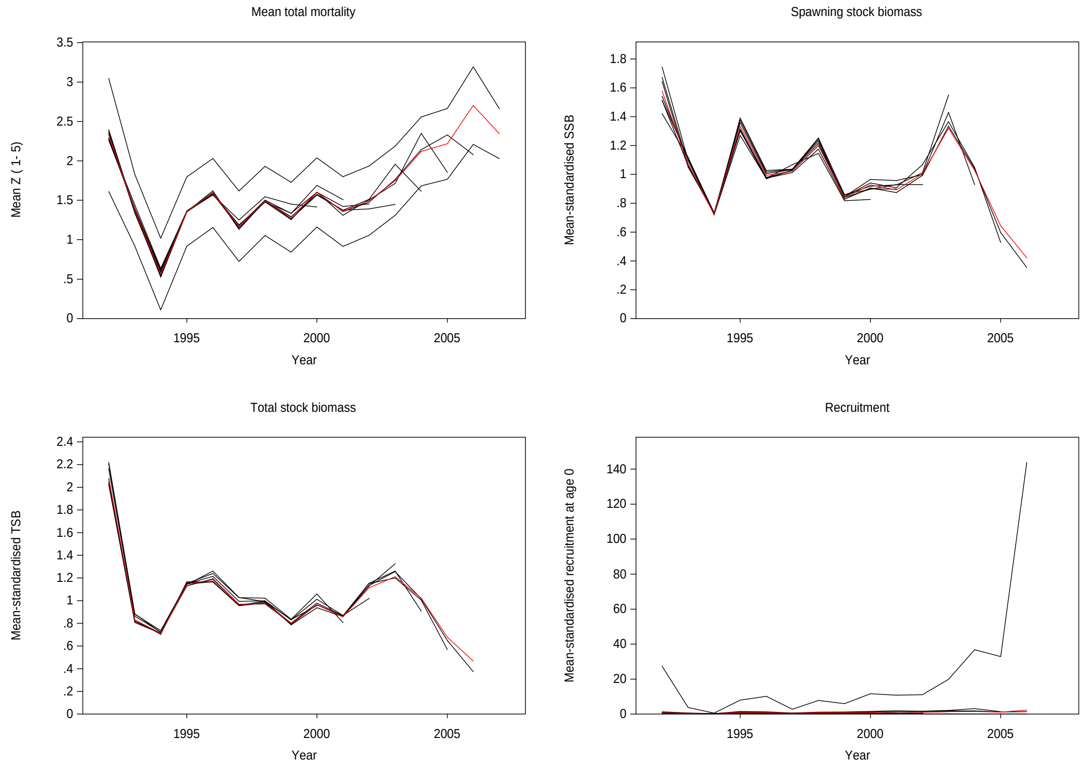


Figure 10.6.8.1 Retrospective Patterns for Multi Fleet SURBA run-NIGFS March and NIFGS October.

11 Plaice in Sub-division VII

ICES has provided advice based on an ICA assessment since 2004, and although the recent increase in SSB was considered to be an overestimate, there was a general body of evidence to suggest that SSB was high and F was low. As the assessment appeared relatively stable an update assessment was proposed for this year, but on inspection of the model fit large trends were obvious in the catchability residuals. Considerable time was then spent adjusting the model parameters in order to gain a better fit, and more suitable model, but eventually, and in accordance with the agreed protocol for conducting update assessments, a final assessment has been presented based on an ICA assessment using the settings from last year.

The 2006 ICES review group raised concerns regarding the lack of discard information in the analysis. Although investigations into methods of determining age based estimates of discards for the entire time-series of catch have been undertaken the results are not considered reliable enough to include as part of the assessment. It was also suggested that further investigations should be made into the effect of the reduced age span used in the assessment in 2006.

11.1 The fishery

A general description of the fishery can be found in the stock annex.

11.1.1 ICES advice applicable to 2006 and 2007

ICES advice for 2007

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

Fishing mortality is estimated to be below $\mathbf{F_{max}}$ (0.36) and close to $\mathbf{F_{0.1}}$ (0.13). There will be little gain to the long-term yield by increasing fishing mortalities above current levels. Fishing at $\mathbf{F_{0.1}}$ is expected to lead to landings of 2100 t in 2007.

Exploitation boundaries in relation to precautionary limits

In order to harvest the stock within precautionary limits, fishing mortality should be kept below $\mathbf{F}_{pa}$ (0.45). This corresponds to catches less than 6 500 t in 2007 and will lead to a reduction in SSB to 11 900 t in 2008.

ICES advice for 2006

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

Fishing mortality is estimated to be below $\mathbf{F_{max}}$ (0.36) and close to $\mathbf{F_{0.1}}$ (0.13). There will be little gain to the long-term yield by increasing fishing mortalities above current levels. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

In order to harvest the stock within precautionary limits, fishing mortality should be kept below $\mathbf{F}_{pa}$ (0.45). This corresponds to catches less than 5 900 t in 2006 and will lead to a reduction in SSB to 11 200 t in 2007. Average fishing mortality in the last three years has been below $\mathbf{F}_{pa}$ and no long-term gains are obtained by increasing the current fishing mortality towards $\mathbf{F}_{pa}$.

For general mixed fisheries advice applicable to this stock and other species taken in the same fisheries, please see section 1.7.

11.1.2 Management applicable in 2006 and 2007

There is a minimum landing size in force for VIIa plaice of 27 cm.

Management of plaice in division VIIa is by TAC and technical measures. The agreed TACs and associated implications for plaice in division VIIa are detailed in the table below. Management regulations for Irish Sea fisheries applicable in 2006 and 2007 are detailed in Section 1.7.

YEAR	SINGLE SPECIES EXPLOITATION BOUNDARY(TONNE	BASIS	TAC	% CHANGE IN F ASSOCIATED WITH TAC[2]	WG LANDINGS
2003[1]	<1.9	Maintain F below $\mathbf{F}_{pa}$	1 675	-12%	1 520
2004[1]	< 1.6	Maintain F below $\mathbf{F}_{pa}$	1 340	-2%	1 115
2005[1]	<3.0	Maintain F below $\mathbf{F}_{pa}$	1 608	-31%	1 281
2006[1]	<5.9	Maintain F below $\mathbf{F}_{pa}$	1 608	0	932
2007[1]	<6.5	Maintain F below $\mathbf{F}_{pa}$	1 849	-14%	

[1] additional mixed fishery considerations

11.1.3 The fishery in 2006

Effort levels have varied slightly for some fleets between 2005 and 2006 but overall levels appear relatively constant and anecdotal information from the fishing industry has suggested an abundance of plaice in area VIIa in recent years.

Belgian vessels operating in Division VII typically move in and out of the Irish Sea depending on the season, specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea. For the UK (E&W), the otter trawl fleet reports the majority (approximately 90%) of plaice landings, which are typically low in the first quarter when the fish are generally found further offshore in deeper water. The Irish fishery landings were split mostly between otter trawlers (50%), and beam trawlers (42%). The beam trawl component is mostly taken as part of a mixed fishery, and some of the landings come as by catch from the *Nephrops* fishery. Landings by the otter fleet were consistent throughout the year, but the beam fleets landings peaked in quarters 1 and 4 along with the effort.

Currently a small number of beam trawlers operating in VIIa are experimenting with more selective gears aimed at reducing by-catches of haddock and whiting as well as benthos. If similar pressure is exerted on UK beam trawl fleet by supermarkets as is applied in Belgium, the level of usage is likely to increase (WGFIFB, 2007).

High levels of discarding are known to occur in this fishery as well as potential misreporting. Previous sampling studies for discards in the Irish Sea indicate that discarding of plaice is substantial and that only a small proportion of the total catch may be retained on-board. Time-series of discard observations are available, but have so far not been raised to fleet level and are therefore not currently incorporated in the assessment. WKDRP has recently investigated the issue of raising discard samples to total catches but has not provided any clear advice on the best approach to adopt. In addition there is a considerable historic time period for which no discard sampling has taken place. Work is ongoing on the issue of raising samples and in the calculation of a historical time-series of discard data.

11.2 Official catch statistics

11.2.1 Revisions to catch data

National landings data reported to ICES and Working Group estimates of total landings are given in Table 11.2.1. The 2005 working group estimate of landings required updating following minor revisions by Ireland and France. New age compositions were supplied from

Belgium, but the final figure remains unchanged. The 1999 to 2004 estimates were updated to include minor revisions supplied by France. The additional catch is shown below:

Year	Additional catch (t)
2004	1.59
2003	4.156
2002	1.55
2001	0.4
2000	0.2
1999	0.023

The TAC in 2007 was 1 849 tonnes. The working group estimate of landings in 2006 is 932 tonnes, 50 % less than the allowable catch and representing a 27 % decrease over 2005 landings. Shortfall of estimated landings from the total allowable catch has occurred in previous years, but appears to be increasing. It seems unlikely that the poor uptake of the quota is a consequence of an inability to catch sufficient quantities of plaice. A shortfall in uptake of the TAC is common for this stock and a significant proportion of the TAC is redistributed between nations through quota swaps.

11.2.2 Quality of the catch data

The level of discarding in this fishery is substantial. Discards are not currently incorporated into the assessment and therefore represent a substantial component of un-accounted mortality. The omission of a substantial portion of the total catch through the lack of sufficient time-series of discards information results in a reduced ability to effectively track cohort strengths through the population and poor determination of recruitment levels in the fishery.

Routine sampling of discards has been conducted in recent years but there are no reliable estimates of the level of discarding in the earlier years for this stock. Updated methods to produce suitable time-series of historical discard data are being investigated, but are not currently considered reliable enough for inclusion in this assessment.

There are currently no data available to assess the accuracy of the catch statistics used in the assessment.

11.3 Commercial catch effort data and research vessel surveys

11.3.1 Commercial effort and lpue data

Effort trends (reported hours fished, corrected for fishing power) for the main fleets operating in the fishery are given in Table 11.3.1. and Figure 11.3.1. The Belgian beam trawl fleet effort (measured in thousand hour values) has been fluctuating throughout the time-series, with a high point of 43.2 in 1987, and a low of 6.8 at the beginning of the series (1972). In 2006 the effort was 28.1, dropping slightly from 31.8 in 2005, but still well above the series mean of 23.8. The UK (E&W) otter trawl fleet effort has been in gradual decline over the last decade and levels in 2006 showed a further drop to the lowest observed values. UK beam trawl effort has been variable over recent years but lower than observed in the late 1980’s to early 1990’s. The Irish otter trawl fleet effort also appears to be declining from the high value in 1999 and the beam trawl fleet from a high value in 2003.

Lpue for the Belgian beam trawl fleet and UK (E&W) otter trawl fleet show very similar trends in the early part of the time-series but divergent patterns from the early 1990’s onwards when effort levels in the otter trawl fleet declined markedly. Lpue for the UK (E&W) beam trawl fleet show large fluctuations over the time-series with little apparent trend, but is close to the time-series low point in 2006. Both the Irish otter and beam trawl fleets have a decreasing lpue trend over recent years. In total lpue in 2006 has decreased for four of the five fleets presented (11.3.1).

11.3.2 Survey cpue data

Cpue values for the UK (E&W) autumn beam trawl surveys are shown in conjunction with the spawning biomass indices derived from NIGFS_MAR and NIGFS_OCT (Table 11.3.2–11.3.3; Figure 11.3.2). All three surveys show similar overall trends of abundance though there is less consistency in terms of year-to-year variability. The issue is discussed further under section 11.6.1.

Work is currently being undertaken to supply cpue values for the Q4 western IBTS survey (UK, E&W) for the Irish Sea area. It is anticipated that this time-series will contribute to this assessment in the future once a sufficient time-series has been developed. For more details see Working Document 4.

11.4 Age compositions and mean weights-at-age

11.4.1 Landings age composition and mean weights-at-age

Catch numbers-at-age are given in Table 11.4.1. Weights-at-age in the catch and stock are given in Tables 11.4.2–11.4.3. In 2005 the catch weights and stock weights were calculated using a cohort based growth model. Although this model fitted the observed weights more appropriately, it was difficult to project weights for the forecast. Especially cohorts with few data points represented a problem to the fitting procedure. Consequently the WG decided to return to the previously employed in-year smoothing, but suggests more appropriate methods continue to be investigated. The history of the derivation of the catch weights and stock weights used in this assessment is described in the stock annex.

Quarterly age compositions for 2006 were available for Ireland (beam trawl and otter trawl), UK (E+W otter trawl, E+W beam trawl) and Belgium (combined gears). The aggregation procedure (as in previous years) was as follows: UK (E+W) quarterly catch numbers-at-age were raised to include Scotland and Isle of Man landings; Ireland quarterly catch-at-age data were raised to include N. Ireland and France landings. The composition of the total international catch was calculated from the summation of the UK (E&W), Ireland and Belgium catch numbers-at-age.

Catch weights-at-age for 2006 were obtained from the weighted mean total international weights-at-age (weighted by-catch numbers), smoothed using a quadratic fit and representing 1 July values (i.e. age = 1.5, 2.5, etc.):

$$Wt = 0.0062*age^2 - 0.0193*age + 0.2479$$

and scaled to give a SOP of 100% using a SOP correction of 0.97263. Stock weights-at-age were derived from the same quadratic fit, but representing 1 January values (i.e. age = 1.0, 2.0 etc.), and scaled by the same SOP-correction factor as the catch weights.

11.4.2 Discards age composition

Discards are not currently included in this assessment. Routine discard sampling has been conducted by the UK (E&W) since 2000, since 1993 by Ireland and more recently by Belgium and Northern Ireland. Length distributions of landed and discarded fish for UK (E&W), Belgian and Irish fleet estimates are presented in Figure 11.4.2. An investigation into methods of determining age based estimates of discards for the entire time-series of catch has been undertaken. However, these values are not yet considered to be estimated with sufficient reliability to warrant their inclusion in the assessment. See Working Document 8. WGNSDS, 2005.

11.5 Natural mortality and maturity at age

Natural mortality is taken as 0.12 yr^{-1} and assumed constant across all ages and all years. Maturity at age was taken as

Age	1	2	3	4	5	6 and above.
Maturity	0	0.24	0.57	0.74	0.93	1.0

The proportion of F and M before spawning was taken as 0, such that SSB values are calculated as of the 1st January.
Details of the methods by which the above values have been derived are provided in the stock annex.

11.6 Catch-at-age analysis

See section 2.7 for the general approach adopted at the WG.

11.6.1 Data screening

The assessment of this stock has traditionally been conducted using XSA, however, to facilitate the use of spawning biomass indices an ICA assessment has been carried out since 2004.

Commercial catch data

For catch data screening, a separable VPA was carried out using a reference age of 4 and F and S values set to 0.35 and 0.8 respectively. The separable model was fitted over the entire time-series and equal weighting was given to all years and all ages. The residuals from the fitted model are shown in Figure 11.6.1.1. Residuals for the partially recruited age 1 data were generally large as were those for the older age groups, particularly in recent years. Ages comprising the bulk of the landings showed smaller residuals.
Log landings at age for the time-series up to 2006 data are shown in Figure 11.6.1.2. These illustrate a progressive change in the selection and discarding pattern over time. During the 1970’s and 1980’s the catch curve peaked at around age 3 whereas in the more recent time this occurs at around age 4. For ages 4 and above there is little apparent change over time in either the level or the gradient of the slope although data from age 10 onwards appear quite noisy. Log catch numbers-at-age 4 show a pronounced dip in 2006. Catches of this year class were also low in 2005 and this may indicate a poor 2002 year class in the population. Evidence of a poor 2002 year class is less apparent in the survey data. The gradient of a straight line fitted through the curve for each cohort between ages 3 and 6 (the Fbar age range) is shown in Figure 11.6.1.3. It can be seen that the gradient of the curve has become progressively less negative since the early 1970’s indicating a shallowing of the catch curve when examining the change in the slopes. This can be interpreted as a reduction in total mortality levels across these ages.

Tuning data

All available tuning data are shown in Table 11.3.3. Age based tuning data available for this assessment comprise 3 commercial fleets; the UK (E&W) otter trawl fleet (UK (E&W)OTB, 1987–2006), the UK (E&W) beam trawl fleet (UK (E&W)BT, 1989–2006) and the Irish otter trawl fleet (IR-OTB, 1995–2006), 3 age-based survey series; the UK beam trawl survey (September: 1989–2006), the UK beam trawl survey (March: 1993–1999), the Irish juvenile plaice survey (1991–2004) and 2 spawning biomass indices; the UK(NI) groundfish survey (Spring 1992–2007) and the UK (NI) groundfish survey (Autumn 1992–2006). Due to inconsistencies in the available tuning fleets, Irish Sea plaice assessments since 2004 have only included the UK (E&W) beam trawl survey (September: 1989–2006) and the two UK (NI) spawning biomass indices. For more information see WGNSDS, 2004.
Plots of the mean standardised indices and comparative scatter plots of adjacent age classes for the UK beam trawl survey are shown in Figures 11.6.1.4 to 11.6.1.6. The UK (E&W) beam trawl survey shows good ability to track year class strengths in some years, though, this ability is less apparent at the beginning and end of the time-series. Internal consistency of this survey appears to be good. Plotting indices by year shows increasing trend in abundance with variability spread more evenly across all years.

The SSB indices of the UK (E&W) beam trawl survey indicates a rise in SSB over the time period (Figure 11.3.2), however this indices covers only the eastern part of the Irish Sea so that the picture is not necessarily representative of the whole stock. Disaggregating the UK (NI) ground fish survey into areas corresponding to the UK beam trawl survey (Strata 4–7 in the UK (NI) ground fish survey further complicates the picture (Figure 11.6.1.7), in part because the estimates are much more variable since this survey is not designed to target plaice. However, although there are varying trends seen in the SSB indices between the surveys and years, the general trend appears to be an increase in abundance until the early 2000's at which point it begins to decrease. This trend is broadly consistent with the UK (E&W) beam trawl survey. The evidence suggests only that until 2003, over the entire area SSB had been increasing in the Irish Sea, but has subsequently started to decline.

Exploratory survey and catch at age analyses

Surba

Survey based analyses were conducted using SURBA 3.0, a version of the software which can now include SSB indices. Considerable time was spent examining the SURBA analysis in 2005 and this has been the basis for the choice of tuning indices used subsequently in Irish Sea plaice assessments. Consequently this years analysis only uses the UK (E&W) beam trawl survey and the two UK (NI) SSB indices in the analysis, and was conducted using the UK (E&W) Beam trawl survey as a single fleet, and by using the UK (E&W) Beam trawl survey with the two UK (NI) SSB indices as a multifleet run. The year range for the UK beam trawl survey was trimmed to 1992 to match the SSB indices when used as a multifleet, and both runs used the same settings as last year, with Lamba value of 1.0, reference age of 5 and mean F & Z between the ages of 3 and 6.

Age disaggregated tuning data shows reasonable internal consistency (Figures 11.6.1.4–11.6.1.6), with 25 out of 28 graphs in the "comparisons of adjacent age groups" plot showing a significant positive linear relationship (Figure 11.6.1.6). Figures 11.6.1.8 a) & b) show the difference between the single and mulitfleet runs. It is seen that by including the SSB indices in the assessment the year effects and cohort effects are changed, but note however that the year range for the analysis has also changed. The age effects appear to be relatively unchanged except at age 1, where there is a marked reversal of the effect between the two runs. Both runs show a reasonable distribution of residuals, particularly since 1996.

Figures 11.6.1.9 a) & b) show the retrospective analysis for SSB. Both runs show broadly similar increasing trends in abundance since 1992, and little retrospective bias, although the multifleet run shows a less dramatic increase in SSB from 2002. The retrospective analysis of F is shown in Figures 11.6.1.10 a) & b) and again both show broadly similar trends over the time period, but with the multifleet run at a lower level of effect. The general consequence of including the SSB indices in the SURBA analysis appears to be to moderate the trends indicated by the beam trawl survey data.

After analysing the SURBA results the multifleet run was chosen for further analysis. One of the reasons for this choice is that the UK (E&W) beam trawl survey is only representative of the eastern side of the Irish Sea and may not adequately represent the western side. By adding the UK (NI) SSB indices the analysis becomes more representative of the Irish Sea as a whole, and was therefore deemed more suitable. The multifleet retrospective analysis do however appear to be show more retrospective bias than the single fleet run, but this is expected as more than one survey is combined within the data. The age effects also appear to be more reasonable in the multifleet run and given the potential problems associated with an analysis being solely reliant on one survey trend (and potential bias), the multifleet option was chosen.

The results of the analysis show little variation in the age effect, except at age 1, and little variation in the cohort effects except in years 1989 and 1990 (Figures 11.6.1.8 b)). The results also show a slowly decreasing year effects and a reasonable distribution of residuals, particularly since 1996. SSB has more than doubled since 1992 with most of this increase occurring in the last five years with little retrospective bias (Figure 11.6.1.9 b)). Total mortality has been slowly decreasing over the time period with some small scale variation, again with relatively small retrospective variability, but some bias for upward revisions (Figure 11.6.1.10 b)).

The scan facility in the software was utilised to examine the sensitivity of the analysis to the choice of settings. The results show that the SURBA analysis is mostly robust to the parameter settings, except at low levels of catchability at age 1 (Figure 11.6.1.11–11.6.1.13).

ICA

ICA analyses were initially conducted based on an update assessment using 2006 parameter settings. On inspection of the model residuals, strong trends were observed between the ages of 2 and 5 in the UK (E&W) beam trawl plots (Figure 11.6.1.14 a) and b)) indicating that the model fit was inappropriate. Considerable time was then spent adjusting the model parameters in order to gain a better fit, and more suitable model. Adjustments investigated include:

Reducing the weight of younger ages to 0.01 in ICA.

Using different year ranges for separable model fit.

Down weighting of catch data.

Using different weighting options for tuning indices.

The proposed update assessment using last year's parameter settings is presented in this report in full. A second model is presented in lesser detail. This second model appeared to have more satisfactory residuals, but was ultimately rejected on the grounds that the parameters required in resolving the residual trend issue were deemed inappropriate for this assessment. The update model parameter settings are given in Section 11.6.2. The second run differs by having a reference age of 6, using a power catchability model for the UK (E&W) beam trawl survey, and by down-weighting the 2006 catch at age data to 0.01.

The diagnostics output from the update assessment are shown in Table 11.6.1.1, along with the catch-at-age and tuning index residuals. The population numbers-at-age and fishing mortality-at-age shown in Tables 11.6.1.2–11.6.3. Stock summaries for both runs are shown in Tables 11.6.2.4–11.6.2.5, and Recruitment, SSB and F from retrospective analysis conducted for the ICA assessments are shown in figures 11.6.1.15 a) and b).

The results show that both runs demonstrate similar trends throughout the time period, but with the update assessment showing less retrospective bias, for recruitment, SSB and F (Figures 11.6.1.15 a) and b)). The ICA residuals for the UK (E&W) beam trawl survey are much improved in the second run, with no trend obvious, but the separable model residuals show a downwards trend in 2006. This is due to the down weighting of 2006 in the model.

The summary plots (Figures 11.6.1.16 a) and b)) show the overall effects of the two models, with recruitment and SSB being reduced and F being increased in the final year of the second run. Figure 11.6.1.17 shows how this years ICA and SURBA assessments compare to the results of 2005, with the update ICA assessment unsurprisingly showing very similar trends, but with a more realistic value of SSB, a decreased recruitment, and a lower F value than in 2005. The SURBA run shows more greatly fluctuating recruitment estimates than the ICA runs, similar downward trends in F but at a reduced gradient, and a very similar upwards trend in SSB.

11.6.2 Final assessment run

The ICA assessment settings for this year and the previous two years assessments are shown in the table below. Changes to the previous years' settings are shown in bold.

ASSESSMENT YEAR	2005	2006	2007
Assessment model	ICA	ICA	ICA
Tuning fleets	**UK(E&W)OTB**	UK(E&W)OTB	UK(E&W)OTB
	Series omitted	Series omitted	Series omitted
	UK(E&W)BTS Sept	UK(E&W)BTS Sept	UK(E&W)BTS Sept
	1989 – 2004	1989 – 2005	1989 – 2006
	ages 1-7	ages 1-7	ages 1-7
	UK(E&W)BTS March	UK(E&W)BTS March	UK(E&W)BTS March
	Survey omitted	Survey omitted	Survey omitted
	UK(E&W)BT	UK(E&W)BT	UK(E&W)BT
	Series omitted	Series omitted	Series omitted
	IR-OTB	IR-OTB	IR-OTB
	Series omitted	Series omitted	Series omitted
	UK(NI) GFS Mar	UK(NI) GFS Mar	UK(NI) GFS Mar
	1992-2004	1992-2005	1992-2006
	Biomss index	Biomss index	Biomss index
	UK(NI) GFS Oct	UK(NI) GFS Oct	UK(NI) GFS Oct
	1992-2004	1992-2005	1992-2006
	Biomass index	Biomss index	Biomss index
Time-series weights	full time-series unweighted	full time-series unweighted	full time-series unweighted
Num yrs for separable	**5**	5	**6**
Reference age	4	**5**	5
Terminal S	**1**	1	1
Catchability model fitted	linear	linear	linear
SRR fitted	No	No	No
Catch-no_at_age range	1-9+	**2-9+**	2-9+

An update ICA assessment has been presented as the final assessment in accordance with the assessment status assigned to this stock prior to the working group. However, the group has serious reservations regarding the appropriateness of the model fit given the clear trends in catchability residuals evident from the beam trawl survey indices. Whilst it was possible to remove the trends in catchability residuals through alternative model settings the group considered that the basis for these model settings was not sufficiently sound, and had little *a. priori* justification.

In accordance with the agreed protocol for conducting update assessments a final assessment has been presented based on the settings used last year. The working group considers the SURBA analysis to be the most appropriate indication of stock status, however since the update ICA analysis and the SURBA analysis show very similar trends in SSB and fishing mortality the update ICA assessment has been retained in order that forecasts and management options advice can be presented.

In previous years it has been noted that the assessment of this stock can overestimate increases in SSB and underestimate fishing mortality. This appears to be the case again this year. However the general trend of increasing SSB and decreasing fishing mortality is clearly evident.

11.6.3 Comparison with last year's assessment

Comparisons from this years and last years ICA assessment are shown in figure 11.6.3. The two assessments SSB estimations are broadly similar with the exception of the later years, in which the 2006 assessment shows a reduction in the estimated increase. The recruitment comparison shows a similar situation, with the 2006 model showing reduced estimates of recruitment over the last few years. The F patterns both show a general reducing trend since the early nineties, but with the 2005 model at a steeper gradient, thus showing a greater overall decline.

11.7 Estimating recruiting year-class abundance

The update ICA estimates the strength of the 2004 year-class at 13.9 million two year olds in 2006, 14% above GM64–04 and 6% above the arithmetic mean (1964–2004). Earlier analyses have however shown that recruitment estimates can be variable depending on model settings. Consequently recruitment is considered to be poorly estimated.

11.8 Long-term trends in biomass, fishing mortality and recruitment

Trends in F, SSB, recruitment and landings, for the full time-series, are shown in Tables 11.6.2.4 and Figure 11.6.1.16. The update assessment estimates that fishing mortality rose to very high levels in the mid 1970's but has declined from these levels over the subsequent 30 years. Fishing mortality since the early 1990's has shown a marked and almost continuous decline and in 2006 is estimated to be at it lowest level in the time-series (Fsq=0.0941). Spawning biomass levels show a sinusoidal pattern over the 42 year time-series. High SSB levels occurred at the beginning of the time-series; however, current SSB levels are estimated to be increasing to similarly high levels. Estimated recruitment levels have been variable over the time-series. Recruitment levels declined markedly in the early 1990's and have shown only minor variations since.

11.9 Short-term catch predictions

Population numbers for short term forecasts were taken from the ICA outputs of survivors at ages 4 and above in 2007. Numbers-at-age 2 were taken as the long-term (64–04) geometric mean and the recruitment estimates from various sources are shown below. Those used for the short term forecasts are shown in bold.

UPDATE ASSESSMENT	ICA ESTIMATE	GM 64-04
2006 recruitment (000's) at age 2	13 893	**12 207**
2007 recruitment (000's) at age 2		**12 207**
2008 recruitment (000's) at age 2		**12 207**

Fishing mortalities were the mean F's at age over the period 2004–2006. Estimates of fishing mortality show a marked decline over the last 15 years and the 2006 values are estimated to be at the lowest level observed in fishery within the time period of this assessment. Fluctuations in the level of fishing mortality are evident earlier in the time-series with sharp increases following similar declines. In the light of this a three year unscaled mean fishing mortality was considered most appropriate for the short term forecasts.

Catch and stock weights used in this assessment are subject to in-year smoothing. Observation of the raw catch weight-at-age data indicate a trend of declining weight-at-age, particularly for the older age groups. This trend is apparent over the last 15 to 20 years in the commercial catches but cannot be identified in the surveys. Catch and stock weights-at-age were taken as three year mean values over the period 2004–2006. They have not been rescaled since weights-at-age appear to decline gradually over a 15 year period but also appear to be quite noisy and the effect over a 3 year period is small. The smoothing of catch and stock weights-at-age has been commented on in section 11.4.

The short term forecast was run as status quo projection. Input data are shown in Table 11.9.1. The single option predicted forecast is given in Table 11.9.2, and the management option output is shown in Table 11.9.3 and summarised in the table below.

Update Assessment

Year	Landings (t)	Source	SSB (t) Jan 1st	Source
2006	932	WG Estimate	9 194	ICA
2007	1 524	SQ Forecast	10 745	SQ Forecast
2008	1 700	SQ Forecast	12,024	SQ Forecast

Proportions that the 2002 to 2006 year-classes will contribute to landings and SSB in 2007 and 2008 are shown in Table 11.9.4. For the update run, approximately 32% of the predicted landings in 2007 and 56% of the predicted landings in 2008 rely on year-classes for which geometric mean recruitment has been assumed. A short term forecast was conducted using the alternative ICA run, but the results were virtually identical. The difference between the predicted landings was less than 1%.

The predicted catch for 2007 assuming status quo F is 1 700t,and SSB is predicted to increase to 17 093t. The TAC for 2007 is 1 849 t.

11.10 Medium-term projections

There appears to be little or no relationship between spawning biomass and recruitment levels at age 1 and no attempt to fit a stock recruitment relationship to these data has been made.

Given the lack of any clear stock and recruitment relationship the working group has in the past considered that the calculation of medium term projections was inappropriate for this stock. Particularly high discard rates result in very poor estimation of the both the overall level and the inter-annual variability of recruitment. Medium term projection were conducted using the MAR-Lab software, but little useful information could be gained from the analysis, as F is well below Fpa and SSB is well above Bpa.

11.11 Yield and biomass per recruit

Yield per recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Table 11.11.1 and Figure 11.9.1. *Status quo* F (0.129) is around 32% of $\mathbf{F}_{max}$ (0.4) and is 5% less than $\mathbf{F}_{0.1}$ (0.1357).

11.12 Reference points

Biological reference point values for $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ were considered in detail in previous WG and ACFM reports, and are given below:

$\mathbf{B}_{pa}$ **= 3100t**, set on the basis of $\mathbf{B}_{loss}$, and evidence of high recruitment at the lowest biomass observed.

$\mathbf{F}_{pa}$ **= 0.45**, based on $\mathbf{F}_{med}$ and long-term considerations.

11.13 Quality of the assessment

It has been noted in previous years that aspects of this assessment appear to be deteriorating. Specific concerns in recent years have been the contradictory signals provided by the commercial tuning indices and the surveys, the lack of contrast in the strength of incoming year-classes and a retrospective bias in estimates of F and SSB.

Estimates of F are very low in this stock in recent assessments. There is little doubt that F has declined in recent years and the relative trends in F seem to be appropriate. However this assessment does not take account of discarding as suitable data for inclusion is not available.

11.13.1 Commercial data

Biological sampling levels for this stock have typically been high with 80 to 90% of the reported landings being represented by age compositions that are derived from market sampling at either a separate sex or combined sex level. Age determination is not considered to be a serious problem in plaice though mis-ageing may occur more often in older fish.

Discard levels in this fishery are estimated to be very high and fish at the younger ages may be subject to substantially higher mortality levels than currently estimated. The landings of young fish represent only a small proportion of those caught and the lack of adequate information on mortality rates at these ages seriously impairs the ability to estimate recruitment levels in the population. There remain no sufficiently reliable estimates of discard levels for the entire time-series of catch for this stock.

Catches-at-age may be poorly estimated particularly in the most recent years due to the lack of information on discard levels. In addition to high discarding levels it is also possible that misreporting levels may have increased as the TAC for plaice has been reduced in recent years in line with effort reductions required in other fisheries in the Irish Sea. It is apparent that plaice may be subject to both over-reporting as well as under-reporting depending on the quota allocation available to the different components of the international fleet.

11.13.2 Survey data

The stock of plaice in the Irish Sea is considered to be separated into 2 components, one in the eastern Irish Sea the other in the west. A similar spatial separation of the fishing fleets exits with the UK (E&W) and Belgian vessels fishing predominantly on the eastern side and Irish vessels on the western side though vessels may travel further afield and shift their distribution on a seasonal basis. The inclusion of the two UK (NI) GFS surveys (which cover the whole of the Irish Sea) reduces the dependency of this assessment on tuning information derived from the eastern Irish Sea only.

The only age based tuning data in this assessment is restricted to the area where the increase in the plaice stock appears to be most dramatic. Further work needs to be carried out to determine to which degree the rise in SSB predicted by the UK (E&W) beam trawl survey is representative of the stock as a whole.

11.13.3 Biological information

There is evidence of a decline in weight-at-age from the raw commercial landings data. This is less apparent in the available survey data.

11.14 Management considerations

Status quo F (average 2004-2006) is estimated to be 0.129; below $\mathbf{F}_{0.1}$ and well below $\mathbf{F}_{max}$ and $\mathbf{F}_{pa}$. SSB in 2006 is estimated at 9 194 t, and at 10 745t in 2007, both of which are well above $\mathbf{B}_{pa}$ (3 100 t). However, given the poor fit of the assessment model, estimates of fishing mortality and stock biomass should be interpreted with caution. Whilst the precise levels of F and SSB are considered poorly estimated, the overall state of the stock is consistently estimated to have low fishing mortality and high spawning biomass. Therefore the stock is considered to be within safe biological limits.

A fishing mortality of Fpa forecasts that landings in 2008 would be 5 097 tonnes (Table11.9.3). This however requires a substantial increase in F (F multiplier = 3.48), and the landings would be greater than the current TAC level, which is currently not met by the fishery.

The considerable level of discarding in this fishery indicates a mismatch between the minimum landing size and the mesh size of the gear being used. A decrease in the minimum landing size would not resolve the discarding problem as the market for small plaice is generally poor.

Table 11.1.2.1 Nominal landings (t) of PLAICE in Division VIIa as officially reported to ICES.

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006 [1]
Belgium	321	128	332	327	3443	459	327	275	325	482	636	628	431	566	345
France	42	19	13	10	11	8	8	5	14	91	8	7	2	9	2
Ireland	1,355	654	547	557	538	543	730	541	420	378	370	490	328	272	176
Netherlands	-	-	-	-	69	110	27	30	47	-	-	-	-	-	-
UK (Eng.&Wales)[2]	1,381	1,119	1,082	1,050	878	798	679	687	610	607	569	409	369	422	411
UK (Isle of Man)	24	13	14	20	16	11	14	5	6	1	1	1	0	0	0
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	70	72	63	60	18	25	18	23	21	11	7	9	4	1	0
UK (Total)															
Total	3,193	2,005	2,051	2,024	1,874	1,954	1,803	1,566	1,443	1,488	1,591	1,544	1,134	1,270	934
Discards	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unallocated	74	-9	15	-150	-167	-83	-38	34	-72	-15	31	10	-19	226	-2
Total figures used by the Working Group for stock assessment	3,267	1,996	2,066	1,874	1,707	1,871	1,765	1,600	1,371	1,473	1,623	1,559	1,143	1,281	932

[1]Provisional.

[2]Northern Ireland included with England and Wales.

{UK (Total) excludes Isle of Man data}.

Table 11.3.1 **Irish Sea plaice. English standardised LPUE and effort, Belgian beam trawl LPUE and effort and Irish otter trawl LPUE and effort series**

Year			LPUE					Effort ('000hrs)				
			English [1]		Belgian [3]	Ireland[7]		English [2]		Belgian [5]	Ireland	
	Beam [4] trawl survey		Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl	Beam Trawl
	March	September										
1972			6.96		9.8			128.4		6.8		
1973			6.33		9.0			147.6		16.5		
1974			7.45		10.4			115.2		14.2		
1975			7.71		10.7			130.7		16.2		
1976			5.03		5.8			122.3		15.1		
1977			4.82		5.3			101.9		13.4		
1978			6.77	4.88	6.9			89.1	0.9	12.0		
1979			7.18	15.23	8.0			89.9	1.7	13.7		
1980			8.24	8.98	8.6			107.0	4.3	20.8		
1981			6.87	4.91	7.1			107.1	6.4	26.7		
1982			4.92	1.77	4.4			127.2	5.5	21.3		
1983			5.32	3.08	7.8			88.1	2.8	18.5		
1984			7.77	6.98	6.8			103.1	4.1	13.6		
1985			9.97	25.70	8.8			102.9	7.4	21.9		
1986			9.27	4.21	8.7			90.3	17.0	38.3		
1987			7.20	3.57	8.2			130.6	22.0	43.2		
1988		392	5.02	3.05	6.3			132.0	18.6	32.7		
1989		253	5.51	13.59	6.2			139.5	25.3	36.7		
1990		239	5.93	12.02	7.2			117.1	31.0	38.3		
1991		157	4.79	10.56	7.5			107.3	25.8	15.4		
1992		188	4.20	9.99	11.9			96.8	23.4	23.0		
1993	91	235	3.97	9.50	5.0			78.9	21.5	24.4		
1994	128	225	4.90	7.79	9.2			43.0	20.1	31.6		
1995	134	169	5.08	7.69	9.5	3.2	17.0	43.1	20.9	27.1	80.3	8.6
1996	-[6]	210	5.37	12.96	11.8	4.1	18.9	42.2	13.3	22.2	64.8	6.3
1997	147	262	5.25	7.66	13.9	3.1	13.7	39.9	10.8	29.3	92.2	9.0
1998	113	249	5.00	5.66	12.3	3.7	22.2	36.9	10.4	23.8	93.5	11.6
1999	-[6]	264	5.38	7.76	12.0	2.3	23.2	22.9	11.0	22.1	110.3	14.7
2000	-[6]	357	5.02	13.04	11.6	2.0	13.8	27.0	6.3	18.2	82.7	11.4
2001		281	3.35	8.33	13.6	2.5	10.8	33.0	12.5	28.5	77.5	13.1
2002		340	5.66	5.46	10.7	2.8	7.9	24.8	8.0	36.2	77.9	17.7
2003		503	2.60	3.76	8.8	4.1	9.5	23.9	14.0	23.0	73.8	18.7
2004		540	3.17	4.20	14.9	2.1	8.6	23.5	7.4	27.6	72.5	14.2
2005		367	4.85	4.67	15.3	2.0	8.0	16.7	11.6	31.8	68.3	14.7
2006		356	6.50	2.19	11.6	1.4	6.3	5.2	4.6	28.1	64.9	11.9

1 Whole weight (kg) per corrected hour fished, weighted by area
2 Corrected for fishing power (GRT)
3 Kg/hr
4 Kg/100km
5 Corrected for fishing power (HP)
6 Carhelmar survey, Kg/100km not available
7 All years updated in 2007 due to slight historical differences

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 11.3.2 Irish Sea Plaice: UK (NI) index of relative SSB trends by region

NI_GFS Mar

	Estimated mean abundance			Estimated standard error		
	Combined	West	East	Combined	West	East
Year	Str1-7	Str1-3	Str4-7	Str1-7	Str1-3	Str4-7
1992	9.59	6.40	10.54	4.39	2.13	5.66
1993	13.27	21.40	10.85	2.22	5.56	2.36
1994	10.09	5.38	11.50	2.56	1.83	3.27
1995	7.59	6.56	7.89	1.39	1.66	1.74
1996	7.96	14.41	6.04	1.68	5.94	1.28
1997	13.73	15.80	13.11	3.99	6.78	4.76
1998	12.50	19.61	10.38	3.62	10.88	3.39
1999	9.37	19.10	6.46	2.34	7.42	2.09
2000	15.79	35.36	9.96	5.40	22.56	1.97
2001	13.52	23.78	10.46	2.11	6.21	2.02
2002	13.36	25.65	9.70	3.24	8.93	3.25
2003	26.79	55.52	18.23	8.36	32.38	4.95
2004	10.55	8.60	11.13	4.77	5.23	7.58
2005	15.86	27.20	12.48	3.54	8.59	3.82
2006	9.57	16.33	7.55	1.80	6.15	1.45
2007	8.73	21.76	4.84	1.81	7.00	1.06

NI_GFS Oct

Autumn

	Estimated mean abundance			Estimated standard error		
	Combined	West	East	Combined	West	East
Year	Str1-7	Str1-3	Str4-7	Str1-7	Str1-3	Str4-7
1991	0.81	3.38	0.04	0.39	1.71	0.03
1992	4.83	2.76	5.45	0.85	1.26	1.04
1993	4.64	2.91	5.16	0.95	1.18	1.18
1994	9.20	8.65	9.36	2.27	3.74	2.72
1995	4.77	8.31	3.72	1.28	3.52	1.29
1996	8.69	9.95	8.32	2.15	5.67	2.22
1997	8.22	7.67	8.38	2.18	2.80	2.71
1998	5.39	4.21	5.74	1.45	2.39	1.75
1999	6.90	4.91	7.50	2.29	3.12	2.82
2000	10.50	2.84	12.78	6.42	1.16	8.33
2001	13.93	4.03	16.88	6.45	1.96	8.35
2002	9.98	6.63	10.98	3.80	3.45	4.82
2003	18.65	10.09	21.20	5.41	4.87	6.87
2004	8.49	2.52	10.28	1.90	1.10	2.44
2005	11.58	3.88	13.88	4.39	2.39	5.66
2006	7.20	2.59	8.57	1.98	1.47	2.53

Table 11.3.3 Irish Sea Plaice: tuning fleet data available to the working. Figures shown in bold are those used in the assessment.

UK BT SURVEY (Sept) - Prime stations only - stn 43 omitted for 2004
1989 2006
1 1 0.75 0.85
1 8

129.710	**309**	**441**	**530**	**77**	**13**	**44**	**3**	**0**
128.969	**1688**	**405**	**176**	**90**	**54**	**30**	**3**	**1**
123.780	**591**	**481**	**68**	**47**	**4**	**4**	**24**	**3**
129.525	**1043**	**470**	**267**	**23**	**19**	**14**	**14**	**3**
131.192	**1106**	**812**	**136**	**101**	**16**	**8**	**21**	**4**
124.892	**815**	**608**	**307**	**68**	**33**	**12**	**17**	**8**
124.336	**1171**	**368**	**169**	**80**	**16**	**18**	**0**	**1**
127.486	**1645**	**582**	**123**	**71**	**45**	**9**	**11**	**2**
132.860	**1450**	**713**	**342**	**76**	**52**	**24**	**10**	**9**
129.339	**1181**	**808**	**221**	**103**	**35**	**24**	**14**	**3**
125.263	**1090**	**951**	**339**	**113**	**38**	**18**	**9**	**6**
123.225	**2002**	**635**	**288**	**141**	**69**	**22**	**7**	**4**
127.301	**1445**	**661**	**219**	**131**	**89**	**30**	**12**	**8**
120.260	**1570**	**1510**	**612**	**231**	**75**	**47**	**15**	**16**
121.001	**1354**	**1718**	**784**	**287**	**114**	**59**	**37**	**10**
113.960	**1653**	**1075**	**1085**	**371**	**248**	**53**	**53**	**13**
119.704	**727**	**1142**	**599**	**467**	**265**	**100**	**19**	**16**
123.743	**1077**	**839**	**727**	**415**	**179**	**82**	**59**	**15**

UK(E+W)TRAWL FLEET (calculated using ABBT age compositions)
1987 2006
1 1 0 1
1 14

130.597	24.4	1475.8	1434.6	1593.3	409.0	291.2	31.4	46.8	16.9	24.2	11.2	1.4	3.2	3.6
131.950	22.0	1374.8	1421.0	455.0	295.5	142.5	78.9	8.1	28.9	6.7	9.6	3.5	4.1	1.1
139.521	10.6	771.5	2102.0	801.1	235.2	99.8	48.0	37.6	13.7	11.0	6.3	6.7	3.2	1.7
117.058	8.2	501.0	1094.3	983.9	217.0	82.8	60.0	17.5	15.9	4.5	3.2	6.7	3.0	2.2
107.288	94.3	949.9	451.3	419.5	245.0	99.7	35.2	38.7	12.1	11.1	0.6	3.6	1.8	1.5
96.802	80.8	851.1	907.2	181.3	114.6	82.4	28.6	8.3	17.8	7.3	5.4	0.4	1.3	0.8
78.945	12.9	387.7	519.1	367.7	63.5	55.7	69.5	21.8	5.2	10.7	2.6	1.1	0.0	0.2
42.995	38.8	408.3	534.9	142.5	92.5	18.2	12.3	15.9	7.3	1.8	1.3	2.2	0.5	0.0
43.146	7.3	350.1	512.5	255.7	88.9	46.1	10.9	4.8	8.3	2.4	1.7	0.7	0.2	0.2
42.239	10.9	326.5	280.3	198.7	80.5	32.9	15.3	4.8	2.0	10.0	2.1	0.7	0.6	0.1
39.886	11.2	250.6	214.7	125.2	74.2	37.5	12.8	12.4	1.8	0.8	1.4	0.4	0.2	0.7
36.902	1.6	202.7	318.6	105.3	40.6	37.6	16.5	9.8	4.5	0.5	0.5	1.0	0.3	0.2
22.903	17.6	139.2	200.5	120.0	35.0	14.0	9.0	5.4	1.6	0.8	0.2	0.1	0.1	0.0
26.967	0.0	107.1	233.3	185.0	95.5	18.5	14.4	9.8	5.9	2.7	2.1	0.9	0.4	.01
32.964	5.5	65.9	130.4	124.0	108.7	53.2	17.4	10.6	7.1	3.0	0.5	0.7	0.1	0.1
24.762	0.5	78.6	175.8	95.3	58.6	33.0	23.8	3.3	2.5	1.4	0.4	0.4	0.0	0.1
23.851	0.0	34.1	79.6	88.7	35.6	16.1	12.3	7.4	2.3	0.4	0.3	0.2	0.0	0.2
23.456	1.5	34.8	149.1	103.1	60.6	27.0	8.7	5.8	4.3	1.2	0.7	0.2	0.1	0.0
16.683	0.0	32.6	52.6	108.1	95.1	40.0	17.8	7.5	5.4	1.7	1.3	0.6	0.2	0.1
5.218	0.8	15.1	46.9	34.8	55.1	23.4	14.0	4.9	2.6	1.9	0.7	0.6	0.1	0.0

```
UK(E+W)BEAM TRAWL FLEET
1987 2006
1 1 0 1
1 14
21.997  0.0   1.1  27.1 113.1 36.0 31.3  2.9  6.7  1.9 3.1 0.6 0.1 0.2 0.1
18.564  0.0   2.0  48.0  23.7 24.4 13.2  8.5  1.4  2.6 1.6 1.5 0.6 0.8 0.3
25.291  3.1 132.8 297.5 163.4 52.6 42.4 25.1 16.1  4.3 5.3 3.3 5.7 2.6 1.1
31.003  2.2 136.2 391.9 361.1 78.2 30.2 17.2  8.4  3.6 1.5 1.9 3.8 1.4 0.5
25.838 17.3 282.5 182.9 174.5 91.8 35.9 11.2 11.8  3.5 4.7 0.2 1.0 0.6 0.3
23.399  3.9 141.5 335.6  79.6 64.6 45.5 18.6  8.0 12.2 7.1 4.0 0.2 0.7 1.0
21.503  0.6  73.4 112.8  95.2 23.3 24.2 32.0 11.8  4.5 7.1 2.2 1.2 0.0 0.4
20.145 13.4 151.8 186.1  39.9 26.0  6.8  6.6  7.8  3.5 1.2 0.9 1.2 0.2 0.0
20.932  5.2 183.4 229.1 100.6 33.1 16.1  3.9  1.7  3.3 1.0 0.9 0.5 0.1 0.2
13.320 13.4 144.0 111.4  75.3 30.8 11.0  5.9  2.1  1.2 2.7 0.5 0.2 0.4 0.3
10.760  0.9  98.6  69.5  39.0 30.2 13.5  3.7  3.2  0.5 0.4 0.3 0.2 0.1 0.1
10.386  0.3  63.5 103.7  32.6 12.0  9.7  6.3  2.7  1.8 0.3 0.2 0.5 0.2 0.0
11.016  4.8  51.3 124.4  80.4 24.4 12.5 10.5  5.6  0.9 0.8 0.2 0.2 0.2 0.1
 6.275  0.0  25.2  61.4  46.6 27.9  7.3  6.5  4.5  1.9 0.7 0.7 0.7 0.1 0.1
12.495  1.5  20.6  47.5  56.6 42.7 20.8  7.0  4.5  2.5 1.2 0.4 0.1 0.1 0.0
 8.017  0.0  11.5  33.1  21.0 18.8 14.9  8.0  2.3  1.3 1.4 0.4 0.4 0.0 0.0
13.996  0.0  11.4  45.5  47.7 20.9 10.0  8.7  5.4  1.7 0.3 0.0 0.3 0.0 0.1
 7.396  0.2  18.0  29.4  11.7 11.9  5.1  1.7  1.4  1.0 0.3 0.2 0.1 0.0 0.0
11.406  0.1   6.5  11.0  24.0 20.7  9.2  3.4  1.6  1.3 0.4 0.4 0.1 0.1 0.0
 4.649  0.2   2.7   8.1   4.9  8.2  3.8  2.6  0.9  0.6 0.5 0.2 0.2 0.1 0.0

UK BT SURVEY (March) - Prime stations only
1993 1999
1 1 0.15 0.25
1 8
126.931  480  662  141  71  12  8  11  3
115.442  361  662  370  98  47  5   7 10
126.189  859  647  340 120  29 28   0 10
134.343 1559  908  295  98  49 16   8  1
121.742  967  905  351  63  39 31  10 13
130.081  648  957  217  82  24 23  12  1
130.822  570  770  389  98  26 11   9  6

IR-JPS : Irish Juvenile Plaice Survey 2nd Qtr - Effort min. towed - Plaice No.
at age
1991 2004
1 1 0.37 0.43
1 7
555   185  206   60  21   9   1  1
570  1785  268   48  16   7   2  2
600   643  630  189  45   8  21  3
585   614  254  196  33   8   2  0
570   840  321  110  86  18   5  2
675   752  221  134  39  57   7  0
675   665  303  105  41  22  17  5
675   311  466  191  48  11   7  4
660     0    0    0   0   0   0  0
645   805  342   72  61  32   9  2
675   743  739  213  88  43  14  5
660   273  145   40   2   1   1  0
660   346  322  152  78  20   9  7
660  1046  501  171  86  50  10  6
```

```
IR-OTB : Irish Otter trawl - Effort in hours - VIIa Plaice numbers-at-age -
Year
1995 2006
1 1 0 1
2 12
70682   5   84  263  202   51   29  24  10   5   1   1
58166   4   94  157  227   97   26   8   6   4   2   1
75029  27  136  197  147   74   74  21  12  16   3   2
81073  49  140  176  124  104  128  64  29  21  10   5
93221  51  129  152  126   71   46  32  19   4   2   1
64320  11   92   98   88   24   10   8   3   1   4   0
77541  55   90   97  104  100   38  16  11   3   1   0
77863   6   67  179  122   90   53  22  11   6   1   0
73854  18  177  278  174  102   48  19   5   3   1  13
72507  25  105  116   90   31   23  16  12   1   4   0
68336   1   45   89  129   80   43  17  10   8   1   2
64876   4   40   34   51   40   37  19  12  12   4   0
```

UK(NI) GFS Spring and autumn spawning biomass indices

2 15 2

'Year''VPA' 'DARDS' 'DARDA'

1992	**1**	**9.59**	**4.83**
1993	**1**	**13.27**	**4.64**
1994	**1**	**10.09**	**9.20**
1995	**1**	**7.59**	**4.77**
1996	**1**	**7.96**	**8.69**
1997	**1**	**13.73**	**8.22**
1998	**1**	**12.50**	**5.39**
1999	**1**	**9.37**	**6.90**
2000	**1**	**15.79**	**10.50**
2001	**1**	**13.52**	**13.93**
2002	**1**	**13.36**	**9.98**
2003	**1**	**26.79**	**18.65**
2004	**1**	**10.55**	**8.49**
2005	**1**	**15.86**	**11.58**
2006	**1**	**9.57**	**7.20**
2007	**1**	**8.73**	

Table 11.4.1 Irish Sea plaice: Catch numbers-at-ages 1 to 15+.

	1964	1965	1966
1	0	28	0
2	997	1416	120
3	1911	3155	4303
4	1680	2841	3605
5	446	1115	2182
6	851	555	620
7	480	309	588
8	140	300	386
9	26	17	181
10	155	20	13
11	30	5	20
12	2	2	7
13	1	1	7
14	1	1	3
15	10	1	6

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	0	0	59	9	0	0	0	7	18	23
2	164	171	430	803	427	142	925	1200	1370	2553
3	1477	1961	2317	2278	3392	3254	4091	2530	4313	4333
4	5593	3410	2932	2179	3882	5136	5233	2694	1902	2425
5	4217	4641	2080	1877	1683	1461	2682	2125	1158	902
6	995	1611	2227	1028	1371	752	642	1045	933	563
7	642	319	779	899	491	555	345	191	152	391
8	267	113	184	239	497	627	238	139	119	198
9	210	135	58	64	244	353	183	56	81	59
10	176	24	100	29	60	169	238	47	94	79
11	86	17	80	52	65	55	129	95	47	47
12	35	3	22	51	36	40	40	40	72	22
13	5	4	9	20	11	38	14	5	18	58
14	6	1	4	3	9	19	11	5	16	11
15	1	1	1	2	1	12	17	5	4	5

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	565	22	12	3	22	27	51	41	4	31
2	4124	3063	3380	2783	1742	715	2924	3159	2357	1652
3	2767	5169	5679	6738	5939	3288	2494	5179	6152	5280
4	2470	1535	1835	2560	2984	3082	3211	1182	3301	2942
5	839	542	363	646	837	1358	1521	1054	614	1287
6	236	202	187	312	222	330	648	459	429	344
7	150	98	109	125	105	137	211	299	262	371
8	112	54	61	64	53	69	110	113	181	112
9	63	52	68	24	52	44	53	60	78	92
10	21	43	68	54	41	36	30	13	36	54
11	15	10	17	16	28	11	13	22	21	24
12	8	9	5	13	35	15	15	15	8	9
13	8	4	6	7	13	11	9	10	7	5
14	10	4	4	5	3	14	11	6	3	3
15	3	2	6	5	11	13	11	13	6	9

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	62	46	24	15	180	151	28	98	21	37
2	3717	2923	1735	1019	2008	1958	910	1146	961	856
3	5317	5040	5945	2715	1506	3209	1649	2173	1703	1345
4	5252	2552	2671	2935	1929	1435	1357	1309	1936	1196
5	1341	1400	854	1132	1205	1358	474	644	764	943
6	1072	750	436	465	465	903	556	318	318	370
7	123	316	214	259	182	388	377	245	138	128
8	121	84	153	98	122	118	179	134	70	44
9	75	112	56	51	49	74	42	86	47	25
10	74	44	47	22	34	44	50	18	23	37
11	25	41	26	15	5	27	16	6	9	14
12	8	28	38	15	6	15	8	9	4	7
13	10	38	18	9	3	9	2	6	1	5
14	12	21	7	6	3	3	3	1	1	1
15	13	37	19	7	4	4	2	3	3	2

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	28	5	68	0	14	1	0	7	6	4
2	830	691	803	450	374	206	286	198	228	180
3	1590	1739	1505	1174	1138	940	1031	967	708	618
4	1513	1025	1294	1284	1083	1482	1314	1104	1177	549
5	1003	612	696	685	767	842	707	705	890	683
6	482	476	280	212	409	539	415	246	461	346
7	285	403	196	219	178	318	253	114	204	219
8	139	177	117	102	90	96	127	88	92	87
9	42	91	69	55	45	48	48	74	55	53
10	53	52	43	19	18	17	22	11	37	46
11	12	25	6	14	6	4	12	11	12	20
12	7	17	4	7	2	3	7	1	12	6
13	1	19	1	2	4	0	1	1	4	2
14	2	2	0	2	0	0	3	0	2	1
15	1	1	1	2	0	0	0	0	1	1

Table 11.4.2 Irish Sea plaice: Catch weights-at-ages 1 to 15+.

	1964	1965	1966
1	0	0.07	0
2	0.19	0.177	0.152
3	0.292	0.269	0.223
4	0.413	0.388	0.316
5	0.463	0.556	0.418
6	0.597	0.653	0.532
7	0.831	0.69	0.697
8	1.042	0.719	0.691
9	1.155	0.801	0.939
10	0.552	1.198	0.983
11	1.358	1.167	1.074
12	1.015	0.971	1.071
13	1.544	1.477	1.233
14	1.605	1.535	1.281
15	1.654	1.581	1.32

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	0	0	0.056	0.058	0	0	0	0.063	0.072	0.06
2	0.133	0.149	0.146	0.149	0.14	0.143	0.143	0.158	0.185	0.15
3	0.218	0.213	0.215	0.219	0.207	0.235	0.218	0.246	0.275	0.228
4	0.299	0.313	0.311	0.324	0.295	0.332	0.316	0.334	0.398	0.323
5	0.382	0.413	0.405	0.417	0.396	0.432	0.415	0.445	0.531	0.419
6	0.516	0.509	0.541	0.523	0.489	0.56	0.491	0.514	0.644	0.525
7	0.518	0.584	0.643	0.648	0.595	0.737	0.645	0.686	0.749	0.59
8	0.759	0.777	0.787	0.685	0.753	0.712	0.694	0.847	0.924	0.719
9	0.791	0.893	0.897	0.908	0.654	0.959	0.791	0.964	1.147	0.797
10	0.682	0.957	0.744	0.925	0.852	1.071	0.898	1.052	1.169	0.842
11	0.783	1.017	0.723	0.877	0.731	1.144	0.927	1.108	1.359	0.834
12	0.514	0.887	1.097	0.603	1.079	1.208	0.863	1.048	1.36	1.003
13	1.152	1.174	1.185	1.231	1.153	1.288	1.204	1.326	1.533	1.267
14	1.198	1.22	1.231	1.279	1.198	1.339	1.252	1.378	1.593	1.317
15	1.234	1.257	1.269	1.318	1.235	1.379	1.29	1.42	1.641	1.357

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.059	0.071	0.069	0.066	0.069	0.201	0.232	0.26	0.29	0.27
2	0.153	0.185	0.176	0.177	0.176	0.274	0.261	0.29	0.31	0.28
3	0.226	0.268	0.262	0.255	0.267	0.284	0.29	0.33	0.34	0.34
4	0.34	0.391	0.376	0.365	0.376	0.348	0.319	0.38	0.39	0.42
5	0.43	0.525	0.557	0.483	0.512	0.421	0.368	0.47	0.47	0.5
6	0.51	0.672	0.668	0.517	0.592	0.545	0.426	0.56	0.54	0.54
7	0.592	0.72	0.794	0.671	0.678	0.65	0.484	0.66	0.63	0.63
8	0.738	0.91	0.915	0.884	0.863	0.651	0.552	0.76	0.73	0.83
9	0.84	1.035	0.997	1.047	1.097	0.78	0.629	0.87	0.84	0.92
10	1.016	1.049	0.968	1.072	0.804	0.777	0.716	0.98	0.94	1.02
11	0.945	1.264	1.274	1.259	1.276	1.185	0.803	1.1	1.06	1.21
12	1.1	1.329	1.227	1.273	1.31	1.164	0.91	1.24	1.2	1.48
13	1.252	1.497	1.471	1.403	1.309	1.147	1.026	1.42	1.38	1.42
14	1.301	1.556	1.529	1.458	1.509	1.164	1.161	1.63	1.6	1.72
15	1.34	1.603	1.575	1.503	1.554	1.744	1.316	1.94	1.9	1.61

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.26	0.23	0.227	0.2	0.247	0.169	0.26	0.156	0.201	0.144
2	0.29	0.26	0.272	0.257	0.267	0.218	0.27	0.207	0.229	0.203
3	0.315	0.3	0.321	0.316	0.295	0.274	0.292	0.268	0.266	0.268
4	0.37	0.37	0.374	0.376	0.332	0.337	0.328	0.338	0.312	0.338
5	0.44	0.46	0.43	0.439	0.377	0.407	0.375	0.416	0.366	0.414
6	0.52	0.55	0.491	0.504	0.431	0.484	0.436	0.504	0.429	0.496
7	0.61	0.68	0.555	0.57	0.494	0.568	0.508	0.6	0.501	0.584
8	0.72	0.82	0.623	0.639	0.566	0.658	0.594	0.706	0.581	0.677
9	0.82	0.96	0.694	0.709	0.646	0.756	0.691	0.821	0.67	0.776
10	0.95	1.12	0.77	0.781	0.735	0.86	0.802	0.945	0.768	0.881
11	1.08	1.3	0.849	0.856	0.832	0.971	0.925	1.077	0.874	0.992
12	1.21	1.48	0.932	0.932	0.938	1.089	1.06	1.219	0.99	1.108
13	1.36	1.69	1.019	1.01	1.053	1.213	1.208	1.37	1.114	1.23
14	1.52	1.9	1.109	1.091	1.176	1.345	1.368	1.53	1.246	1.358
15	1.7	2.13	1.205	1.173	1.309	1.483	1.541	1.698	1.387	1.492

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.134	0.202	0.174	0	0.142	0.185	0	0.207	0.172	0.227
2	0.184	0.222	0.213	0.222	0.205	0.225	0.244	0.23	0.212	0.232
3	0.239	0.252	0.257	0.257	0.269	0.271	0.289	0.261	0.254	0.249
4	0.299	0.294	0.309	0.302	0.337	0.324	0.34	0.3	0.299	0.279
5	0.362	0.346	0.366	0.357	0.407	0.383	0.395	0.348	0.345	0.32
6	0.43	0.41	0.43	0.422	0.479	0.449	0.455	0.404	0.394	0.374
7	0.502	0.484	0.501	0.497	0.554	0.521	0.52	0.468	0.445	0.44
8	0.579	0.569	0.577	0.581	0.632	0.6	0.59	0.542	0.499	0.517
9	0.66	0.665	0.661	0.676	0.712	0.685	0.665	0.623	0.554	0.607
10	0.745	0.773	0.751	0.78	0.795	0.776	0.745	0.713	0.612	0.709
11	0.834	0.891	0.847	0.894	0.88	0.874	0.83	0.811	0.672	0.823
12	0.928	1.02	0.949	1.018	0.968	0.978	0.92	0.918	0.734	0.949
13	1.027	1.16	1.058	1.152	1.058	1.089	1.014	1.033	0.799	1.087
14	1.129	1.31	1.174	1.296	1.151	1.206	1.114	1.157	0.865	1.237
15	1.236	1.472	1.296	1.45	1.247	1.329	1.219	1.289	0.934	1.399

Table 11.4.3 Irish Sea plaice: Stock weights-at-ages 1 to 15+.

	1964	1965	1966
1	0.024	0.023	0.019
2	0.109	0.105	0.087
3	0.226	0.213	0.177
4	0.348	0.327	0.266
5	0.412	0.48	0.366
6	0.545	0.587	0.48
7	0.767	0.641	0.643
8	0.981	0.68	0.652
9	1.085	0.769	0.881
10	0.54	1.152	0.947
11	1.311	1.128	1.036
12	0.991	0.948	1.038
13	1.508	1.442	1.204
14	1.544	1.477	1.233
15	1.63	1.558	1.301

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	0.018	0.018	0.019	0.019	0.018	0.02	0.019	0.021	0.024	0.02
2	0.082	0.083	0.084	0.087	0.082	0.091	0.085	0.094	0.109	0.09
3	0.169	0.168	0.17	0.175	0.164	0.186	0.173	0.192	0.218	0.181
4	0.251	0.263	0.261	0.272	0.249	0.28	0.267	0.282	0.336	0.272
5	0.336	0.36	0.355	0.365	0.346	0.379	0.363	0.39	0.463	0.368
6	0.464	0.458	0.485	0.472	0.442	0.504	0.445	0.468	0.582	0.475
7	0.482	0.541	0.593	0.599	0.55	0.678	0.596	0.634	0.695	0.548
8	0.716	0.732	0.742	0.647	0.709	0.672	0.655	0.798	0.873	0.679
9	0.747	0.838	0.841	0.854	0.625	0.902	0.748	0.906	1.078	0.757
10	0.66	0.921	0.719	0.891	0.821	1.031	0.866	1.014	1.127	0.812
11	0.758	0.982	0.701	0.848	0.708	1.103	0.895	1.07	1.311	0.808
12	0.509	0.862	1.062	0.594	1.044	1.168	0.84	1.018	1.317	0.974
13	1.125	1.146	1.157	1.201	1.126	1.258	1.176	1.295	1.497	1.237
14	1.152	1.174	1.185	1.231	1.153	1.288	1.204	1.326	1.533	1.267
15	1.216	1.238	1.25	1.298	1.217	1.359	1.271	1.399	1.617	1.337

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.02	0.024	0.023	0.022	0.023	0.02	0.019	0.02	0.02	0.02
2	0.089	0.106	0.104	0.099	0.103	0.09	0.087	0.1	0.1	0.12
3	0.179	0.213	0.208	0.201	0.21	0.209	0.213	0.23	0.24	0.26
4	0.286	0.33	0.317	0.307	0.318	0.309	0.3	0.35	0.36	0.38
5	0.375	0.457	0.481	0.422	0.446	0.408	0.348	0.43	0.43	0.44
6	0.461	0.602	0.599	0.474	0.537	0.478	0.397	0.52	0.51	0.52
7	0.55	0.668	0.733	0.623	0.63	0.568	0.455	0.61	0.59	0.61
8	0.696	0.859	0.862	0.833	0.814	0.658	0.523	0.71	0.68	0.72
9	0.794	0.977	0.941	0.983	1.03	0.747	0.59	0.82	0.79	0.83
10	0.978	1.011	0.935	1.032	0.777	0.847	0.677	0.93	0.89	0.96
11	0.914	1.22	1.23	1.215	1.231	0.946	0.765	1.04	1	1.12
12	1.065	1.286	1.19	1.232	1.268	1.046	0.861	1.17	1.13	1.26
13	1.222	1.462	1.436	1.37	1.28	1.146	0.968	1.33	1.29	1.41
14	1.252	1.497	1.471	1.403	1.452	1.255	1.094	1.53	1.49	1.56
15	1.321	1.58	1.552	1.48	1.532	1.365	1.239	1.79	1.75	1.72

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.02	0.245	0.206	0.173	0.241	0.147	0.259	0.133	0.19	0.117
2	0.1	0.258	0.249	0.229	0.256	0.193	0.263	0.18	0.214	0.173
3	0.24	0.288	0.296	0.286	0.28	0.245	0.28	0.236	0.247	0.234
4	0.345	0.335	0.347	0.346	0.312	0.305	0.308	0.302	0.288	0.302
5	0.405	0.401	0.402	0.408	0.353	0.372	0.35	0.376	0.338	0.375
6	0.48	0.484	0.46	0.471	0.403	0.445	0.404	0.459	0.396	0.454
7	0.56	0.585	0.522	0.537	0.462	0.525	0.47	0.551	0.464	0.539
8	0.66	0.704	0.588	0.604	0.529	0.612	0.549	0.652	0.54	0.63
9	0.77	0.841	0.658	0.674	0.605	0.706	0.641	0.762	0.625	0.726
10	0.885	0.995	0.732	0.745	0.689	0.807	0.745	0.882	0.718	0.828
11	1.01	1.168	0.809	0.818	0.782	0.914	0.862	1.01	0.82	0.936
12	1.15	1.358	0.89	0.894	0.884	1.029	0.991	1.147	0.931	1.049
13	1.29	1.565	0.975	0.971	0.994	1.15	1.132	1.293	1.051	1.168
14	1.44	1.791	1.064	1.05	1.114	1.278	1.287	1.449	1.179	1.293
15	1.61	2.034	1.156	1.132	1.241	1.413	1.453	1.613	1.316	1.424

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.11	0.197	0.158	0	0.112	0.167	0	0.199	0.153	0.228
2	0.158	0.211	0.193	0.208	0.173	0.204	0.223	0.217	0.192	0.228
3	0.211	0.236	0.234	0.238	0.237	0.247	0.266	0.244	0.233	0.239
4	0.268	0.272	0.282	0.278	0.303	0.297	0.314	0.279	0.276	0.263
5	0.33	0.319	0.337	0.328	0.372	0.353	0.367	0.323	0.322	0.298
6	0.396	0.377	0.397	0.388	0.443	0.415	0.424	0.375	0.369	0.346
7	0.466	0.445	0.465	0.458	0.517	0.484	0.487	0.435	0.419	0.405
8	0.54	0.525	0.538	0.538	0.593	0.56	0.554	0.504	0.472	0.477
9	0.619	0.616	0.618	0.627	0.672	0.641	0.627	0.581	0.526	0.561
10	0.702	0.718	0.705	0.727	0.753	0.73	0.704	0.667	0.583	0.656
11	0.789	0.83	0.798	0.836	0.837	0.824	0.787	0.761	0.642	0.764
12	0.881	0.954	0.897	0.955	0.924	0.925	0.874	0.864	0.703	0.884
13	0.977	1.088	1.003	1.084	1.013	1.033	0.966	0.975	0.766	1.016
14	1.077	1.234	1.115	1.223	1.105	1.147	1.063	1.094	0.832	1.16
15	1.182	1.39	1.234	1.372	1.199	1.267	1.166	1.222	0.9	1.316

Table 11.6.1.1 Irish Sea plaice: Final ICA diagnostics and output.

Fitted Selection Pattern

AGE	1964	1965	1966	1967	1968	1969	1970	1971
2	0.2677	0.1155	0.0121	0.0170	0.0264	0.0814	0.0926	0.0377
3	1.0659	0.4398	0.2937	0.1660	0.3018	0.6532	0.5037	0.3690
4	2.1410	1.0019	0.4834	0.5389	0.6722	0.9628	0.9032	1.1560
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	2.2953	0.7399	0.6473	0.9788	1.0538	1.4344	0.7672	1.1130
7	1.9475	0.5407	0.9358	1.4555	0.7984	1.6065	1.0775	0.4213
8	1.8434	0.8067	0.7174	0.8533	0.8071	1.2303	0.9267	0.8584
9	1.8434	0.8067	0.7174	0.8533	0.8071	1.2303	0.9267	0.8584

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979
2	0.0168	0.1306	0.1481	0.1704	0.3424	0.3636	0.3174	0.4725
3	0.3441	0.5926	0.6322	0.8542	0.7485	0.6777	1.2157	1.7769
4	0.9204	0.8555	0.9725	0.9705	0.9842	1.1771	1.1621	1.8888
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.9483	0.9170	1.3590	1.0989	1.1235	0.6825	0.7914	1.2272
7	1.0266	0.8727	0.7441	0.4677	1.1057	0.9229	0.7818	1.4596
8	0.8968	0.9364	1.0323	1.0048	1.1055	0.9941	1.1776	1.7445
9	0.8968	0.9364	1.0323	1.0048	1.1055	0.9941	1.1776	1.7445

Fitted Selection Pattern

AGE	1980	1981	1982	1983	1984	1985	1986	1987
2	0.2755	0.2377	0.1776	0.2163	0.3217	0.2275	0.2661	0.3804
3	1.0346	1.0101	0.6688	0.7103	0.8216	1.0841	0.9261	1.0424
4	1.2606	1.0325	1.1529	0.9609	0.9299	1.0623	1.3641	1.5236
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0731	0.6975	0.7821	0.7192	0.9661	0.8237	1.4640	1.3338
7	1.0809	0.7675	0.7670	0.6936	0.9176	1.2248	1.9359	0.8214
8	1.2473	1.0572	0.9733	0.9240	1.0522	1.2084	1.4799	1.2978
9	1.2473	1.0572	0.9733	0.9240	1.0522	1.2084	1.4799	1.2978

Fitted Selection Pattern

AGE	1988	1989	1990	1991	1992	1993	1994	1995
2	0.2386	0.2951	0.3281	0.4766	0.3397	0.2026	0.3163	0.3478
3	0.7675	1.0116	0.7501	0.8043	0.8305	0.6550	0.6831	0.7695
4	1.0345	1.0669	1.1148	1.0567	0.9461	1.0912	0.8631	1.1959
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.1992	0.8527	1.2505	0.8359	0.9883	1.4975	1.3706	1.0223
7	0.8583	1.0859	1.0589	1.1524	0.8375	1.5033	1.6474	1.4988
8	1.0857	1.1600	1.1462	1.0936	1.0464	1.2467	1.2180	1.2153
9	1.0857	1.1600	1.1462	1.0936	1.0464	1.2467	1.2180	1.2153

Fitted Selection Pattern

AGE	1996	1997	1998	1999	2000	2001	2002	2003
2	0.3010	0.1886	0.1935	0.2240	0.1968	0.1106	0.1106	0.1106
3	0.6308	0.6714	0.7011	0.4913	0.7099	0.5534	0.5534	0.5534
4	0.8026	1.0120	0.9360	0.7266	1.0243	1.0377	1.0377	1.0377
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7512	0.7490	1.2039	0.6779	0.8352	1.0335	1.0335	1.0335
7	0.6239	0.8070	1.5795	0.7948	1.4532	0.9704	0.9704	0.9704
8	0.8566	0.9490	1.1923	0.8126	1.1151	1.0000	1.0000	1.0000
9	0.8566	0.9490	1.1923	0.8126	1.1151	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	2004	2005	2006
2	0.1106	0.1106	0.1106
3	0.5534	0.5534	0.5534
4	1.0377	1.0377	1.0377
5	1.0000	1.0000	1.0000
6	1.0335	1.0335	1.0335
7	0.9704	0.9704	0.9704
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

No of years for separable analysis : 6
Age range in the analysis : 2 . . . 9
Year range in the analysis : 1964 . . . 2006
Number of indices of SSB : 2
Number of age-structured indices : 1

Parameters to estimate : 31
Number of observations : 179

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	2001	0.3320	17	0.2350	0.4689	0.2783	0.3959	0.3372
2	2002	0.3086	17	0.2189	0.4351	0.2590	0.3677	0.3134
3	2003	0.2565	17	0.1814	0.3626	0.2150	0.3060	0.2605
4	2004	0.1575	17	0.1120	0.2214	0.1323	0.1874	0.1599
5	2005	0.1621	17	0.1160	0.2266	0.1367	0.1923	0.1645
6	2006	0.1039	17	0.0739	0.1460	0.0873	0.1236	0.1055
Separable Model: Selection (S) by age								
7	2	0.1106	19	0.0751	0.1631	0.0908	0.1349	0.1128
8	3	0.5534	17	0.3911	0.7829	0.4636	0.6605	0.5621
9	4	1.0377	16	0.7562	1.4241	0.8830	1.2196	1.0513
	5	1.0000	Fixed : Reference Age					
10	6	1.0335	14	0.7803	1.3689	0.8955	1.1929	1.0442
11	7	0.9704	14	0.7358	1.2798	0.8426	1.1176	0.9801
	8	1.0000	Fixed : Last true age					

Separable model: Populations in year 2006

```
   12      2      13891  32       7357     26230     10044     19213     14641
   13      3      10696  22       6818     16778      8501     13458     10982
   14      4       6833  18       4716      9899      5655      8256      6956
   15      5       6480  16       4719      8899      5512      7618      6566
   16      6       3858  15       2865      5196      3315      4491      3903
   17      7       2525  15       1878      3395      2171      2937      2554
   18      8       1212  16        871      1687      1024      1435      1230

Separable model: Populations at age
   19   2001        345  31        185       643       251       474       363
   20   2002        416  24        258       671       326       531       429
   21   2003        704  21        462      1073       568       873       720
   22   2004        880  20        589      1316       717      1081       899
   23   2005        916  18        638      1315       761      1101       931

 SSB Index catchabilities
   DARDS
 Linear model fitted. Slopes at age :
   24   1  Q  .2438E-02   7 .2262E-02 .3074E-02 .2438E-02 .2851E-02 .2645E-02
   DARDA
 Linear model fitted. Slopes at age :
   25   2  Q  .1666E-02   7 .1545E-02 .2100E-02 .1666E-02 .1948E-02 .1807E-02

 Age-structured index catchabilities
                                        UK BT SURVEY (Sept) - Prime stations on

 Linear model fitted. Slopes at age :
   26   2  Q  .7397E-03  16 .6309E-03 .1208E-02 .7397E-03 .1030E-02 .8851E-03
   27   3  Q  .4542E-03  16 .3880E-03 .7388E-03 .4542E-03 .6310E-03 .5426E-03
   28   4  Q  .3010E-03  16 .2572E-03 .4891E-03 .3010E-03 .4179E-03 .3595E-03
   29   5  Q  .2105E-03  16 .1798E-03 .3423E-03 .2105E-03 .2924E-03 .2514E-03
   30   6  Q  .2079E-03  16 .1774E-03 .3394E-03 .2079E-03 .2895E-03 .2487E-03
   31   7  Q  .2241E-03  17 .1898E-03 .3740E-03 .2241E-03 .3167E-03 .2704E-03

 RESIDUALS ABOUT THE MODEL FIT
 ------------------------------

        Separable Model Residuals
        -------------------------
------+------------------------------------------------
Age   |    2001    2002    2003    2004    2005    2006
------+------------------------------------------------
  2   |  0.0725 -0.4590 -0.1292  0.2293  0.1027  0.1846
  3   |  0.0975 -0.3213 -0.0670  0.1442  0.0372  0.0923
  4   | -0.0958  0.1736 -0.0944  0.1327 -0.0712 -0.1825
  5   | -0.0789  0.2103  0.0660  0.1427  0.2079  0.1239
  6   | -0.1354  0.0543  0.0631 -0.2026 -0.0620 -0.0691
  7   |  0.0505  0.1918 -0.0478 -0.3460 -0.0758 -0.0427
  8   | -0.0287 -0.0881 -0.1717 -0.3203 -0.3424 -0.2614
------+------------------------------------------------

 SPAWNING BIOMASS INDEX RESIDUALS
 ---------------------------------

          DARDS
        -------
------+----------------------------------------------------------------
      |    1992    1993    1994    1995    1996    1997    1998    1999
------+----------------------------------------------------------------
  1   | -0.1747  0.3009  0.0501 -0.1995 -0.2095  0.4092  0.2610 -0.0175
------+----------------------------------------------------------------

          DARDS
        -------
------+--------------------------------------------------------
      |    2000    2001    2002    2003    2004    2005    2006
```

1	0.4475	0.1334	0.0043	0.5030	-0.4706	-0.1871	-0.8513

DARDA

	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.4796	-0.3689	0.3387	-0.2830	0.2592	0.2771	-0.1992	0.0575

DARDA

	2000	2001	2002	2003	2004	2005	2006
1	0.4204	0.5443	0.0936	0.5218	-0.3069	-0.1207	-0.7550

AGE-STRUCTURED INDEX RESIDUALS

UK BT SURVEY (Sept) - Prime stations on

Age	1989	1990	1991	1992	1993	1994	1995	1996
2	-0.681	-0.203	-0.385	-0.309	0.008	-0.009	-0.368	0.117
3	0.135	-0.625	-0.989	0.144	-0.637	-0.014	-0.375	-0.610
4	-0.518	-0.496	-0.879	-0.929	0.258	-0.338	-0.334	-0.362
5	-0.877	0.172	-2.579	-0.637	-0.278	0.177	-0.865	0.030
6	0.836	0.759	-1.822	-0.537	-0.624	0.265	0.167	-0.959
7	-0.922	-1.237	1.208	0.025	0.660	1.035	*******	0.022

UK BT SURVEY (Sept) - Prime stations on

Age	1997	1998	1999	2000	2001	2002	2003	2004
2	0.027	0.136	0.470	0.030	-0.251	0.623	0.561	0.387
3	0.492	-0.234	0.128	0.104	-0.300	0.480	0.689	0.844
4	-0.071	0.268	0.025	0.112	0.136	0.635	0.495	0.691
5	0.304	0.139	0.281	0.357	0.428	0.429	0.670	1.066
6	-0.065	0.243	0.010	0.201	-0.038	0.300	0.589	0.277
7	-0.403	0.129	-0.221	-0.430	-0.081	-0.321	0.363	0.762

UK BT SURVEY (Sept) - Prime stations on

Age	2005	2006
2	0.159	-0.311
3	0.435	0.332
4	0.635	0.671
5	0.946	0.238
6	0.406	-0.010
7	-0.594	0.005

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2001 to 2006

Variance	0.0677
Skewness test stat.	-2.6805
Kurtosis test statistic	-0.1126
Partial chi-square	0.2290
Significance in fit	0.0000
Degrees of freedom	19

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR DARDS

Linear catchability relationship assumed

Variance	0.1354
Skewness test stat.	-0.9795
Kurtosis test statistic	0.0224
Partial chi-square	0.7043
Significance in fit	0.0000
Number of observations	15
Degrees of freedom	14
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR DARDA

Linear catchability relationship assumed

Variance	0.1558
Skewness test stat.	-0.3726
Kurtosis test statistic	-0.8002
Partial chi-square	0.9915
Significance in fit	0.0000
Number of observations	15
Degrees of freedom	14
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR UK BT SURVEY (Sept) - Prime stations on

Linear catchability relationship assumed

Age	2	3	4	5	6	7
Variance	0.0213	0.0437	0.0457	0.1170	0.0694	0.0722
Skewness test stat.	0.1841	-0.3938	-0.4080	-2.8727	-2.3205	0.2185
Kurtosis test statisti	-0.6181	-0.7647	-0.9175	2.6503	1.4802	-0.4175
Partial chi-square	0.1998	1.0876	17.9241	3.4991	0.7280	0.4890
Significance in fit	0.0000	0.0000	0.6064	0.0002	0.0000	0.0000
Number of observations	18	18	18	18	18	17
Degrees of freedom	17	17	17	17	17	16
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	42.6062	179	31	148	0.2879
Catches at age	1.2858	42	23	19	0.0677
SSB Indices					
DARDS	1.8955	15	1	14	0.1354
DARDA	2.1806	15	1	14	0.1558
Aged Indices					
UK BT SURVEY (Sept) - Prime stations o	37.2444	107	6	101	0.3688

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.3964	179	31	148	0.0432
Catches at age	1.2858	42	23	19	0.0677
SSB Indices					
DARDS	1.8955	15	1	14	0.1354
DARDA	2.1806	15	1	14	0.1558
Aged Indices					
UK BT SURVEY (Sept) - Prime stations o	1.0346	107	6	101	0.0102

Table 11.6.2.2 Irish Sea plaice: Final ICA population numbers-at-age.

Population Abundance (1 January)

AGE	1964	1965	1966	1967	1968	1969	1970	1971
2	21660.	29067.	15067.	13589.	10901.	12504.	18544.	17281.
3	11201.	18273.	24448.	13250.	11898.	9508.	10686.	15692.
4	5383.	8139.	13243.	17642.	10363.	8711.	6258.	7339.
5	2770.	3199.	4557.	8364.	10404.	5995.	4978.	3509.
6	2577.	2038.	1793.	2002.	3479.	4887.	3369.	2658.
7	1663.	1488.	1287.	1009.	846.	1579.	2252.	2024.
8	508.	1025.	1030.	592.	297.	452.	673.	1156.
9	816.	161.	632.	1150.	487.	673.	622.	991.

x 10 ^ 3

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
2	11824.	8745.	11709.	11514.	9662.	15012.	16166.	20088.
3	14925.	10354.	6887.	9257.	8924.	6174.	9446.	11461.
4	10733.	10183.	5353.	3738.	4178.	3865.	2888.	3554.
5	2884.	4719.	4144.	2231.	1539.	1444.	1129.	1129.
6	1539.	1193.	1684.	1691.	897.	524.	498.	494.
7	1077.	662.	459.	520.	629.	271.	244.	253.
8	1334.	437.	265.	229.	318.	193.	101.	125.
9	1460.	1159.	483.	638.	452.	221.	231.	356.

x 10 ^ 3

Population Abundance (1 January)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
2	18191.	13550.	7386.	18735.	18773.	19797.	14382.	17594.
3	14642.	13519.	10381.	5879.	13869.	13683.	15343.	11203.
4	4859.	6686.	6435.	6125.	2880.	7451.	6382.	8661.
5	1438.	1919.	3139.	2827.	2434.	1448.	3520.	2909.
6	661.	672.	919.	1513.	1087.	1173.	710.	1917.
7	263.	294.	388.	506.	736.	535.	638.	308.
8	122.	117.	163.	215.	251.	373.	229.	220.
9	237.	403.	340.	278.	309.	328.	402.	395.

x 10 ^ 3

Population Abundance (1 January)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
2	18824.	11496.	6605.	10238.	9053.	9916.	8297.	7191.
3	12114.	13949.	8566.	4901.	7195.	6191.	7939.	6282.
4	4966.	6028.	6810.	5052.	2935.	3380.	3944.	5003.
5	2787.	2021.	2848.	3294.	2675.	1262.	1728.	2272.
6	1327.	1164.	993.	1466.	1793.	1104.	675.	929.
7	700.	477.	624.	446.	865.	746.	459.	302.
8	158.	325.	223.	311.	225.	404.	310.	179.
9	605.	449.	284.	265.	336.	278.	298.	225.

x 10 ^ 3

Population Abundance (1 January)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
2	6779.	8488.	8709.	7752.	7824.	10232.	10301.	12339.
3	5475.	5208.	6747.	7075.	6120.	6516.	8748.	8830.
4	3974.	3594.	3128.	4353.	4862.	4326.	4809.	6540.
5	2625.	2403.	1772.	1814.	2647.	3107.	2718.	3097.
6	1299.	1445.	1193.	998.	957.	1705.	1978.	1771.
7	526.	805.	830.	613.	622.	650.	1073.	1275.
8	139.	346.	447.	359.	360.	347.	418.	705.
9	287.	294.	523.	381.	356.	281.	287.	435.

x 10 ^ 3

Population Abundance (1 January)

AGE	2004	2005	2006	2007
2	9671.	12280.	13893.	11638.
3	10637.	8429.	10697.	12181.
4	6795.	8647.	6834.	8958.
5	4445.	5118.	6482.	5442.
6	2125.	3368.	3860.	5182.
7	1205.	1602.	2526.	3075.
8	882.	917.	1214.	2026.
9	713.	871.	1386.	2078.

x 10 ^ 3

Table 11.6.2.3 Irish Sea plaice: Final ICA fishing mortality-at-age.

Fishing Mortality (per year)

AGE	1964	1965	1966	1967	1968	1969	1970	1971
2	0.0501	0.0531	0.0085	0.0129	0.0168	0.0372	0.0470	0.0266
3	0.1993	0.2019	0.2063	0.1257	0.1918	0.2982	0.2557	0.2598
4	0.4003	0.4600	0.3395	0.4081	0.4273	0.4395	0.4585	0.8139
5	0.1870	0.4591	0.7024	0.7573	0.6356	0.4565	0.5077	0.7040
6	0.4292	0.3397	0.4546	0.7412	0.6698	0.6548	0.3895	0.7836
7	0.3641	0.2482	0.6573	1.1022	0.5075	0.7334	0.5470	0.2966
8	0.3447	0.3704	0.5039	0.6461	0.5130	0.5616	0.4704	0.6043
9	0.3447	0.3704	0.5039	0.6461	0.5130	0.5616	0.4704	0.6043

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
2	0.0128	0.1189	0.1150	0.1348	0.3278	0.3432	0.2239	0.1963
3	0.2623	0.5397	0.4910	0.6756	0.7167	0.6397	0.8576	0.7381
4	0.7018	0.7791	0.7552	0.7675	0.9424	1.1111	0.8197	0.7846
5	0.7625	0.9107	0.7766	0.7909	0.9575	0.9439	0.7054	0.4154
6	0.7231	0.8351	1.0553	0.8691	1.0757	0.6443	0.5583	0.5098
7	0.7827	0.7948	0.5778	0.3699	1.0587	0.8711	0.5515	0.6063
8	0.6838	0.8527	0.8016	0.7947	1.0585	0.9384	0.8307	0.7247
9	0.6838	0.8527	0.8016	0.7947	1.0585	0.9384	0.8307	0.7247

Fishing Mortality (per year)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
2	0.1768	0.1464	0.1083	0.1807	0.1963	0.1349	0.1298	0.2531
3	0.6639	0.6224	0.4076	0.5934	0.5014	0.6427	0.4518	0.6936
4	0.8089	0.6361	0.7027	0.8028	0.5675	0.6297	0.6655	1.0138
5	0.6417	0.6161	0.6095	0.8355	0.6102	0.5928	0.4879	0.6654
6	0.6886	0.4298	0.4767	0.6009	0.5895	0.4883	0.7143	0.8875
7	0.6936	0.4729	0.4675	0.5795	0.5599	0.7260	0.9445	0.5465
8	0.8004	0.6514	0.5932	0.7720	0.6421	0.7163	0.7220	0.8635
9	0.8004	0.6514	0.5932	0.7720	0.6421	0.7163	0.7220	0.8635

Fishing Mortality (per year)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
2	0.1797	0.1742	0.1784	0.2328	0.2600	0.1023	0.1582	0.1527

3	0.5780	0.5971	0.4080	0.3928	0.6355	0.3309	0.3417	0.3379
4	0.7791	0.6298	0.6063	0.5160	0.7240	0.5512	0.4318	0.5251
5	0.7531	0.5903	0.5439	0.4883	0.7652	0.5051	0.5003	0.4391
6	0.9031	0.5033	0.6801	0.4082	0.7563	0.7565	0.6857	0.4488
7	0.6463	0.6409	0.5759	0.5627	0.6409	0.7594	0.8242	0.6580
8	0.8176	0.6847	0.6234	0.5341	0.8007	0.6297	0.6093	0.5336
9	0.8176	0.6847	0.6234	0.5341	0.8007	0.6297	0.6093	0.5336

Fishing Mortality (per year)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
2	0.1436	0.1094	0.0879	0.1163	0.0629	0.0367	0.0341	0.0284
3	0.3010	0.3897	0.3183	0.2551	0.2270	0.1837	0.1708	0.1419
4	0.3829	0.5873	0.4250	0.3773	0.3276	0.3445	0.3202	0.2662
5	0.4771	0.5804	0.4541	0.5193	0.3198	0.3320	0.3086	0.2565
6	0.3584	0.4347	0.5466	0.3520	0.2671	0.3431	0.3190	0.2651
7	0.2977	0.4684	0.7172	0.4127	0.4647	0.3221	0.2995	0.2489
8	0.4087	0.5508	0.5414	0.4220	0.3566	0.3320	0.3086	0.2565
9	0.4087	0.5508	0.5414	0.4220	0.3566	0.3320	0.3086	0.2565

Fishing Mortality (per year)

AGE	2004	2005	2006
2	0.0174	0.0179	0.0115
3	0.0871	0.0897	0.0575
4	0.1634	0.1682	0.1078
5	0.1575	0.1621	0.1039
6	0.1627	0.1676	0.1074
7	0.1528	0.1573	0.1008
8	0.1575	0.1621	0.1039
9	0.1575	0.1621	0.1039

Table 11.6.2.4. Irish Sea plaice: Update ICA stock summary.

Year	Recruits Age 2 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1964	21660	11711	8261	2879	0.3485	0.3039	100
1965	29060	14152	9360	3664	0.3915	0.3652	100
1966	15060	13774	9884	4268	0.4318	0.4257	100
1967	13580	13250	10092	5059	0.5013	0.5081	99
1968	10900	12068	9550	4695	0.4916	0.4811	100
1969	12500	11242	9008	4394	0.4877	0.4622	100
1970	18540	10898	8298	3583	0.4318	0.4029	99
1971	17280	10858	8115	4232	0.5215	0.6403	99
1972	11820	11818	8948	5119	0.5720	0.6124	99
1973	8740	9174	7012	5060	0.7215	0.7661	100
1974	11700	7337	5426	3715	0.6846	0.7695	100
1975	11510	7889	5669	4063	0.7167	0.7758	100
1976	9660	5593	3903	3473	0.8898	0.9231	100
1977	15010	4819	3003	2904	0.9669	0.8347	101
1978	16160	5992	3540	3231	0.9125	0.7352	99
1979	20080	7095	4152	3428	0.8256	0.6120	99
1980	18190	7686	4622	3903	0.8444	0.7008	99
1981	13550	8302	5408	3906	0.7222	0.5761	100
1982	7380	7193	5149	3237	0.6287	0.5491	100
1983	18730	6860	4536	3639	0.8022	0.7082	100
1984	18770	8642	5509	4241	0.7698	0.5671	99
1985	19790	10040	6382	5075	0.7952	0.5884	99
1986	14380	11009	7243	4806	0.6635	0.5799	98
1987	17590	10232	6879	6220	0.9041	0.8150	99
1988	18820	13036	7334	5005	0.6824	0.7533	100
1989	11490	11239	6687	4372	0.6537	0.5801	100
1990	6600	8644	5747	3275	0.5698	0.5596	100
1991	10230	7881	4808	2554	0.5312	0.4513	101
1992	9050	7071	4683	3267	0.6975	0.7202	100
1993	9910	7056	4027	1996	0.4955	0.5359	100
1994	8290	6231	3935	2066	0.5249	0.4899	100
1995	7190	6065	3799	1874	0.4932	0.4377	100
1996	6770	5848	4025	1707	0.4241	0.3799	100
1997	8480	5537	3740	1871	0.5003	0.4980	100
1998	8700	6290	3948	1765	0.4470	0.4360	100
1999	7750	6121	3910	1600	0.4092	0.3759	100
2000	7820	6414	4139	1371	0.3312	0.2854	100
2001	10230	7283	4851	1473	0.3036	0.3008	100
2002	10300	8420	5455	1623	0.2975	0.2796	100
2003	12330	10358	6643	1559	0.2347	0.2324	100
2004	9670	10231	6926	1143	0.1650	0.1427	100
2005	12270	11214	7842	1281	0.1633	0.1469	99
2006	13890	13304	9194	932	0.1014	0.0941	100

Table 11.9.1 VIIa plaice, input to short-term forecast for update run.

MFDP version 1a
Run: p7a-stf1
Time and date: 17:39 03/07/2007
Fbar age range: 3-6

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12207	0.12	0.24	0	0	0.212	0.016	0.225
3	12181	0.12	0.57	0	0	0.239	0.078	0.255
4	8958	0.12	0.74	0	0	0.273	0.146	0.293
5	5442	0.12	0.93	0	0	0.314	0.141	0.338
6	5182	0.12	1	0	0	0.363	0.146	0.391
7	3075	0.12	1	0	0	0.420	0.137	0.451
8	2026	0.12	1	0	0	0.484	0.141	0.519
9	2078	0.12	1	0	0	0.621	0.141	0.663

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12207	0.12	0.24	0	0	0.212	0.016	0.225
3	.	0.12	0.57	0	0	0.239	0.078	0.255
4	.	0.12	0.74	0	0	0.273	0.146	0.293
5	.	0.12	0.93	0	0	0.314	0.141	0.338
6	.	0.12	1	0	0	0.363	0.146	0.391
7	.	0.12	1	0	0	0.420	0.137	0.451
8	.	0.12	1	0	0	0.484	0.141	0.519
9	.	0.12	1	0	0	0.621	0.141	0.663

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12207	0.12	0.24	0	0	0.212	0.016	0.225
3	.	0.12	0.57	0	0	0.239	0.078	0.255
4	.	0.12	0.74	0	0	0.273	0.146	0.293
5	.	0.12	0.93	0	0	0.314	0.141	0.338
6	.	0.12	1	0	0	0.363	0.146	0.391
7	.	0.12	1	0	0	0.420	0.137	0.451
8	.	0.12	1	0	0	0.484	0.141	0.519
9	.	0.12	1	0	0	0.621	0.141	0.663

Input units are thousands and kg - output in tonnes

Table 11.9.2 VIIa plaice, Single option prediction detailed forecast for update run.

MFDP version 1a
Run: p7a-stf1
Time and date: 17:39 03/07/2007
Fbar age range: 3-6

Year:	2007	F multiplier:	1	Fbar:	0.1279				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0156	178	40	12207	2592	2930	622	2930	622
3	7.81E-02	863	220	12181	2907	6943	1657	6943	1657
4	0.1465	1152	337	8958	2443	6629	1807	6629	1807
5	0.1412	676	228	5442	1711	5061	1591	5061	1591
6	0.1459	664	259	5182	1883	5182	1883	5182	1883
7	0.137	371	168	3075	1290	3075	1290	3075	1290
8	0.1412	252	131	2026	981	2026	981	2026	981
9	0.1412	258	171	2078	1291	2078	1291	2078	1291
Total		4415	1554	51149	15098	33924	11123	33924	11123

Year:	2008	F multiplier:	1	Fbar:	0.1279				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0156	178	40	12207	2592	2930	622	2930	622
3	7.81E-02	755	192	10659	2544	6076	1450	6076	1450
4	0.1465	1285	376	9992	2724	7394	2016	7394	2016
5	0.1412	853	288	6862	2157	6382	2006	6382	2006
6	0.1459	537	210	4191	1523	4191	1523	4191	1523
7	0.137	480	216	3972	1667	3972	1667	3972	1667
8	0.1412	295	153	2378	1152	2378	1152	2378	1152
9	0.1412	393	260	3161	1964	3161	1964	3161	1964
Total		4776	1736	53422	16323	36483	12400	36483	12400

Year:	2009	F multiplier:	1	Fbar:	0.1279				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0156	178	40	12207	2592	2930	622	2930	622
3	7.81E-02	755	192	10659	2544	6076	1450	6076	1450
4	0.1465	1124	329	8743	2384	6470	1764	6470	1764
5	0.1412	951	321	7654	2406	7119	2238	7119	2238
6	0.1459	677	265	5285	1920	5285	1920	5285	1920
7	0.137	388	175	3213	1348	3213	1348	3213	1348
8	0.1412	382	198	3072	1488	3072	1488	3072	1488
9	0.1412	530	351	4266	2651	4266	2651	4266	2651
Total		4986	1872	55099	17333	38429	13481	38429	13481

Input units are thousands and kg - output in tonnes

Table 11.9.3 VIIa Plaice, Prediction with management options for update run.

MFDP version 1a
Run: p7a-stf1
p7a
Time and date: 17:39 03/07/2007
Fbar age range: 3-6

2007				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
15098	11123	1	0.1279	1554

2008					2009	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
16323	12400	0	0	0	19070	15123
.	12400	0.1	1.28E-02	184	18885	14949
.	12400	0.2	2.56E-02	366	18704	14777
.	12400	0.3	0.0384	545	18524	14607
.	12400	0.4	5.12E-02	722	18347	14440
.	12400	0.5	6.40E-02	896	18173	14275
.	12400	0.6	0.0767	1069	18000	14112
.	12400	0.7	8.95E-02	1239	17830	13951
.	12400	0.8	0.1023	1407	17662	13792
.	12400	0.9	0.1151	1573	17497	13635
.	12400	1	0.1279	1736	17333	13481
.	12400	1.1	0.1407	1898	17172	13329
.	12400	1.2	0.1535	2057	17013	13178
.	12400	1.3	0.1663	2215	16855	13030
.	12400	1.4	0.1791	2370	16700	12884
.	12400	1.5	0.1919	2524	16547	12739
.	12400	1.6	0.2047	2675	16396	12597
.	12400	1.7	0.2175	2825	16247	12456
.	12400	1.8	0.2302	2972	16100	12318
.	12400	1.9	0.243	3118	15955	12181
.	12400	2	0.2558	3262	15811	12046
.	12400	3.52	0.45	5235	13851	10204

Input units are thousands and kg - output in tonnes

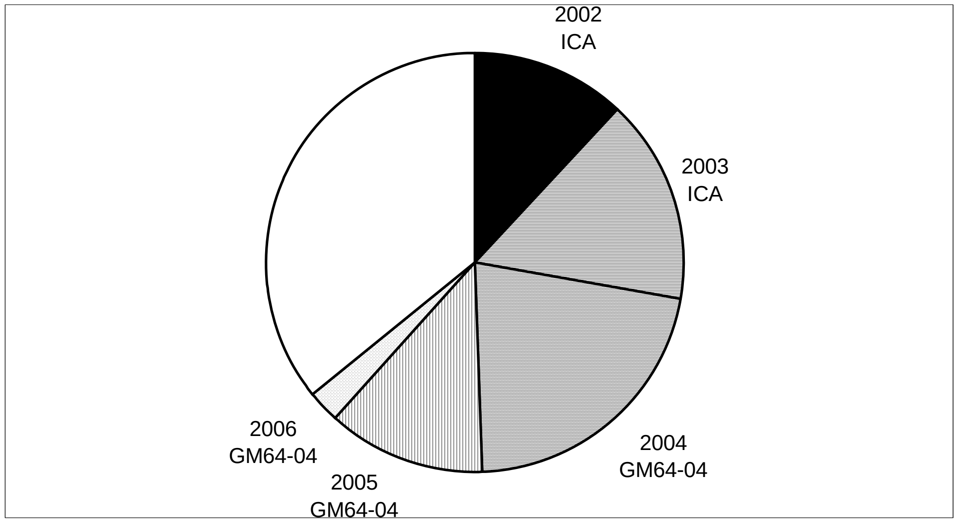
Table 11.9.4 Plaice in VIIa - Final run.
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class			2002	2003	2004	2005	2006
Stock No. (thousands) of	2	year-olds	10736	11069	12800	12800	12800
Source			ICA	ICA	GM64-04	GM64-04	GM64-04
Status Quo F:							
% in	2007	landings	14.1	21.8	14.4	2.9	-
% in	2008		11.9	15.8	21.7	12.1	2.6
% in	2007	SSB	13.5	15.6	14.9	6.5	-
% in	2008	SSB	11.5	15.1	15.5	12.6	5.8
% in	2009	SSB	9.4	13.2	15.3	13.4	11.4

GM : geometric mean recruitment

Plaice in VIIa - Final run. : Year-class % contribution to

a) 2008 landings



b) 2009 SSB

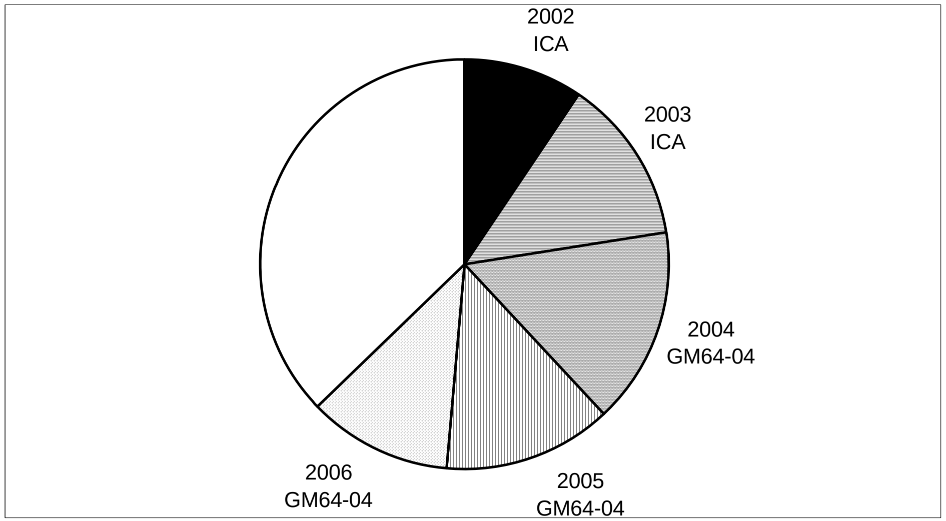


Table 11.11.1 Update run - Yield per Recruit table under current selection pattern.

MFYPR version 2a
Run: finalypr
Time and date: 10:37 13/05/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	8.8433	4.0388	7.4486	3.7061	7.4486	3.7061
0.1000	0.0129	0.0897	0.0447	8.0966	3.5768	6.7057	3.2451	6.7057	3.2451
0.2000	0.0258	0.1627	0.0791	7.4898	3.2058	6.1026	2.8751	6.1026	2.8751
0.3000	0.0387	0.2231	0.1060	6.9868	2.9021	5.6033	2.5723	5.6033	2.5723
0.4000	0.0516	0.2741	0.1273	6.5632	2.6495	5.1833	2.3208	5.1833	2.3208
0.5000	0.0645	0.3176	0.1444	6.2015	2.4368	4.8252	2.1090	4.8252	2.1090
0.6000	0.0774	0.3552	0.1582	5.8891	2.2554	4.5163	1.9286	4.5163	1.9286
0.7000	0.0903	0.3880	0.1694	5.6165	2.0994	4.2472	1.7735	4.2472	1.7735
0.8000	0.1032	0.4170	0.1786	5.3765	1.9641	4.0107	1.6391	4.0107	1.6391
0.9000	0.1161	0.4426	0.1861	5.1637	1.8457	3.8013	1.5216	3.8013	1.5216
1.0000	0.1290	0.4655	0.1923	4.9736	1.7415	3.6146	1.4184	3.6146	1.4184
1.1000	0.1419	0.4861	0.1975	4.8028	1.6492	3.4471	1.3270	3.4471	1.3270
1.2000	0.1548	0.5048	0.2017	4.6485	1.5671	3.2961	1.2457	3.2961	1.2457
1.3000	0.1677	0.5217	0.2053	4.5084	1.4936	3.1592	1.1731	3.1592	1.1731
1.4000	0.1806	0.5371	0.2082	4.3806	1.4276	3.0346	1.1079	3.0346	1.1079
1.5000	0.1935	0.5513	0.2107	4.2635	1.3679	2.9208	1.0491	2.9208	1.0491
1.6000	0.2064	0.5643	0.2127	4.1559	1.3139	2.8163	0.9960	2.8163	0.9960
1.7000	0.2193	0.5763	0.2144	4.0567	1.2648	2.7202	0.9477	2.7202	0.9477
1.8000	0.2322	0.5874	0.2158	3.9648	1.2201	2.6314	0.9037	2.6314	0.9037
1.9000	0.2451	0.5978	0.2169	3.8796	1.1791	2.5491	0.8636	2.5491	0.8636
2.0000	0.2580	0.6074	0.2179	3.8002	1.1415	2.4728	0.8268	2.4728	0.8268

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.129
FMax	3.1011	0.4
F0.1	1.0522	0.1357
F35%SPR	1.1354	0.1465

Weights in kilograms

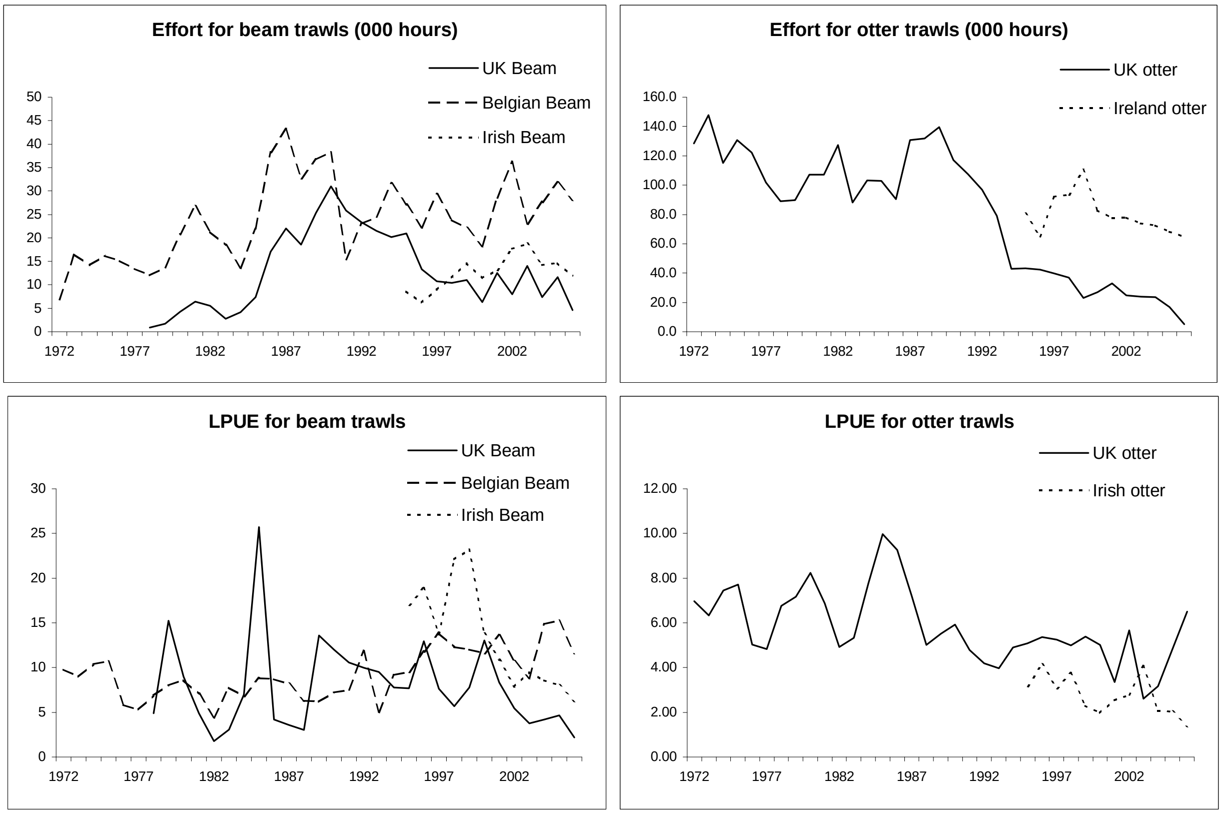


Figure 11.3.1 Irish Sea plaice: Effort and lpue for commercial fleets.

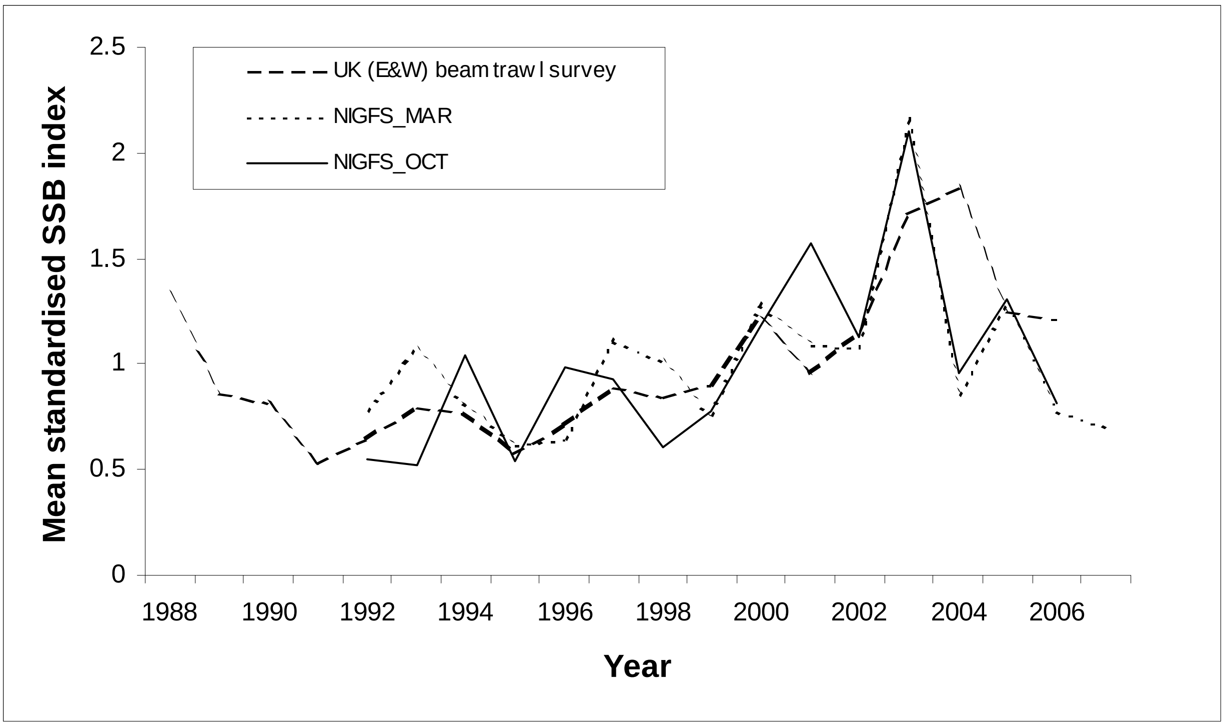


Figure 11.3.2 Mean standardised indices of spawning biomass derived from NIGFS_MSR, NIGFS_OCT and UK (E&W) beam trawl survey.

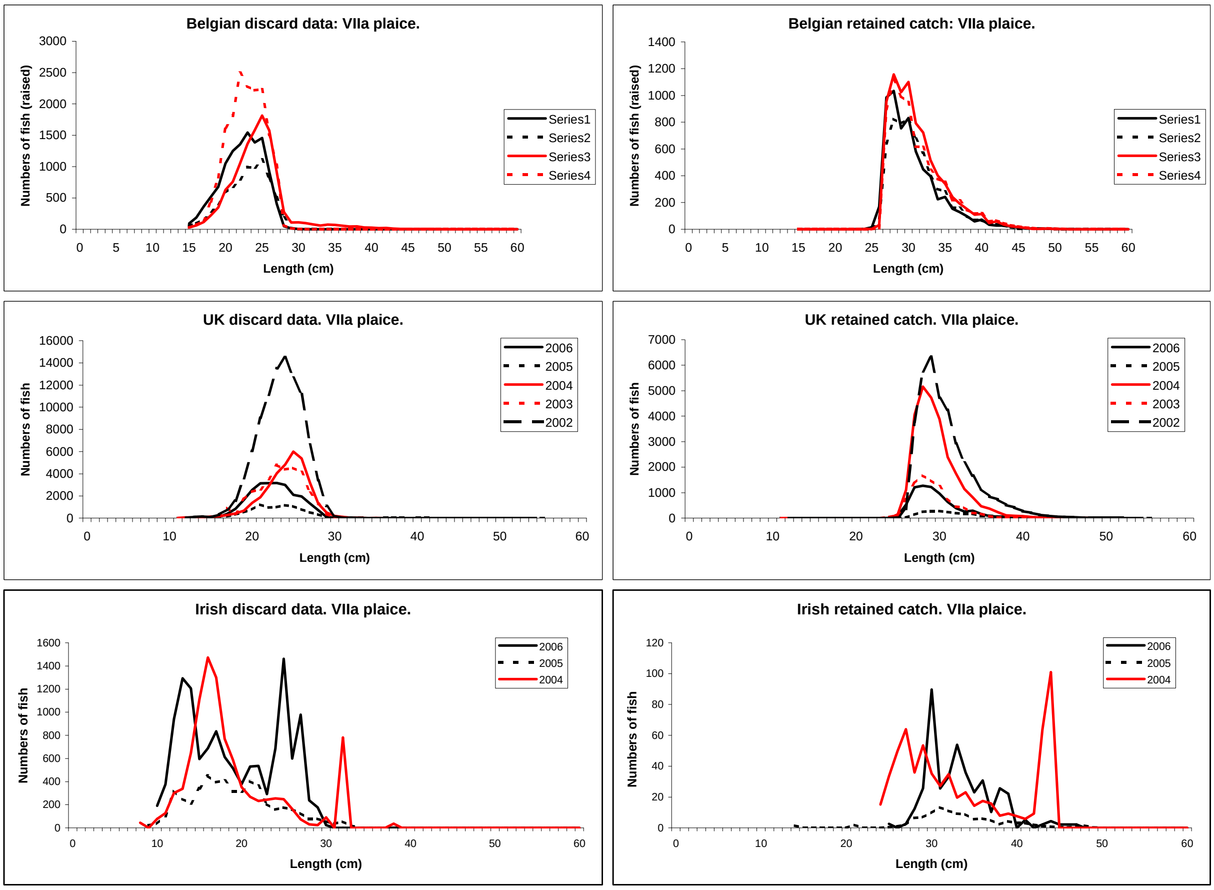


Figure 11.4.2 Length distributions of discarded and retained catches by country.

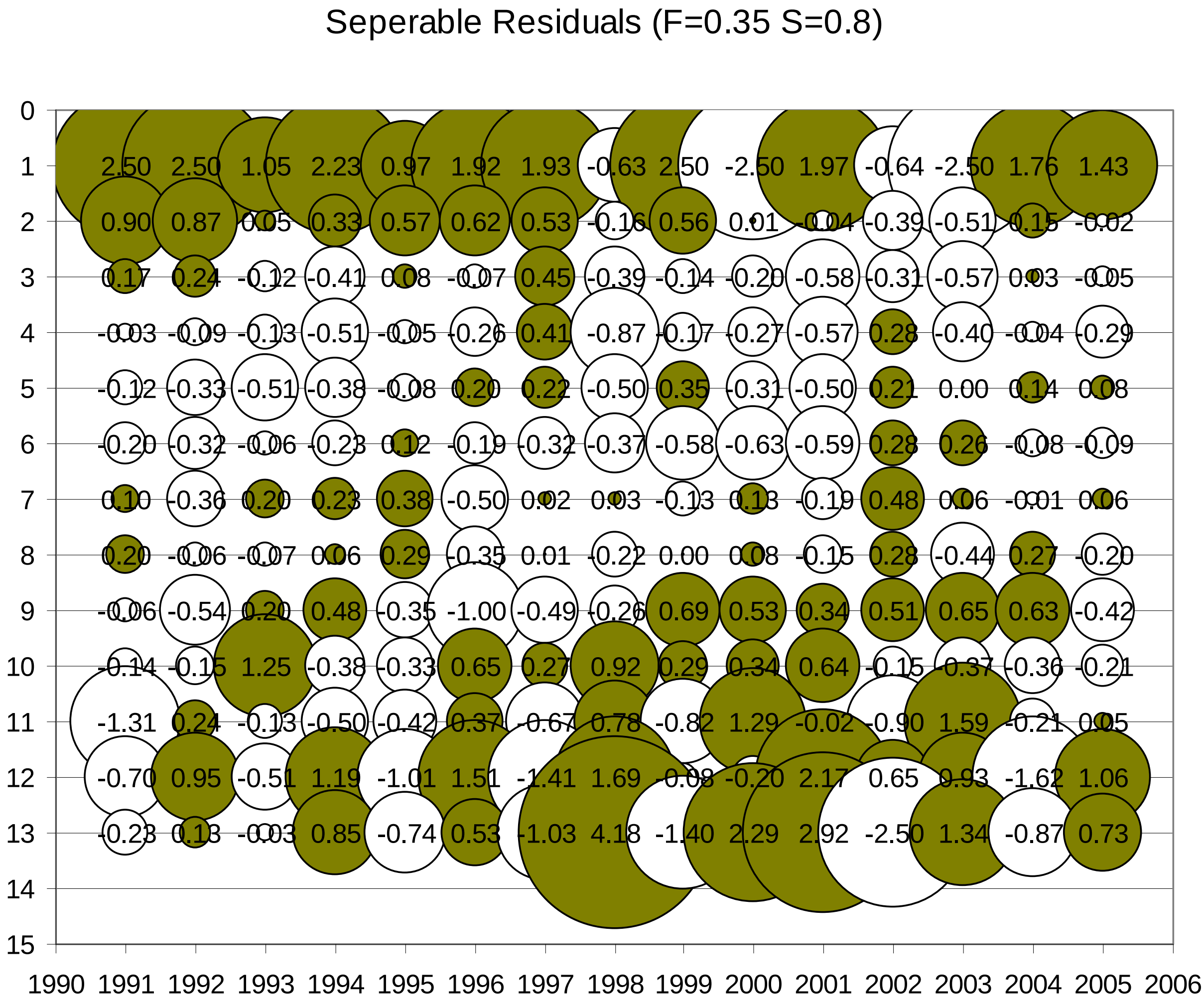


Figure 11.6.1.1 Irish Sea plaice: Separable residuals.

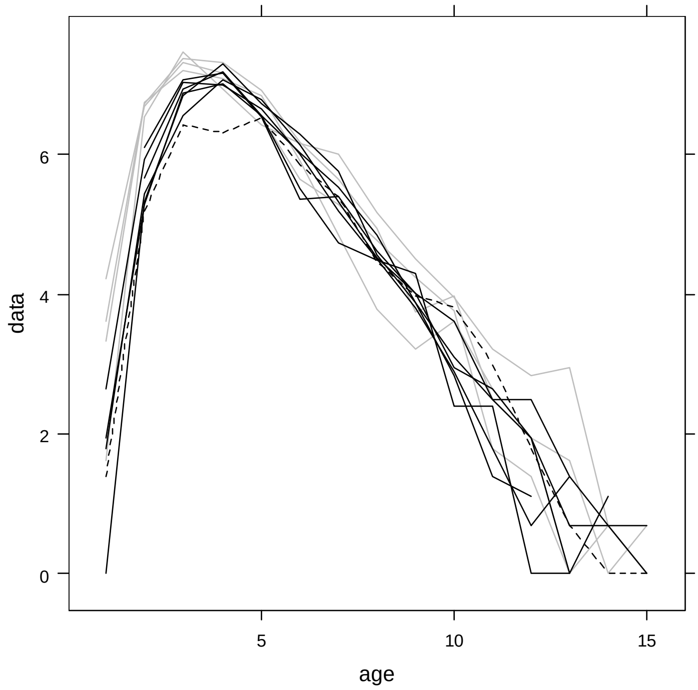


Figure 11.6.1.2 Irish Sea plaice: Log landings numbers-at-age for the period 1996 to 2006. Curves for 1996:2000 are shown in grey, curves for 2001:2005 are shown as solid black lines, dotted line shows 2006.

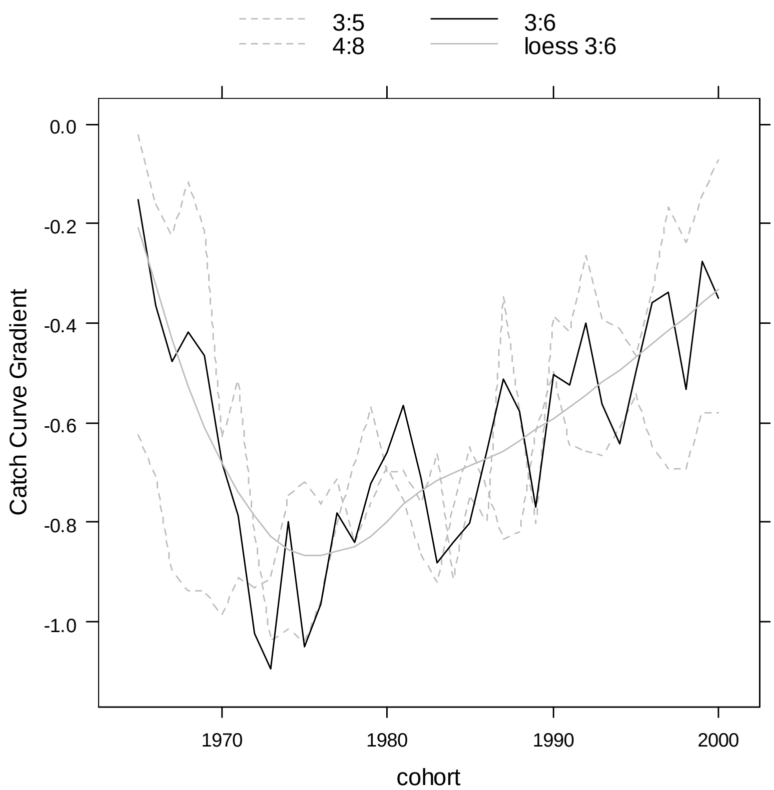


Figure 11.6.1.3 Irish Sea plaice: Catch curve gradients for cohorts 1965:2001 calculated over different Fbar age ranges.

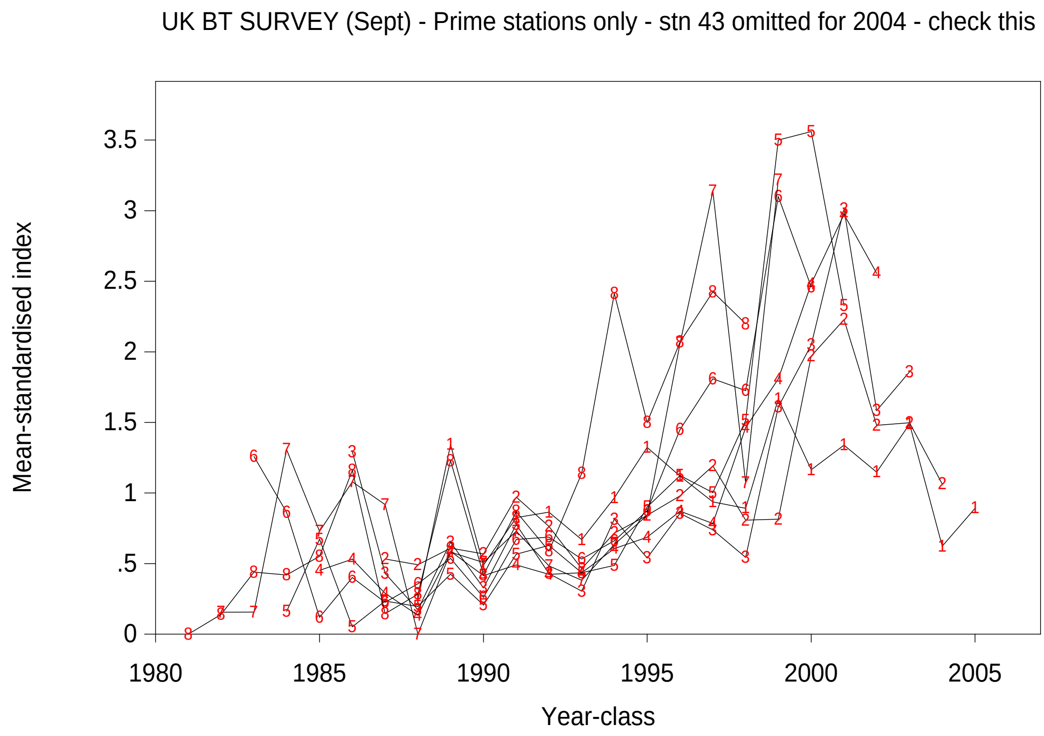


Figure 11.6.1.4 Mean Standardised indices by year-class for UK (E&W) beam trawl survey 1 to 8.

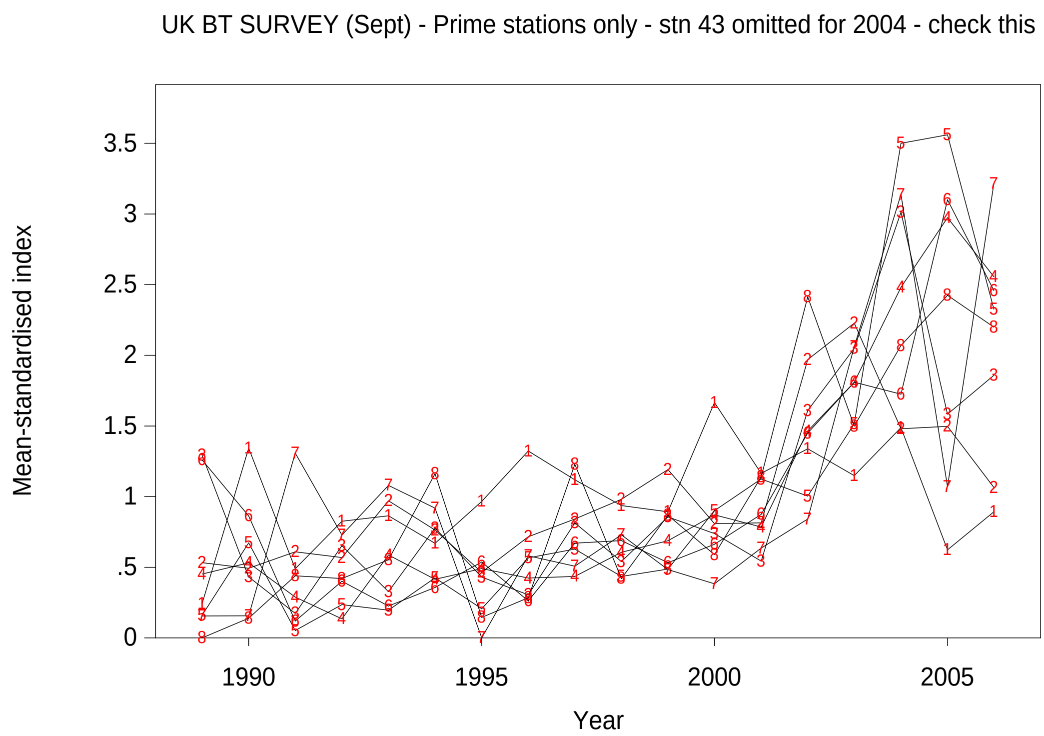


Figure 11.6.1.5 Mean standardised indices by year for UK (E&W) beam trawl survey ages 1 to 8.

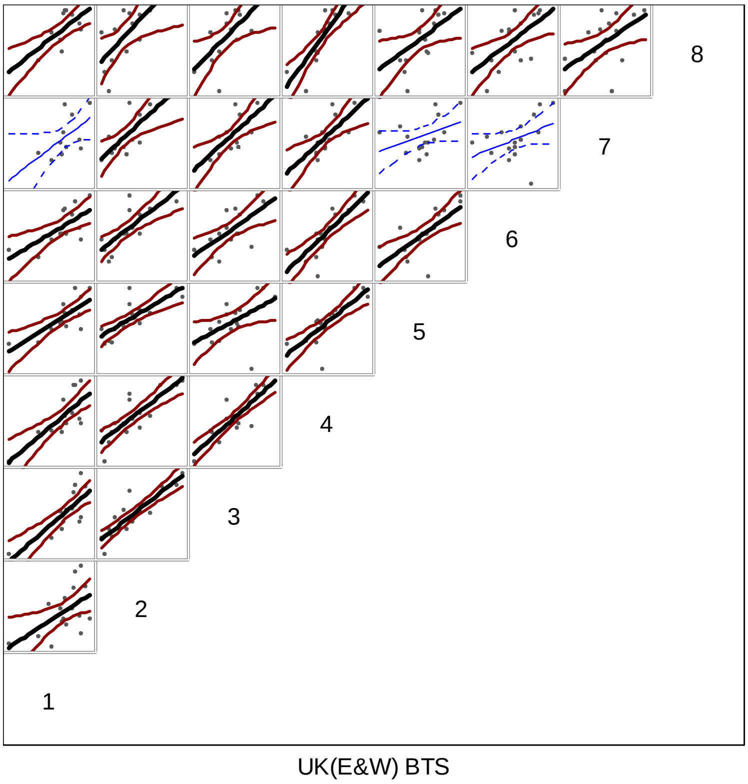


Figure 11.6.1.6 Comparative scatter plots of adjacent age groups showing the internal consistency of the UK (E&W) beam trawl survey. Panels shown in bold indicate a significant linear relationship at the 95% confidence level.

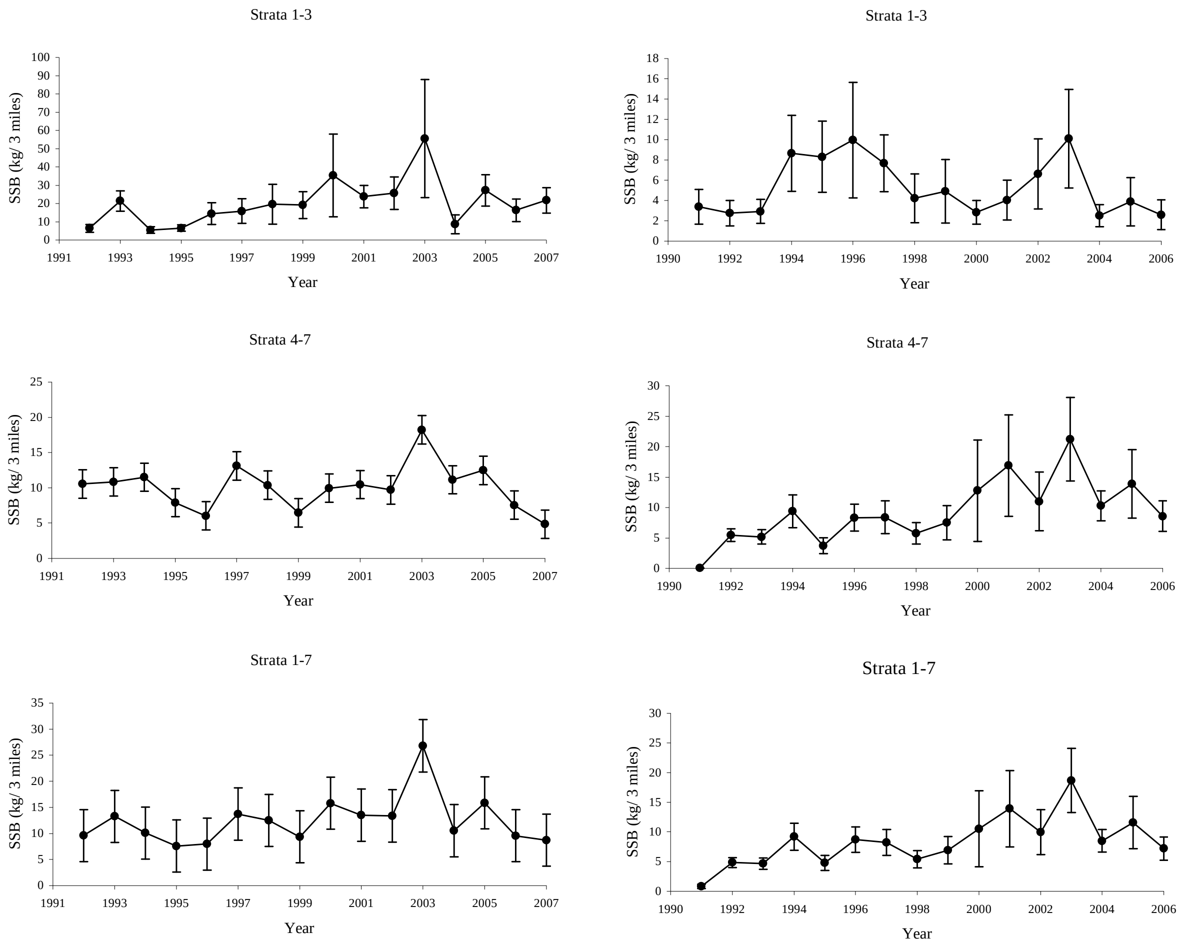


Figure 11.6.1.7 UK (NI) groundfish survey SSB indices split into spring and autumn sampling and eastern (strata 4-7), western (strata 1–3) and total.

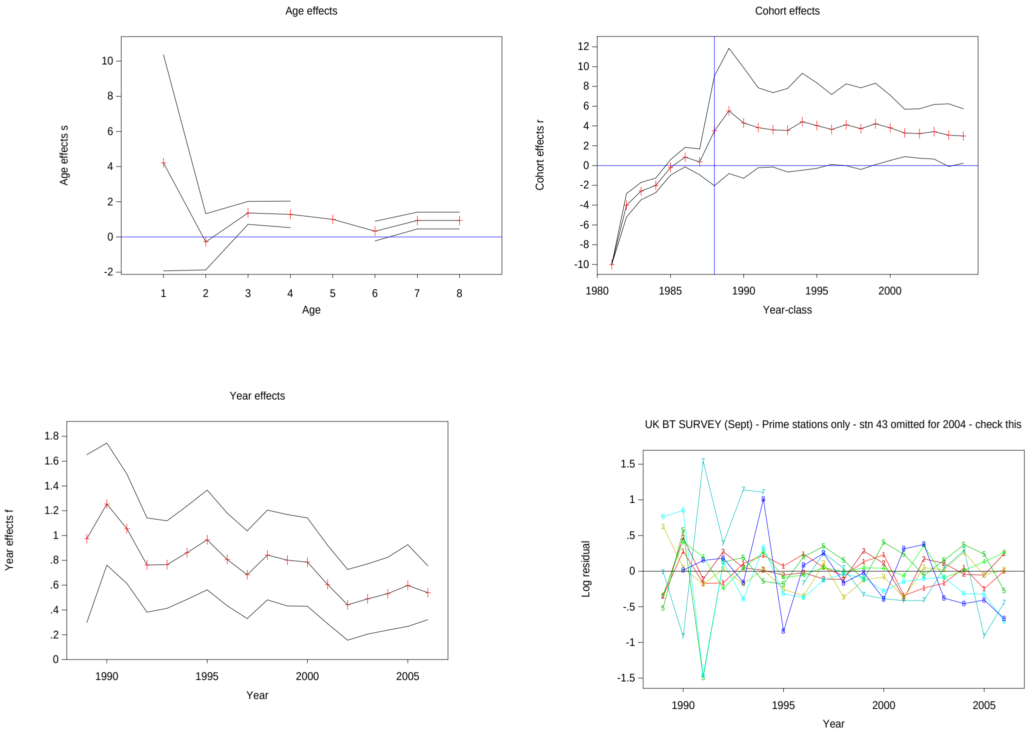


Figure 11.6.1.8 a) Surba diagnostic output for single fleet UK (E&W) beam trawl survey.

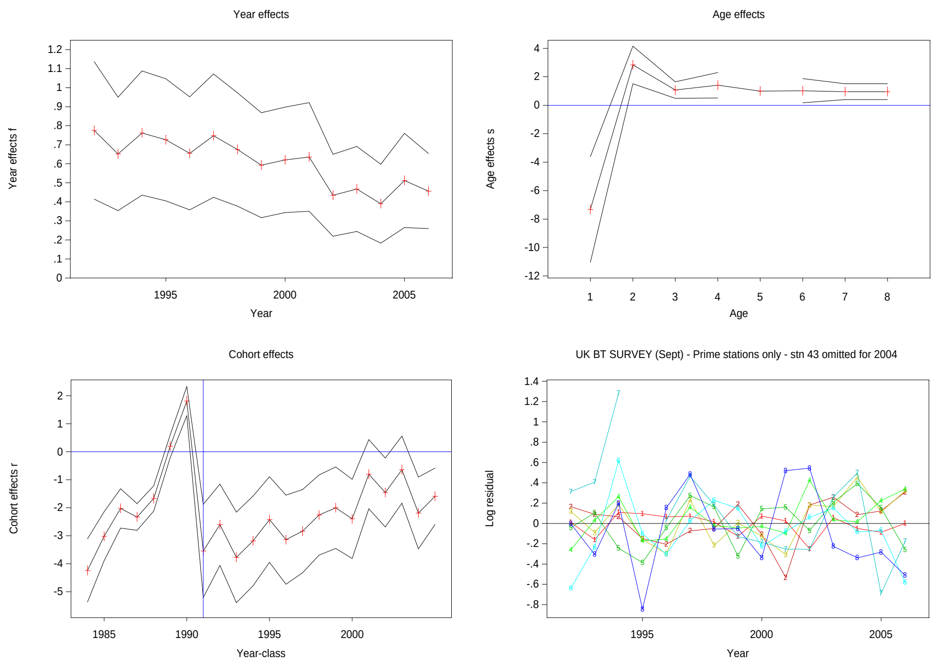


Figure 11.6.1.8 b) Surba diagnostic output for multifleet for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

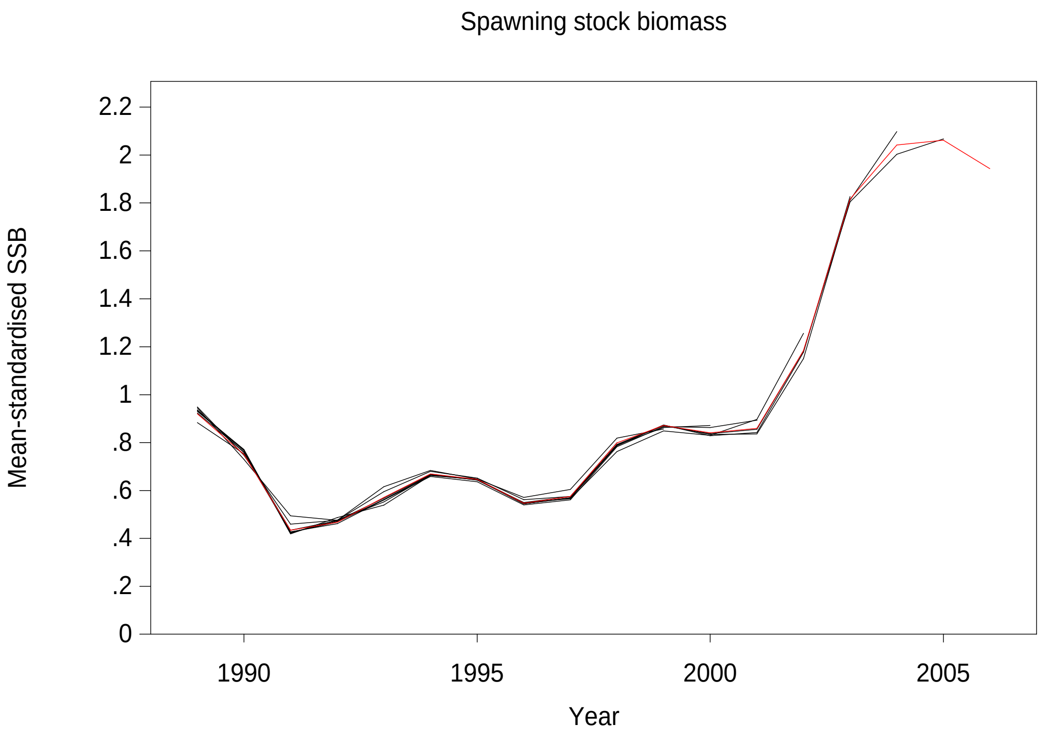


Figure 11.6.1.9 a) Surba retrospective analysis of SSB trends for single fleet UK (E&W) beam trawl survey.

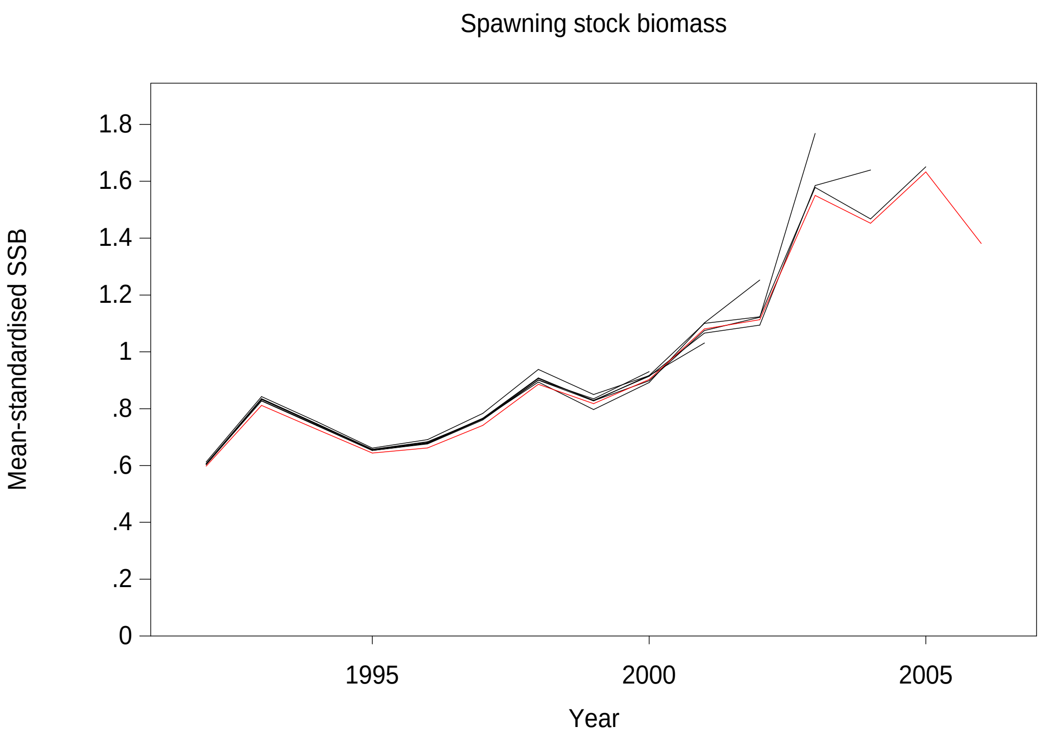


Figure 11.6.1.9 b) Surba retrospective analysis of SSB trends for multifleet for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

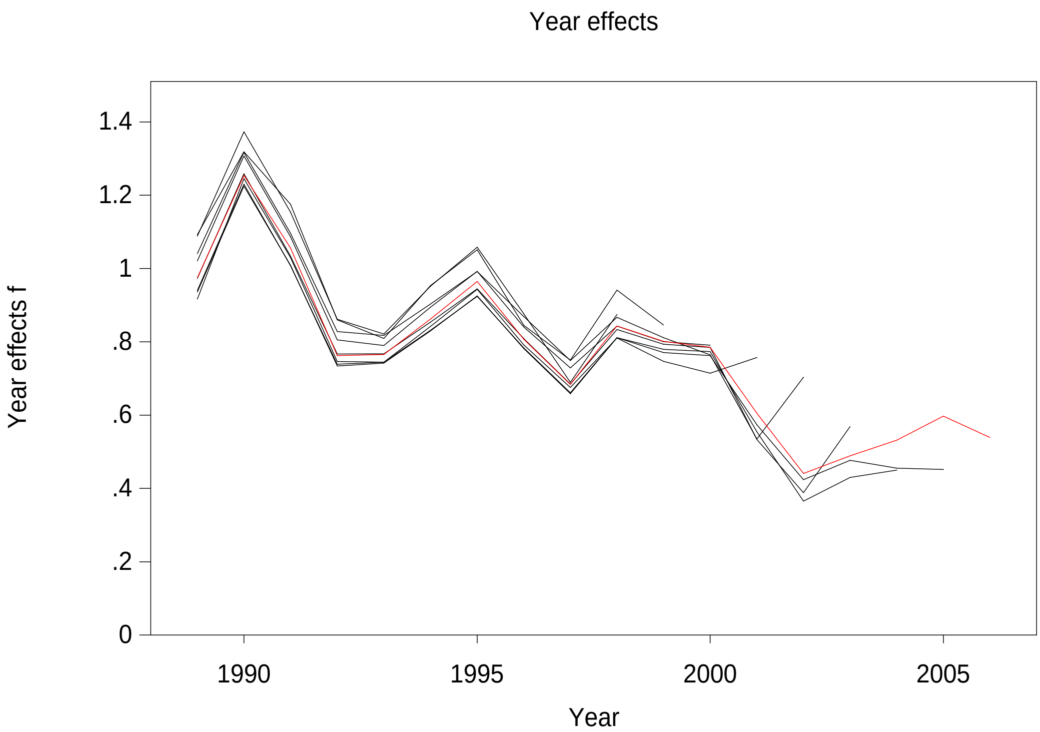


Figure 11.6.1.10 a) Surba retrospective analysis of F trends for single fleet UK (E&W) beam trawl survey.

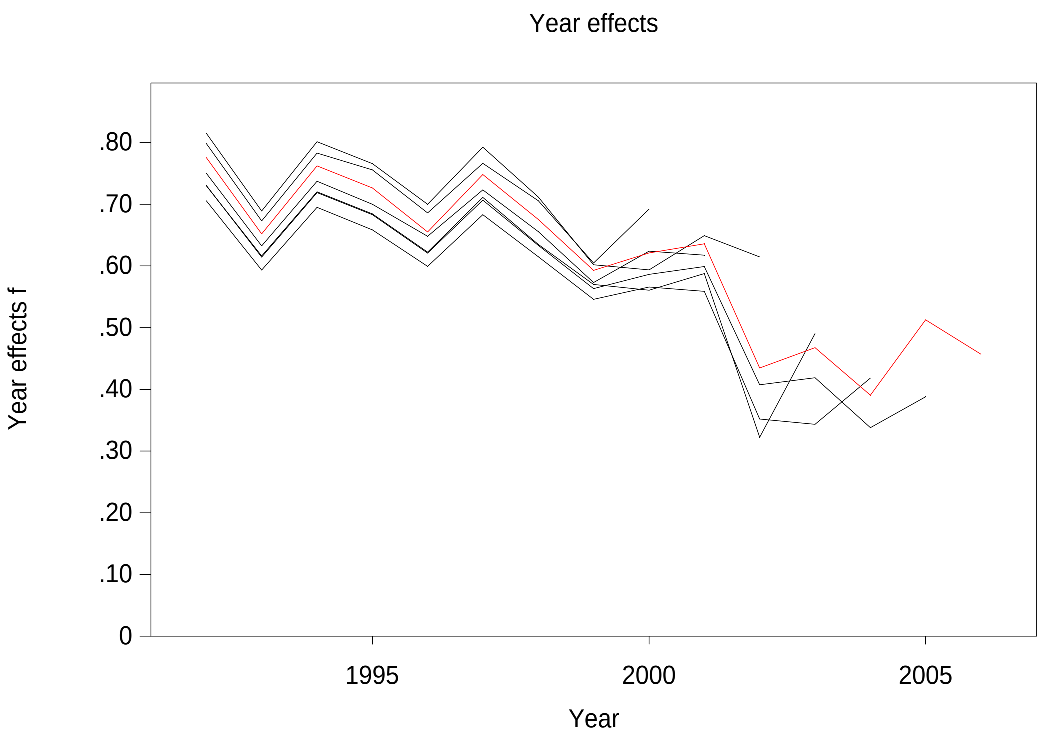


Figure 11.6.1.10 b) Surba retrospective analysis of F trends for multifleet for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

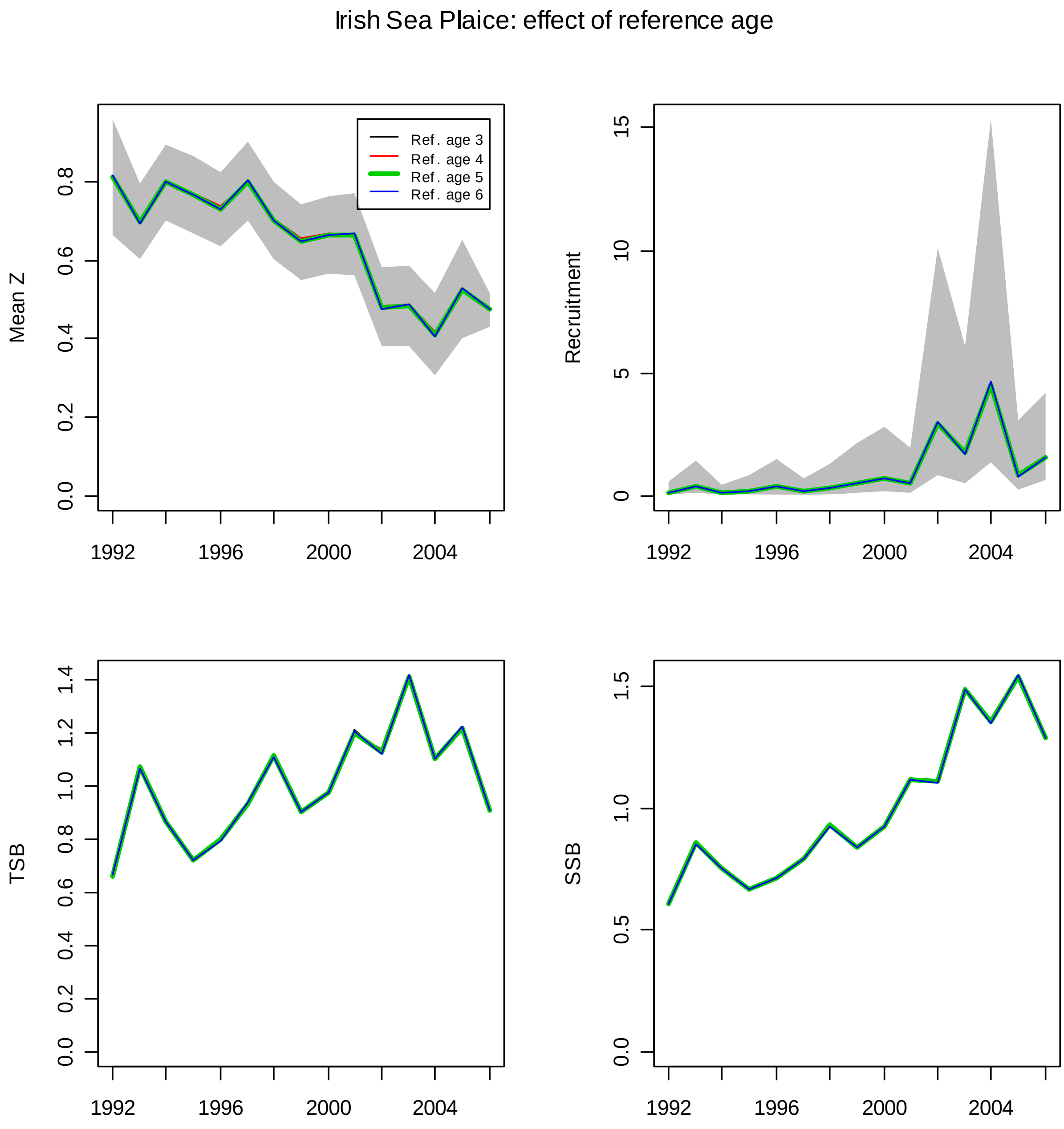


Figure 11.6.1.11 Surba sensitivity to choice of reference age for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

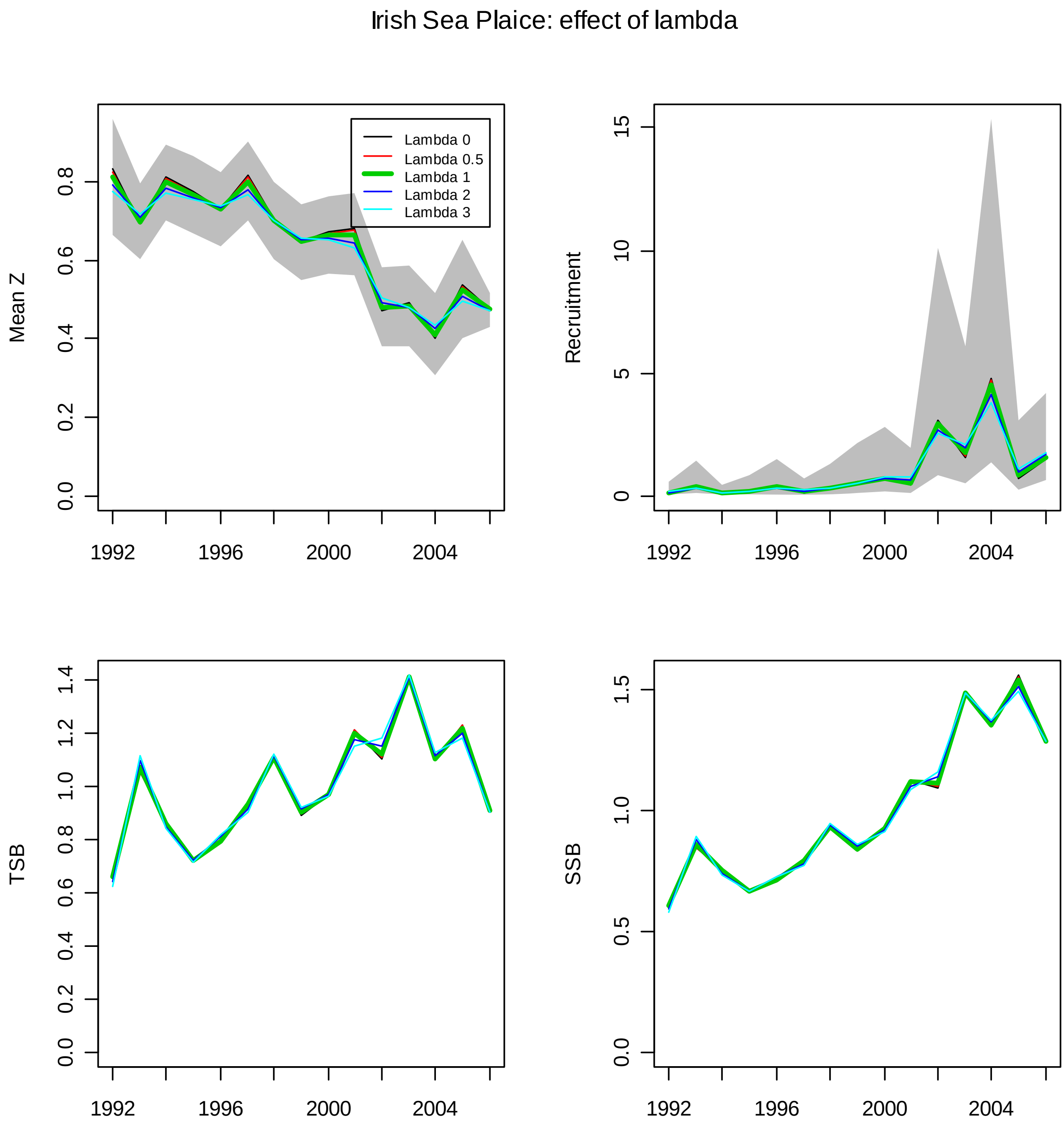


Figure 11.6.1.12 Surba sensitivity to choice of lambda smoothing value for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

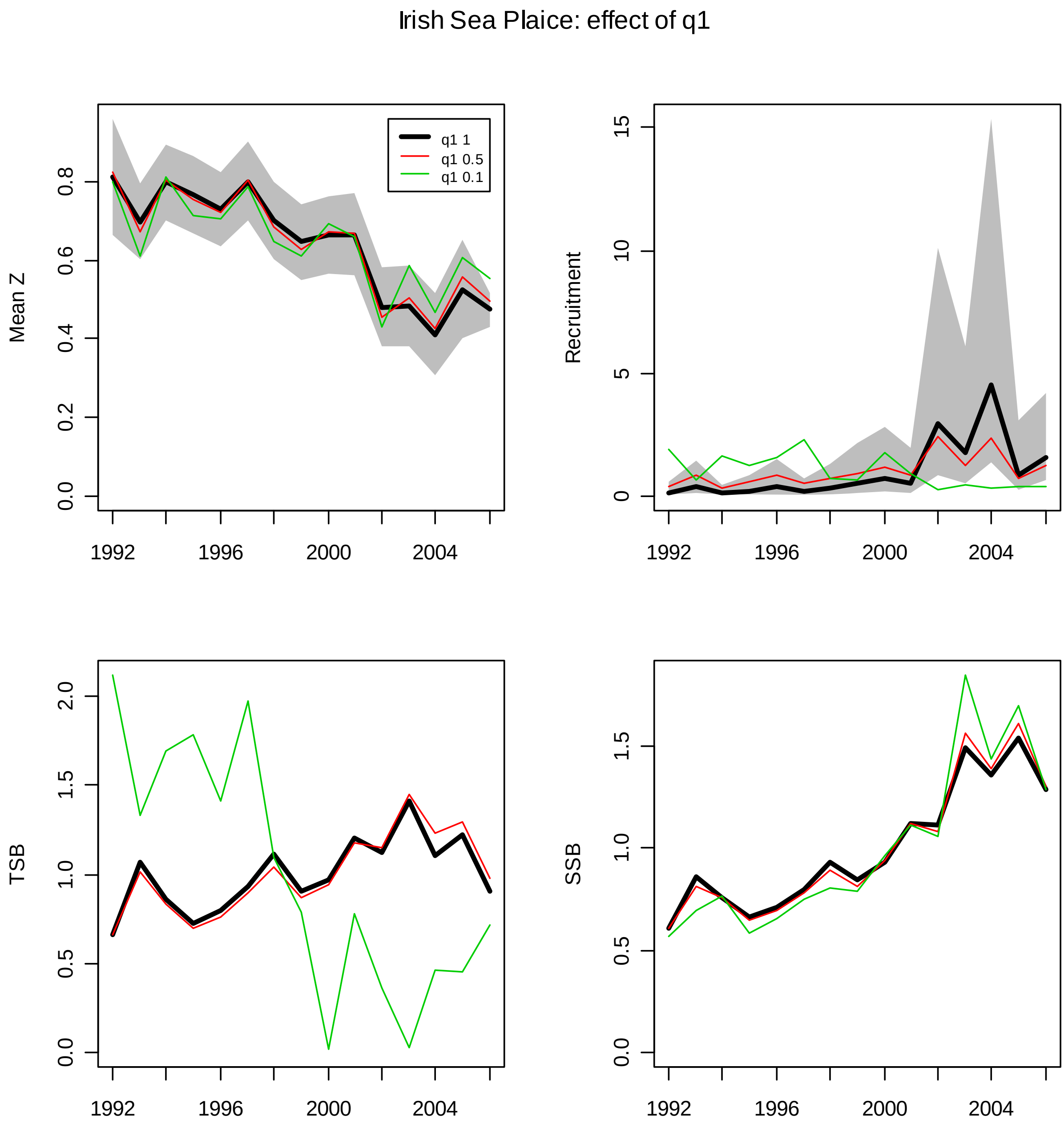


Figure 11.6.1.13 Surba sensitivity to choice of survey selectivity at age 1 for UK (E&W) beam trawl survey and UK (NI) groundfish survey SSB indices (Spring and Autumn).

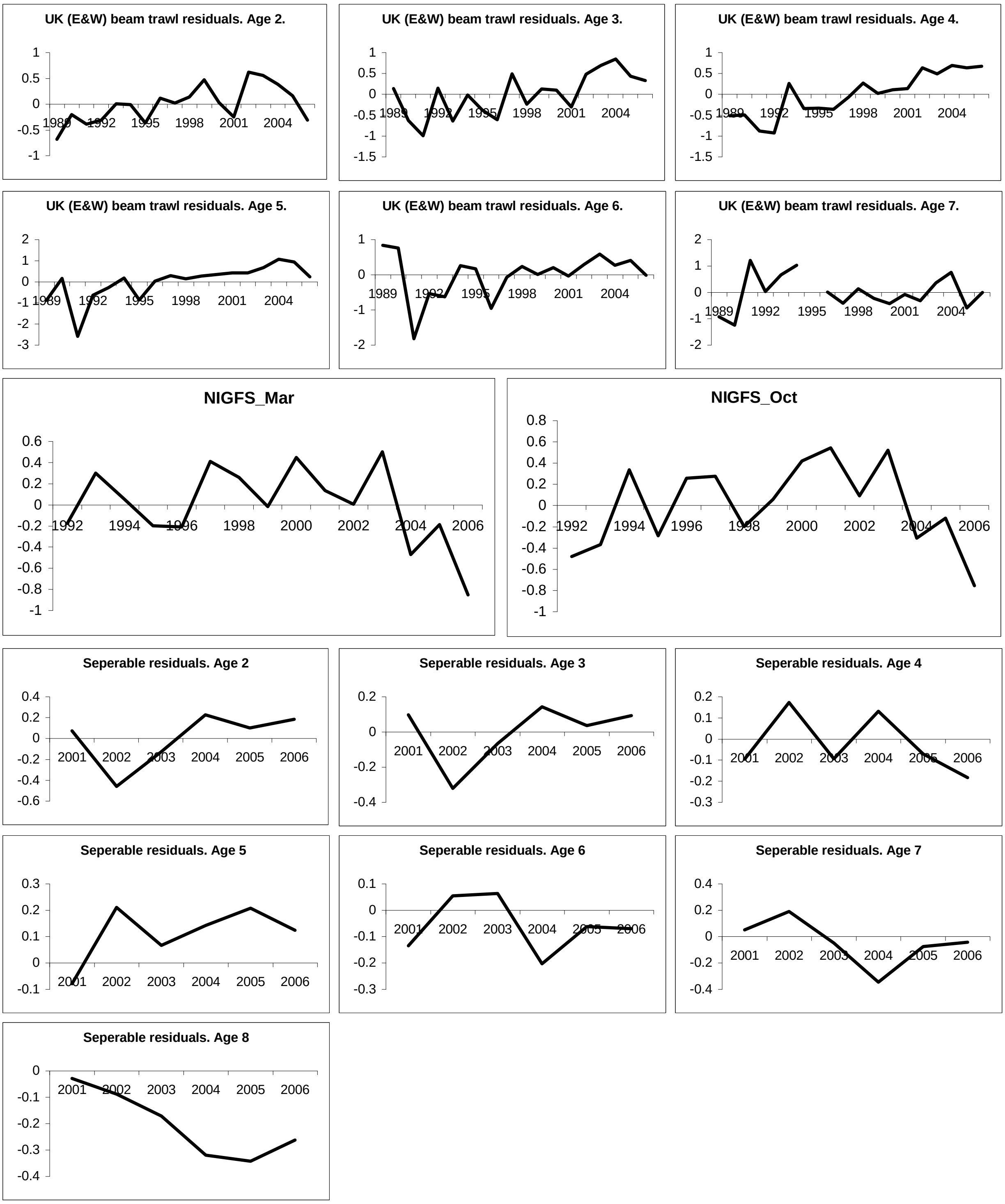


Figure 11.6.1.14 a) Update ICA residuals for UK (E&W) beam trawl survey at age, NIGFS SSB indices and Separable model residuals.

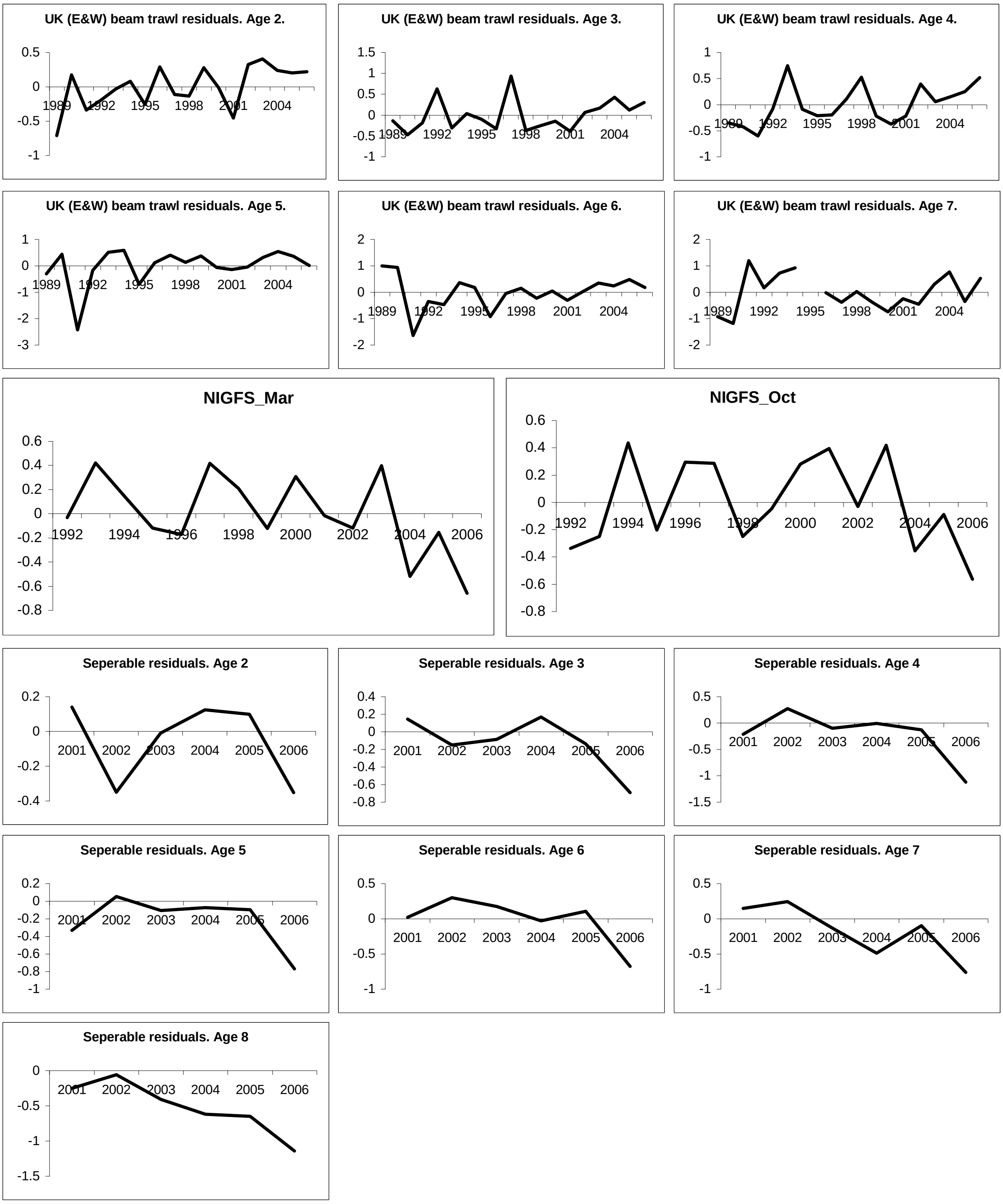
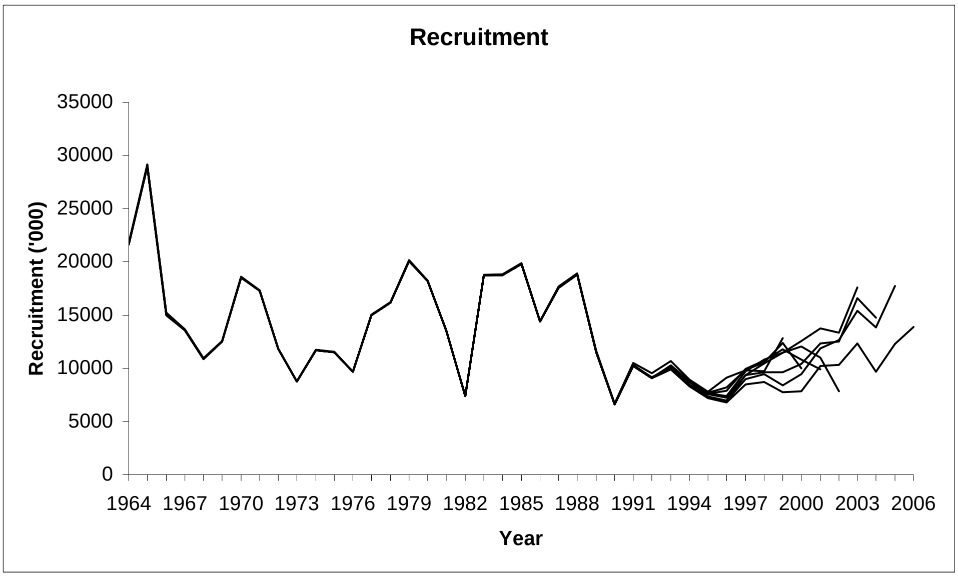
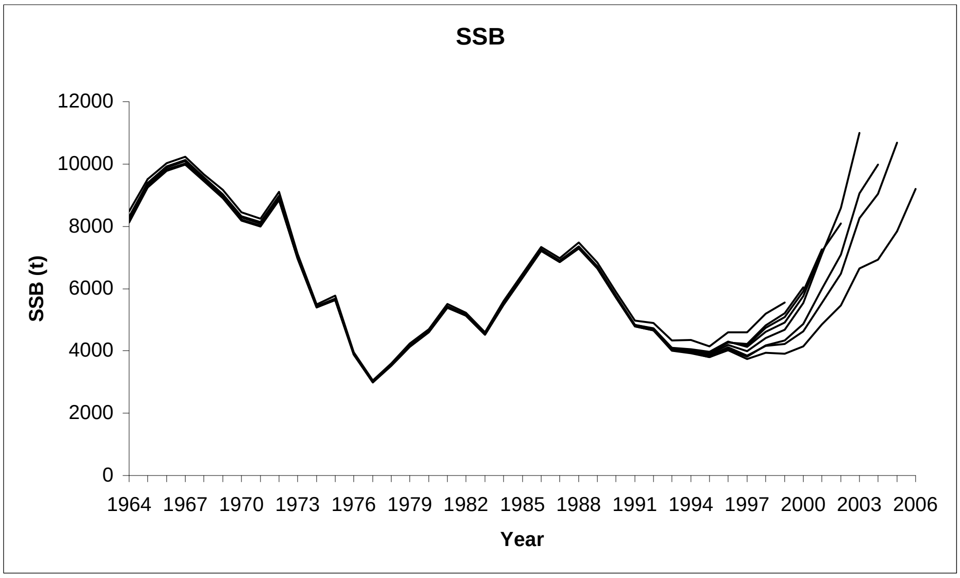


Figure 11.6.1.14 b) Final ICA residuals for UK (E&W) beam trawl survey at age, NIGFS SSB indices and Separable model residuals.





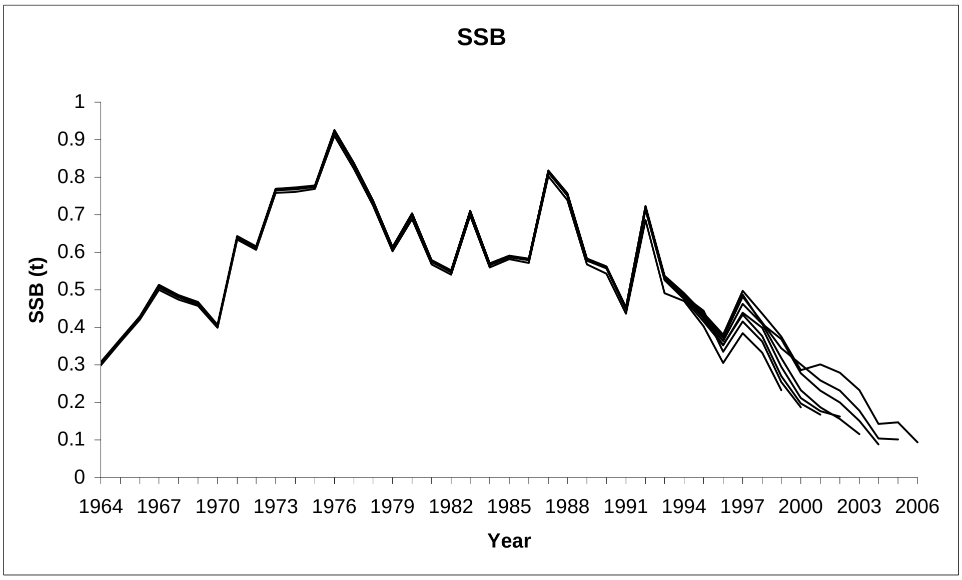


Figure 11.6.1.15 a) Retrospective pattern for update ICA.

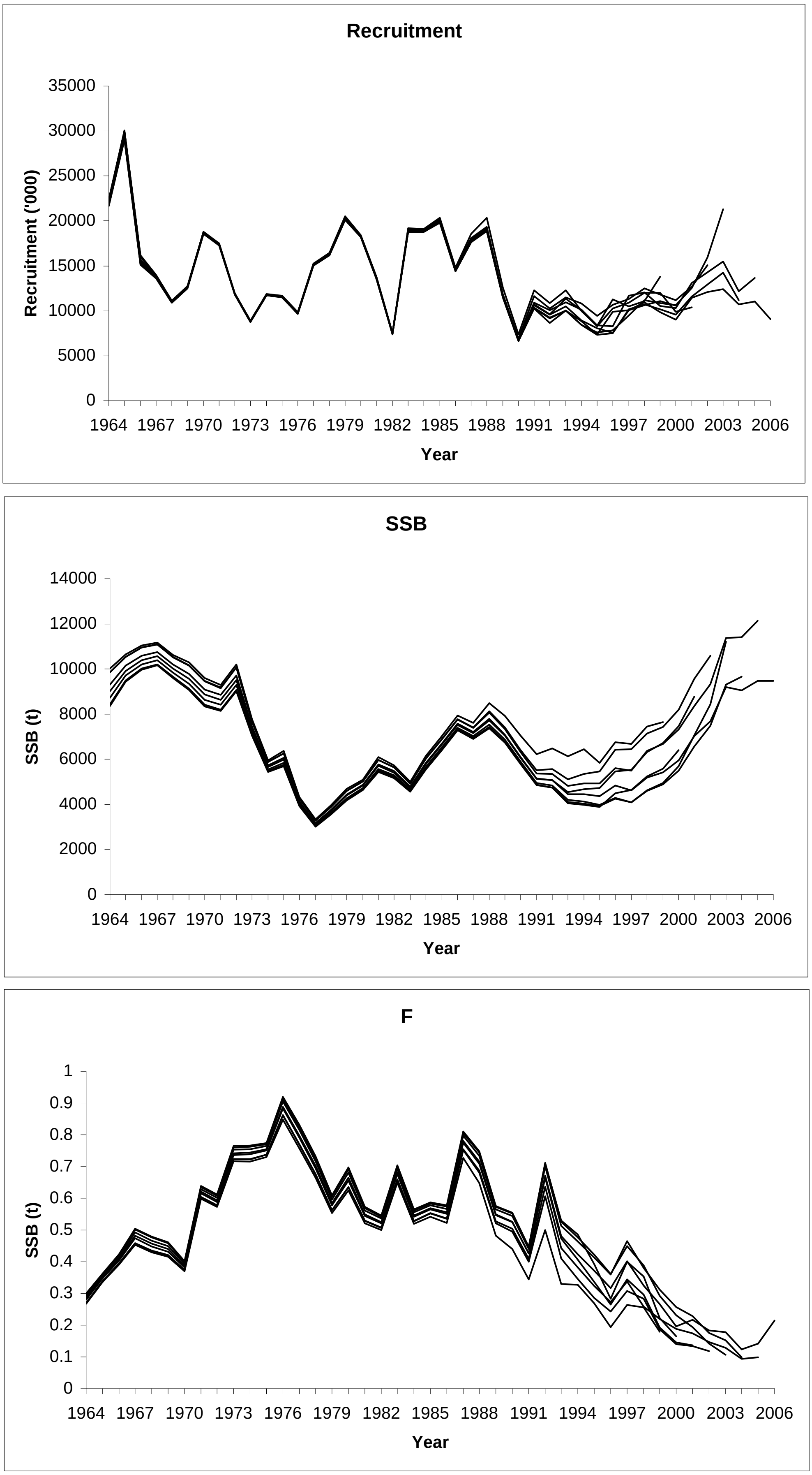


Figure 11.6.1.15 b) Retrospective pattern for final ICA.

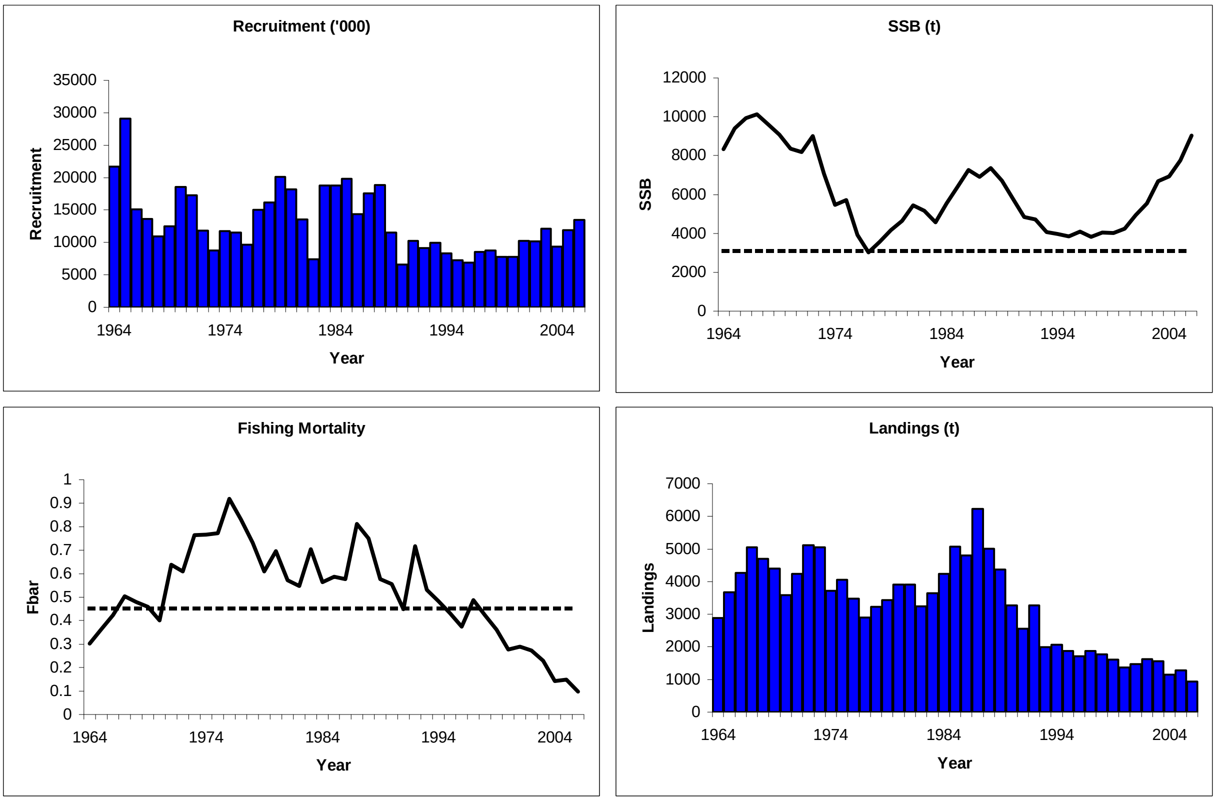


Figure 11.6.1.16 a) Irish Sea plaice: Summary plot for update ICA assessment. Dotted lines show Fpa and Bpa.

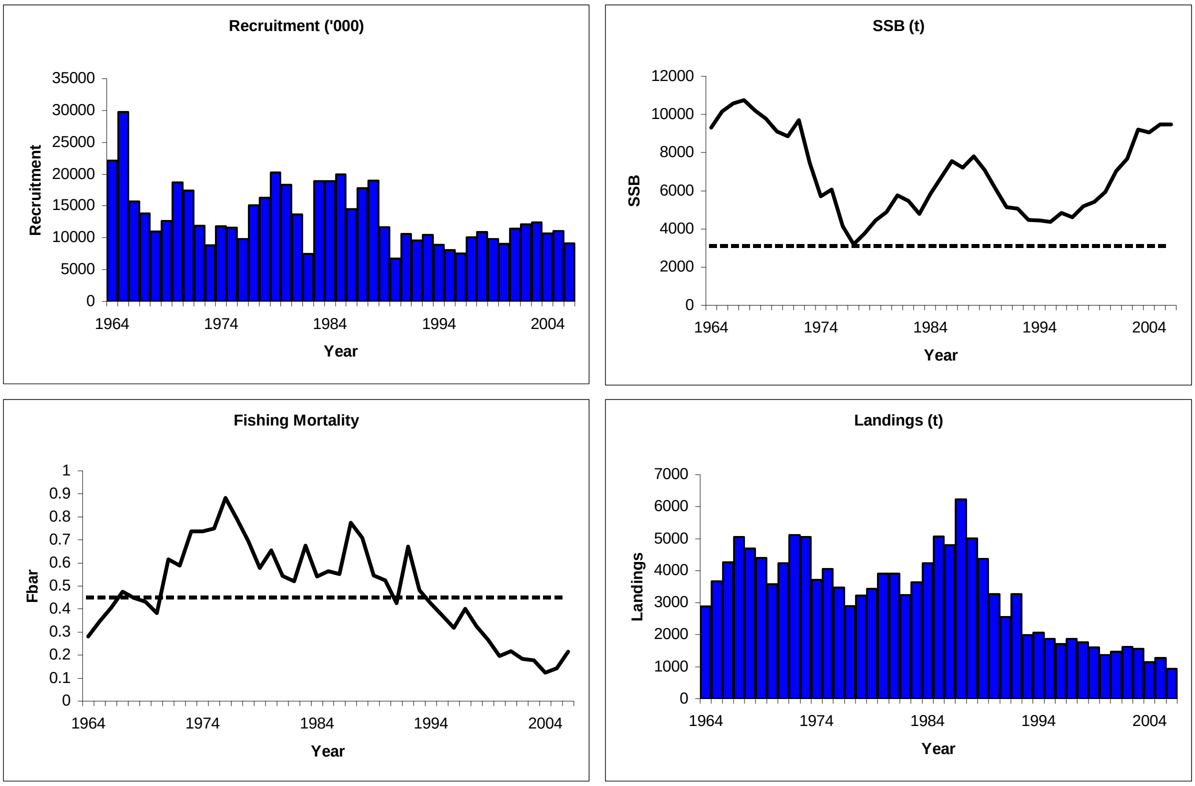


Figure 11.6.1.16 b) Irish Sea plaice: Summary plot for alternative ICA assessment. Dotted lines show Fpa and Bpa.

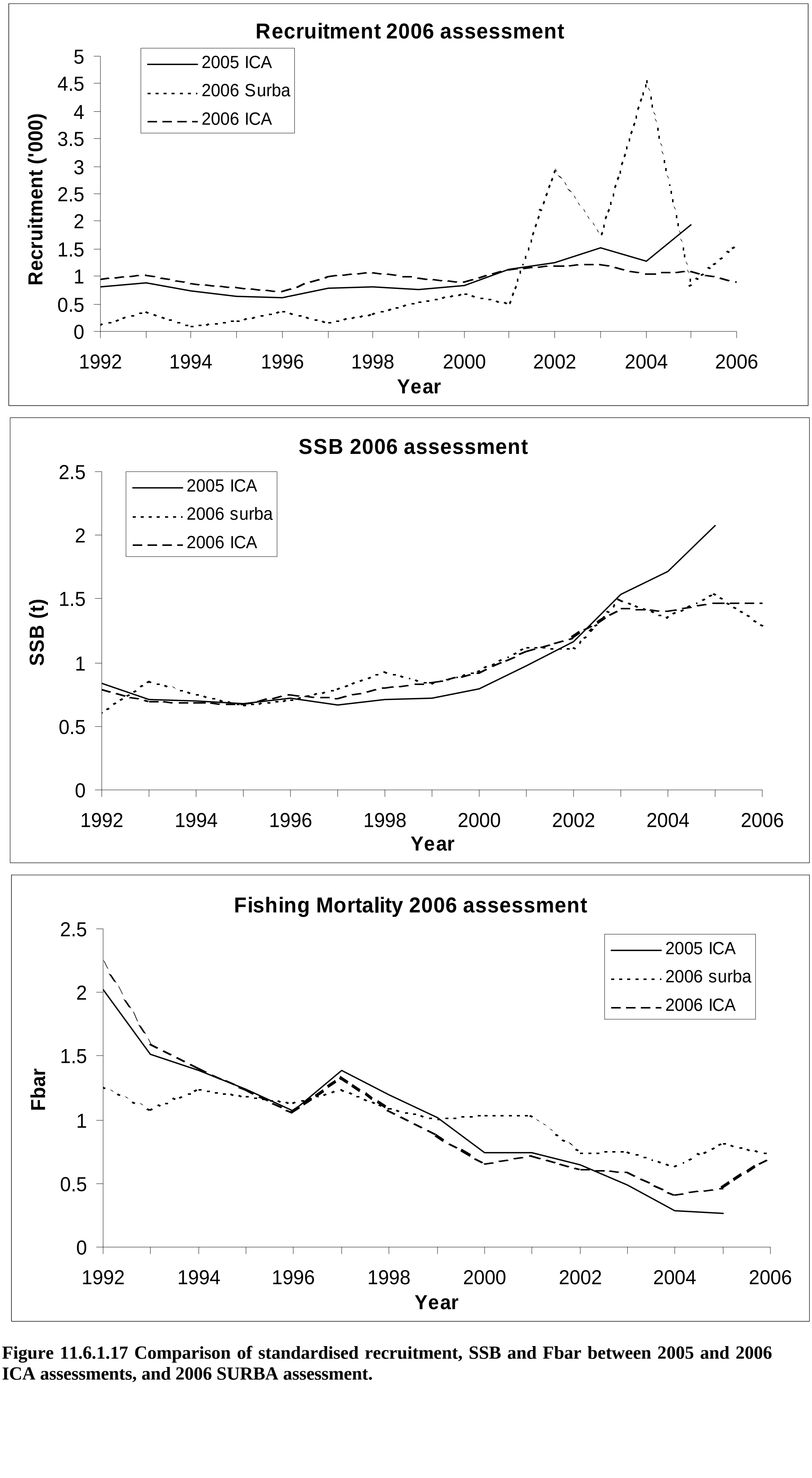


Figure 11.6.1.17 Comparison of standardised recruitment, SSB and Fbar between 2005 and 2006 ICA assessments, and 2006 SURBA assessment.

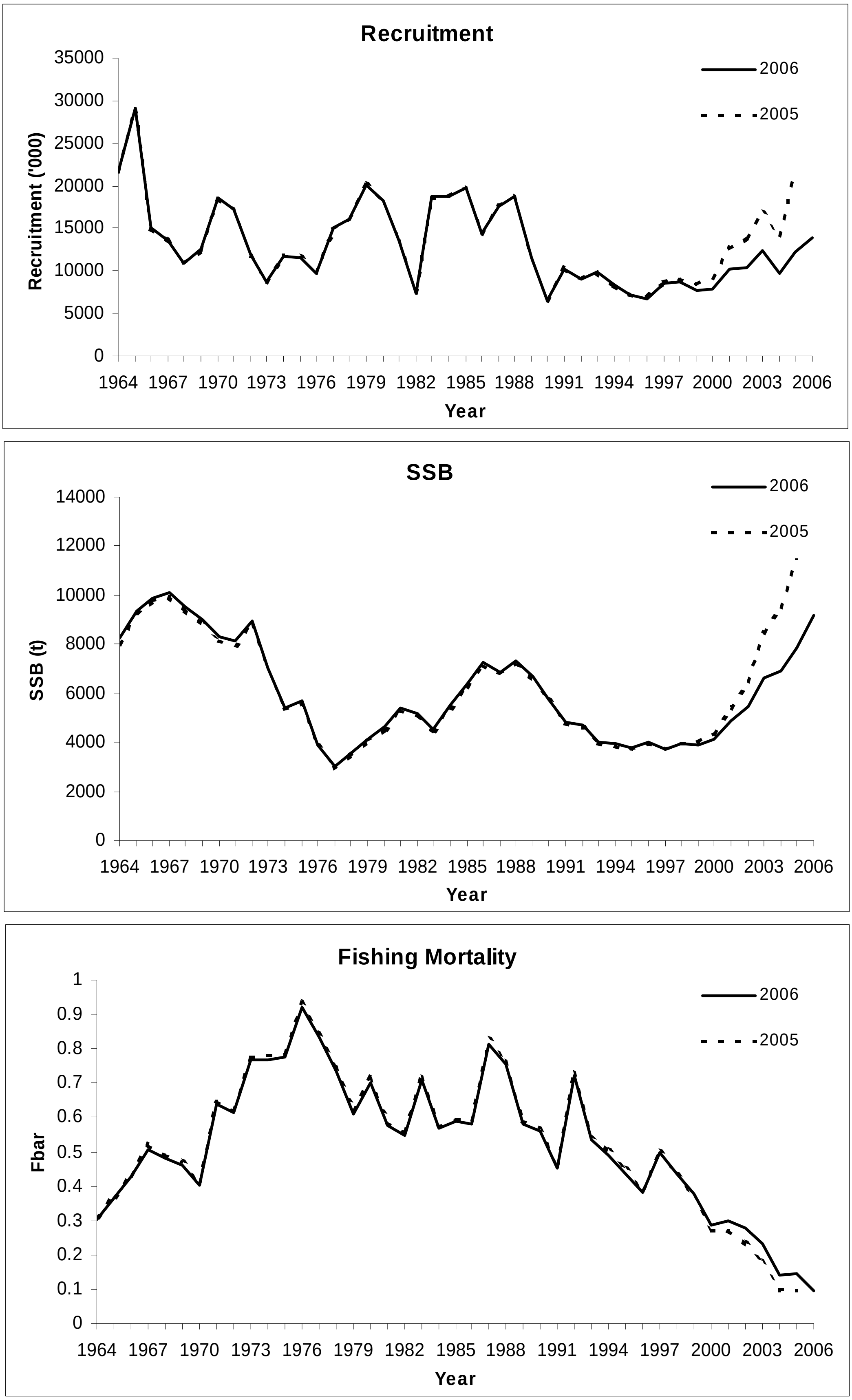
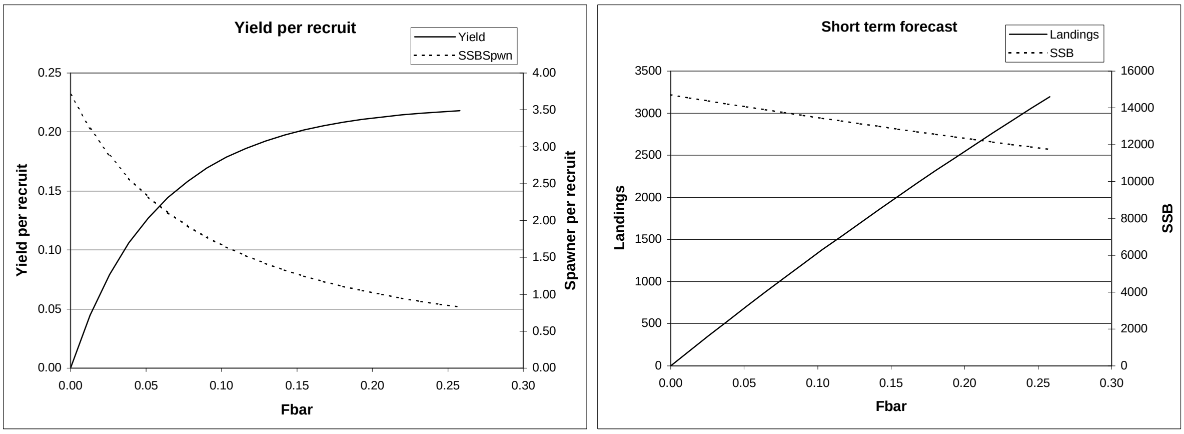


Figure 11.6.3 Comparison of recruitment, SSB and Fbar between 2005 and 2006 ICA assessments.

Figure 11.9.1 VIIa plaice, yield per recruit and short term forecast from ICA update.



MFYPR version 2a
Run: finalypr
Time and date: 10:37 13/05/2007

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.1290
FMax	3.1011	0.4000
F0.1	1.0522	0.1357
F35%SPR	1.1354	0.1465

Weights in kilograms

MFDP version 1a
Run: finalstf
IRISH SEA PLAICE 2007
Time and date: 10:26 13/05/2007
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

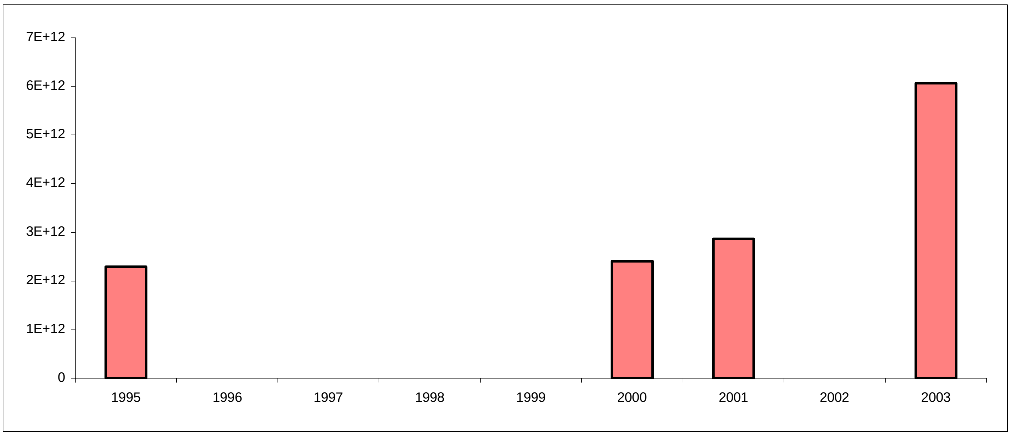


Figure 11.6.2.3 Estimated total (all stages) egg abundance for plaice in the Irish Sea. (Fox, (CEFAS) unpublished data).

12 Sole in Division VIIa

The assessment of sole in Division VIIa was scheduled as a Benchmark-assessment.

There was no final assessment agreed during WGNSDS 2006. Extra work was carried out before the ACFM meeting of October 2006 (Darby (2006) and Scott (2006)) and the current assessment is largely based on that work. The major differences between the final assessment, agreed by ACFM 2006, and previous assessments were the exclusion of commercial fleets for tuning and changes in the plusgroup setting. This year the q plateau was increased, due to changes in the exploitation pattern.

12.1 The fishery

A description of the fishery is available in the stock annex file.

12.1.1 ICES advice applicable to 2006 and 2007

ICES advice for 2006 - Single-stock exploitation boundaries

For 2006, ICES recommended that there are not sufficient data available to complete a quantitative catch prediction. Indications from recent cpue and effort data are that the stock situation has been stable in recent years. Therefore as a precautionary measure a TAC based on recent catch levels is recommended (2002–2004).

ICES advice for 2007 - Single-stock exploitation boundaries

Given the low SSB and low recruitment since 2000, it is not possible to identify any non-zero catch which will be compatible with the precautionary approach. However, a zero catch in 2007 should allow SSB to achieve B_{pa} in 2008. If the implied 100% reduction is not possible then ICES recommends that a recovery plan be implemented which ensures a safe and rapid rebuilding of SSB to levels above B_{pa}.

12.2 Management applicable in 2006 and 2007

The sole fisheries in the Irish Sea are managed by TAC (see text table below) and technical measures.

YEAR	SINGLE STOCK EXPLOITATION BOUNDERIES	BASIS	TAC	% CHANGE IN F ASSOCIATED WITH TAC *	WG LANDINGS
2005	<1000t	Keep F below $\mathbf{F}_{pa}$	960t	+ 3	855t
2006	< 930t	Recent catch levels (2002-2004)	960t	-	570t
2007	0t	Zero catch	816t	+ 1	-

*** F calculated, based on a *Status quo* forecast**

Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). In addition beam trawlers, fishing with mesh sizes equal to or greater than 80mm, are obliged to have 180 mm mesh sizes in the entire upper half of the anterior part of their net. More details can be found in Reg 254/2002. Other regulations applicable to area VIIa are summarized in Section 1.7.

Since 2000, a spawning closure for cod has been in force. The first year of the regulation the closure covered the Western and Eastern Irish Sea. Since then, closure has been mainly in the Western part whereas the sole fishery takes place mainly in the Eastern part of the Irish Sea and no direct impact on the sole stock is expected from this closure.

12.2.1 The fishery in 2006

The main countries fishing for Irish Sea sole remain Belgium, UK, and Ireland. Effort of all fisheries fishing for sole decreased markedly in 2006 compared to 2005.

The following remarks on some developments in the beam trawl fleet operating in the Irish Sea were made by FTFB 2007: A small number of beam trawlers operating in VIIa are experimenting with more selective gears aimed at reducing by-catches of haddock and whiting as well as benthos. If similar pressure, being exerted on UK beam trawl fleet by supermarkets, is applied in Belgium, the use of these gears is likely to increase (ICES WGFTFB, 2007).

12.3 Catch data

12.3.1 Official Landing Statistics

National landings data reported to ICES, and Working Group estimates of total landings are given in Table 12.2.1. The total international landings in 2006, as used by the Working Group, were 569 t, which is 30% below the agreed TAC and is the lowest observed value in the time series.

12.3.2 Revisions to landing data

France has revised landings figures slightly for the period 1999–2005. There were no revisions to the other landing data series.

12.3.3 Quality of the Catch data

Discarding of sole based on Belgian vessel trips ranged between 0 to 5% by weight in 2004 (5 trips and 115 hauls) and between 0 to 8% in 2005 (4 trips and 90 hauls). Discard information from the UK indicated that around 2% numbers of fish were discarded in 2005 and around 20% in 2006. The latter figure is unusual high for a species like sole but was due to high discard rates during one observer trip in the fourth quarter. Sparse discard information from previous years also indicated low discard rates of sole. It is therefore unlikely that the non-inclusion of discard data in the assessment is seriously undermining the quality of the assessment.

There is no accurate information on the level of misreporting for this stock.

12.4 Commercial catch-effort and research vessel surveys

Cpue and effort series were available from Belgium beam trawlers, UK (E&W) beam and otter-trawlers, Irish beam and otter trawlers and from two UK beam trawl surveys (September and March) (Table 12.3.1 and Figure 12.3.1).

Effort from both Belgian and UK commercial beam trawl fleets increased from the early seventies until the late eighties. Since then UK beam trawl effort has declined. The Belgian beam trawl effort declined in the early nineties but increased again thereafter. Effort of the Irish beam trawl fleet has increased over the period 1995–2003 and decreased thereafter.

Cpue for both UK and Belgian beam trawlers was at a higher level in the late seventies and early eighties. More recently cpue for these beam trawlers is fluctuating at a lower level. Irish beam trawl cpue declined over the period 1995-2002 and has remained stable since.

Available tuning data are given in Table 12.3.2.

12.5 Age compositions and mean weights at age

12.5.1 Landings age composition and mean weight-at-age

A revision was made to the input data for the years 2001–2005. There were changes made to the landings data of France for the period 1999–2005, and the Belgian length distributions and ALKs for 2001, 2002, 2004 and 2005. Extra information for the latter was mainly originating from measurements made during observer trips that were not included before. This resulted in minor changes to the input data (Figure 12.4.1). In 2003, Belgian sampling for Irish Sea sole was poor and other ALKs were used for calculating the Belgian age distribution (same procedure as previously). Despite the revision of the data, the 2004 catch weights-at-age remain relatively higher compared to the weights of other years. This was mainly caused by a different sex ratio in 2004 compared to other years (16% males in 2004 compared to 30% in other recent years). Since the average weight at age of males is lower compared to the average weight at age of females, a lower male/female sex ratio in 2004 implies higher catch weights at age for the sexes combined. More details are presented in the Stock Annex.

Quarterly age compositions for 2006 were available from Belgium, UK (E&W) and Ireland as well as quarterly landings from Northern Ireland, the Isle of Man and France. The sampled fleets are those taking the major part of the international landings.

Catch numbers-at-age data are given in Table 12.4.1.

Table 2.2 shows the countries that provide data; Table 2.3 gives their sampling levels.

Catch weights at age for 2005 were calculated from Belgium, UK and Ireland data, weighted by national catch numbers at age, and then quadratically smoothed (using age = 1.5, 2.5 etc.) and SOP-corrected (1.8%). The quadratic fit used was:

$$Wt=0.146+(0.025*(AGE+0.5))-(1E-5*(AGE+0.5)^2)$$

Table 12.4.2 gives landing weights.

Stock weights at age were derived from the smoothed catch weight at age by setting age=1.0, 2.0, etc. Stock weights-at-age are given in Table 12.4.3.

Annual length compositions for 2004 are given by fleet in Table 12.4.4

12.5.2 Discards age composition

Information from Belgium, UK (E&W) and Ireland indicates that discarding is low in general. During 2006 high discard rates were observed in the UK (E+W) fleet, but this was due to high discard rates in one observer trip in the fourth quarter. Length distributions for 2004 and 2005 from onboard sampling on Belgium vessels for discard and landings during the same trips are presented in Figure 12.4.2.

12.6 Natural mortality, maturity

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years.

Natural mortality was set at 0.1 yr^{-1} (all ages and all years).

The maturity ogive used is as previously:

Age	1	2	3	4	5	6 and older
	0.00	0.38	0.71	0.97	0.98	1.00

The proportions of natural mortality and fishing mortality before spawning were both set to 0 to reflect the SSB calculation date of 1 January.

12.7 Catch-at-age analysis

The results of exploratory XSA runs, which are not included in this report, are available in ICES stock files.

General approaches and methods are described in Section 2.

12.7.1 Data screening and exploratory runs

A preliminary inspection of the quality of international catch-at-age data (for ages 2–15) was carried out using separable VPA, with a reference age of 4, terminal F=0.5 and terminal S=0.8 (Same settings as in previous WG's). As usual the residuals for the younger (2/3 and partly 3/4) and older ages (10+) were large (Table 12.6.1 and Figure 12.6.1).

The log catch curves and the catch curve gradients per cohort are presented in Figure 12.6.2-3. In general the log catch curves show no major anomalies, and their gradient becomes slightly more negative over time indicating slightly increasing fishing mortality.

12.7.1.1 Commercial catch data

Commercial tuning data were available for Belgium beam trawlers (1975–2006), UK (E&W) beam and otter trawlers (both 1991–2006) and Irish otter trawlers (1995–2006) (Table 12.3.2). Last year, the commercial tuning fleets were removed from the final assessment. The main reason for their removal was a retrospective step change in the time series of SSB. Consequently, the commercial tuning fleets were not subject to any close analysis this year.

12.7.1.2 Survey data

Survey tuning data were available from a UK (E&W) September beam-trawl survey (1988–2006), a UK March beam-trawl survey (1993–1999).

12.7.1.3 Exploratory assessment runs

SURBA 2.2 was used for screening the survey data. Catchabilities at age were set to 1. Diagnostic plots of the mean standardised indices, comparative scatterplots at age and plots of smoothed SSB and F trends for the UK (E+W) are shown in Figures 12.6.4-9. The UK (E&W) September beam-trawl survey seems to have the ability to track year-class strengths relatively consistently and shows good internal consistency. Log cohort abundances seem to be noisier. Smoothed Z trends suggest that mortality remains stable, but SSB has declined over the last decade. No new SURBA runs have been applied to the UK (E+W) March beam trawl survey. This survey was discontinued in 1999, and past analysis concluded that the survey could be used for tuning.

Given the revision of the catch data over the period 2001–2005, last year's final XSA run (tuned with indices from the UK (E+W) September and UK (E+W) March survey only) was repeated to look at the impact of the new dataset on the results. The new dataset did result in only minor changes in the most recent estimates. A comparison plot is presented in Figure 12.6.10. Next, an XSA (same settings) with the 2006 data included was carried out. The stock and fishing mortality trends remain similar and are also shown in Figure 12.6.10. The retrospective analysis with these settings is given in Figure 12.6.11. Although F and SSB are rather well converged in most recent years, divergence is obvious in earlier periods. This might be partly due to plusgroup settings. Increasing the plusgroup from ages 8+ to 9+ and 10+ (Figures 12.6.11-13) does improve the convergence of F and SSB in the earlier part of the time series, but has no impact on the retrospective pattern in the most recent years. The retrospective pattern of recruitment is not influenced by the plusgroup setting. Given the rather good convergence in most recent years with an 8 plusgroup setting, age 8 was kept as plusgroup.

The evolution of the exploitation pattern over time is presented in Figure 12.6.14. The exploitation pattern has changed and since the late eighties fishing mortality has increased on younger ages (ages 2 and 3) and has decreased on the older ages (5 and older) compared to the beginning of the time series. Given the dome shaped exploitation pattern in recent years, it seemed appropriate to increase the q-plateau setting from age 5 to age 7. In addition, increasing the q-plateau improved the retrospective pattern for SSB in the earlier years, but less so for fishing mortality (Figure 12.6.15).

12.7.1.4 Final assessment run

The model settings for the final assessment are summarized below. Settings are very similar to last year's run, except for the q-plateau which was increased from age 5 to age 7. Log catchability residuals for the final run are given in Figure 12.6.16. The XSA diagnostics, and the estimates of the population numbers and fishing mortality are given in Tables 12.6.2-4. The summary table is given in Table 12.6.5.

Assmnt Year	: 2004	: 2006	: 2007
Assmnt Model	: XSA	: XSA	: XSA
Fleets	:	:	:
Bel Beam Trawl	: 1975–2003 4-9	: **omitted**	: omitted
UK Trawl	: 1991–2003 2-9	: **omitted**	: omitted
UK Sept BTS	: 1988–2003 2-9	: 1988–2005 2-7	: 1988-2006 2-7
UK Mar BTS	: 1993–1999 2-9	: 1993–1999 2-7	: 1993-1999 2-7
Time Series Wts	: tricubic 20yrs	: **linear 20 yrs**	: linear 20 yrs
Power Model	: none	: none	: none
Q plateau	: 5	: 5	: **7**
Shk se	: 0.8	: **1.5**	: 1.5
Shk age-yr	: 5 yrs 5 ages	: 5 yrs 3 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3	: 0.3
Prior Wting	: none	: none	: none
Plusgroup	: 10	: **8**	: 8
Fbar	: 4-7	: 4-7	: 4-7

The UK (E+W) September beam trawl survey gets high weights (>90%) in the terminal survivor and F estimates. The March survey was discontinued in 1999, and therefore does not contribute to the estimates in the final year.

The highest difference of the survivor and F estimates between the survey and F shrinkage can be found in the 2001 and 2000 year classes. The survey, with high scaled weights has higher abundance estimates for the 2001 year class and lower abundance estimates for the 2000 year class, and vice versa for the F estimates. As a consequence the estimate of fishing mortality is low at age 5 in 2006 and high at age 6 in 2006.

The retrospective analysis is presented in Figure 12.6.15. A retrospective pattern is apparent in both SSB and fishing mortality, although in most recent years the retrospective pattern has improved. Recruitment levels appear to be consistently estimated throughout the retrospective period.

12.7.1.5 Comparison with last years assessment

A comparison of the estimates of this year's assessment with last year's is given in Figure 12.6.17. Recruitment trends are very similar, but SSB and fishing mortality estimates diverge from 1987 onwards. This is mainly due to changes in the model settings, i.e. the q plateau was increased from age 5 to age 7. The estimate of F in 2005 is revised upwards (from 0.39 to 0.50), while the estimate of SSB in 2005 was revised downwards (3021 t compared to 2123 t).

12.7.2 Estimating recruitment year class abundance

The estimates up to the 2003 year class were taken from XSA.

The 2004 year class (age 2 in 2006) was estimated using RCT3 (input and output in Tables 12.6.6–7). Both RCT3 and XSA estimate a weak 2004 year class, but the RCT3 estimate was preferred over the XSA estimate since one extra data point was used, i.e. the index at age 1 in 2005 from UK(E+W) September beam trawl survey. The 2004 year class at age 3 in 2007, was calculated from the value of this year class at age 2 decreased with mortality.

The 2005 year class (age 2 in 2007) was estimated using RCT3 (input and output in Tables 12.6.6–7). The information from the UK (E+W) September beam trawl survey indicates a below average year class. Given that previously, this survey was able to track year class strength rather well, the RCT3 estimate was used for the prediction.

The different estimates are summarized below. The values in bold were selected for further predictions.

Yearclass	: 2004	: 2005
XSA	: 1 886	: -
RCT3	: **2 541**	: **3 439**
$GM_{70\text{-}04}$	: 5 771	: 5 771

12.7.3 Long-term trends in biomass, fishing mortality and recruitment

Estimated trends of Irish Sea sole landings, SSB, fishing mortality and recruitment are presented in Figure 12.6.18. Landings of Irish Sea sole have been declining since the late eighties and reached a record low of 570 t in 2006. SSB has been at a lower level since the early nineties compared to the period before. Since 2001 SSB has been decreasing and reached the lowest observed estimate in 2006. High fishing mortalities were observed over the period 1987–97. Thereafter fishing mortality has come down, but remains F_{lim}. Since 2001 recruitment has been well below average.

12.7.4 Short-term catch predictions

The input to the short term catch predictions is given in Table 12.6.8. Weights at age averaged over the last two years were used as input for the predictions. The estimated weights at age in 2004 were not included since these were higher compared to other years (see also section 12.4.1). Given that there is no retrospective pattern for fishing mortality in most recent years, and given that there is no consistent down- or upward trend in fishing mortality in recent years, fishing mortality at age averaged over the last three years, not rescaled, was used for input into the predictions. XSA estimates up to year class 2003 were used for the starting population. For the year classes 2004 and 2005 the RCT3 estimates were used. GM over the full period (1970–2004) was assumed for the recruiting ages from 2008 onwards.

The short term catch option table is given in Table 12.6.9, a detailed management option table is presented in Table 12.6.10. A short term forecast plot is shown in Figure 12.6.19. Assuming F_{sq}, landings in 2007 are estimated to be around 660 t, compared to a TAC of 816 t.

The relative contributions of the different year classes to the landings and SSB are presented in Table 12.6.11. Around 16% of the predicted landings in 2008, assuming F_{sq} are dependent on GM recruitment. The estimated SSB in 2009 is around 50% dependent on the assumption of GM recruitment.

12.7.5 Medium-term predictions

Medium-term predictions using the MLA software are available in the ICES stock files (Since the MLA software cannot cope with recruitment at age 2, new sen and sum files were constructed labelling the 2 year olds as 1 year olds, the 3 as 2, etc. These files are also available in ICES stock files).

Given the status of the stock, a more extensive evaluation of HCRs is required to evaluate appropriate management plans for this stock. It was not possible to carry out these simulations during the scope of the working group.

12.7.6 Yield and biomass per recruit

Weights at age were the average over the last 10 years, fishing mortality the average over the last three years. The yield and biomass per recruit results are given in Table 12.6.12 and Figure 12.6.19. Current fishing mortality (0.41) is well above $F_{0.1}$ (0.18). F_{max} is estimated at 0.51, but is not well defined given the flat yield per recruit curve.

12.7.7 Reference points

Biological reference points are:

$\mathbf{B}_{lim}$=2800t Basis: $\mathbf{B}_{lim}$=$\mathbf{B}_{loss}$ The lowest observed spawning stock in an earlier assessment.

$\mathbf{B}_{pa}$=3800t Basis: $\mathbf{B}_{pa} \sim \mathbf{B}_{lim} * 1.4$

$\mathbf{F}_{lim}$=0.4 Basis: $\mathbf{F}_{lim}$=$\mathbf{F}_{loss}$ Although poorly defined, based that there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above-average recruitment.

$\mathbf{F}_{pa}$=0.3 Basis: $\mathbf{F}_{pa}$ be set at 0.30. This F is considered to have a high probability of avoiding

$\mathbf{F}_{lim}$

The change in model settings changed the absolute estimates of SSB and F since 1987. However this did not have an impact on the reference points, if the basis for setting these, still is believed to be valid. The lowest observed spawning stock biomass that is followed by an increase in SSB is estimated at 2800 t (1996). F_{loss} is still estimated to be 0.4 (result from PASoft in Stock files).

12.7.8 Quality of the assessment

Landings

There is no reliable information on the accuracy of the landing statistics.

Previous years there have been problems with the input data for some years. This year the data for 2001, 2002, 2004 and 2005 have slightly been revised. No major anomalies were found for these years except for the weights at age in 2004. These weights at age remain higher compared to other years due to a low male/female sex ratio in that year (see also Section 12.4.1).

Effort

There are no indications of Irish Sea sole fisheries misreporting effort.

Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from 2003, 2004 and 2005 indicates that discarding ranges by weight vary between 0 and 8%. In 2006 high discard rates were estimated for the UK beam trawl fleet, but this estimate was heavily influenced by one observation made in the fourth quarter.

Surveys

The UK (E&W) September beam trawl survey appears to track year class strength well. It was also quite consistent in estimating year class strength of the same year class at different ages. Therefore the Working Group had confidence in using the UK (E&W) September survey. The UK (E+W) March beam trawl survey was discontinued in 1999.

Model Formulation

At the moment XSA is used to assess Irish Sea sole. Changing the model settings (increasing the q plateau from age 5 to age 7) did have an impact on the estimates of SSB and fishing mortality. The absolute estimates of SSB were rescaled downwards since 1987. Considerable changes were also noticed in fishing mortality, especially over the period 1987–1997. No changes in absolute estimates of recruitment were apparent.

12.7.9 Management considerations

SSB in 2006 is estimated to be lowest observed value, and well below B_{lim}. Recruitment at age 2 has been well below average since 2001, and is estimated to remain low in 2006 and 2007. Although fishing mortality has probably come down in 2006 (as did effort for most fleets fishing on Irish Sea sole), F remains well above F_{pa} and above F_{lim}.

Even with no fishing for sole in 2008, the stock cannot be rebuilt above B_{pa} in 2009.

A change in exploitation pattern is observed. Relative F increased at younger ages and decreased at the older ages.

Given the successive recent low recruitment predictions become more dependent on the assumption of GM recruitment. The predicted SSB in 2009 relies almost for 50% on that assumption.

Given the status of the stock, a more extensive evaluation of HCRs is required to evaluate appropriate management plans for this stock.

Table 12.2.1 - Irish Sea Sole. Nominal landings (tonnes) as officially reported by ICES, and working group estimates of the landings.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	930	987	915	1010	786	371	531	495	706	675	533	570	525	469	493	674	817	687	527	662	419
France	17	5	11	5	2	3	11	8	7	5	5	3	3	1	3	4	4	4	1	3	0
Ireland	235	312	366	155	170	198	164	98	226	176	133	130	134	120	135	135	96	103	77	85	83
Netherlands	-	-	-	-	-	-	-	-	-	-	149	123	60	46	60	-	-	-	-	-	-
UK (Engl.& Wales)[1]	637	599	507	613	569	581	477	338	409	424	194	189	161	165	133	195	165	217	106	103	69.4
UK (Isle of Man)	1	3	1	2	10	44	14	4	5	12	4	5	3	1	1	+	+	+	+	+	+
UK (N. Ireland)[1]	50	72	47																		
UK (Scotland)	46	63	38	38	39	26	37	28	14	8	5	7	9	8	8	4	3	3	1	1	n/a
Total	1,916	2,041	1,885	1,823	1,576	1,223	1,234	971	1,367	1,300	1,023	1,027	895	810	833	1,012	1,085	1,014	712	854	572
Unallocated	79	767	114	10	7	-11	25	52	7	-34	-21	-24	16	54	-15	41	2	0	-13	1	-3
Total used by Working Group in Assessment	1,995	2,808	1,999	1,833	1,583	1,212	1,259	1,023	1,374	1,266	1,002	1,003	911	863	818	1,053	1,087	1,014	699	855	569

* Preliminary

[1] 1989 onwards: N. Ireland included with England & Wales

Table 12.3.1 - Sole in VIIa. Effort and CPUE series.

	CPUE							Effort				
	Belgium[1]	UK(E+W)[3]		UK[5]		Ireland		Belgium[2]	UK(E+W)[4]		Ireland[6]	
	beam	beam	otter	beam survey		otter	beam	beam	beam	otter	otter	beam
Year	Whole year	Whole year	Whole year	Sept	March	Whole year	Whole year	Whole year	Whole year	Whole year	Whole Year	Whole Year
1972	-	-	1.06	-	-	-	-	-	-	128.4	-	-
1973	-	-	1.06	-	-	-	-	-	-	147.6	-	-
1974	-	-	1.09	-	-	-	-	-	-	115.2	-	-
1975	21.4	-	1.39	-	-	-	-	28.4	-	130.7	-	-
1976	23.1	-	0.94	-	-	-	-	24.9	-	122.3	-	-
1977	19.8	-	0.80	-	-	-	-	22.1	-	101.9	-	-
1978	18.1	34.32	1.04	-	-	-	-	17.5	0.9	89.1	-	-
1979	33.4	32.01	1.43	-	-	-	-	20.4	1.7	89.9	-	-
1980	28.2	31.70	1.01	-	-	-	-	32.0	4.3	107.0	-	-
1981	22.2	21.32	0.75	-	-	-	-	36.5	6.4	107.1	-	-
1982	22.0	29.94	0.53	-	-	-	-	26.5	5.5	127.2	-	-
1983	13.9	37.31	0.57	-	-	-	-	28.7	2.8	88.1	-	-
1984	22.5	16.24	0.71	-	-	-	-	17.5	4.1	103.1	-	-
1985	20.6	17.34	0.56	-	-	-	-	27.0	7.4	102.9	-	-
1986	19.1	19.23	0.84	-	-	-	-	44.5	17.0	90.3	-	-
1987	17.7	14.82	0.77	-	-	-	-	51.6	22.0	130.6	-	-
1988	21.3	11.81	0.46	158.7	-	-	-	38.2	18.6	132.0	-	-
1989	21.9	9.17	0.70	145.9	-	-	-	42.2	25.3	139.5	-	-
1990	17.5	9.52	0.61	190.1	-	-	-	42.4	31.0	117.1	-	-
1991	18.7	10.43	1.12	170.5	-	-	-	17.1	25.8	107.3	-	-
1992	19.2	9.50	1.02	158.3	-	-	-	25.1	23.4	96.8	-	-
1993	20.0	7.60	0.54	97.3	104.7	-	-	23.9	21.5	78.9	-	-
1994	19.1	11.76	0.74	107.7	91.9		-	32.5	20.1	43.0	-	-
1995	18.1	14.96	0.95	89.5	79.3	0.38	12.69	28.6	20.9	43.1	80.3	8.64
1996	17.7	9.44	0.53	86.8	-	0.25	14.94	23.2	13.3	42.2	64.8	6.26
1997	16.6	10.49	0.73	151.2	63.3	0.23	8.53	30.7	10.8	39.9	92.2	9.86
1998	19.0	8.42	0.48	140.8	89.3	0.38	7.77	24.7	10.4	36.9	93.5	11.58
1999	19.5	9.94	0.60	107.3	-	0.29	9.22	22.7	11.0	22.9	110.3	14.67
2000	15.5	12.90	0.44	122.6	-	0.29	8.49	26.0	6.3	27.0	82.7	11.42
2001	15.0	11.72	0.15	96.9	-	0.38	7.86	36.8	12.5	32.8	77.5	13.13
2002	15.0	16.73	1.48	76.0	-	0.32	4.67	47.0	8.0	24.8	77.9	17.67
2003	14.8	13.20	0.15	89.0	-	0.34	4.20	43.6	14.0	23.9	73.9	18.70
2004	15.4	13.86	0.17	99.0	-	0.14	4.31	32.0	7.4	23.5	72.5	14.19
2005	16.7	9.14	0.19	49.0	-	0.16	4.70	37.5	11.4	16.7	68.3	14.67
2006*	15.7	7.83	0.52	43.0	-	0.17	6.15	24.6	4.6	5.2	64.9	11.90

All CPUE values in Kg/hr except UK beam survey (Kg/100 km)

[1]Kg/000'hr

[2]000' hours fishing

[3]Kg/000'hr fished (GRT corrected > 40' vessels)

[4]000'hours fished (GRT corrected > 40' vessels)

[5]Kg/100km fished

[6] 000'hours

* Provisional

Table 12.3.2 - Sole in VIIa. Available tuning series.

IRISH SEA SOLE.2007 WG.VPA TUNING DATA
104
BELGIUM BEAM TRAWL EFFORT 107A (HRS*aBHP**b).
1975 2005
1 1 0 1
4 14
12.3 1045 275 393 69 105 94 61 72 11 15 64
11.8 568 1066 80 263 64 58 35 5 56 5 5
10.7 434 307 509 76 93 45 23 20 2 35 32
9.9 169 304 155 258 41 90 12 29 12 7 17
11.2 1455 510 323 193 162 37 36 9 41 0 0
16.7 958 1644 296 268 247 210 30 64 31 14 7
22.6 909 721 998 62 92 44 161 13 92 10 8
19.5 451 608 378 394 52 64 11 29 24 5 0
20.5 259 310 394 238 216 44 38 28 49 3 26
12.0 107 204 143 188 91 121 2 1 4 14 0
19.6 606 171 186 99 150 125 83 27 13 4 23
38.0 1531 468 138 135 90 104 69 69 20 8 21
43.2 1527 881 297 167 69 39 54 59 40 13 9
30.5 2027 1012 480 21 33 37 34 42 35 0 7
34.0 376 2423 751 250 59 15 9 2 14 0 1
36.1 307 223 1263 276 142 13 9 11 11 8 5
13.8 253 78 60 588 115 40 16 1 1 11 3
23.9 298 330 68 40 203 93 36 12 0 0 0
24.5 862 253 149 89 79 160 66 77 0 0 0
31.0 680 786 164 103 39 117 58 19 15 0 7
26.2 729 366 410 52 27 6 28 15 6 11 3
21.6 537 334 241 219 53 13 11 14 9 7 2
28.5 270 376 180 162 134 28 27 15 9 8 1
23.3 248 146 142 89 73 62 20 20 9 10 3
21.7 693 199 65 50 37 21 17 9 6 4 6
18.6 685 220 107 31 15 33 13 7 9 0.6 8
30.5 600 284 248 39 35 44 33 1 3 0.2 4
38.6 1138 814 349 109 30 9 2 1 1 1 0
24.45 724 436 196 84 20 7 2 1 0 2 1
25.58 313 197 159 47 12 11 6 3 0 0 0
32.15 505 342 156 71 87 9 7 1 13 2 1
E-W September beam trawl survey (Effort=Km towed)
1988 2006
1 1 0.75 0.85
1 9
100.062 118 196 180 410 76 40 4 0 4
129.710 218 304 180 74 284 56 32 8 6
128.969 1712 534 122 42 88 194 40 20 6
123.780 148 1286 122 26 16 14 55 19 7
129.525 220 309 657 142 34 22 7 75 17
131.192 83 330 143 211 40 17 7 16 36
124.892 60 408 203 73 132 49 11 13 6
124.336 249 148 243 106 29 65 12 6 4
127.486 851 119 30 85 44 25 29 7 2
132.860 1158 593 75 23 57 27 16 30 8
129.339 538 706 291 18 6 23 23 5 18
125.263 285 247 242 194 28 8 26 5 6
123.225 265 454 158 210 114 35 13 2 14

127.301 83 241 200 91 90 70 32 4 8
120.260 183 64 105 107 57 59 54 28 0
119.889 204 191 47 90 76 36 38 26 1
113.960 340 207 108 25 68 41 36 14 17
119.704 50 144 65 23 12 31 24 5 7
123.743 108 111 91 46 37 10 17 14 11
E+W March beam trawl survey (Effort= Km towed)
1993 1999
1 1 0.15 0.25
1 9
126.931 18 337 147 332 73 15 17 10 41
115.442 8 354 208 69 151 51 14 11 9
126.189 24 96 186 140 30 104 27 10 8
134.343 651 114 49 110 78 32 54 10 12
121.742 130 417 33 17 69 23 11 46 17
130.081 47 421 330 39 19 48 27 12 37
130.822 45 227 284 177 14 4 34 12 7

Table 12.3.2 - Sole VIIa. Continued

UK(E+W) BEAM TRAWL (Using unsexed data)
1991 2006
1 1 0 1
2 14
25.838 267 426 212 84 58 218 53 34 4 1 2 1 0
23.399 36 460 176 68 37 32 121 34 38 3 1 0 0
21.503 11 74 355 98 36 48 25 34 13 22 5 2 4
20.145 24 228 150 234 87 17 25 19 42 10 17 1 0
20.392 47 239 231 130 199 55 11 22 5 34 10 11 3
13.320 0 13 109 98 49 100 37 9 8 6 14 8 3
10.760 0 111 50 81 58 24 46 34 12 12 0 8 1
10.386 43 219 40 28 49 31 12 22 11 9 2 1 0
11.016 53 115 134 12 15 25 10 9 14 9 0 1 2
6.275 16 90 84 82 9 6 10 5 5 7 2 1 1
12.495 33 184 100 145 107 12 4 17 12 10 6 4 2
8.017 4 63 152 50 79 47 5 4 6 3 1 1 1
13.996 28 63 178 149 78 52 72 7 5 8 3 7 14
7.396 54 61 29 43 25 12 10 5 1 1 4 0 1
11.406 10 81 44 16 45 37 17 10 17 3 0 3 3
4.649 7 28 33 11 5 10 12 7 9 5 2 0 1
IR-OTB : Irish Otter trawl - Effort in hours - VIIa Sole numbers at age – Year

1995	2005									
1	1	0	1							
2	10									
70682	6.8	17.7	25.5	9.2	25.8	3.6	0.8	1.5	1.9	1995
58166	0.0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0.0	1996
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1.0	0.2	1997
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1.0	1998

93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2	1999
64320	1.6	13.2	13.4	11.0	3.4	1.1	1.0	0.4	0.0	2000
77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3	2001
39996	20.3	20.0	30.2	16.4	8.2	2.9	2.4	1.4	0.5	2002
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2	2003
72507	9.0	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1	2004

##
#####

31142	4.0	1.7	1.6	1.6	0.6	0.1	0.0	0.0	0.0	2005

##
#####

Please note the 2005 data is based only on Q3 and Q4 data and has not been raised to annual effort. It should not be included as part of this time series.

IRGFS : Irish Groundfish Survey (Celtic Explorer) - VIIa Sole numbers at age - Year

2003	2004									
1	1	0.89	0.91							
0	10									
1	12	8 2003	18	12	7	5	2	2	3	0
1	00	24 2004	20	13	8	7	6	5	5	0

Table 12.4.1 - Sole in VIIa. Landings numbers at age

	year														
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	29	113	31	368	25	262	29	221	65	108	187	70	8	37	651
3	895	434	673	363	891	733	375	416	958	1027	939	580	346	165	786
4	1009	2097	730	2195	576	2386	1332	1292	649	3433	1968	1668	1241	998	380
5	467	1130	1537	557	1713	539	2330	774	1009	829	3055	1480	1298	758	610
6	1457	232	537	815	383	842	247	1066	442	637	521	1640	711	757	343
7	289	878	172	267	422	157	544	150	638	326	512	114	641	416	424
8	228	141	522	112	232	227	134	218	98	285	361	184	91	334	178
9	803	106	97	329	58	158	151	89	204	65	352	86	113	69	251
10	265	327	46	74	226	91	80	64	29	76	45	258	23	74	23
11	729	376	279	104	44	139	16	46	69	20	107	22	81	35	30
12	91	265	142	150	55	24	98	7	33	65	53	130	46	83	19
13	74	298	152	135	103	24	28	63	16	6	26	26	10	23	36
14	14	54	98	87	110	110	9	49	48	1	14	22	2	36	3
15	333	320	164	152	143	233	223	112	90	102	187	137	31	55	17

	year														
age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	154	141	189	32	179	564	1317	363	83	122	132	60	789	167	301
3	1601	3336	3348	444	771	1185	1270	2433	543	1342	920	469	713	1728	1069
4	1086	3467	4105	4752	775	986	841	918	1966	1069	1444	1188	474	466	1258
5	343	961	3185	2102	3978	598	300	556	559	1578	737	741	710	256	297
6	334	235	844	1310	1178	2319	226	190	251	394	1010	430	408	315	115
7	164	277	307	203	552	592	1173	156	199	133	179	509	258	191	136
8	259	210	224	83	121	333	255	523	147	98	62	142	295	126	82
9	188	187	139	76	23	38	125	217	257	141	48	49	85	150	37
10	127	125	153	45	28	17	27	156	114	171	61	28	58	51	45
11	45	157	87	93	8	18	4	23	93	37	80	37	34	45	22
12	22	27	87	70	41	13	6	3	19	55	32	35	13	18	10
13	6	46	17	62	4	11	14	1	12	4	40	23	26	17	5
14	37	22	17	7	8	5	5	0	10	8	9	14	5	6	8
15	55	74	84	80	22	31	23	6	34	10	18	19	15	10	23

	year						
age	2000	2001	2002	2003	2004	2005	2006
2	88	267	88	329	146	518	115
3	1013	1259	442	1082	946	1066	630
4	1180	909	1329	1042	352	617	554
5	556	604	1122	704	332	408	233
6	190	471	551	308	292	257	126
7	66	68	194	155	91	167	142
8	53	59	51	118	29	143	94
9	63	80	13	20	21	28	70
10	26	52	24	9	5	32	38
11	25	14	20	10	6	5	14
12	16	10	4	4	4	20	8
13	3	5	4	10	5	7	4
14	13	8	1	16	2	5	3
15	25	10	2	14	6	8	19

attr(,"units")
[1] "thousands"

Table 12.4.2 - Sole in VIIa. Landing weights at age

year

age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.13	0.152	0.126	0.151	0.138	0.13	0.12	0.085	0.093	0.134	0.146	0.162
3	0.153	0.178	0.164	0.178	0.174	0.172	0.161	0.146	0.147	0.165	0.169	0.183
4	0.178	0.204	0.201	0.204	0.209	0.21	0.2	0.202	0.197	0.199	0.193	0.207
5	0.204	0.23	0.237	0.23	0.241	0.244	0.239	0.251	0.243	0.234	0.219	0.234
6	0.232	0.257	0.272	0.256	0.272	0.275	0.276	0.293	0.286	0.271	0.247	0.264
7	0.26	0.284	0.306	0.283	0.301	0.303	0.313	0.33	0.326	0.311	0.275	0.296
8	0.29	0.312	0.338	0.309	0.328	0.327	0.348	0.36	0.361	0.352	0.305	0.331
9	0.321	0.34	0.369	0.335	0.353	0.347	0.383	0.384	0.394	0.395	0.337	0.369
10	0.353	0.369	0.4	0.361	0.377	0.364	0.416	0.401	0.422	0.441	0.37	0.41
11	0.387	0.398	0.428	0.387	0.399	0.378	0.449	0.413	0.447	0.488	0.404	0.454
12	0.422	0.427	0.456	0.413	0.419	0.387	0.48	0.418	0.468	0.537	0.439	0.5
13	0.458	0.457	0.483	0.439	0.437	0.394	0.511	0.417	0.486	0.589	0.476	0.55
14	0.495	0.487	0.508	0.464	0.453	0.396	0.541	0.409	0.5	0.642	0.515	0.602
15	0.533	0.517	0.533	0.49	0.468	0.396	0.569	0.395	0.511	0.697	0.555	0.657

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.112	0.189	0.191	0.144	0.122	0.135	0.111	0.125	0.135	0.133	0.149	0.102
3	0.171	0.212	0.225	0.189	0.164	0.164	0.147	0.163	0.162	0.172	0.177	0.156
4	0.225	0.238	0.257	0.231	0.203	0.196	0.183	0.201	0.192	0.208	0.207	0.205
5	0.275	0.266	0.288	0.272	0.241	0.231	0.218	0.237	0.227	0.241	0.239	0.248
6	0.321	0.298	0.318	0.31	0.277	0.268	0.252	0.271	0.265	0.272	0.274	0.285
7	0.362	0.332	0.347	0.346	0.311	0.308	0.286	0.304	0.307	0.3	0.31	0.318
8	0.399	0.369	0.374	0.38	0.344	0.35	0.319	0.336	0.354	0.326	0.349	0.345
9	0.432	0.41	0.4	0.412	0.375	0.395	0.352	0.366	0.404	0.349	0.39	0.366
10	0.461	0.453	0.425	0.441	0.404	0.442	0.384	0.395	0.458	0.369	0.433	0.382
11	0.485	0.499	0.449	0.469	0.432	0.492	0.415	0.422	0.516	0.386	0.478	0.392
12	0.505	0.548	0.472	0.494	0.458	0.545	0.446	0.448	0.578	0.401	0.525	0.397
13	0.52	0.599	0.493	0.517	0.482	0.6	0.476	0.473	0.644	0.413	0.574	0.397
14	0.531	0.654	0.513	0.538	0.505	0.658	0.505	0.496	0.714	0.423	0.625	0.391
15	0.538	0.712	0.532	0.557	0.525	0.719	0.534	0.517	0.788	0.43	0.679	0.38

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.175	0.129	0.156	0.154	0.187	0.179	0.143	0.184	0.163	0.143	0.188	0.203
3	0.198	0.182	0.193	0.197	0.209	0.217	0.19	0.231	0.212	0.206	0.257	0.231
4	0.227	0.232	0.228	0.237	0.234	0.252	0.235	0.273	0.257	0.262	0.318	0.258
5	0.261	0.277	0.263	0.275	0.263	0.285	0.276	0.308	0.298	0.31	0.372	0.284
6	0.301	0.318	0.296	0.311	0.295	0.314	0.315	0.338	0.334	0.352	0.418	0.308
7	0.346	0.356	0.327	0.345	0.331	0.341	0.351	0.362	0.367	0.386	0.456	0.331
8	0.397	0.389	0.358	0.376	0.369	0.365	0.384	0.381	0.395	0.413	0.487	0.352
9	0.453	0.419	0.387	0.406	0.411	0.387	0.415	0.393	0.419	0.433	0.51	0.372
10	0.515	0.444	0.414	0.433	0.457	0.406	0.442	0.4	0.439	0.445	0.525	0.39
11	0.582	0.466	0.44	0.458	0.506	0.422	0.467	0.401	0.454	0.451	0.533	0.407
12	0.654	0.484	0.465	0.481	0.558	0.436	0.489	0.401	0.466	0.449	0.533	0.423
13	0.732	0.497	0.488	0.501	0.614	0.446	0.508	0.401	0.473	0.44	0.526	0.437
14	0.816	0.507	0.51	0.519	0.672	0.454	0.525	0.401	0.476	0.424	0.511	0.45
15	0.905	0.513	0.531	0.536	0.735	0.46	0.538	0.401	0.475	0.4	0.489	0.462

year

age	2006
2	0.209
3	0.234
4	0.259
5	0.284
6	0.309
7	0.334
8	0.359
9	0.384
10	0.41
11	0.435
12	0.46
13	0.485
14	0.511
15	0.536

attr(,"units")
[1] kg

Table 12.4.3 - Sole in VIIa. Stock weights at age

age \ year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.118	0.139	0.106	0.138	0.119	0.108	0.1	0.052	0.065	0.119	0.135	0.152
3	0.141	0.165	0.145	0.164	0.156	0.151	0.141	0.116	0.12	0.149	0.157	0.172
4	0.166	0.191	0.183	0.191	0.192	0.191	0.181	0.175	0.172	0.182	0.181	0.195
5	0.191	0.217	0.219	0.217	0.225	0.228	0.22	0.227	0.22	0.216	0.206	0.22
6	0.218	0.244	0.255	0.243	0.257	0.26	0.258	0.273	0.265	0.252	0.233	0.249
7	0.246	0.271	0.289	0.27	0.287	0.29	0.295	0.312	0.306	0.291	0.261	0.28
8	0.275	0.298	0.322	0.296	0.315	0.315	0.331	0.346	0.344	0.331	0.29	0.313
9	0.305	0.326	0.354	0.322	0.341	0.338	0.366	0.373	0.378	0.373	0.321	0.35
10	0.337	0.354	0.385	0.348	0.365	0.356	0.4	0.393	0.408	0.418	0.353	0.39
11	0.37	0.383	0.414	0.374	0.388	0.371	0.433	0.408	0.435	0.464	0.386	0.432
12	0.404	0.412	0.443	0.4	0.409	0.383	0.465	0.416	0.458	0.512	0.421	0.477
13	0.439	0.442	0.47	0.426	0.428	0.391	0.496	0.418	0.478	0.563	0.458	0.525
14	0.476	0.472	0.496	0.451	0.445	0.396	0.526	0.414	0.494	0.615	0.495	0.575
15	0.514	0.502	0.521	0.477	0.461	0.397	0.555	0.403	0.506	0.669	0.534	0.629

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	0.081	0.179	0.174	0.121	0.101	0.121	0.093	0.105	0.123	0.113	0.135	0.073
3	0.142	0.2	0.208	0.167	0.143	0.149	0.129	0.144	0.148	0.153	0.162	0.13
4	0.198	0.224	0.241	0.21	0.183	0.18	0.165	0.182	0.176	0.19	0.192	0.181
5	0.251	0.252	0.273	0.252	0.222	0.213	0.2	0.219	0.209	0.225	0.223	0.227
6	0.299	0.282	0.303	0.291	0.259	0.249	0.235	0.254	0.245	0.257	0.256	0.267
7	0.342	0.315	0.332	0.328	0.294	0.287	0.269	0.288	0.286	0.286	0.292	0.302
8	0.381	0.35	0.36	0.363	0.328	0.328	0.302	0.32	0.33	0.313	0.33	0.332
9	0.416	0.389	0.387	0.396	0.36	0.372	0.335	0.351	0.378	0.337	0.369	0.356
10	0.447	0.431	0.413	0.427	0.39	0.418	0.368	0.381	0.431	0.359	0.411	0.375
11	0.473	0.475	0.437	0.455	0.418	0.467	0.399	0.409	0.487	0.378	0.455	0.388
12	0.495	0.523	0.46	0.482	0.445	0.518	0.43	0.436	0.547	0.394	0.501	0.396
13	0.513	0.573	0.482	0.506	0.47	0.572	0.461	0.461	0.611	0.408	0.549	0.398
14	0.526	0.626	0.503	0.528	0.493	0.629	0.491	0.484	0.679	0.418	0.599	0.395
15	0.535	0.683	0.523	0.548	0.515	0.688	0.52	0.507	0.751	0.427	0.652	0.386

age \ year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	0.165	0.101	0.136	0.132	0.177	0.159	0.119	0.158	0.137	0.109	0.151	0.189
3	0.186	0.156	0.174	0.176	0.198	0.199	0.167	0.208	0.188	0.175	0.224	0.218
4	0.212	0.207	0.211	0.217	0.221	0.235	0.213	0.253	0.235	0.235	0.289	0.245
5	0.243	0.255	0.246	0.257	0.248	0.269	0.256	0.291	0.278	0.287	0.346	0.271
6	0.28	0.298	0.279	0.294	0.279	0.3	0.296	0.324	0.317	0.332	0.396	0.296
7	0.323	0.338	0.312	0.328	0.312	0.328	0.334	0.351	0.351	0.37	0.438	0.32
8	0.371	0.373	0.343	0.361	0.349	0.354	0.368	0.372	0.382	0.4	0.472	0.342
9	0.424	0.405	0.372	0.391	0.39	0.377	0.4	0.388	0.408	0.424	0.499	0.362
10	0.483	0.432	0.4	0.42	0.434	0.397	0.429	0.397	0.43	0.44	0.518	0.381
11	0.548	0.456	0.427	0.446	0.481	0.414	0.455	0.401	0.447	0.449	0.53	0.399
12	0.617	0.475	0.453	0.469	0.531	0.429	0.479	0.399	0.461	0.451	0.534	0.416
13	0.693	0.491	0.477	0.491	0.585	0.441	0.499	0.391	0.47	0.445	0.531	0.431
14	0.774	0.503	0.5	0.511	0.643	0.451	0.517	0.378	0.475	0.433	0.52	0.444
15	0.86	0.511	0.521	0.528	0.703	0.458	0.532	0.358	0.476	0.431	0.501	0.456

age \ year	2006
2	0.196
3	0.221
4	0.246
5	0.271
6	0.296
7	0.321
8	0.347
9	0.372
10	0.397
11	0.422
12	0.447
13	0.473
14	0.498
15	0.523

attr(,"units")
[1] kg

Table 12.4.4 - Sole in VIIa. Annual lenght distributions by fleet (2006)

	UK (England & Wales)		Belgium	Ireland
Length (cm)	Beam trawl	All but beam	All gears	All gears
20				
21		283		83
22	125	444	19340	83
23	7353	1151	70822	248
24	15168	4362	170004	578
25	17495	6022	198153	909
26	16385	5789	188742	2230
27	19757	5051	184970	6016
28	17353	4975	143216	12809
29	16708	4693	119523	24968
30	11965	3515	96903	18927
31	9393	2653	81138	10686
32	7283	2274	86799	12059
33	7579	1353	56033	7186
34	5652	1323	50712	8603
35	3565	825	39447	5711
36	3249	1168	31383	8901
37	2589	928	30748	8787
38	2133	415	18926	8101
39	1918	684	15092	11569
40	1080	287	12265	6462
41	777	331	8312	9231
42	1078	367	6184	4435
43	357	135	4721	2923
44	119	0	1838	1226
45	264	0	2013	2643
46	90	47	641	578
47	85		137	2643
48	23		127	330
49			137	909
50			137	0
51				165
52				0
53				165
54				0
55				0
56				165
57				165
58				83
59				165
60				
Total	169543	49075	1638462	179832

* Lower limit

Table 12.6.1 - Sole in VIIa. Separable analysis

Title : II 2007 WG COMBSEX PLUSGROUP.

At 10/05/2007 19:15

Separable analysis
from 1970 to 2006 on ages 2 to 14
with Terminal F of .500 on age 4 and Terminal S of .800

Initial sum of squared residuals was 456.947 and
final sum of squared residuals is 205.073 after 113 iterations

Matrix of Residuals

Years	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76
2/ 3	-1.262	-0.484	-0.949	0.477	-1.898	0.931
3/ 4	-0.805	-0.619	-1.066	-0.505	-0.91	-0.72
4/ 5	-0.231	0.048	0.223	0.038	-0.028	-0.269
5/ 6	0.352	0.25	0.359	-0.068	0.385	0.253
6/ 7	-0.036	-0.393	0.229	0.021	0.374	-0.285
7/ 8	0.531	0.188	0.314	-0.137	0.46	-0.201
8/ 9	0.093	-0.449	-0.139	-0.107	-0.258	-0.44
9/10	0.71	0.499	0.153	0.099	-0.606	0.326
10/11	-0.71	-0.35	-1.104	0.072	0.161	1.212
11/12	0.828	0.642	0.508	0.366	0.458	0.002
12/13	-1.095	0.502	0.212	0.38	0.953	-0.227
13/14	0.068	0.718	0.382	-0.132	-0.282	0.564
TOT	0.004	0.004	0.004	0.004	0.004	0.004
WTS	0.001	0.001	0.001	0.001	0.001	0.001

Years	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
2/ 3	-1.357	-0.033	-1.361	-0.386	0	-0.431	-1.47	-1.846	0.511	-1.298
3/ 4	-1.332	-0.408	-1.277	-0.29	-0.892	-1.013	-0.909	-1.041	-0.315	-0.415
4/ 5	0.283	0.121	-0.41	0.3	-0.223	-0.175	0.474	0.113	-0.055	0.299
5/ 6	0.29	0.205	0.064	0.417	-0.133	0.07	0.289	0.177	0.213	0.324
6/ 7	-0.19	-0.038	-0.287	-0.009	0.577	0.081	0.096	-0.231	0.155	-0.046
7/ 8	0.585	0.231	0.573	0.023	0.456	-0.266	0.568	0.404	0.268	-0.127
8/ 9	-0.41	-0.616	-0.31	-0.552	0.382	-0.495	-0.287	-0.65	-0.766	-0.018
9/10	0.527	0.923	0.753	0.512	-0.229	0.834	0.346	0.659	0.457	0.552
10/11	0.05	-0.445	-0.035	-0.363	0.006	0.502	-0.666	0.292	-1.067	-0.233
11/12	0.5	0.138	-0.17	-0.818	-0.72	-1.215	-0.094	0.179	0.091	0.667
12/13	0.392	-0.745	1.751	1.335	0.456	2.364	0.894	0.679	1.209	-0.32
13/14	-0.95	0.016	2.479	-0.768	-0.444	2.017	-1.42	1.535	-0.311	-1.222
TOT	0.004	0.004	0.004	0.004	0.003	0.004	0.003	0.003	0.003	0.003
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Years	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
2/ 3	-1.46	0.216	-2.044	-0.475	0.19	0.615	1.074	-1.355	-0.68	0.09
3/ 4	0.009	-0.835	-0.929	-0.324	-0.153	0.104	0.249	-0.711	-0.21	-0.382
4/ 5	0.08	-0.063	-0.418	-0.036	0.479	0.003	0.343	-0.014	0.028	0.329
5/ 6	-0.121	-0.121	-0.28	-0.009	-0.001	-0.199	0.402	-0.13	-0.149	-0.052
6/ 7	-0.672	0.253	-0.166	-0.026	-0.472	-0.47	-0.62	-0.019	0.021	-0.076
7/ 8	0.173	0.541	-0.123	0.168	0.081	0.339	-0.149	0.424	0.371	-0.153
8/ 9	-0.064	-0.152	0.172	0.363	-0.264	-0.788	0.03	-0.71	-0.146	-0.613
9/10	0.238	0.458	0.428	0.032	-0.364	-0.661	0.465	0.167	0.498	0.213
10/11	0.245	-0.334	0.992	0.01	0.574	-0.448	0.173	0.72	0.255	0.011
11/12	0.657	-0.416	0.276	-0.729	0.417	-0.137	0.028	0.304	-0.173	0.525
12/13	0.769	-0.046	2.575	1.322	-0.492	1.635	-1.287	1.596	0.258	0.284
13/14	0.946	0.118	1.389	-0.579	0	4.431	-2.552	0.089	-1.231	0.642
TOT	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002
WTS	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Years	1996/97	1997/98	1998/99	1999/**	2000/**	2001/**	2002/**	2003/**	2004/**	2005/**	TOT	WTS
2/ 3	-1.019	0.464	-0.818	0.106	-1.137	0.728	-1.22	-0.327	-0.13	0.985	0.018	0.307
3/ 4	-0.058	0.138	-0.164	-0.259	0.137	-0.357	-1.101	0.342	0.831	0.309	0.008	0.53
4/ 5	0.243	0.09	-0.258	0.448	0.477	-0.752	0.154	0.144	0.055	0.396	0	0.968
5/ 6	0.07	0.019	-0.176	-0.174	-0.278	-0.718	0.545	-0.39	0.222	0.33	-0.007	1
6/ 7	-0.176	-0.194	-0.309	-0.238	0.424	-0.083	0.362	-0.236	0.363	-0.417	-0.013	0.924
7/ 8	0.236	0.156	0.093	0.526	-0.119	-0.289	-0.019	0.624	-0.293	-0.042	-0.013	0.945
8/ 9	-0.247	-0.342	-0.003	-0.621	-1.092	0.477	-0.035	0.179	-0.25	-0.367	-0.005	0.767
9/10	-0.402	0.041	0.523	-0.01	0.034	0.717	-0.058	0.39	-0.21	-0.841	0.007	0.628
10/11	-0.586	-0.376	-0.005	0.061	0.302	0.308	0.291	-0.762	0.054	0.129	0.018	0.53

Table 12.6.2–Sole in VIIa. Diagnostics of final XSA run.

Lowestoft VPA Version 3.1
13/05/2007 17:53
Extended Survivors Analysis
IRISH SEA SOLE,2007 WG,COMBSEX,PLUSGROUP.
cpue data from file sol7atn.dat
Catch data for 37 years. 1970 to 2006. Ages 2 to 8.

Fleet,	First,	Last,	First,	Last,	Alpha,	Beta
	, year,	year,	age ,	age		
BELGIUM BEAM TRAWL E,	1975,	2006,	4,	7,	.000,	1.000
E-W September beam t,	1988,	2006,	1,	7,	.750,	.850
E+W March beam trawl,	1993,	2006,	1,	7,	.150,	.250
UK(E+W) BEAM TRAWL (,	1991,	2006,	2,	7,	.000,	1.000

Time series weights:

Tapered time weighting applied
Power = 1 over 20 years

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 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting applied :

Fleet	Weight
BELGIUM	.00
E-W Sept	1.00
E+W Marc	1.00
UK(E+W)	.00

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .01081

Final year F values

Age ,	2,	3,	4,	5,	6,	7
Iteration 29,	.0664,	.3121,	.4691,	.2972,	.5905,	.3520
Iteration 30,	.0663,	.3115,	.4677,	.2958,	.5870,	.3483

Regression weights

,	.550,	.600,	.650,	.700,	.750,	.800,	.850,	.900,	.950, 1.000

Fishing mortalities

Age,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006
2,	.107,	.028,	.055,	.016,	.076,	.033,	.103,	.048,	.182,	.066
3,	.330,	.320,	.225,	.237,	.293,	.156,	.616,	.424,	.501,	.311
4,	.531,	.333,	.362,	.368,	.309,	.505,	.578,	.366,	.478,	.468
5,	.518,	.541,	.326,	.240,	.290,	.681,	.486,	.322,	.833,	.296
6,	.537,	.405,	.441,	.318,	.293,	.415,	.351,	.338,	.393,	.587
7,	1.011,	.458,	.272,	.433,	.160,	.168,	.174,	.148,	.293,	.348

Table 12.6.2 – Sole in VIIa. Continued.

XSA population numbers (Thousands)

	AGE					
YEAR ,	2,	3,	4,	5,	6,	7,
1997 ,	8.15E+03,	2.66E+03,	1.21E+03,	1.85E+03,	1.03E+03,	4.26E+02,
1998 ,	6.34E+03,	6.63E+03,	1.73E+03,	6.44E+02,	9.94E+02,	5.46E+02,
1999 ,	5.89E+03,	5.57E+03,	4.35E+03,	1.12E+03,	3.39E+02,	6.00E+02,
2000 ,	5.86E+03,	5.04E+03,	4.03E+03,	2.74E+03,	7.34E+02,	1.97E+02,
2001 ,	3.84E+03,	5.22E+03,	3.60E+03,	2.52E+03,	1.95E+03,	4.84E+02,
2002 ,	2.83E+03,	3.22E+03,	3.52E+03,	2.39E+03,	1.71E+03,	1.32E+03,
2003 ,	3.53E+03,	2.47E+03,	2.50E+03,	1.92E+03,	1.09E+03,	1.02E+03,
2004 ,	3.30E+03,	2.88E+03,	1.21E+03,	1.27E+03,	1.07E+03,	6.97E+02,
2005 ,	3.28E+03,	2.84E+03,	1.71E+03,	7.59E+02,	8.31E+02,	6.91E+02,
2006 ,	1.89E+03,	2.47E+03,	1.56E+03,	9.57E+02,	2.98E+02,	5.08E+02,

Estimated population abundance at 1st Jan 2007

,	0.00E+00,	1.60E+03,	1.64E+03,	8.87E+02,	6.47E+02,	1.51E+02,

Taper weighted geometric mean of the VPA populations:

,	3.96E+03,	3.66E+03,	2.52E+03,	1.57E+03,	9.27E+02,	6.06E+02,

Standard error of the weighted Log(VPA populations) :

,	.4595,	.4301,	.5301,	.5757,	.6616,	.5666,

Log catchability residuals.

Fleet : BELGIUM BEAM TRAWL E

Age ,	1975,	1976
2 ,	No data for this fleet at this age	
3 ,	No data for this fleet at this age	
4 ,	99.99,	99.99
5 ,	99.99,	99.99
6 ,	99.99,	99.99

```
  7 , 99.99, 99.99


 Age  ,  1977,  1978,  1979,  1980,  1981,  1982,  1983,  1984,  1985,  1986
   2 , No data for this fleet at this age
   3 , No data for this fleet at this age
   4 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   5 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   6 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   7 , 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99


 Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996
   2 , No data for this fleet at this age
   3 , No data for this fleet at this age
   4 ,  -.70,  -.63,  -.41,  -.53,   .07,  -.55,  -.41,  -.08,   .04,   .01
   5 ,  -.69,  -.07,   .01,  -.31,  -.27,   .46,  -.19,  -.19,   .09,   .11
   6 ,   .11,   .05,   .38,   .14,   .21,  -.32,   .47,  -.13,   .13,   .72
   7 ,   .55,  -.70,   .46,   .44,  1.44,   .34,   .98,   .87,  -.17,   .76


 Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
   2 , No data for this fleet at this age
   3 , No data for this fleet at this age
   4 ,   .06,  -.27,  -.08,   .15,  -.40,   .12,   .50,   .25,   .20, 99.99
   5 ,  -.01,   .30,   .03,  -.65,  -.78,   .27,   .23,  -.27,   .80, 99.99
   6 ,  -.03,  -.08,   .30,   .12,  -.52,  -.22,   .07,  -.17,  -.14, 99.99
   7 ,  1.29,   .40,  -.28,   .58,  -.71,  -.92,  -.46,  -.72,  -.46, 99.99
```

Table 12.6.2 – Sole in VIIa. Continued.

```
 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time


   Age ,        4,         5,         6,         7
 Mean Log q,   -4.6150,   -4.6326,   -4.7699,   -5.0989,
 S.E(Log q),     .3067,     .4518,     .3026,     .7520,

 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

  4,    1.30,   -1.192,      3.64,     .68,     19,     .39,   -4.62,
  5,    1.68,   -1.673,      2.74,     .45,     19,     .69,   -4.63,
  6,    1.23,   -1.024,      4.27,     .73,     19,     .37,   -4.77,
  7,    1.60,    -.854,      4.30,     .21,     19,    1.22,   -5.10,
1
 Fleet : E-W September beam t

 Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996
```

2	99.99	.14	.13	.52	.63	.08	-.16	.27	.17	-.44
3	99.99	.72	.48	.00	-.16	.62	-.12	.09	.39	-.74
4	99.99	.17	.24	-.11	-.77	.62	.09	-.09	.20	.00
5	99.99	-.32	.05	1.06	-.59	.04	-.24	.14	-.48	-.19
6	99.99	-.31	-.28	.26	-.21	.05	-.13	.51	-.01	-.04
7	99.99	-.62	-.08	.10	-.27	-.21	-.32	.04	-.43	-.20

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	.20	.59	-.33	.26	.07	-.93	.00	.16	-.14	.02
3	-.23	.23	.18	-.12	.09	-.13	-.29	.28	-.20	.09
4	-.30	-1.04	.47	.65	-.15	.25	.48	-.20	-.58	.16
5	.07	-1.09	-.24	.22	.07	.04	.39	.61	-.25	.18
6	-.23	-.43	-.35	.27	-.06	.05	-.04	.15	.12	.13
7	.40	.10	.01	.58	.33	-.09	-.17	.18	-.15	-.17

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7
Mean Log q	-7.5425	-7.8837	-8.0455	-7.9375	-7.7973	-7.6832
S.E(Log q)	.3840	.3023	.4696	.4385	.2262	.2779

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	.74	1.340	7.73	.76	19	.27	-7.54
3	.70	2.093	7.98	.85	19	.18	-7.88
4	.69	1.669	7.98	.78	19	.30	-8.05
5	.79	1.035	7.82	.75	19	.35	-7.94
6	.99	.106	7.79	.90	19	.24	-7.80
7	1.28	-1.478	8.05	.76	19	.34	-7.68

Table 12.6.2 – Sole in VIIa. Continued.

Fleet : E+W March beam trawl

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	99.99	99.99	99.99	99.99	99.99	99.99	.10	.40	-.10	-.33
3	99.99	99.99	99.99	99.99	99.99	99.99	.06	.23	.18	-.28
4	99.99	99.99	99.99	99.99	99.99	99.99	.54	-.15	.32	.11
5	99.99	99.99	99.99	99.99	99.99	99.99	.48	.39	-.46	.36
6	99.99	99.99	99.99	99.99	99.99	99.99	-.18	.68	.46	.14
7	99.99	99.99	99.99	99.99	99.99	99.99	.12	.07	.14	.02

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	.08	.26	-.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	-.95	.38	.37	99.99	99.99	99.99	99.99	99.99	99.99	99.99

```
   4 ,  -.65,  -.28,   .31, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   5 ,   .37,   .07,  -.84, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   6 ,  -.23,   .45,  -.96, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99
   7 ,  -.44,   .03,   .12, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99, 99.99

 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

  Age ,        2,        3,        4,        5,        6,        7
 Mean Log q,   -7.8151,   -8.1589,   -8.2918,   -8.3376,   -8.2447,   -7.7950,
 S.E(Log q),    .3000,    .5457,    .4497,    .5771,    .6481,    .2318,

 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,    .79,    .597,     7.96,    .85,     7,    .28,   -7.82,
  3,    .55,   1.567,     8.23,    .89,     7,    .24,   -8.16,
  4,    .59,   4.542,     8.16,    .99,     7,    .09,   -8.29,
  5,    .74,    .507,     8.08,    .72,     7,    .51,   -8.34,
  6,    .56,   1.683,     7.58,    .91,     7,    .27,   -8.24,
  7,    .92,    .192,     7.68,    .81,     7,    .27,   -7.80,

Fleet : UK(E+W) BEAM TRAWL (

  Age  ,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996
   2 , 99.99, 99.99, 99.99, 99.99,   .48,  -.50, -1.87,  -.86,   .70, 99.99
   3 , 99.99, 99.99, 99.99, 99.99,   .51,  -.15, -1.05,  -.10,   .07, -1.45
   4 , 99.99, 99.99, 99.99, 99.99,   .14,  -.19,  -.30,  -.29,   .01,  -.24
   5 , 99.99, 99.99, 99.99, 99.99,   .03,  -.25,  -.15,  -.11,   .16,   .22
   6 , 99.99, 99.99, 99.99, 99.99,   .04,  -.41,  -.33,   .16,   .15,   .10
   7 , 99.99, 99.99, 99.99, 99.99,   .00,   .32,   .68,  -.32,   .32,   .64

  Age  ,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004,  2005,  2006
   2 , 99.99,   .19,   .43,  -.22,   .26, -1.11,   .09,  1.42,  -.63,   .41
   3 ,   .54,   .34,  -.24,   .19,   .20,  -.01,  -.09,   .28,   .18,   .06
   4 ,   .22,  -.42,  -.17,   .00,  -.43,   .55,   .52,  -.02,  -.33,   .36
   5 ,   .28,   .32, -1.24,   .31,   .30,  -.09,   .57,   .31,  -.37,  -.32
   6 ,   .31,   .15,   .00,  -.77,   .03,   .36,   .20,  -.28,   .15,  -.04
   7 ,   .53,   .34,  -.12,   .21,  -.81,   .00,  -.20,  -.66,   .11,   .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
 Mean Log q,   -7.4612,   -5.8828,   -5.4842,   -5.4887,   -5.2638,   -5.2819,
 S.E(Log q),    .8287,    .4655,    .3501,    .4614,    .3037,    .4322,

 Regression statistics :

 Ages with q independent of year class strength and constant w.r.t. time.

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q
```

2,	1.43,	-.442,	7.12,	.13,	14,	1.25,	-7.46,
3,	.80,	.660,	6.35,	.57,	16,	.38,	-5.88,
4,	1.11,	-.414,	5.22,	.62,	16,	.41,	-5.48,
5,	.75,	1.099,	5.94,	.72,	16,	.34,	-5.49,
6,	.86,	.931,	5.47,	.85,	16,	.26,	-5.26,
7,	1.10,	-.334,	5.17,	.59,	16,	.50,	-5.28,

Table 12.6.2 – Sole in VIIa. Continued.

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
BELGIUM BEAM TRAWL E,	1.,	.000,	.000,	.00,	0,	.000,	.000
E-W September beam t,	1637.,	.402,	.000,	.00,	1,	.929,	.065
E+W March beam trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK(E+W) BEAM TRAWL (,	1.,	.000,	.000,	.00,	0,	.000,	.000

F shrinkage mean , 1183., 1.50,,,, .071, .088

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1600.,	.39,	.09,	2,	.223,	.066

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
BELGIUM BEAM TRAWL E,	1.,	.000,	.000,	.00,	0,	.000,	.000
E-W September beam t,	1664.,	.252,	.110,	.44,	2,	.961,	.308
E+W March beam trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
UK(E+W) BEAM TRAWL (,	1.,	.000,	.000,	.00,	0,	.000,	.000

F shrinkage mean , 1222., 1.50,,,, .039, .399

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1644.,	.25,	.09,	3,	.352,	.311

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
BELGIUM BEAM TRAWL E,	1.,	.000,	.000,	.00,	0,	.000,	.000

E-W September beam t, 885., .235, .125, .53, 3, .949, .467
E+W March beam trawl, 1., .000, .000, .00, 0, .000, .000
UK(E+W) BEAM TRAWL (, 1., .000, .000, .00, 0, .000, .000

F shrinkage mean , 931., 1.50,,,, .051, .449

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
887., .24, .10, 4, .423, .468

Table 12.6.2 – Sole in VIIa. Continued.

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
BELGIUM BEAM TRAWL E, 1., .000, .000, .00, 0, .000, .000
E-W September beam t, 669., .228, .182, .80, 4, .955, .286
E+W March beam trawl, 1., .000, .000, .00, 0, .000, .000
UK(E+W) BEAM TRAWL (, 1., .000, .000, .00, 0, .000, .000

F shrinkage mean , 322., 1.50,,,, .045, .524

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
647., .23, .17, 5, .756, .296

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
BELGIUM BEAM TRAWL E, 1., .000, .000, .00, 0, .000, .000
E-W September beam t, 147., .217, .132, .61, 5, .953, .597
E+W March beam trawl, 1., .000, .000, .00, 0, .000, .000
UK(E+W) BEAM TRAWL (, 1., .000, .000, .00, 0, .000, .000

F shrinkage mean , 278., 1.50,,,, .047, .359

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
151., .22, .13, 6, .598, .587

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
BELGIUM BEAM TRAWL E, 1., .000, .000, .00, 0, .000, .000
E-W September beam t, 331., .175, .110, .63, 6, .975, .342
E+W March beam trawl, 1., .000, .000, .00, 0, .000, .000
UK(E+W) BEAM TRAWL (, 1., .000, .000, .00, 0, .000, .000

F shrinkage mean , 237., 1.50,,,, .025, .452

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
328., .17, .10, 7, .582, .348

Table 12.6.3 – Sole in VIIa. Fishing mortality at age.

Run title : IRISH SEA SOLE,2007 WG,COMBSEX,PLUSGROUP.

At 13/05/2007 17:54

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE							
2,	.0083,	.0117,	.0103,	.0299,	.0045,	.0421,	.0079,
3,	.1196,	.1480,	.0809,	.1436,	.0847,	.1575,	.0704,
4,	.2956,	.3988,	.3518,	.3621,	.3157,	.3032,	.4193,
5,	.4445,	.5545,	.5057,	.4394,	.4722,	.4844,	.4816,
6,	.4292,	.3671,	.4930,	.4873,	.5435,	.3972,	.3793,
7,	.3909,	.4416,	.4517,	.4310,	.4453,	.3962,	.4281,
+gp,	.3909,	.4416,	.4517,	.4310,	.4453,	.3962,	.4281,
FBAR 4- 7,	.3900,	.4405,	.4506,	.4300,	.4442,	.3952,	.4271,

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
2,	.0148,	.0076,	.0129,	.0395,	.0164,	.0034,	.0069,	.0454,	.0101,	.0064,
3,	.1350,	.0743,	.1426,	.1332,	.1485,	.0949,	.0808,	.1784,	.1349,	.2785,
4,	.3255,	.2866,	.3645,	.3925,	.3281,	.4756,	.3819,	.2412,	.3543,	.4242,
5,	.4072,	.4036,	.6322,	.5665,	.5099,	.4064,	.5295,	.3772,	.3176,	.5374,
6,	.3752,	.3816,	.4260,	.9480,	.6017,	.4356,	.3903,	.4294,	.3247,	.3328,
7,	.3704,	.3583,	.4759,	.6383,	.4816,	.4407,	.4354,	.3504,	.3332,	.4332,
+gp,	.3704,	.3583,	.4759,	.6383,	.4816,	.4407,	.4354,	.3504,	.3332,	.4332,
FBAR 4- 7,	.3696,	.3575,	.4747,	.6363,	.4803,	.4396,	.4343,	.3495,	.3324,	.4319,

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
2,	.0602,	.0097,	.0442,	.1143,	.1185,	.0827,	.0144,	.0249,	.0664,	.0212,
3,	.1829,	.1755,	.2988,	.4018,	.3585,	.2969,	.1538,	.3006,	.2360,	.3139,
4,	.5740,	.3782,	.4623,	.6777,	.4909,	.4223,	.3692,	.4488,	.5397,	.4777,
5,	.7688,	.5776,	.5538,	.6956,	.3945,	.6219,	.4364,	.5045,	.5649,	.5204,
6,	1.1735,	.7466,	.6620,	.6475,	.5443,	.4133,	.5626,	.5555,	.6239,	.6726,
7,	.8441,	.9004,	.7274,	.7368,	.7116,	.8025,	.8974,	.5839,	.4668,	.6587,
+gp,	.8441,	.9004,	.7274,	.7368,	.7116,	.8025,	.8974,	.5839,	.4668,	.6587,

FBAR 4- 7,	.8401,	.6507,	.6014,	.6894,	.5353,	.5650,	.5664,	.5232,	.5488,	.5824,

Table 8 Fishing mortality (F) at age

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	FBAR **-**
AGE											
2,	.1073,	.0281,	.0553,	.0159,	.0758,	.0333,	.1032,	.0477,	.1816,	.0663,	.0985,
3,	.3305,	.3204,	.2252,	.2374,	.2926,	.1557,	.6161,	.4236,	.5010,	.3115,	.4120,
4,	.5309,	.3325,	.3623,	.3683,	.3089,	.5051,	.5777,	.3656,	.4784,	.4677,	.4372,
5,	.5183,	.5414,	.3256,	.2399,	.2902,	.6807,	.4857,	.3221,	.8333,	.2958,	.4837,
6,	.5370,	.4050,	.4411,	.3175,	.2927,	.4147,	.3508,	.3378,	.3932,	.5870,	.4393,
7,	1.0110,	.4585,	.2721,	.4333,	.1600,	.1682,	.1741,	.1476,	.2930,	.3483,	.2630,
+gp,	1.0110,	.4585,	.2721,	.4333,	.1600,	.1682,	.1741,	.1476,	.2930,	.3483,	
FBAR 4- 7,	.6493,	.4343,	.3503,	.3398,	.2630,	.4422,	.3971,	.2932,	.4995,	.4247,	

Table 12.6.4 – Sole in VIIa. Stock numbers at age.

Run title : IRISH SEA SOLE,2007 WG,COMBSEX,PLUSGROUP.

At 13/05/2007 17:54

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE							
2,	3695,	10178,	3186,	13136,	5872,	6682,	3858,
3,	8349,	3316,	9102,	2853,	11536,	5289,	5797,
4,	4145,	6703,	2587,	7596,	2237,	9591,	4089,
5,	1368,	2791,	4071,	1647,	4785,	1476,	6408,
6,	4389,	794,	1450,	2221,	960,	2700,	823,
7,	939,	2586,	498,	802,	1235,	505,	1642,
+gp,	8212,	5534,	4321,	3418,	2829,	3221,	2222,
TOTAL,	31098,	31902,	25215,	31673,	29453,	29464,	24838,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										

2,	15778,	9046,	8862,	5081,	4512,	2477,	5627,	15422,	16107,	23415,
3,	3463,	14066,	8124,	7916,	4419,	4016,	2233,	5056,	13335,	14428,
4,	4888,	2738,	11816,	6374,	6269,	3447,	3305,	1864,	3827,	10543,
5,	2433,	3194,	1860,	7426,	3895,	4086,	1938,	2041,	1325,	2430,
6,	3582,	1465,	1930,	894,	3814,	2117,	2463,	1033,	1267,	873,
7,	509,	2227,	905,	1141,	314,	1891,	1239,	1508,	608,	828,
+gp,	2193,	2042,	1714,	2537,	2369,	1166,	2103,	1975,	2733,	2526,
TOTAL,	32847,	34779,	35211,	31368,	25592,	19199,	18908,	28898,	39202,	55042,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
2,	3403,	3501,	4349,	5490,	12388,	4808,	6092,	5214,	2161,	3007,
3,	21053,	2899,	3138,	3765,	4431,	9956,	4005,	5433,	4601,	1830,
4,	9882,	15864,	2201,	2106,	2279,	2801,	6694,	3108,	3640,	3288,
5,	6242,	5036,	9835,	1254,	967,	1262,	1662,	4187,	1795,	1920,
6,	1285,	2618,	2558,	5115,	566,	590,	613,	972,	2288,	923,
7,	566,	360,	1123,	1194,	2422,	297,	353,	316,	505,	1109,
+gp,	1479,	907,	515,	934,	942,	1758,	1208,	1239,	982,	752,
TOTAL,	43909,	31186,	23718,	19857,	23995,	21473,	20628,	20469,	15972,	12829,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	2006,	2007,	GMST 70-**	AMST 70-**
AGE													
2,	8152,	6335,	5885,	5858,	3843,	2826,	3528,	3296,	3280,	1886,	0,	5771,	6945,
3,	2663,	6626,	5573,	5039,	5217,	3223,	2473,	2880,	2844,	2475,	1600,	5188,	6232,
4,	1210,	1732,	4352,	4026,	3596,	3523,	2496,	1208,	1706,	1559,	1644,	3884,	4744,
5,	1845,	644,	1124,	2741,	2521,	2389,	1924,	1268,	759,	957,	887,	2381,	2908,
6,	1032,	994,	339,	734,	1951,	1706,	1094,	1071,	831,	298,	647,	1386,	1692,
7,	426,	546,	600,	197,	484,	1317,	1020,	697,	691,	508,	151,	768,	940,
+gp,	870,	1204,	1021,	667,	1690,	807,	1320,	597,	1024,	891,	897,		
TOTAL,	16199,	18081,	18894,	19263,	19301,	15792,	13855,	11017,	11134,	8573,	5826,		

Table 12.6.5–Sole in VIIa. Stock summary.

Run title : IRISH SEA SOLE,2007 WG,COMBSEX,PLUSGROUP.

At 13/05/2007 17:54

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 7,
1970,	3695,	6708,	6071,	1785,	.2940,	.3900,
1971,	10178,	6981,	5895,	1882,	.3193,	.4405,
1972,	3186,	5276,	4652,	1450,	.3117,	.4506,
1973,	13136,	6140,	4830,	1428,	.2957,	.4300,
1974,	5872,	5695,	4705,	1307,	.2778,	.4442,
1975,	6682,	5701,	4960,	1441,	.2905,	.3952,
1976,	3858,	5031,	4505,	1463,	.3248,	.4271,
1977,	15778,	4603,	3942,	1147,	.2910,	.3696,
1978,	9046,	5371,	4488,	1106,	.2464,	.3575,
1979,	8862,	6300,	5223,	1614,	.3090,	.4747,
1980,	5081,	6040,	5189,	1941,	.3741,	.6363,
1981,	4512,	5582,	4883,	1667,	.3414,	.4803,
1982,	2477,	4275,	3944,	1338,	.3392,	.4396,
1983,	5627,	4684,	3898,	1169,	.2999,	.4343,
1984,	15422,	6336,	4343,	1058,	.2436,	.3495,
1985,	16107,	7015,	5130,	1146,	.2234,	.3324,
1986,	23415,	8359,	6226,	1995,	.3205,	.4319,
1987,	3403,	7785,	6540,	2808,	.4293,	.8401,
1988,	3501,	5402,	4993,	1999,	.4004,	.6507,
1989,	4349,	4629,	4160,	1833,	.4407,	.6014,
1990,	5490,	3822,	3225,	1583,	.4908,	.6894,
1991,	12388,	3881,	2799,	1212,	.4330,	.5353,
1992,	4808,	3950,	3058,	1259,	.4118,	.5650,
1993,	6092,	3262,	2792,	1023,	.3665,	.5664,
1994,	5214,	4514,	3647,	1374,	.3767,	.5232,
1995,	2161,	3432,	3056,	1266,	.4142,	.5488,
1996,	3007,	2795,	2419,	1002,	.4142,	.5824,
1997,	8152,	3067,	2246,	1003,	.4465,	.6493,
1998,	6335,	3926,	2836,	911,	.3212,	.4343,
1999,	5885,	4067,	3128,	863,	.2759,	.3503,
2000,	5858,	3668,	2952,	818,	.2771,	.3398,
2001,	3843,	4789,	4056,	1053,	.2596,	.2630,
2002,	2826,	3822,	3368,	1090,	.3236,	.4422,
2003,	3528,	3244,	2851,	1014,	.3556,	.3971,
2004,	3296,	2957,	2442,	709,	.2904,	.2932,
2005,	3280,	2704,	2123,	855,	.4027,	.4995,
2006,	1886,	2155,	1750,	569,	.3251,	.4247,
Arith. Mean ,	6709,	4810,	3982,	1329,	.3394,	.4724,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 12.6.6 – Sole in VIIa. Input to RCT3

Irish Sea sole recruits - age 2

4	38	2			
1968	3695	-11	-11	-11	-11
1969	10178	-11	-11	-11	-11
1970	3186	-11	-11	-11	-11
1971	13136	-11	-11	-11	-11
1972	5872	-11	-11	-11	-11
1973	6682	-11	-11	-11	-11
1974	3858	-11	-11	-11	-11
1975	15778	-11	-11	-11	-11
1976	9046	-11	-11	-11	-11
1977	8862	-11	-11	-11	-11
1978	5081	-11	-11	-11	-11
1979	4512	-11	-11	-11	-11
1980	2477	-11	-11	-11	-11
1981	5627	-11	-11	-11	-11
1982	15422	-11	-11	-11	-11
1983	16107	-11	-11	-11	-11
1984	23415	-11	-11	-11	-11
1985	3403	-11	-11	-11	-11
1986	3501	-11	196	-11	-11
1987	4349	-11	234	-11	118
1988	5490	-11	414	-11	168
1989	12388	-11	1039	-11	1327
1990	4808	-11	239	-11	120
1991	6092	265	252	-11	170
1992	5214	307	327	14	63
1993	2161	76	119	7	48
1994	3007	85	93	19	200
1995	8152	343	446	485	668
1996	6335	324	546	107	872
1997	5885	174	197	36	416
1998	5858	-11	368	34	228
1999	3843	-11	189	-11	215
2000	2826	-11	53	-11	65
2001	3528	-11	159	-11	152
2002	3296	-11	182	-11	170
2003	-11	-11	120	-11	298
2004	-11	-11	91	-11	42
2005	-11	-11	-11	-11	77
M2					
S2					
M1					
S1					

Table 12.6.7 – Sole in VIIa. Output from RCT3

```
Analysis by RCT3 ver3.1 of data from file :

 s7rec.csv

 Irish Sea sole recruits - age 2,,,,,

 Data for    4 surveys over   38 years :  1968 - 2005

 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    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2004

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error          Pts  Value   Value    Error   Weights

 M2,,,,
 S2,,,,    .70   4.64    .23   .785     17   4.53    7.79     .267     .630
 M1,,,,
 S1,,,,    .60   5.28    .36   .611     16   3.76    7.54     .430     .242

                                   VPA Mean =    8.66     .591     .128


 Yearclass =   2005

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error          Pts  Value   Value    Error   Weights

 M2,,,,
 S2,,,,
 M1,,,,
 S1,,,,    .60   5.28    .36   .611     16   4.35    7.89     .409     .676

                                   VPA Mean =    8.66     .591     .324


 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio             VPA
         Prediction           Error   Error

 2004       2541      7.84     .21     .23    1.23
 2005       3439      8.14     .34     .36    1.13
```

Table 12.6.8 - Sole in VIIa. Input data to the short term predictions

MFDP version 1a
Run: SOL7a_STF_
Time and date: 15:24 16/05/2007
Fbar age range: 4-7

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	3439	0.1	0.38	0	0	0.193	0.099	0.206
3	2152	0.1	0.71	0	0	0.220	0.412	0.233
4	1644	0.1	0.97	0	0	0.246	0.437	0.259
5	887	0.1	0.98	0	0	0.271	0.484	0.284
6	647	0.1	1	0	0	0.296	0.439	0.309
7	151	0.1	1	0	0	0.321	0.263	0.333
8	897	0.1	1	0	0	0.375	0.263	0.386

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	5771	0.1	0.38	0	0	0.193	0.099	0.206
3	.	0.1	0.71	0	0	0.220	0.412	0.233
4	.	0.1	0.97	0	0	0.246	0.437	0.259
5	.	0.1	0.98	0	0	0.271	0.484	0.284
6	.	0.1	1	0	0	0.296	0.439	0.309
7	.	0.1	1	0	0	0.321	0.263	0.333
8	.	0.1	1	0	0	0.375	0.263	0.386

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	5771	0.1	0.38	0	0	0.193	0.099	0.206
3	.	0.1	0.71	0	0	0.220	0.412	0.233
4	.	0.1	0.97	0	0	0.246	0.437	0.259
5	.	0.1	0.98	0	0	0.271	0.484	0.284
6	.	0.1	1	0	0	0.296	0.439	0.309
7	.	0.1	1	0	0	0.321	0.263	0.333
8	.	0.1	1	0	0	0.375	0.263	0.386

Input units are thousands and kg - output in tonnes

Table 12.6.9 - Sole in VIIa. Catch option table

MFDP version 1a
Run: SOL7a_STF_
IRISH SEA SOLE
Time and date: 15:24 16/05/2007
Fbar age range: 4-7

2007				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
2355	1791	1.0000	0.4058	616

2008					**2009**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
2848	1965	0.0000	0.0000	0	3976	2930
.	1965	0.1000	0.0406	78	3898	2856
.	1965	0.2000	0.0812	154	3823	2785
.	1965	0.3000	0.1217	227	3750	2717
.	1965	0.4000	0.1623	298	3680	2651
.	1965	0.5000	0.2029	366	3613	2587
.	1965	0.6000	0.2435	431	3547	2526
.	1965	0.7000	0.2841	495	3485	2467
.	1965	0.8000	0.3247	556	3424	2410
.	1965	0.9000	0.3652	615	3365	2355
.	1965	1.0000	0.4058	672	3309	2302
.	1965	1.1000	0.4464	727	3254	2251
.	1965	1.2000	0.4870	780	3201	2202
.	1965	1.3000	0.5276	832	3150	2154
.	1965	1.4000	0.5681	882	3101	2109
.	1965	1.5000	0.6087	930	3053	2065
.	1965	1.6000	0.6493	977	3007	2022
.	1965	1.7000	0.6899	1022	2963	1981
.	1965	1.8000	0.7305	1065	2920	1941
.	1965	1.9000	0.7711	1108	2878	1903
.	1965	2.0000	0.8116	1148	2838	1866

Input units are thousands and kg - output in tonnes

Fpa	2263	0.7400	**0.30**	519	3460	2444

Bpa = 3800t
Blim = 2800t

Table 12.6.10 - Sole in VIIa. Detailed management option table.

MFDP version 1a
Run: SOL7a_STF_
Time and date: 15:24 16/05/2007
Fbar age range: 4-7

Year: 2007 F multiplier: 1 Fbar: 0.4058

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.099	307	63	3439	662	1307	252	1307	252
3	0.412	694	161	2152	472	1528	335	1528	335
4	0.437	556	144	1644	404	1595	391	1595	391
5	0.484	325	92	887	240	869	236	869	236
6	0.439	220	68	647	192	647	192	647	192
7	0.263	33	11	151	48	151	48	151	48
8	0.263	198	76	897	337	897	337	897	337
Total		2333	616	9817	2355	6994	1791	6994	1791

Year: 2008 F multiplier: 1 Fbar: 0.4058

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.099	516	106	5771	1111	2193	422	2193	422
3	0.412	909	211	2820	619	2002	439	2002	439
4	0.437	436	113	1290	317	1251	307	1251	307
5	0.484	352	100	961	260	941	255	941	255
6	0.439	168	52	495	146	495	146	495	146
7	0.263	83	28	377	121	377	121	377	121
8	0.263	161	62	729	274	729	274	729	274
Total		2625	672	12442	2848	7988	1965	7988	1965

Year: 2009 F multiplier: 1 Fbar: 0.4058

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.099	516	106	5771	1111	2193	422	2193	422
3	0.412	1526	355	4732	1039	3360	737	3360	737
4	0.437	572	148	1690	415	1639	402	1639	402
5	0.484	276	78	754	204	739	200	739	200
6	0.439	182	56	536	159	536	159	536	159
7	0.263	64	21	289	92	289	92	289	92
8	0.263	170	66	770	289	770	289	770	289
Total		3305	830	14540	3309	9524	2302	9524	2302

Table 12.6.11 - Sole in VIIa. Percentage contributions of yearclasses to yield and SSB for the years 2007-09.

Year:	2007						
Yearclass	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**Source**
2005	13.2	10.2	35.0	28.1	18.7	14.1	RCT3
2004	29.7	26.2	21.9	20.0	21.8	18.7	RCT3
2003	23.8	23.4	16.7	17.2	22.8	21.8	XSA
2002	13.9	15.0	9.0	10.2	12.4	13.2	XSA
2001	9.4	11.1	6.6	8.2	9.3	10.7	XSA
2000	1.4	1.8	1.5	2.0	2.2	2.7	XSA
1999	8.5	12.4	9.1	14.3	12.8	18.8	XSA
Year:	2008						
Yearclass	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**Source**
2006	19.7	15.8	46.4	39.0	27.5	21.5	GM
2005	34.6	31.4	22.7	21.7	25.1	22.4	RCT3
2004	16.6	16.8	10.4	11.1	15.7	15.6	RCT3
2003	13.4	14.9	7.7	9.1	11.8	13.0	XSA
2002	6.4	7.7	4.0	5.1	6.2	7.4	XSA
2001	3.2	4.2	3.0	4.2	4.7	6.2	XSA
2000	6.1	9.2	5.9	9.6	9.1	14.0	XSA
Year:	2009						
Yearclass	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**Source**
2007	15.6	12.8	39.7	33.6	23.0	18.3	GM
2006	46.2	42.8	32.5	31.4	35.3	32.0	GM
2005	17.3	17.8	11.6	12.5	17.2	17.5	RCT3
2004	8.3	9.4	5.2	6.2	7.8	8.7	RCT3
2003	5.5	6.7	3.7	4.8	5.6	6.9	XSA
2002	1.9	2.5	2.0	2.8	3.0	4.0	XSA
2001	5.1	8.0	5.3	8.7	8.1	12.6	XSA

Summary - yield (t)			
Source	**2007**	**2008**	**2009**
GM	-	15.8	55.5
RCT3	36.4	48.2	27.2
XSA	63.6	36.0	17.2
Summary - SSB (t)			
SSB	**2007**	**2008**	**2009**
GM	-	21.5	50.4
RCT3	32.8	38.0	26.2
XSA	67.2	40.5	23.5

Table 12.6.12 - Sole in VIIa. Yield and biomass per recruit

MFYPR version 2a
Run: SOLVIIa_YPR_
Time and date: 15:25 16/05/2007
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.5122	9.5866	3.3557	9.5866	3.3557
0.1000	0.0406	0.2342	0.0774	8.1685	2.5873	7.2519	2.4321	7.2519	2.4321
0.2000	0.0812	0.3823	0.1215	6.6908	2.0120	5.7791	1.8578	5.7791	1.8578
0.3000	0.1217	0.4830	0.1481	5.6871	1.6276	4.7801	1.4745	4.7801	1.4745
0.4000	0.1623	0.5550	0.1648	4.9695	1.3577	4.0671	1.2056	4.0671	1.2056
0.5000	0.2029	0.6087	0.1755	4.4363	1.1610	3.5382	1.0099	3.5382	1.0099
0.6000	0.2435	0.6498	0.1824	4.0278	1.0132	3.1340	0.8631	3.1340	0.8631
0.7000	0.2841	0.6822	0.1868	3.7069	0.8996	2.8172	0.7504	2.8172	0.7504
0.8000	0.3247	0.7082	0.1897	3.4497	0.8104	2.5639	0.6620	2.5639	0.6620
0.9000	0.3652	0.7295	0.1915	3.2396	0.7392	2.3577	0.5916	2.3577	0.5916
1.0000	0.4058	0.7473	0.1926	3.0654	0.6813	2.1872	0.5346	2.1872	0.5346
1.1000	0.4464	0.7622	0.1932	2.9190	0.6338	2.0443	0.4878	2.0443	0.4878
1.2000	0.4870	0.7749	0.1934	2.7944	0.5942	1.9232	0.4490	1.9232	0.4490
1.3000	0.5276	0.7859	0.1934	2.6871	0.5608	1.8193	0.4163	1.8193	0.4163
1.4000	0.5681	0.7955	0.1933	2.5939	0.5324	1.7294	0.3886	1.7294	0.3886
1.5000	0.6087	0.8040	0.1930	2.5122	0.5079	1.6508	0.3648	1.6508	0.3648
1.6000	0.6493	0.8114	0.1927	2.4399	0.4867	1.5817	0.3443	1.5817	0.3443
1.7000	0.6899	0.8181	0.1923	2.3755	0.4682	1.5203	0.3264	1.5203	0.3264
1.8000	0.7305	0.8242	0.1919	2.3178	0.4519	1.4655	0.3107	1.4655	0.3107
1.9000	0.7711	0.8296	0.1915	2.2657	0.4374	1.4163	0.2968	1.4163	0.2968
2.0000	0.8116	0.8346	0.1911	2.2184	0.4244	1.3718	0.2845	1.3718	0.2845

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.4058
FMax	1.2520	0.5081
F0.1	0.4547	0.1845
F35%SPR	0.414	0.168

Weights in kilograms

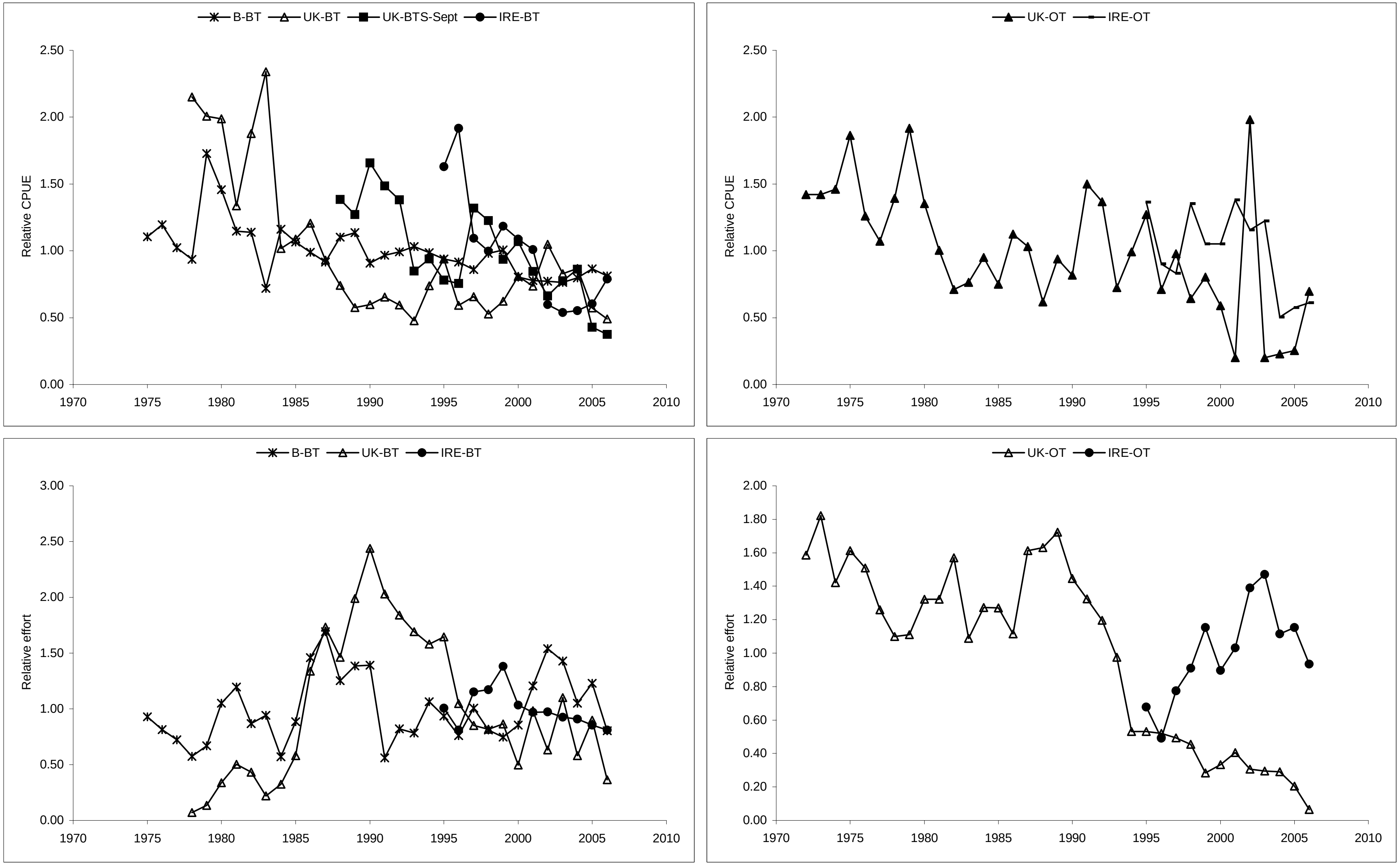
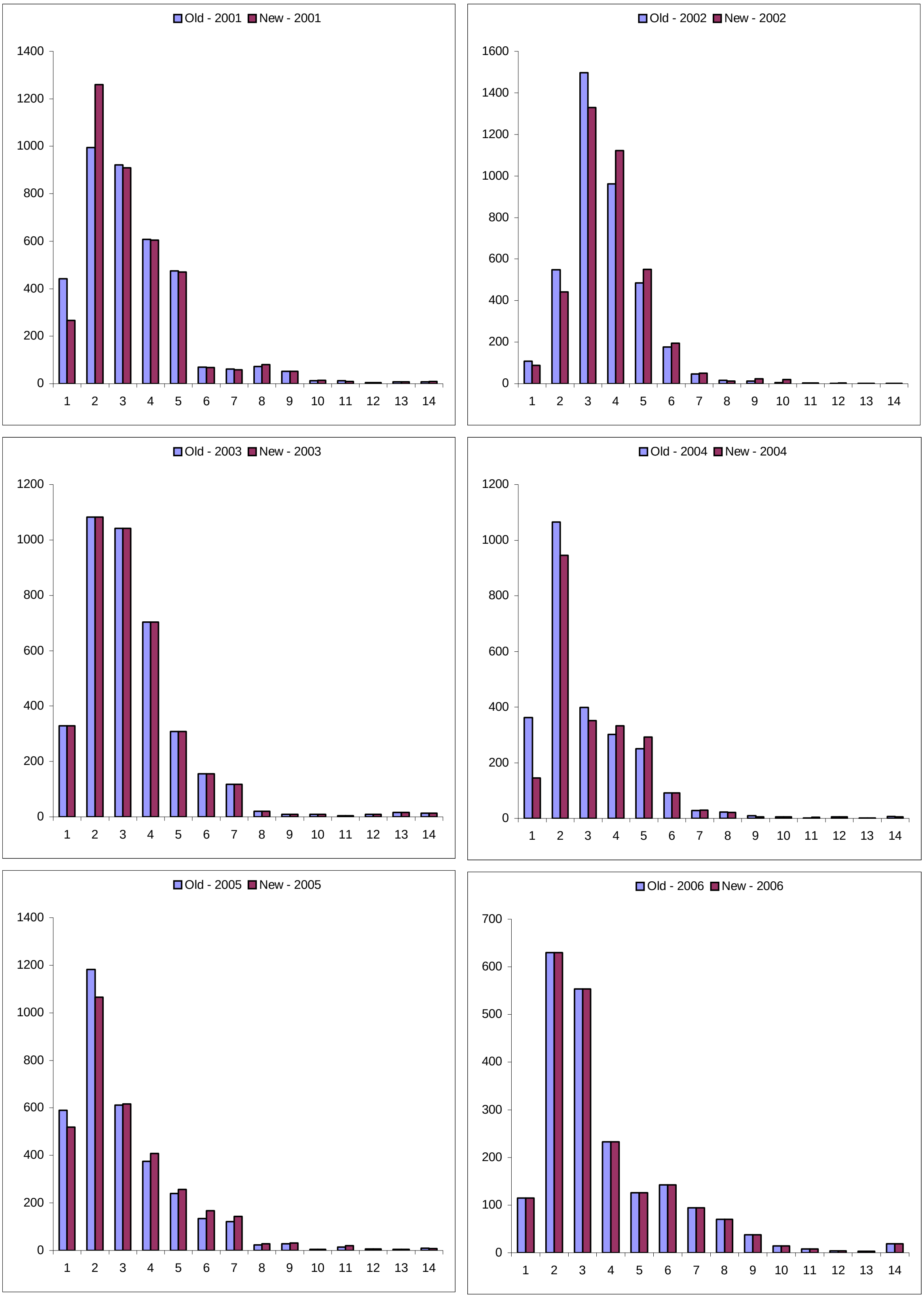


Figure 12.3.1 - Sole in VIIa. Relative CPUE and effort series for beam trawlers from Belgium (B-BT), the UK (UK-BT) and Ireland (IRE-BT); for otter trawlers from the UK (UK-OT) and Ireland (IRE-OT); and CPUE series for the UK(E+W) September beam trawl survey (UK-BTS-Sept)

Figure 12.4.1 - Sole in VIIa. Comparison of catch numbers at age before and after corrections were made to the data.



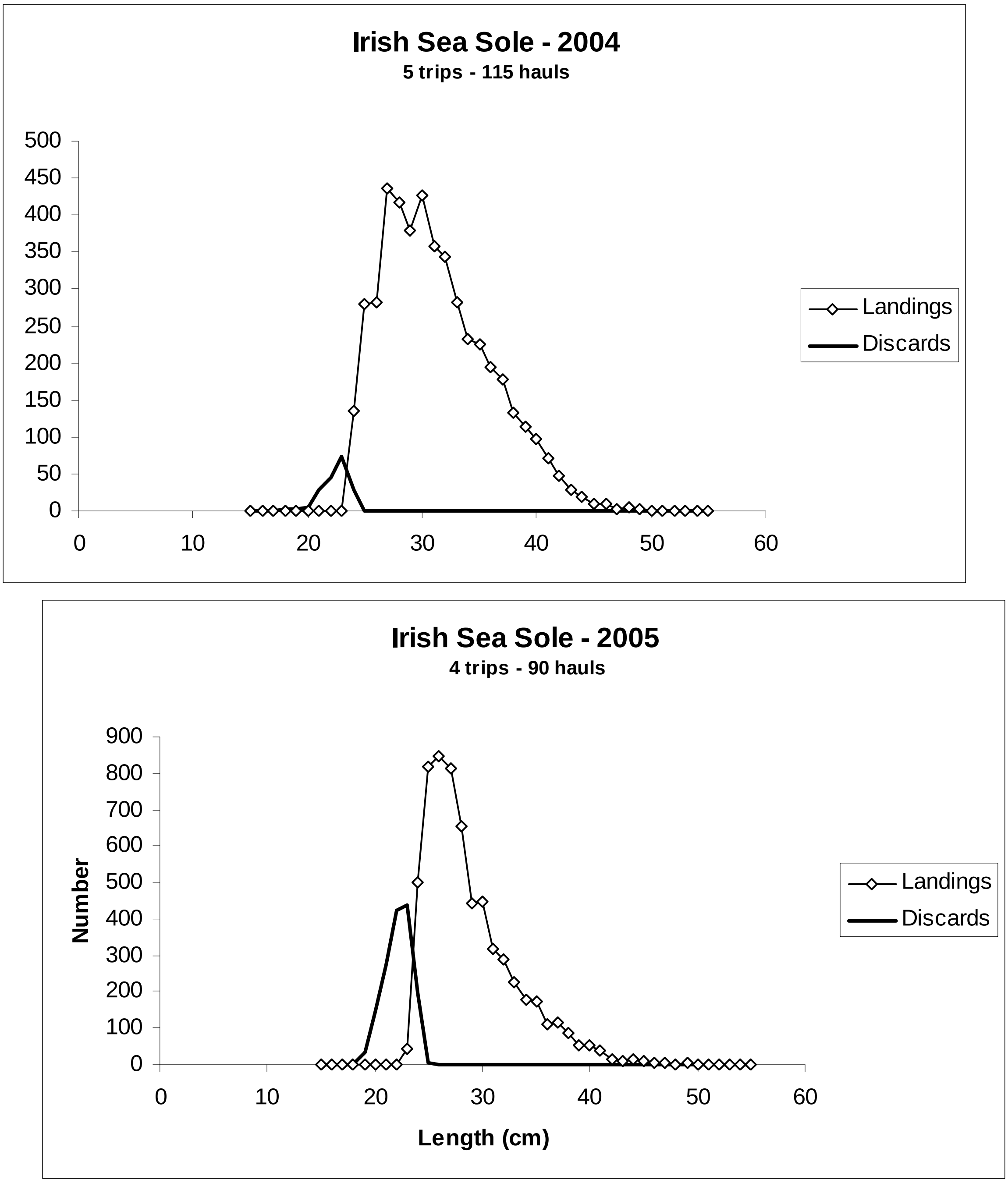
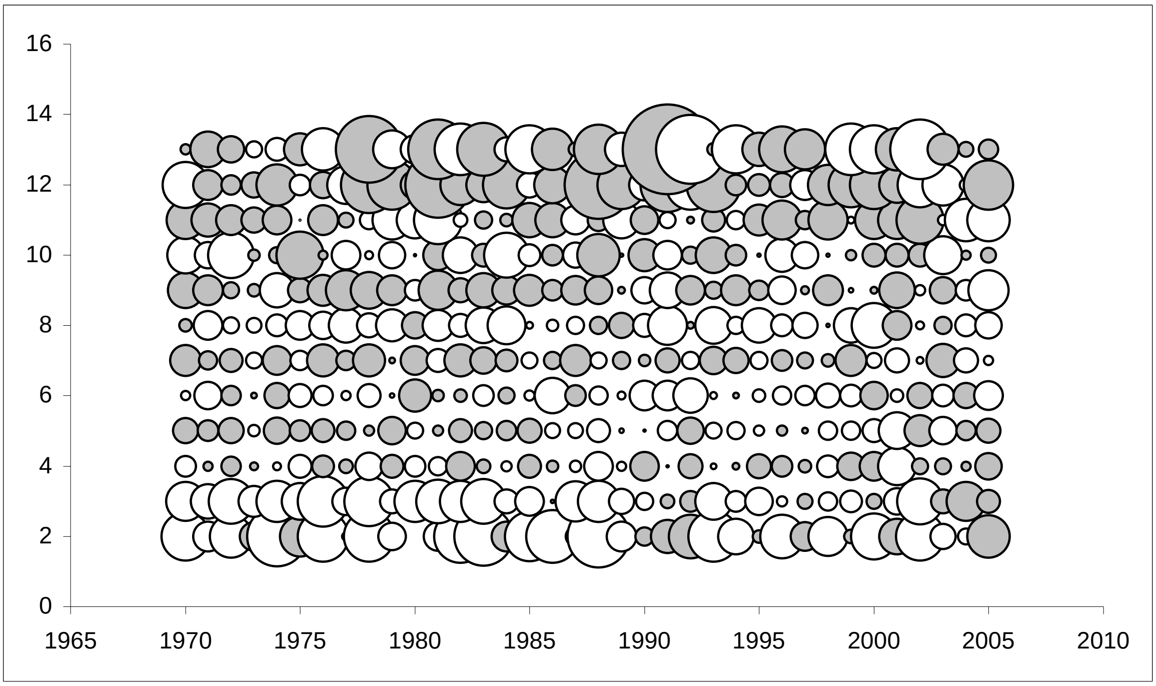


Figure 12.4.2–Sole in VIIa. Length distribution of retained and discarded sole in VIIa from 4 trips and 95 hauls from Belgian beam trawls in 2004 and 2005.

Figure 12.6.1 - Sole in VIIa. Separable analysis



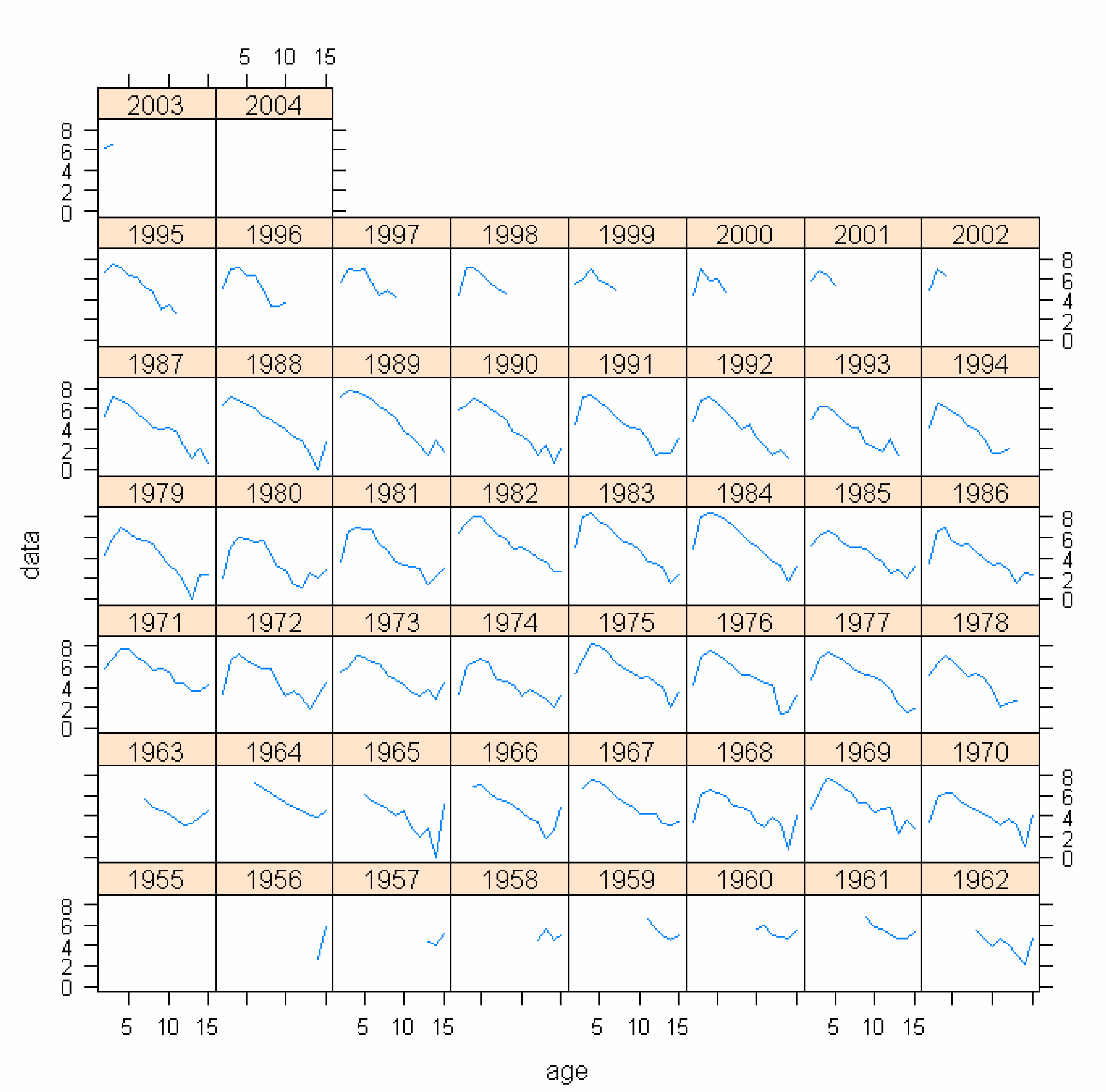


Figure 12.6.2 - Sole in VIIa. Catch curves.

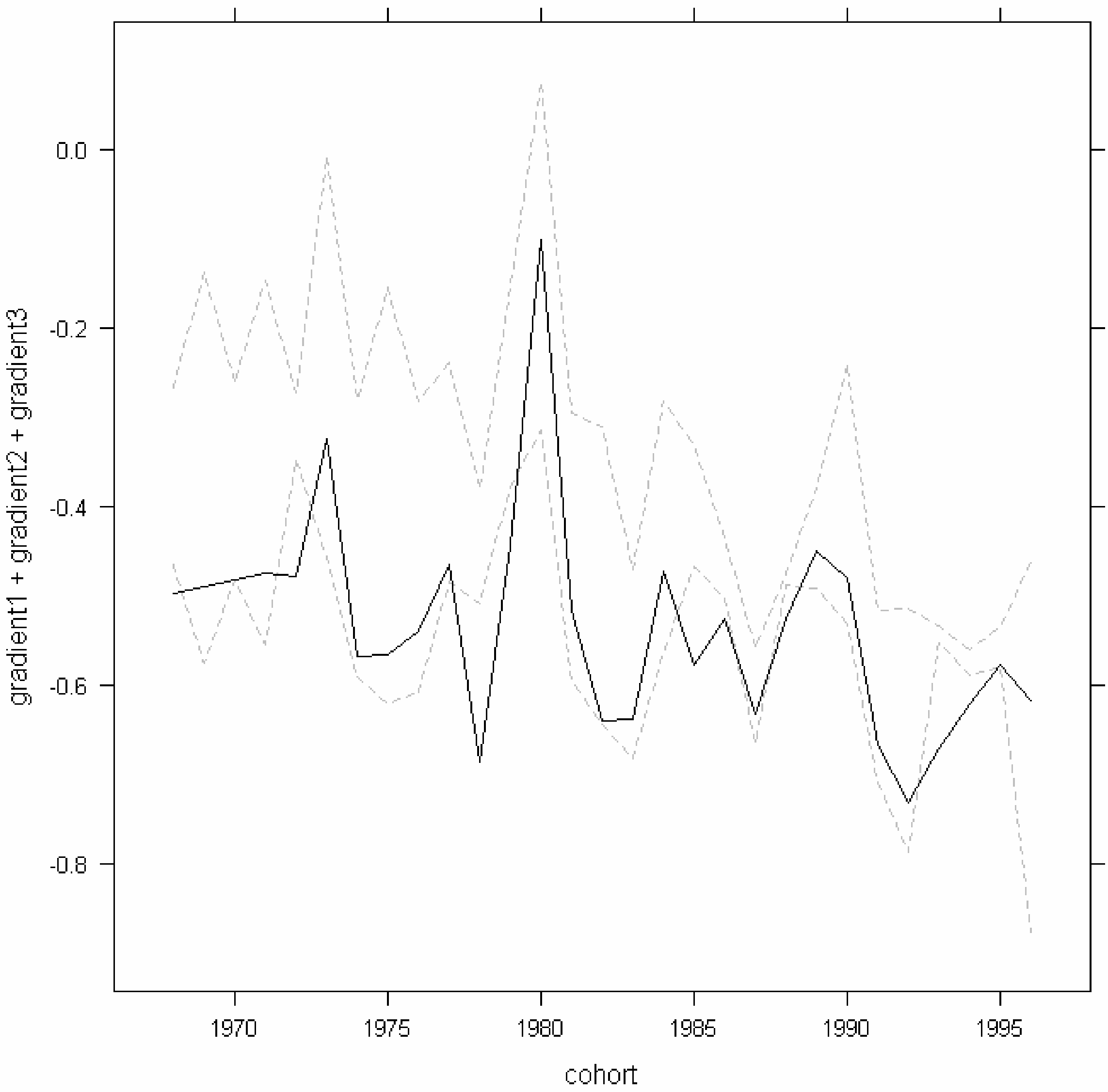


Figure 12.6.3 - Sole in VIIa. Catch curve gradients by cohort.

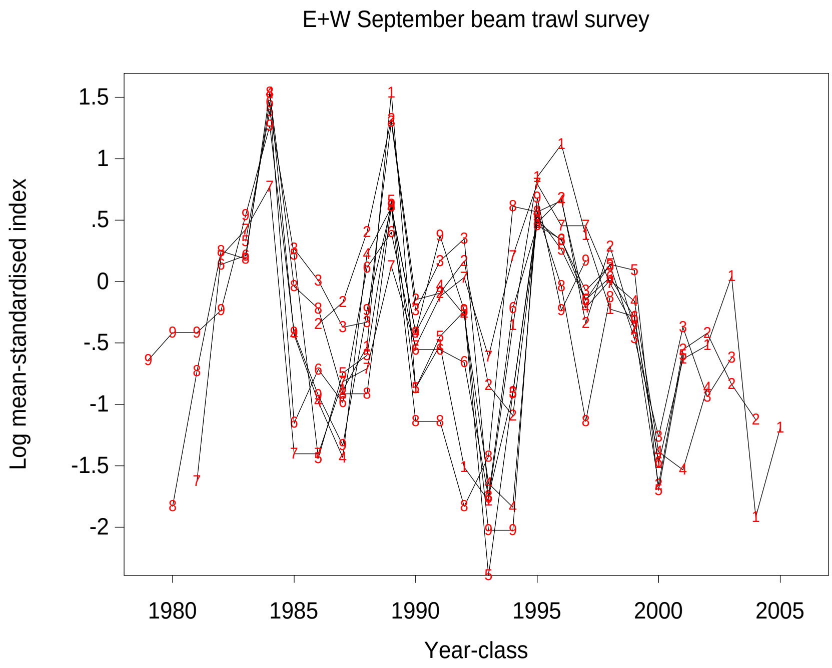


Figure 12.6.4 – Sole in VIIa. Log mean standardised index by year class for the UK(E+W) September beam trawl survey.

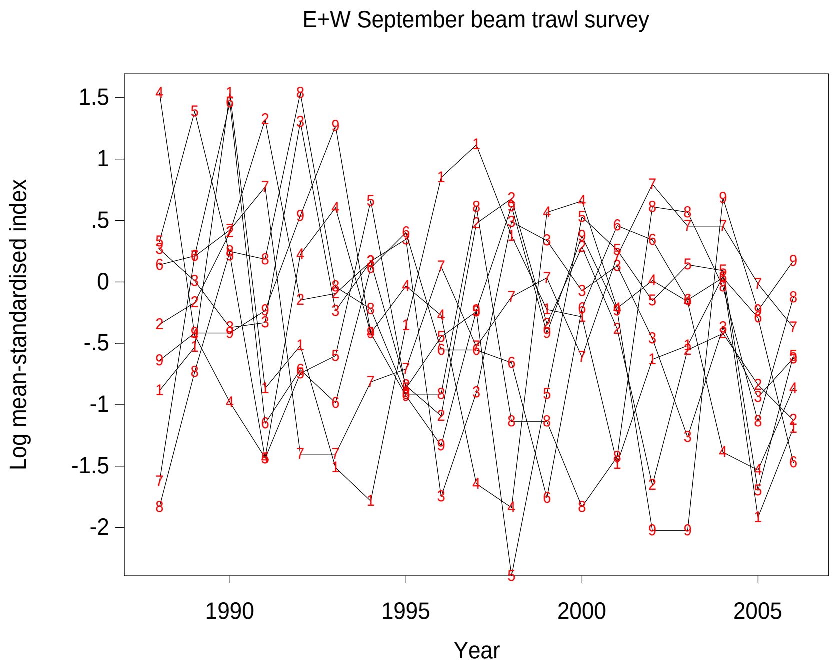


Figure 12.6.5 – Sole in VIIa. Log mean standardised index by year for the UK(E+W) September beam trawl survey

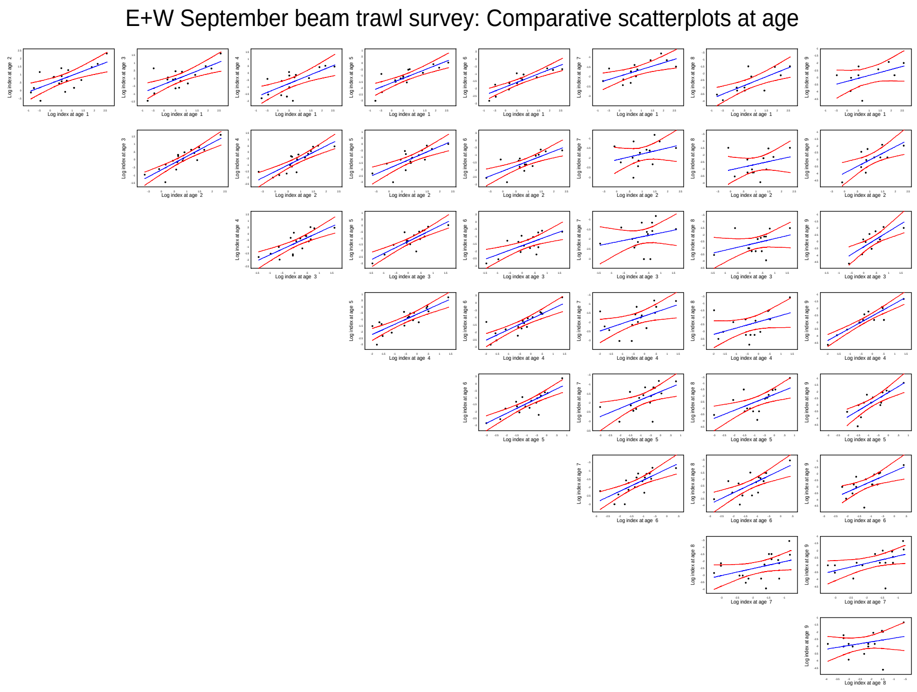


Figure 12.6.6 – Sole in VIIa. Comparative scatterplots at age for the UK(E+W) September beam trawl survey.

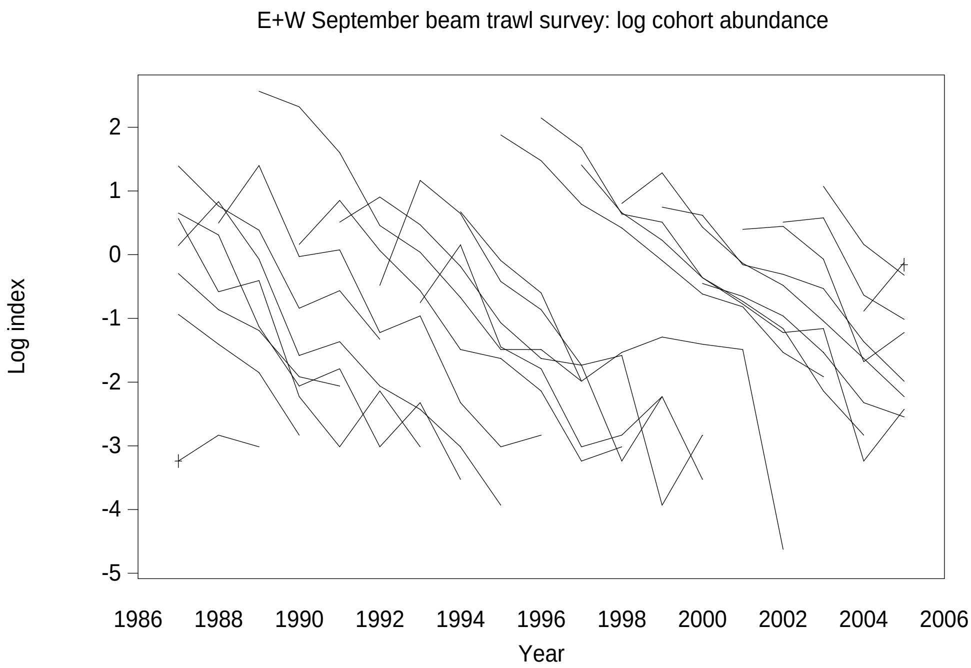


Figure 12.6.7 – Sole in VIIa. Log cohort plots for the UK(E+W) September beam trawl survey.

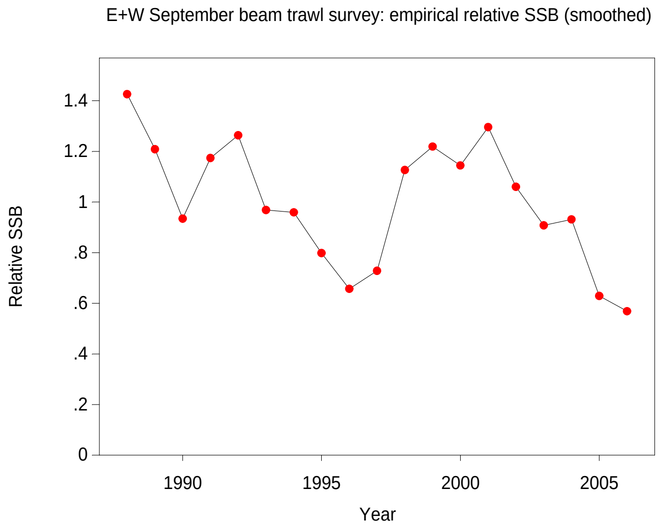


Figure 12.6.8 – Sole in VIIa. SURBA. Smoothed trend of relative SSB for the UK (E+W) September beam trawl survey

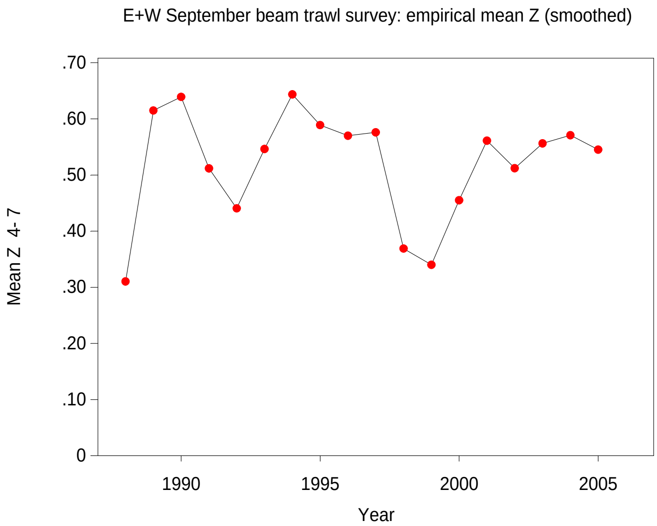
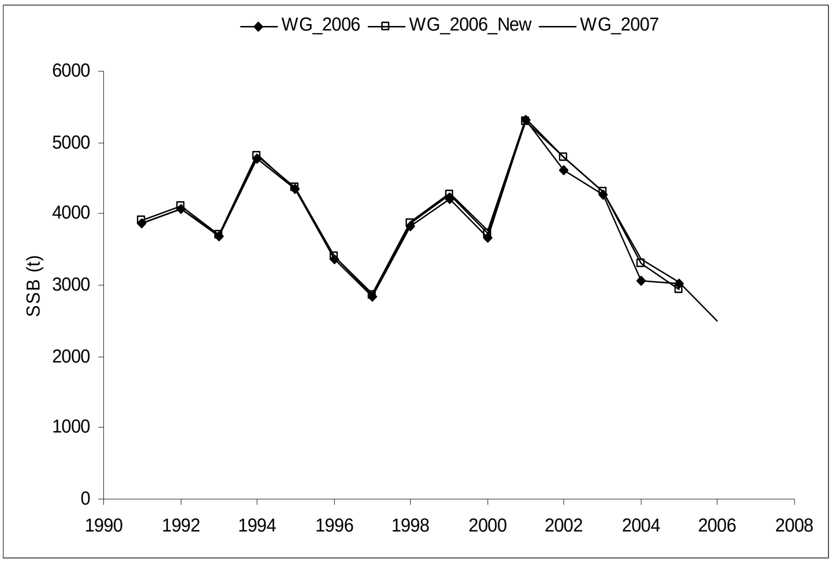


Figure 12.6.9 – Sole in VIIa. SURBA. Smoothed trend of relative Z for the UK (E+W) September beam trawl survey.



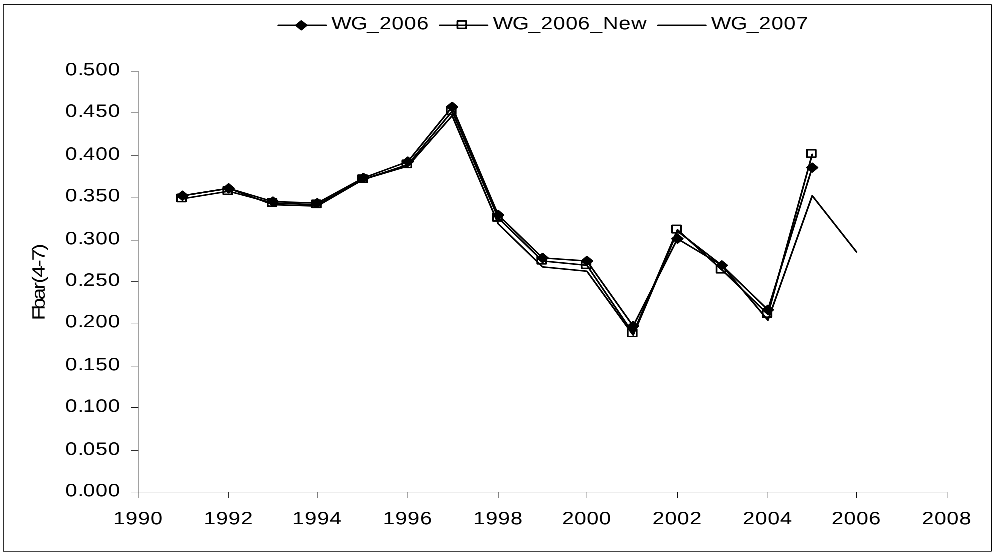


Figure 12.6.10–Sole in VIIa. Comparison plots of SSB and fishing mortality (WG_2006: final run of 2006, WG_2006_New: similar run as in 2006 but with revised data for the period 2001-2005, WG_2007: XSA run with similar settings and with the addition of the 2006 data).

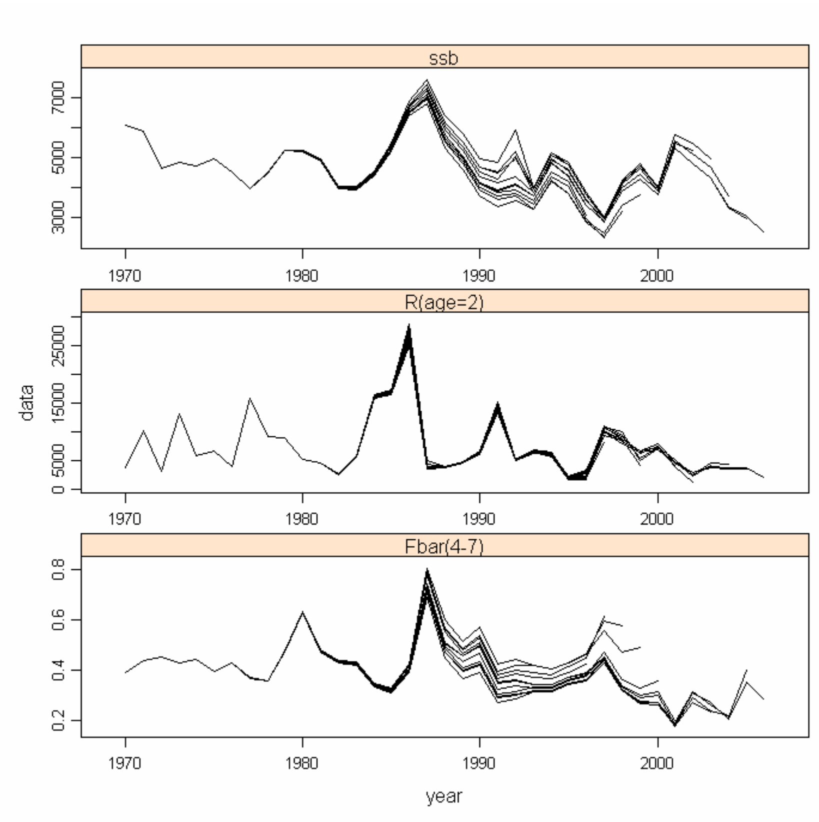


Figure 12.6.11 – Sole in VIIa. Retrospective analysis (Plusgroup 8).

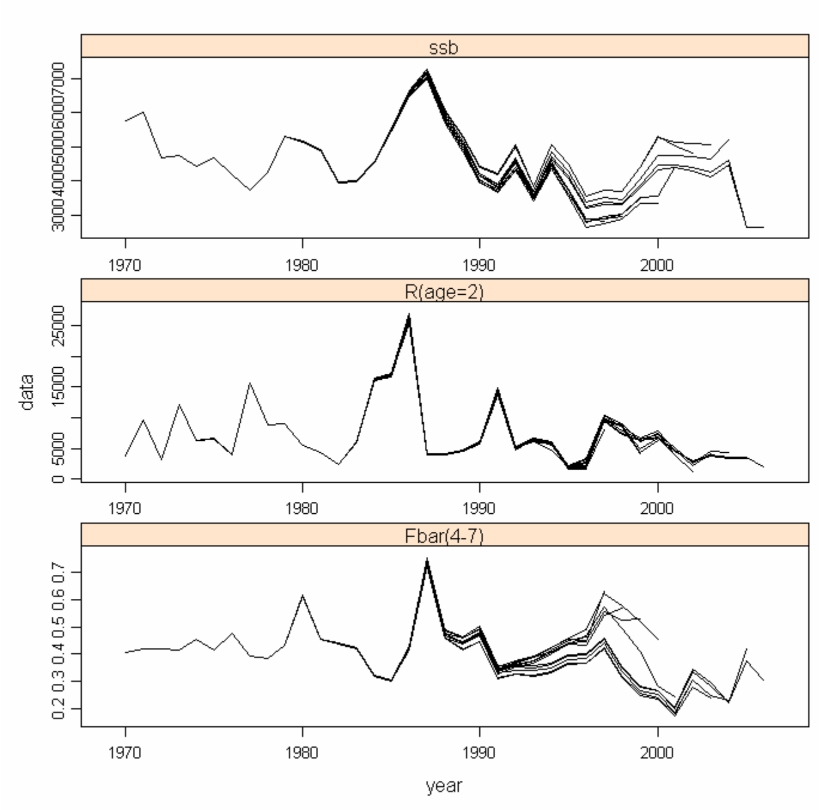


Figure 12.6.12 – Sole in VIIa. Retrospective analysis (Plusgroup 9)

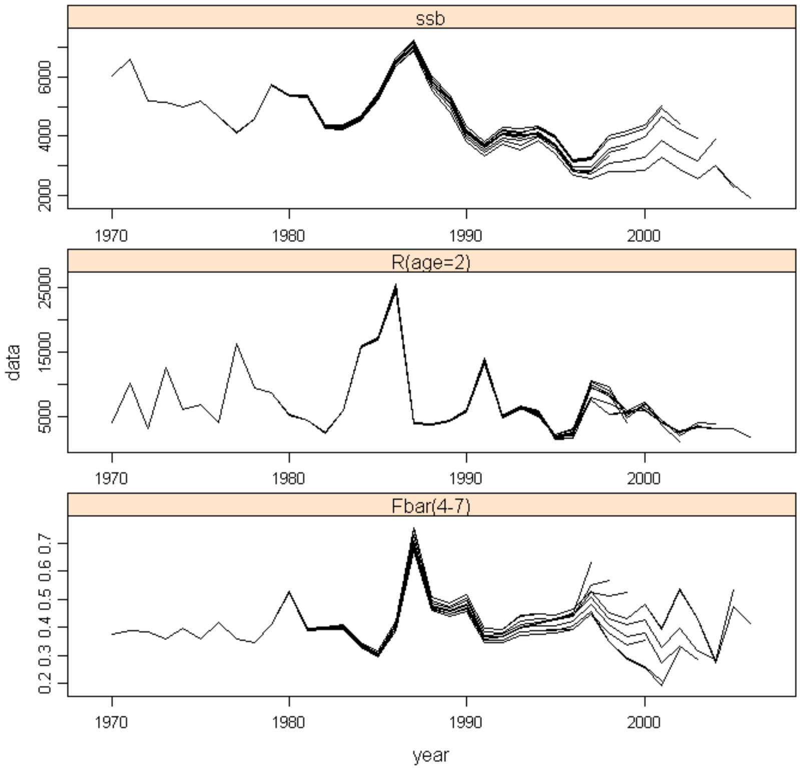


Figure 12.6.13 – Sole in VIIa. Retrospective analysis (Plusgroup 10)

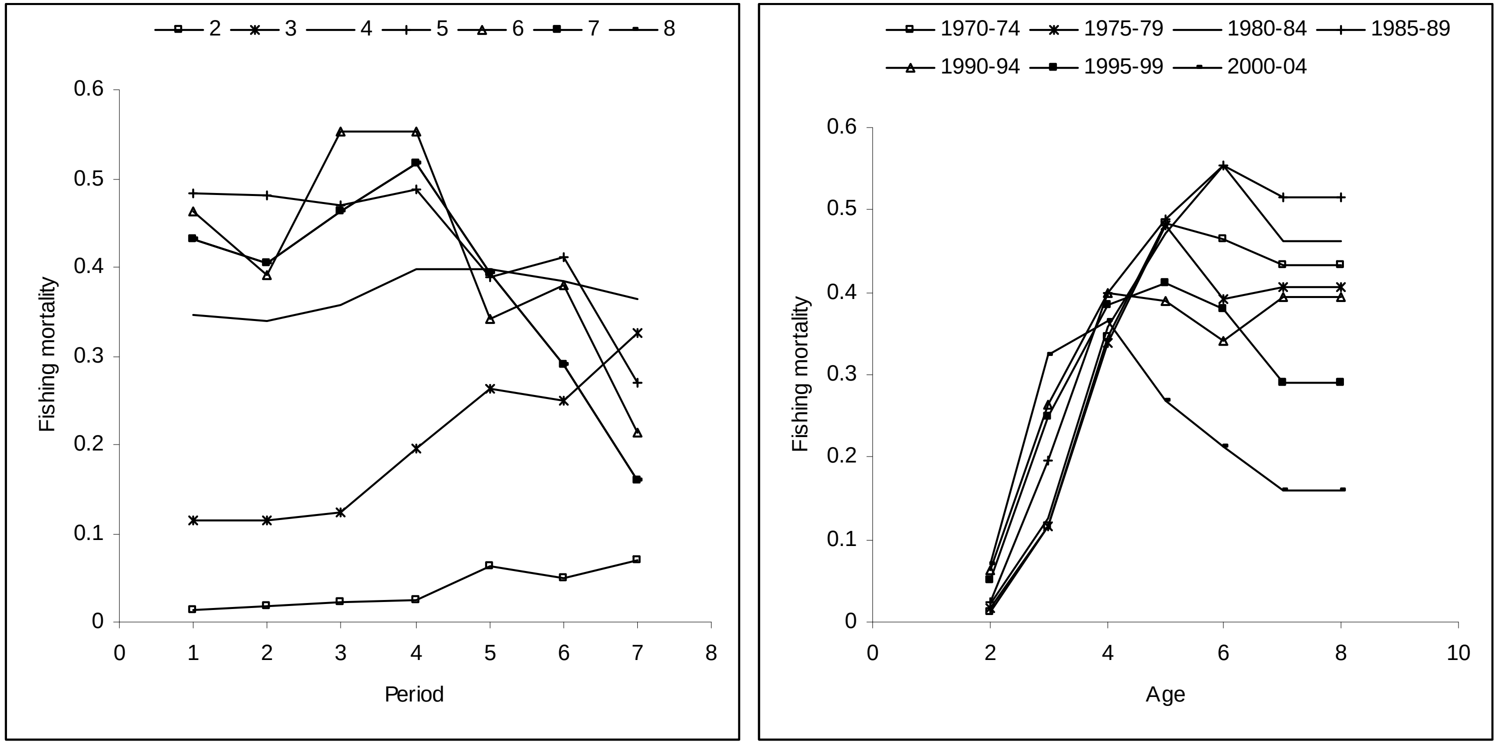


Figure 12.6.14 – Sole in VIIa. Evolution of the fishing mortality of Irish Sea sole by age (left panel, period 1 = average F over the years1970–1974, 2 = 1975-79, 3 = 1980–84, 4 = 1985–89, 5 = 1990–94, 6 = 1994–99, and 7 = 2000-04); and evolution of exploitation pattern (right panel). The fishing mortalities were derived from an XSA assessment using the same parameter settings as WGNSDS 2006. Both figures indicate that fishing mortality has increased on age 2 and age 3, and decreased on age 5 and older. Currently ages 4 to 7 are used for Fbar.

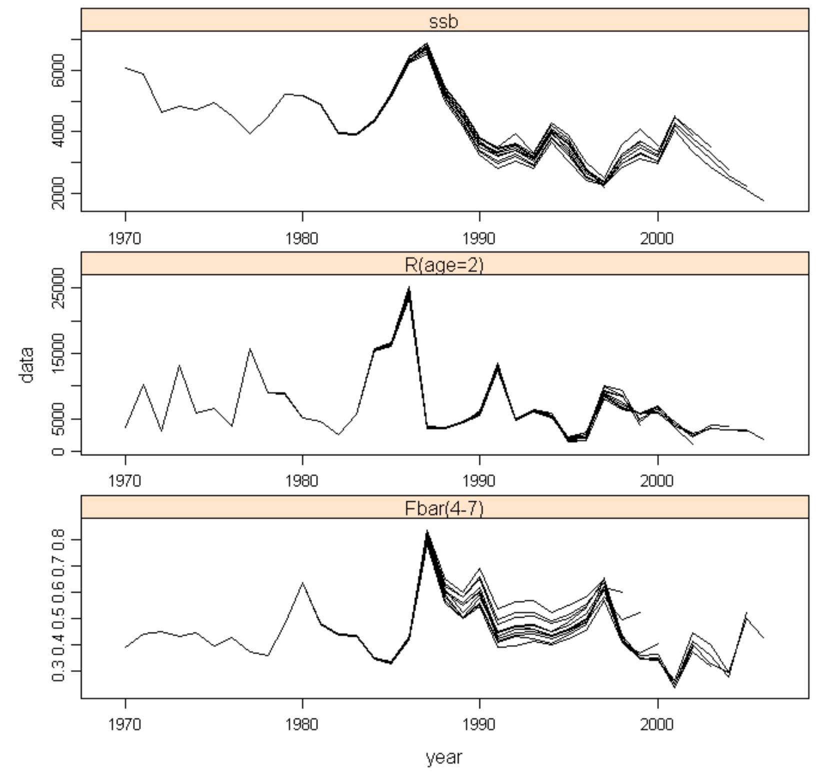


Figure 12.6.15 – Sole in VIIa. Retrospective analysis (q-plateau age 7)

Figure 12.6.16 - Sole in VIIa. Catchability residual plots of final XSA run

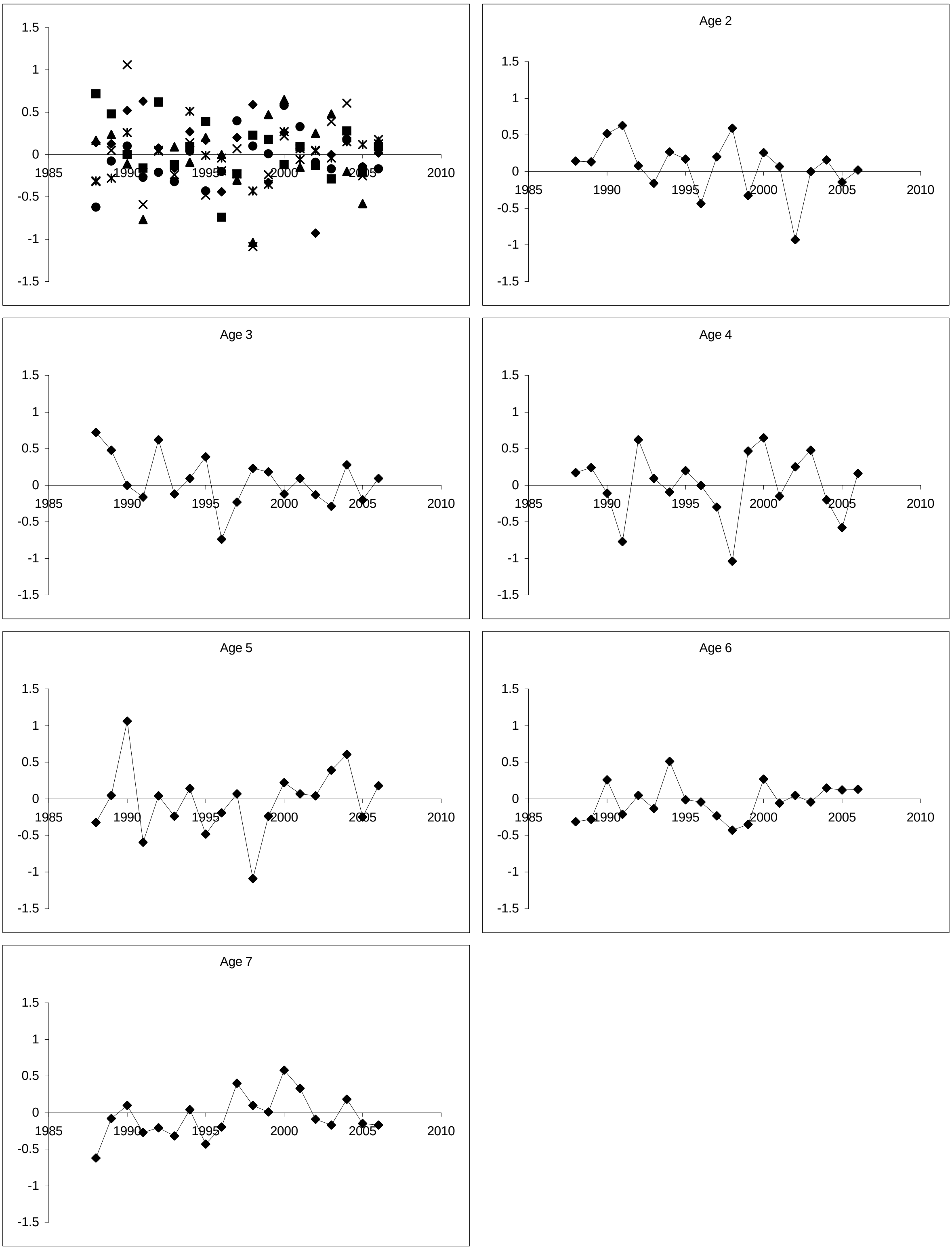
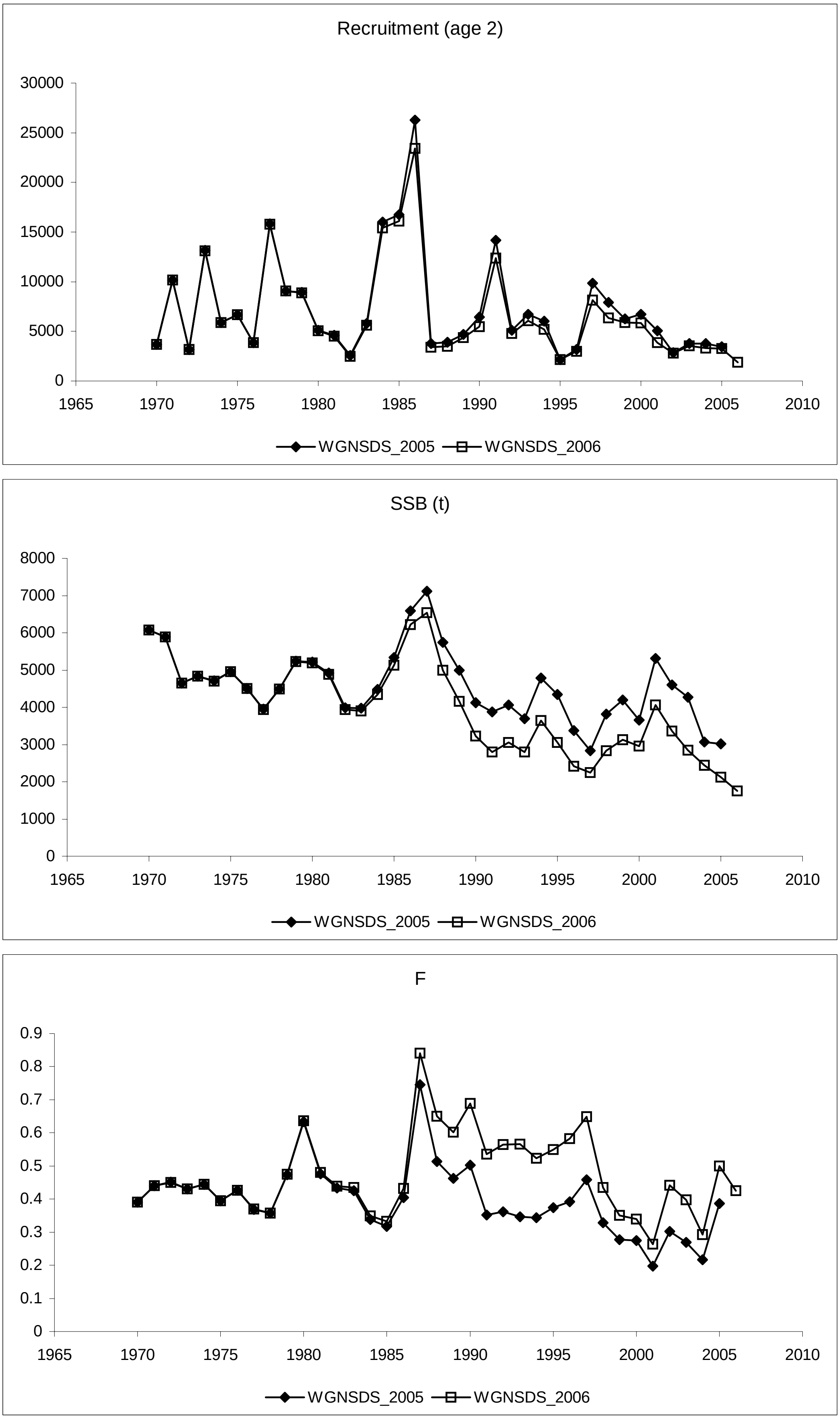


Figure 12.6.17 - Sole in VIIa. Comparison of trends in recruitment, SSB and F as estimated by the WG 2006 and 2007



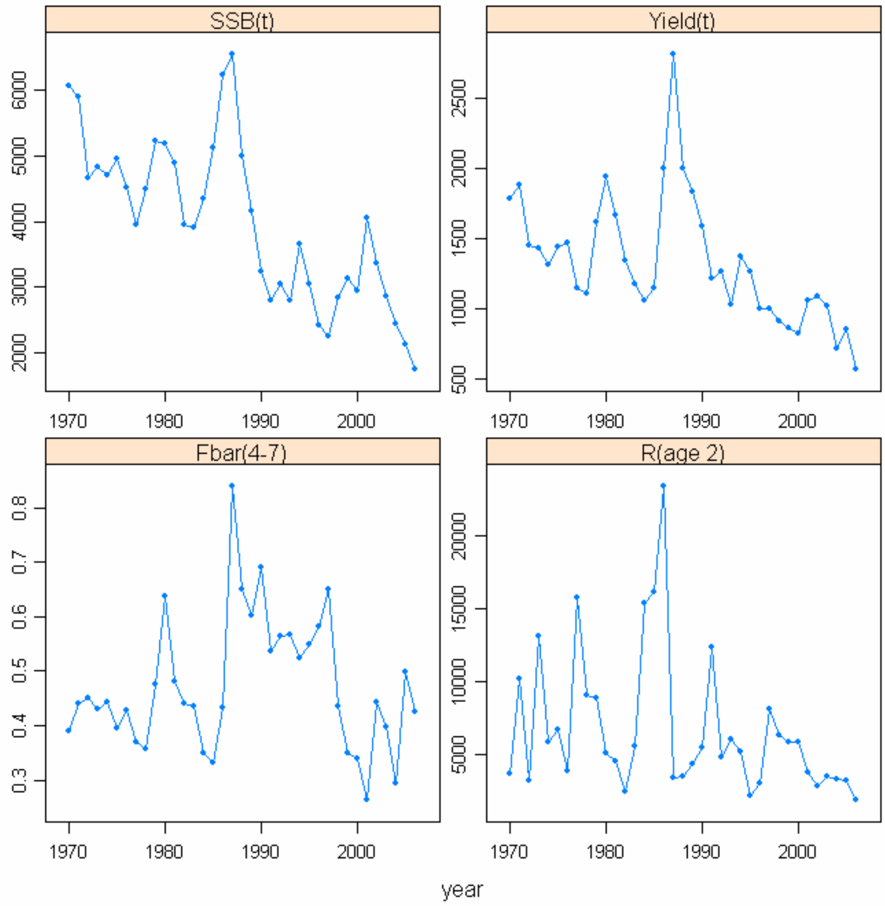
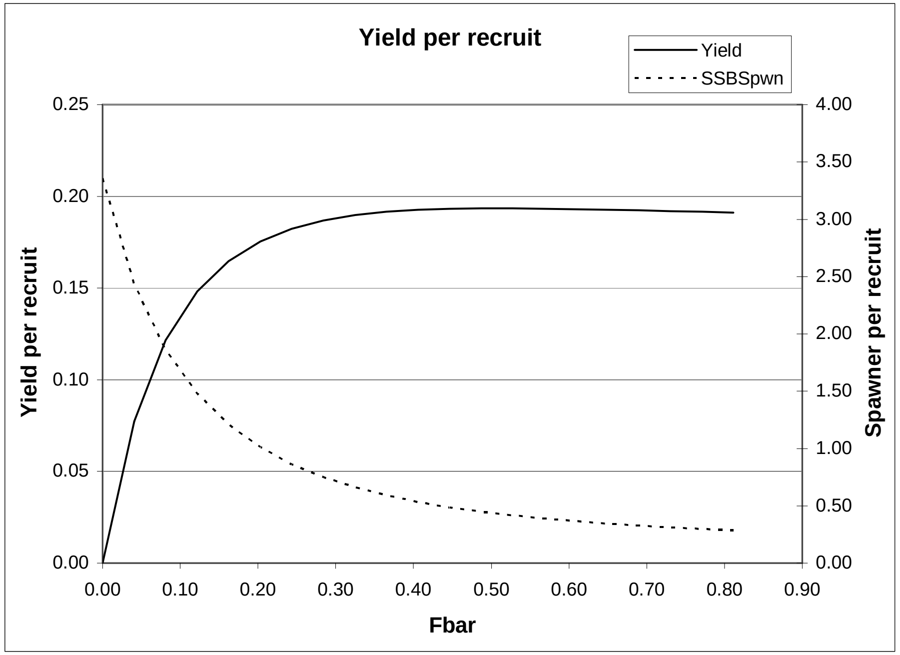
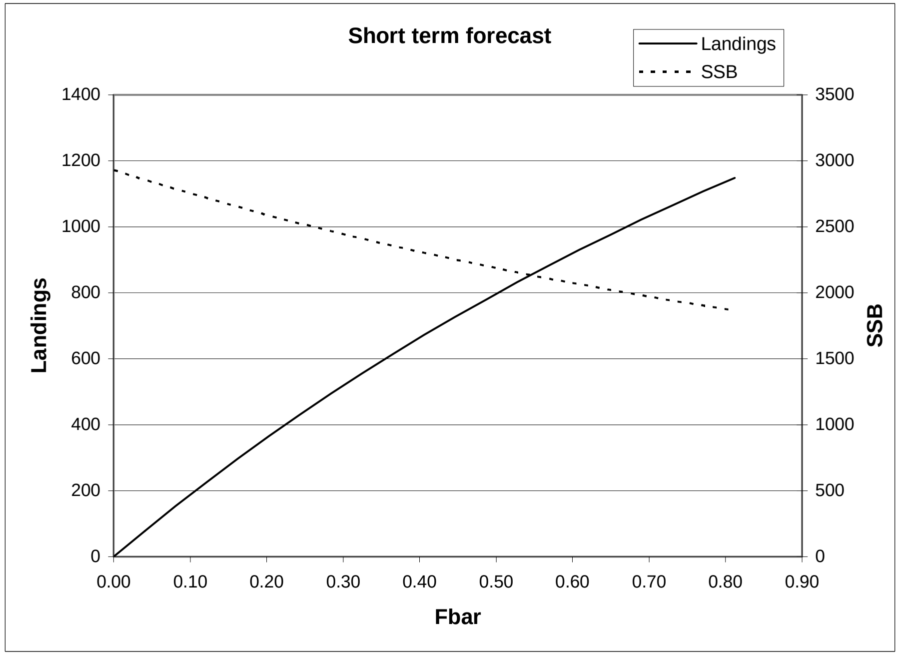


Figure 12.6.18 – Sole in VIIa. Summary plots

Figure 12.6.19 - Sole in VIIa. Plots of short term forecast and yield per recruit.





MFYPR version 2a
Run: SOLVIIa_YPR_
Time and date: 15:25 16/05/2007

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.4058
FMax	1.2520	0.5081
F0.1	0.4547	0.1845
F35%SPR	0.4140	0.1680

Weights in kilograms

MFDP version 1a
Run: SOL7a_STF_
IRISH SEA SOLE
Time and date: 15:24 16/05/2007
Fbar age range: 4-7

Input units are thousands and kg - output in tonnes

13 *Nephrops* in Division VIa

13.1 *Nephrops* in Division VIa (Functional Units 11, 12 & 13)

In accordance with the terms of reference for this year's meeting the information on *Nephrops* contained within this report is an update of catch tables and fishery statistics only. No new assessment of *Nephrops* stocks has been carried out this year. There is, therefore, no basis for revision of the advice provided in 2006. The working group considers that management advice provided in 2006 is applicable to 2007 and 2008. The working group continues to stress the importance of regular monitoring of *Nephrops* stocks through annual surveys and monitoring of catch statistics.

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FUs) are defined by the groupings of ICES statistical rectangles given in Table 13.1 and illustrated in Figure 13.1. The Functional Unit is the level at which the WG collects fishery data (quantities landed and discarded, fishing effort, cpues and lpues, etc.) and length distributions, and the level at which WGNEPH and ACFM have previously recommended management should take place.

Nominal landings as reported to ICES, along with WG estimates of landings are presented in Table 13.2. Landings are also made from Division VIa outside Functional Units, although at relatively low levels, and are presented separately in Table 13.3.

Prior to 2005, WGNEPH conducted a variety of analyses on the *Nephrops* data for this stock, including analytical assessments and a review of a number of stock indicators. In 2005, owing to serious concerns about the quality of landings statistics and uncertainty about model assumptions, WGNSDS and WGNSSK decided that continued attempts to conduct 'age' based assessments using 'knife-edge sliced' age compositions from length data were ill-advised. Other ICES groups (e.g. WKNEPH and SGASAM) will continue to investigate emerging techniques that facilitate size based approaches and tackle spatial issues. The 2005 meeting of WGNSDS did not base its advice on XSA assessments but used underwater television survey information as a measure of absolute abundance instead. This approach was continued at the 2006 meeting.

In response to the terms of reference, updates of the landings in the FUs are provided together with a brief commentary. The implementation in the UK of buyers and sellers regulations towards the end of 2005 and effective throughout 2006 is believed to have improved the quality of reported landings information.

There were no new assessments performed this year and new catch advice is not provided. Examination and analysis of the data available is provided on a stock by stock basis, with the North Minch (FU11) in Section 13.2, the South Minch (FU12) in Section 13.3 and the Clyde in Section 13.4. *Nephrops* stocks outside the Functional Units are considered in Section 13.5 and management considerations for Division VIa as a whole are discussed in Section 13.6. Section 13.6 also describes broad scale changes in effort expressed in KW days. UK effort in VIa has generally declined through marked reductions in the larger whitefish trawl categories. Effort directed at *Nephrops* by the UK trawl fleet (by far the main contributor to landings of *Nephrops* from VIa) has been fairly stable however there is anecdotal evidence of increased activity in the *Nephrops* creel fishery.

13.1.1 ICES advice applicable to 2006 and 2007

ICES to provide has provided formal catch advice on the basis of a harvest rate, using underwater television surveys of *Nephrops* burrow density to inform population size estimates. Predictions have not been based on landings information, due to historical uncertainties.

2006

ICES advice on Division VIa *Nephrops* for 2006 was based on underwater television assessments provided by WGNSSDS in 2005.

ACFM concluded that "All stocks in this Management Area appear to be exploited at sustainable levels."

and advised

Single stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

Information on these stocks is considered inadequate to provide an advice based in precautionary limits. The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and by-catch species.

Short term implications

Outlook for 2006:

The harvest ratio is a proxy for relative effort. Historically for this stock the harvest ratio has been around 15%. As an indication of relation between landings (tonnes) and effort the table below shows calculated landings for the three functional units for a range of harvest ratios applied to TV survey biomass results.

Harvest ratio %	North Minch	South Minch	Clyde	Total
15	**3150**	**7037**	**3068**	**13255**
20	4201	9383	4091	17675
25	5251	11729	5113	22093

Shaded options are not in accordance with the advice as this implies increased effort.

Mixed fishery considerations

See Section 1.7.

2007

ICES advice on Division VIa *Nephrops* for 2007 was based on underwater television assessments provided in the report of an *ad hoc* study group convened in 2006.

ACFM concluded that "The uncertain quality of fishery information, particularly landings, is inadequate to use analytical methods relying on accurate catch statistics to evaluate spawning stock or exploitation rate relative to risk. Results from TV surveys, and trends in mean size, however, suggest that the stocks comprising this Division VIa appear to be exploited at a sustainable level."

and advised

Single stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits

The effort in this fishery should not be allowed to increase relative to the past three years. In addition to the ceiling on effort ICES advises that the exploitation ratio in this stock should be no more than 15%, until such time that more reliable catch information becomes available. This corresponds to landings of less than 3 200 t for North Minch, 7200 t for the South Minch, and 3 800 t for the Firth of Clyde stock. Landings from other areas in Division VIa should be below the average of 2003–2005, corresponding to landings of 2100 t.

Short-term implications

Outlook for 2007

A range of candidate harvest ratios were applied to the TV abundance estimates (average of last 3 years) and adjusted to the landed weight equivalent to provide predictions of landings in 2007 under the different options as follows:

Harvest Ratio	North Minch	South Minch	Firth of Clyde	Total
15%	**3213**	**7226**	**3765**	**14204**
20%	4284	9634	5020	18938
25%	5355	12043	6275	23673

Shaded options are not in accordance with the advice as this implies increased effort.

These are predicted landings for the three Functional Units only and, in the case of the Clyde this only includes the Firth of Clyde component, not the Sound of Jura component. Additional allowance needs to be made for *Nephrops* in areas that are outside the main FUs but still part of the VIa TAC area (Management C). Some of these areas are now being surveyed by TV, but the data series is short. A predicted landing based on recent landings provides a short-term solution which should be replaced as soon as more reliable data become available. Figures below should be added to the predicted landings figure adopted:

Creeling areas: average creel landings 2003–2005 =1 673 tonnes

Sound of Jura: average landings 2003–2005 = 35 tonnes

Other areas in Division VIa: 2003–2005 = 363 tonnes

Mixed fishery considerations

See Section 1.7.

13.1.2 Management applicable in 2006 and 2007

2006

The 2006 TAC for *Nephrops* in ICES area VI was 17 675 tonnes.

The ACFM adoption of a 15% harvest rate for these stocks, based on the observation that historical harvest rates had been at this level, was founded on the time series of reported landings. Both the WGNSDS and ACFM reports drew attention to the likelihood of misreporting in these fisheries and it therefore could not be concluded that harvest rates at this level are a proxy for recent effort. STECF were asked to consider what appropriate harvest rates for *Nephrops* might be, consistent with long term sustainable objectives and concluded that a harvest rate based on a fishing mortality rate equivalent to $F_{0.1}$ from a yield per recruit curve was likely to be sustainable providing that fishing effort was controlled and providing *Nephrops* were managed at the Functional Unit level. The harvest rate equivalent to $F_{0.1}$ for these stocks is close to 20% and when applied to the TV abundance estimates from the 2005 WGNSDS report gave a predicted aggregate landing of 17675 tonnes. This became the TAC for 2006.

2007

The 2007 TAC for *Nephrops* in ICES area VI is 19 885 tonnes.

ACFM adopted a 15% harvest rate for these stocks based on the observation that historically, harvest rates, founded on the time series of reported landings, had been at this level. STECF were asked to consider what an appropriate harvest rates for *Nephrops* would be, consistent with long term sustainable objectives. STECF concluded that, as proposed by WGNSDS, a harvest rate based on a fishing mortality rate equivalent to $F_{0.1}$ from a yield per recruit curve was likely to be sustainable providing that fishing effort was controlled and providing *Nephrops* were managed at the Functional Unit level. The harvest rate equivalent to $F_{0.1}$ for these stocks is close to 21% ($F_{0.1} = 0.23$) and when applied to the TV abundance estimates derived in 2006 gave a predicted aggregate landing of 19 885 tonnes. This became the TAC for 2007.

An additional management measure continued in place in the Firth of Clyde (FU13). UK legislation has been applied in the southern areas of the Firth of Clyde in recent years, aimed at protecting the aggregating cod in the south of the Clyde during February, March and April (14th February to 30th April-Scottish Statutory Instrument 2002 No. 58–The Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2002.

The minimum landings size for *Nephrops* in area VI is 20 mm carapace length.

13.1.3 Research vessel surveys

Fishery independent underwater TV (UTV) surveys continue to provide a way of assessing trends in *Nephrops* populations and offering guidance on catch possibilities. Several countries already have well established surveys but these are neither internationally coordinated nor operating to the same protocol as happens with other survey such as the IBTS. There is, however, considerable exchange of expertise between the laboratories regarding equipment and protocol but the need for standardisation remains. A special workshop, WKTVNEPH was convened in April 2007 with the following TOR.

a) review and report technological developments used in underwater TV surveys for Nephrops;

b) compare survey designs employed in different areas and evaluate, where possible, the relative performance of these;

c) report on work addressing outstanding issues influencing the accuracy and precision of TV estimates of abundance inter alia burrow identification, occupancy rate, counting method, survey data analysis, raising procedures;

d) document the protocols used to conduct surveys across the range of European stocks, highlighting standard practices and ‘norms’ adopted in UWTV work;

e) investigate and make recommendations on procedures for inter-calibration, quality assurance and the reporting of precision from TV surveys;

f) report on developments in the translation of survey estimates into stock assessment information and catch forecast advice, recommending where additional work is most urgently required;

g) consider the wider utility of the techniques employed in Nephrops UWTV surveys for estimation of other benthic species and habitat assessment.

The report of the meeting was not available to WGNSDS, although a number of working group participants also attended WKNEPHTV. The workshop was of the view that these surveys provide good indications of population abundance trends and there was full support for the further development of the methodology. Significant progress was made in the collation of survey designs, equipment specifications and survey SOPs with recommendations regarding minimum standards and best practice.

The requirement for training, analyses and standardisation was emphasised and there are recommendations for the creation of reference datasets for the analysis of counting performance as well as the creation of a standard burrow-identification key to aid with the training and development of counters. Adoption of these practices would put the quality control of *Nephrops* burrow counting on a par with otolith reading.

The workshop considered the major uncertainties and assumptions in translating UWTV survey data into abundance or biomass information. The conclusion was that there is a continuum in terms of how surveys are used, from tuning indices to absolute measures of abundance. A list of the areas of uncertainty regarding the estimation of population abundance was developed by the group with a view to refining and improving the methodology. Factors such as burrow occupancy and edge-effects become critical when using the survey as a measure of absolute abundance. Variations in the field of view, when not quantified, can lead to an over-estimation of burrow abundance by up to 30%. This bias may be weather dependent. Burrow species identification and uncertainties in the distribution of suitable sediments also impact upon abundance estimates and suggestions for how these areas might be tackled were proposed.

More general uncertainties relating to underwater TV surveys for *Nephrops* include the extent to which the area of coverage of the survey reflects the distribution of the stock and fishery, and the sensitivity of the outcome to potential differences in the size composition of the fisheries (used to provide a mean weight) and the size compositions implied by the size range of burrows actually counted.

Based on the findings of the workshop it seems unlikely that the current perceptions of stocks assessed by UTV at the 2006 meeting of WGNSDS will change significantly. Update assessments based on UTV surveys (where available) will be provided at the 2008 WG meeting.

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Section 2.5.1. Specific details of the survey in each functional unit are given in the relevant technical annexe.

13.2 North Minch

13.2.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.2.1.1 ICES advice applicable to 2006 and 2007

ICES advice for this stock is included in advice for Division VIa as a whole, and is described in Section 13.1.1.

13.2.1.2 Management applicable in 2006 and 2007

Management applicable to this stock is included in management for Division VIa as a whole, and is described in Section 13.1.2.

13.2.1.3 The fishery in 2006

The fishery in 2006 was generally similar to previous years with a fleet of mainly smaller trawlers working 1–4 day trips from the main ports of Lochinver, Ullapool, Stornaway and Gairloch. The largest part of the North Minch fleets continued to be based at Stornaway. The reported effort by *Nephrops* trawlers in the North Minch was slightly up in 2006. Fishing was conducted throughout the year with slightly more reported effort in the second and third quarter. Boats based in Stornoway reported very good catches during the summer, coupled with a high price-prices for tails between July and September being three times that seen in previous years-whilst boats based on the other side of the Minch at Lochinver reported a poor summer.

Most vessels use 80 mm single rig trawls, with a small number of larger vessels using 95 mm twin rigs. Creel fishing continued to expand in 2006 with anecdotal reports of creels being fished more widely in the Minch and significant increases in creel numbers being fished inshore along the Outer Hebrides side of the Minch. This has lead to conflict between the trawl and creel fisheries, with complaints that entrants to the creel fishery are failing to observe traditional demarcation between trawl and creel only areas.

Little if any marketable fish by-catch was reported by the boats fishing in the North Minch, this was confirmed by *Nephrops* observer discard trips on board North Minch boats. Anecdotal evidence from creel boats suggests increased numbers of small cod being seen in their catches.

Traditionally, some local boats leave the North Minch after July to fish in the Moray Firth squid fishery, or in the Farn Deeps. In 2006 there was no noticeable drop in effort in Q3, and no commensurate increase in the Moray Firth, suggesting that this did not take place this year.

13.2.2 Catch data

13.2.2.1 Official catch statistics

Catch statistics reported to ICES are shown in Table 13.2. These relate to the whole of VIa of which the North Minch is a part. Official catch statistics for FU 11 provided through national laboratories are presented in Table 13.4 Landings from this fishery are only reported from Scotland. A variety of gear types make landings of *Nephrops*. Total reported landings in 2006 was 4 093 tonnes, consisting of 3 426 tonnes landed by trawlers and 667 tonnes landed by creel vessels (Table 13.5 and Figure 13.2). These estimates for total landings have increased sharply on 2005 values, rising by almost 40%. Landings from creel vessels have risen since the mid 1990s, although the sharp increase in landings was not seen in the creel fishery. In 2006 creeling contributed 16% of the total landings. Reported effort by Scottish *Nephrops* trawlers has declined steadily between 1999 and 2005, the 2005 value being 63% of that in 1999 (Figure 13.2 & Table 13.6). Effort has remained stable between 2005 and 2006. Scottish *Nephrops* trawler lpue remains at a high level and in 2006 rose to over 54Kg/hr–the highest since the time series began in 1981.

Revisions to catch data

The last assessment of Division VIa *Nephrops* stocks was conducted by WGNSDS in 2006. Some minor revisions were made to 2005 catch data.

13.2.2.2 Quality of the catch data

In recent years, anecdotal evidence suggests that the spatial development of the fishery in VIa has lead to a restrictive TAC, and extensive under-reporting of landings has been taken place. These developments have affected the North Minch component and also the other stocks in Division VIa. Sampling of the *Nephrops* fishery, both through markets and discard observer trips, remains high. The FRS whitefish discard sampling program also covers the *Nephrops* fleet in VIa.

13.2.3 Commercial catch-effort data and research vessel surveys

13.2.3.1 Commercial catch-effort

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 averaged over the period 2003 to 2005 for this stock were 24% by number. This represents an increase in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in the Stock Annexe (Section B1).

Owing to the decision not to proceed with tuned assessments in 2006, tuning files have not been updated. The available commercial cpue data are, however, described in the Stock Annex (Sections B.3 and B.4). A cpue tuning series is available for Scottish *Nephrops* trawlers between 1981 and 2005. The Stock Annex (Section B.4) describes how the tuning series is calculated. However, recording of effort in hours has become erratic, and there are concerns over the accuracy of official landings and effort statistics and the implications of technological creep in the fleet.

13.2.3.2 Research vessel surveys

Underwater TV survey data is available for this stock from 1994, with missing years in 1995 and 1997. See section 13.1.3 and the Stock Annex for details.

13.2.4 Size composition and mean weights-at-length

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in Table 2-2. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.7. Mean size of all categories appears to have been relatively stable since 1996. Examination of the cpue data in conjunction with the changes in mean size of the two size categories (Figure 13.2), leads to the suggestion that a strong year class entered the fishery in 1994, since mean size dropped in the < 35 mm CL category but was stable in the larger animals. The progression of this year class through the fishery may have led to the increase and then decrease in cpue of the larger individuals. The rise in catch rates of small animals in 2005 (Figure 13–2) accompanied by the recent increase in discard rate and the drop in the mean size of small animals suggests that another period of good recruitment has occurred.

Length composition data for 2003–2005 were used to generate LCA male and female input data files to provide a recent average length composition for use in the TV survey predicted catch calculations (Figure 13.4). Size compositions and mean weights have not been updated in 2007, due to data availability issues, but will be made available to the working group in 2008.

13.2.5 Natural mortality, maturity at length and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of values is provided in the Stock Annex.

13.2.6 Catch-at-age-analyses

No assessment has been conducted in 2007.

13.2.6.1 Data screening and exploratory runs

13.2.6.1.1 Commercial catch data

Levels of market and discard sampling are good, and the length structure of removals in the fishery is considered to be well represented.

Justification for discontinuing age disaggregated assessments relate to concerns earlier raised at both WGNEPH and WGNSDS about the implications of the use of the knife edge slicing technique for catch at age analysis of the resulting year classes. The increase in variability in length at age for older individuals may lead to a number of "real" ages being included within a sliced age, leading to an overestimation of F. This applies to each of the main *Nephrops* stocks in Division VIa.

13.2.6.1.2 Exploratory assessment runs

Analytical assessments

No assessment has been conducted in 2007.

13.2.6.2 Final assessment run

Underwater Ts Survey

The details of the 2005 survey are shown in Table 13.8, compared with the 2004 outcome. At present it is not possible to extract any length or age structure information from the survey and it therefore only provides information on absolute abundance over the area of the survey.

13.2.6.3 Comparison with last years assessment

No assessment has been conducted in 2007.

13.2.6.4 Long-term trends in biomass, fishing mortality and recruitment

The details of the 12 year span covered by TV surveys in the North Minch are provided in the stock annex. The TV survey estimates of abundance for *Nephrops* in the North Minch suggest that the population remained relatively stable between 1994 and 2001 (although no surveys were conducted in 1995 and 1997). The abundance then increased significantly between 2001 and 2003, remaining at a level of around 1100 million individuals in 2004 and 2005 (Figure 13.4). The increase in abundance observed between 2001 and 2003 coincides with the increases in cpue observed in the catch data, particularly for the smaller size category, interpreted as increase in recruitment.

13.2.6.5 Medium-term projections

No assessment has been conducted in 2007. WGNEPH has previously expressed concerns over the appropriateness of such approaches for *Nephrops*, where stock recruit relationships are poorly understood, and WGNSDS had further concerns over the required age structured assessment. This applies to each of the main *Nephrops* stocks in Division VIa.

13.2.6.6 Yield and biomass per recruit

No assessment has been conducted in 2007.

13.2.6.7 Reference points

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

13.2.6.8 Quality of assessment

No assessment has been conducted in 2007.

13.3 South Minch

13.3.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.3.1.1 ICES advice applicable to 2006 and 2007

ICES advice for this stock is included in advice for Division VIa as a whole, and is described in Section 13.1.1.

13.3.1.2 Management applicable in 2006 and 2007

Management applicable to this stock is included in management for Division VIa as a whole, and is described in Section 13.1.2.

13.3.1.3 The fishery in 2006

The fleet size in the South Minch has remained stable in 2006. Around one fifth of the trawl fleet use 95 mm twin rigs, with the remainder using 80 mm single rig nets. Again, prices have risen steeply in 2006, with values for catch increasing by 50% for *Nephrops* tails, and 150–200% for creel-caught animals within the past year. Boats are looking for a higher quality of catch, rather than bulk landings. This has been reflected in a large increase in creeling effort, with a number of former white-fish boats switching to creeling, and working 800–1000 creels each. Due to current high prices, larger South Minch *Nephrops* trawlers are fishing more heavily on inshore grounds, as they are able to make a profit without needing to land the larger *Nephrops* they would catch in more offshore areas, whilst using less fuel. This has moved effort away from the mixed *Nephrops*-fish grounds in the outer South Minch/Stanton Bank region. In recent years, small boats from the east coast and Firth of Clyde have visited the South Minch during the spring. In 2005 very few boats migrated into the area, and while there were more in 2006, including some boats from Kilkeel and Portavogie, the consensus was that there were fewer than in the recent past. Very few boats moved round from the South Minch to the Moray Firth for the seasonal squid fishery.

13.3.1.4 Official catch statistics

Catch statistics reported to ICES are shown in Table 13.2; these relate to the whole of VIa of which the South Minch is a part. Official catch statistics for FU 12 provided through national laboratories are presented in Table 13.9, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, with low levels reported from the rest of the UK in the mid 1990’s, and low levels more recently reported for Ireland. Total international reported landings in 2006 was 4 581 tonnes, consisting of 3 573 tonnes landed by Scottish trawlers, 964 tonnes landed by creel vessels and 44 tonnes landed by other vessels. These landings estimates show a sharp increase on 2005 values, with combined international landings increasing by almost 20%. Landings from creel vessels increased again in 2006, although not in line with the major increases seen in the trawl fishery, therefore their contribution to total landings declined from 33% to 19%. Reported effort by Scottish *Nephrops* trawlers has shown a long term decline since 1990 (Table 13.9 & Figure 13.5), although the reliability of these data is questionable since the log sheet recording of ‘hours fished’ is known to have become more erratic. Scottish *Nephrops* trawler lpue remained stable between 1998 and 2001, but has shown a steady increase in more recent years.

13.3.1.5 Revisions to catch data

The last assessment of Division VIa *Nephrops* stocks was conducted by WGNSDS in 2006. Some minor revisions were made to 2005 catch data.

13.3.1.6 Quality of the catch data

See Section 13.2.2.2.

13.3.2 Commercial catch-effort data and research vessel surveys

13.3.2.1 Commercial catch effort

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 averaged over the period 2003 to 2005 for this stock were 26% by number. This represents a small increase on the 2002 to 2004 period. Further details of discarding are provided in the Stock Annex (Section B1).

13.3.3 Size composition and mean weights-at-length

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in Table 2.2. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.11. Mean size of all categories appears to have been relatively stable since 1996. Examination of the cpue data in conjunction with the changes in mean size of the two size categories (Figure 13.5), leads to the suggestion that a strong year class entered the fishery in 1994, since mean size dropped in the < 35 mm CL category but was stable in the larger animals. The progression of this year class through the fishery may have led to the increase and then decrease in CPUE of the larger individuals.

Length composition data for 2003–2005 were used to generate LCA male and female input data files to provide a recent average length composition for use in the TV survey predicted catch calculation. Size compositions and mean weights have not been updated for 2007, but will be for 2008.

13.3.4 Natural mortality, maturity at length and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of values is provided in the Stock Annex (Sections B1 and B2).

13.3.5 Catch-at-age-analyses

No assessment was conducted in 2007.

13.3.5.1 Data screening and exploratory runs

13.3.5.1.1 Commercial catch data

See Section 13.2.6.1.1.

13.3.5.1.2 Exploratory assessment runs

No assessment has been conducted in 2007.

13.3.5.2 Final assessment run

Underwater TV survey

The underwater TV survey is presented as the best available information on the South Minch *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. The details of the 2005 survey are shown in Table 13.12 compared with the 2004 outcome. At present it is not possible to extract any length or age structure information from the survey and it therefore only provides information on absolute abundance over the area of the survey.

13.3.5.2.1 Comparison with last years assessment

No assessment was conducted in 2007.

13.3.5.3 Long-term trends in biomass, fishing mortality and recruitment

The details of the 11 year span covered by TV surveys in the South Minch are provided in the Stock Annex. The TV survey estimate of abundance for *Nephrops* in the South Minch suggests that the population fluctuated without trend between 1995 and 2000, but appears to have remained more stable and at a slightly higher level from 2001 to 2003 (Figure 13.7). The survey suggests that this higher abundance was maintained through to 2005. The increase to the more stable level of abundance observed after 2001 coincides with the increase in cpue and reduction in mean size observed in the catch data, particularly for the smaller size category, interpreted as increase in recruitment.

13.3.5.4 Medium-term projections

No assessment was conducted in 2007.

13.3.5.5 Yield and biomass per recruit

No assessment was conducted in 2007.

13.3.5.6 Reference points

No precautionary approach reference points have been determined for *Nephrops* stocks.

13.3.5.7 Quality of assessment

No assessment has been conducted in 2007.

13.4 Clyde

13.4.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.4.1.1 ICES advice applicable to 2005 and 2006

ICES advice for this stock is included in advice for Division VIa as a whole, and is described in 13.1.1.

13.4.1.2 Management applicable in 2006 and 2007

Management applicable to this stock is included in management for Division VIa as a whole, and is described in 13.1.2.

13.4.1.3 The fishery in 2006

There has been a slight reduction in the size of the Clyde fleet in 2006, and a reduction in the number of boats visiting from Northern Ireland, due to decommissioning schemes. Most vessels operated single rig 80 mm trawl gears, with a few boats working 80 mm twin-rigs. The most significant landings were made at the main Clyde ports of Troon, Girvan, Largs on the East side of the Clyde and Campbelltown, Tarbert, and Carradale on the west side of the Clyde. The Clyde *Nephrops* fleet fishes daily trips during the winter period, moving to a combination of 1 and 2 day trips during the summer, working day and night.

Fishing in the Clyde was generally steady through the year although there was a dip in catches during April and May. Most of the Clyde fleet stayed in the area during the whole of 2006 and overall effort was little changed from 2005. No boats left to join the Moray Firth squid fishery, and although a number of vessels moved to Blyth in late 2006, they had returned before the end of the year.

In common with other years, very little marketable by-catch of fish was taken in the Clyde. Traditionally this has been mainly cod and whiting, but these species have been rare in Clyde catches this year, as confirmed by discard observers.

A small number of Northern Irish boats fish the Clyde at various times of the year. These boats land mainly into Campbelltown or Troon depending on where they have been fishing.

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21 m in length. An increasing number of creel boats operate in the Clyde (70 registered in 2005). Creeling activity often takes place during the weekend when the trawlers cannot fish due to the ban. Only about a third of creelers operated throughout the year, the rest prosecuted a summer fishery. There has been considerable gear conflict in for a number of years.

13.4.2 Catch data

13.4.2.1 Official catch statistics

Catch statistics reported to ICES are shown in Table 13.2; these relate to the whole of VIa of which the Firth of Clyde is a part. Official catch statistics for FU 13 provided through national laboratories are presented in Table 13.13, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although the remainder of the UK also contributes, and landings from Northern Ireland form the main part of this. Landings from England, Wales and Northern Ireland contributed about 5% of the total in 2006. Total international reported landings in 2006 was 4 723 tonnes, consisting of 4 312 tonnes landed by trawlers and 165 tonnes landed by creel vessels. Creel landings have increased in recent years but remain at a low level. The Clyde FU comprises two distinct *Nephrops* fisheries in the Firth of Clyde and the Sound of Jura, to the east and west of the Mull of Kintyre (Figure 13.1). UK landings are broken down between these sub-areas for recent years in Table 13.14, which shows that the contribution from the Sound of Jura has declined in recent years. Due to a problem in allocating landings to the east and west of the Kintyre Peninsula in the new FRS database, the figures for 2006 are provisional. Landings in 2006 were a sharp increase on figures from previous years, increasing by approximately 40% (Table 13.15 & Figure 13.8). The reliability of the historical data is clearly questionable, although improvements since buyers and sellers regulations were introduced are apparent. Effort is also poorly measured, since the log sheet recording of ‘hours fished’ is known to have become more erratic.

13.4.2.2 Revisions to Catch data

The last assessment of Division VIa *Nephrops* stocks was conducted by WGNSDS in 2006. Some minor revisions have been made to 2005 catch data.

13.4.2.3 Quality of the Catch data

See Section 13.2.2.2.

13.4.3 Commercial catch-effort data and research vessel surveys

13.4.3.1 Commercial catch effort

Sampling data are not as extensive in the Sound of Jura as in the Firth of Clyde, and discard data are only available for the later area. More detailed analysis of the catches and landings are only available for the Firth of Clyde.

See also Section 13.2.3.1.

13.4.3.2 Research vessel surveys

Underwater TV data is available from 1995 onwards for the Firth of Clyde, and for some years between 1997 and 2005 for the Sound of Jura. See the Stock Annex for details.

13.4.4 Size composition and mean weights-at-length

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in Table 2.3. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.18. Mean size of all categories appears to have been relatively stable although small changes are apparent. Examination of the cpue data in conjunction with the changes in mean size of the two size categories (Table 13.16), leads to the suggestion that the increases in cpue observed in 1995, 1998 and 2003 were all associated with drops in mean size in the < 35 mm CL category, implying increases in recruitment. Mean sizes in the larger category of both males and females have shown a very gradual decline.

In previous years when XSA has been performed, length compositions of combined landings and dead discards were raised to annual values of removals and sliced using the WGNEPH program L2AGE into numbers at nominal age and weights at age. These were not prepared in 2006. Size compositions and mean weights have not been updated for 2007, but will be for 2008.

13.4.5 Natural mortality, maturity at length and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of input values is given in the Stock Annex (Section B1 and B2).

13.4.6 Catch-at-age-analyses

No assessment has been conducted in 2007.

13.4.6.1 Data screening and exploratory runs

13.4.6.1.1 Commercial catch data

See Section 13.2.6.6.1.

13.4.6.1.2 Exploratory assessment runs

No assessment has been conducted in 2007.

13.4.6.2 Final assessment run

Underwater TV Survey

No new UWTV data was presented for 2006. The details of the 2005 Clyde survey are presented in Table 13–19. Details of the 2005 data from the Sound of Jura survey are given in Table 13-21.

13.4.6.3 Long-term trends in biomass, fishing mortality and recruitment

The TV survey estimate of abundance for *Nephrops* in the Firth of Clyde is presented in the Stock Annex. It suggests that the population has increased steadily since 1999. The data for 2005 appear to suggest a continuation of the previously observed high abundance in recent years (Figure 13.10, *Nephrops*, Firth of Clyde (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005).

Reductions in the mean size in catches coincident with increases in cpue. The increase to the more stable level of abundance observed after 2001 coincides with the increase in cpue suggest strong recruitments in 1995, 1998 and 2003. A series of good recruitments would be consistent with the increase in abundance observed from the TV surveys. The higher levels of discarding observed in recent years are associated with the increase in cpue of smaller individuals.

The TV survey estimate of abundance for *Nephrops* in the Sound of Jura (also found in the Stock Annex) suggest that the population increased between the mid 1990’s and 2002 (although there is a gap in the survey time series), but appears to have declined from the high 2002 figure in 2003. No survey was available in 2004 but in 2005 the abundance was similar to 2003 ((Figure 13.11, *Nephrops,* Sound of Jura (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005).

13.4.6.4 Medium-term projections

No assessment has been conducted in 2007.

13.4.6.5 Yield and biomass per recruit

No assessment has been conducted in 2007.

13.4.6.6 Reference points

No precautionary approach reference points have been determined for *Nephrops* stocks.

13.4.6.7 Quality of assessment

No assessment has been conducted in 2007.

13.5 Other *Nephrops* stocks

Nephrops fisheries also take place outside the Functional Units in Division VIa, although they only represent about 3% of the reported landings. The main areas of activity are the Stanton Bank (to the west of the South Minch; Figure 13–1) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides.

13.5.1 Stanton Bank

Underwater TV surveys have been conducted at the Stanton Bank ground when time allows on the annual west of Scotland survey. Figure 13.12 shows the time series of estimated abundance for the Stanton Bank TV surveys, with 95% confidence intervals on annual estimates, (details are shown in Figure 13.21 and Table 13.23). An average of 8.2 stations have been sampled in each year, and then raised to a stock area of 287.5 km^2. Surveys conducted in 1995 and 1997 were stratified in a slightly different way to those after 2001, and have broader confidence intervals. Surveys between 2001 and 2003 indicate a general increase in abundance, although the annual confidence intervals overlap. No survey was conducted in 2004. In 2005 a new survey suggested a further increase in abundance but again, the confidence intervals overlap with previous years.

13.5.2 Shelf edge west of Scotland

FRS has taken the opportunity of using the Scotia deepwater surveys conducted in 2000, 2002 and 2004 to conduct preliminary underwater TV work on the *Nephrops* populations along the shelf edge. These TV runs are carried out during the night (when the vessel is not required for fishing). It is hoped that this can continue as an annual survey.

To date, successful survey runs have been conducted to a depth of 635 m, observing *Nephrops* burrows at a range of locations along the shelf edge and slope. Observed densities have been very low (average $0.04.m^{-2}$) compared to shelf stocks on the west coast and in the North Sea (typically $0.2–0.9.m^{-2}$), although the animals on the shelf edge are considerably larger than those found on the shelf.

13.6 Division VIa Overview and management Considerations

13.6.1 Summary and discussion of assessments

WGNSDS, 2006 concluded that underwater TV surveys of the *Nephrops* stocks in the Division VIa Functional Units indicate a continuation of the general upward trend in abundance over recent years (Figure 13.13). A detailed discussion of this was provided in the previous WGNSDS report.

13.6.2 Management considerations

In accordance with the terms of reference for this year's meeting the information on *Nephrops* contained within this report is an update of catch tables and fishery statistics only. No new assessment of *Nephrops* stocks has been carried out this year. There is, therefore, no basis for revision of the advice provided in 2006. The working group considers that management advice provided in 2006 is applicable to 2007 and 2008. The working group continues to stress the importance of regular monitoring of *Nephrops* stocks through annual surveys and monitoring of catch statistics.

Previous ACFM advice states that “the effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and by-catch species”. Results from the yield analysis, albeit preliminary, suggest that a harvest rate based around $F_{0.1}$ would not be inconsistent with the first part of this advice. There is a need for management measures to be put in place to ensure that expansion of effort is restricted.

It is expected that the quality of fishery data available for these stocks will improve following the introduction of Buyers and Sellers regulations and the increased TAC. Monitoring continues and enhanced work on observer trips onboard commercial vessels should furnish additional data.

13.6.3 Mixed fishery aspects

The overall position of stable or increasing *Nephrops* stocks in Division VIa is similar to that in Division IIIa, IV and VIIa and appears to be representative of a general increase in *Nephrops* in more northerly waters. These increases imply increased catching opportunities without the need for increased effort and on a single species basis should be sustainable. Such opportunities also present a challenge in a mixed fisheries context since there is the potential for by-catch in a number of FUs–this is often unwanted by-catch of small individuals of other fish species. This represents a particular problem where smaller mesh sizes are used and where emergent year classes of demersal fish, especially cod are found.

A recent investigation (SGRST, 2004) suggests by-catches of cod are generally low in Division VIa *Nephrops* fisheries. Analysis of 2005–06 discard observer trips suggests a discard rate of between 1.9 and 4.3 kg of cod are discarded per tonne of *Nephrops* landed. Nevertheless, young cod frequently occur in inshore areas and any emerging year classes should not be subject to mortality as by-catch in smaller mesh fisheries. The use of 70 mm mesh continues in a number of the VI *Nephrops* fisheries and all efforts should be made to improve selectivity and species selection to avoid these fish. Other technical measures (e.g. seasonal and spatial closures) should be investigated.

13.6.4 Future developments in approach

It is recognised that a number of key issues require further work and this is planned as follows: i) Attempts will be made to provide a more accurate estimation of the entire mud area in each of the three FUs; ii) improving Y/R estimation using a modelling approach incorporating seasonal availability of the two sexes will be attempted; iii) there is an urgent need for a more thorough sensitivity analysis of the approach. iv) it is hoped that new improvements in software available for analysis of the video image will facilitate methodological development to establish the size range of animals from the size range of burrows observed and also to permit partition of the abundance estimate into ‘recruit sizes’ and ‘older’ *Nephrops*.

Table 13-1. *Nephrops* Functional Units and descriptions by statistical rectangle and management area.

FUNCTIONAL UNIT	STOCK	DIVISION	ICES RECTANGLES	MANAGEMENT AREA
11	North Minch	VIa	44–46 E3-E4	C
12	South Minch	VIa	41–43 E2-E4	C
13	Clyde	VIa	39–40 E4-E5	C
14	Irish Sea East	VIIa	35–38E6; 38E5	J
15	Irish Sea West	VIIa	36E3; 35-37 E4-E5; 38E4	J

Table 13-2. Nominal catch (tonnes) of *Nephrops* in Division VIa, 1986–2006, as officially reported to ICES.

DIVISION VIA	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	8	6	1	0	0	0	0	0	3	4	0	0	0	0	1	9	0	0	0	0	+
Ireland	20	128	11	9	10	1	10	7	6	9	8	5	25	136	130	115	117	145	150	154	132
Spain	5	11	7	2	4	0	0	0	0	3	1	15	18	40	69	30	25	17	8	18	na
UK - Eng+Wales+N.Irl.	0	12	44	25	35	37	56	191	290	346	176	133	202	256	137	139	152	81	10,208	10,258	13,640
UK – Scotland	11,283	11,203	12,649	10,949	10,042	10,458	10,783	11,178	11,047	12,527	10,929	11,104	10,949	11,078	10,667	10,568	10,225	10,450			
TOTAL	11,316	11,360	12,712	10,985	10,091	10,496	10,849	11,376	11,346	12,889	11,114	11,257	11,194	11,510	11,004	10,861	10,519	10,693	10,366	10,430	13,772
Unallocated	-20	-122	-10	-11	-23	31	0	-44	-245	-104	51	-4	-23	-18	35	0	6	58	65	72	-135
WG TOTAL	11296	11238	12702	10974	10068	10527	10849	11332	11101	12785	11165	11253	11171	11492	11039	10861	10525	10751	10,431	10,502	13,637

.

Table 13-3. Nominal catch (tonnes) of *Nephrops* in Division VIb, 1986–2006, as officially reported to ICES.

DIVISION VIB	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
France	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	0	0	3	+
Germany	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	na	na
Ireland	0	0	0	0	0	0	0	0	0	0	0	1	1	0	8	1	0	1	0	na	na
Spain	8	18	27	14	10	30	2	2	5	2	5	3	6	5	3	14	7	5	2	na	Na
UK - Eng+Wales+N.Irl.	0	11	4	0	1	0	4	6	16	26	65	88	46	2	4	2	3	6	20	14	3
UK – Scotland	0	0	0	0	0	0	1	9	5	1	5	23	7	5	4	7	7	18			
TOTAL	8	29	31	14	11	30	7	17	26	30	81	115	60	12	21	25	18	30	22	17	3
Unallocated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WG TOTAL	8	29	31	14	11	30	7	17	26	30	81	115	60	12	21	25	18	30	22	17	3

Table 13-4. *Nephrops*, Division VIa: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1981–2006.

Year	FU 11	FU 12	FU 13	Other Areas	Total
1981	2861	3651	2968	39	9519
1982	2799	3552	2623	27	9001
1983	3196	3412	4077	34	10719
1984	4144	4300	3310	36	11790
1985	4061	4008	4285	104	12458
1986	3382	3484	4341	89	11296
1987	4083	3891	3007	257	11238
1988	4035	4473	3665	529	12702
1989	3205	4745	2812	212	10974
1990	2544	4430	2912	182	10068
1991	2792	4442	3038	255	10527
1992	3560	4237	2805	248	10850
1993	3192	4465	3342	344	11343
1994	3616	4415	2629	441	11101
1995	3656	4680	3989	460	12785
1996	2871	3995	4060	239	11165
1997	3046	4446	3618	243	11353
1998	2441	3729	4843	157	11170
1999	3257	4051	3752	438	11498
2000	3246	3952	3419	421	11038
2001	3259	3992	3182	420	10853
2002	3440	3305	3383	397	10525
2003	3268	3879	3171	433	10751
2004	3135	3868	3025	403	10431
2005	2948	3843	3397	254	10442
2006*	4093	4581	4723	240	13637

**provisional*

Table 13-5. *Nephrops*, North Minch (FU11), Nominal Landings of *Nephrops*, 1981–2006, as officially reported.

Year	UK Scotland				Total *
	Nephrops trawl	Other trawl	Creel	Sub-total	
1981	2320	170	371	2861	2861
1982	2323	105	371	2799	2799
1983	2784	95	317	3196	3196
1984	3449	161	534	4144	4144
1985	3236	117	708	4061	4061
1986	2642	203	537	3382	3382
1987	3458	143	482	4083	4083
1988	3449	149	437	4035	4035
1989	2603	112	490	3205	3205
1990	1941	134	469	2544	2544
1991	2228	125	439	2792	2792
1992	2978	150	432	3560	3560
1993	2699	85	408	3192	3192
1994	2916	246	454	3616	3616
1995	2940	184	532	3656	3656
1996	2355	147	369	2871	2871
1997	2553	102	391	3046	3046
1998	2023	67	351	2441	2441
1999	2791	56	410	3257	3257
2000	2695	28	523	3246	3246
2001	2651	41	567	3259	3259
2002	2775	79	586	3440	3440
2003	2607	44	617	3268	3268
2004	2400	25	710	3135	3135
2005	2269	17	662	2948	2948
2006	3409	17	667	4093	4093

* There are no landings by other countries from this FU

Table 13-6. *Nephrops*, North Minch (FU 11): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2005 (data for all *Nephrops* gears combined, and for single and multirigs separately).

	All *Nephrops* Gears			Single Rig			Multi Rig		
Year	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2320	78.5	29.6	2320	78.5	29.6	na	na	na
1982	2323	82.4	28.2	2323	82.4	28.2	na	na	na
1983	2784	64.9	42.9	2784	64.9	42.9	na	na	na
1984	3449	79.3	43.5	3449	79.3	43.5	na	na	na
1985	3236	96.8	33.4	3236	96.8	33.4	na	na	na
1986	2642	93.2	28.3	2642	93.2	28.3	na	na	na
1987	3458	121.2	28.5	3458	121.2	28.5	na	na	na
1988	3449	115.0	30.0	3449	115.0	30.0	na	na	na
1989	2603	87.9	29.6	2603	87.9	29.6	na	na	na
1990	1941	79.8	24.3	1941	79.8	24.3	na	na	na
1991	2228	93.4	23.9	2123	90.5	23.5	105	2.9	36.7
1992	2978	99.4	30.0	2810	95.7	29.4	168	3.7	45.4
1993	2699	105.4	25.6	2657	104.4	25.4	42	1.0	43.4
1994	2916	100.8	28.9	2916	100.8	28.9	0	0.0	0.0
1995	2940	94.2	31.2	2937	94.1	31.2	3	0.1	60.0
1996	2355	78.0	30.2	2354	78.0	30.2	1	0.0	0.0
1997	2553	90.0	28.4	2510	88.8	28.3	43	1.2	35.8
1998	2023	84.9	23.8	1973	83.4	23.7	50	1.5	33.3
1999	2791	96.7	28.9	2750	95.5	28.8	41	1.2	34.2
2000	2695	92.6	29.1	2675	92.2	29.0	21	0.4	52.5
2001	2651	82.1	32.3	2599	80.9	32.1	51	1.2	43.3
2002	2775	79.3	35.0	2684	76.5	35.1	91	2.8	32.5
2003	2607	74.1	35.2	2589	73.9	35.0	17	0.2	85.0
2004	2400	69.7	34.4	2377	69.0	34.4	23	0.2	99.6
2005	2269	58.0	39.1	2244	57.7	38.9	26	0.2	130.0
2006	3409	62.2	54.8	3347	61.3	54.6	63	0.6	105.0

Table 13-7. *Nephrops*, North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2005.

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

Table 13-8 *Nephrops*, North Minch (FU11) North Minch (FU 11): Results by stratum of the 2004 and 2005 TV surveys. Note that stratification was based on a series of arbitrary rectangles.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2004 TV survey							
U	656	15	0.71	0.07	464	2148	0.315
V	425	9	0.57	0.05	240	1031	0.151
W	563	10	0.57	0.09	319	2849	0.418
X	131	4	0.64	0.18	84	786	0.115
Total	1775	38			1107	6813	1
2005 TV survey							
U	656	14	0.80	0.10	521	3780	0.540
V	425	10	0.54	0.05	228	863	0.120
W	563	11	0.49	0.07	274	2053	0.290
X	131	6	0.91	0.12	119	359	0.050
Total	1775	41			1142	7055	1

Table 13-9 *Nephrops*, North Minch (FU 11): Results of the 1994-2005 TV surveys.

Year	Station Number	Mean density	Abundance	95% confidence	Biomass
		burrows/m²	millions	millions	'000 tonnes
1994	41	0.38	665	99	12.5-16.9
1995		No survey			
1996	38	0.25	439	62	8.3-11.1
1997		No survey			
1998	38	0.41	728	103	13.8-18.4
1999	36	0.32	565	104	10.2-14.8
2000	39	0.41	725	80	14.2-17.8
2001	56	0.39	691	75	13.6-16.9
2002	37	0.49	876	149	16.1-22.6
2003	41	0.64	1131	209	20.4-29.6
2004	38	0.62	1107	165	20.8-28.1
2005	41	0.64	1142	168	21.5-28.9

Table 13-10 *Nephrops*, South Minch (FU12), Nominal Landings of *Nephrops*, 1981–2006, as officially reported.

Year	UK Scotland				Other UK	Ireland	Total
	Nephrops trawl	Other trawl	Creel	Sub-total			
1981	2965	254	432	3651	0	0	3651
1982	2925	207	420	3552	0	0	3552
1983	2595	361	456	3412	0	0	3412
1984	3228	478	594	4300	0	0	4300
1985	3096	424	488	4008	0	0	4008
1986	2694	288	502	3484	0	0	3484
1987	2927	418	546	3891	0	0	3891
1988	3544	364	555	4463	10	0	4473
1989	3846	338	561	4745	0	0	4745
1990	3732	262	436	4430	0	0	4430
1991	3597	341	503	4441	1	0	4442
1992	3479	208	549	4236	1	0	4237
1993	3608	193	659	4460	5	0	4465
1994	3743	265	404	4412	3	0	4415
1995	3442	716	508	4666	14	0	4680
1996	3107	419	468	3994	1	0	3995
1997	3519	331	592	4442	3	1	4446
1998	2851	340	538	3729	0	0	3729
1999	3165	359	513	4037	0	14	4051
2000	2939	312	699	3950	0	2	3952
2001	2823	393	767	3983	0	9	3992
2002	2234	315	742	3291	0	14	3305
2003	2812	203	858	3873	0	6	3879
2004	2865	104	880	3849	0	19	3868
2005	2812	46	953	3811	1	31	3843
2006	3554	19	964	4537	9	35	4581

Table 13-11 *Nephrops*, South Minch (FU 12): Landings (tonnes), effort ('000 hours trawling) and lpue (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2006 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* Gears			Single Rig			Multi Rig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2965	81.6	36.4	2965	81.6	36.4	na	na	na
1982	2925	93.1	31.4	2925	93.1	31.4	na	na	na
1983	2595	77.9	33.3	2595	77.9	33.3	na	na	na
1984	3228	93.4	34.6	3228	93.4	34.6	na	na	na
1985	3096	130.3	23.8	3096	130.3	23.8	na	na	na
1986	2694	105.8	25.5	2694	105.8	25.5	na	na	na
1987	2927	126.3	23.2	2927	126.3	23.2	na	na	na
1988	3544	120.9	29.3	3544	120.9	29.3	na	na	na
1989	3846	138.3	27.8	3846	138.3	27.8	na	na	na
1990	3732	153.5	24.3	3732	153.5	24.3	na	na	na
1991	3597	150.5	23.9	3109	134.6	23.1	488	15.8	30.8
1992	3479	127.3	27.3	3092	115.0	26.9	387	12.3	31.5
1993	3608	126.5	28.5	3441	122.5	28.1	167	4.0	41.5
1994	3743	144.4	25.9	3650	141.4	25.8	93	3.0	31.3
1995	3442	100.4	34.3	3407	99.6	34.2	35	0.9	39.8
1996	3108	106.4	29.2	3036	104.1	29.2	71	2.4	30.1
1997	3519	117.5	29.9	3345	112.1	29.8	174	5.4	32.0
1998	2851	101.4	28.1	2792	99.5	28.1	59	1.9	30.4
1999	3165	111.5	28.4	3111	109.3	28.5	54	2.2	24.6
2000	2939	106.2	27.7	2819	102.1	27.6	121	4.1	29.7
2001	2823	101.7	27.8	2764	99.8	27.7	59	1.9	30.8
2002	2234	75.7	29.5	2210	75.1	29.4	25	0.6	38.9
2003	2812	94.3	29.8	2716	93.5	29.0	96	0.8	113.9
2004	2865	89.8	31.9	2598	84.7	30.7	267	5.1	52.0
2005	2812	82.6	34.0	2568	79.4	32.3	244	3.2	76.3
2006	3554	92.7	38.3	3256	88.9	36.6	298	3.8	78.4

Table 13-12 *Nephrops*, South Minch (FU 12): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2005.

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

Table 13-13 South Minch (FU12) Results by stratum of the 2004 and 2005 TV surveys. Note that stratification was based on a series of sediment strata.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2004 TV survey							
M	303	3	0.53	0.02	162	604	0.011
SM	2741	19	0.56	0.12	1533	48089	0.921
MS	2028	16	0.42	0.01	848	3512	0.067
Total	5072	38			2543	52206	1
2005 TV survey							
M	303	2	0.69	0.04	208	1674	0.015
SM	2741	17	0.55	0.24	1504	106640	0.732
MS	2028	14	0.40	0.13	816	37418	0.257
Total	5072	33			2528	145732	1

Table 13-14 *Nephrops*, South Minch (FU 12): Results of the 1994–2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	33	0.30	1520	331	25.8-40.2
1996	21	0.38	1945	700	27.1-57.5
1997	36	0.28	1434	244	25.8-36.5
1998	38	0.38	1916	306	35.0-48.3
1999	37	0.23	1146	275	18.9-30.9
2000	41	0.37	1851	332	33.0-47.5
2001	47	0.44	2228	512	37.9-60.5
2002	31	0.42	2114	671	31.9-61.5
2003	25	0.42	2121	721	30.9-62.8
2004	38	0.50	2543	457	46.1-66.3
2005	33	0.50	2529	763	38.9-72.7

Table 13-15 *Nephrops*, Clyde (FU13), Nominal Landings of *Nephrops*, 1981–2005, as officially reported.

Year	UK Scotland				Other UK	Total
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	2498	404	66	2968	0	2968
1982	2373	171	79	2623	0	2623
1983	3890	120	53	4063	14	4077
1984	3069	154	77	3300	10	3310
1985	3921	293	64	4278	7	4285
1986	4074	175	79	4328	13	4341
1987	2859	80	65	3004	3	3007
1988	3507	108	43	3658	7	3665
1989	2577	184	35	2796	16	2812
1990	2732	122	24	2878	34	2912
1991	2845	145	25	3015	23	3038
1992	2532	246	10	2788	17	2805
1993	3199	110	5	3314	28	3342
1994	2503	49	28	2580	49	2629
1995	3767	132	26	3925	64	3989
1996	3880	111	27	4018	42	4060
1997	3486	44	25	3555	63	3618
1998	4539	81	40	4660	183	4843
1999	3475	29	38	3542	210	3752
2000	3143	63	76	3282	137	3419
2001	2889	67	94	3050	132	3182
2002	3074	53	105	3232	151	3383
2003	2954	20	117	3091	80	3171
2004	2659	18	90	2767	258	3025
2005	3148	1	100	3249	148	3397
2006	4314	0	165	4479	244	4723

Table 13-16 *Nephrops*, Clyde (FU13): Breakdown of UK Nominal Landings of *Nephrops*, 1981–2006 into Clyde sub area, Firth of Clyde and Sound of Jura.

Year	UK		
	Firth of Clyde	Sound of Jura	All sub-areas
1981			2968
1982			2623
1983			4077
1984			3310
1985			4285
1986			4341
1987			3007
1988			3665
1989			2812
1990			2912
1991			3038
1992			2805
1993	2766	576	3342
1994	2094	535	2629
1995	3690	299	3989
1996	3673	387	4060
1997	3132	486	3618
1998	4372	471	4843
1999	3424	328	3752
2000	3230	189	3419
2001	2980	202	3182
2002	3349	34	3383
2003	3148	18	3166
2004	2975	50	3025
2005	3387	36	3423
2006*	4467	60	4527
* - provisional			

Table 13-17 *Nephrops*, Clyde (FU 13): Landings (tonnes), effort ('000 hours trawling) and lpue (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981–2005 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* Gears			Single Rig			Multi Rig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1861	108.8	17.1	1861	70.5	26.4	na	na	na
1982	1798	93.1	19.3	1798	148.0	12.1	na	na	na
1983	3258	131.9	24.7	3258	108.8	29.9	na	na	na
1984	2433	122.5	19.9	2433	93.1	26.1	na	na	na
1985	3154	131.6	24.0	3154	131.9	23.9	na	na	na
1986	2745	141.5	19.4	2745	122.5	22.4	na	na	na
1987	2126	126.8	16.8	2126	131.6	16.2	na	na	na
1988	3190	141.6	22.5	3190	141.5	22.5	na	na	na
1989	2393	144.3	16.6	2393	126.8	18.9	na	na	na
1990	2435	142.8	17.0	2435	141.6	17.2	na	na	na
1991	2489	152.9	16.3	1594	144.3	11.0	895	39.5	22.7
1992	2091	144.6	14.5	1316	142.8	9.2	775	42.4	18.3
1993	2650	156.8	16.9	1771	113.5	15.6	879	43.1	20.4
1994	1996	118.0	16.9	1484	102.2	14.5	512	27.6	18.6
1995	3501	133.8	26.2	2583	113.7	22.7	918	31.5	29.1
1996	3530	150.1	23.5	2474	90.4	27.4	1048	38.1	27.5
1997	3020	131.9	22.9	2158	98.0	22.0	861	33.9	25.4
1998	4107	150.8	27.2	2964	110.2	26.9	1142	40.5	28.2
1999	3175	117.2	27.1	2322	86.3	26.9	853	30.9	27.6
2000	2980	124.4	24.0	2100	90.9	23.1	880	33.5	26.3
2001	2711	111.6	24.3	2445	100.2	24.4	266	11.4	23.3
2002	3043	99.6	30.6	2896	94.0	30.8	147	5.6	26.3
2003	2937	84.2	34.9	2839	81.2	35.0	97	3.0	32.3
2004	2611	72.3	36.1	2531	69.6	36.4	80	2.7	29.6
2005	3147	80.0	39.3	3121	78.9	39.6	26	1.1	23.6
2006	4314	84.7	50.9	4306	84.5	51.0	8	0.2	40.0

Table 13-18 *Nephrops*, Clyde (FU 13): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	28.4	27.3	30.2	29.3	40.3	39.3
1982	28.2	26.4	29.9	29.0	39.9	40.1
1983	27.9	26.7	29.3	28.5	40.8	39.5
1984	27.0	25.9	28.0	26.8	40.9	39.6
1985	27.1	26.1	28.1	27.2	39.8	39.3
1986	27.1	26.0	27.9	27.1	40.5	39.0
1987	28.5	26.5	29.6	28.3	39.4	40.0
1988	28.1	27.0	30.6	29.5	41.2	40.1
1989	26.9	26.9	30.2	30.0	41.6	39.8
1990	27.4	26.2	30.4	29.5	40.1	39.8
1991	28.6	27.1	29.2	28.2	39.3	40.3
1992	29.6	28.8	30.1	29.2	39.9	41.1
1993	29.6	29.7	31.4	30.9	40.4	39.9
1994	26.4	27.0	29.4	29.4	40.8	39.2
1995	27.2	25.8	28.7	27.6	40.3	39.8
1996	28.8	28.0	30.0	29.1	38.6	40.4
1997	27.9	26.9	30.0	29.2	40.0	40.3
1998	25.9	25.2	28.4	27.9	38.9	39.1
1999	26.5	25.3	28.5	27.3	39.0	39.5
2000	28.3	27.7	29.3	28.6	38.7	39.1
2001	27.4	26.8	29.5	28.7	39.0	39.6
2002	27.5	25.6	28.4	26.4	39.0	39.4
2003	27.2	25.9	29.1	27.9	39.2	38.6
2004	27.1	26.5	28.4	27.6	39.2	39.5
2005*	28.0	26.7	29.2	27.9	38.7	38.1

* provisional na = not available

Table 13-19 *Nephrops*, Firth of Clyde (part of FU 13): Results by stratum of the 2004 and 2005 TV surveys. Note that stratification was based on a series of sediment strata.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2004 TV survey							
M	717	10	0.87	0.10	621	4990	0.276
SM(N)	316	8	0.73	0.10	229	1280	0.071
SM(S)	366	4	1.20	0.03	437	1142	0.063
MS	665	10	0.88	0.24	582	10649	0.590
Total	2063	32			1869	18060	1
2005 TV survey							
M	717	19	0.96	0.17	688	4618	0.296
SM(N)	316	4	0.93	0.01	294	271	0.017
SM(S)	366	7	1.45	0.22	530	4124	0.264
MS	665	14	0.70	0.21	464	6564	0.461
Total	2063	44			1975	15576	1

Table 13-20 *Nephrops*, Firth of Clyde (FU 13): Results of the 1994–2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	29	0.33	671		
1996	38	0.56	1156	248	20.0-31.0
1997	31	0.66	1365	266	24.2-36.0
1998	38	0.67	1384	232	25.4-35.7
1999	39	0.44	907	215	15.2-24.7
2000	40	0.62	1270	188	23.8-32.1
2001	39	0.65	1339	209	24.9-34.2
2002	36	0.73	1499	287	26.7-39.4
2003	37	0.82	1682	233	32.0-42.2
2004	32	0.91	1869	269	35.3-47.2
2005	44	0.96	1975	250	38.1-49.1

Table 13-21 *Nephrops*, Sound of Jura (Part of FU 13): Results by stratum of the 2003 and 2005 TV surveys (most recent). Note that stratification was based on a series of sediment strata.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
M	90	5	0.81	0.05	73	82	0.050
SM	150	4	0.71	0.02	106	107	0.065
MS	142	3	0.92	0.21	131	1432	0.883
Total	382	12			309	1621	1
2005 TV survey							
M	90	4	0.94	0.05	84	106	0.042
SM	150	4	0.65	0.00	98	9	0.004
MS	142	3	1.26	0.36	178	2404	0.954
Total	382	11			360	2519	1

Table 13-22 *Nephrops*, Sound of Jura (FU 13): Results of the 1994–2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	7	0.50	190	69	
1996	10	0.53	204	31	
1997	no surveys				
1998					
1999					
2000					
2001	13	0.85	324	90	
2002	9	1.24	474	199	
2003	12	0.81	309	81	
2004	no survey				
2005	11	0.94	360	100	

Table 13-23 *Nephrops*, Stanton Banks: Results by stratum of the 2003 and 2005 TV surveys (most recent). Note that stratification was based on a series of sediment strata.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
SM	26.5	2	0.30	0.00	8	1	0.99
MS	261	6	0.32	0.01	82	151	0.01
Total	288	8			90	152	1.00
2005 TV survey							
SM	26.5	2	0.44	0.05	12	18	0.11
MS	261	5	0.32	0.01	83	144	0.89
Total	288	7			95		1.00

Table 13-24 *Nephrops*, Stanton Bank: Results of the 1995–2005 TV surveys.

Year	Station number	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	9	0.22	64	35
1996		no survey		
1997	9	0.28	80	31
1998		no surveys		
1999				
2000				
2001	8	0.24	68	25
2002	8	0.27	78	21
2003	8	0.31	90	25
2004		no survey		
2005	7	0.33	95	26

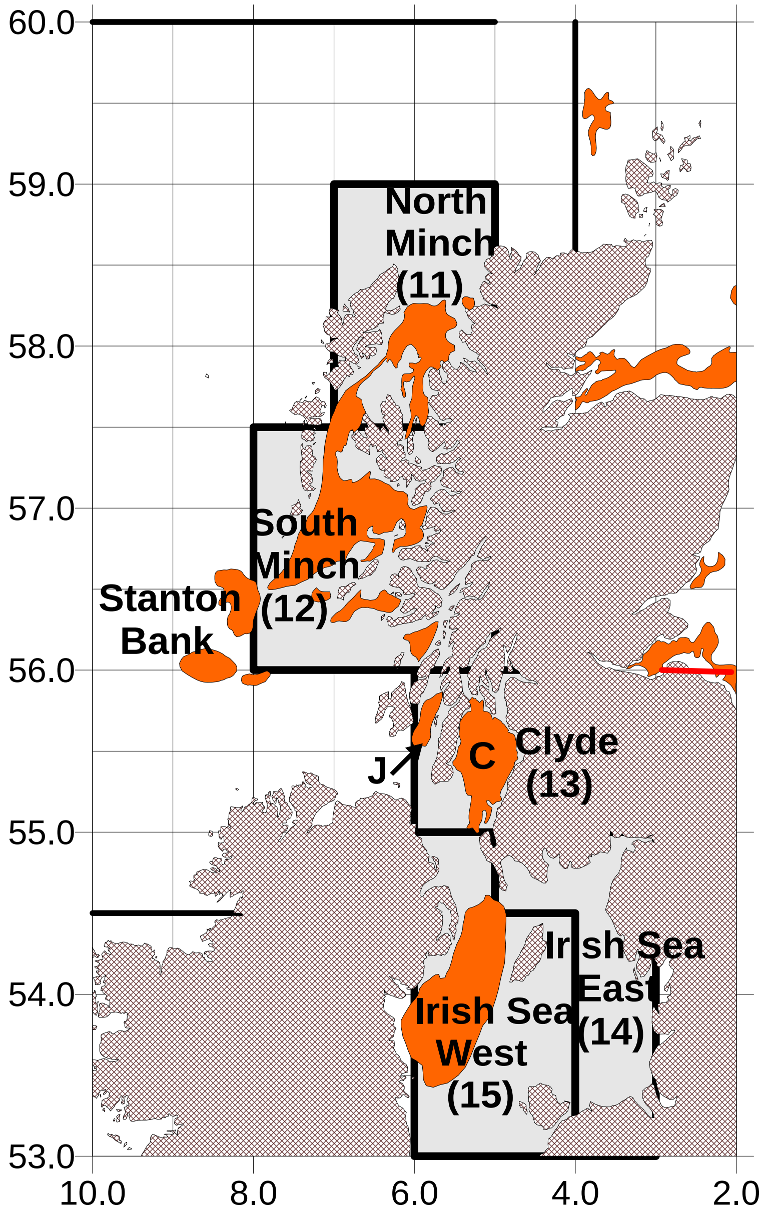


Figure 13-1. ***Nephrops*** **Functional Units in VIa and VIIa. Bold lines show boundaries of FUs, shaded regions within FUs indicate mud distribution. Within the Clyde FU, C denotes Firth of Clyde and J denotes Sound of Jura.**

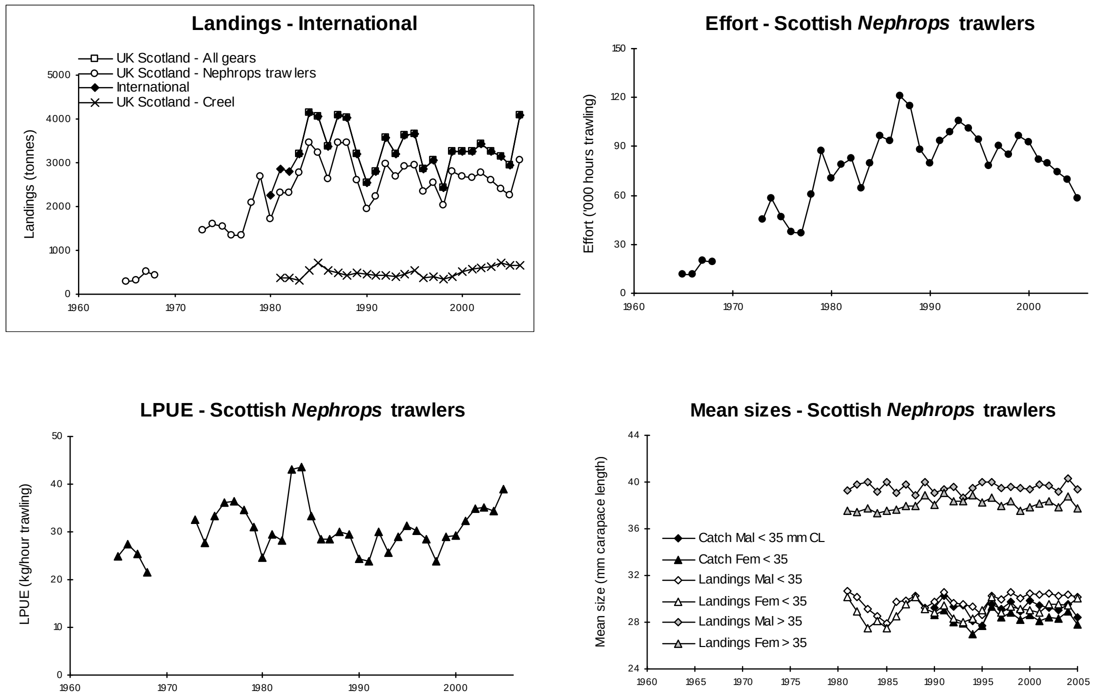


Figure 13-2. *Nephrops*, North Minch (FU11), Long term landings, effort, lpue and mean sizes.

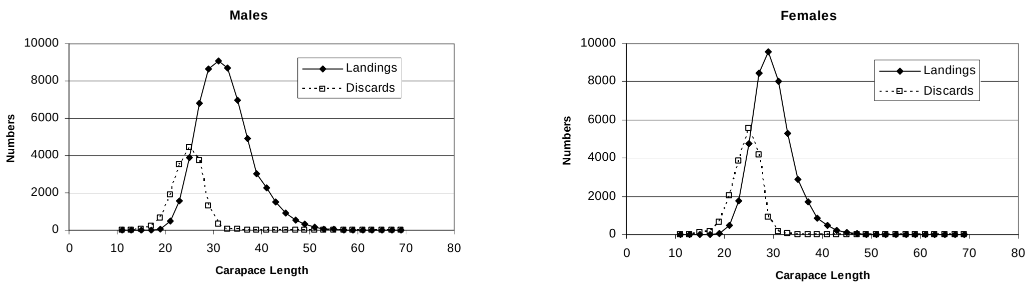


Figure 13-3. *Nephrops*, North Minch (FU11), Length frequency distributions of male and female landings and discards, averaged over 2003–2005.

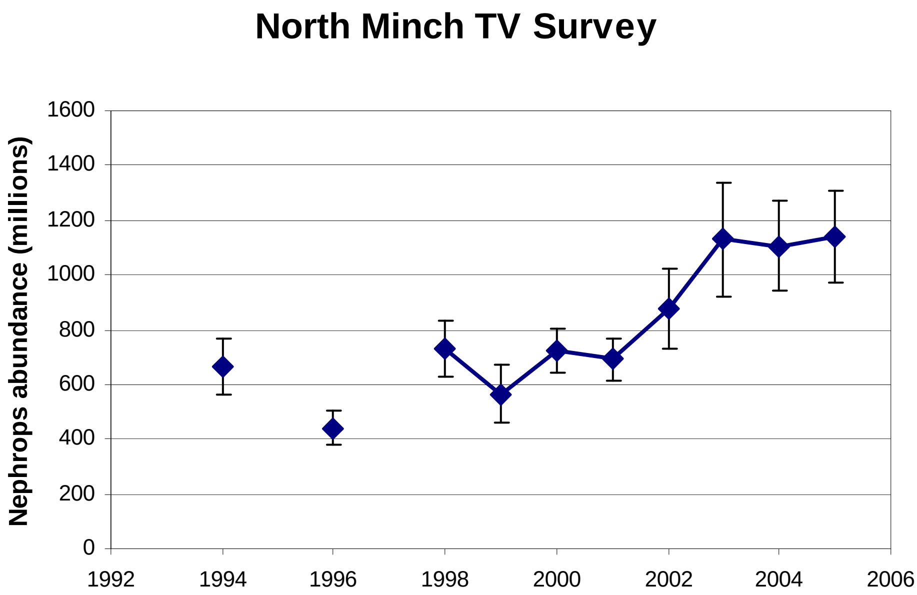


Figure 13-4. *Nephrops*, North Minch (FU11), Time series of TV survey abundance estimates, with 95% confidence intervals, 1994–2005.

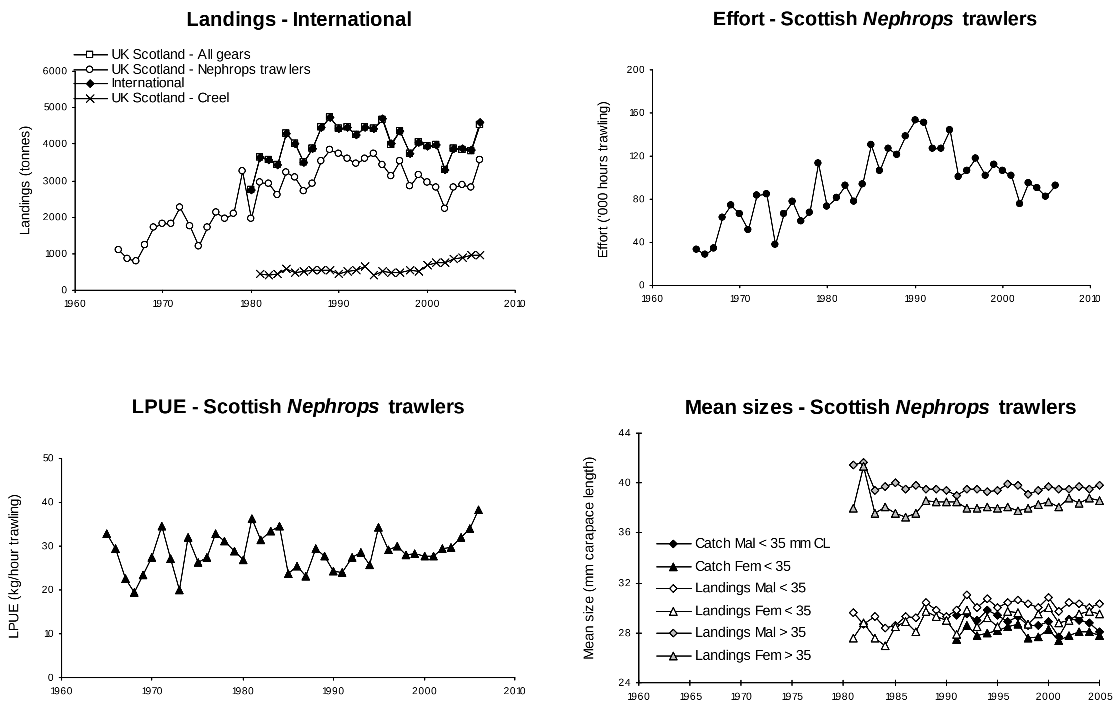


Figure 13-5. *Nephrops*, South Minch (FU12), Long term landings, effort, lpue and mean sizes.

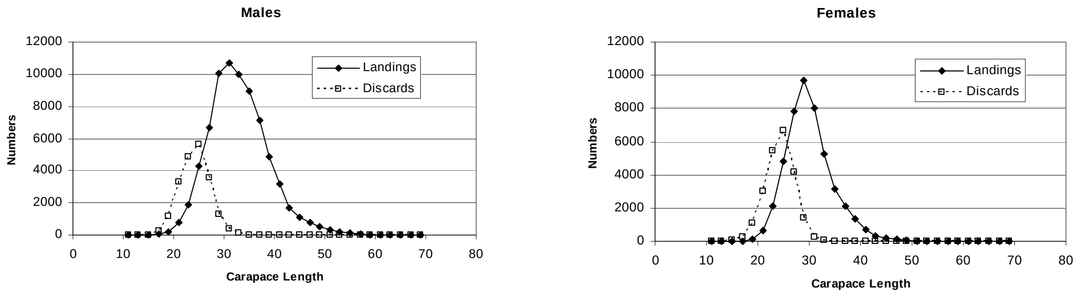


Figure 13-6. *Nephrops*, South Minch (FU12), Length frequency distributions of male and female landings and discards, averaged over 2003–2005

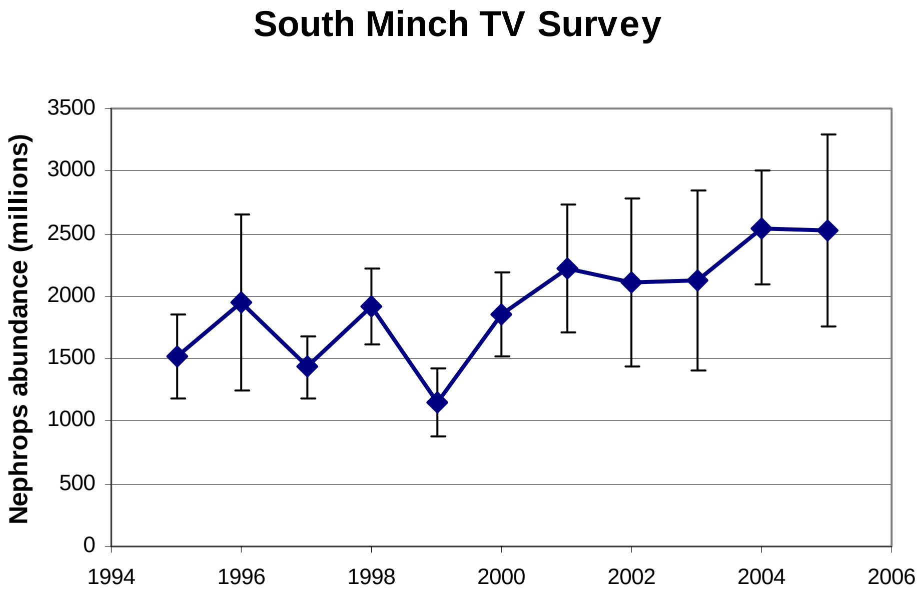


Figure 13-7. *Nephrops*, South Minch (FU12), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005.

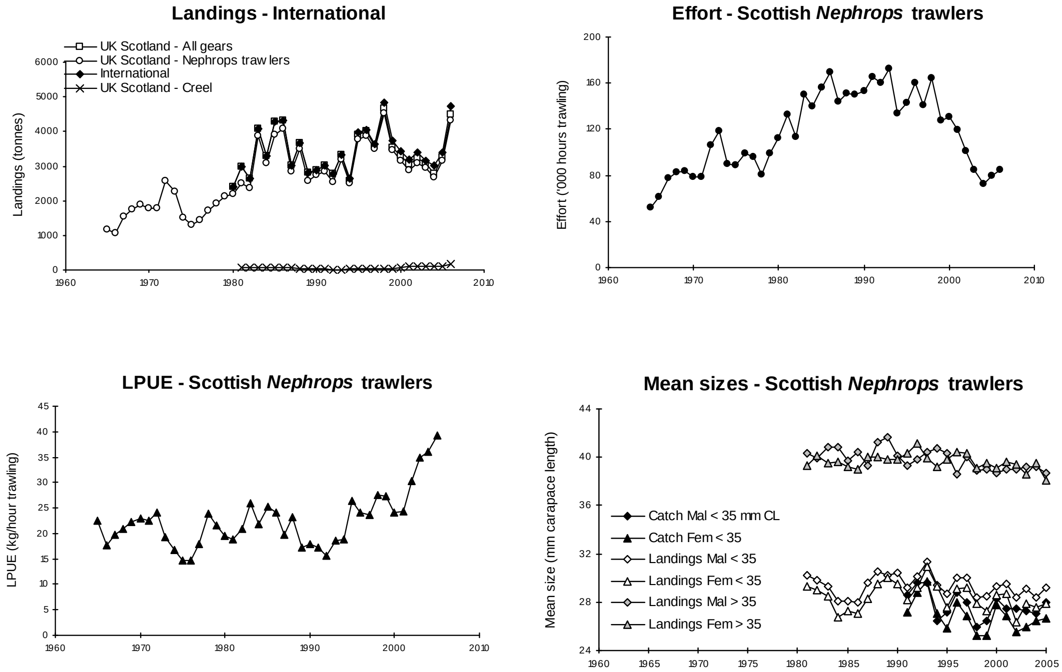


Figure 13-8. *Nephrops*, Clyde (FU13), Long term landings, effort, lpue and mean sizes.

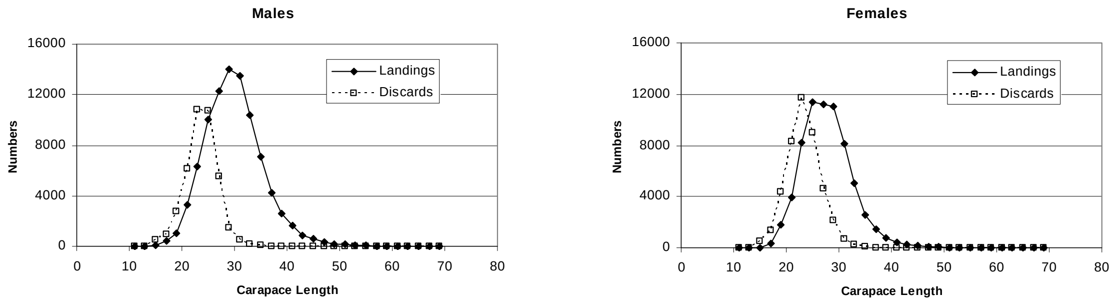


Figure 13-9. *Nephrops*, Firth of Clyde (FU13), Length frequency distributions of male and female landings and discards, averaged over 2002–2004.

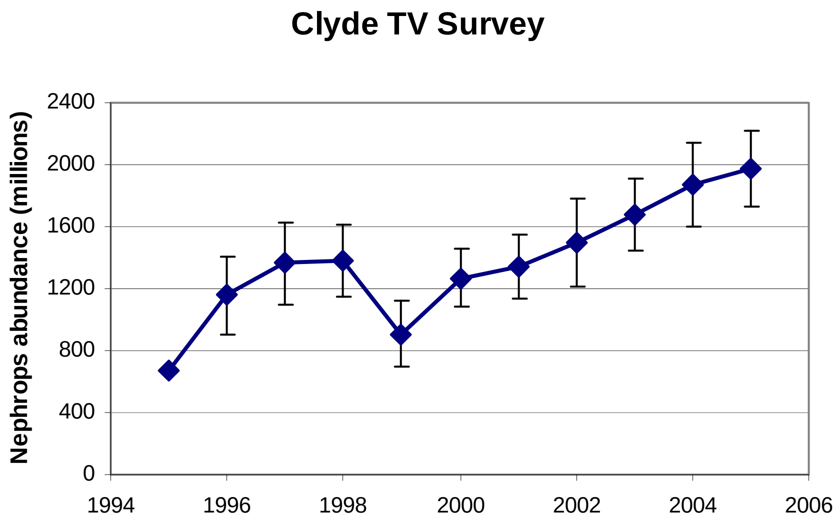


Figure 13-10. *Nephrops*, Firth of Clyde (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005.

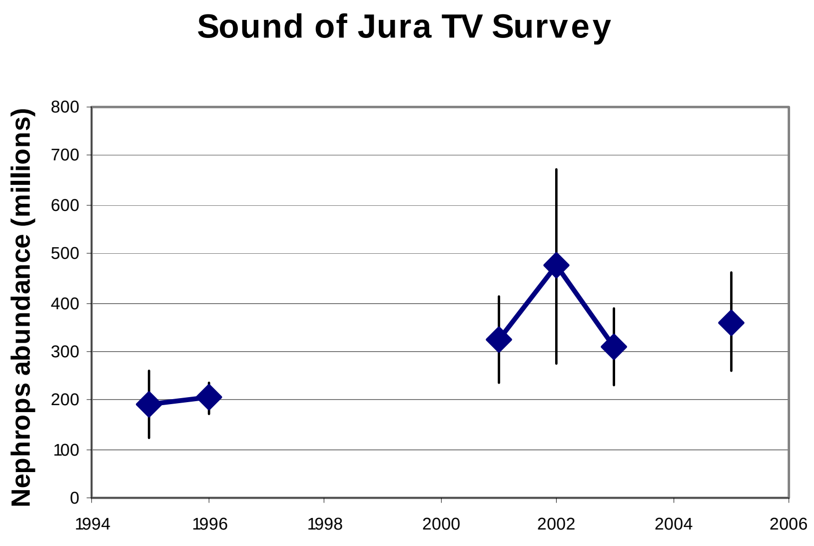


Figure 13-11. ***Nephrops*, Sound of Jura (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005.**

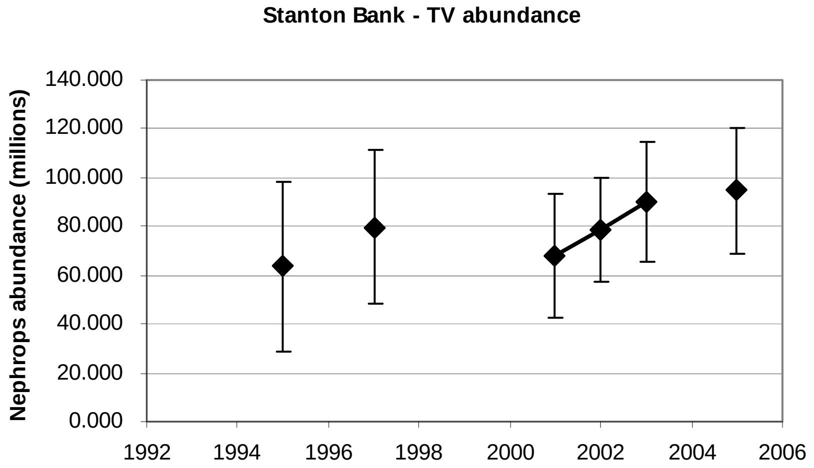


Figure 13-12. ***Nephrops*, Stanton Bank, Time series of TV survey abundance estimates, with 95% confidence intervals, 1995–2005.**

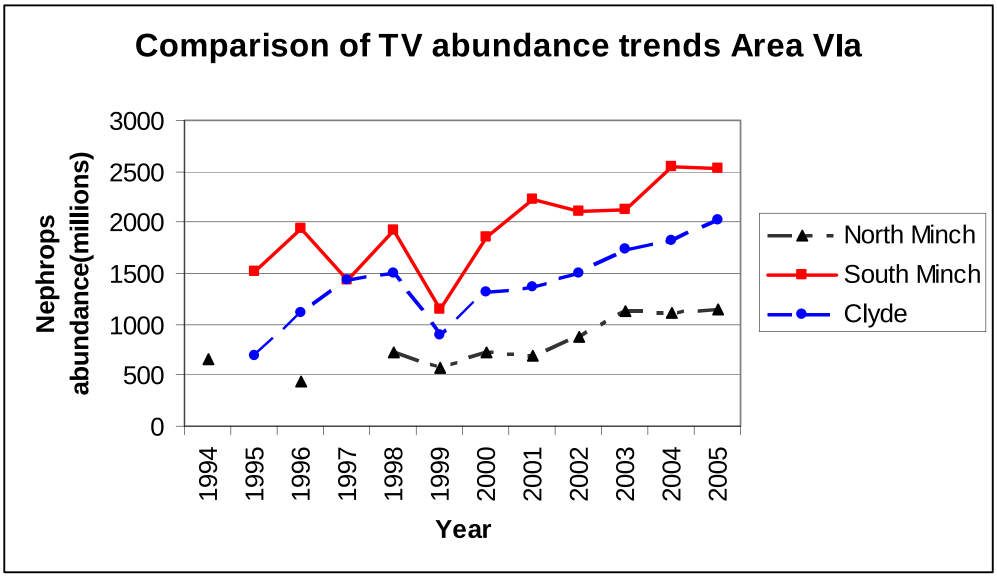


Figure 13-13. *Nephrops*, Comparison of TV abundance trends in the three FUs making up Division VIa – ICES area VIa.

14 *Nephrops* in Division VIIa

14.1 *Nephrops* in VIIa

In accordance with the terms of reference for this year's meeting the information on Nephrops contained within this report is an update of catch tables and fishery statistics only. No new assessment of Nephrops stocks has been carried out this year. There is, therefore, no basis for revision of the advice provided in 2006. The working group considers that management advice provided in 2006 is applicable to 2007 and 2008. The working group continues to stress the importance of regular monitoring of Nephrops stocks through annual surveys and monitoring of catch statistics.

Management advice for 2007 and 2008 is determined from assessments conducted in 2006. Consequently no new assessments have been carried out in 2007. The information presented in this report is an update of the catch and landings statistics.

Nephrops were assessed by WGNEPH on the basis of population distribution, and defined as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 14.1 and Figure 13.1.

The Functional Unit is the level at which the WG collects fishery data (quantities landed and discarded, fishing effort, cpues and lpues, etc.) and length distributions, and at which it performs analytical assessments.

Nephrops from the north of 53^{o}N of Division VIIa form two Functional Units, Irish Sea East (FU14) and Irish Sea West (FU15).

14.1.1 ICES Advice applicable to 2006 and 2007

ICES advice for 2006

The *Nephrops* trawl fisheries take considerable bycatches of other species. The management of these fisheries should be seen in the context of mixed fisheries. Evidence of under-reporting of landings creates problems with using commercial data for analytical assessments and in TAC recommendations. Despite evidence of under reporting, the *Nephrops* fisheries in Division VIIa have been sustained for over 20 years with similar high levels of fishing effort. Because of some uncertainty regarding the accuracy of recent landings the advice for these FUs (14 & 15) is based on effort, whereas the advice for other *Nephrops* stocks within the TAC area is based on recent average landings (2000–2002). There is no information on the accuracy of landings for these other *Nephrops* stocks.

ICES advice for 2007

The advice implies maintaining fishing effort in *Nephrops*-directed fleets at recent levels of around 4.4 million kW days. This is based on the 2003–2005 average effort by *Nephrops* single- and twin-rig trawls as estimated by STECF for 2003 and 2004 and updated by ICES for 2005. If effort can be effectively controlled, this fishery can be managed without a TAC. If the true landings can be established ICES considers that the harvest ratio based on the TV surveys could be adjusted over time in the fishery to ensure that the stock is exploited at a sustainable rate in the long term. Implicit in this approach is that catch and effort are reported accurately and that the fishery is managed at an appropriate geographic scale (i.e. Functional Unit). The *Nephrops* trawl fisheries take bycatches of other species such as cod and particularly juvenile whiting. The management of these fisheries should be seen in the context of mixed fisheries.

Management objectives

Nephrops in Division VIIa are managed through a total TAC for Subarea VII. There are no specific management objectives set for this fishery.

Reference points

No reference points have been determined for *Nephrops*.

Single-stock exploitation boundaries

Exploitation boundaries in relation to precautionary limits.

Given the uncertainties surrounding the landings for this stock it is not possible to provide advice on catches in 2007. The stocks in this area appear to be in good condition and have sustained current levels of effort for many years. Therefore ICES advises that effort in this fishery should not be allowed to increase compared to 2003–2005 levels.

Mixed fishery considerations.

See Section 1.7.

14.1.2 Management applicable in 2006 and 2007

The table below gives the ICES advice and its basis as provided for each Functional Unit in the TAC area as a whole in 2007. The table also gives the TACs in 2006 and 2007 for all of VII. The TAC was increased by 10% for 2006 and by a further 15% for 2007.

FUNCTIONAL UNITS	ICES ADVICE FOR MA IN VII	BASIS OF ICES ADVICE IN 2006	TAC 2006	TAC 2007
14, 15	9 440	Effort maintained at recent levels		
16, 17, 18,19	3 300	Restrict landings to average landings of recent years		
20–22	4 600	Average landings 1993-2002		
14–22	17 340		21 498	25 153

In 2006 the main fleets targeting *Nephrops* include directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Ireland. Details of all regulations including effort controls in place are provided in Section 1.7.

These regulations incorporate a system of 'mesh size ranges' for each of which has been identified a list of target species. In effect, nets in the 70-79 mm mesh size range must have at least 35 % of the list of target species (which includes *Nephrops*) and the 80–99 mm mesh size range requires at least 30% of the list of target species. A square mesh panel (SMP) of 80 mm is required for 70-79 mm nets in the Irish Sea. Vessels using twin-rig gear in the Irish Sea must comply with a minimum mesh size of 80 mm (no SMP is required for nets with 80 mm meshes and above). In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels from 14 February to 30 April as part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

Other *Nephrops* conservation measures in the Irish Sea are a minimum landing size of 20 mm CL length (equivalent to 37 mm tail length or 70 mm total length).

Official declared landings from Division VIIa are presented in Tables 14.2, 14.3 and 14.4.

14.2 Irish Sea East (FU14)

14.2.1 The fishery in 2006

Between 1999 and 2003 the number of vessels fishing for *Nephrops* in FU14 declined by 40% to a fleet of around 50 vessels. This was largely due to the reduction in the number of visiting UK vessels and the decommissioning of part of the Northern Irish and local English fleets. Since then the fleet has consisted of around 50 to 60 vessels. Despite 12 vessels visiting this fishery for the first time in 2006 there was no net increase in the size of the fleet. Currently, around 25 of these vessels, between 9 and 21 m in length, have their ‘home’ ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is generally made up of larger vessels from Kilkeel, Northern Ireland.

In 2006 about 65% of the landings from this fishery were made to Whitehaven and about 25% to Kilkeel. Over half of the Northern Irish and a few of the English vessels use twin or triple trawls and account for around 40% of the *Nephrops* landings in weight from this FU. Between 1999 and 2006, the recorded number of vessels using these multiple trawls has fluctuated without trend between 15 and 26 vessels, with around 85% of these vessels coming from Northern Ireland. The earlier decline in the fleet was mainly in the number of single trawlers.

Of the Northern Irish fleet, the proportion of vessels using multiple trawls, the average vessel size and average fishing effort per trip have all increased since 1999. The proportion returning, at the end of a *Nephrops* trip in FU14 to land in to Northern Ireland has also increased from 6 to 37% over the same period.

The decline in the English and Welsh fleet has had little affect on the average vessel size and gear make up overall. However the changes to the fleets at individual ports has been far more significant. The decline in other stocks, technical conservation and cod recovery measures have affected mesh sizes and fishing patterns. The number of UK vessels moving from this fishery in the summer to the Farn Deeps fishery in the winter has increased from around a couple of vessels in 2004 to around 15 in 2006.

14.2.2 Catch data

14.2.2.1 Official Catch Statistics

Official landings as reported to ICES from FU 14 are presented in Table 14.3 and were updated for 2005.

14.2.2.2 Revision to catch data

The official landings as reported by each country were updated for 2005.

14.2.2.3 Quality of the Catch data

A 10% TAC increase in 2006 coupled with the implementation in the UK of buyers and sellers regulations towards the end of 2005 and effective throughout 2006 is believed to have improved the quality of reported landings information.

14.2.3 Biological Sampling

Biological sampling of this fishery is presented in Table 14.6.

14.2.4 Commercial catch-effort data and research vessel surveys

Over the past 19 years, landings from FU 14 have been relatively stable, fluctuating around a long-term average (1991–2006) of about 550 t (Figure 14.1). Landings in 2006 are at the highest level since 1999, after landings dropped in 2003 to their lowest point since 1974. Over the last 10 years UK vessels have landed, on average, 86% of the annual international landings. Irish vessels increased their share of the landings to 35% in 2002 but this has since declined to around 6% in 2006. (Table 14.5). In 2006, most of the landings were made into England with a high proportion of these landings (58 % of the directed landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1978 reaching a minimum in 2004. Effort in 2006 decreased by 5% on the 2006 level. Quarterly effort plots show a predominance of effort in the 2nd and 3rd quarters (Figure 14.2).

The UK lpue series is based on a combination of directed *Nephrops* voyages by English and Welsh vessels landing to Fleetwood and Whitehaven, where the weight of *Nephrops* landed is more than 25% of the total landing, and all trips by visiting Northern Irish vessels which target *Nephrops* (Table 14.7). The combined lpue has fluctuated between 17 and 30 kg/hour trawling in the last 10 years with the lowest and the highest lpue figure occurring in 2003 and 2006 respectively (Figure 14.1). A particular feature of the recent lpue is the dramatic increase observed in 2004, which is mainly driven by the Northern Irish fleet. Such a pattern has been seen before (1989–1990) and is therefore not unique. It might reflect a change in reporting or a change in targeted effort rather than biological phenomena. Lpues for males and females < 35 mm CL (Figure 14.3) appear to exhibit the same general trends fluctuating around averages of 5.5 and 4.5 kg/hour trawling respectively with minima in 2003. The lpue of the larger males (>35 mm) has been increasing since 2002. For females >35 mm, the quarterly pattern of availability to the fishery means that meaningful statistics for this portion of the population are highly dependent upon the level of fishing/sampling effort deployed in the 3rd quarter. There are no recent research vessel survey data for this Functional Unit.

14.2.5 Reference points

No reference points have been determined for this *Nephrops* stocks.

14.2.6 Management considerations

This is discussed in Section 14.4 in relation to FU 14 in ICES division VIIa.

14.3 Irish Sea West (FU15)

14.3.1 The Fishery in 2006

General information on the fishery can be found in section 1.52 and in the stock files.

Following a range of decommissioning rounds in Northern Ireland since 1992 there remained 108 vessels >10 m in 2005 capable of fishing for *Nephrops*, Of these vessels roughly 50 work twin trawls for part of the year. Apart from a small migration into twin-rig *Nephrops* fishing during 2006 by redundant whitefish vessels which has contributed to increased landings, the fleet has remained much the same. Single trawl vessels normally do 1–2 day trips of 3–4 hour tows while twin-trawl vessels stay at sea for 3–5 days and do tows of 4–12 hours duration. Landings were into the three traditional Northern Ireland ports of Kilkeel, Ardglass and Portavogie. Quota shortage during 2006 caused a number of vessels to move into the North Sea via the Caledonian canal,, a situation that has been reduced in 2007 by the increased TAC allocated to Area VII. Historically, *Nephrops* were landed into Northern Ireland as tails only and sold to supply the lucrative 'scampi' industry for consumption at home and abroad. During the last few years there has been an increasing trend towards landing whole large *Nephrops* for export.

Irish otter board trawlers fishing in FU15 generally use twin-rig gear with mesh size between 70–80mm to fish for *Nephrops*. The Irish Sea *Nephrops* fleet is highly opportunistic and of this fleet, there are only a handful of boats that fish the Irish Sea Prawn Grounds 100% of the time. *Nephrops* landings generally reach a peak in quarter 3, when the fishery is traditionally at its peak. The rest of the fleet divides its time between the Irish Sea, Smalls, Aran and Porcupine Grounds depending on tides, weather and market forces. Because of the need to fish further away from their homeport and in rougher sea conditions, many of the older and smaller wooden vessels are being replaced with new and second hand steel vessels. Most of these newer vessels are French-style twin-riggers. To maximize the return on their investment, many of the owners of newer vessels are opting for relief skippers and crews so that the vessels are fishing as much as possible. The number of older vessels in fleet has further been reduced with the implementation of the Irish vessel-decommissioning scheme. Under the scheme, 26 vessels with a track record of fishing in VIIa were permanently removed in August 2006. The number of older vessels in fleet has further been reduced with the implementation of the Irish vessel-decommissioning scheme. Under the scheme, 26 vessels with a track record of fishing in VIIa were permanently removed in August 2006. Overall, *Nephrops* landings by Irish vessels from the Irish Sea have been declining. This reflects the increasing amount of effort by East Coast vessels in FU20–22. This redirection of effort is due to the increase in vessel operation costs. Two significant fleet movements occurred in 2006. Firstly, there was a brief shift in effort by the *Nephrops* fleet towards the Aran Grounds around October due to reports of good fishing in the area. Also, some of the larger twin-riggers in the fleet switched to tuna fishing in the Bay of Biscay during the summer months.

14.3.2 Catch data

14.3.2.1 Official Catch Statistics

Official landings as reported to ICES from FU 15 are presented in Table 14.3 and were updated for 2005.

14.3.2.2 Revision to catch data

The official landings as reported to by each country were updated for 2005.

14.3.2.3 Quality of Catch data

A 10% TAC increase in 2006 coupled with the implementation in the UK of buyers and sellers regulations towards the end of 2005 and effective throughout 2006 is believed to have improved the quality of reported landings information.

14.3.3 Biological Sampling

Biological sampling of this fishery by country is presented in Table 14.10. Access to market sampling has been restricted in recent years.

14.3.4 Commercial catch-effort data and research vessel surveys

Total declared international *Nephrops* landings reported from FU 15 in 2006 was 7 508 t (Table 14.11). Reported Republic of Ireland landings peaked at 4 582 t in 1999 and dropped to a provisional 2 013 t in 2006 the lowest level in the last ten year period. Officially reported landings by UK vessels from this FU were 5 495 t, which is 73% of the international landings. Northern Ireland landings represented 98 % of the total UK landings from this FU.

Cpues and lpues for the Northern Ireland fleet have remained relatively constant since 1995 with a drop in 2000. There has been an increasing trend since 2000 to the highest value in 2006 in the available time series (Figure 14.1. and Table 14.12). This may be attributed to reduced under reporting. Effort data for this FU is available from 1995 for the Irish otter trawl *Nephrops* directed fleet. A threshold of 30% of *Nephrops* in reported landings by trip is used to identify the catches and effort of this fleet. This threshold was based on an analysis of the trip-by-trip catch compositions. Republic of Ireland landings per unit effort (lpues) data available for *Nephrops* from 1995 peaked in 2003 and declined in 2005 and 2006. (Table 14.13 and Figure 14.4).

The mean sizes of *Nephrops* in the catches of both the Northern Ireland and the Republic of Ireland fisheries have fluctuated without obvious trend for many years (1984–2000). Data from recent years (2001–2006) suggests a slight decrease in mean size. (Tables 14.14 and 14.15 and Figure 14.4).

Discard rates have been estimated using unsorted catch and discards samples for Irish data. Discard rates range between 18 to 27% of total catch by weight and 31–42% of total catch by number (Table 14.16). Discard rate of females tends to be higher due to the smaller average size. There is no information on discard survival rate in this fishery.

14.3.5 Survey data

ACFM have recommended that UWTV surveys could provide useful fishery independent data on the status of poorly assessed *Nephrops* stocks. Since 2003 Ireland and Northern Ireland have jointly carried out and underwater television surveys of the main *Nephrops* grounds in the western Irish Sea. These surveys were based on a randomised fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere (See Chapter 13 and Section 2.5.1).

The underwater TV surveys performed in 2003, 2004 and 2005 are presented as the best available information on the Western Irish Sea *Nephrops* stock. These surveys provide a fishery independent estimate of *Nephrops* abundance. The underwater TV survey information was used to set the TAC for 2007 and 2008. Further information on the survey results are provided in the Stock Annex 7 Section B.5.

The methods employed during the Irish Sea UWTV surveys have recently been discussed and documented by WKNEPHTV (ICES, 2007) which was convened in April 2007 with the following TOR:

- a) review and report technological developments used in underwater TV surveys for *Nephrops*;
- b) compare survey designs employed in different areas and evaluate, where possible, the relative performance of these;
- c) report on work addressing outstanding issues influencing the accuracy and precision of TV estimates of abundance *inter alia* burrow identification, occupancy rate, counting method, survey data analysis, raising procedures;
- d) document the protocols used to conduct surveys across the range of European stocks, highlighting standard practices and 'norms' adopted in UWTV work;
- e) investigate and make recommendations on procedures for inter-calibration, quality assurance and the reporting of precision from TV surveys;
- f) report on developments in the translation of survey estimates into stock assessment information and catch forecast advice, recommending where additional work is most urgently required;

g) consider the wider utility of the techniques employed in *Nephrops* UWTV surveys for estimation of other benthic species and habitat assessment.

This is discussed more fully in Section 13.1.3. Research Vessel Surveys.

Northern Ireland have also carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and LFDs from stations throughout in the western Irish Sea and are compared to the Irish commercial LFDs.

14.4 Nephrops in VIIa Management Considerations

Concerns about the affects of under reporting on commercial catch data coupled with developments in the use of survey data to assess *Nephrops* stocks has resulted in UWTV assessments being adopted for management advice. Since it has been agreed that *Nephrops* assessments should only be performed every two years advice for 2008 is based upon the assessment performed in 2006 by WGNSDS06. This is supported by the absence of evidence from population trends of a problem, suggesting the fishery is sustaining current exploitation levels. As there is no new assessment upon which to base management considerations a *status quo* regime is recommended for the Division VIIa component of Area VII *Nephrops* with fishing effort in 2008 being maintained at 2007 levels.

Table 14.1. *Nephrops* Functional Units and descriptions by statistical rectangle.

FUNCTIONAL UNIT	STOCK	ICES RECTANGLES
14	Irish Sea East	35–38E6; 38E5
15	Irish Sea West	36E3; 35–37E4-E5; 38E4

Table 14.2. Official catch data *Nephrops* VIIa as reported to ICES

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	0	0	0	0	0	0	0	0	0	2	1
France	91	55	62	3,539	3,797	2,977	8	8	16	6	1
Ireland	4,682	4,639	3,201	2,840	2,000	3,200	2,370	2,614	2,337	3,303	2,156
Isle of Man	7	18	39	8	25	61	14	32	14	29	20
UK - Eng+Wales+N.Irl.	0	0	0	6,002	6,155	6,805	5,572	5,900	6,300	5,944	6,103
UK - England & Wales	693	474	693	0	0	0	0	0	0	0	0
UK - N. Ireland	5,188	5,091	5,255	0	0	0	0	0	0	0	0
UK – Scotland	32	29	16	43	24	59	29	17	18	63	14
Total	**10693**	**10306**	**9266**	**12432**	**12001**	**13102**	**7993**	**8571**	**8685**	**9347**	**8295**

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006*
Belgium	1	1	0	0	1	0	1	1	1	2	0
France	1	1	0	0	1	0	0	1	0	1	0
Ireland	2,156	3,695	2,754	4,698	3,621	2,892	2,403	2,846	2,896	2,187	2,160
Isle of Man	20	24	17	10	3	2	0	1	13	12	0
UK - Eng+Wales+N.Irl.	6,103	7,163	6,316	6,514	5,328	5,213	4,841	4,621	4,899	5,046	6,148
UK - England & Wales	0	0	0	0	0	0	0	0	0	0	0
UK - N. Ireland	0	0	0	0	0	0	0	0	0	0	0
UK – Scotland	14	17	74	38	31	34	90	27	55	8	30
Total	**8295**	**10901**	**9161**	**11260**	**8985**	**8141**	**7335**	**7497**	**7864**	**7256**	**8338**

***Preliminary**

na not available

Table 14.3. Vlla, North of 53° N: Total *Nephrops* landings (tonnes) by Functional Unit plus Other rectangles, 1997–2006.

Year	FU 14	FU 15	Other	Total
1997	597	9979	44	**10620**
1998	389	9145	4	**9538**
1999	625	10786	2	**11412**
2000	567	8370	0	**8937**
2001	532	7441	1	**7974**
2002	577	6793	0	**7370**
2003	377	7052	2	**7431**
2004	472	7398	11	**7881**
2005	570	6537	1	**7106**
2006*	627	7517	1	**8144**
	*** provisional**			

Table 14.4. Vlla, North of 53° N: Total Nephrops landings (tonnes) by country, 1997–2006.

Year	Belgium	France	Rep. of Ireland	Isle of Man	UK	Other Rectangles	Total
1997	2	0	3365	7	7202	44	**10620**
1998	1	0	3126	17	6389	4	**9537**
1999	0	0	4735	6	6669	2	**11412**
2000	2	0	3547	0	5388	0	**8937**
2001	0	0	2715	3	5255	1	**7974**
2002	1	0	2494	0	4875	0	**7370**
2003	0	0	2766	4	4658	2	**7430**
2004	0	0	2844	13	5011	11	**7880**
2005	0	0	2116	0	4990	1	**7106**
2006*	1	0	2047	0	6095	1	**8144**
	*** provisional**						

Table 14.5. Irish Sea East (FU 14): Landings (tonnes) by country, 1997–2006.

Year	Rep. of Ireland	UK	Other countries **	Total
1997	16	580	1	597
1998	26	362	1	389
1999	153	471	0	625
2000	114	451	2	567
2001	26	506	0	532
2002	203	373	1	577
2003	70	306	1	376
2004	62	409	1	472
2005	34	536	0	570
2006*	34	592	0	627

*** provisional na = not available**

**** Other countries includes Belgium and Isle of Man**

Table 14.6. Irish Sea East (FU 14): Biological Sampling.

FU	**14**	**MA**	**J**
FLEET	**UK England & Wales**	**GEAR**	**Trawl**

	2006					**2005**				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	5	0	0	153	3	6	5	0	189
Landings	1	1	2	0	289	2	4	2	0	240
Discards	0	0	0	0	0	0	0	0	0	0

	Number of samples									
Year	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
Catch	5	14	26	5	14	12	15	4	0	0
Landings	4	8	13	20	22	20	25	18	9	8
Discards	0	0	0	0	0	0	0	0	0	0

Table 14.7. Irish Sea East (FU 14): Effort ('000 hours trawling) and LPUE (kg/hour trawling) of Nephrops directed voyages by UK trawlers, 1997–2006.

YEAR	EFFORT	LPUE
1997	16.6	25.3
1998	13.7	19.6
1999	18.4	19.8
2000	17.9	21.2
2001	20.3	20.7
2002	14.7	20.1
2003	14.1	16.7
2004	12.1	27.5
2005	13.8	28.5
2006*	13.1	29.6
	***provisional na=not available**	

Table 14.8. Irish Sea East (FU 14): Effort (‘000 hours trawling) and lpue (kg/hour trawling) of Nephrops directed voyages by Republic of Ireland trawlers, 1997–2006.

YEAR	EFFORT	LPUE
1997	0.3	46.6
1998	0.6	33.2
1999	2.3	55.4
2000	2.5	43.6
2001	0.5	43.9
2002	3.3	57.1
2003	1.1	37.6
2004	1.4	42.8
2005	0.8	40.6
2006*	0.7	53.7
*** provisional na=not available**		

Table 14.9. Irish Sea East (FU 14): Mean sizes (mm CL) of male and female Nephrops from UK vessels landing in England and Wales, 1997–2006.

YEAR	CATCH		LANDINGS		DISCARDS	
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES
1997	na	na	34.0	31.3	na	na
1998	na	na	31.7	28.6	na	na
1999	na	na	35.5	32.5	na	na
2000	29.2	28.3	33.7	32.3	na	na
2001	31.6	29.2	34.2	32.5	na	na
2002	32.0	29.2	35.1	32.0	na	na
2003	36.4	30.7	38.4	34.5	na	na
2004	32.0	29.3	35.2	33.1	na	na
2005	32.4	29.5	34.6	32.3	na	na
2006*	33.5	31.2	36.1	32.6	na	na
*** provisional na=not available**						

Table 14.10. Irish Sea West (FU 15): Biological Sampling

FU	**15**	**MA**	**J**
FLEET	**UK Northern Ireland**	**GEAR**	**Trawl**

	2006					**2005**				
	Number of samples*				Mean no. per sample	Number of samples*				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	0	0	0	0		0	0	0	0	
Discards	0	0	0	0		0	0	0	0	
	Number of samples									
Year	2006*	2005*	2004*	2003*	2002	2001	2000	1999	1998	1997
Catch	0	0	0	0	35	45	44	40	48	40
Landings	0	0	0	0	35	45	44	40	48	40
Discards	0	0	0	0	35	45	44	40	48	40

* break down of co-operation from industry prevented sampling

FU	15	MA	J
FLEET	**Rep. of Ireland**	**GEAR**	**Trawl**

	2006					2005				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	4	3	6	0	742	4	3	5	0	856
Landings										
Discards	3	3	7	0	873	4	3	5	0	1283

	Number of samples									
Year	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
Catch	13	12	42	19	42	19	4	18	16	19
Landings							4	18	16	18
Discards	13	12	44	19	42	19	4	17	16	18

Table 14.11. Irish Sea West (FU 15): Landings (tonnes) by country, 1997–2006.

YEAR	REP. OF IRELAND	ISLE OF MAN	UK	OTHER COUNTRIES**	TOTAL
1997	3349	7	6622	1	**9979**
1998	3101	17	6027	0	**9145**
1999	4582	6	6198	0	**10786**
2000	3433	0	4937	0	**8370**
2001	2689	3	4749	0	**7441**
2002	2291	1	4501	0	**6793**
2003	2696	4	4352	0	**7052**
2004	2782	13	4602	0	**7398**
2005	2106	0	4497	0	**6603**
2006*	2013	0	5495	0	**7508**

***provisional**

Table 14.12. Irish Sea West (FU 15): Catches and landings (tonnes), effort (‘000 hours trawling), cpue and lpue (kg/hour trawling) of Northern Ireland *Nephrops* trawlers, 1997–2006.

YEAR	CATCHES	LANDINGS	EFFORT	CPUE	LPUE
1997	7070	6415	175	40.3	36.6
1998	6603	5842	171	38.7	34.2
1999	6974	6032	172	40.6	35.1
2000	5929	4758	169	35.1	28.2
2001	5769	4587	164	35.2	28.0
2002	5168	4495	131	39.5	34.4
2003	-	4146	141	-	29.4
2004	-	4302	141	-	30.5
2005	-	4280	140	-	30.6
2006*	-	5495	142	-	37.9

*** provisional**

Table 14.13. Irish Sea West (FU 15): Catches and landings (tonnes), effort (‘000 hours trawling), cpue and lpue (kg/hour trawling) of Republic of Ireland Nephrops Directed Trawlers 1997–2006.

YEAR	EFFORT	LANDINGS	LPUE
1997	63134	2832.5	44.87
1998	53916	2654.1	49.23
1999	74560	4010.7	53.79
2000	61160	3159.6	51.66
2001	52548	2474.8	47.10
2002	48979	2237.9	45.69
2003	46110	2621.7	56.86
2004	53887	2646.5	49.11
2005	48074	2044.0	42.52
2006*	49361	1921.7	38.93

Table 14.14. Irish Sea West (FU 15): Mean sizes (mm CL) of male and female *Nephrops* in Northern Ireland catches, landings and discards, 1997-2006.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
1997	26.1	24.3	27.2	25.7	19.9	20.1
1998	27.5	25.0	28.7	26.4	21.6	21.6
1999	27.7	24.5	29.1	26.1	22.0	21.7
2000	27.7	24.5	29.4	26.3	22.5	22.6
2001	25.7	23.6	26.1	24.4	21.7	21.2
2002	26.7	24.1	26.7	24.9	21.8	21.7
2003	na	na	na	na	na	na
2004	na	na	na	na	na	na
2005	na	na	na	na	na	na
2006	na	na	na	na	na	na
	*** provisional na=not available**					

Table 14.15. Irish Sea West (FU 15): Mean sizes (mm CL) of male and female *Nephrops* in Republic of Ireland catches, landings and discards, 1997–2006.

YEAR	CATCHES		LANDINGS		DISCARDS	
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES
1997	26.8	26.1	28.3	27.7	na	na
1998	26.3	25.2	28.4	27.6	na	na
1999	26.4	24.9	28.7	27.1	23.3	22.8
2000	29.1	27.1	32.2	29.7	24.3	24.0
2001	26.7	24.8	28.6	27.0	23.0	22.2
2002	28.9	25.4	30.2	27.8	24.6	23.6
2003	27.7	24.9	29.7	26.9	24.0	23.1
2004	28.1	26.1	29.7	27.8	23.9	23.7
2005	28.5	26.8	30.1	29.1	23.9	23.2
2006	27.9	25.8	29.8	27.7	23.9	23.2
*** provisional na=not available (Qtr 3 & Qtr 4 missing)**						

Table 14.16 Percentage Discard Rates by Weight and Number for Republic of Ireland.

	Quarters					% Discards by Weight	% Discards by Number
Year	**Q1**	**Q2**	**Q3**	**Q4**	**Total**		
2003	307.5	366.4	302.7	43.8	1020.4	27%	42%
2004	168.1	251.2	272.0	75.5	766.7	22%	34%
2005	165.3	83.9	185.0	22.8	457.0	18%	31%
2006	157.7	69.5	345.5	70.5	643.2	24%	38%

15

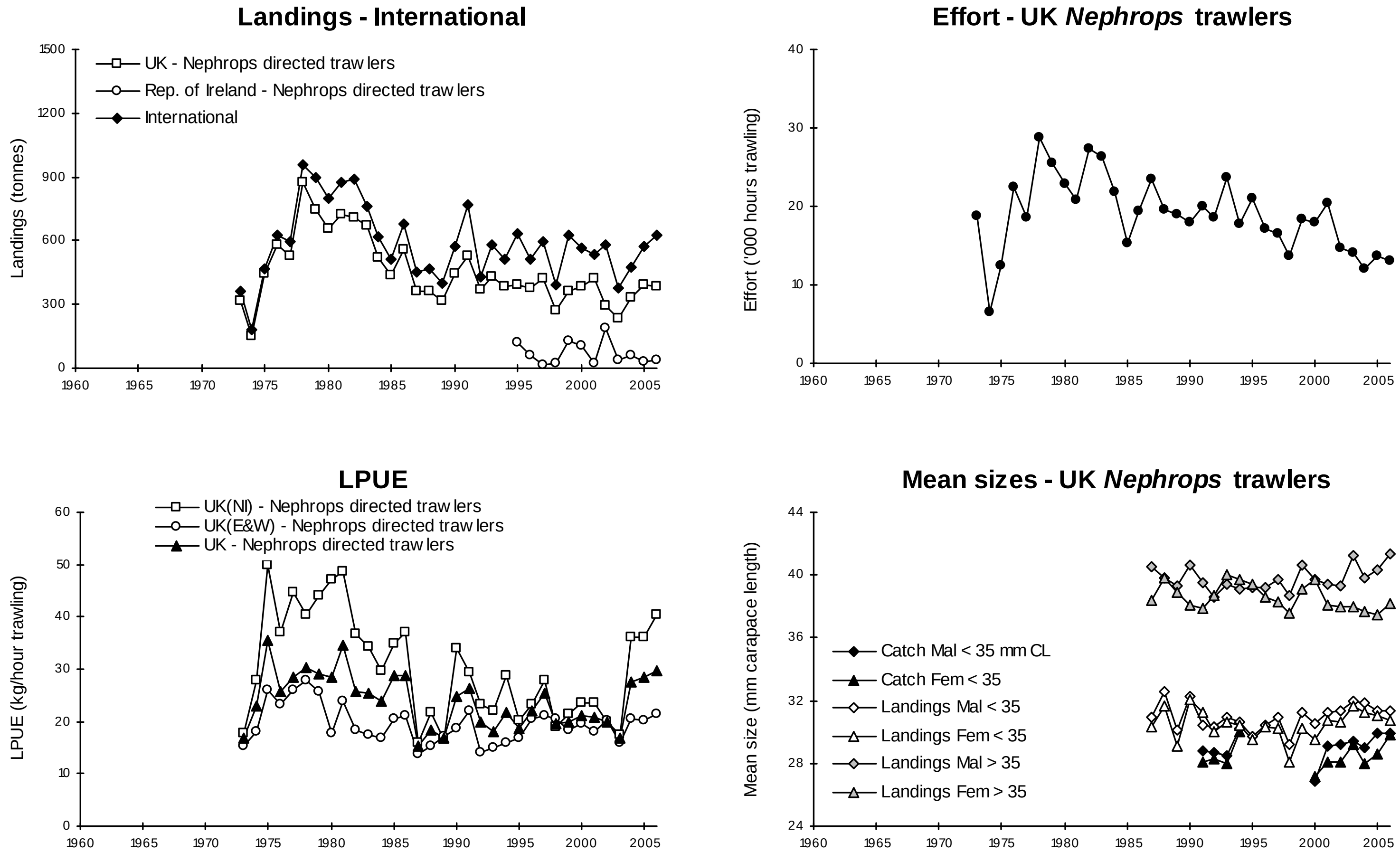


Figure 14.1. Irish Sea East (FU 14): Long-term trends in landings, effort, cpues and/or lpues, and mean sizes of *Nephrops*.

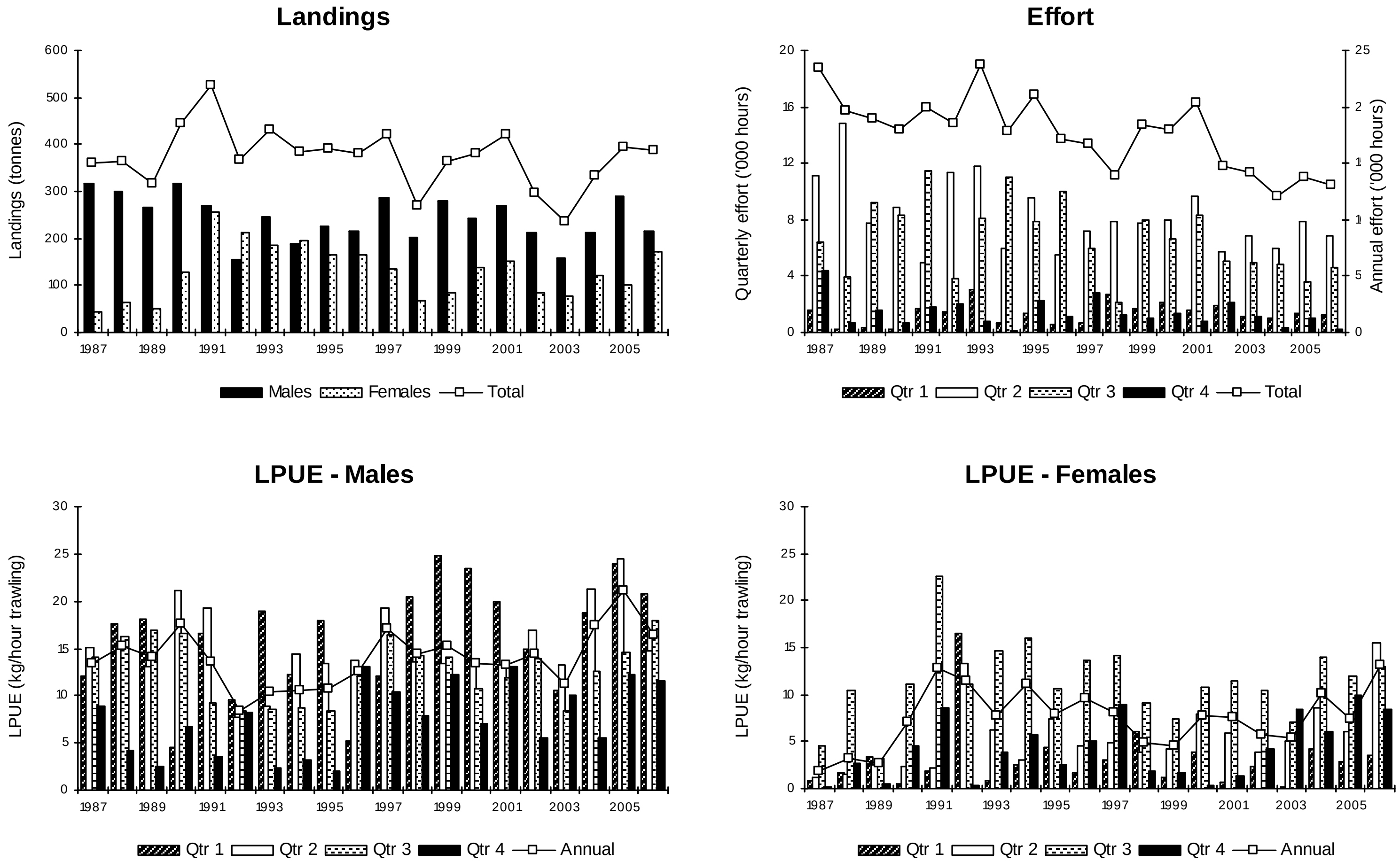


Figure 14.2. Irish Sea East (FU 14): Landings, effort and lpues by quarter and sex from UK *Nephrops* directed trawlers.

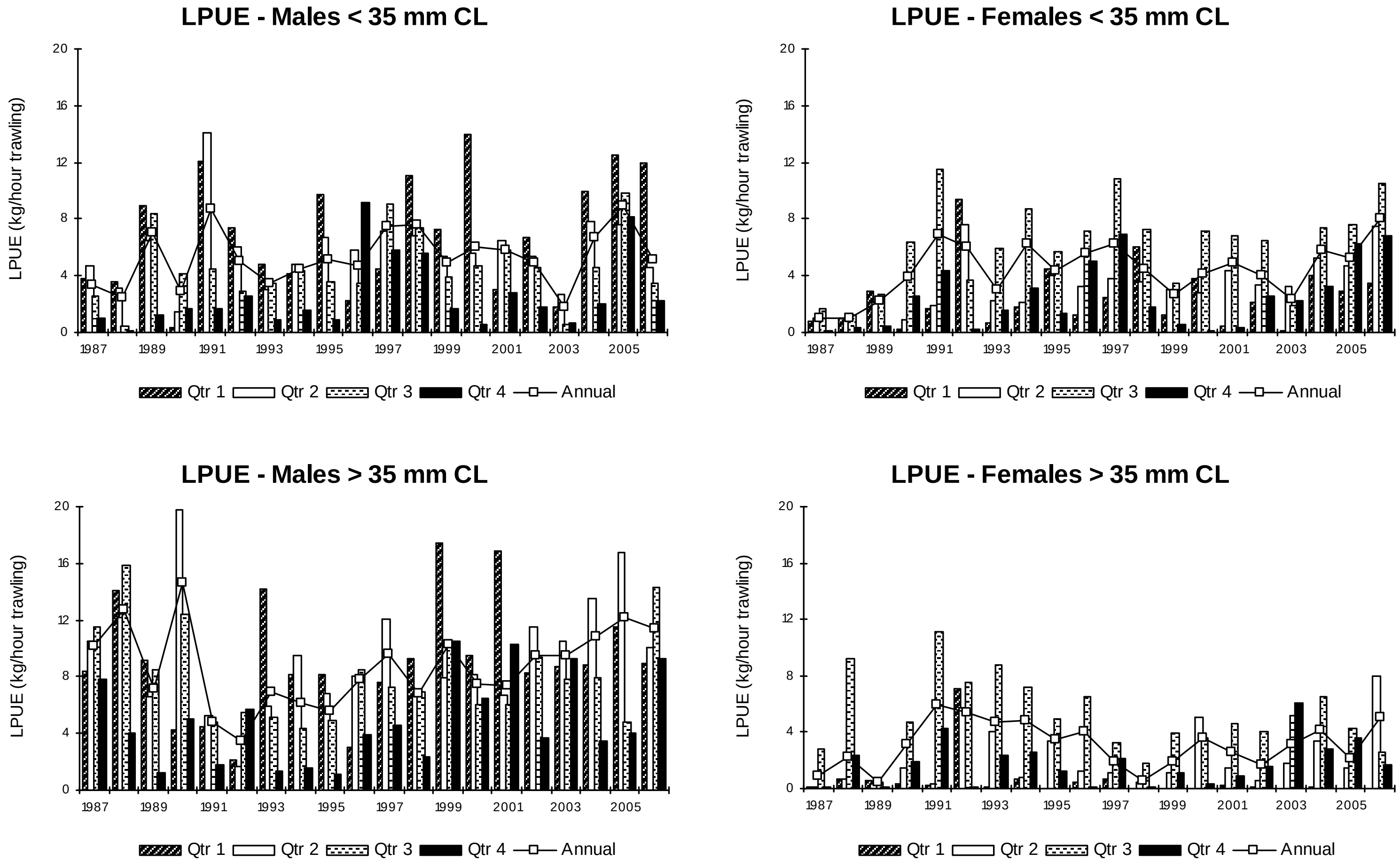


Figure 14.3. Irish Sea East (FU 14): lpues by sex and quarter for selected size groups, UK *Nephrops* directed trawlers.

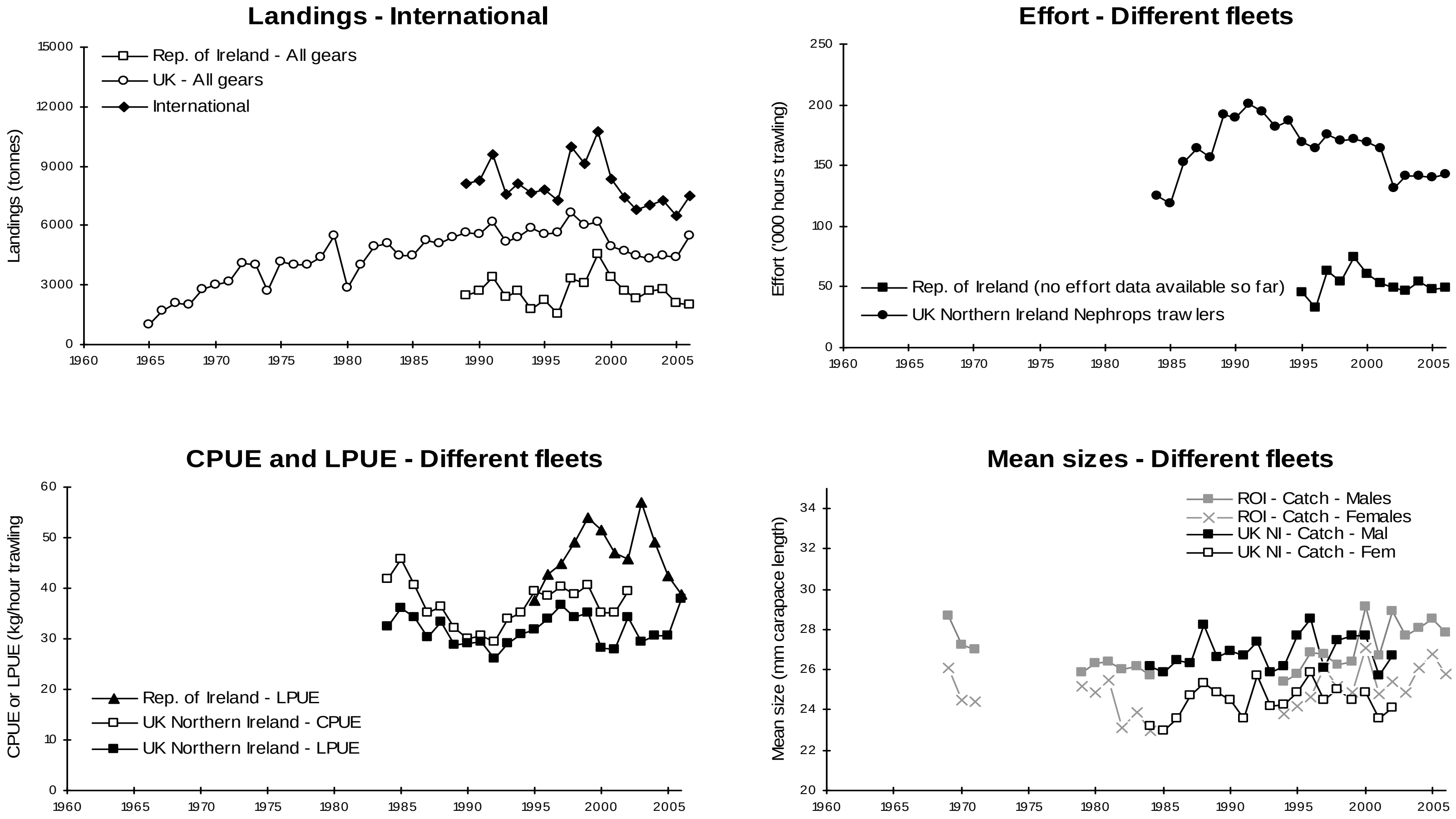


Figure 14.4. Irish Sea East (FU 15): Long-term trends in landings, effort, cpues and/or lpues, and mean sizes of *Nephrops*.

15 Quality of the assessments

The year-to-year consistency of stock assessment results is an important consideration when determining management advice, particularly when the management framework is reliant on annual updates of estimates of stock abundance and exploitation levels. The quality of individual assessments is considered in some detail within the individual stock sections. Typically the consistency of the assessment has also been considered in the individual sections, however, in order to take a more holistic view of the performance of the stock assessments considered by the group a separate section has been included to present retrospective analyses of final assessments for recent years. It should be noted that the retrospective analyses presented here differ from those presented within the individual stock sections. The figures shown here plot the final agreed assessment in each year. Assessment methods and the availability of data may have changed over the period of the analysis so one might expect greater variation in the plots than that shown in the retrospective analyses for a single assessment method shown in the individual stock sections.

15.1 Retrospective analysis of assessment results

Time series of estimates of spawning biomass, fishing mortality and recruitment are shown in Figure 15.1 for stocks of cod and haddock in area VIa, haddock in VIb, whiting in VIa and for cod, haddock, whiting, plaice and sole in area VIIa respectively. It is instantly apparent that some stocks show considerable variability in estimates of stock parameters whilst others are more consistent. In many cases this variability results from a switch from an assessment based on catch numbers at age to an assessment that uses survey information alone. In such cases estimates of spawning biomass and recruitment from the survey-based assessment are shown on a secondary Y axis. For the case of Rockall Haddock the assessment method has not changed, but the recent inclusion of Russian catch data along with discards information for the EU fleets has resulted in a re-scaling of the estimates of stock biomass and recruitment and secondary Y axes have been included here also. Note that, in some years, an assessment may not have been accepted by ACFM in which case no estimates of stock parameters have been presented.

Both VIa cod and VIIa cod were assessed using survey only methods in 2005, however, the specific implementation of the model allowed the model estimates to be re-scaled to a level similar to those previously estimated. For this reason no secondary Y axis is shown for these stocks. The use of this method accounts for the anomalous estimates of fishing mortality apparent for both stocks from the 2004 assessment.

In general, estimates of spawning biomass are more consistent over time than estimates of recruitment or fishing mortality. Estimates of fishing mortality are in some cases particularly variable, especially where survey only assessment methods are employed.

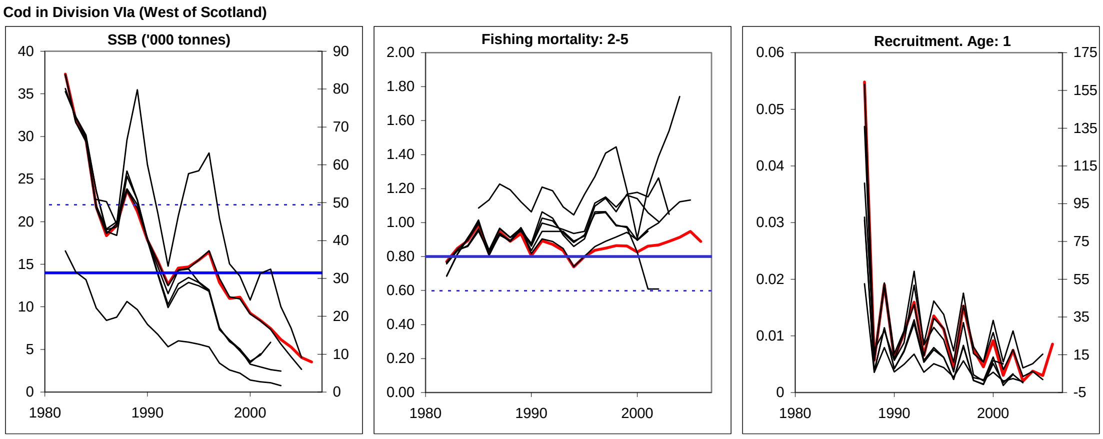
It should be noted that the plots show estimates for the period 1980 to 2006. Several of the assessments extend further back in time. Typically estimates of spawning biomass and recruitment were higher and less variable during this earlier period. Estimates of stock parameters are presented only for the most recent period in order to better illustrate recent changes in stock perception.

15.2 Sampling levels

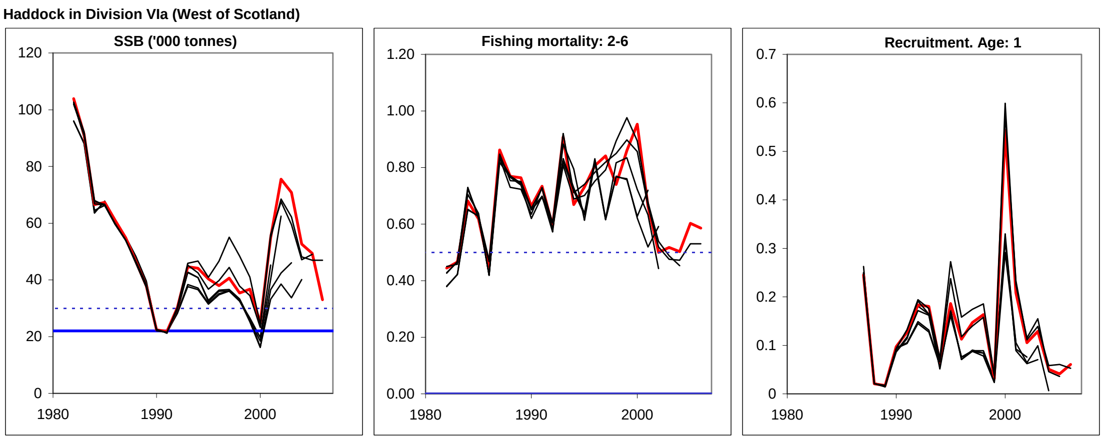
Following an analysis of recent stock assessment results it seemed appropriate to consider how the sampling levels of the commercial catch data may have changed in recent years. The number of samples collected for each stock is recorded in Section 2 of the working group report. Figure 15.2 shows how those sampling levels have changed over the period 1995 to

2007. Data were not available for 2003. It can be seen that in area VIa sampling levels have declined commensurate with landings from the commercial fishery, whereas in area VIIa they have declined less or in some cases increased. It should be noted that for some stocks these data are no longer included in the assessment.

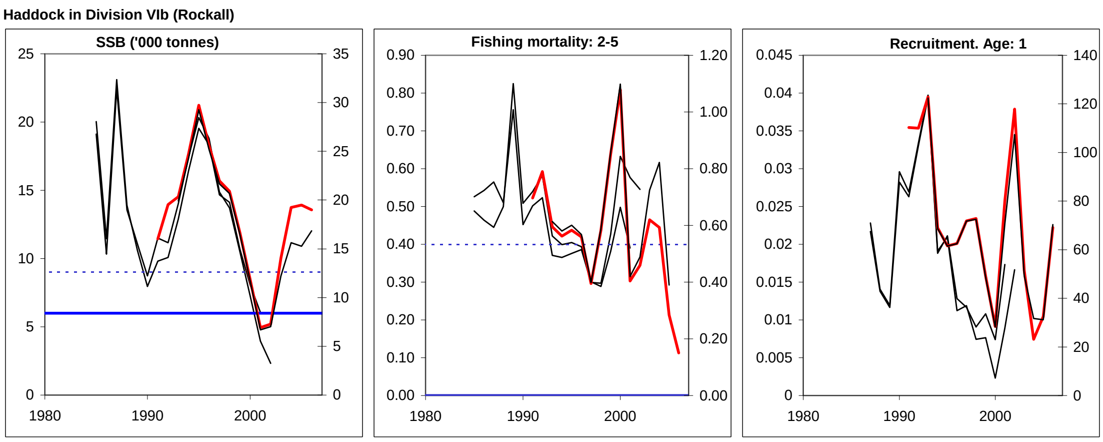
a



b

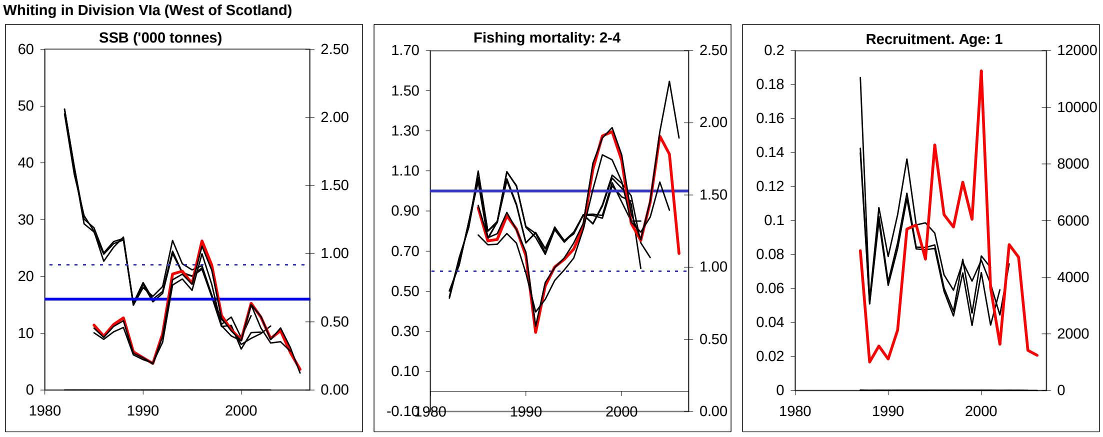


c



Figures 15.1a, b, c. Working group estimates of spawning stock biomass, fishing mortality and recruitment for assessment years 2001 to 2007 for cod and haddock in division VIa and haddock in division VIb. Thick grey line shows most recent 2007 estimates.

d



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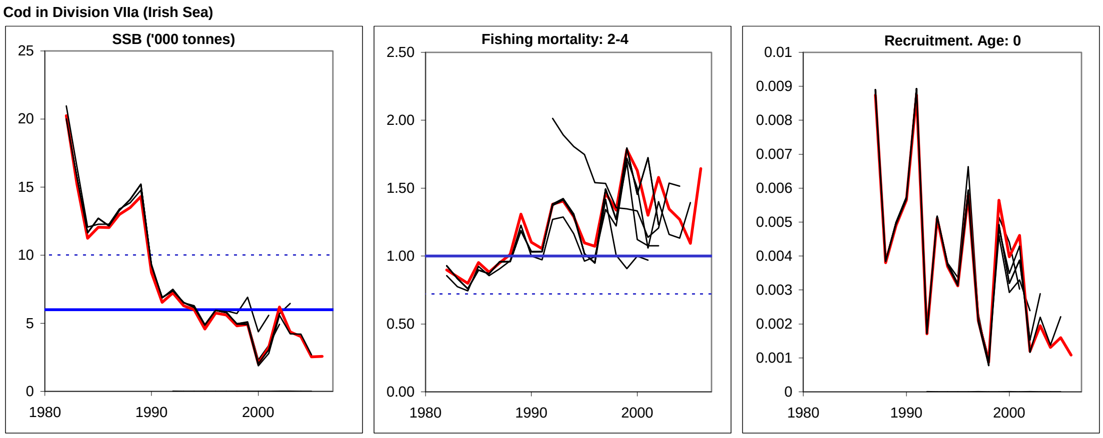
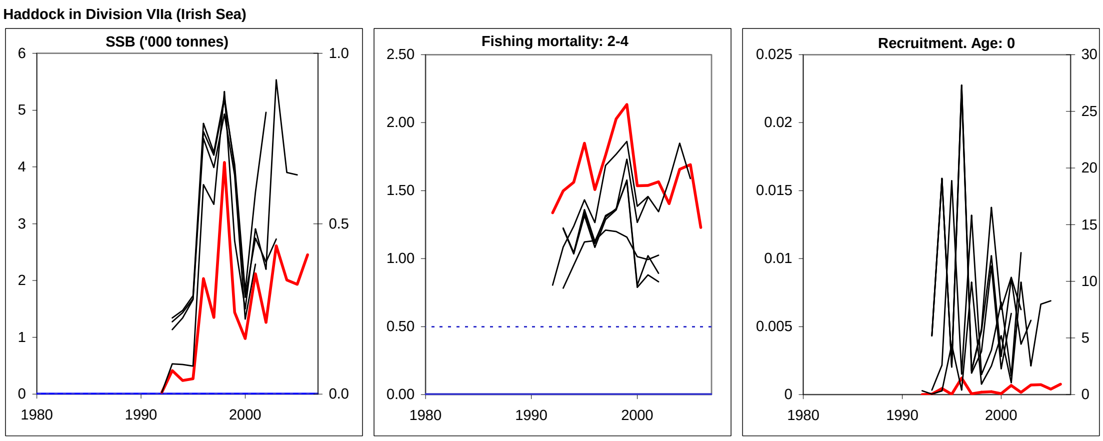
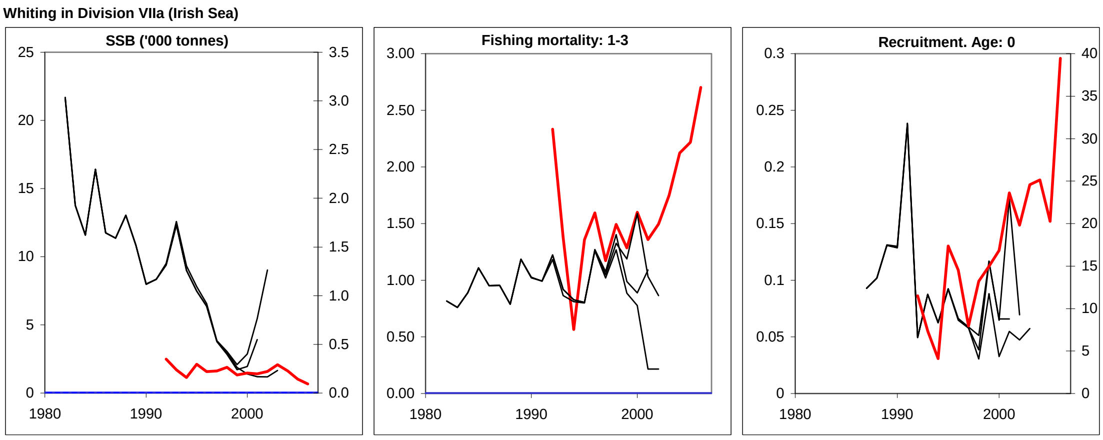


f

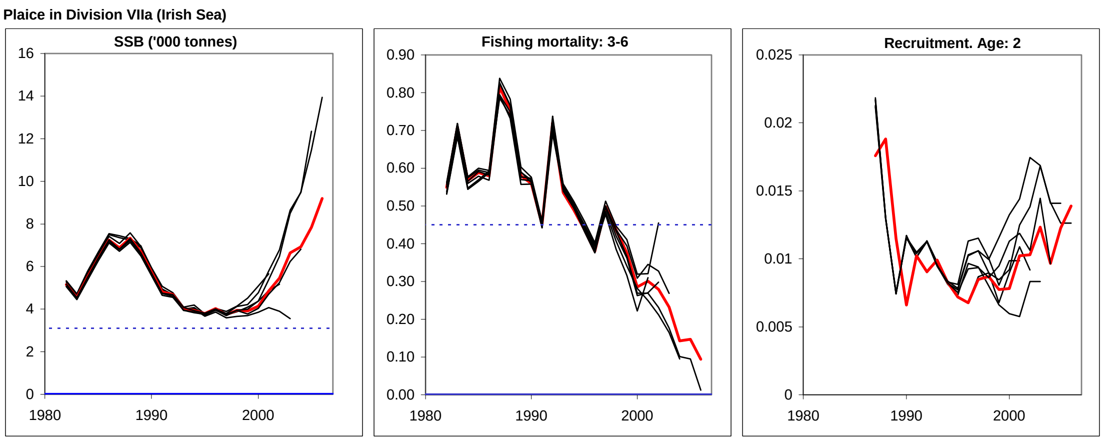


Figures 15.1d, e, f. Working group estimates of spawning stock biomass, fishing mortality and recruitment for assessment years 2001 to 2007 for whiting in division VIa and for cod and haddock in division VIIa. Thick grey line shows most recent 2007 estimates.

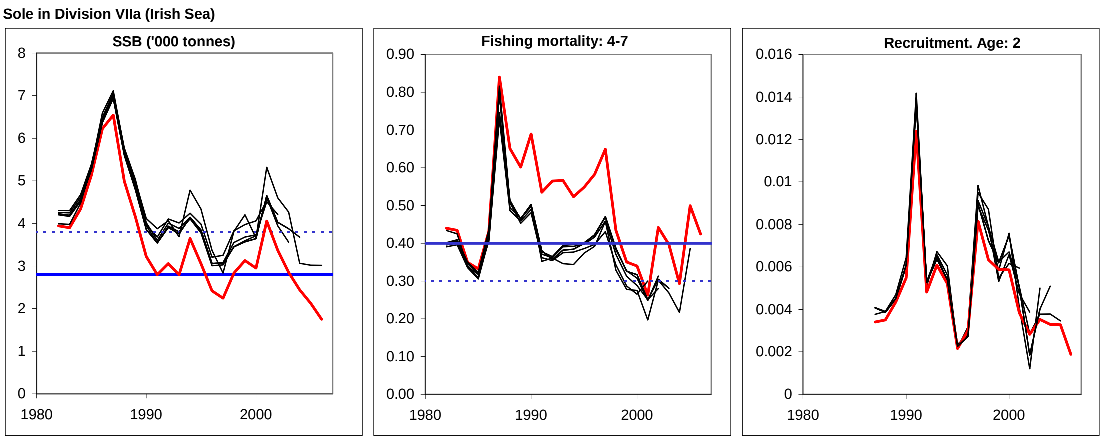
g



h



i



Figures 15.1g, h, i. Working group estimates of spawning stock biomass, fishing mortality and recruitment for assessment years 2001 to 2007 for whiting, plaice and sole in division VIIa. Thick grey line shows most recent 2007 estimates.

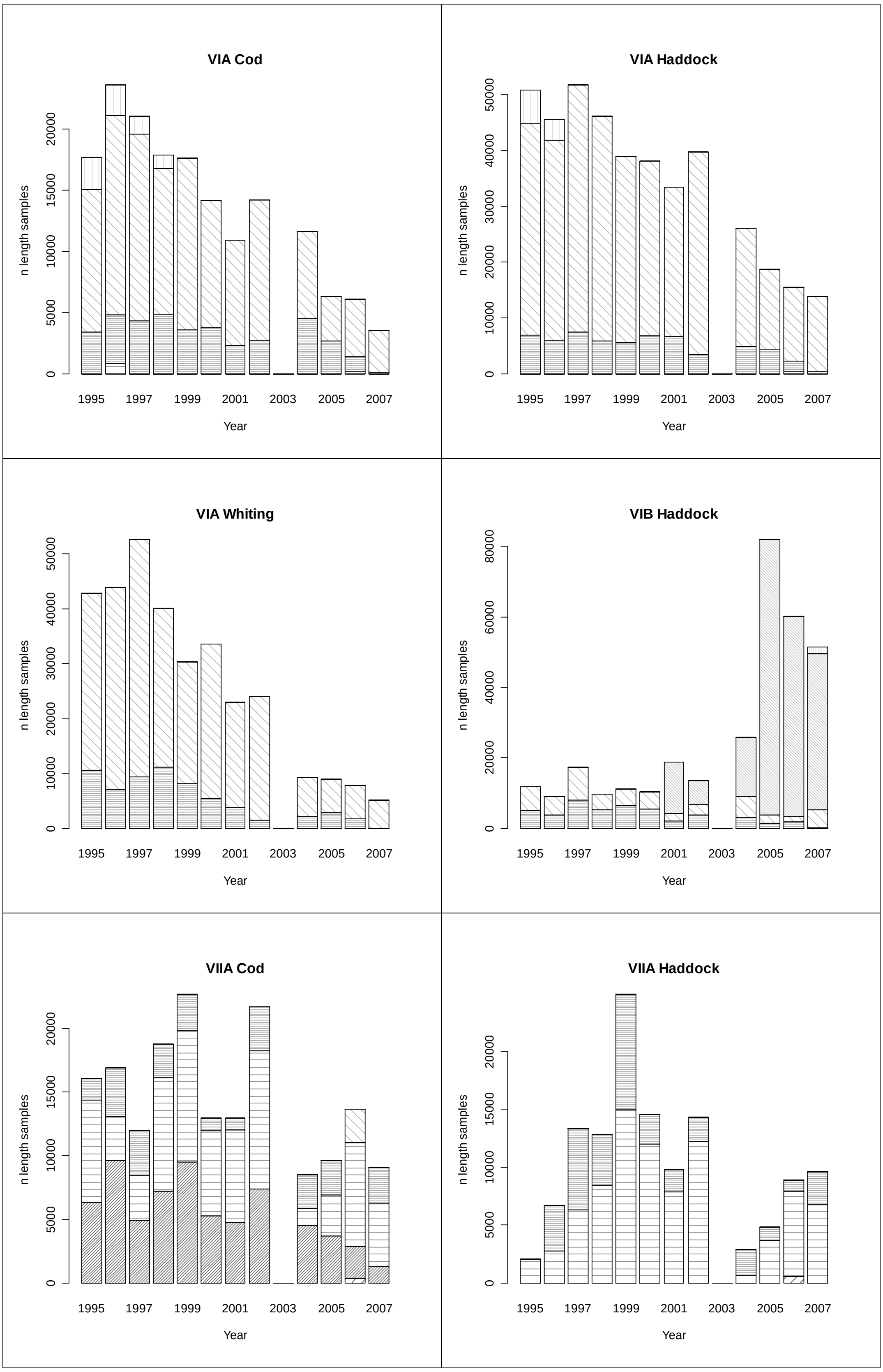

VIA Cod
VIA Haddock
VIA Whiting
VIB Haddock
VIIA Cod
VIIA Haddock
n length samples
Year
1995
1997
1999
2001
2003
2005
2007

Figure 15.2

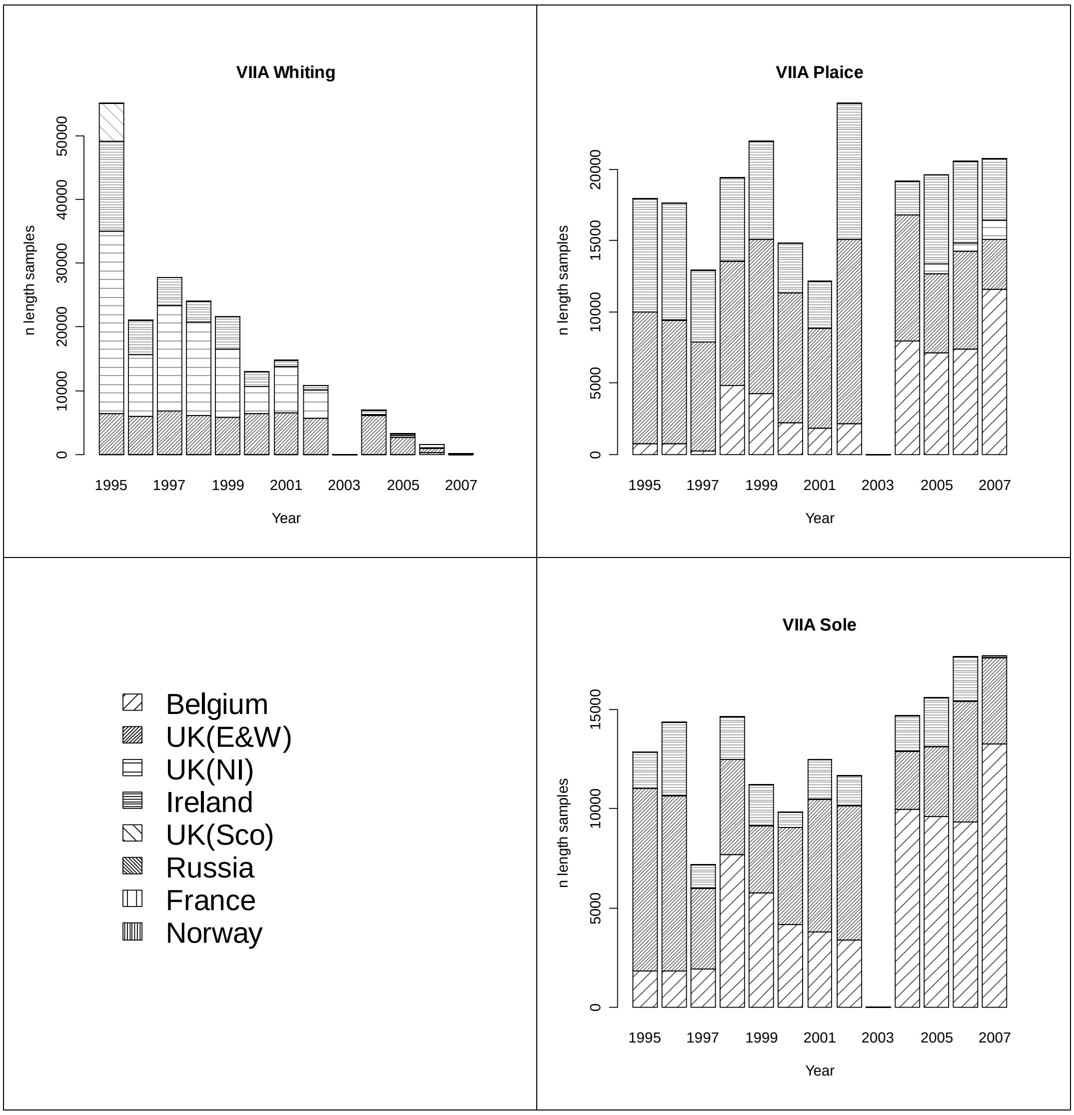


Figure 15.2. cont. Number of length samples taken over the period 1995 to 2007 (no information available for 2003) for stocks in VIa, VIb and VIIa.

16 Fishing effort trends

Fishing effort data are reported on fishermen's log sheets according to the nature of the fishing operation. Measures of effort directly related to the fishing operation, such as hours spent trawling, or total length of gill-nets multiplied by soak time, provide the most useful statistic for stock assessment purposes. However, not all effort records are mandatory, and WGNSDS has noted for several stocks that trends in hours-fished for some fleets may be biased by variable effort reporting over time. Information on time spent at sea is more accurately recorded, and the implementation of effort limitation schemes in recent years has required accurate records of days at sea. The STECF Sub-group SGRST has compiled data on fishing effort of effort-regulated and unregulated fleets, by gear type and mesh band, using kW*days as a measure of nominal effort. Preliminary data were available for 2000–2006 from the May 2007 meeting of SGRST, and are reproduced here with permission from the SGRST Chair and relevant national SGRST members. The data may be subject to revision during the planned SGRST meeting in September 2007.

Longer-term trends in fishing effort for fleets relevant for specific assessments are given in individual stock sections, using effort measures such as hours fished which may not be complete and indicative of general trends only.

16.1 Fleet notations

The following text is adapted from STECF SGRST reports.

Annex IIA of Council Reg. (EC) No. 41/2007 categorises fleet effort in terms of a "gear group" (specified in point 4 of the annex) and whether the fleet using a given gear group has qualified for any "special condition", (specified in point 8 of the Annex IIA). The days at sea allowances prescribed for these combinations are presented in "Table I" of the regulation's annex. The table specifies effort limits for various fishing areas, defined in point 2 of the annex. This report adopts the labelling as used in "Table I" for gear group, special condition and fishing area. Table 17.1.1 lists notation and links it to descriptions of the associated fishing gears and special conditions as specified in Annex IIA. Table 17.1.2 lists and describes the fishing area definitions.

As convenient shorthand this report uses the term 'derogation' to refer to any combination of gear group and special condition. So for example, a vessel using a trawl gear of mesh size between 70 and 89 mm but which qualifies for no special condition belongs to derogation "4.a.ii none". A vessel using a trawl gear of the same mesh size but where a vessel has a catch composition with less than 5% cod from 2002 would belong to derogation "4.a.ii IIA81c", (the 'IIA' distinguishes a special condition from Annex IIA as opposed to Annex IIB or Annex IIC). The notation for regulated areas can also be added. If a vessel using the gear "4.a.ii IIA81c" fishes in the Kattegat this can be labelled as effort in the category "4.a.ii IIA81c 2a".

16.2 Area VIa

STECF data for west of Scotland fleets are given in Table 17.2.1.

In terms of kWdays the overall nominal effort in ICES division VIa decreased by 46% since 2002 following a continuous downward trend which had already started by 2001 (Table 17.2.1). Irish effort data prior to 2003 contains no information on mesh size. Trawls with mesh 70–89 mm are thought to be the main gears in use by the Irish fleet prior to 2003. Effort of otter trawls with mesh 70–89 mm (group 4.a.ii) declined by 26% between 2003 and 2006.

Historically, the highest effort was deployed by otter trawls of 100–119 mm (gear group 4.a.iv) (Table 17.2.1). Effort since 2002 decreased by 81% for vessels not qualifying for special condition, 55% for vessels with low catch of cod, plaice and sole (special condition 8.1.d) and 75% for vessels with low catch of cod only (8.1.c), (this last derogation is only a minor component of the effort in this mesh size range).

The marked decline in kW days for gear group 4.a.iv is principally explained by the recent, significant decommissioning schemes in the UK. Some of the reduction in 4.a.iv effort might be explained by a switch to mesh >120 mm, (gear group 4.a.v). Effort in group 4.a.v in 2006 was 17% greater than in 2002.

Overall, effort has declined in recent years in Area VIa, and declines in particular categories have mostly not been compensated by increases in other categories.

Trends in fishing effort for EU and Russian vessels at Rockall (VIb) are discussed in section 4.2.

16.3 Irish Sea Division VIIa

Within categories 4.a.iv (trawls, seines etc., ≥ 100 mm) and 4.a.ii-iii (trawls, seines etc., 70–99 mm) gears in the Irish Sea, there is a range of fishing gears of quite different design. Demersal trawls in the 4.a.iv category include a variety of single and multiple rig otter trawls used for gadoids, rays and other demersal fish, and semi-pelagic (mid-water) trawls that have been used extensively in the deeper waters of the Irish Sea to target hake, whiting, cod and haddock since the 1980s. Categories 4.a.ii and 4.a.iii includes single-rig and multiple-rig *Nephrops* trawls, and whitefish trawls targeting species such as plaice and whiting where catch composition rules permit this mesh size. The change in mesh size regulations in 2000, requiring the use of 100 mm mesh for vessels targeting species such as cod, resulted in a change in the distribution of effort between mesh bands.

Data for 2006 provided to SGRST in May 2007 were incomplete, and are hoped to be completed in September. Specifically, data were not available for Belgian vessels, which will apply exclusively to beam trawls. Therefore, the description given here is preliminary. The overall trend indicates a slow decline in effort since 2003 within the Irish Sea. Unidentified effort is relatively high accounting for approximately 30% of overall effort prior to 2003. A large proportion of this group was due to Irish effort reported without mesh size information. This is reflected by a decrease in unassigned effort from 2003. The remainder of unknown gears and mesh sizes comprises of mesh size groups 32–54 and 55–69mm targeting pelagic resources. Recent Irish Sea fisheries have been dominated by trawlers, with the rest divided between beam trawls and negligible effort directed towards gillnets.

Trawls are dominated by the small mesh gear group 4.a.ii (70–89 mm) (Table 17.3.1) for which effort has been stable since 2003. Approximately one quarter of effort by the 70–99 mm derogation was classified into special condition 8.1.d (<5% of each cod, sole and plaice in 2002). Effort of trawls with 100–119 mm mesh (4.a.iv) declined by over 60% between 2003 and 2006. Again, approximately one third of the effort for this mesh size range is classified into low cod landing special conditions (IIA8.1.c, and IIA8.1.d). The effort of the gear group 4.a.v (≥120 mm) has fluctuated substantially but represents only a small part of the trawl fleet.

Effort deployed by beam trawlers from all countries was relatively stable from 2002–2005. Belgian beamers contributed 60% of the total beam trawl effort in VIIa in 2004 and 2005. Provisional data for 2006 provided to the WG (but not available to SGRST in May) indicates a 30% decline in Belgian beam trawl effort between 2005 and 2006, with the 2006 effort being the lowest in the 2000–2006 series.

Table 17.1.1. Gear group and special conditions of Annex IIA, Reg. (EC) No. 41/2007 (courtesy STECF SGRST).

DEROGATION			MESH SIZE RANGE		SPECIAL CONDITION							
					CATCH COMPOSITION TRACK RECORD			TECHNICAL GEAR OR OTHER MEASURE				
Gear group Point 4	Special condition Point 8	Gear	mesh size mm From	mesh size To mm	< 5 % cod	> 60 % plaice	< 5 % of cod & < 5% sole & < 5% plaice	escape window: App 1	escape window: App 2	escape window: App 3	GRID: App 2 to Annex III	other
4.a.i		TD	16	31								
4.a.ii		TD	70	89								
4.a.iii		TD	90	99								
4.a.iv		TD	100	119								
4.a.v		TD	120	inf								
4.a.iii	8.1.(a)	TD	90	99				120				
4.a.iv	8.1.(a)	TD	100	119				120				
4.a.v	8.1.(a)	TD	120	inf				120				
4.a.ii	8.1.(b)	TD	70	89							x	
4.a.v	8.1.(j)	TD	120	inf					140			
4.a.v	8.1.(h)	TD	120	inf								(#) 1
4.a.v	8.1.(hj)	TD	120	inf					140			(#) 1
4.a.iii	8.1.(l)	TD	90	99						95		
4.a.ii	8.1.(c)	TD	70	89	x							
4.a.iv	8.1.(c)	TD	100	119	x							
4.a.v	8.1.(c)	TD	120	inf	x							
4.a.iv	8.1.(k)	TD	100	119	x	x						
4.a.v	8.1.(k)	TD	120	inf	x	x						
4.a.ii	8.1.(d)	TD	70	89			x					
4.a.iii	8.1.(d)	TD	90	99			x					
4.a.iv	8.1.(d)	TD	100	119			x					
4.a.v	8.1.(d)	TD	120	inf			x					
4.b.i		BT	80	89								
4.b.ii		BT	90	99								
4.b.iii		BT	100	119								
4.b.iv		BT	120	inf								
4.b.iii	8.1.(c)	BT	100	119	x							
4.b.iv	8.1.(c)	BT	120	inf	x							
4.b.iv	8.1.(e)	BT	120	inf	x	x						
4.b.iii	8.1.(i)	BT	100	119	x[4]							
4.b.iv	8.1.(i)	BT	120	inf	x[4]							
4.c.i		GE	0	109								
4.c.ii		GE	110	149								
4.c.iii		GE	150	219								

Derogation			Mesh size range		Special condition							
					Catch composition track record			Technical gear or other measure				
4.c.iv		GE	220	inf								
4.c.iv[5]	8.1.(f)	GE	220	inf	x							(#) 2
4.d		TR	0	inf								
4.d	8.1.(g)	TR	0	109								(#) 3
4.e		LL	-	-								

TD = Trawl or Danish seine or 'similar gears' (dredges are included under similar gears)

BT = Beam Trawl

GE = Gillnet or entangling net

TR = Trammel net

LL = Long lines

(#) 1: automatic suspension of licences.

(#) 2: >5% turbot & lumpsucker.

(#) 3 absent from port < 24 h.

4. 2007 logbook.

5. Table 1 of Annex IIA refers to 4.c.iii 8.1.(f) but only gear with mesh size ≥ 220 mm is eligible for this derogation.

Table 17.1.2. Regulated area notation used in this report. For full definitions of these areas refer to Annex IIA, Regulation (EC) No. 41/2007.

Regulated Area	Area name or ICES divisions
2a	Kattegat
2b1	Skaggerak
2b2	ICES sub areas II (EC waters) & IV
2b3	ICES division VIId
2b	Regulated areas 2b1, 2b2 & 2b3 combined
2c	ICES division VIIa
2d	ICES division VIa

Table 17.2.1. Trend in nominal effort (kW*days at sea) by derogation to the West of Scotland, 2000–2006 (provisional data from STECF SGRST, May 2007).

ANNEX	REG AREA (	REG GEAR	SPECON	2000	2001	2002	2003	2004	2005	2006	Rel. Change to 2002
IIa	2d	4ai	none	206922	60135	65474	94003	94321	67742	31241	-0.52
IIa	2d	4aii	IIA81c	155990	176159	176097	137146	60508	46884	38036	-0.78
IIa	2d	4aii	IIA81d	3126958	3228460	3304175	3576338	3012623	2549104	2329737	-0.29
IIa	2d	4aii	none	2721888	2420619	2337897	3119863	3056106	2780395	2651215	0.13
IIa	2d	4aiii	IIA81d	447	3275	4336	44955	29340	52949	74655	16.22
IIa	2d	4aiii	none	7339	7826	7003	879941	1057063	664448	707415	100.02
IIa	2d	4aiv	IIA81c	79395	85148	90931	71670	42049	14101	22890	-0.75
IIa	2d	4aiv	IIA81d	10380273	9170727	7502869	5027440	3801694	4585337	3381031	-0.55
IIa	2d	4aiv	none	8222831	9183960	6823919	3707723	2942407	1961129	1323531	-0.81
IIa	2d	4av	IIA81c						5564	749	
IIa	2d	4av	IIA81d	61256	54153	53370	45881	70054	147686	24059	-0.55
IIa	2d	4av	none	22681	47805	1439716	4027622	3116030	2081772	1686071	0.17
IIa	2d	4bi	none	9425			13658	25947	9875	6676	
IIa	2d	4biii	IIA81c				30385	35077			
IIa	2d	4biii	none	98149	84541	103897					-1.00
IIa	2d	4biv	IIA81c					1519			
IIa	2d	4biv	none	4894			60023	151480	119958	81194	
IIa	2d	4ci	none		3620	19769	51	13723	128		-1.00
IIa	2d	4cii	none	23249	46312	25310	32140	7957	38976	36900	0.46
IIa	2d	4ciii	none		60143	128118	55521	1026	44981	1468	-0.99
IIa	2d	4civ	none	149902	162829	64472	423556	406338	227744	87953	0.36
IIa	2d	4d	IIA81g		64768						
IIa	2d	4d	none	2633	1416		636	320		428	
IIa	2d	4e	none	472195	407347	378386	229357	235881	263166	428103	0.13
IIa	2d	none	none	7055616	6360813	6779511	3387625	3430947	3037790	2822695	-0.58
Sum				32802043	31630056	29305250	24965534	21592410	18699729	15736047	-0.46

Table 17.3.1. Trend in nominal effort (kW*days at sea) by derogation in the Irish Sea, 2000–2006 (provisional data from STECF SGRST, May 2007).

ANNEX	REG AREA	REG GEAR	SPECON	2000	2001	2002	2003	2004	2005	2006	Rel. Change to 2003
IIa	2c	4ai	none				17,489	15,581	28,975	47,848	1.74
IIa	2c	4aii	IIA81c	802,236	797,840	681,140	800,510	546,992	581,466	493,867	-0.38
IIa	2c	4aii	IIA81d	1,112,314	1,247,380	1,211,091	1,471,996	1,573,236	1,551,731	1,486,957	0.01
IIa	2c	4aii	none	2,826,758	2,445,946	1,407,441	2,709,132	2,994,184	2,970,270	2,638,114	-0.03
IIa	2c	4aiii	IIA81d	8,353	333	8,360	7,055	845	11,629	12,282	0.74
IIa	2c	4aiii	none	14,443	12,657	1,045	12,240	55,278	42,884	24,645	1.01
IIa	2c	4aiv	IIA81c	82,367	141,403	267,945	301,492	207,792	58,025	50,495	-0.83
IIa	2c	4aiv	IIA81d	505,696	640,260	829,453	749,853	671,571	454,610	396,835	-0.47
IIa	2c	4aiv	IIA81k			3,214	2,568				-1.00
IIa	2c	4aiv	none	1,216,889	1,810,325	1,850,828	2,379,587	1,014,998	1,305,640	914,080	-0.62
IIa	2c	4av	IIA81c	82	1,154	902	2,026	264	820	6,254	2.09
IIa	2c	4av	IIA81d	5,994	1,887	1,054	4,149				-1.00
IIa	2c	4av	none	149	243	588	52,186	3,239	4,670	15,999	-0.69
IIa	2c	4bi	none	1,662,883	1,040,310	1,767,008	1,859,378	1,491,584	1,808,048	476,641	-0.74
IIa	2c	4bii	none				26,444	5,710	12,573		-1.00
IIa	2c	4biii	none	288			409,658	17,011	12,670		-1.00
IIa	2c	4ci	none	470	440		1,961		23,755	3,395	0.73
IIa	2c	4cii	none	18,486	10,971	6,927	28,088	23,925	3,982	8,020	-0.71
IIa	2c	4ciii	none	4,765	2,442	6,477	17,674	11,489	471	18,810	0.06
IIa	2c	4civ	none		350	1,522	191	1,432	2,999		-1.00
IIa	2c	4d	none	523						476	
IIa	2c	4e	none	174,400	152,675	81,240	47,385	52,783	81,118	22,301	-0.53
IIa	2c	none	none	4,010,641	3,839,095	3,967,881	1,581,277	1,648,939	1,100,990	1,153,892	-0.27
Sum				12,447,737	12,145,711	12,094,116	12,482,339	10,336,853	10,057,326	7,770,911	-0.38

Note: Data for gear group 4b (beam trawls) in VIIa are incomplete for 2006.

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Annex 1: Participants' list

Assessment of Northern Shelf Demersal Stocks Workshop–WGNSDS

Galway, Ireland, 8–17 May 2007

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Annex 2: Fleet definitions templates

Copy the following fleet definition table template for each fleet:

FLEET CHARACTERISTIC MANDATORY CHARACTERISTIC ARE MARKED WITH (*MANDATORY*)	DESCRIPTION OF CHARACTERISTIC	CODES TO USE OR EXPLANATION
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod VIIa haddock VIIa whiting FU 11–15 *Nephrops*	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_NEP_S	
Description (*Mandatory*)	*Nephrops* otter trawl, single trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70–99	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod VIIa haddock VIIa whiting FU 11–15 *Nephrops*	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_NEP_M	
Description (*Mandatory*)	*Nephrops* otter trawl, multiple nets	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70–99	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

FLEET CHARACTERISTIC MANDATORY CHARACTERISTIC ARE MARKED WITH (*MANDATORY*)	DESCRIPTION OF CHARACTERISTIC	CODES TO USE OR EXPLANATION
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	FU 11–15 *Nephrops*	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	CREEL	
Description (*Mandatory*)	*Nephrops* creels	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range		In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

FLEET CHARACTERISTIC MANDATORY CHARACTERISTIC ARE MARKED WITH (*MANDATORY*)	DESCRIPTION OF CHARACTERISTIC	CODES TO USE OR EXPLANATION
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod VIIa haddock VIIa whiting	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	PT	
Description (*Mandatory*)	Pelagic trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Fleet characteristic **Mandatory characteristic are marked with (*Mandatory*)**	**Description of characteristic**	**Codes to use or explanation**
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod VIIa haddock VIIa whiting VIIa sole VIIa plaice	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	BT	
Description (*Mandatory*)	Beam trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish (all areas)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	GILLNET	
Description (*Mandatory*)	Directed gillnet fishery for anglerfish	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>220	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish IV and VI Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_LIGHT	
Description (*Mandatory*)	Otter trawl, roundfish, light trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>100 ?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish IV and VI Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_HEAVY	
Description (*Mandatory*)	Otter trawl, roundfish, heavy trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>100 ?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_OTHER	
Description (*Mandatory*)	Otter trawl, roundfish, other trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Fleet characteristic **Mandatory characteristic are marked with (*Mandatory*)**	**Description of characteristic**	**Codes to use or explanation**
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI?	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_NEP	
Description (*Mandatory*)	*Nephrops* otter trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70–99?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	Description of characteristic	Codes to use or explanation
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI?	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	DEM_SEINES	
Description (*Mandatory*)	Demersal seines, e.g. Scottish and Danish seines	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

FLEET CHARACTERISTIC MANDATORY CHARACTERISTIC ARE MARKED WITH (*MANDATORY*)	DESCRIPTION OF CHARACTERISTIC	CODES TO USE OR EXPLANATION
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas Cod VIa Haddock VIa Haddock VIb Whiting VIa Megrim VI?	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	DEM_PAIR	
Description (*Mandatory*)	Demersal pair trawls	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

FLEET CHARACTERISTIC MANDATORY CHARACTERISTIC ARE MARKED WITH (*MANDATORY*)	DESCRIPTION OF CHARACTERISTIC	CODES TO USE OR EXPLANATION
Name and e-mail of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	All stocks	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTHER	
Description (*Mandatory*)	Other gears	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Unspecified fleet	Unspecified fleet Human consumption Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range		In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Annex 3: Quality Handbook: WGNSDS-North Minch *Nephrops* (FU11)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North Minch Nephrops (FU11)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2005 (updated May 2007, N. Campbell)

A. General

A.1. Stock definition

Throughout its distribution, Nephrops is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult Nephrops only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. The North Minch Functional Unit (FU 11) is located off the north-west coast of Scotland. The northern boundary of the FU is the 59°N line, although there are no areas of suitable sediment north of 58°30’N. The boundary with the South Minch FU is at 57°30’N. The North Minch includes areas of sediment in the Inner Sound, between Skye and the mainland, with other small, isolated areas of sediment.

A.2. The fishery

The North Minch Nephrops fishery is predominantly exploited by Nephrops trawlers using single rig gear with a 70 mm mesh, although about 20 % of landings are made by creel vessels. About 15 % of the trawl landings are made with a 100 mm mesh, and only 1 % of landings appear to be made by twin-rig vessels.

All the creel vessels are local, and roughly three quarters of the trawl landings are made by vessels based between Mallaig and Kinlochbervie on the mainland, and Stornoway on the Isle of Lewis. In all, about 135 trawlers contribute to the landings, 75 % of which are local. Most of the local trawlers exploiting the North Minch are based around Stornoway and Mallaig, although the vessels from Gairloch and Ullapool also contribute significantly. Mean engine power is 206 kW, and mean vessel length 15.5 m. Most vessels were built between the 1960s and 1980s. The major landing ports are Ullapool, Gairloch and Stornoway.

The minimum landing size for Nephrops in the North Minch is 20 mm CL, and less than 0.5 % of the animals are landed under size. Discarding takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails. The main by-catch species is haddock, although whiting and Norway pout also feature significantly in discards.

The fishery is exploited throughout the year, with the highest landings usually made in the spring and summer. Vessels usually have a trip duration of one day in the winter, but up to six days in the summer.

The current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56^{0}N, A mesh size of 100 mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5 mm double twine. By comparison, vessels using a single trawl may use 70–89 mm mesh with a lifting bag and 120 meshes round the cod-end but with 4mm single twine.

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 and sex compositions of *Nephrops* landed from the North Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Table A3–1. *Nephrops*, North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1981–2005.

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

In general, males make the largest contribution to the landings and the lpues, though in some years (e.g. 1998 and 2004) the contributions from the two sexes were more equal (Table A3–1). Effort has traditionally been higher in the 2nd and 3rd quarters of the year in this fishery, but has declined in the 3rd quarter in the most recent years and is now more equally spread. Male lpue declined between 1996 and 1998, but has increased since then. There were generally lower lpues in 2004 the reason for which is not known. Male lpue has been particularly high in the 1st and 4th quarters of recent years. The lpue for females has shown a gradual steady increase since 1995 and is highest in the summer months between the hatching and spawning periods.

Length distributions of landings and discards in 2005 is shown in Figure A3–11. Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure A3–2. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in cpue for smaller individuals in 1994 (and for females in 1995), with values declining to the longer term average until 2001. Since then, values have been increasing and reached a peak in 2005. The cpue for larger males showed a similar pattern. Cpue for the larger females appears to be very stable with an aberrant peak in the fourth quarter of 2004, this appears to be due to a sample fill-in problem which will be corrected for 2008.

Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in Nephrops, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

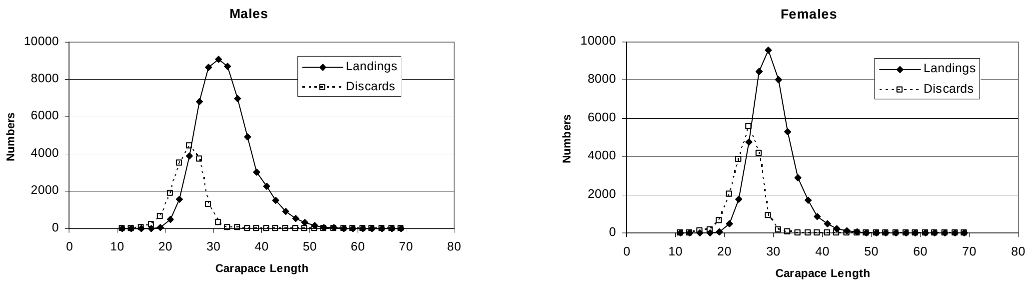

Figure A3–1. ***Nephrops*****, North Minch (FU11), Length frequency distributions of male and female landings and discards, averaged over 2003–2005.**

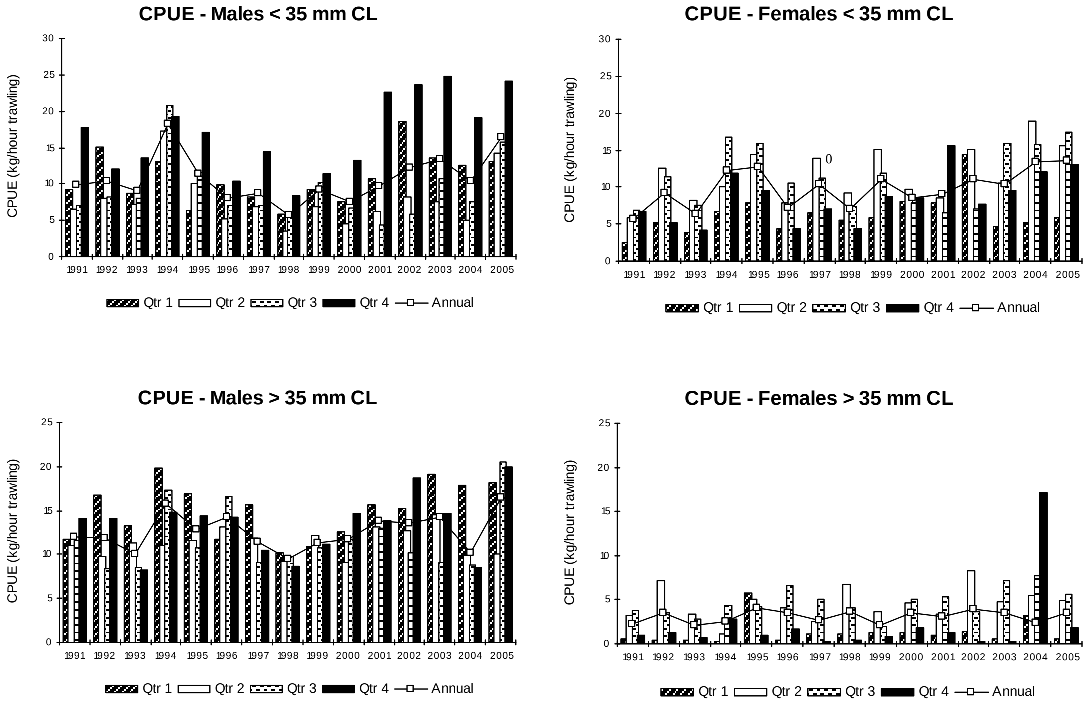

Figure A3–2. *Nephrops*, North Minch (FU11), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.

B.2. Biological

Growth: males $L_{infinity}$ = 70 mm, k=0.16:

Immature Females $L_{infinity}$ = 70 mm k= 0.16; mature females $L_{infinity}$ =60 mm, k=0.06: size maturity =27 mm

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard *et al*., 1988–citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

Abundance indices are available from the following research-vessel surveys:

Underwater TV survey: years 1995–present. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. The survey provides a total abundance estimate, and is not age or length structured.

Because of this uncertainty in sediment distribution and suitability, the North Minch is divided into four arbitrary rectangles, roughly corresponding to discrete patches of mud in (or on the border of) the functional unit, for survey purposes (fig. A3–3). Samples are distributed randomly over the area of suitable sediment within each rectangle. In the assessment, burrow densities in the four rectangles are raised to the area of suitable sediment in each region.

Historical burrow density plots for the period 1994–2005 are presented in Figure A3–4.

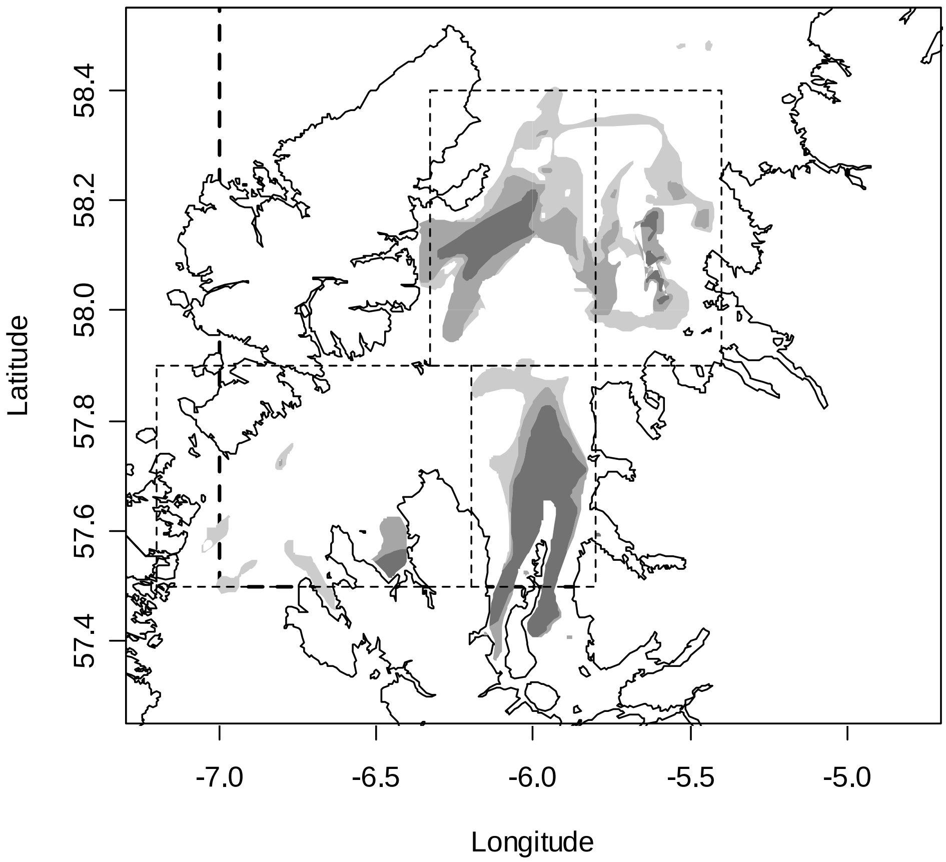

Figure A3–3. Distribution of *Nephrops* sediments, in the North Minch. Thick dashed lines represent the boundary of the functional unit. Thin dashed lines represent the arbitrary rectangles used as survey strata. Sediments are : Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy Sand.

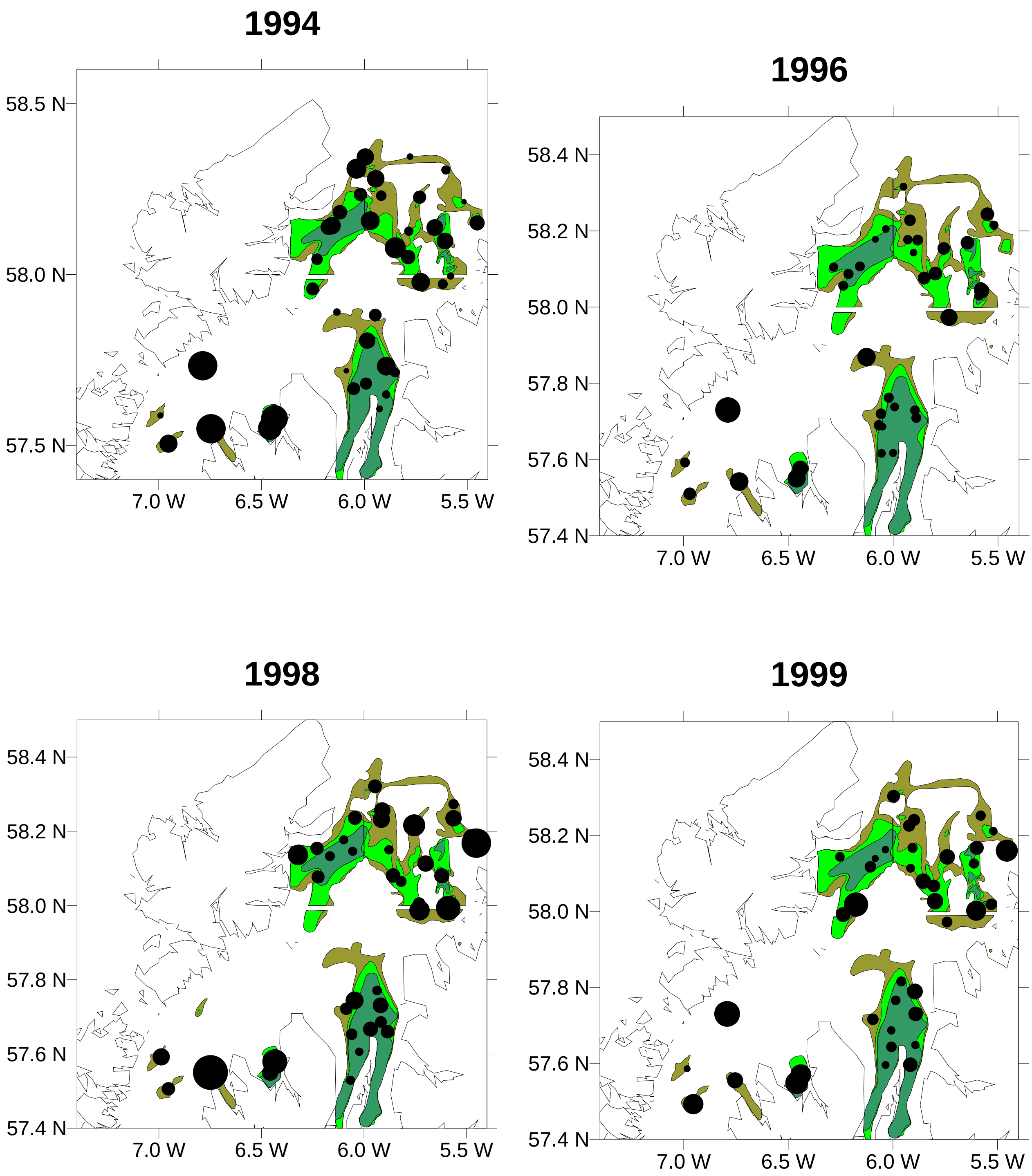

Figure A3–4. *Nephrops*, North Minch (FU11), TV survey station distribution and relative density, 1994–1999. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same.

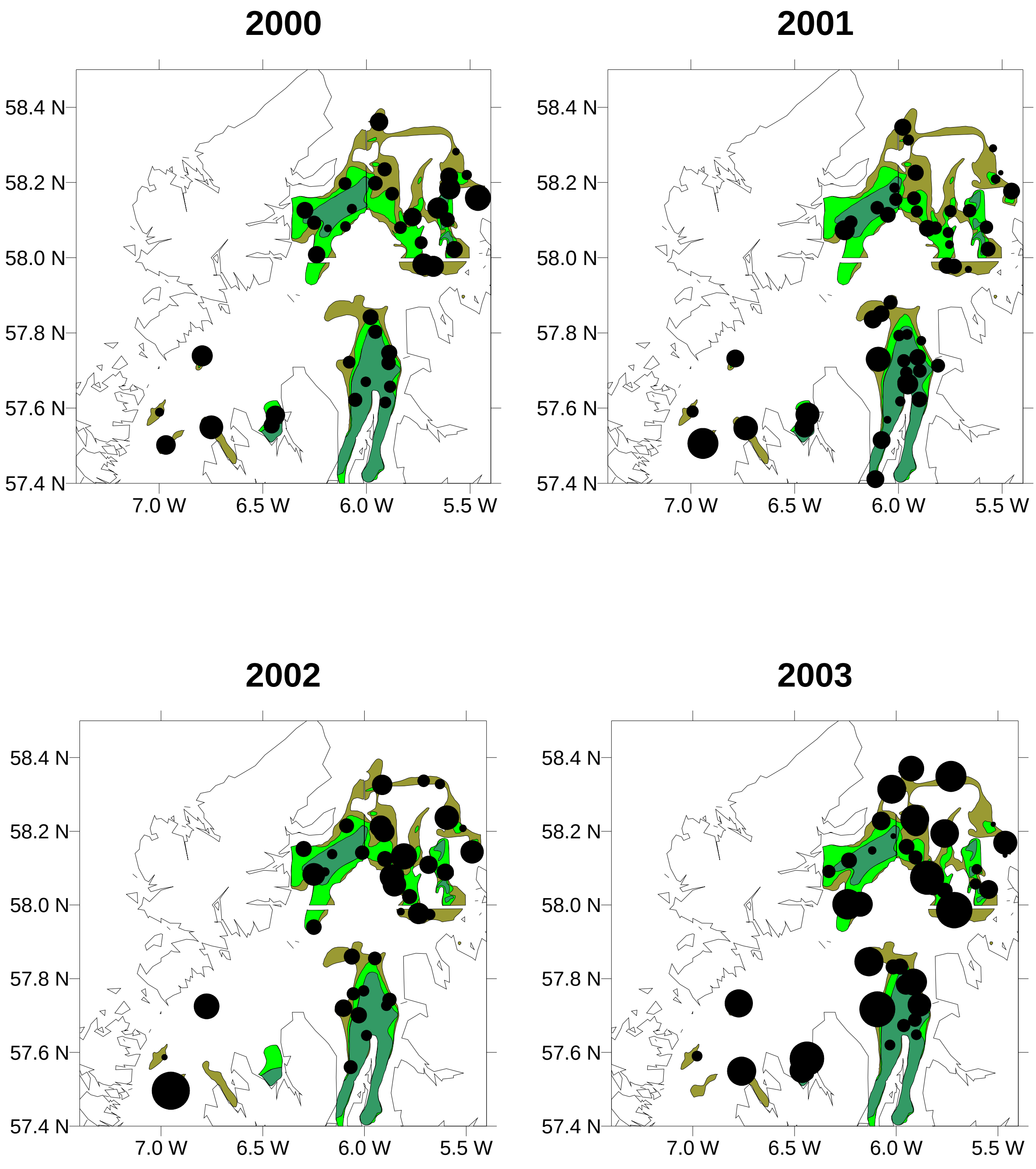

Figure A3–4 *Nephrops*, North Minch (FU11), cont. 2000–2003.

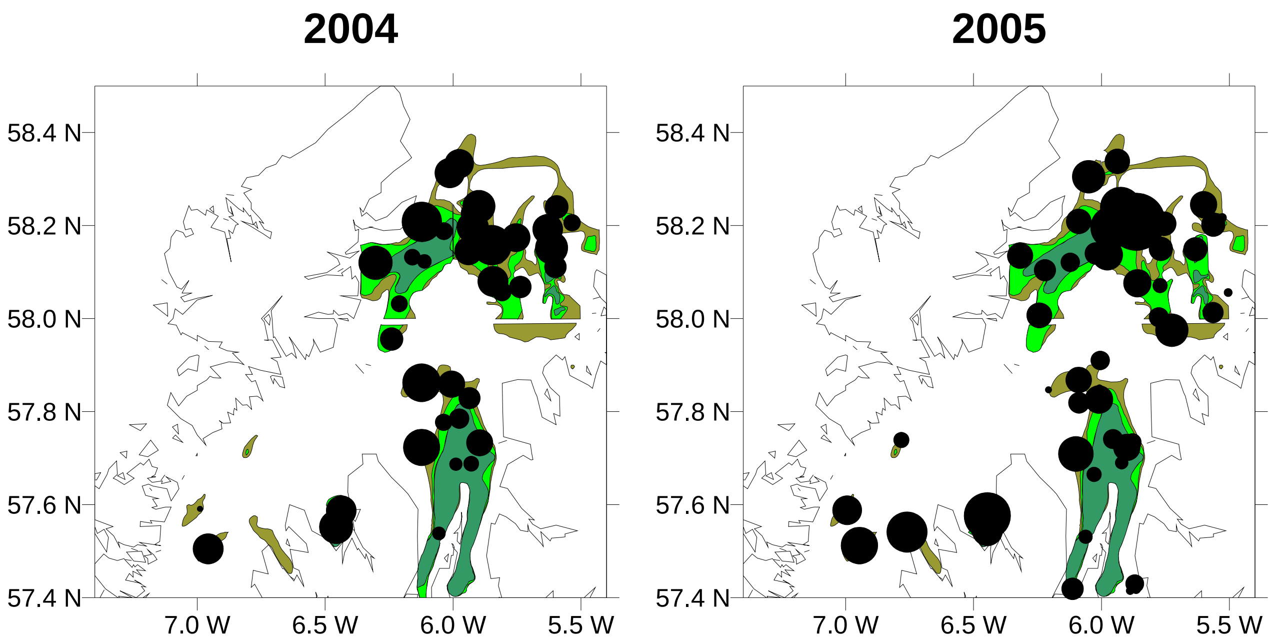

Figure A3–4. *Nephrops*, North Minch (FU11), cont. 2004 and 2005.

B.4. Commercial cpue

Catch-per-unit-effort time-series are available from the following fleets:

Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate a cpue index. Catch-at-age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). cpue is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for Nephrops 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.

B.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

This section is in the Working Group report.

E. Medium-Term Projections

This section is in the Working Group report.

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

G. Biological Reference Points

This section is in the Working Group report.

H. Other Issues

None.

I. References

Refer to References section in Working Group report

Annex 4: Quality Handbook: WGNSDS-South Minch *Nephrops* (FU12)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	South Minch *Nephrops* (FU12)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2005 (updated May 2007, N. Campbell)

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the South Minch area the *Nephrops* stock inhabits a generally continuous area of muddy sediment extending from the south of Skye to the Stanton Bank, to the south of the Outer Hebrides. The South Minch functional unit (FU12) is located off the west coast of Scotland, and is bounded to the north and south by the 56°00' and 57°30' circles of latitude, and to the west by the 8°W meridian. Out with the functional unit, a mixed fishery for gadoids and *Nephrops* takes place on Stanton Bank, to the south-west of the Outer Hebrides.

A.2. The fishery

The South Minch Nephrops fishery is predominantly exploited by Nephrops trawlers, although about 10 % of landings are made by creel vessels. About 90 % of trawler landings are made by vessels targeting Nephrops, and only 1 % of landings are made by twin-rig vessels. Of the Nephrops trawlers, about 80 % of landings are made with a 70 mm mesh.

All the creel vessels are local, and roughly half of the trawl landings are made by vessels based between Mallaig and Campbeltown. Visiting vessels originate from the North Minch (8% of landings) and the Scottish East coast. The East coast vessels tend to be larger than the local ones, and carry out longer trips. Mean engine power of the local vessels is 200 kW, and their mean length 15.0 m. Most vessels were built between the 1960s and the 1980s. The major landing ports are Oban and Mallaig. The smaller vessels usually have a trip duration of 1–3 days, while larger boats may stay out for 5–6 days.

The minimum landing size for Nephrops in the South Minch is 20 mm CL and less than 0.5% of animals are landed under size. Discarding takes place at sea and landings are made by category for whole animals (small and large) and as tails. The main by-catch species are whiting and haddock, with whiting in particular featuring heavily in discards. Of the non-commercial species caught, poor cod, Norway pout and long rough dab contribute significantly to the discards.

The fishery is exploited throughout the year, with the highest landings usually being made in the spring and summer. A seasonal sprat fishery often develops in November and December, which is targeted by vessels of all sizes (including those that usually target Nephrops). Some vessels also turn to scallop dredging when Nephrops catches or prices drop, although the scope for this has been limited in recent years with ASP and PSP closures of the scallop fishery in some areas.

The current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56^0N, A mesh size of 100 mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5 mm double twine. By comparison, vessels using a single trawl may use 70–89 mm mesh with a lifting bag and 120 meshes round the cod-end but with 4 mm single twine.

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 and sex compositions of *Nephrops* landed from the South Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed *Nephrops* changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Males contribute more to the landings and the lpues than females, although the proportion of females tends to increase in years when the effort distribution between the 2nd and 3rd quarter is more evenly spread (Figure A4–1). Effort is normally highest in the 2nd quarter in this fishery, and generally lowest in the 4th quarters. Male lpue showed an increase in 1995, declined to a relatively stable level between 1996 and 2001, but has increased steadily to 2005.

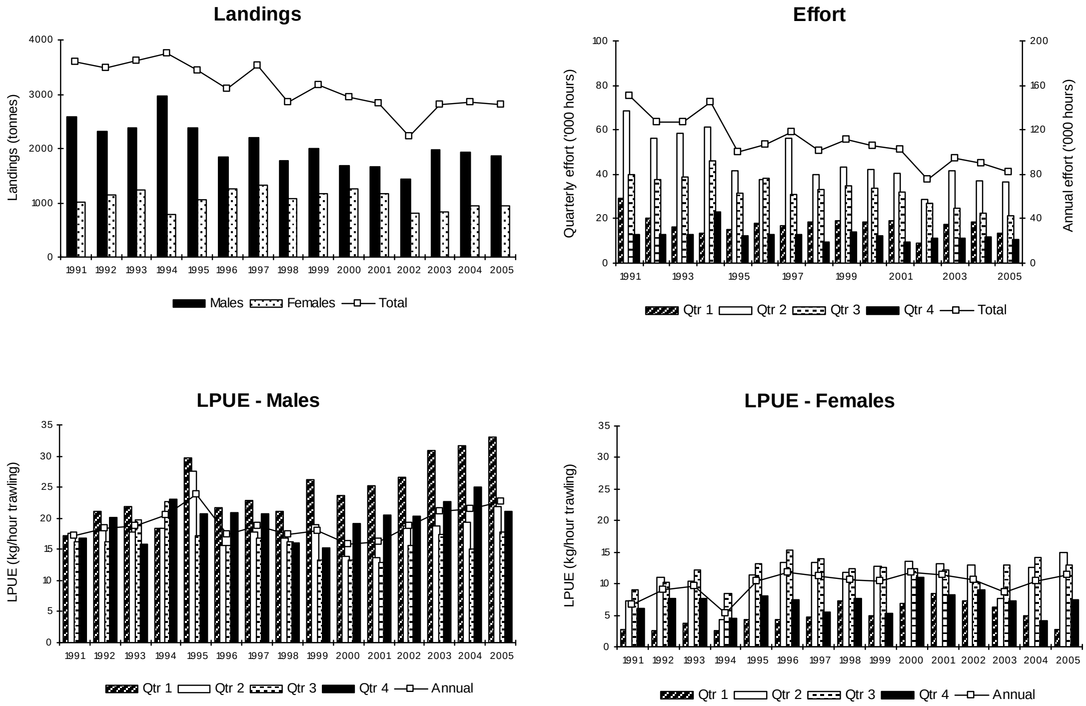

Figure A4–1. *Nephrops*, South Minch (FU12), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers.

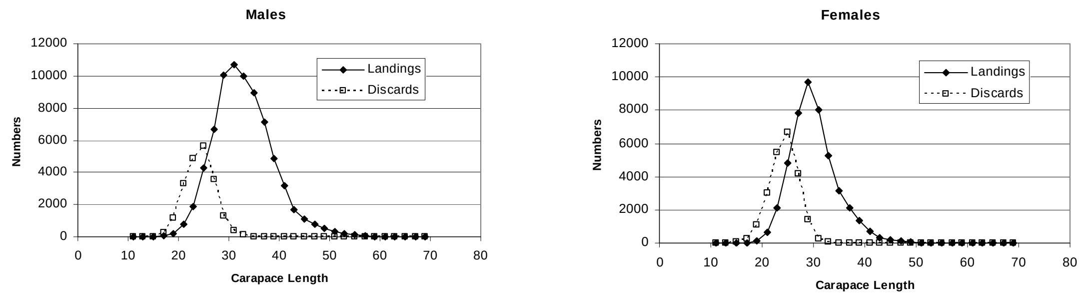

Figure A4–2. *Nephrops*, South Minch (FU12), Length frequency distributions of male and female landings and discards, averaged over 2003–2005.

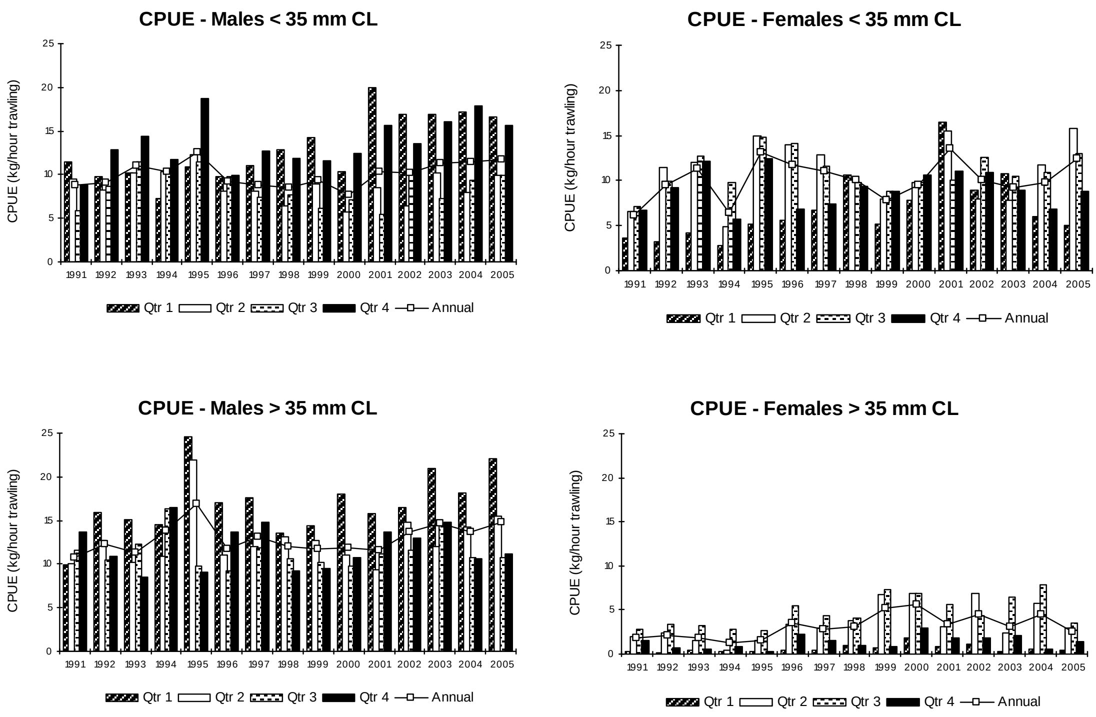

Figure A4–3.*Nephrops*, South Minch (FU12), cpues by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.

An indication of the size distribution of discards compared to landings is provided in Figure A4–2. Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure A4–3. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in cpue for smaller individuals in 1995, with values declining to the longer term average after this, and a second rise in 2001 which has continued upward to 2005. The higher values are particularly evident for males in the 1st and 4th quarters. The cpue for larger males increased in 1994, and also shows a similar increase to the smaller size category in the most recent years. Cpue for the larger females appears to have fluctuated without trend since 2001. Mean sizes above and below 35 mm for the period 1981–2005 can be found in table A4–1.

Table A4–1. Mean sizes of *Nephrops* above and below 35 mm, by sex, for the period 1981–2005.

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

Trawl and creel fisheries are sampled separately.

In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

B.2. Biological

Growth: males $L_{infinity}$ = 68 mm, k=0.161:

Immature Females $L_{infinity}$ = 68 mm k= 0.161; mature females $L_{infinity}$ =59 mm, k=0.06: size maturity =25 mm.

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard *et al*., 1988 – citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1995–present. The survey usually occurs in June. The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata. The survey provides a total abundance estimate, and is not age or length structured (Figure A4–4). Historic distribution of sample sites and burrow densities are given in Figure A4–5.

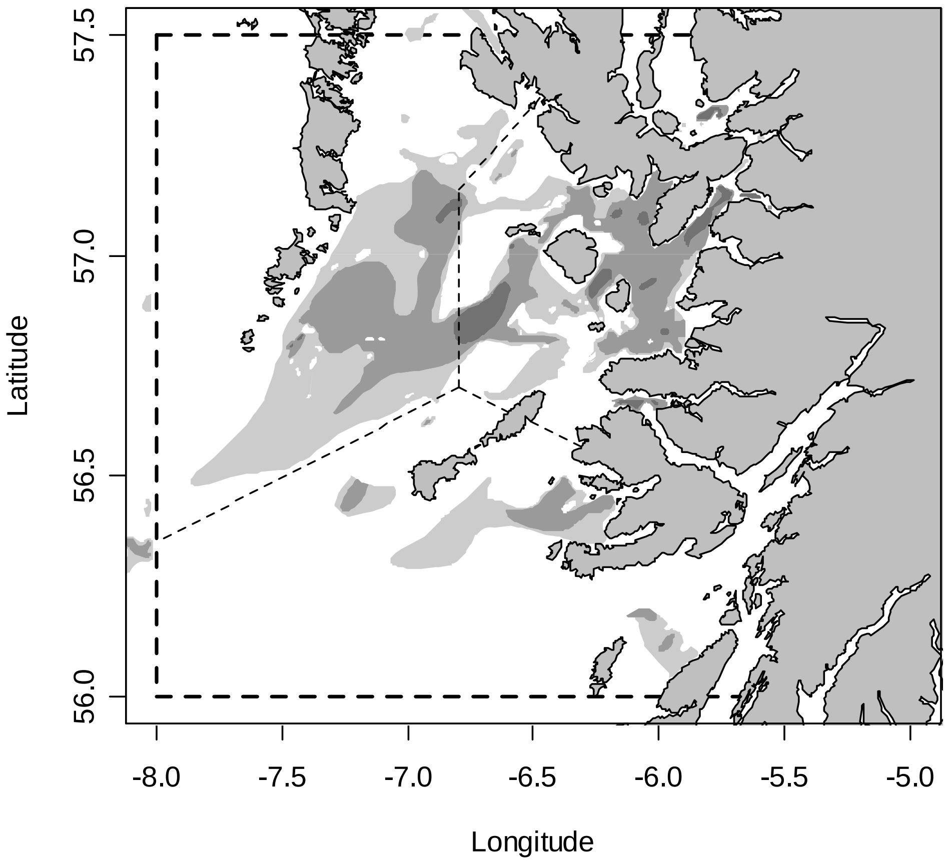

Figure A4–4. Sediment strata in the South Minch. Light Grey – Muddy sand, Grey – Sandy mud, Dark Grey – Mud. Light dashed lines represent spatial strata imposed on the sampling regieme to ensure adequate spatial coverage.

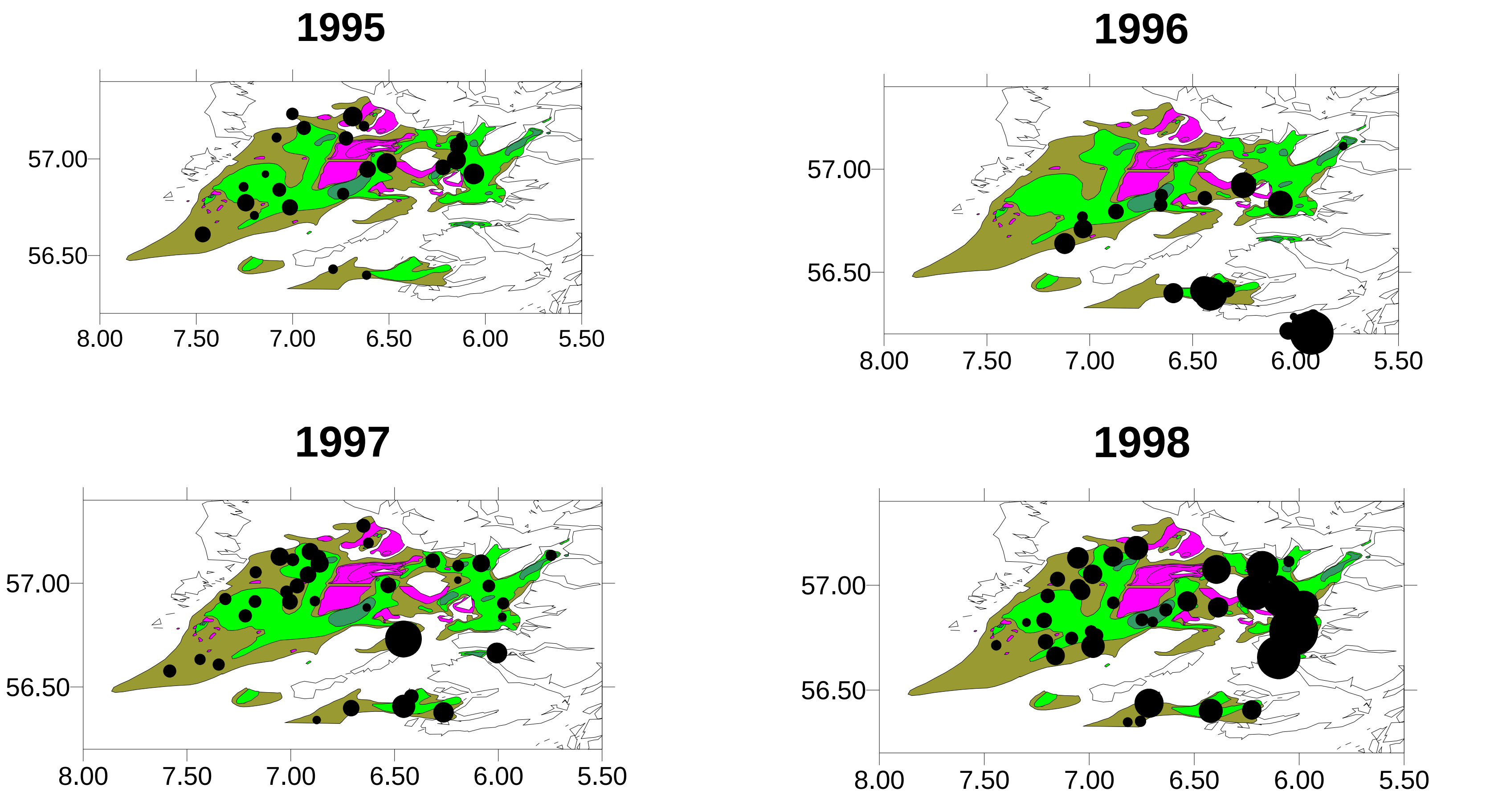

Figure A4–5 *Nephrops*, South Minch (FU12), TV survey station distribution and relative density, 1995–1998. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same.

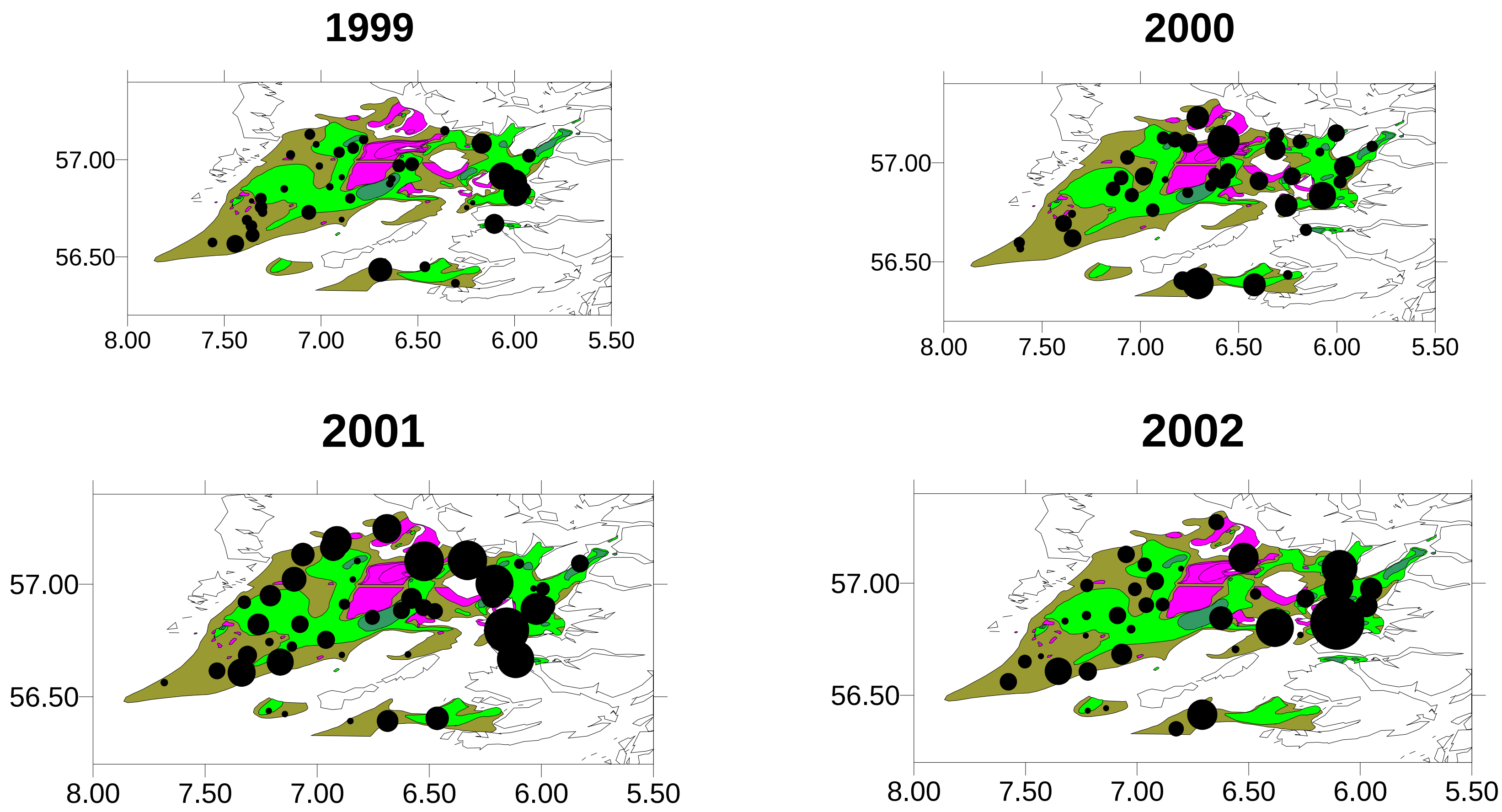

Figure A4–5 *Nephrops*, South Minch (FU12) cont. 1999–2002.

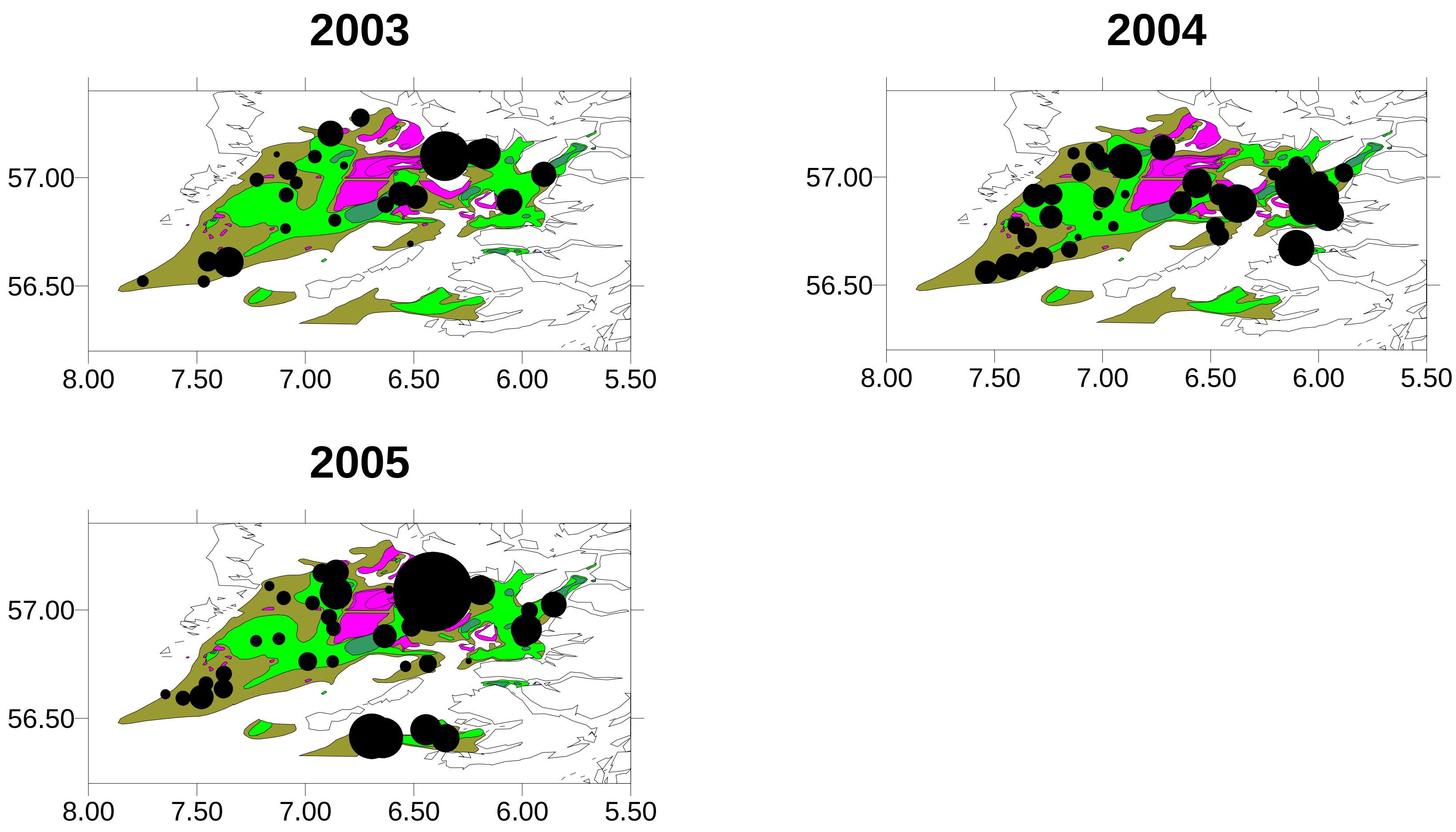

Figure A4–5 *Nephrops*, South Minch (FU12) cont. 2003–2005.

Historical details of burrow density estimates are found in Table A4–2 for the South Minch and Table A4–3 for Stanton Bank.

Table A4–2. Historical trends in South Minch burrow density and biomass as indicated by the UTV survey, 1995–2005.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	33	0.30	1520	331	25.8-40.2
1996	21	0.38	1945	700	27.1-57.5
1997	36	0.28	1434	244	25.8-36.5
1998	38	0.38	1916	306	35.0-48.3
1999	37	0.23	1146	275	18.9-30.9
2000	41	0.37	1851	332	33.0-47.5
2001	47	0.44	2228	512	37.9-60.5
2002	31	0.42	2114	671	31.9-61.5
2003	25	0.42	2121	721	30.9-62.8
2004	38	0.50	2543	457	46.1-66.3
2005	33	0.50	2529	763	38.9-72.7

Table A4–3. Historical trends in Stanton Bank burrow density and biomass as indicated by the UTV survey, 1995–2005.

Year	Station number	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	9	0.22	64	35
1996		no survey		
1997	9	0.28	80	31
1998		no surveys		
1999				
2000				
2001	8	0.24	68	25
2002	8	0.27	78	21
2003	8	0.31	90	25
2004		no survey		
2005	7	0.33	95	26

B.4. Commercial cpue

Landings-per-unit-effort time-series are available from the following fleets:

- Scottish *Nephrops* trawl gears. Landings at age and effort data for Scottish *Nephrops* trawl gears are used to generate an cpue index. Catch-at-age are estimated from raising length sampling of discards and landings to Officially recorded landings (*Nephrops* single trawl, multiple *Nephrops* trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). cpue is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* 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.

B.5. Other relevant data

None.

C. Historical stock development

This section is in the Working Group report.

D. Short-term projection

This section is in the Working Group report.

E. Medium-term projections

This section is in the Working Group report.

F. Yield and biomass per recruit/long-term projections

This section is in the Working Group report.

G. Biological reference points

This section is in the Working Group report.

H. Other issues

None.

I. References

Refer to References section in Working Group report

Annex 5: Quality Handbook: WGNSDS-Clyde *Nephrops* (FU13)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Clyde *Nephrops* (FU13)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2005 (updated May 2007, N. Campbell)

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Clyde area the *Nephrops* stock inhabits an area of muddy sediment extending throughout the Firth of Clyde, and another smaller area in the Sound of Jura, as shown in Figure A5–1. The two areas are separated by a large area of sandy gravely sediment around the Mull of Kintyre, and are treated as separate populations since they have differing population characteristics.

A.2. The fishery

Firth of Clyde

The Firth of Clyde Nephrops fishery is predominantly exploited by a dedicated Nephrops trawler fleet of approximately 120 vessels, with less than 2–3 % of the landings made by creel vessels. The 90 resident Clyde trawlers make about 90 % of the Nephrops landings. Under the Scottish 'Inshore Fishing Order' of 1989 (Prohibition of Fishing and Fishing Methods), fishing with mobile gear is prohibited within the Firth of Clyde over weekends, and with vessels > 70 feet (about 21 m) in length.

The trawler fleet that fishes the Firth of Clyde mostly consists of vessels between 10 and 20 m in length (mean overall length 14 m), with a mean engine power of 185 kW. Almost half the fleet was built during the 1960s, with less than 20 % built after 1979. Most vessels use single otter trawls with a 70 mm mesh codend, but just under a third of Nephrops landings are taken by vessels using twin-rig trawls with an 80 mm mesh codend. Vessels employing twin-rig gear are generally slightly more powerful than the single rig vessels (mean power 214 kW compared to 176 kW).

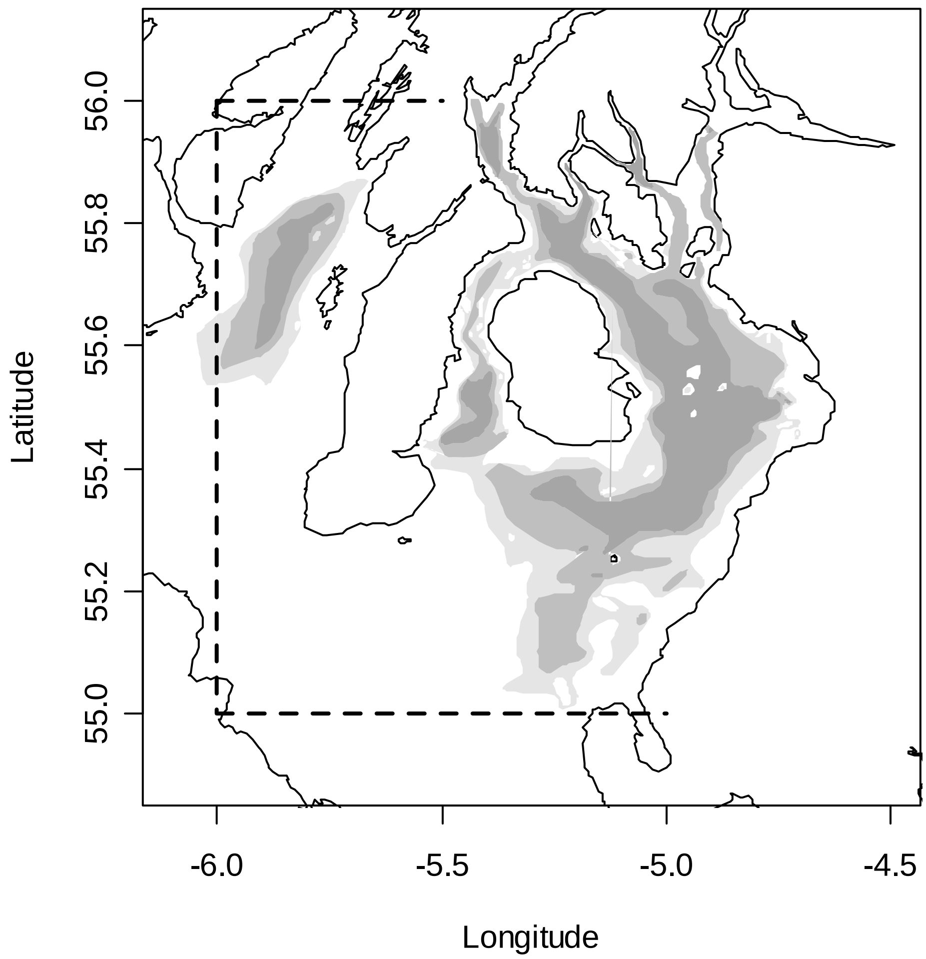

Figure A5-1. Distribution of suitable sediments in FU13. Light grey - muddy sand; medium grey - sandy mud; dark grey - mud.

The regular fleet is comprised of Scottish vessels, but some catches are taken by Northern Ireland and Republic of Ireland vessels. The major landing ports are Troon, Campbeltown, Girvan and Tarbert, but smaller landings are also made at Carradale, Largs and Rothsay.

The minimum landing size for Nephrops in the Clyde is 20 mm CL. Compliance with the minimum landing size is good, with samples suggesting only a very small undersized component in the landings (< 0.5 %).

Nephrops growth varies within the area, with low density animals growing to large sizes in the North, and with higher density animals reaching smaller sizes in the South. Far more Nephrops material (undersized individuals and 'heads' from tailed animals) is discarded in the South. Discarding usually takes place at sea and landings are made by category for whole animals (small, medium and large) and as tails. In poor weather or for the last haul of the day, discarding may take place within the harbour, thus increasing discard mortality.

Only a small fish by-catch is made in the Firth of Clyde, with whiting and cod being the most important species. The composition of the by-catch and discards varies within the Firth of Clyde, with more flatfish (common and long rough dab), echinoderms and crustaceans (other than Nephrops) caught in the North, while more roundfish (particularly whiting) are caught in the South. These differences reflect the different habitats and fish communities in the area.

The fishery is exploited throughout the year, with highest landings usually made between July and September. Vessels usually have a trip duration of one day, sailing to shoot before dawn, and carrying out 3–4 hauls of 4 hours per day.

Sound of Jura

The fishery for Nephrops in the Sound of Jura constitutes part of the Clyde FU, but is examined separately from the fishery within the Firth of Clyde, because of differences in the biological parameters of the Nephrops populations.

The fleet exploiting the Sound of Jura is also different to the Firth of Clyde, with vessels tending to be slightly smaller but more powerful. In 1999, the vast majority of landings were made by 30 trawlers specifically targeting Nephrops, with a small number of creel vessels also active. Most landings are taken by Scottish vessels (which are virtually all local to the area), with a very small proportion taken by boats from the rest of the UK. The local trawler fleet consists of vessels between 9 and 16 m in length, and with a mean engine power of 185 kW.

Just over half the landings are made by twin-rig Nephrops trawlers using 80 mm meshes, with most of the remainder landed by single rig vessels using 70 mm meshes. Vessels employing twin-rig gear are generally larger and more powerful than those using single rig trawls (15 m and 220 kW compared to 13 m and 160 kW). The main landing ports are Port Askaig, West Loch Tarbert and Crinan.

The minimum landing size for Nephrops in the Sound of Jura is 20 mm CL. Nephrops are found in high densities in this stock, but only grow to relatively small sizes. Discarding takes place at sea (this can be a high proportion of the catch by number, because of the small mean size of the animals caught), and landings are made by category for whole animals (small, medium and large) and as tails.

Catches of fish in the Sound of Jura area are generally poor, and Nephrops is by far the target species, with only small by-catches of whitefish and flatfish.

The fishery is exploited throughout the year, with highest landings usually made between April and June. Vessels usually have a trip duration of one day, with 3–4 hauls per day.

For both areas the current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70–99 mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery. Additional UK legislation has also been applied in the southern areas of the Firth of Clyde in recent years, aimed at protecting the aggregating cod in the south of the Clyde during February, March and April.

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 and sex compositions of *Nephrops* landed from the Firth of Clyde are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed *Nephrops* changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Males contribute more to the landings and the lpues than females, although the proportion of females tends to increase in years with considerably more effort in the 3rd quarter than the second (i.e. 1994; Figure A5–2). Effort has previously been highest in the 3rd quarter in this fishery, but has become far more even through the year as the overall level of effort has declined. Male lpue showed an increase in 1995, to a relatively stable level, and then a further increase between 2001 and 2003; it remains high in 2005 particularly in the first and fourth quarters. Female lpue is lower than that for males, but shows similar increases after 1995 and 2001, highest rates are obtained in the second and third quarters.

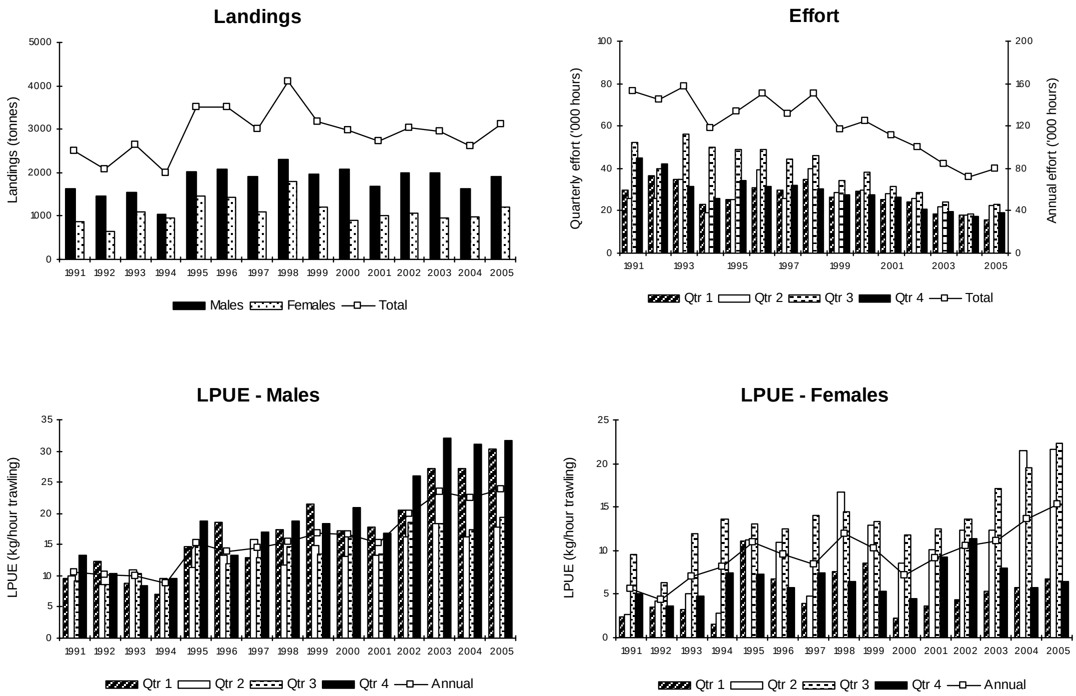

Figure A5–2. *Nephrops*, Firth of Clyde (FU13), Landings, effort and lpues by quarter and sex from Scottish *Nephrops* trawlers.

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 averaged over the period 2003 to 2005 for this stock were particularly high at 35% by number. This represents a decrease in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure A5–3. Cpue data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure A5–4. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. For both sexes the data show a series of increases in cpue for smaller individuals in 1995, 1998 and 2003. In small males this rate did not increase further in 2005 but in females there was further rise. The cpue for larger males remained relatively stable prior to 1997, fell to a slightly lower stable level until 2002, and then increased markedly in 2003–it remained high in 2005. Cpue for the larger females shows a similar pattern in the early part of the time series but there has not been a noticeable increase recently.

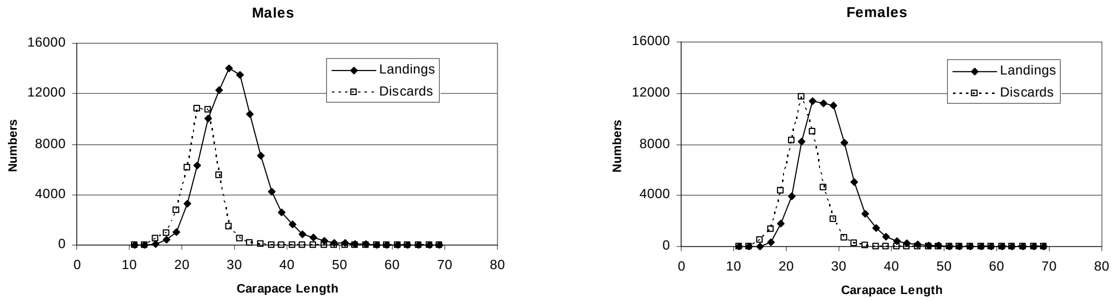

Figure A5–3. *Nephrops*, Firth of Clyde (FU13), Length frequency distributions of male and female landings and discards, averaged over 2002–2004.

In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

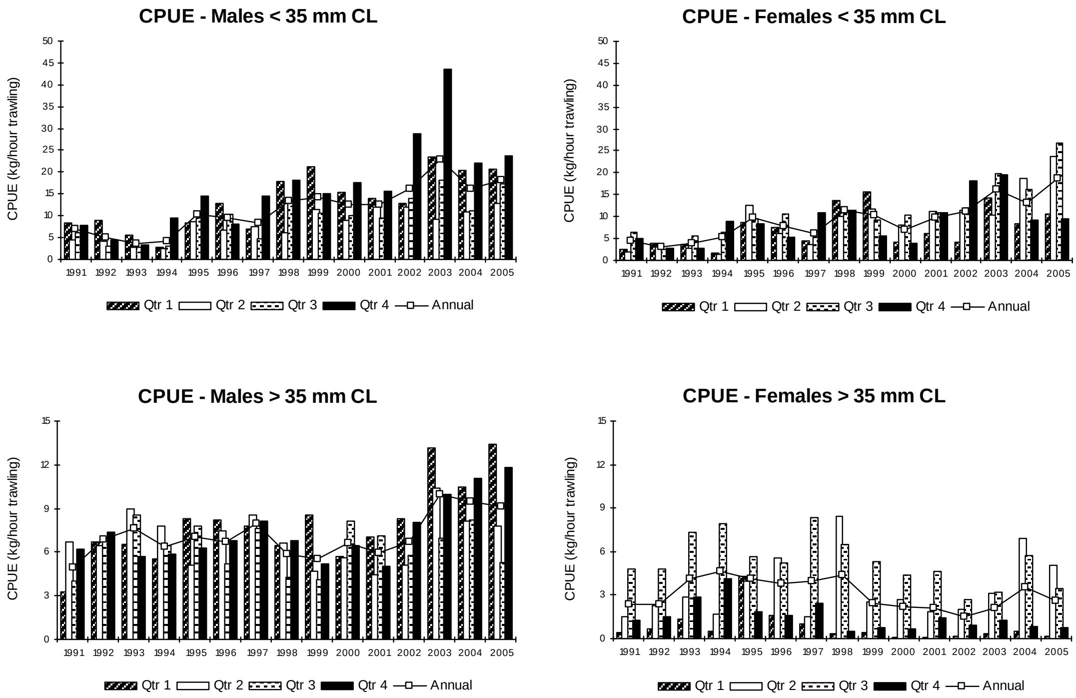

Figure A5–3. *Nephrops*, Firth of Clyde (FU13), cpues by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.

B.2. Biological

Growth: males Linfinity = 73 mm, k=0.16:

Immature Females Linfinity = 73 mm k= 0.16; mature females Linfinity =62 mm, k=0.06: size maturity =27 mm.

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard *et al.,* 1988 – citation required).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights at age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

The burrowing nature of *Nephrops*, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating *Nephrops* population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata and latitude (Tuck *et al*., 1999) (see Figure A5–1). The survey provides a total abundance estimate, and is not age or length structured. A series of annual underwater TV surveys are available since 1995 for the Firth of Clyde and Sound of Jura. Whilst the survey in the Clyde has been continuous, the TV survey for the Sound of Jura was not conducted from 1997 to 2000, and again in 2004. Such large gaps in the series make interpretation of any trends from the data difficult. The number of valid stations in the survey have remained relatively stable throughout the time period. An average of 36.6 stations have been sampled in each year, and then raised to a stock area of 2062.2 km^2 for the Firth of Clyde, and an average of 10.3 stations have been considered valid each year for the Sound of Jura. Confidence intervals around the abundance estimates have remained relatively stable through the time period.

Historical details of survey distribution and burrow density are presented in Figure A5–4.

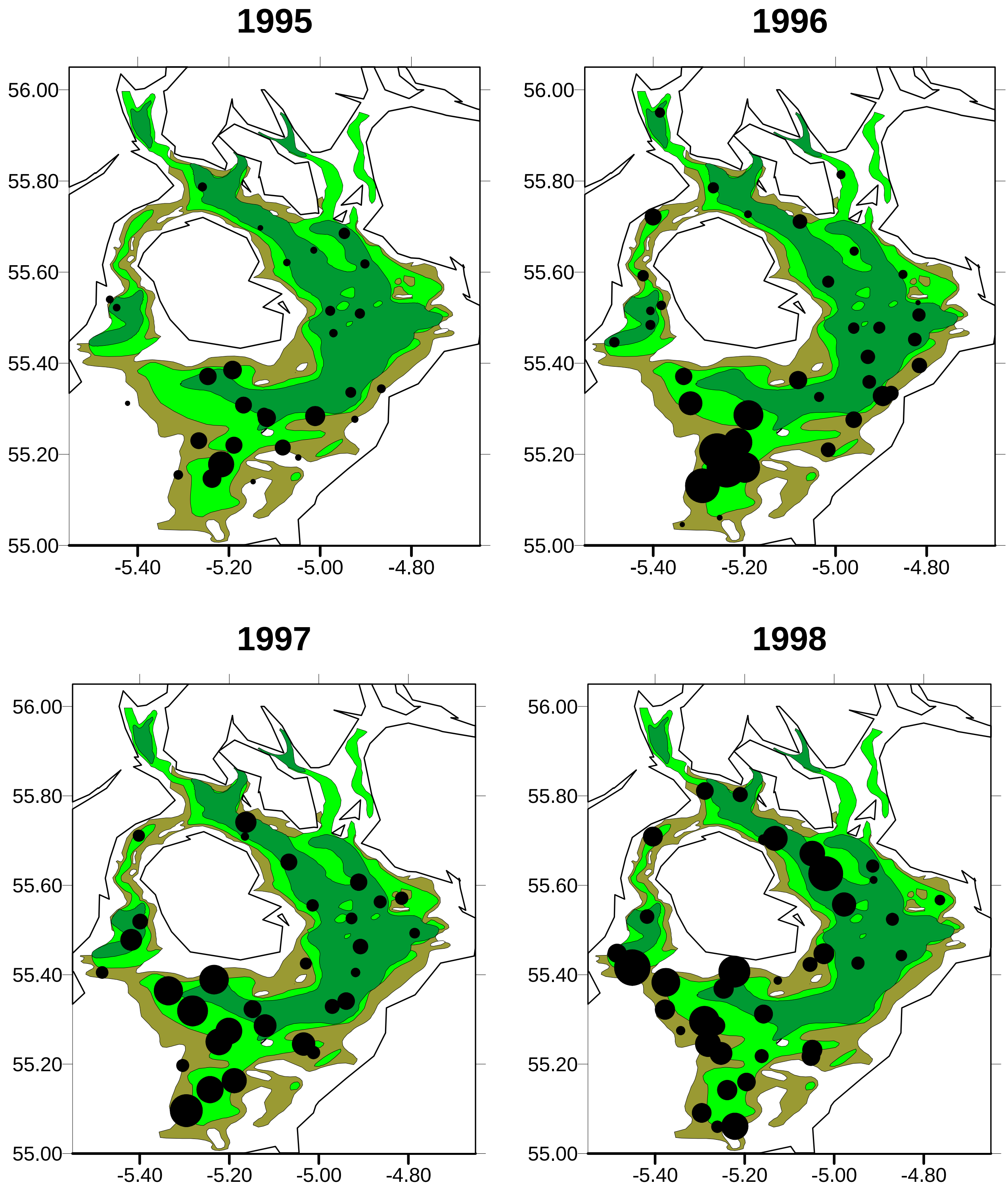

Figure A5–4. ***Nephrops*****, Firth of Clyde (FU13), TV survey station distribution and relative density, 1995–2004. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles scaled the same.**

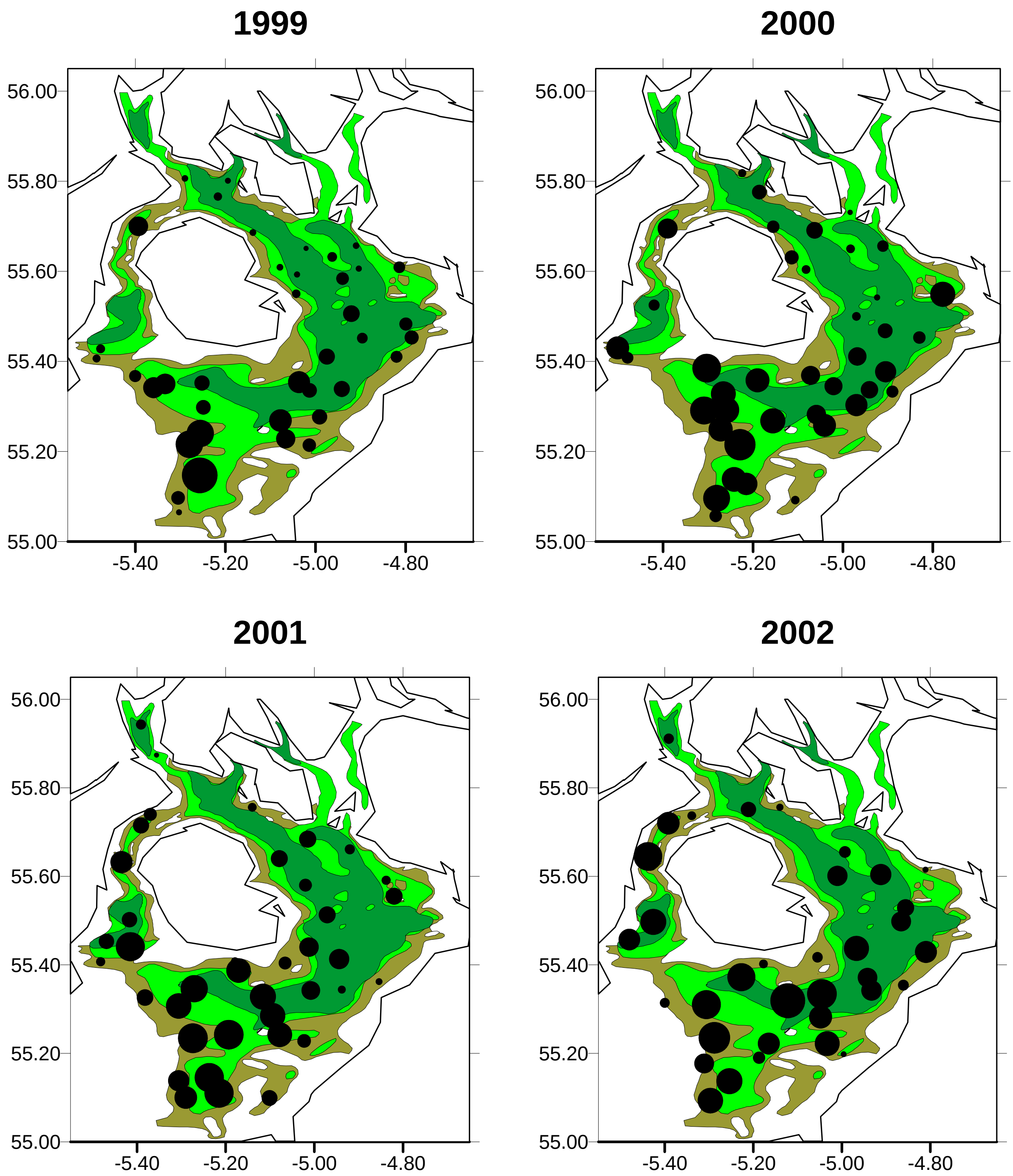

Figure A5–4 *Nephrops*, Firth of Clyde (FU13) cont. 1999–2002.

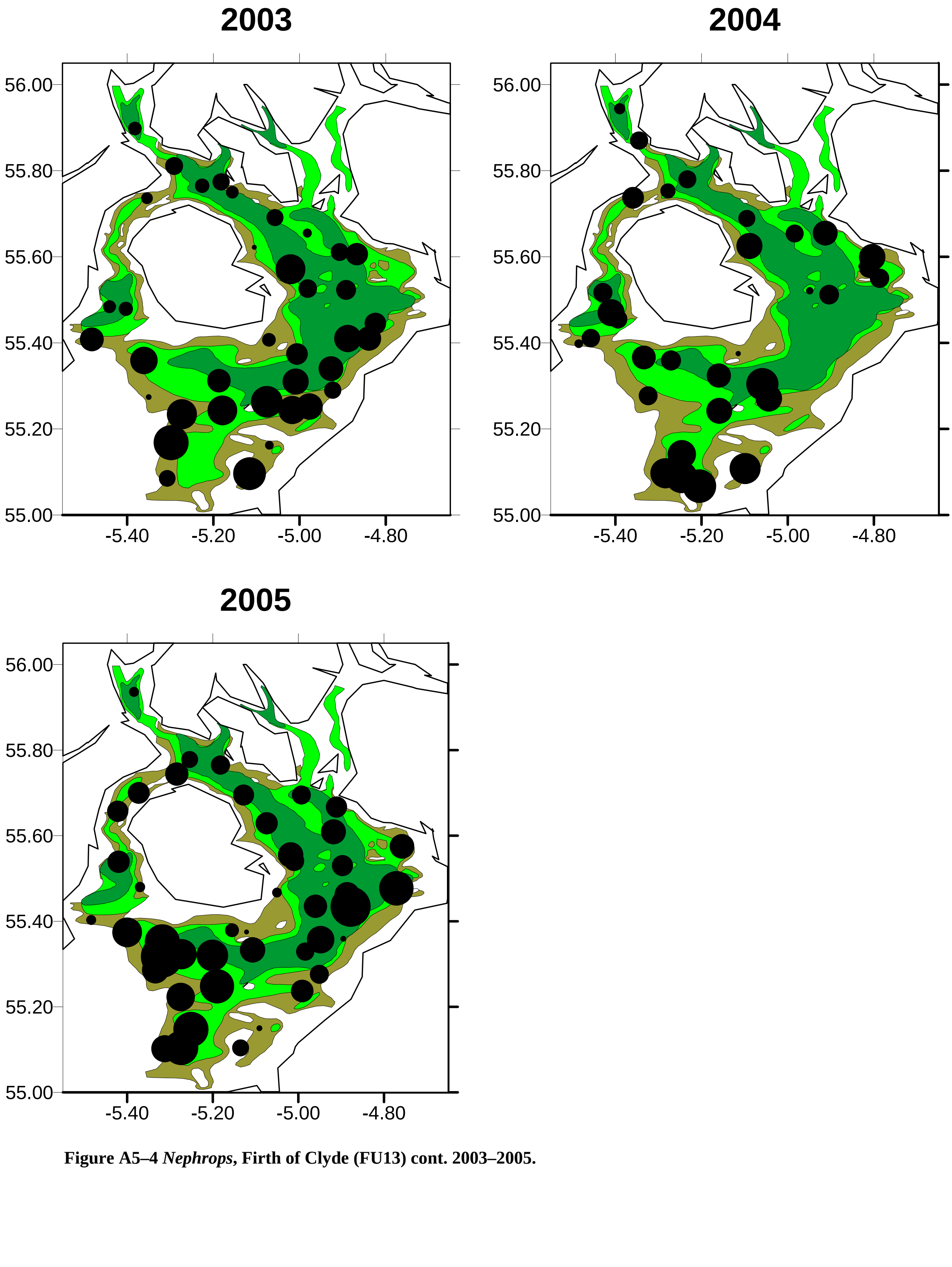

Figure A5–4 *Nephrops*, Firth of Clyde (FU13) cont. 2003–2005.

B.4. Commercial cpue

Landings-per-unit-effort time-series are available from the following fleets:

- Scottish *Nephrops* trawl gears. Landings at age and effort data for Scottish *Nephrops* trawl gears are used to generate an cpue index. Catch-at-age are estimated from raising length sampling of discards and landings to Officially recorded landings (*Nephrops* single trawl, multiple *Nephrops* trawl, Light trawl and multiple demersal trawl), and slicing into ages (knife edge slicing using growth parameters). Cpue is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* 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.

B.5. Other relevant data

None.

C. Historical stock development

This section is in the Working Group report.

D. Short-term projection

This section is in the Working Group report.

E. Medium-term projections

This section is in the Working Group report.

F. Yield and biomass per recruit/long-term projections

This section is in the Working Group report.

G. Biological reference points

This section is in the Working Group report.

H. Other issues

None.

I. References

Refer to References section in Working Group report

Annex 6: Quality Handbook Annex: WGNSDS-Irish Sea East *Nephrops* (FU14)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea East *Nephrops* (FU14)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2007

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the eastern Irish Sea the *Nephrops* stock inhabits an area of muddy sediment extending along the Cumbria coast and its fishery contributes to less than 10% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements in the Irish Sea. The two are treated as separate populations since they have differing population characteristics.

A.2. The fishery

Over the past 19 years, landings from FU 14 have been relatively stable, fluctuating around a long-term average (1991–2006) of about 550 t. Landings in 2003 were the lowest since 1974. They have since risen to a value, in 2006, 14 % above the long-term average. Over the last 10 years UK vessels have landed, on average, 86% annually of the international landings. Irish vessels increased their share of the landings to 35% in 2002 but this has since declined to around 6% in 2006. In 2006, most of the landings were made into England with a high proportion of these landings (59% of the directed landings and 54% of the total landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1993 and in 2006 was at the lowest level in the series, bar 2004, since 1975.

The changes to the structure and landing practices of the Northern Irish fleet (see above) will have had some impact on this data series. In recent years, fewer of the Northern Irish fleet were landing in England. The differences between lpue figures for individual vessels suggest that earlier years may have included less truly directed effort. Recent reductions in quota between 2002 and 2006 for VIIa cod and plaice may have restricted total effort in FU14 thereby reducing the more casual effort on *Nephrops*. Further research is needed to better define directed fishery. In 2003 and 2004 the main fleets targeting *Nephrops* include *Nephrops* directed single-rig and twin-rig otter trawlers operating out of ports in UK (NI), UK (E&W) and Ireland. Regulations introduced as part of a revised package of EC Fisheries Technical Conservation measures in 2000 remain in place. This legislation incorporates a system of 'mesh size ranges' for each of which has been identified a list of target species. In effect, nets in the 70–79 mm mesh size range must have at least 35% of the list of target species (which includes *Nephrops*) and the 80–99 mm mesh size range requires at least 30% of the list of target species. A square mesh panel (SMP) of 80 mm is required for 70–79 mm nets in the Irish Sea. Vessels using twin-rig gear in the Irish Sea must comply with a minimum mesh size of 80 mm (no SMP is required for nets with 80 mm meshes and above). Other *Nephrops* conservation measures in the Irish Sea are a minimum landing size of 20 mm CL length (equivalent to 37 mm tail length or 70 mm total length).

In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels between 14th February to 30th April part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

A.3. Ecosystem aspects

The Working Group has collated no information on the ecosystem aspects of this stock.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea East are estimated from port sampling by England and Wales. Length data from this sampling are applied to catches and raised to total international landings.

The lack of discard data since 1994 is likely to aversely affect the quality of analytical assessments. Apparent differences between catch LFDs and discard practices in 1992 to 1994 and 1999 to 2000 are discussed in the Section 5.12 of the 2001 WGNEPH report (ICES, 2001a). 2001 and 2002 catch and landings sampling provided catch compositions to help estimate the LFDs for the missing years. Quarterly discard distributions for the years 1995 to 1999 were estimated by using the discard LFDs for the two preceding and the two following years. Trial XSAs using these data were attempted at the 2003 WGNEPH. Two more years of catch and landings sampling has provided further catch compositions to add to the data series available for assessments.

In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of ‘slicing’. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate ‘true’ as opposed to ‘nominal’ age classes (ICES, 2001a). The age classes are ‘true’ to the extent that the first slicing boundary, i.e. lower length boundary for ‘age’ 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of ‘age’ classes across stocks.

B.2. Biological

Mean weights-at-age for this stock are estimated from studies by Bailey and Chapman, 1983.

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights at age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

There are no documented surveys of this stock.

Landings-per-unit-effort time-series are available from the following fleets:

England and Wales *Nephrops* trawl gears. Landings at age and effort data from this fishery are used to generate a cpue index. There is also a cpue series from 1995 for Republic of Ireland vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife edge slicing using growth parameters). Cpue is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* trawlers is raised to landings. Discard sampling commenced in 1992 for this fishery, though some years have been missed as discussed above. There is no account taken of any technological creep in the fleet.

B.5. Other relevant data

None.

C. Historical stock development

D. Short-Term Projection

E. Medium-term projections

F. Yield and biomass per recruit/long-term projections

G. Biological reference points

H. Other issues

I. References

Biological Input Parameters

PARAMETER	VALUE	SOURCE
Discard Survival	0.00	
MALES		
Growth - K	0.160	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Length/weight - a	0.00022	Hossein et al. (1987)
Length/weight - b	3.348	"
FEMALES		
Immature Growth		
Growth - K	0.160	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Size at maturity	24	Briggs (1988)
Mature Growth		
Growth - K	0.100	Irish Sea West data ; Bailey and Chapman (1983)
Growth - L(inf)	56	"
Natural mortality - M	0.2	Brander and Bennett (1986, 1989)
Length/weight - a	0.00114	Hossein et al. (1987)
Length/weight - b	2.820	"

Annex 7: Quality Handbook: WGNSDS-Irish Sea West *Nephrops* (FU15)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea West *Nephrops* (FU15)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	17 May 2007

A. General

A.1. Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 30–100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the western Irish Sea the *Nephrops* stock inhabits an extensive area of muddy sediment between the Isle of Man and Northern Ireland and its fishery contributes to more than 90% of overall Irish Sea landings. There is little evidence of mixing between the east and west Irish Sea stocks due to the nature of water current movements, which is characterised in the west by a gyre, which has a retention affect on both sediment and larvae. The eastern and western Nephrops stocks are treated as separate populations as they have different population characteristics.

A.2. The fishery

Northern Ireland

In 1991, the Northern Ireland *Nephrops* fleet operating in the Irish Sea consisted of 230 trawlers of over 10 m length and with an engine power of 200–500 hp. The vessels used single net otter trawls of low headline height (< 1.5 m) and the same mesh size throughout. The minimum mesh size was increased to 70 mm in the mid–1980s, and for single net otter trawls is the optimum mesh size for Irish Sea *Nephrops* (BRIGGS, *et al.*, 1999).

A revised package of EC Fisheries Technical Conservation measures came into force on January 1st, 2000. This new legislation incorporates a system of 'mesh size ranges' for each of which has been identified a list of target species. In effect, nets in the 70-79 mm mesh size range must have at least 35% of the list of target species (which includes *Nephrops*) and the 80–99 mm mesh size range requires at least 30% of the list of target species. A square mesh panel (SMP) of 80 mm is required for 70-79 mm nets in the Irish Sea. Vessels using twin-rig gear in the Irish Sea must comply with a minimum mesh size of 80 mm (no SMP is required for nets with 80 mm meshes and above). Other *Nephrops* conservation measures in the Irish Sea are a minimum landing size of 20 mm CL length (equivalent to 37 mm tail length or 70 mm total length).

Over the seven-year period from 1992 to 1998, there have been six decommissioning rounds in Northern Ireland. These removed 56 vessels from the fleet traditionally associated with *Nephrops* fishing, leaving a fleet of 174 vessels at the end of December 1998. Further fleet reductions left 158 vessels >10 m capable of fishing for *Nephrops*, of which up to 47 work twin-trawls for part of the year.

Single trawl vessels normally do 1–2 day trips of 3–4 hour tows, while twin-trawl vessels stay at sea for 3–5 days and do tows of 4–12 hours duration.

Landings are into the three traditional Northern Ireland *Nephrops* ports of Kilkeel, Ardglass and Portavogie. Historically, *Nephrops* were landed into Northern Ireland as tails only and sold to supply the lucrative 'scampi' industry for consumption at home and abroad. The scampi industry requires a sustained supply of small *Nephrops*, which are homogenised and coated in breadcrumbs to produce the popular product. In the last 10–15 years, however, the trend has been towards landing whole large *Nephrops* for the export market. In 2001 and 2002, 35.7% and 30.9% of the *Nephrops* were landed whole.

Although the *Nephrops* fishery represents nearly 50% of the combined value of all Northern Ireland sea fisheries, there is an important by-catch component for a range of species, with haddock, and cod ranking as the most important. Analysis of landings data and observations at sea (BRIGGS, unpublished) have indicated that fish by-catch is a more significant component of catches by twin-trawls than single trawls with no significant difference in *Nephrops* catch per unit effort between the two gear types. This is thought to be mainly due to differences in the species targeted by voyages.

Republic of Ireland

FU 15 contains the largest *Nephrops* fishery in the Republic of Ireland. In 2002 48 vessels reported *Nephrops* landings from this FU of these 42 reported annual landings in excess of 10 t. This *Nephrops* fleet is by far the largest fleet segment in the Irish Sea. The smaller vessels are mainly side trawlers and the larger ones stern trawlers. Engine power ranges from 110–450 kW. Most of the fleet now use twin-rigged trawls. The minimum mesh size and SMP restrictions for the Irish fleet are as described for the NI fleet above. Separator trawls were introduced in the Irish fishery in 2000 in an attempt to reduce cod by-catches. Uptake of separator trawls has increased in recent years to around 80% of vessels in 2002.

Trip duration is 1–5 days, depending on the size of the vessel. The twin-rig boats, which are on average the larger, make 3–4 tows of about 5 hours each during a 3–5 day trip. Single rigged boats, which are generally smaller, make 4–hour tows during 1–3 day trips. The main landing ports are Howth, Clogherhead, Skerries and Balbriggan.

Most of the larger boats move freely between the *Nephrops* fisheries in FUs 15, 14, 20-22 and other areas, depending on the tides and weather in the Irish Sea. Historically the fleet also switched to finfish trawling but due to the poor state of finfish stocks in the Irish Sea most vessels now concentrate on *Nephrops*. The fishery show seasonal patterns with highest catches in the summer months.

In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels from 14 February to 30 April as part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

A.3. Ecosystem aspects

The Working Group has collated no information on the ecosystem aspects of this stock.

B. Data

B.1. Commercial catch

Length and sex compositions of *Nephrops* landed from the Irish Sea East are estimated from port sampling by Ireland and Northern Ireland. A lack of co-operation by the Northern Ireland industry prevented sampling during 2003 and 2004. The Irish LFDs were therefore raised to the Northern Ireland and international catch for these years in the trial assessment performed by WGNSDS, 2005.

Length data from this sampling are applied to catches and raised to total international landings.

In the absence of routine methods of direct age determination in *Nephrops*, age compositions of removals were inferred from length compositions by means of 'slicing'. This procedure, introduced at the 1991 WG, uses von Bertalanffy growth parameters to determine length boundaries between age classes. All animals in length classes between boundaries are assigned deterministically to the same age class. The method is implemented in the L2AGE programme which automatically generates the VPA input files. The programme was modified in 1992 to accommodate the two-stage growth pattern of female *Nephrops* (ICES, 1992) and again in 2001 to separate 'true' as opposed to 'nominal' age classes (ICES, 2001a). The age classes are 'true' to the extent that the first slicing boundary, i.e. lower length boundary for 'age' 0, is the *length-at-age* zero rather than the lowest length in the data. This ensures comparability of 'age' classes across stocks.

B.2. Biological

Mean weights-at-age for this stock are estimated from studies by Pope and Thomas (1955).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of these values is not known.

Proportion of F and M prior to spawning was specified as zero to give estimates of spawning stock biomass at January 1. In the absence of independent estimates, the mean weights-at-age in the total catch were assumed to represent the mean weights in the stock.

B.3. Surveys

Ireland and Northern Ireland jointly carried out underwater television (UWTV) surveys on the main *Nephrops* grounds in the western Irish Sea in 2003, 2004 and 2005. These surveys were based on a randomised fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere (See Chapter 13 of WGNSDS Report). A harvest ratio was derived from a YPR generated from an LCA performed on ROI catch sample data for 2003–2005. Catch options for $F_{0.1}$ were obtained by applying the harvest ratio to a stock biomass calculated from burrow density and a mean weight from trawl surveys for the period 2003–2005.

Northern Ireland have carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and LFDs from of stations throughout in the western Irish Sea.

Landings-per-unit-effort time-series are available from the following fleets:

- Northern Ireland Nephrops trawl gears. Landings at age and effort data from this fishery from 1986 are used to generate a cpue index. There is also a cpue series from 1995 for a sub-set of Republic of Ireland *Nephrops* vessels. Catch-at-age are estimated by raising length sampling of discards and landings to officially recorded landings and slicing into ages (knife edge slicing using growth parameters). Cpue is estimated using Officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* trawlers is raised to landings. Discard sampling commenced in the mid 1980s by Northern Ireland and the Republic of Ireland. There is no account taken of any technological creep in the fleet.

B.5. Other relevant data

A sub-group of WGNSDS members met during 1–2 August 2006 in Lowestoft to address specific issues raised by RGNSDS, 2006 regarding the assessment of *Nephrops* in the Irish Sea (Scott *et al.*, 2006). The method adopted for the derivation of the survey index and the assessment of *Nephrops* in FU15 by WGNSDS, 2006 was very similar to that used for stocks in management area C. However, a number of differences in the approach were considered to exist. These differences related primarily to the calculation of the UWTV abundance index. The sub-group discussed details of the methods used to derive indices of abundance from the UWTV surveys and highlighted the similarities and dissimilarities between the approach used for the West of Scotland and that used for the Irish Sea. A revised estimate of abundance in 2005 for FU15 was calculated and catch options for 2007 based on the revised estimates were presented and are summarised in the tables below.

Table 1. Summary table of NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003, 2004 and 2005.

Year	No. stations	Non Zero stations	total area of tows (M2)	Burrow count for tow tracks	Mean of density estimates (No./m2)	St.dev of density estimates	SE of mean density	CV of mean	Mean density raised to survey area (X10^3)	-2SE	+2SE
2003	166	147	27566	42493	1.66	0.87	0.07	4.3%	9,614,257	8,779,531	10448983
2004	147	131	23214	38484	1.43	0.75	0.07	4.6%	8,288,735	7,527,584	9049887
2005	144	125	21415	22100	1.16	0.59	0.05	4.6%	6,728,971	6,113,721	7344221
							2003-05	Mean	8,210,654		
	Survey area	5790	km2				2004-05	mean	7,508,853		

Table 2. Calculation of total removals and landings of FU15 *Nephrops* for $F_{0.1}$ harvest rate of 20% applied to total burrow count in 2005 UWTV survey. Length frequencies are mean 2003–05 international fishery LFDs raised to potential $F_{0.1}$ removals in 2005.

Males — Weight = a*CLb — a = 0.00032, b = 3.21

Females — a = 0.00068, b = 2.96

Mean 2003-05 international removals raised to 20% of 2005 survey burrow count

	Males					Females				
CL	Landings ('000)	Discards ('000)	Removals ('000)	Removals (t)	Landings (t)	Landings ('000)	Discards ('000)	Removals ('000)	Removals (kg)	Landings (t)
10.5	0	7	5	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	2	2	0	0
12.5	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	106	80	0	0
14.5	0	337	252	0	0	0	471	353	1	0
15.5	0	176	132	0	0	0	273	205	0	0
16.5	2	783	589	2	0	0	1036	777	2	0
17.5	43	1792	1387	4	0	77	3040	2357	8	0
18.5	196	4178	3330	12	1	333	5741	4639	18	1
19.5	661	9024	7429	33	3	737	10326	8481	38	3
20.5	1459	15904	13387	70	8	1706	18040	15236	79	9
21.5	3704	21463	19801	120	22	4932	29386	26972	161	29
22.5	8324	28071	29377	206	58	10181	35321	36672	251	70
23.5	15662	34561	41583	335	126	17035	39409	46591	362	132
24.5	25148	36840	52778	486	232	24914	38985	54153	476	219
25.5	36368	32452	60707	636	381	32823	33772	58152	576	325
26.5	43349	26640	63328	751	514	38139	26544	58047	644	423
27.5	54168	19361	68689	917	723	40291	16423	52608	652	499
28.5	57403	13781	67738	1014	859	37309	8532	43708	602	514
29.5	63394	8804	69998	1170	1060	33048	4647	36533	557	504
30.5	57521	5476	61628	1147	1070	25535	2347	27295	459	430
31.5	47788	3113	50123	1035	986	17685	1378	18719	347	327
32.5	40220	1792	41565	948	918	13279	653	13769	280	270
33.5	33602	832	34226	861	845	10046	343	10303	229	223
34.5	28894	0	28894	799	799	7750	0	7750	188	188
35.5	21549	0	21549	653	653	5413	0	5413	143	143
36.5	16773	0	16773	556	556	3801	0	3801	109	109
37.5	12371	0	12371	447	447	2562	0	2562	79	79
38.5	11060	0	11060	435	435	2113	0	2113	71	71
39.5	7518	0	7518	321	321	2088	0	2088	76	76
40.5	4706	0	4706	218	218	1189	0	1189	46	46
41.5	3380	0	3380	169	169	1042	0	1042	44	44
42.5	2097	0	2097	113	113	558	0	558	25	25
43.5	1300	0	1300	76	76	809	0	809	39	39
44.5	1283	0	1283	80	80	394	0	394	20	20
45.5	501	0	501	34	34	290	0	290	16	16
46.5	576	0	576	42	42	303	0	303	18	18
47.5	341	0	341	26	26	147	0	147	9	9
48.5	241	0	241	20	20	125	0	125	8	8
49.5	251	0	251	22	22	0	0	0	0	0
50.5	296	0	296	28	28	46	0	46	3	3
51.5	89	0	89	9	9	42	0	42	3	3
52.5	90	0	90	10	10	33	0	33	3	3
53.5	0	0	0	0	0	73	0	73	6	6
Total	602328	265386	801367	13,802	11,862	336847	276774	544427	6,649	4,886

Note "removals" includes 75% of discards

proportion landed 0.8189 by weight
0.6979 by number

Landings calculation for 20% removals:

	mean	burrows -2SE
TV burrow count (thousands)	6,728,971	6113721
catch number:	1345794	1222744
Proportion landed	0.6979	0.6979
number landed	939175	853303
mean wt landed	0.0178	0.0178
landings:	**16,748**	15217

Table 3. Catch options for 2007 for different harvest rates using the burrow count only for 2005.

Surveys used	Burrow count x 10^{-3}	Harvest rate	Removals (t)	landings (t)
(i) 2005	6,728,971	25%	25,564	20,935
		20% (F0.1)	20,451	16,748
		15%	15,338	12,561

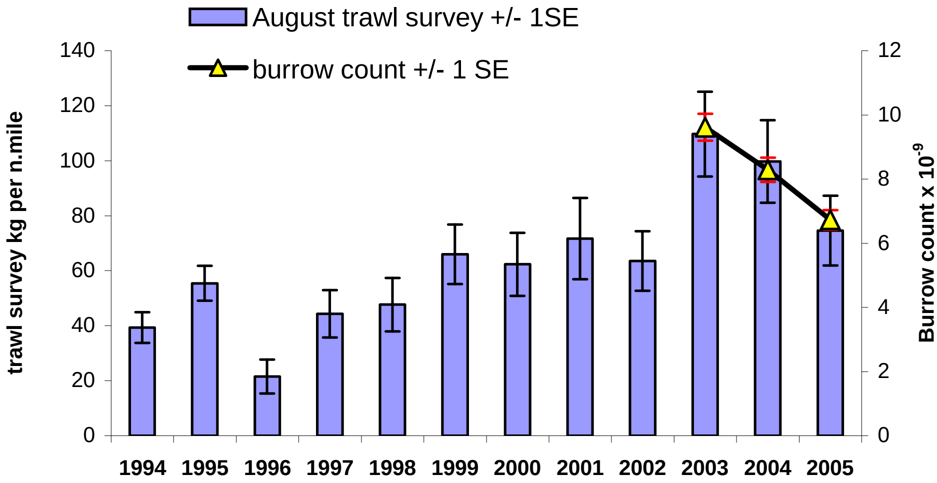

Figure 1. Indices of abundance from the UK(NI) August trawl survey and the underwater TV survey.

C. Historical stock development

This section is in the Working Group report.

D. Short-term projection

E. Medium-term projections

F. Yield and biomass per recruit/long-term projections

This section is in the Working Group report.

G. Biological reference points

H. Other issues

References

Scott, R. Armstrong, M. J., Bailey, N., Briggs, R.P. and Elson J., 2006. Re-Assessment of *Nephrops* in the Irish Sea: Management Area J. Lowestoft, 1–2 August 2006.

Biological Input Parameters

PARAMETER	VALUE	SOURCE
Discard Survival	0.10	ICES (1991a)
MALES		
Growth - K	0.160	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Length/weight - a	0.00032	After Pope and Thomas (1955) (data for Scottish stocks)
Length/weight - b	3.210	"
FEMALES		
Immature Growth		
Growth - K	0.160	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	60	"
Natural mortality - M	0.3	Brander and Bennett (1986, 1989)
Size at maturity	24	Briggs (1988)
Mature Growth		
Growth - K	0.100	Hillis (1979) ; ICES (1991a)
Growth - L(inf)	56	"
Natural mortality - M	0.2	Brander and Bennett (1986, 1989)
Length/weight - a	0.00068	After Pope and Thomas (1955) (data for Scottish stocks)
Length/weight - b	2.960	"

Annex 8: Quality Handbook WGNSDS-Northern Shelf Anglerfish

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Anglerfish (Northern Shelf–Division IIIa, Sub-area IV & Sub-area VI)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	17 May 2005
Last updated:	17 May 2005

A. General

A.1. Stock definition

Northern Shelf anglerfish occur in a wide range of depths, from quite shallow inshore waters down to at least 1,000 m. Small anglerfish occur over most of the northern North Sea and Division VIa, but large fish, the potential spawners, are more rarely caught. Little is known about when and where anglerfishes spawn in northern European waters and consequently stock structure is unclear. This lack of knowledge is due to the unusual spawning habits of anglerfish. The eggs and larvae are pelagic, but whereas most marine fish produce individual free-floating eggs, anglerfish eggs are spawned in a large, buoyant, gelatinous ribbon which may contain more than a million eggs. Due to this strange behavior, anglerfish eggs and larvae are rarely caught in conventional surveys.

A recent EU-funded research project entitled ‘Distribution and biology of anglerfish and megrim in the waters to the West of Scotland’ (Anon, 2001) has however, improved our understanding. A particle tracking model was use to predict the origins of young fish and indicates that post-larval anglerfish may be transported over considerable distances before settling to the seabed (Hislop *et. al.*, 2001). Anglerfish in deeper waters to the west of Scotland and at Rockall could therefore be supplying recruits to the western shelf and the North Sea. Furthermore, results of microsatellite DNA analysis carried out as part of this project show no structuring of the anglerfish stock into multiple genetic populations within or among samples from Divisions IVa, Division VIa and Rockall. In fact this project also suggested that anglerfish from further south (Sub-area VII) may also be part of the same stock.

A.2. Fishery

The fishery for anglerfish in Sub-Area VI occurs largely in Division VIa with the UK and France being the most important exploiters, followed by Ireland. Landings from Rockall (Division VIb) are generally less than 1 000 t with the UK taking on average around 50% of the total.

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed round-fish. The Scottish Light Trawl Fleet (SCOLTR) takes around 60% of landings and the Scottish Heavy Trawl Fleet (SCOTRL) over 20%. Around 10% of landings are by-catch from the Nephrops trawlers. The development of a directed fishery for anglerfish has led to considerable changes in the way the Scottish fleet operates. Part of this is a change in the distribution of fishing effort; the development of a directed fishery having led to effort shifting away from traditional round-fish fisheries in inshore areas to more offshore areas and deeper waters. The expansion in area and depth range fished has been accompanied by the development of specific trawls and vessels to exploit the stock. There has been an almost linear increase in landings from Division VIa since the start of the directed fishery until 1996 which has been followed more recently by a very severe decline, indicating the previous increase was almost certainly due only to the expansion and increase in efficiency of the fishery.

There is no minimum landing size for anglerfish and discarding is known to occur at low levels in the targeted fishery for anglerfish, but also in other fisheries, for example for scallops. However, discard data are not routinely collated.

The Irish fleet which takes around 15–20% of the total Division VIa landings is a light trawl fleet targeting anglerfish, hake, megrim and other gadoids on the Stanton Bank and on the slope northwest of Ireland. This fleet uses a mesh size of 80 mm or greater. Irish Division VIa landings come mainly from the Stanton bank with some landings from Donegal Bay and the slope northwest of Ireland. Since 1996 there has been an increase in the number of vessels using twin rigs in this fleet. There have also been changes to the fleet composition since 2000, with around ten vessels decommissioned and four new vessels joining the fleet. The activity of this fleet is not thought to have been significantly effected by the recent hake and cod recovery plans.

The Irish fleet otter trawl in Division VIb take anglerfish as a by-catch in the haddock fishery on the Rockall Bank. The fleet targeting haddock uses 100 mm mesh and twin rig trawls. Occasionally Irish-Spanish flag vessels target anglerfish, witch and megrim with 80 mm mesh on the slope in VIb. Discarding practices of these vessels are not known. Discarding of anglerfish from the fleet targeting haddock in Division VIb is not thought to be significant (Anon, 2001). The fleet composition changed in 2001. Four vessels have recently been decommissioned and two new vessels have joined the fleet that targets haddock.

French demersal trawlers also take a considerable proportion of the total landings from this area. The vessels catching anglerfish may be targeting saithe and other demersal species or fishing in deep water for roundnose grenadier, blue ling or orange roughy.

Landings of anglerfish from the North Sea show a similar trend to those in Division VIa–a rapid increase in the late 1980s followed by a decline since 1996. Around 90% of the landings are taken in the Northern North Sea and the fishery is dominated by the Scottish fleet which takes around 80% of the total landings in this area. As in Division VIa, the fishery in this region has moved into deeper more offshore areas. A Norwegian directed gillnet fishery (360 mm mesh size), targeting large anglerfish, carried out by small vessels in coastal waters in the eastern part of the Northern North Sea started in the early 1990s. The landings from this fishery have comprised around 6% of the total landings from Division IVa since 1999. Danish trawlers, mostly operating east of E 2°, have increased their landings from the area in recent years and were responsible for around 10% of the landings from IVa in 2001–2002. Reports from the Norwegian Coastguard indicate that this fleet increased their focus on anglerfish in succeeding years.

The trend in landings in the total North Sea is very similar to that in the Northern North Sea. This reflects the northerly distribution of the species within the North Sea (Knijn *et. al.*, 1993) and the development of a directed fishery in the Northern North Sea since about 1984.

Landings from Division IIIa are extremely low, accounting for less than 5% of the total Northern Shelf landings with Denmark and Norway responsible for the bulk of the landings. Most of the Norwegian landings are taken in the directed gillnet fishery. Until the end of the 1990s the Danish landings were taken mainly as bycatches in fisheries for shrimp (*Pandalus*), lobster (*Nephrops*) and mixed roundfish, but in recent years some Danish demersal trawlers have been targeting Anglerfish.

Since the mid-1990s, a deepwater gillnet fishery targeting anglerfish has been conducting a fishery on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. These vessels, though mostly based in Spain are registered in the UK, Germany and other countries outside the EU such as Panama. Gear loss and discarding of damaged catch are thought to be substantial in this fishery. Until now these fisheries have not been well documented or understood and they seem to be largely unregulated, with little or no information on catch composition, discards and a high degree of suspected misreporting. There are currently (2005) around 16 vessels participating in the fishery, 12 UK registered and four German registered.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

Quarterly length-frequency distribution data were available from Scotland and Ireland for Division VIa and Spain for Sub-area VI. A total international catch-at-length distribution for Division VIa was obtained by summing national raised catch-at-length distributions and then raising this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. Since 2001, the Scottish market sampling length-weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division VIa.

Year Range	Formula (L – length in cm, W – weight in g)	Source
1992–2000	$W=0.01626L^{2.988}$	Coull *et. al.*, 1989
2001 onwards	$W=0.0232L^{2.828}$	Scottish Market Sampling

For anglerfish in the North Sea, catch-at-age composition data are available from Scotland for the years 1992 to 2000. The Scottish quarterly age-length keys were applied to the available length-frequency data and non-sampled catches were attributed to age assuming their length-frequency distributions to be equivalent to the combined sampled distribution.

As a first step in assembling assessment data for the North Sea component of the stock, length compositions from Scottish market sampling have been raised to Working Group estimates of total landings. The Working Group estimate of total landings was assumed equal to the landings obtained by national scientists plus official landings as reported to ICES for those countries not providing landings data to the Working Group. The Scottish market sampling data are only available from 1993 onwards, and even for these years the level of sampling has been relatively low. Some additional length samples are available from the Danish and Norwegian fisheries since 2002.

Total international catch-at-length distribution data for the whole Northern shelf (Division IIIa, Sub-area IV and Sub-area VI) were obtained by summing the length distributions from the individual areas and assuming that this distribution is representative of the whole Northern Shelf. This was then raised to Working Group estimates of total landings for the Northern shelf. Scottish market sampling information from RockallNo market sampling information is available from landings from either Division IIIa or Rockall.

B.2. Biological

Previous assessments of this stock used the natural mortality rate applied to anglerfish in Division VI adopted by an earlier Hake Assessment Working Group of 0.15 yr^{-1}. This value is once more adopted for all ages and lengths in the absence of any direct estimates for this stock.

Traditionally, the catch-at-age analysis of anglerfish in Division VIa has used the same maturity ogive as that applied to anglerfish in Sub-areas VII and VIII by the Working Group on the Assessment of Southern Shelf Demersal Stocks. However, it has always been unknown as to whether this provided a good estimate of the maturity ogive for the VIa stock. A number of more recent maturity studies based on the VIa stock indicate that maturity does not occur until much later than previously estimated. Afonso-Dias and Hislop (1996) give a length-maturity ogive for this stock, 50% maturity at approximately 74 cm in females, and 50 cm in males. However, this study was based on few samples. New information has become available from the EU-funded project which indicates female 50% maturity at approximately 94 cm and males at 57 cm. The corresponding age-based ogives indicate 50% maturity at approximately age 9 in females and age 5 in males.

B.3. Surveys

As in previous years, the recruitment index used in the assessment is obtained from the Scottish March West Coast survey. The index consists of numbers of anglerfish less than 30 cm caught per hour.

B.4. Commercial cpue

The present assessment of the stocks does not make use of commercial catch-per-unit effort data, but does use effort data to constrain the temporal trend in fishing mortality. Scottish Light Trawl data, disaggregated into an inshore and offshore component, the latter of which is associated with the anglerfish fishery, for both West of Scotland and Shetland (N Sea) were provided to the Working Group. The data from recent years have been excluded due to changes in the practices of effort recording for the Scottish Light Trawl in these years. Fishing effort was consistent from 1991–1995, increased in 1996 and declined in 1998. These data are not corrected for fishing power or the proportion of the fleet likely to be targeting anglerfish. Further details of the Scottish fleet effort recording problem can be found in the report of the 2000 WGNSSK (ICES, 2001).

B.5. Other relevant data

None.

C. Historical stock development

In previous years the stock assessment has been conducted using a length-based model for which the settings are outlined below.

Model used: Catch-at-length analysis (modified CASA-Sullivan *et. al.*, 1990, Dobby, 2002).

Software used: Fortran coded executable-LBAV4_1.

Model Options chosen:

Sex differentiated von Bertalanffy growth, variability distributed according to a beta function. Parameters taken from Scottish anglerfish survey in 2000: L_4(F)=140.5, K(F)=0.117, L_4(M)=110.5, K(M)=0.154.

Fishing mortality in 1993=1.0

Historical equilibrium fishing mortality fitted using mean of historical WG estimates of landings which is approximately 18 000 t over 1987–1991.

Logistic exploitation pattern with fitted parameters.

Trend in temporal fishing mortality equal to trend in recent SCOLTR effort data

Total recruitment normally distributed over length classes

Input data types and characteristics:

Name	Year range	Variable from year to year Yes/No
Catch in tonnes	1993–last data year	Yes
Catch at length-in-numbers	1993–last data year	Yes
Weight-at-length in the commercial catch	1993–last data year	Yes/No–2 weight-length relationships: covering 1993–2000, and 2001 onwards
Weight-at-length of the spawning stock at spawning time.	1993–last data year	Yes/No-assumed to be the same as weight-at-length in the catch
Proportion mature at length	1993–last data year	No–the same ogive for all years
Natural mortality	1993–last data year	No–set to 0.15 for all lengths in all years

Auxiliary data:

Type	Name	Year range	Size range
Recruitment index	Scottish March West Coast survey	1993–last data year	< 30 cm

D. Short-Term Projection

In previous years the short-term forecast has used a length-structured method with settings outlined below.

Model used: Length-structured

Software used: Fortran coded executable LBForecast.exe

Initial stock size: taken from catch-at-length analysis. The long-term geometric mean recruitment is used in all projection years. Natural mortality: Set to 0.15 for all lengths in all years

Maturity: The same ogive as in the assessment is used for all years

Weight-length relationship: as used in the assessment (Scottish Market sampling)

Exploitation pattern: Fixed exploitation at length pattern is estimated in the catch-at-length analysis. This is assumed to apply in all further years.

E. Medium-Term Projections

No medium-term projections are carried out for this stock.

F. Yield and Biomass per Recruit / Long-Term Projections

Length-based model.

G. Biological Reference Points

Precautionary approach reference points: “ICES considers that there is currently no biological basis for defining B_{lim} or F_{lim}. ICES proposes that $F_{35\%SPR}$ =0.30 be chosen as F_{pa}. It is considered to be an approximation of F_{MSY}.”

H. Other Issues

None.

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Annex 9: Quality Handbook WGNSDS-CodVIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	West of Scotland Cod (Division VIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	May 2006

A. General

A.1. Stock definition

Cod occur mainly in the central and northern areas of Division VIa. Young adult cod are distributed throughout the waters to the west of Scotland, but mainly occur in offshore areas where they can occasionally be found in large shoals. Tagging experiments have shown that in late summer and early autumn there is a movement of cod from west of the Hebrides to the north-coast areas. There is a return migration in the late winter and early spring. There is only a very limited movement of adult fish between the West Coast and the North Sea.

Recent surveys of spawning fish distribution in ICES area VIa (West of Scotland) suggested the persistence of the main spawning concentrations identified over 50 years ago by egg surveys. From 383 cod tagged during the spawning season and recaptured during successive spawning seasons >90% were recaptured within 80 km of coastal release sites, such as the Clyde, Moray Firth and the Minch. Cod released at these coastal spawning grounds also tended to remain in these areas during the summer feeding season implying that they belonged to resident spawning groups, (Wright *et al.*, 2006).

A.2. Fishery

The minimum landing size of cod in the human consumption fishery in this area is 35 cm.

The demersal fisheries in Division VIa are predominantly conducted by otter-trawlers fishing for cod, haddock, anglerfish and whiting, with bycatches of saithe, megrim, lemon sole, ling and skate *sp*. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend.

Cod are a bycatch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size of 80 mm, but landings of cod are restricted through bycatch regulations.

2000 onwards:

Emergency measures were introduced in 2001 to allow the maximum number of cod to spawn (see emergency measures below). Council Regulation No 423\2004 introduced a cod recovery plan affecting division VIa. The measures only take effect, however east of a line defined in Council Regulation No 51\2006.

From mid September 2003 to mid July 2004 the Irish trawl fishery off Greencastle, Co. Donegal that traditionally targets juvenile cod was closed. The closure was instigated by the local fishing industry to allow an assessment of seasonal closure as a potential management measure. The fishing industry again called for and received statutory instruments closing the fishery from November 2004 until mid February 2005 and from mid November until 14th February 2006. Most of the cod catch during the closed period is normally taken in the fourth quarter. During 2000–2002 50% of the Irish catch weight of cod in VIa (61% by number) was taken in the fourth quarter. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003 to 2005. As the Greencastle codling fishery is a mixed demersal fishery, any benefits flowing from the closure are likely to extend to other demersal stocks.

The days at sea limitations associated with the cod recovery plan and this seasonal closure has lead some of the Irish Demersal fleet to switch effort away from VIa.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth. WGFTFB, 2006 report that this has greatly reduced effort at depths greater than 200 m in VIa. The measure was aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on cod.

Technical measures:

The minimum mesh size for vessels fishing for cod in the mixed demersal fishery in EC Zones 1 and 2 (West of Scotland and North Sea excluding Skagerrak) changed from 100 mm to 120 mm from the start of 2002. This came under EU regulations regarding the cod recovery plan (Commission Regulation EC 2056/2001), with a one–year derogation of 110 mm for vessels targeting species other than cod. This derogation was not extended beyond the end of 2002.

Since mid–2000, UK vessels in this fishery have been required to include a 90 mm square mesh panel (SSI 227/2000), predominantly to reduce discarding of the large 1999 year class of haddock. Further unilateral legislation in 2001 (SSI 250/2001) banned the use of lifting bags in the Scottish fleet.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200 m depth.

Emergency measures and effort limitation:

Emergency measures were enacted in 2001, consisting of area closures from 6 March–30 April, in an attempt to maximise cod egg production. These measures were retained into 2003 and 2004.

In 2005 the following area closures were in effect

The Greencastle codling fishery from mid November to mid February. This closure has been operating since 2003.

A closure in the Clyde for spawning cod from 14th February to 30th April. This closure has been operating since 2001 and was last revised by The Sea Fish (prohibited methods of fishing) (Firth of Clyde) Order 2002.

A closure introduced in 2004 by Council Regulation No. EC 2287\2003, known as the ‘windsock’.

Effort reductions for much of the international fleet to 16 days at sea per month have been imposed since February 2003 (EU 2003\0090). The maximum number of days in any calendar month for which a fishing vessel may be absent from port to the West of Scotland varies for particular gears and the allocations since 2003 are given below:

GEAR	MAXIMUM DAYS ALLOWED			
	2003:	2004:	2005:	2006:
Demersal trawls, seines or similar towed gears of mesh size ≥ 100 mm except beam trawls	9	10	8	91/12
Demersal trawls, seines or similar towed gears of mesh size between 70 mm & 99 mm except beam trawls[1];	25	22	21	127/12
Demersal trawls, seines or similar towed gears of mesh size between 16 mm & 31 mm except beam trawls.	23	20	19	128/12

[1] With mesh size between 80 mm & 99 mm in 2004.

The documents listing these days at sea limitations are,

2004: (EC) No 2287/2003

2005: (EC) No 27/2005 – Annex IVa

2006: (EC) No 51/2006 – Annex IIa

A Commission Decision (C(2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. United Kingdom vessels were granted 4 additional days per month (based on evidence of decommissioning programmes). An additional two days was granted to demersal trawls, seines or similar towed gears (mesh ≥ 100 mm, except beam trawls) to compensate for steaming time between home ports and fishing grounds and for the adjustment to the newly installed effort management scheme.

For 2006 one extra day was allocated to trawls >=100 mm if the mesh was >120 mm and the net contained a square mesh panel of 140 mm mesh size. A total of 148 days in the year was allowed for vessels with mesh between 100 and 120 mm if the catch contained < 5% cod in 2002. This allowance rises to 160 days in the year if the same 140 mm square mesh panel is used together with a mesh size >120 mm.

The new effort regulations provided an incentive for some vessels previously using >100 mesh in otter trawls to switch to smaller mesh gears to take advantage of the higher numbers of days at sea available. This would also require these vessels to be targeting *Nephrops* or anglerfish, megrim and whiting with various catch and by-catch composition limits after EC Regulation No 850/98.

Council regulation (EC) No 423\2004 sets out a multi-annual recovery plan that constrains effort to specified harvest control rules. For stocks above $\mathbf{B}_{\mathrm{lim}}$, the harvest control rule (HCR) requires:

1) setting a TAC that achieves a 30% increase in the SSB from one year to the next,

2) limiting annual changes in TAC to ± 15% (except in the first year of application), and,

3) a rate of fishing mortality that does not exceed $\mathbf{F}_{\mathrm{pa}}$.

For stocks below $\mathbf{B}_{\mathrm{lim}}$ the Regulation specifies that:

4) conditions 1–3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application,

5) a TAC will be set lower than that calculated under conditions 1-3 when the application of conditions 1–3 is not expected to result in an increase in SSB above $\mathbf{B}_{\mathrm{lim}}$ in the year of application.

Decommissioning schemes. Vessel decommissioning has been underway since 2002. Information on the number of vessels operating in the cod recovery zone to have been decommissioned in Division VIa between 2001 and 2004, was as follows:

	TOTAL VIA 2001	DECOMM. TO 2004	PERCENTAGE
Number of vessels > 10 m	298	96	30.2%

A.3. Ecosystem aspects

Geographic location and timing of spawning

Spawning has occurred throughout much of the region in depths <200 m. However, a number of spawning concentrations can be identified from egg surveys in the 1950s, 1992 and from recent surveys of spawning adult distribution. The most commercially important of these range from the Butt of Lewis to Papa Bank. There are also important spawning areas in the Clyde and off Mull. The relative contribution of these areas is not known. Based on recent evidence there are no longer any significant spawning areas in the Minch. Peak spawning appears to be in March, based on egg surveys (Raitt, 1967). Recent sampling suggests that this is still the case.

The main concentrations of juveniles are now found in coastal waters.

Fecundity

Fecundity data are available from West (1970) and Yoneda and Wright (2004). Potential fecundity for a given length is higher than in the northern North Sea but lower than off the Scottish east coast (see Yoneda and Wright, 2004). There was no significant difference in the potential fecundity–length relationship for cod between 1970 (West, 1970) and 2002–2003 (Yoneda and Wright, 2004).

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for West of Scotland cod:

	KIND OF DATA				
COUNTRY	CATON (CATCH IN WEIGHT)	CANUM (CATCH AT AGE IN NUMBERS)	WECA (WEIGHT AT AGE IN THE CATCH)	MATPROP (PROPORTION MATURE BY AGE)	LENGTH COMPOSITION IN CATCH
UK(NI)	X				
UK(E&W)	X				
UK(Scotland)	X	X	X	X	X
Ireland	X	X	X		X
France	X				
Norway	X				

Quarterly landings and length/age composition data are supplied from data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied in the requested format to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (Scotland), UK (E/W), UK (NI), France and Ireland .The quarterly estimates of landings-at-age by UK (Scotland) and Ireland are raised to include landings by France, UK (NI) and Norway (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\cod-iris\input data\xsa_ica**

B1.2. Discards

EU countries are now required under the EU Data Collection regulation to collect data on discards of cod and other species. Up to 2003, estimates of discards are available only from UK (Scotland) and Ireland.. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES.

The quantity, length and age of cod discarded by Scottish Nephrops trawlers is collected during observer trips on board commercial vessels. Cod discarded by boats using other gears (heavy trawl, seine, light trawl and pair trawl) are also collected by Scotland. Cod discarded by otter board trawl and otter board/twin rig gears are collected by Ireland.

Discards from Scottish and Irish boats using several different gear types is currently estimated by observers.

B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years. There are no direct estimates of M.

Proportion mature at age is currently assumed constant over the full time-series.

AGE	1	2	3	4+
Prop mat	0.0	0.52	0.86	1.0

B.3. Surveys

Four research vessel survey series for cod in VIa were available to the Working Group in 2005. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2006.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4–stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.,* 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced, (by the IRGFS).

- Scottish forth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2005.

The Scottish quarter four survey was presented to the WG for the first time in 2005.

- Irish forth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2005.

This survey used the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomised stations. Effort is recorded in terms of minutes towed. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 minutes towed.

For surveys existing at the time survey descriptions are given in Appendices 1 and 2 of the report of the 1999 meeting of the Northern shelf working group (ICES CM 2000/ACFM:1).

B.4. Commercial cpue

Three commercial Scottish cpue series have been made available in recent years. However, none have been used in the final assessment presented by the WG during any of its last seven meetings, although they were previously used in exploratory and comparative analyses.

Irish otter trawl cpue data (IreOTR) were presented for the first time at the 2001 WG meeting. Updated series have been presented to subsequent meetings. Given the current concerns about misreporting of catch and effort, this series has not been considered further as a tuning fleet.

The commercial cpue data available consists of the following:

- Scottish seiners (ScoSEI): ages 1–6, years 1978–2005.
- Scottish light trawlers (ScoLTR): ages 1–6, years 1978–2005.
- Irish otter trawlers (IreOTR): ages 1–7, years 1995–2005.

B.5. Other relevant data

None.

C. Historical stock development

Models used: XSA (up to 2001 WG); TSA (2002 & 2003 WG); TSA & XSA (2004 WG); SURBA (2005 WG). SURBA & TSA (2006 WG).

Software used: Lowestoft VPA suite; Marine Lab Aberdeen TSA and SURBA software.

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1966–last data year	1–7+	Yes
Canum	Catch-at-age in numbers	1966 – last data year	1–7+	Yes
Weca	Weight-at-age in the commercial catch	1966 – last data year	1–7+	Yes
West	Weight-at-age of the stock at spawning time.	1968 – last data year	0–7+	Yes
Mprop	Proportion of natural mortality before spawning	1978 – last data year	1–7+	No–set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1978 – last data year	1–7+	No–set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1978 – last data year	1–7+	No–the same ogive for all years
Natmor	Natural mortality	1978 – last data year	1–7+	No–set to 0.2 for all ages in all years

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Research Vessel Survey			
Tuning fleet 1	ScoGFS-Q1	1985–last data year	1–7
Tuning fleet 2	IreGFS-Q4	1993–2002	0–3
Tuning fleet 3	ScoGFS-Q4	1996–last data year	0–8
Tuning fleet 4	IRGFS – Q4	2003–last data year	0–3
Commercial cpue data			
Tuning fleet 5	Scottish Seiners	1978–last data year	1–6
Tuning fleet 6	Scottish Light Trawlers	1978–last data year	1–6
Tuning fleet 7	Irish Otter Trawlers	1995–last data year	1–7

XSA

Model Options chosen:

Tapered time weighting not applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 4
Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages
S.E. of the mean to which the estimate are shrunk = 2.00
Minimum standard error for population estimates derived from each fleet = 0.300
Prior weighting not applied

TSA

TSA parameter settings for the 2004, 2005 and 2006 analysis.

PARAMETER	SETTING	JUSTIFICATION
Age of full selection.	$a_m = 4$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{\text{landings}}(a) = 2$ for ages 6, 7+ $B_{\text{survey}}(a) = 2$ for age 1, 5, 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	$H(1) = 4$	Allows for more variable fishing mortalities for age 1 fish.
Downweighting of particular data points (implemented by multiplying the relevant *q* by 9)	Landings: age 2 in 1981 and 1987, age 7 in 1989. Discards: age 1 in 1985 and 1992, age 2 in 1998. Survey: age 1 in 2000, age 2 in 1993 and 1994, age 6 in 1995 and 2002, ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins.)	Large values indicated by exploratory prediction error plots.
Discards	Discards are allowed to evolve over time constrained by a trend. Ages 1 and 2 are modelled independently.	
Recruitment.	Modelled by a Ricker model, with numbers-at-age 1 assumed to be independent and normally distributed with mean $\eta_1 S \exp(-\eta_2 S)$, where *S* is the spawning stock biomass at the start of the previous year. To allow recruitment variability to increase with mean recruitment, a constant coefficient of variation is assumed.	
Large year classes.	The 1986 year class was large, and recruitment at age 1 in 1987 is not well modelled by the Ricker recruitment model. Instead, $N(1, 1980)$ is taken to be normally distributed with mean $5\eta_1 S \exp(-\eta_2 S)$. The factor of 5 was chosen by comparing maximum recruitment to median recruitment from 1966-1996 for VIa cod, haddock, and whiting in turn using previous XSA runs. The coefficient of variation is again assumed to be constant.	

SURBA

The model settings for the preferred SURBA run in 2006 were:

Year range:	1985–2006						
Age range:	1–6						
Catchability at age:	0.0304,	0.1045,	0.2092,	0.4443,	0.7217,	1	
Age weighting:	1.0,	1.0,	0.0,	0.0,	0.0,	1.0	for 2001
	1.0,	1.0,	1.0,	1.0,	1.0,	1.0	for all other years
Lambda:	2.0						
Cohort weighting:	not applied						

This differed from the final run performed in 2005 only in terms of the down weighting of data from 2001 and the values (but not method of determination) of catchabilities at age.

Catchabilities at age are derived by comparing raw survey indices with numbers-at-age estimates from a TSA run. These ratios were then standardised relative to a given reference age. The justification is that even if there are concerns over misreporting of commercial data, so long as the relative catch numbers between ages remain constant the catchabilities generated using a catch-at-age analysis will be valid. A TSA run not allowing a trend in survey catchability and using all years of available catch data is chosen to provide the TSA output.

D. Short-term projection

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield per recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

- Initial stock size. Taken from XSA or TSA for age 1 and older. The recruitment at age 0 in the last data year is estimated as a short-term GM (1992 onwards) because of a perceived downward trend in recruitment in recent years.
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0 for all ages in all years
- Weight-at-age in the stock: average stock weights for last three years. Assumed equal to the catch weight-at-age.
- Weight-at-age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years. Discard F's, are held constant while landings F's are varied in the management option table.
- Intermediate year assumptions: status quo F
- Stock recruitment model used: None, the short-term (last 10 years) geometric mean recruitment at age 1 is used

In 2006 a short term projection was made but it was considered little confidence could be placed in the short term projections. This was because concerns over the reliability of the commercial catch-at-age data lead to use of a catch-at-age analysis but with landings and discards data removed from 1995 onward. Consideration of the diagnostics lead to the conclusion that mean F is estimated with considerable uncertainty (these estimates are based on the age structure indicated by the survey series, which are known to be noisy).

In 2005 projections were attempted using outputs from a survey based assessment and an *ad hoc* spreadsheet. Similar concerns over adequate estimation of mortality also apply in this case.

E. Medium term projections

Medium term projections have been carried out in previous years using the Aberdeen software suite.

Medium term predictions were not made at the 2005 and 2006 working groups on the grounds that recruitment could not be assumed to conform to historical patterns given the stock was at a historic low.

F. Yield and biomass per recruit/long term projections

Model used: yield and biomass per recruit over a range of F values.

Software used: MFDP

Selectivity pattern: mean F array from last 3 years of assessment (to reflect recent selection patterns).

Stock and catch eights-at-age: mean of last three years.

Maturity: Fixed maturity ogive as used in assessment.

G. Biological Reference Points

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

H. Other Issues

None.

I. References

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Annex 10: Quality Handbook Annex WGNSDS-CodVIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Cod (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	May 2005

A. General

A.1. Stock definition

Meristic evidence for stock structure in this area is limited. Brander (1979) derived a general relationship between vertebral number and water temperature for cod from around the North Atlantic. Samples from the Irish Sea did not conform to the relationship with observed water temperatures at the time of spawning. Irish Sea cod had a lower average vertebral count than expected. Since vertebral count is influenced by water temperature during the early life stages, this led to the suggestion that there might be a significant level of immigration of cod into the region that had been spawned in warmer waters to the south.

Agnew (1988) examined length at age data from market sampling data from Northern Irish ports. Landings in the first quarter (at time of spawning) showed evidence for two distinct populations of cod with differing growth rates. This bimodality was not apparent in samples from the other quarters of the year. The maintenance of two distinct populations would however require reproductive isolation for which there is limited evidence.

Evidence for population structuring from genetic studies in this region is limited and equivocal. Glucose phosphate isomerase and lactate dehydrogenase allelle frequencies gave evidence of separate populations based on samples of larvae collected in the eastern (Solway) and western Irish Sea (Child, 1988). Similar differences appeared to be present in samples collected the following year but these differences had vanished one year further on. This was interpreted as evidence for movement away from nursery grounds and population mixing of the older fish. However, haemoglobin (Hbl) allelle frequencies collected over a longer time period were for the most part similar all around the British Isles, but with a few unusual samples (Jamieson and Birley, 1989). More recent research by Hutchinson *et al.*, (2001) using micro-satellite markers did not find evidence for genetic sub-structuring within the Irish Sea and between the Irish and Celtic Seas.

Results of tagging mature fish during the 1970s suggested separation between cod in the eastern and western Irish Sea. Mature fish tagged on spawning grounds in the northeast and northwest Irish Sea (and in the Bristol Channel) were recaptured from the same sites in subsequent spawning seasons but movement of fish from distinct spawning grounds to mixed feeding grounds may occur (Brander 1975).

More recent studies on cod movements in this region by tagging did not provide evidence for large-scale movements of cod between the Celtic and Irish Seas. One problem with interpreting this evidence is that the overall stock sizes in both areas have declined significantly in recent years. There may therefore have been changes in geographic range and movement patterns making comparison of recent results with earlier studies problematic.

Immature cod may disperse over a wide area as demonstrated by fish tagged and released from various parts of the Irish Sea (including Belfast Lough). These showed a substantial migration into the Celtic Sea and round the north and west of Ireland. Once these fish mature however they appear to return to the Irish Sea spawning grounds. Extensive tagging off the West of Scotland produced no recaptures from the Irish Sea. A summary of cod movements between the Irish Sea and Celtic Sea and Bristol Channel is given in Pawson (1995). Although movements in a north-south orientation seem common, very few recaptures of tagged fish that had crossed the deep-water trough separating the eastern and western Irish Sea have been made (Figure 5). A recent tagging program run from 1997–2000, in which over 2 200 cod were tagged using external and data storage tags showed that while there was some movement of cod between the Irish and Celtic Seas, the component of Irish Sea cod in the Celtic Sea was low. Furthermore, no cod tagged in the Celtic Sea were recovered from the Irish Sea (Connolly and Officer, 2001).

A.2. Fishery

Irish Sea fisheries for cod have changed considerably over the last four decades: A brief description is given below.

1960s and 70s. UK and Irish single otter trawlers targeted spawning cod in spring in both the western and eastern Irish Sea. Fisheries for young cod (codling) took place in autumn and winter. The growing single-rig *Nephrops* fleet took by-catches of cod. Several strong year classes of cod were formed resulting in good catches. Fleets were catching around 40–50% of the stock of adult fish each year.

1980s. Development of mid-water trawls and bottom-trawls capable of fishing on rough grounds opened up opportunities to fish in difficult areas such as the North Channel. “Dual purpose” trawls were developed to optimize catches of *Nephrops* and whitefish. The English beam-trawl fleet grew rapidly in the 1980s, taking a bycatch of cod. The percentage of the stock of adult cod caught each year increased from 50% to 60%. Throughout the 1980s, TACs remained well above scientific advice to avoid triggering of the Hague Preference agreement which would have given Irish fleets a relatively bigger fraction of the TAC.

1990s. Mid-water trawlers developed a summer and autumn fishery for cod. The English otter trawl fleet declined and was reduced to inshore vessels taking mixed demersal fish, including codling. Fishing effort of the English beam-trawl fleet peaked in 1990 and then declined. Twin-rig trawling for *Nephrops* and whitefish grew rapidly in the 1990s. This fleet also took a bycatch of cod. The Irish whitefish fleet moved increasingly to grounds off the south and west coasts, leaving mainly a *Nephrops* fleet and a number of vessels fishing rays, cod and haddock in the Irish Sea. A major change in the 1990s was the growth of the haddock stock. Vessels that would have fished for cod also targeted haddock in the western Irish Sea, although still taking a bycatch of cod in certain areas and time periods.

*2000 onwards***.** Emergency measures were introduced in 2000 to allow the maximum number of cod to spawn. These measures included a closure of the western and eastern Irish Sea spawning grounds from mid February to the end of April, and modifications to trawl gear to improve selectivity. The closure was retained in 2001–2005, but only in the western Irish Sea. Derogations were allowed for *Nephrops* fishing in the closure, and experimental fisheries for haddock, flatfish and rays were permitted in some years with observers. Irish scientists successfully tested inclined separator panels in *Nephrops* trawlers, showing large reductions in bycatch of cod. Vessels using such panels have been allowed to fish over a wider area of the closure since 2002. Vessels displaced from the closed area either switched to twin-rigging for *Nephrops*, fished for cod in the North Channel and Clyde, or tied up. From 2001, the Clyde fishing grounds were also closed in spring as part of emergency measures to protect west-of-Scotland cod. TACs for Irish Sea cod from 2000 onwards were reduced substantially.

Technical measures. Vessels operating with 70 mm and 80 mm mesh are required to use square mesh panels. Square mesh panels were introduced as a technical measure to reduce fishing mortality on whiting. Square mesh panels have been mandatory for all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993 and for Irish trawlers since 1994.

New technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/98 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Since 2001, cod in Division VIIa have been a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. The minimum landing size for cod in the Irish Sea is 35 cm.

Emergency measures. Due to the depleted state of the stock and following the advice from ICES, a recovery plan for cod in the Irish Sea was introduced in 2000. Commission regulation (EC) 304/2000 established emergency closed areas to fishing for cod between 14 February and 30 April in the western and eastern Irish Sea to protect spawning adults at spawning time. Council regulation (EC) 2549/2000, which came into force on 1 January 2001, established additional technical measures for the protection of juveniles. The closed area and additional technical regulations were extended to 2001 in Council Regulation (EC) 300/2001 and to 2002 in Council Regulation (EC) 254.2002. The main difference in the recovery measures for 2002, 2003 and 2004 from those of 2001 is that a closed area remained only in the western Irish Sea. Derogations have existed for fleets targeting *Nephrops* in all years.

Decommissioning schemes. There has been some decommissioning of UK vessels in the Irish Sea, most recently at the start of 2002 and during 2003. Whilst few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches in VIIa. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas.

A.3. Ecosystem aspects

Geographic location and timing of spawning

Several studies have produced maps of the spawning location for cod in the Irish Sea (Nichols *et al.*, 1993; Fox *et al.*, 1997; Fox *et al.*, 2000; Armstrong, 2002). However, these have been based on the assumption that the majority of eggs between 1.25 and 1.75 mm diameter and not possessing oil globules were those of cod. Eggs of other species, particularly haddock overlap this size range and have a similar appearance (Figure 7). Maps for the occurrence of late stage cod eggs and cod larvae broadly match the assumed spawning locations. Currently, biochemical based methods for identifying gadoid eggs are being developed and applied to ichthyoplankton surveys in this region (Mork *et al.*, 1983; Armstrong, 2002; Taylor *et al.*, 2002). DNA probes have recently been developed and applied to eggs collected in the Irish Sea in 2003 (Fox *et al.*, 2005). This indicated that eggs towards the lower end of the 1.25–1.75 mm size range do include those of other species including whiting.

Based on the above, and Brander (1975), spawning is concentrated in the western Irish Sea close to the coast (between Carlingford, Lough and Dublin) but also occurs in the eastern Irish Sea over a wider area. Estimation of the relative importance of the eastern and western spawning components has previously been hindered by the inability to unambiguously identify cod, haddock and whiting eggs.

Spawning begins in late January and is largely completed by end of May (Nichols *et al.*, 1993; Fox *et al.*, 1997; Fox *et al.*, 2000). According to Brander (1994), the peak of spawning probably occurs in early March in the western Irish Sea and late March in the northeast. Similarly based on more extensive surveys undertaken in 1995, the peak of spawning occurred at the end of March-early April (Fox *et al.*, 2000). There is relatively little information regarding interannual variability in the timing of spawning as egg surveys have not been conducted on a regular basis in this region.

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for Irish Sea cod:

	Kind of data				
Country	Caton (catch-in-weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
UK(NI)	X	X	X	X	X
UK(E&W)	X	X	X		X
UK(Scotland)	X				
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				
Netherlands	X				

Quarterly landings and length/age composition data are supplied from data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quarterly estimates of landings at age into UK (E&W), UK (NI) and Ireland are raised to include landings by France, Belgium, UK (Scotland), UK (IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\cod-iris\input data\xsa_ica**

B1.2. Discards

EU countries are now required under the EU Data Collection regulation to collect data on discards of cod and other species. Up to 2003, estimates of discards are available only from limited observer schemes and a self-sampling scheme. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES.

The quantity of cod discarded from the UK (NI) *Nephrops* fishery from 1996 to 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length-weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of cod in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of cod discarded using the cod:*Nephrops* ratio in the discard samples. The length frequency of cod in the discard samples is then raised to the fleet estimate. Age data have not been collected, however the discards are mainly of small cod that can be allocated to ages 0 and 1 based directly on their length. Roughly 40 discard samples are collected annually.

Discards from Irish and UK(E&W) trawlers is currently estimated by observers.

B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years. There are no direct estimates of M.

Proportion mature at age is currently assumed constant over the full time-series, and was estimated from UK(NI) trawl surveys in March 1992–1996.

AGE	1	2	3+
Prop mat	0.0	0.38	1.00

B.3. Surveys

Eight research vessel survey series for cod in VIIa were available to the Working Group in 2005. In all surveys listed the highest age represents a true age not a plus group.

- UK (England and Wales) Beam Trawl Survey (UKE&W-BTS): ages 0 and 1, years 1988–2004.

The survey covers the entire Irish Sea and is conducted in September on the R.V. *Corystes*. The survey uses a 4 m beam trawl targeted at flatfish. The survey is stratified by area and depth band, although the survey indices are calculated from the total survey catch in the eastern Irish Sea, and without accounting for stratification except for ALKs. Numbers of 0–gp and 1–gp cod at age per 100 km towed are provided for prime stations only (i.e. those fished in most surveys).

- UK (Northern Ireland) October Groundfish Survey (NIGFS-October): ages 0–3, years 1992–2004.

The survey series commenced in its present form in 1992. It comprises 45 3–mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1–mile tows at fixed station positions in the St George’s channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. *Lough Foyle*. The survey designs are stratified by depth and sea-bed type. Virtually all cod are aged apart from 0–gp and 1–gp fish when particularly abundant. An ALK for the whole survey is used for filling in for any length groups with no ages at a station. Mean numbers-at-age per 3–mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The survey design and time-series of results including distribution patterns of cod are described in detail in Armstrong *et al.*, (2003). From 2002 onwards, all stations in the survey have been reduced to 1 nautical mile. A number of comparative 1–mile and 3–mile tows are done during each survey to build up calibration data.

- UK (Northern Ireland) March Groundfish Survey (NIGFS-March): ages 1–5, years 1992–2005.

General description as for NIGFS-October above, except that 3–mile stations have been retained in all strata other than in the St Georges Channel. Since 2005, the RV Lough Foyle used for all surveys since 1992 has been replaced by the larger RV Corystes. The trawl gear and towing practices have remained the same.

- UK (Northern Ireland) Methot-Isaacs Kidd Survey (UKNI-MIK): age 0, years 1993–2004.

The survey uses a Methot-Isaacs Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place in June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers per unit sea area.

- Ireland's Irish Sea Celtic Sea Groundfish Survey (IR-ISCSGFS): ages 0–5, years 1997–2002.

This survey commenced in 1997 and is conducted in October-November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard ground gear and a 20 mm cod-end liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area.

- UK (Scotland) groundfish survey in Spring (ScoGFS-spring): ages 1–8, years 1996–2005.

This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 30'.

- UK (Scotland) groundfish survey in Autumn (ScoGFS-autumn): ages 0–5, years 1997–2004.

The survey covers a similar area to the ScoGFS in Spring, but has only 11–12 stations.

- Irish groundfish survey (IR GFS - autumn). Ages 0–5, years 2003–2004.

This survey used the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomised stations. There were 34 stations in 2003 and 39 in 2004.

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys are shifted back accordingly in the data files.

Further details of the tuning data are given in Appendix 1 and 2 of the 1999 WG Report.

B.4. Commercial cpue

No cpue data have been provided for the French (Lorient) trawl fleet since 1992. Four commercial catch-effort dataseries were available to the WG: But have not been used in the assessment for several years.

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2004.

Effort and cpue data provided for the Irish fleet comprise total annual effort (hours fished, not corrected for fishing power) and total numbers-at-age in landings from otter trawlers. The data were revised to take account of updated logbook information. This fleet operates mainly in the western Irish Sea, targeting *Nephrops* and/or whitefish. The distribution of fishing is concentrated in the western part of the range of the cod stock in the Irish Sea. Hence the catch rates will represent changes in abundance of cod in the western part of VIIa. The use of this fleet as a tuning index would therefore rely on the assumption that trends in abundance in the west of VIIa reflect those of the entire stock. The otter trawl catch-at-age data contained data for landings only.

- UK (Northern Ireland) pelagic trawl: ages 2–6, years 1993–2001.

The pelagic trawl catch-at-age data contained data for landings only. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. The fleet is considered unsuitable for indexing cod abundance. A recent survey series of the western Irish Sea using a pelagic trawler from Northern Ireland has commenced as part of the UK Fisheries Science Partnership.

- UK (Northern Ireland) single rig otter trawl: ages 0–6, years 1993–2001.

This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the cod stock (which surveys suggest is distributed across the Irish Sea).

- UK (England and Wales) otter trawl: ages 2–6, years 1981–2004.

Estimates up to and including 2004 of commercial lpue from UK (E&W) otter trawlers contain data for landings only. Hence the reliability of the tuning fleet will be limited for age group 1 which may be discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the cod stock.

B.5. Other relevant data

None.

C. Historical stock development

Models used: XSA (up to 2003 WG); TSA (2004 WG); SURBA (2005 WG).

Software used: Lowestoft VPA suite; Marine Lab Aberdeen TSA and SURBA software.

XSA

Model Options chosen:

Tapered time weighting not applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 4
Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages
S.E. of the mean to which the estimate are shrunk = 0.500
Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1968–last data year	0–7+	Yes
Canum	Catch-at-age in numbers	1968–last data year	0–7+	Yes
Weca	Weight-at-age in the commercial catch	1968–last data year	0–7+	Yes
West	Weight-at-age of the stock at spawning time.	1968–last data year	0–7+	Yes:
Mprop	Proportion of natural mortality before spawning	1968–last data year	0–7+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1968–last data year	0–7+	No-set to 0 for all ages in all years
Matprop	Proportion mature at age	1968–last data year	0–7+	No-the same ogive for all years
Natmor	Natural mortality	1968–last data year	0–7+	No-set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1992–last data year	0–5
Tuning fleet 2	NIGFS-Mar (adjusted)	1991–(last data year-1)	0–4
Tuning fleet 3	ScoGFS-Spring	1996–last data year	1–5
Tuning fleet 4	UK(E&W) BTS	1988–last data year	0–1
Tuning fleet 5	NI MIK net		

For analysis of alternative procedures see WG reports from WGNSDS 1997-2003.

D. Short-term projection

Model used: Age structured.

Software used*:* MFDP prediction with management option table and yield per recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment at age 0 in the last data year is estimated as a short-term GM (1992 onwards) because of a reduction in mean recruitment since then.

Natural mortality: Set to 0.2 for all ages in all years.

Maturity: The same ogive as in the assessment is used for all years.

F and M before spawning: Set to 0 for all ages in all years.

Weight-at-age in the stock: average stock weights for last three years.

Weight-at-age in the catch: Average weight of the three last years.

Exploitation pattern: Average of the three last years. Discard F's, which are generated by the *Nephrops* fleet as there are no discard estimates for other fleets, are held constant while landings F's are varied in the management option table.

Intermediate year assumptions: status quo F.

Stock recruitment model used: None, the short-term geometric mean recruitment at age 0 is used.

E. Medium-term projections

Medium term projections have been carried out in previous years using the Aberdeen software suite.

F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass per recruit over a range of F values.

Software used: MFDP

Selectivity pattern: mean F array from last 3 years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age: mean of last three years.

Maturity: Fixed maturity ogive as used in assessment.

G. Biological Reference Points

Precautionary approach reference points have remained unchanged since 1999.

B_{pa} = 10,000t ; B_{lim} = 6,000t. F_{pa} = 0.72; F_{lim} = 1.0.

H. Other Issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 33pp.

Annex 11: Quality Handbook WGNSDS-Irish Sea Plaice

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Plaice (division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	4th May 2004
Last updated:	13th May 2004

A. General

A.1 Stock definition

The degree of separation between the stocks of plaice in the Irish Sea and the Celtic Sea is currently unclear. Numerous tagging studies indicate a southerly movement of mature fish from the southeast Irish Sea into the Bristol Channel during the spawning season. Whilst some of these fish remain in this area the majority return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002). Mixing is also considered to occur between the Celtic Sea and Eastern Channel stocks and time series of recruitment estimates for all three stocks show very similar patterns.

The majority of movements by plaice in the Irish Sea is considered to be in the northsouth direction and the level of mixing between the east and west components of the Irish Sea stock is believed to be small. (Dunn and Pawson, 2002). Length-at-age measurements from research surveys as well as anecdotal information from the fishing industry suggests that plaice in the western Irish Sea grow at a much slower rate than those in the eastern Irish Sea. Earlier studies have suggested that the east and west components of the stock are distinct (Brander, ????; Sideek 1989) and should therefore be considered independently of one another. Morphometric differences have been observed between the east and west components of the stock; a comment in the 1982 WG report states that plaice to the west of the 5°W line are approximately 3 cm larger-at-age (for the most abundant age groups) than those to the east of this line. This however, contradicts the findings of the September beam trawl survey for which plaice caught off the Irish coast are found to be smaller-at-age than those caught in the eastern Irish Sea.

Recent examination of survey results which contrasted recruitment indices from the east with those from the west showed good levels of correspondence of year-class strengths between the two sub-stocks. This would indicate either that the two sub-stocks are subject to similar large-scale environmental forces and respond similarly to them, or alternatively that they represent two sub-populations of a single stock which share a common spawning.

There are considered to be three principle spawning areas of plaice in the Irish Sea. One off the Irish coast, another between the Isle of Man and the Cumbrian coast and the third off the north Wales coast (Nichols *et al.,* 1993; Fox *et al.*, 1997). Cardigan Bay has also been identified as a spawning ground for plaice in the Irish Sea (Simpson, 1959).

A.2 Fishery

The status and activities of the fishing fleets operating in ICES sub division VIIa are described by Pawson *et al.* (2002) and also by Anon (2002). The majority of vessels operating in the Irish Sea are otter trawlers fishing for cod, haddock, whiting and plaice with bycatches of angler-fish, hake and sole. Since 2001 these trawlers have adopted mesh sizes of 100–120 mm and other gear modifications depending on the requirements of recent EU technical conservation regulations and national legislation. Square mesh panels have been mandatory for UK otter trawlers since 1993 and for Irish trawlers since 1994. The number of Irish vessels operating in this area has declined in recent years. Fishing effort in the England and Wales fleet declined rapidly after 1989 and over 1992–1995 was about 40% of the levels reported in the late 1980s.

Although some of the otter trawlers also take part in the fishery for sole, there have been a growing number of beam trawlers, particularly from southern England and Belgium exploiting this stock. This fishery has important bycatches of plaice, rays, brill, turbot and angler-fish. The fishing effort of the Belgium beam trawl fleet varies according to the catch rates of sole in the Irish Sea compared with other areas in which the fleet operates.

A fleet of vessels primarily from Ireland and Northern Ireland take part in a targeted *Nephrops* fishery using 70 mm mesh nets with 75 mm square mesh panels. This fishery takes a substantial bycatch of whiting, most of which is discarded. Some inshore shrimp beam trawlers occasionally switch to flatfish when shrimp become temporarily unavailable. Other gear types employed in the Irish Sea to catch demersal species are gillnets and tanglenets, notably by inshore boats targeting cod, bass, grey mullet, sole and plaice.

The minimum landing size for plaice in the Irish Sea was set in 1980 to 25 cm (Council Regulation (EEC) No 2527/80). This was increased in 19?? To 27 cm (Council Regulation (EEC) No ?).

Since 2000 a recovery program has been implemented to reduce exploitation of the cod spawning stock in the Irish Sea. In 2002 the European Commission regulations included a prohibition on the use of demersal trawl, enmeshing nets or lines within the main cod spawning area in the northwest Irish Sea between the 14th February and 30th April. Some derogations were permitted for *Nephrops* trawls and beam trawlers targeting flatfish.

A.3 Ecosystem aspects

B. Data

B.1 Commercial Catch

Landings

International catch-at-age data based on quarterly market sampling and annual landings figures are available from 1964. Throughout the period 1978 to 2003 quarterly age compositions have typically represented around 80–90% of the total international landings. Table B1 details the derivation of international landings for the period 1978 to 2003.

Up until 1982 the stock was assessed on a separate sex basis. The catch numbers of males and females were worked up separately and the numbers of males and females in the stock as estimated from each assessment combined to give a total biomass estimate. From 1983 a combined sex assessment of the stock has been conducted and the numbers of males and females in the catch have been combined at the international data aggregation level prior to running a single assessment.

Discards

In 1986 the UK fleet was restricted to a 10% bycatch of plaice for almost the entire year. Estimates were made of the increased quantity of plaice that would have been discarded based on comparisons of cpue values for 1985–86 with those for 1984–85. The estimated quantity of 250 tonnes was added to the catch. A similar situation arose the following year and 250 tonnes was added to the catch for 1987.

The 10% plaice bycatch restriction was enforced again in 1988 to all UK (E&W) vessels in the 1st quarter and to beam trawlers in the 2nd and 3rd quarters however, this time the landings were not corrected for discard estimates.

Discard information is not routinely incorporated into the assessment. A sufficient time-series of discard information is not currently available though studies were conducted in 1993–94 and since.

B.2. Biological

Weights-at-age

A number of different methodologies have been employed to determine weights-at-age for this stock. Stock weights and catch weights-at-age were determined on a separate sex basis and remained unchanged from 1978 until 1983. Catch weights were derived from a von Bertalanffy length-at-age fit to Belgian (70–74), UK (E&W) (64–74) and Irish (62–66) catch samples. The estimated lengths-at-age were converted to weights-at-age using a Belgian length-weight data set (ages 2–15 females; 3–9 males). Stock weights were calculated as the mean of adjacent ages from the catch weights, where catch weights represented 1st July values and stock weights 1st January.

From 1983 weights-at-age have been calculated on a combined sex basis. Catch weights were taken from market sampling measurements combined on a sex weighted basis and smoothed. For the period 1983 to 1990 catch weights were smoothed by eye, from 1991 onwards a smooth curve was fitted using a numerical minimisation routine. Stock weights were derived from the smoothed international catch weights-at-age curve with values representing 1st January. In 1985 the stock weights-at-age were adjusted for ages 1 to 4. The difference between the smoothed catch weights and survey (F.V. *Silver Star*) observations were adjusted using the maturity ogive to give "best estimate" stock weights "for ages where growth and maturity differences can bias sampling procedures". (*This procedure remains a little opaque*). The same procedure was adopted in 1996 (when stock weights in 1982 and 1983 were also revised so as to be consistent with this methodology) and 1997. In 1988 however, the *Silver Star* survey was discontinued and stock weights at ages 1 to 3 were calculated as means of the 3 previous years. Correction of the estimated stock weights of the younger age groups did not occur in 1989 or in subsequent years which explains the sudden increase in weight of the younger age groups for this stock from 1988 onwards.

Catch weights at the younger ages also show a similar increase coincident with the start of the smoothing process. This apparent increase in the estimated catch weights is not believed to have affected the derivation of catch numbers since smoothing of the catch weights occurs after having determined the catch numbers at age. SOP checks are generally very close to 100%.

The 1982 WG report notes a study by R. Cross (unpublished) stating that there was no evidence for a change in growth rates for the stock nor was there any evidence of density dependent effects on growth.

Natural mortality and maturity ogives

As for the weights-at-age, natural mortality and maturity was initially determined on a separate sex basis. Natural mortality was taken as 0.15 for males and 0.1 for females. In 1983 when a combined sex assessment was undertaken a sex weighted average value of 0.12 was used as an estimate of natural mortality. This estimate of natural mortality has remained unchanged since 1983.

The maturity estimates used prior to 1982 are not specified. A new separate sex maturity ogive (Sideek, 1981) was implemented in 1982. This ogive was recalculated as sex weighted mean values in 1983 when the assessment was conducted on a combined sex basis. The maturity ogive was revised again in 1992 based on the results of an EU project. Maturity ogives are applied as vectors to all years in the assessment.

Age	1978–82		1983–92	1992–03
	M	F		
1	0	0	0	0
2	0.3	0.04	0.15	0.24
3	0.8	0.4	0.53	0.57
4	1.0	0.94	0.96	0.74
5	1.0	1.0	1.0	0.93
6	1.0	1.0	1.0	1.0

The proportion of fishing mortality and natural mortality before spawning was originally set to 0. It was changed in 1983 to a value of 0.2 on the grounds that approximately 20% of the catch was taken prior to March (considered to be the time of peak spawning activity). As for Celtic Sea plaice the proportion of F and M before spawning was reset to 0, as it was considered that these settings were more robust to changes in the fishing pattern, especially with respect to the medium term projections.

B.3 Surveys

B.4 Commercial cpue

B.5 Other relevant data

C. Historical stock development

The stock of plaice in the Irish Sea has been assessed by ICES since 1977 and has been managed by TAC since 19??.

Commercial tuning data

Prior to 1981 tuning data were not used in the assessment of this stock. A separable assessment method was used and estimates of terminal S and F were derived iteratively based on an understanding of the recent dynamics of the fishery.

In 1981 the choice of terminal F was determined from a regression of exploited stock biomass on cpue. Catch and effort series were available for the UK (E&W) trawl fleet and the Belgian beam trawl fleet for the period 1964 to 1980. In 1994 the Belgian and UK cpue series were combined to provide one mean standardised international index. The UK (E&W) trawl series was revised in 1986 (not known how) and in 1987 was recalculated as an age based cpue index enabling the use of the hybrid method of tuning an *ad hoc* VPA.

The UK (E&W) trawl tuning series was revised in 1999 and separate otter trawl and beam trawl tuning series were produced using length samples from each gear type and an all gears ALK. Since the data could only be separated for 1988 onwards the two new tuning series were slightly reduced in length. In 1996 UK (E&W) commercial effort data were re-scaled to thousands of hours so as to avoid numerical problems associated with low cpue values and in 2000 the UK (E&W) otter trawl series was re-calculated using otter trawl age compositions only rather than combined fleet age compositions as previously.

Two newly revised survey indices for the *Lough Beltra* were presented to the WG in 1996 though they were considered too noisy for inclusion in the assessment. They were revised again for the following year and found to be much improved but were again not included because they ended in 1996 and the WG felt that they would add little to the assessment. An Irish otter trawl tuning index was made available in 2001 (1995–2000, age 0 to 15). Whilst this fleet mainly targets *Nephrops*, vessels do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet were approximately 15% of total international landings in 2000 and the WG considered that this fleet could provide a useful index of abundance for plaice.

The effects of vessel characteristics on lpue for UK (E&W) commercial tuning series was investigated in 2001 to investigate the requirement for fishing power corrections due to MAGP IV re-measurement requirements. It was found that vessel characteristics had less effect on lpue than geographic factors and unexplained noise and concluded that corrections were not necessary. However, vessels of certain size tended to fish in certain rectangles. This confounding may have resulted in the under-estimation of vessel effects.

Survey tuning indices

In 1993 the UK (E&W) beam trawl survey series which began in 1988 was considered to be of sufficient length for inclusion in the assessment. Since 1991 tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997 values for 1988 to 1990 were raised to 30 minute tows, however, data for 1988 and 1989 were of poor quality and gave spurious results. The series was therefore truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the WG in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

An Irish juvenile plaice survey index was presented to the WG in 2002 (1976–2001, ages 2–8). Between 1976 and 1990 this survey had used an average ALK for that period. Serious concerns were expressed regarding the quality of the data for this period and the series was truncated to 1991. The stations for this survey are located along the coast of south-east Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localised survey series would not be representative of the plaice population over the whole of the Irish Sea. Numerous tests were conducted at the 2002 WG to determine the validity of this and other tuning indices and it was concluded that this survey could be used as an index of the plaice population over the whole of the Irish Sea.

Assessment methods and settings

In 1987 the stock was assessed using a Laurec-Shepherd (hybrid) tuned VPA. Concerns about deteriorating data quality prompted the use in 1994 of XSA. The XSA settings for each of the assessments since 1992 are detailed in table C1.

Trial runs have, over the years, explored many of the options with regards XSA settings.

- The applicability of the power model on the younger ages was explored in 1994; 1996; 1998; 1999; 2000 and 2001.
- Different levels of F shrinkage were explored in 1994; 1995; 1997.
- The effect of different time tapers was investigated in 1996.
- The S.E. threshold on fleets was examined in 1996.
- The level of the catchability plateau was investigated in 1994.

D. Short term projection

Software: Multi Fleet Deterministic Projection (MFDP)

Age based short term projections are conducted for a 3 year period using initial stock numbers derived from XSA analyses. Numbers at age 1 are considered poorly estimated and are generally overwritten using a geometric mean of past recruitment values. Recent recruitments have been estimated to be at a lower level and to be less variable than those earlier in the time series. Consequently a short term geometric mean (from 1989–present) is used.

The exploitation pattern is typically an un-scaled 3 year arithmetic mean, though alternative options may be used depending on recent F trajectories and the working groups perception of the fishery.

Catch and stock weights-at-age are generally taken as the mean of the last 3 years. Maturity ogive and natural mortality estimates are those used in the assessment method.

E. Medium term projections

Software: MLA miscellany

Input values to the medium term forecast are the same as those used in the short term forecast. Any stock recruit relationship is poorly defined and whilst a Beverton Holt SRR has been assumed in earlier years, a simple geometric mean may now be considered more appropriate, though it remains unclear whether the full time series or a reduced time series from 1989 should be used.

F. Yield and biomass per recruit/long term projections

Software: Multi Fleet Yield per Recruit (MFYPR)

Yield per recruit calculations are conducted using the same input values as those used for the short term forecasts.

G. Biological reference points

Biological reference points were proposed for this stock by the 1998 working group as below

F_{lim}	No proposal	
F_{pa}	0.45	(on the basis of Fmed and long term considerations)
B_{lim}	No proposal	
B_{pa}	3 800 t	(on the basis of Bloss and evidence of high recruitments at low SSBs

H. Other issues

None

I. References

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Table B.1 Data sources and derivation of international landings. % sampled indicates the percentage of the total landings represented by sampling.

Year of WG	Data	Source: UK	Belgium	Ireland	Netherland	Derivation of international landings	% sampled
1978	Len. comp.	quarterly[1]	quarterly[1]	quarterly[1]		Irish raised to Irish and N.Irish; UK raised to UK (E&W) and Scotland	85
	ALK	quarterly[1]	quarterly[1]	quarterly[1]		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly[1]	quarterly[1]	quarterly[1]		UK + Bel + IR combined to total int. separate sex	
1979							
1980	Len. comp.	quarterly[1]	quarterly[1]	quarterly[1]		Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM.	86
	ALK	quarterly[1]	quarterly[1]	quarterly[1]		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly[1]	quarterly[1]	quarterly[1]		UK + Bel + IR combined to total int. separate sex	
1981							
1982		As for 1980	As for 1980	As for 1980		As for 1980, separate sex	92
1983		As for 1980	As for 1980	As for 1980		As for 1980; sexes combined	90
1984	Len. comp.	quarterly	2nd qtr	quarterly		Irish raised to Irish and N.Irish	90
	ALK	quarterly	2nd qtr	quarterly		UK raised to UK (E&W), Scotland, I.O.M., French, Dutch and Belgian	
	Age comp.	quarterly	2nd qtr	quarterly		UK + IR combined to total int. sexes combined	
1985	Len. comp.	quarterly	quarterly	quarterly		Irish raised to Irish and N.Irish; UK raised to UK (E&W), Sco and IOM	92
	ALK	quarterly	quarterly	quarterly		Belgian raised to Belgian, Dutch and French	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int. sexes combined	
1986	Len. comp.	quarterly	quarterly	quarterly		Irish raised to Irish.,N.Irish and French	91
	ALK	quarterly	quarterly	quarterly		UK raised to UK (E&W), Scotland and I.O.M.; Belgian used alone	
	Age comp.	quarterly	quarterly	quarterly		UK + Bel + IR combined to total int.	
1987		As for 1986	As for 1986	As for 1986		As for 1986	84
1988		As for 1986	As for 1986	As for 1986		As for 1986 except Irish beam trawl raised using UK age comps	75
1989		As for 1986	As for 1986	As for 1986		As for 1986 (Irish beam trawl now sampled)	86

Year of WG	Data	Source UK	Belgium	Ireland	Netherland	Derivation of international landings	% sampled
1990							
1991		As for 1986	As for 1986	As for 1986		As for 1986	83
1992		As for 1986	As for 1986	As for 1986		As for 1986	83
1993		As for 1986	As for 1986	As for 1986		As for 1986	91
1994		As for 1986	As for 1986	As for 1986		As for 1986 (Belgian samples supplemented with UK data)	90
1995							
1996		As for 1986	As for 1986	As for 1986		As for 1986	89
1997		As for 1998	As for 1998	As for 1998	As for 1998	As for 1998	83
1998	Len. comp.	quarterly	quarterly	quarterly	Quarterly	Irish raised to Irish., N.Irish and French; Belgian and Dutch used alone	87
	ALK	quarterly	quarterly	quarterly	Quarterly	UK raised to UK (E&W), Scotland and I.O.M.	
	Age comp.	quarterly	quarterly	quarterly	Quarterly	UK + Bel + IR + NL combined to total int.	
1999		As for 1986	As for 1986	As for 1986		As for 1986 (except UK raised to include NL landings)	89
2000		As for 1999	As for 1999	As for 1999		As for 1999	88
2001		As for 1998	As for 1998	As for 1998	As for 1998	As for 1998	87
2002		As for 1986	As for 1986	As for 1986		As for 1986	88
2003	Len. comp.	quarterly	1st qtr	quarterly		Belgium raised using 1st qtr values	70
	ALK	quarterly	1st qtr	quarterly		UK raised to Sco and France; Irish raised to Irish and N.Irish	
	Age comp.	quarterly	1st qtr	quarterly		UK + Bel + IR combined to total int.	

[1] **Assumed – (not explicitly stated in report)**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assmnt Age Range	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+	1–9+
Fbar Age Range	3–8	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6	3–6
Assmnt Method	L.S.	L.S.	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets													
UK trawl yrs	81–90	82–91	76–92	76–93	76–94								
ages	1–8	1–8	1–8	1–8	1–8								
UK otter yrs						86–95	87–96	88–97	89–98	90–99	91–00	87–01	87–02
ages						2–8	2–8	2–8	2–8	2–8	2–8	2–8	2–8
UK beam yrs									89–98	90–99	91–00	89–01	89–02
Ages									2–8	2–8	2–8	2–8	2–8
Bel Beam yrs					85–94	86–95	87–96	88–97					
Ages					2–8	3–8	3–8	3–8					
IR otter yrs												95–01	95–02
Ages												2–8	2–8
UKBTS Sept yrs			88–92	88–93	88–94	88–95	89–96	89–97	89–98	90–99	91–00	89–01	89–02
Ages			1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4
UKBTS Mar yrs								93–97	93–98	93–99	93–99	93–99	93–99
Ages								1–4	1–4	1–4	1–4	1–4	1–4
IR-JPS yr												91–01	91–02
agess												1–6	1–6
Time taper			20yr tri	20yr tri	20yr tri	No	No	No	No	No	No	No	No
Power model ages			1	0	1	1	1	1	1	0	0	0	0
P shrinkage			True	False	True	True	True	True	True	False	False	False	False
Q plateau age			5	5	5	5	5	5	5	5	5	5	5
F shrinkage S.E			0.3	0.3	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Num yrs			5	5	5	5	5	5	5	5	5	5	5
Num ages			5	5	4	4	4	4	4	4	4	4	4
Fleet S.E.			0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Annex 12: Quality Handbook WGNSDS-SoleVIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Sole (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	22 May 2003

A. General

A.1. Stock definition

Sole occur throughout the Irish Sea, but are found more abundant in depth less than 60 m.

A.2. The fishery

There are three main countries fishing for sole in the Irish Sea; Belgium, taking the bulk of the landings (50–75%), and the UK and Ireland, also taking considerable amounts. The Netherlands and France take the remainder. Approximately 25 Belgian beam trawlers are operating in the Irish Sea, targeting sole. The UK trawl fleet operates predominantly in the eastern side of the Irish Sea in Liverpool Bay and Morecambe Bay. Sole catches from Ireland are mainly coming from bycatches in the *Nephrops* fishery (operation in the North West of the Irish Sea).

When fishing in VIIa it is prohibited to use any beam trawl of mesh size range 70–79 mm or 80–90 mm unless the entire upper half of the anterior part of such a net consists of a panel of netting material attached directly to the headline of the net, extending towards the posterior of the net for at least 30 meshes and constructed of diamond-meshed netting material of which no individual mesh is of mesh size less than 180 mm. The Irish otter trawl fleet employs either a 70 mm mesh with square mesh panels or more commonly an 80 mm mesh. Similarly the Belgian and UK (E&W) beam trawls use 80 mm mesh gear. Otter trawlers targeting roundfish have, since 2000, used 100 mm mesh gear.

It was concluded at the 2000 working group and confirmed in 2001 that the cod recovery measures first enacted in 2000 would have had little impact on the sole fishery. The closed area in 2001 covered a reduced area confined to the west of the Irish Sea and therefore is also expected to have had little effect on the level of fishing effort for sole The spawning closure for cod in 2002 is also unlikely to have had an impact on the sole fishery. The effort regulations and maximum daily uptake, implemented in 2003 will delay the uptake of the quota but is also unlikely to be restrictive for the total uptake.

Discard estimates are estimated to be minor. Preliminary data indicating ranges from 0 to 2% by weight discarded.

No data are available on the extent of misreporting of landings from this stock. However, the quota in 2003 became restrictive.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

Quarterly age compositions for 2002 were available from UK (E&W), Belgium and Ireland, as well as quarterly landings from France and Northern Ireland. The quarterly UK (E & W) age compositions were raised to total UK landings. A total international age composition was obtained by combining the quarterly age compositions from Belgium, the UK, and Ireland, and raising them to the total international landings.

B.2. Biological

Currently there are no direct (from tagging) or independent (from survey information) estimates of natural mortality. Therefore, as in previous years, annual natural mortality (M) was assumed to be constant over ages and years, at 0.1 yr^{-1}.

The maturity ogive used in this and previous assessments is based on survey information for this stock.:

Age	1	2	3	4	5	6 and older
Mat.	0.00	0.38	0.71	0.97	0.98	1.00

Proportions of M and F before spawning were set to zero, as in previous years.

Males and Females of this stock are strongly dimorphic, with much reduced rates of growth after reaching maturity, whilst females continue to grow. Given the minimum landing size of 24 cm the majority of landings represent mature females.

B.3. Surveys

Two UK (E&W) beam trawl surveys were available to the working group.

Area covered

Irish Sea; 52^0 N to 55^0 N; 3^0 W to 6^0 30’ W.

Target species

Flatfish species, particularly juvenile plaice and sole. Length data recorded for all finfish species caught; samples for age analysis taken from selected species.

Time Period

1988–2002: September (continuing).

1993–1999: March.

Gear used

Commercially-rigged 4 m steel beam trawl; chain matrix; 40 mm codend liner.

Mean towing speed: 4 knots over the ground. Tow duration: 30 minutes. Tow duration for trips in 1988–1991 was 15 minutes; in 1992 comparative tows of 15 and 30 minutes length were carried out, and subsequent cruises used a standard 30 minute tow. The data from earlier years were converted to 30 minutes tow equivalent using relationships for each species derived from the comparative work in 1992.

Vessel used: R.V. *Corystes* (CEFAS).

Survey design

Survey design is stratified by depth band and sector (Depth bands are 0–20, 20–40, 40+). Station positions are fixed. Number of stations = 35 in the eastern Irish Sea, 15 in the western Irish Sea, and 16 in St. George’s Channel (primary stations). Sampling intensity highest in the eastern Irish Sea, in the main flatfish nursery and fishery areas.

Method of analysis

Raised, standardized length frequencies for each station combined to give total length distribution for a stratum (depth band/sector). Sector age length keys applied to stratum length distributions 1988–1994; stratum age-length keys applied 1995 onwards. Mean stratum cpue (kg per 100 km and numbers-at-age per 100 km) are calculated. Overall mean cpue values are simple totals divided by distance in metres (or hours fished). Population number estimates derived using stratum areas as weighting factors.

The September beam trawl survey has proven to estimate year class strength well, and providing 50% to 80% of the weighting to the total estimates of the incoming years classes.

B.4. Commercial catch-effort data

Cpue and effort series were available from the Belgium beam trawlers, UK (E&W) beam and otter-trawlers, the Irish otter trawlers and from two UK beam trawl surveys (September and March) (Table 12.2.1 and Figure 12.2.1).

Cpue for both UK and Belgian beam trawlers has declined since the beginning of the time series, but has remained relatively constant over the last decade.

Effort from both commercial beam trawl fleets increased from the early seventies until the late eighties. Since then UK beam trawl effort has declined to a minimum in 2000, and has remained at this level up till now. In the nineties, the Belgian beam trawl effort fluctuated around a lower level than the late eighties. Since 2000 the effort has increased substantially with 64% and 27% respectively each year, despite which cpue has remained stable in this and other fleets.

Indices of abundance derived from the UK September survey (data from 1988 onwards) are shown in Table 12.2.2. High abundance indices for the UK September survey can be seen for year classes 1989, 1995 and 1996. The data series from the UK March beam trawl survey is rather short (from 1993 to 1999), and therefore difficult to interpret.

There has been no March beam trawl survey since 1999. The tuning data available for this assessment comprise the beam trawl survey UK beam trawl survey, September and March cruise series, UK (E&W) beam trawl fleet (UK (E&W)BTF), UK(E&W) otter trawl fleet (UK (E&W)OTF), the Irish juvenile plaice survey (IR-JPS), the Irish Sea Celtic Sea ground fish survey (ISCS-GFS), and Irish otter trawl fleet (IR-OTF). Standardized cpue for the above fleets are shown in Table 11.2.1. Details of surveys and commercial fleet tuning data are given in Appendices 1 and 2 of the 1998 report (ICES CM 1998: Assess1).

Similarly the Irish otter trawl fleet mainly targets *Nephrops*, however, vessels from this fleet do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet have been approximately 15% of the total international landings and the working group considered that this fleet may provide a reliable index of abundance for plaice.

B.5. Tuning data evaluation

A thorough investigation of the utility of the different tuning indices available for this stock was conducted by the 2002 working group the results of which are summarized below:

Following an initial consideration of the appropriateness of each tuning fleet and its anticipated utility as an index of abundance, the tuning data from both commercial fleets and research surveys were evaluated externally to the assessment program to test for internal and external consistency. These tests comprised plots of the effort corrected-mean standardised indices for each age; tests for cross correlation of ages between fleets and of ages within fleets and the results of single fleet SurBA (WD1) runs.

The working group considered that the Irish ground fish survey would not be appropriate for use in the assessment as it is designed principally for gadoids and would not be expected to provide a reliable index for flatfish stocks. Similarly the Irish otter trawl fleet mainly targets *Nephrops*, however, vessels from this fleet do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet are approximately 15% of the total international landings and the working group considered that this fleet may provide a reliable index of abundance for plaice. For the period 1976 to 1990 the juvenile plaice survey had used a combined ALK. Serious concerns were expressed regarding the quality of the data for this period and it was decided that this series should be truncated to 1991.

The juvenile plaice survey stations are located along the coast of southeast Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localised survey series would not be representative of the plaice population over the whole of the Irish Sea. Plots of the effort corrected-mean standardised indices for the juvenile plaice survey and the September beam trawl survey by age showed some correspondence between the two series. It should be noted that recruitment over the past 13 years has been remarkably stable and there is very little contrast in year-class strengths for the period covered by the tuning fleets making cross comparisons difficult. The 1991 year class is clearly identified by the juvenile plaice survey at ages 1, 2, 4, 5,and 6, suggesting good internal consistency for this fleet. This year class is also apparent, though to a lesser extent, in the September beam trawl survey series. It was therefore decided that the juvenile plaice survey could be used as an appropriate index for the plaice population in the whole of the Irish Sea.

A test for cross correlation between fleets (following a test for auto-correlation) showed significant results for the UK (E&W) beam trawl fleet and the UK (E&W) otter trawl fleet at ages 1 to 4; for the juvenile plaice survey and the UK (E&W) otter trawl fleet at age 6 and for the juvenile plaice survey and the September beam trawl survey at age 5, indicating a consistent signal between these fleets at these ages. The lack of contrast in year-class strengths, mentioned above, and the short time series of some fleets meant that it was difficult to identify consistent signals between fleets and resulted in very few significant tests for cross-correlation.

SurBA runs for the September beam trawl survey, the UK (E&W) beam trawl fleet and the UK (E&W) otter trawl fleet showed fairly consistent results in terms of predicted SSB and mean F. Results for the juvenile plaice survey showed a much noisier pattern but were considered to conform sufficiently to the general trend. Although SurBA has been developed specifically for use with survey data, runs for the two commercial series were considered to be acceptable as the residual patterns over time did not show any apparent trends. This was not the case for the Irish otter trawl fleet and the results of SurBA runs for this fleet were not considered further.

Whilst it was difficult to derive any firm conclusions from individual tests, it was concluded from the overall body of evidence that in addition to the four fleets used last year, the juvenile plaice survey and the Irish otter trawl fleet should be considered as appropriate abundance indices for tuning the assessment.

C. Historical stock development

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen:

No time weighting applied
Catchability independent of stock size for all ages

Catchability independent of age for ages >= 5

Survivor estimates shrunk towards the mean F of the final 5 years or the 4 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.5

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1964–last data year	2–9+	Yes
Canum	Catch-at-age in numbers	1964–last data year	2–9++	Yes
Weca	Weight-at-age in the commercial catch	1964–last data year	2–9+	Yes/No-constant-at-age from 1960–1979
West	Weight-at-age of the spawning stock at spawning time.	1964–last data year	2–9+	Yes-but based on back caluclated catch weights
Mprop	Proportion of natural mortality before spawning	1964–last data year	2–9+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1964–last data year	2–9+	No-set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1964–last data year	2–9+	No-the same give for all years
Natmor	Natural mortality	1964–last data year	2–9+	No-set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	UK beam trawl survey (September)	1989–last data year	1–4
Tuning fleet 2	UK beam trawl survey (March)	1993–1999	1–4
Tuning fleet 3	Irish Juvenile Plaice Survey	1991–last data year	1–6
Tuning fleet 4	UK(E&W) beam trawl fleet	1989–last data year	2–8
Tuning fleet 5	UK(E&W) otter trawl fleet	1987–last data year	2–8
Tuning fleet 6	Irish otter trawl fleet	1995–last data year	2–8

For analysis of alternative procedures see WG reports from AFWG 1997–2002.

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 the XSA for age 5 and older. The recruitment at age 2 and 3 in the last data year is estimated using RCT3 and the corresponding numbers at age 3 and 4 in the start year of the projection is calculated applying a natural mortality of 0.2 and fishing mortality according to the catches taken of these age groups. The long-term geometric mean recruitment is used for age 2 in all projection years.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: 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. Medium-term projections

Model used: Age structured

Software used: IFAP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years

- F and M before spawning: Set to 0.2 for all ages in all years
- Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch
- Weight-at-age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC
- Stock recruitment model used: Truncated lognormal distribution, TLOGNORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960–4th last year.

F. Yield and biomass per recruit/long-term projections

Not done

G. Biological reference points

Precautionary approach reference points have remained unchanged since 1999. B_{pa} is set at 3 100 t and is based on a lowest observed SSB (ACFM 1999). There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. F_{pa} is set at 0.45 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above $B_{pa.}$

Annex 13: Quality Handbook WGNSDS-WhitingVIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Whiting (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	WGNSDS 2006
Updates:	Inclusion of Fishery Data from Ireland

Stock Annex needs to be re-drafted at WGNSDS 2008.

A. General

A.1. Stock definition

Whiting in Division VIIa are considered a single stock for management purposes. In 2004 an informal meeting was established to review current knowledge of the distribution, movements and stock structure of whiting in the Irish Sea, and linkages between whiting in the Irish Sea and surrounding management areas. Information on egg and larval, tagging, survey studies was presented as a working document (WD10) in WGNSDS, 2005. The results of this are synopsized below:

UK egg and larva surveys have shown that whiting spawn in spring throughout the eastern Irish Sea and in the coastal waters of the western Irish Sea. This is supported by the distribution of actively spawning fish caught during trawl surveys in March.

Transport of whiting eggs, larvae or pelagic pre-recruits from Celtic Sea spawning grounds into the Irish Sea is likely to be impeded by the Celtic Sea thermal front that becomes increasingly established from spring onwards.

Whiting recruitment grounds are in the same general area as the spawning grounds, and young whiting are widespread in the coastal bights of the Irish Sea. The gyre system that becomes established from late spring onwards in the western Irish Sea appears important in retaining larvae and pelagic pre-recruits of whiting, as shown by the results of frame-trawl surveys of pelagic pre-recruits in the western Irish Sea.

As the whiting become demersal from late summer onwards, they are found throughout the western Irish Sea although densities appear highest around the periphery of the mud patch in coastal waters and along the southern boundary between Ireland and the Isle of Man. This pattern is also noted by fishermen operating in this area. Densities of young whiting in the eastern Irish Sea appear highest off Cumbria and the Solway Firth in autumn, but are more widespread in spring.

Tagging studies in the late 1950s show some seasonal dispersal of whiting from the Irish Coast to as far as the Clyde, Liverpool Bay and the Celtic Sea, with evidence of return migrations. Whiting tagged in these studies ranged from about 20–40 cm, averaging around 30 cm. Whiting recaptured well away from the tagging sites off County Down in the western Irish Sea tended to be several cm larger, on average, than the tagged whiting.

Both the western Irish Sea and the Clyde have historically been characterised by catches of immature and first-maturing whiting, whilst the eastern Irish Sea has a broader age-range of whiting. This pattern persists to the present day.

The evidence for interchange of whiting between the western Irish Sea and other areas within the Irish Sea precludes treating different areas within the Irish Sea as containing functionally separate stocks. Spatial modelling of the populations would require information on rates of dispersal between areas.

Trawl surveys continue to show that juvenile whiting are very abundant in the coastal waters of the Irish Sea, and that whiting are one of the most abundant fish species taken in the surveys. Hence, there have been no indications of depressed recruitment associated with the apparent steep decline in abundance of large whiting. Length at 50% maturity in female whiting is only 20–21 cm in the Irish Sea and neighbouring management areas, and spawning appears predominantly by young whiting of 1–3 years old.

A.2. Fishery

Most landings by the Irish and UK (NI) fleet, which take the bulk of the Division VIIa whiting catch, are from the western Irish Sea (ICES CM 2003/ACFM:04) and are made predominately by single- and twin-rig trawlers. A small number of UK pair trawlers also fish for whiting. The UK (E&W) fleet has declined substantially over time, and the bulk of its landings are from inshore otter trawlers targeting mixed flatfish and roundfish in the eastern Irish Sea. Discarding in this stock is thought to be high in all fleets, particularly in the *Nephrops* fishery. The *Nephrops* directed fishery operates on the main whiting nursery areas in the western Irish Sea, and is particularly intensive in the summer months. The mesh size mainly in use in the fishery is 70 mm in single trawls and 80 mm in twin trawls targeting *Nephrops*. The western Irish Sea fishery for whiting has declined substantially in recent years, and the increase in abundance of haddock has resulted in few vessels targeting whiting.

Vessels operating with 70 mm and 80 mm mesh are required to use square mesh panels. Square mesh panels were introduced as a technical measure to reduce fishing mortality on whiting. Square mesh panels have been mandatory for all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993 and for Irish trawlers since 1994. While the effects of this technical measure have not been formally evaluated, the *Nephrops* fishery still generates substantial quantities of whiting discards. Effort by Irish *Nephrops* trawlers in the main areas of whiting by-catch has shown some reduction during the period of the Irish Sea cod recovery plan closures. However, the summer peak in activity of the *Nephrops* fishery was not affected by the recovery plans. As the activities of the *Nephrops* fleet were not restricted by the cod recovery plan, it is unlikely that the recovery plan was effective in reducing levels of discarding in this stock.

There has been some decommissioning of vessels in the Irish Sea, most recently at the start of 2002. The reported landings of whiting in 1999–2001 by UK vessels decommissioned in 2002 amounted to about 7% of the total international landings of whiting in those years. Whilst few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches of whiting in VIIa. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas. Irish landings of whiting in the southwestern part of VIIa now contribute the bulk of the total Irish landings in the Division (ICES CM 2003/ACFM:04). The difference in grounds in the southern part of VIIa means that whiting in the area are more likely to function as part of the Celtic Sea stock rather than the Irish Sea stock.

Irish otter board trawlers fishing ICES area VIIa generally use twin-rig gear to fish for *Nephrops*. However there are also localized mixed fisheries both in the north and south ends of VIIa. The Irish Sea *Nephrops* fleet is highly opportunistic and of this fleet, there are only a handful of boats that fish the Irish Sea Prawn Grounds 100% of the time. The rest of the fleet divides its time between the Irish Sea, Smalls, Aran and Porcupine Grounds dependant on tides, weather and market forces. Because of the need to fish further away from their home port and in rougher sea conditions, many of the older and smaller wooden vessels are being replaced with new and second hand steel vessels. Most of these newer vessels are French-style twin-riggers. To maximize the return on their investment, many of the owners of newer vessels are opting for relief skippers and crews so that the vessels are fishing as much as possible.

The main species targeted by the otter trawl fleet are *Nephrops*, cod, ray, haddock, anglerfish and whiting. The Irish beam trawl fleet predominantly targets black sole and other high-quality flatfish and divides its effort between VIIa and VIIg depending on weather, tides and market forces.

For the UK NI fleet decommissioning at the end of 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that used demersal trawls with mesh size >=100 mm. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and 4 UK(E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size >=100 mm.

A.3. Ecosystem aspects

Recruitment in Irish Sea whiting appears less variable than in cod and haddock, although there is some similarity in the timing of strong and weak year classes that may indicate a similar response to changes in environmental conditions affecting spawning or early-stage survival. The diet of Irish Sea whiting has been examined in some detail since the 1970s using samples collected from research vessels. Cannibalism occurs in adult whiting, however the effect of this on the assessment of the stock has not yet been investigated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for Irish Sea whiting:

	KIND OF DATA				
COUNTRY	CATON (CATCH IN WEIGHT)	CANUM (CATCH AT AGE IN NUMBERS)	WECA (WEIGHT AT AGE IN THE CATCH)	MATPROP (PROPORTION MATURE BY AGE)	LENGTH COMPOSITION IN CATCH
UK(NI)	X	X	X	X	X
UK(E&W)	X	X	X		X
UK(Scotland)	X		X		
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				
Netherlands	X				

Quarterly landings and length/age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by the ICES Northern Shelf

Demersal Working Group, who compiles the international landings and catch at age data, and maintains a time series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

The UK (E&W) currently supplies raised quarterly length frequencies of landings but only sporadic age data. The catch and mean weight at age are estimated using combined UK(NI) and Irish quarterly length-weight relationships and age-length keys. Quarterly landings are provided by the UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quarterly estimates of landings at age into UK (E&W), UK (NI) and Ireland are raised to include landings by France, Belgium, UK (Scotland), UK (IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings at age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

B1.2. Discards

The Irish Sea *Nephrops* fishery takes place on the whiting nursery grounds of the north western Irish Sea and has traditionally produced high whiting discarding. The quantity of whiting discarded from the UK (NI) *Nephrops* fishery in 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length-weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of whiting in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of whiting discarded using the whiting:*Nephrops* ratio in the discard samples. The length frequency of whiting in the discard samples is then raised to the fleet estimate, and numbers and mean weight-at-age of discarded whiting is computed from the age length key and length-weight parameters for whiting. The UK (NI) estimates are available since 1980 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually.

There are several limitations to these data: only a small sub-set of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded at age. However, the WG has used these data in past assessments because removal of discards data would remove a large fraction of catch from the assessment.

A re-analysis of the Irish discard data raised to the *Nephrops* landings produced estimates of discards from the Irish *Nephrops* fleet that were more consistent with those of the UK (NI) *Nephrops* fleet. However, this method of raising could not be used to recalculate an entire time series of discard estimates from the Irish *Nephrops* fleet. The quarterly UK (NI) discard ratios were therefore used by the Working Group to estimate the tonnage discarded from the Irish *Nephrops* fishery. Length frequencies and age-length keys from the whiting discarded by the Irish *Nephrops* fleet are used to estimate the numbers discarded at age from the Irish *Nephrops* fleet.

At the WGNSDS 2006 revised Irish discard estimates (1996–2005) raised according to the methods described in Borges *et al* (2005) were available to the Working Group See table 1.0. These are available in the ICES files. Discard rates in this series were variable compared with previous estimates based on the UK NI self sampling scheme. Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers at age can be made. The Working Group did therefore not estimate international discard volumes and numbers at age for 2004.

B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence for substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity at age 1, particularly in males, since 1998.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero.

Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year *i* and age *j* the following formula is adopted:

$(CW_{i,j} + CW_{i+1,j+1})/2$ = SW at start of year.

These values are then smoothed using a 3–year moving average.

Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in VIIa (funded under the Data Directive Regulation (1639/2001)) took place during a Biological Sampling survey (BBS) in March 2004. Parameter estimates of maturity at length indicate the L_{50} for whiting in VIIa for males and females is 13.65 cm and 19.76 cm, respectively. Maturity-at-age for both sexes are similar for most stock area (VIIa, b, j and g) with the notable exception of age 1 males in the Celtic Sea where the estimates are outside the 95% CI bounds for VIIa and considerably lower than VIa. In most areas whiting were mature by age three and most were mature at age 2. The sex ratio for whiting tended to increase with length for nearly all the age classes in all areas indicating that females tend to have larger length at age than males (Gerritsen, 2005).

Gerritsen *et al* (2002) describes the relationships between maturity, length and age of whiting sampled on a length-stratified basis from NI groundfish surveys of the Irish Sea during spawning in spring 1992–2001. Findings show that most one year old females were immature whilst most two year old females were mature, almost all 3 year olds of both sexes were mature. Length at 50 maturity average around 19 cm in males and 22 cm in females.

B.3. Surveys

Seven research vessel survey series for whiting in VIIa were available to the Working Group in 2005. In all surveys listed the highest age represents a true age not a plus group.

- UK (England and Wales) Beam Trawl Survey (UKE&W-BTS): ages 0 and 1, years 1988–2002.
  The survey covers the entire Irish Sea and is conducted in September on the R.V. *Corystes*. The survey uses a 4–m beam trawl targeted at flatfish. The survey is stratified by area and depth band, although the survey indices are calculated from the total survey catch without accounting for stratification. Numbers of whiting at age per km towed are provided for prime stations only (i.e. those fished in most surveys).
- UK (Northern Ireland) October Groundfish Survey (NIGFS-October): ages 0–5, years 1992–2005.
  The survey series commenced in its present form in 1992. It comprises 45 3–mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1–mile tows at fixed station positions in the St George's channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. *Lough Foyle*. The survey designs are stratified by depth and sea bed type. The mean numbers at length per 3–mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The strata are grouped into western Irish Sea and eastern Irish Sea, and a separate age length key is derived for each area to calculate abundance indices by age class. The survey design and time series of results including distribution patterns of whiting are described in detail in Armstrong *et al* (2003).
- UK (Northern Ireland) March Groundfish Survey (NIGFS-March): ages 1–5, years 1992–2006.
  Description as for UKNI-GFS-October above.
- UK (Northern Ireland) Methot-Isaacs Kidd Survey (UKNI-MIK): age 0, years 1993–2005.
  The survey uses a Methot-Isaacs Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place in June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers per unit sea area.
- Ireland's Irish Sea Celtic Sea Groundfish Survey (IR-ISCSGFS): ages 0–5, years 1997–2002.
  This survey commenced in 1997 and is conducted in October-November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard ground gear and a 20 mm cod-end liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area.
- UK (Scotland) groundfish survey in Spring (ScoGFS – spring): ages 1–8, years 1996–2006.
  This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 30'.
- UK (Scotland) groundfish survey in Autumn (ScoGFS – autumn): ages 0–5, years 1997–2005.
  The survey covers a similar area to the ScoGFS in Spring, but has only 11–12 stations.
- IRGFS (Ireland)
  This survey commenced in 2003 aboard the R.V. Celtic Explorer. It is a depth

stratified survey using a GOV trawl with a 20mm mesh liner on the cod end. The survey covers VIIa, b, j g and VIa in its entirety. Prototcols for the survey are governed by the International Bottom Trawl Survey Working Group (IBTS).

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data in an XSA, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys may be shifted back accordingly in the data files.

Further details of the tuning data are given in Appendix 1 and 2 of the 1999 WG Report.

B.4. Commercial cpue

No cpue data have been provided for the French (Lorient) trawl fleet since 1992. Four commercial catch-effort data series were available to the WG:

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2002. Effort and cpue data provided for the Irish fleet comprise total annual effort (hours fished, not corrected for fishing power) and total numbers at age in landings from otter trawlers. The data were revised to take account of updated logbook information. This fleet operates mainly in the western Irish Sea, targeting *Nephrops* and/or whitefish. The distribution of fishing is concentrated in the western part of the range of the whiting stock in the Irish Sea. Hence the catch rates will represent changes in abundance of whiting in the western part of VIIa. The use of this fleet as a tuning index therefore relies on the assumption that trends in abundance in the west of VIIa reflect those of the entire stock. The catch-at-age data comprise a large proportion of the total international catch. Hence, some correlation of errors can be expected between the tuning data set and the catch at age data. The effect of such correlations has not been evaluated. The otter trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded.
- UK (Northern Ireland) pelagic trawl: ages 2–6, years 1993–2002. The pelagic trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. By-catches of whiting are currently very small and are heavily discarded due to their low value. The fleet is considered unsuitable for indexing whiting abundance.
- UK (Northern Ireland) single rig otter trawl: ages 0–6, years 1993–2002. This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea). Whiting discards from single-rig trawlers (estimated from fisher self-sampling scheme) are included.
- UK (England and Wales) otter trawl: ages 2–6, years 1981–2000. Estimates up to and including 2000 of commercial lpue from UK (E&W) otter trawlers contain data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea) or the main whiting nursery grounds (in the western Irish Sea). Age compositions in most years have been estimated from length frequencies using ALKs that were obtained from sampling of fleets operating mainly in the western Irish Sea. This has introduced additional uncertainties into the data.

B.5. Other relevant data

None.

C. Historical stock development

- Model used:

  XSA (up to 2002)

  SURBA 2.0–2003

  SURBA 3.0–2004

- Software used:

  Lowestoft VPA suite

- XSA Model Options chosen:

  Tapered time weighting not applied

  Catchability independent of stock size for all ages

  Catchability independent of age for ages >= 4

  Survivor estimates shrunk towards the mean F of the final 5 years or the 2 oldest ages

  S.E. of the mean to which the estimate are shrunk = 0.500

  Minimum standard error for population estimates derived from each fleet = 0.300

  Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980 – last data year	0 – 6+	Yes
Canum	Catch at age in numbers	1980 – last data year	0 – 6+	Yes
Weca	Weight at age in the commercial catch	1980 – last data year	0 – 6+	Yes
West	Weight at age of the stock at spawning time.	1980 – last data year	0 – 6+	Yes: uses smoothed catch weights adjusted to start of year
Mprop	Proportion of natural mortality before spawning	1980 – last data year	0 – 6+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980 – last data year	0 – 6+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1980 – last data year	0 – 6+	No – the same ogive for all years
Natmor	Natural mortality	1980 – last data year	0 – 6+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1992 – last data year	0–5
Tuning fleet 2	NIGFS-Mar (adjusted)	1991 – (last data year-1)	0–4
Tuning fleet 3	ScoGFS-Spring	1996– last data year	1–5
Tuning fleet 4	UK(E&W) BTS	1988–last data year	0–1

For analysis of alternative procedures see WG reports from WGNSDS 1997-2005.

D. Short-term projection

- Model used: Age structured
- Software used: MFDP prediction with management option table and yield per recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.
- Initial stock size. Taken from the XSA for age 1 and older. The recruitment at age 0 in the last data year is estimated as a short-term GM (1992 onwards) because of a reduction in mean recruitment since then.
- Natural mortality: Set to 0.2 for all ages in all years.
- Maturity: The same ogive as in the assessment is used for all years.
- F and M before spawning: Set to 0 for all ages in all years.

- Weight-at-age in the stock:
  average stock weights for last three years.
- Weight-at-age in the catch:
  Average weight of the three last years.
- Exploitation pattern:
  Average of the three last years. Discard F's, which are generated by the *Nephrops* fleet as there are no discard estimates for other fleets, are held constant while landings F's are varied in the management option table.
- Intermediate year assumptions:
  status quo F
- Stock recruitment model used:
  None, the short-term geometric mean recruitment at age 0 is used.
- Procedures used for splitting projected catches:
  F vectors in each of the last three years of the assessment are multiplied by the proportion landed or discarded at age to give partial Fs for landings and discards. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

E. Medium-term projections

No medium-term projections are done for this stock due to problems with estimating current F.

F. Yield and biomass per recruit/long-term projections

- Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.
- Software used: MFY or MLA
- Selectivity pattern:
  mean F array from last 3 years of assessment (to reflect recent selection patterns).
- Stock and catch weights-at-age:
  mean of last three years (weights-at-age have declined as the stock has declined since the 1980s; it is not known if this is an environmental effect on growth that is independent of stock size).
- Proportion discarded:
  partial F vectors are the recent average.
- Maturity: Fixed maturity ogive as used in assessment.

G. Biological reference points

Precautionary approach reference points have remained unchanged since 1999. B_{pa} is set at 7 000 t and is defined as B_{lim}*1.4. B_{lim} is defined as the lowest observed SSB (ACFM, 1999), considered to be 5 000 t. There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. F_{pa} is set at 0.65 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above B_{pa} in the long term. F_{lim} is defined as 0.95, the fishing mortality estimated to lead to a potential stock collapse.

H. Other issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 33pp.

Borges, L.; Rogan, E. and Officer, R. 2005. “Discarding by the demersal fishery in the waters around Ireland”, Fish. Res. (in press).

Gerritsen, H. 2005. Biological parameters for Irish Demersal Stocks in 2004. WD5 (WGNSDS, 2005)

Table 1.0 Revised Discard estimates raisesd according to the method oulined in Borges *et al.*, (2005).

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
Age	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	5631.20	0.015	4110.63	0.027	5073.57	0.027	187.26	0.036	7850.12	0.033	20981.54	0.016	29017.16	0.021	1921.76	0.016	17091.56	0.018	442.07	0.010
1	5925.33	0.035	8361.19	0.044	5939.53	0.064	276.50	0.102	3098.24	0.047	8883.11	0.054	12097.93	0.033	2419.56	0.036	7347.29	0.034	2531.84	0.035
2	1802.90	0.111	3243.45	0.120	3826.20	0.107	150.99	0.174	137.80	0.153	1413.48	0.126	576.17	0.112	1287.21	0.178	731.35	0.101	783.68	0.091
3	144.34	0.217	696.18	0.200	440.05	0.185	43.70	0.235	30.31	0.229	479.38	0.133	152.95	0.105	603.20	0.246	142.50	0.165	129.28	0.159
4	6.02	0.206	68.71	0.241	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	108.64	0.268	96.30	0.218	40.12	0.154
5	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	22.95	0.136	17.66	0.123	0.00	0.000	0.00	0.000	24.48	0.371
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
7	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
8	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
9	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
10	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
OTB Discards (tonnes, whole weight)		520.8		#####		1010.3		71.6		434.3		1054.5		1100.9		523.6		680.3		201.3

Sampling Information	1996	1997	1998	1999	2000	2001	2002	2003	2004	
Number of Trips	8	8	7	4	10	2	1	9	11	8
Number of Hauls	48	44	58	40	111	34	7	60	122	96

Annex 14: Quality Handbook WGNSDS-Haddock VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Haddock (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	19 May 2005

A. General

A.1. Stock definition

Haddock in Division VIIa

A.2. Fishery

Directed fishing for haddock in the Irish Sea is mainly carried out by UK (Northern Ireland) midwater trawlers using 100 mm mesh codends, particularly targeting aggregations that can be detected acoustically. These conditions prevail mainly during winter and spring when the hours of darkness are longest, and the fish are aggregating on the spawning grounds in the western Irish Sea. Other demersal whitefish vessels from Northern Ireland, Ireland and to a lesser extent Scotland, using single or twin trawls with 100 mm mesh, also target haddock when abundant. (Prior to the introduction of Council technical conservation Regulation 850/98 in 2001, most whitefish vessels in the Irish Sea used 80 mm codends.) Bycatches of haddock are made in the UK (NI) and Irish *Nephrops* fisheries using single nets with 70 mm codends or twin trawls with 80 mm codends. The haddock stock is mainly distributed in the western Irish Sea and south of the Isle of Man, preferring the coarser seabed sediments around the periphery of the muddy *Nephrops* grounds. Juveniles are taken extensively in the otter trawl fisheries in these areas, leading to substantial discarding (see Section B1.2).

The nature of the fishery has been modified by the cod closure since 2000 (Council Regulation (EC) No 304/2000). Targeted fishing with whitefish trawls was prohibited inside the closure from mid February to the end of April. Derogations for *Nephrops* fishing were allowed. Irish *Nephrops* trawlers were involved in an experiment to test inclined separator panels in 2000 and 2001, the object being to minimise the bycatch of cod. Fishing inside a small area of the western Irish Sea closed to all fishing in spring 2000 and 2001 was permitted if separator panels were used. These panels would also have allowed escapement of part of the haddock catch. Closure of the main whitefish fishing grounds in spring 2000 resulted in a shift in fishing activities of midwater trawlers and other UK (NI) whitefish vessels into the North Channel (area VIIa) and Firth of Clyde (VIa south). A subsequent closure of the Firth of Clyde in spring 2001 under the VIa cod recovery programme (Council Regulation (EC) No 456/2001) resulted in a reduction in reported fishing activity in this region. Several rounds of decommissioning in 1995–97, 2001 and 2003 have reduced the size of the commercial fleets. UK vessels decommissioned at the beginning of 2002 accounted for 17% of the haddock landings from the Irish Sea in 1999–2001. A further round of decommissioning in 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea at the beginning of 2004, representing a loss of 8% of the fleet by number and 9.3% by tonnage.

Gear specific effort regulations (days at sea) have been introduced in the Irish Sea in 2004. Annex V to Council Regulation (EC) No 2341/2002 regulated the maximum number of days in any calendar month of 2004 for which a fishing vessel may be absent from port in the Irish Sea. Monthly effort limitation under this Regulation is as follows: 10 days for demersal trawls, seines and similar towed gears with mesh size >= 100 mm, 14 days for beam trawls of mesh size >= 80 mm and static demersal nets, 17 days for demersal longlines, and 22 days for demersal trawls, seines and similar towed gears with mesh size 70–99 mm. Additional days are available for vessels meeting certain conditions such as track record of low cod catches. In particular, an additional two days are available for whitefish trawlers (mesh >= 100 mm) and beam trawlers (mesh >=80 mm) which spend more than half of their allocated days in a given management period fishing in the Irish Sea, in recognition of the area closure in the Irish Sea and the assumed reduction in fishing mortality on cod.

A.3. Ecosystem aspects

To do

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for Irish Sea haddock:

	Kind of data				
Country	Caton (catch in weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature by age)	Length composition in catch
UK(NI)	X	X	X	X	X
UK(E&W)	X				
UK(Scotland)	X				
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				

Quarterly landings and length/age composition data are supplied from data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

Quarterly landings are provided by the UK (E&W), UK (Scotland), Belgium and France and annual landings are provided by UK (IOM). The quarterly estimates of landings at age into UK (NI) and Ireland are raised to include landings by France, Belgium, UK (E&W), UK (Scotland), UK (IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings at age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock co-ordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock co-ordinator).

The result files (FAD data) can be found at ICES and with the stock co-ordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7a**.

B1.2. Discards

The potential magnitude of discarding was evaluated using limited data from the following fleets:

- Northern Ireland *Nephrops* fishery. The fisher self-sampling scheme that provides discards data for VIIa whiting was altered in 1996 to record quantities of other species in the samples. The quantity of haddock discarded from the UK (NI) *Nephrops* fishery is estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length-weight relationship, the live weight of *Nephrops* that would have been landed as tails only, is calculated from the carapace lengths of the discarded heads. The number of haddock in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e., those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of haddock discarded using the haddock: *Nephrops* ratio in the discard samples. Length frequencies of haddock in the samples are then raised to the fleet estimate. No otoliths were collected, but the length frequencies could be partitioned to age class based on appearance of modes and comparison with length-at-age distributions in March and October surveys. The age data from 2001and 2002 were derived using survey and commercial fleet ALKs. The UK (NI) estimates are available since 1996 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually. There are several limitations to these data: only a small sub-set of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded at age. The WG has not used these data in past assessments.
- Northern Ireland midwater trawl and twin-trawl fleets. These fleets were sampled randomly by observers as part of two EU contracts. Data were available for quarters 2–4 in 1997, 1–3 in 1998, 3–4 in 1999, 1–4 in 2000 and 1 in 2001.
- Irish otter trawl fleet (IR-OTB). Discards are estimated by observers on Irish trawlers operating in VIIa. Estimates for this fleet are given in the report of the ICES Study Group on Discards and By-catch Information (ICES CM 2002 ACFM:09). The anomalous high estimate of discards for this fleet in 2001 was a result of an inappropriate raising procedure, and data for this year are not presented. No discard data were available for 2002 due to a very limited number of sampling trips (n=1). This sampling level has increased in 2003, but is still low (n=6). A re-analysis of the Irish discard data raised to the number of trips, instead of landings, was performed based on methods described by Borges *et al.,* 2005 and provided to the WG in 2005.

B.2. Biological

Natural mortality was assumed to be constant (M=0.2, applied annually) for the whole range of ages and years, in the absence of a direct estimate of natural mortality of Irish Sea haddock.

A combined sex maturity is assumed, knife-edged at age 2 for all years. Recent research on the changes in maturity of the Irish Sea haddock stock conducted by the UK (NI) showed, using a GLM analysis on the effects of year, region, age, and length on the probability of being mature, that maturity is determined differently for male and female haddock. Maturity was found to be predominantly a function of length in male haddock, while age was the main factor in females. Inter-annual variation in the proportion mature was mostly confined to the age 2 group, while other age groups were either fully immature or fully mature. Over 99% of 3–year olds were mature.

The proportion of F and M before spawning are set to zero to reflect a SSB calculation date of 1 January.

Working Groups prior to 2001 used constant weights-at-age over years based on analysis of some early survey data. However, evidence for a decline in mean length of adult haddock over time needed to be reflected in the stock weights-at-age. Since 2001 the WG calculated stock weights are calculated by fitting a von Bertalanffy growth curve to all available survey estimates of mean length at age in March, with an additional vector of parameters estimated to allow for year-class effects in asymptotic length. To increase the number of observations for older age classes, the mean lengths at age in UK (NI) first-quarter landings were included for age classes three and over. (Comparisons of survey and landings data showed that values from landings were larger than from the survey at ages 1 and 2 because of selectivity patterns in the fishery, but very similar for ages 3 and over.) Stock weights-at-age were calculated from the model-fitted mean lengths-at-age, using length-weight parameters calculated from all March survey samples (2001 WG) or annual length-weight parameters (since 2002 WG).

The following model was fitted to the length at age data:

- $L_{t,yc} = LI_{yc} . (1-\exp(-K(t-t_0)))$

where LI_{yc} is the estimated asymptotic length for year class yc. Parameters were estimated using Microsoft Solver in Excel by minimising $\Sigma(\ln(\text{observed } L_t / \text{expected. } L_t))^2$.

The year-class effects show a smooth decline from the mid–1990s coincident with the rapid growth of the stock, and may represent density-dependent growth effects. The year-class parameters effectively remove the temporal trend in residuals around a single von Bertalanffy model fit without year-class effects.

To estimate mean weight-at-age for year-classes prior to 1990, represented as older fish in the early part of the time-series, the year-class effect for the 1990 year-class and length-weight parameters for 1993 were assumed.

B.3. Surveys

Seven research vessel survey series for haddock in VIIa were available to the Working Group in 2005. In all surveys listed the highest age represents a true age not a plus group.

- UK(NI) groundfish survey (NIGFS) in March (age classes 1 to 6, years 1992–2005)

The survey series commenced in its present form in 1992. It comprises 45 three mile tows at fixed station positions in the northern Irish Sea, with an additional 12 one mile tows at fixed station positions in the St George’s channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. Lough Foyle (1992–2004) and the R.V. Corystes since 2005. The survey designs are stratified by depth and sea bed type. The mean numbers at length per three mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The survey design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.*, (2003).

- UK(NI) groundfish survey (NIGFS) in October (age classes 0 to 5; years 1991 to 2004)

Description as for UKNI-GFS-March above.

- UK(NI) Methot-Isaacs Kidd (MIK) net survey in June (age 0; years 1994–2004)

The survey uses a Methot-Isaacs Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place end of May/early June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers per unit sea area.

- Republic of Ireland Irish Sea-Celtic Sea groundfish survey (IR-ISCSGFS) in November (ages 0 to 5; years 1997–2002)

This survey commenced in 1997 and is conducted in October-November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard ground gear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area. The survey was terminated in 2002 due to a vessel change.

- Republic of Ireland groundfish survey (IR-GFS) in autumn (age classes 0 to 6, years 2003–2004)

This survey commenced in 2003 and is an IBTS-coordinated survey, conducted in October-November on the R.V. *Celtic Explorer*. The survey is an extension of a survey covering Divisions VI and VIIb-k. The survey uses a GOV otter trawl with standard ground gear and a 20 mm codend liner. The survey operates over the whole of the Irish Sea. Indices are calculated as arithmetic means of all stations, without stratification by area.

- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 6, years 1996–2005)

This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 30’.

- UK(Scotland) groundfish survey (SCOGFS) in autumn (age classes 0 to 6, years 1996–2004)

The survey covers a similar area to the ScoGFS in spring, but has only 11–12 stations.

To allow the inclusion of the NIGFS-March and ScoGFS-Spring surveys for the year after the last year with commercial catch data, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys are shifted back accordingly in the data files.

B.4. Commercial cpue

No cpue data are provided to the WG for VIIa haddock.

B.5. Other relevant data

None.

C. Historical stock development

Model used: XSA
Software used: Lowestoft VPA suite

Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for ages 1–3

Catchability independent of age for ages >= 3

Survivor estimates shrunk towards the mean F of the final 5 years or the oldest age

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1993–last data year	0–5+	Yes
Canum	Catch-at-age in numbers	1993–last data year	0–5+	Yes
Weca	Weight-at-age in the commercial catch	1993–last data year	0–5+	Yes
West	Weight-at-age of the stock at spawning time.	1993–last data year	0–5+	Yes: uses growth model from UK (NI) March GFS data
Mprop	Proportion of natural mortality before spawning	1993–last data year	0–5+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1993–last data year	0–5+	No-set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1993–last data year	0–5+	No-the same ogive for all years
Natmor	Natural mortality	1993–last data year	0–5+	No-set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1991–last data year	0–3
Tuning fleet 2	NIGFS-Mar (adjusted)	1991–(last data year–1)	0–3
Tuning fleet 3	ScoGFS-Spring (adjusted)	1996–(last data year–1)	0–3
Tuning fleet 4	MIK net May/June	1994–last data year	0

For analysis of alternative procedures see WG reports from WGNSDS 1997–2003.

D. Short-term projection

Model used: Age structured

Software used*:* MFDP prediction with management option table and yield-per-recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.

Initial stock size. Taken from the XSA for age 1 and older. The recruitment at age 0 in the last data year is estimated as a short-term GM (1993 onwards).

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: average stock weights for last three years.

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years. Landings F's are varied in the management option table.

Intermediate year assumptions: status quo F

Stock recruitment model used: None, the short-term geometric mean recruitment at age 0 is used

Procedures used for splitting projected catches: F vectors in each of the last three years of the assessment are multiplied by the proportion landed at age to give partial Fs for landings. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

E. Medium-term projections

No medium-term projections are done for this stock as the short time-series of stock and recruitment estimates precluded any meaningful prediction of the medium-term dynamics of the stock.

F. Yield and biomass per recruit/long-term projections

Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.

Software used: MFY or MLA

Selectivity pattern: mean F array from last 3 years of assessment (to reflect recent selection patterns).

Stock and catch weights-at-age: long-term mean (1993 onwards).

Proportion discarded: partial F vectors are the recent average

Maturity: Fixed maturity ogive as used in assessment.

G. Biological reference points

The ACFM view on this stock (ACFM, October 2002) is that there is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period. ACFM proposes that F_{pa} be set at 0.5 by association with other haddock stocks. The absolute level of F in this stock at present is poorly known. The point estimate of F(2–4) for 2002 (0.89), however, is above F_{pa}.

H. Other issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN) : 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 33pp.

Borges, L., Zuur, A.F., Rogan, E. and Officer, R. 2005. Choosing the best sampling unit and auxiliary variable for discards estimations. Working Document No. 3 submitted to 2005 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 25pp.

Annex 15: Quality Handbook: WGNSDS-Whiting in Area VI

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Whiting (Area VI)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	17 May 2007
Last updated:	17 May 2007 (N.Campbell@marlab.ac.uk)

A. General

A.1. Stock definition

Whiting occur throughout northeast Atlantic waters, in a wide range of depths, from shallow inshore waters down to 200 m. Adult whiting are widespread throughout Area VIa, while high numbers of juvenile fish occur in inshore areas. Whiting are less common in Division VIb, and it is likely these fish are migrants from VIa, rather than a separate stock.

While an exploration of stock identity in the North Sea has been carried out, stock definition in Area VI and surrounding waters remains poorly defined (ICES-SGISIMUW, 2005). Tagging experiments on recruiting fish have shown that whiting stocks west of Ireland are distinct from those in the Minches, Clyde and the Irish Sea. On the basis of preliminary results from FRS project MF0464, there appears to be three putative populations of whiting are found in VIa, between which interchange is limited. These are along the northwest of Scotland, the Stanton Bank region and the Firth of Clyde. Maximum likelihood analysis indicates a high degree of mixing for adult whiting between IVa whiting and the VIa component off the northwest of Scotland. Within VIa, there was little indication of interaction between population components in the south and that off the northwest coast.

A.2. Fishery

The demersal fisheries in Division VIa are predominantly conducted by otter-trawlers fishing for cod, haddock, anglerfish and *Nephrops*, with by-catches of whiting, saithe, megrim, lemon sole, ling and a number of skate species. Since 1976, effort by Scottish heavy trawlers and seiners has decreased. Light trawler effort has declined rapidly since 1997 after a long-term increasing trend. More recently, days at sea limitations associated with the cod recovery plan and the seasonal closure of some areas has lead to some switching of effort away from VIa.

The demersal whitefish fishery in Area VI occurs largely in Division VIa with the UK, Ireland, Spain and France being the most important exploiters. Landings from Rockall (Division VIb) are generally less than 10 t. The whiting fishery in VIa is dominated by the UK (Scotland) and Irish fleets. French whiting landings have declined considerably since the late 1980s.

Landings of whiting in Division VIa are affected by emergency measures introduced in 2001 as part of the cod recovery programme. Council Regulation 423\2004 introduced a cod recovery plan affecting division VIa. The measures only take effect, however east of a line defined in Council Regulation No 51\2006. Measures brought in 2002, such as a switch from 100 to 120 mm mesh cod ends at the start of 2002 (Commission Regulation EC2056/2001), are likely to have had some impact on whiting. The UK implemented a regulation requiring the fitting of a square mesh panel in certain towed gears.

Most catch of whiting comes in non-whiting directed fisheries, particularly the *Nephrops* trawl fishery. The *Nephrops* trawl fishery in VIa discards significant amounts of small whiting, making whiting landings figures a poor indicator of fishing mortality. The proportion of whiting discarded has been very high and appears to have increased in recent years. Whiting also has a low market demand, which contributes to increased discarding and high-grading.

The minimum landing size of whiting in the human consumption fishery in this area is 27 cm.

There have been some problems regarding area misreporting of Scottish landings during the early 1990s, which are linked to area misreporting of other species such as haddock and anglerfish into Division VIb. More recently there has been area misreporting of anglerfish from VIa to IVa, which has affected the reliability of whiting landings distribution.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

Monthly length-frequency distribution data were available from Scotland for Area VIa. A total international catch-at-age distribution for Division VIa was obtained using the raising procedure described in Section 2.3, raising this distribution to the WG estimates of total international catch from this area. Landings officially reported to ICES were used for countries not supplying estimates directly to the WG. The Scottish market sampling length-weight relationships (given below) have been used to raise the sampled catch-at-length distribution data Working Group estimates of total landings for Division Via.

Month	b	a
1	2.9456	0.01
2	2.9456	0.0094
3	2.9456	0.009
4	2.9456	0.0088
5	2.9456	0.0088
6	2.9456	0.0089
7	2.9456	0.009
8	2.9456	0.0092
9	2.9456	0.0095
10	2.9456	0.0096
11	2.9456	0.0097
12	2.9456	0.0097

B.2. Biological

Natural mortality is assumed to be constant (M=0.2, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence for substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity-at-age 1, particularly in males, since 1998, in the Irish Sea.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero. Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year i and age j the following formula is adopted:

$$(CW_{i,j} + CW_{i+1,j+1})/2 = SW \text{ at start of year.}$$

B.3. Surveys

Four research vessel survey series for whiting in VIa were available to the Working Group in 2007. In all surveys listed the highest age represents a true age not a plus group.

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2007.

The survey gear is a GOV trawl, and the design is a minimum of one station per rectangle, but with more depending on logistic limitations. Ages are reported from 0 to the maximum obtained. Sex/Maturity-Sex and Maturity (ICES 4–stage scale) are reported. The Scottish groundfish survey has been conducted with a new vessel and gear since 1999. The catch rates for the series as presented are corrected for the change on the basis of comparative trawl haul data (Zuur *et al.*, 2001).

- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced by the IRGFS.

- Scottish forth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2007.

The Scottish quarter four survey was presented to the WG for the first time in 2007.

- Irish forth-quarter west coast groundfish survey (IRGFS); ages 0–3, years 2003–2007.

This survey used the RV Celtic Explorer and is part of the IBTS coordinated western waters surveys. The vessel uses a GOV trawl, and the design is a depth stratified survey with randomised stations. Effort is recorded in terms of minutes towed. There were 41 stations sampled in 2003, 44 in 2004 and 34 in 2005, corresponding to 1229, 1321 and 1010 minutes towed.

For surveys existing at the time survey descriptions are given in Appendices 1 and 2 of the report of the 1999 meeting of the Northern shelf working group (ICES, 2000).

B.4. Commercial cpue

Due to a number of concerns, the present assessment of the stocks does not make use of commercial catch-per-unit effort data.

B.5. Fecundity

Fecundity data for a number of areas are available from Hislop & Hall (1974), and was estimated at 4.933 $L^{3.25}$ for whiting in Area VI.

C. Historical stock development

Whiting has never been a particularly valuable species and has tended not to be targeted by commercial fishermen. It tends to be taken more as a by-catch, with other species fished more intensively in Division VIa, such as haddock, cod and angler fish. As with other gadoids in VIa, whiting stocks have declined steadily since the late 1970’s.

D. Short-term projection

Not done.

E. Medium-term projections

No medium-term projections are carried out for this stock.

F. Yield and biomass per recruit/long-term projections

Not done

G. Biological reference points

Precautionary approach reference points:

VIa– “Long-term information on the historical yield and catch composition all indicate that the present stock size is low. A survey-based assessment covering the more recent period indicates that the stock is at its lowest level over this time period. Total mortality is at the highest level over the time period. ICES considers that B_{lim} is 16 000 t and B_{pa} be set at 22 000 t. ICES proposes that F_{lim} is 1.0 and F_{pa} be set at 0.6.”

VIb–“Landings of whiting from Division VIb are negligible. No assessment has been carried out on this stock.”

H. Other issues

None.

I. References

J. R. G. Hislop (1975) The breeding and growth of whiting, *Merlangius merlangus*, in captivity. J. Cons. int. Explor. Mer, **36(2):** 119–127.

Hislop, J. & Hall, W. (1974) The fecundity of whiting, *Merlangius merlangius* (L.), in the North Sea, Minch and at Iceland. J. Cons. int. Explor. Mer, **36(1):** 42–49.

ICES (2000) ICES CM 2000/ACFM:1.

ICES-SGSIMUW (2005) Report of the Study Group on Stock Identity and Management Units of Whiting. ICES CM 2005/G:03.

Annex 16: WGNSDS Technical Minutes

Review of the Working Group on Northern Shelf Demersal Stocks (WGNSDS), 3–7 September 2007

Venue:	ICES, Copenhagen
RG Chair:	Alain Biseau
Reviewers:	Yuri Efimov
Presentation:	Robert Scott (Chair WGNSDS)

The RG commended the WGSSDS for the overall clarity of the report and for the way they have dealt with the numerous (too) terms of references.

Most of the choices made by the WG are well explained and documented.

General points for the RG:

The chair of the WG kindly prepared an overview graph of effort per fleet (Table 17.2.1/2 as in 2006 report) that is a valuable contribution to the overview section of the advice.

Many different regulations are applicable in the area, but the RG asks the WG to make sure that in the text too specific Regulation terminology should be avoided or better defined.

The description of the main fisheries is brief and clear and informative.

The WG prepared a general Section (15) on the quality of the assessments. The RG thought this made a good presentation of the differences and likenesses between stocks.

In a few cases, the WG had backshifted the spring surveys to the end of the preceding year… The RG had doubts about the accuracy / advantage of this procedure: in addition to the loss of information on the oldest true age, there is a need to investigate the effect of F in the first month of the years.

The RG supported the suggestion to create a separate SG to specifically address methodological issues (comprehensive evaluation of catch free assessment methods, predicting future landings from such assessments). The RG also supports more work done on disaggregating the total mortality / potential trends in predation mortality.

Since the WG signals a clear requirement for further training in advanced assessment techniques (XSA, ICA, TSA, SURBA, B-Adapt), this might also be dealt with in this or a separate SG.

The RG felt that IBTS-WG should be stimulated to work with Surba themselves, analyse the data and give recommendations to WGs.

Feedback from the NWWRAC on the basis of last years advice has been:

How about fisheries for crabs and influences of that on the fish stocks and fisheries in the area?
Keep contact with the relevant expert group under the living resources, etc.

How can plaice and sole (same fisheries) show such different trends?

What are the effects of cod recovery measures in area VIIa?

Area closures should be evaluated: can ICES conclude if closures worked to reduce F?

It would be good if the WG could keep these types of questions in mind when preparing next years advice.

General remark for WG's

There is a semantic problem between the results of F or Z. WG's should be very clear in using either 'catch' or 'removals'.

The tuning fleet CPUE tables need a better layout since the cohorts are difficult to follow as they are now. The RG felt it would be easier to be looked at if standardized. Effort values should be kept as the last column on the right. This is true for Surveys but also for commercial data. This can be done directly on the input files without affecting the results.

Comments on the trend in landings should be made in the fishery section and not when commenting the output of the assessment.

Individual fleet exploratory runs results should be looked at to check the consistency. Comments on the overall trends are not expected in this exploratory section. Furthermore, the RG felt that any comment on the absolute levels of the outputs should be avoided.

General points on the Reviewing process:

The WG signals problems with determining the exact meaning of different assessment status. This is a matter to be taken up by ACFM.

RG needs insight in the raw data to be able to technically review the WG report. This will be taken up with the ICES secretariat.

The RG would expect the WG to come up with recommendations on the 'appropriate deadlines for submission of data' in future.

The RG shared the notes from the chair: Timely provision and adequate preparation before the meeting [implying man power availability] are needed.

General fisheries issues in the Northern Celtic Seas:

There are some indications that misreporting levels have reduced since 2006.

Discards seem to have increased (VIa discard surveys are well surveyed, VIIa not so good).

General shift from demersal ottertrawl to Nephrops (as in North Sea).

The RG comments that on this basis desegregation of catch data by fishery/fleet seems to be utopian while overall landings (and even more catches) remain unreliable. This is even more true for effort data (at least in terms of hours fished).

The relation between sole and plaice is different from earlier experiences. As in the North Sea, the status of the plaice stock seems better in comparison to the sole stock. This may be caused by spatial differences in stock distribution as well as a different exploitation pattern of the fisheries targeting the stocks. There is significant reduction in the otter trawl fleet that traditionally targeted plaice.

VIa Cod essentially update assessment

Observation list assessment: Accepted for SSB, R and Z trends

Forecast: Rejected

Like last year, a TSA assessment used to broach unreliable catch data since about 1994. Q1 Scottish groundfish survey is used since then. There is little certainty on the level of seal predation and increase of natural mortality. Therefore mismatches between reported and assessed catches are interpreted as ‘unallocated removals’ up to 3x higher than the official landings.

Review group comments

When describing the unallocated removals it is unclear if total Z or F is implied. The RG would prefer the use of Z (‘Z-0.2’).

Since 2006 the landing data are supposed to be more precisely estimated (increased enforcement), and since discards data are available, the ‘estimated total removals’ from the model could be compared to the actual values.

Natural mortality/predation.

The WG states that seal predation is not looked into, but goes on to mention that ‘M = 0,2 might not be appropriate’ (mgt considerations and section 3.1.4). It would be good to investigate and quantify this further to be able to allocate/partition extra mortality. Possible increases in discards due to more restrictive quota should be taken up here as well. The RG would like the MultiSpecies Study Groups and/or WGHARP to look into this question.

Forecast is produced. Given the uncertainty of the assessment and the fact that only variations of Z(-0.2) can be simulated, they were not considered in details for management purposes. However, it is clear from them that a zero catch option in 2008 is unlikely to rebuild SSB to Bpa in 2009.

VIIa Cod Observation essentially an update assessment

Observation list assessment: Accepted for SSB, R and Z trends

Forecast: Rejected

As with VIa cod, the WG has a similar problem with quality of data, assessed with B-Adapt like last year, including (biased) catch data. No discards are included yet. A 4-5 year time series should be available. The WG has spent time compiling information on discards, for which there seems to be a more consistent basis then for VIa cod.

The RG shared the views of the WG on the way 2006 landings data should be treated. Since the model estimates Z for the years without reliable landings information (2000-2005), using 2006 landings would create a mismatch since only F+M would be estimated for that year. Extra sources of natural mortality would create uncertainties. On the other hand, if M is OK, then the bias estimated in 2006 should lead to the conclusion that the estimate of catches is not accurate enough. In both cases, assuming no bias is not accurate.

Review group comments

The RG recommends that the WG includes discard data in the stock data file in the future, even when data series are short. It would be beneficial if this information could be taken up in the InterCatch database.

Additional catches are estimated within only one member state. More might be needed in future.

The RG notes that the WG uses two different assessment methods for two stocks with basically similar data deficiencies (VIa (with a 7+ group) and VIIa (5+)). For Irish Sea cod the B-Adapt gives a worrying signal, while apparently leaving out information that could be used in other models.

The WG performed medium term predictions assuming incoming recruitment to be re-sampled from the 1992-2006 year-classes. Given the very low level of R in recent years, the RG considered that this would lead to an over optimistic assumption.

Furthermore, the RG felt that using a TAC constraint in 2007 is very unreliable: in addition to the fact that Removals are compared to a TAC value, this constraint resulted in a 57% reduction in mortality which is thought to be very unlikely. A 15% reduction in TAC was found by the RG as a very weak scenario given the very low size of the stock.

The RG is of the opinion that the maturity ogive for this stock needs to be revised.

In conclusion, the RG considers F too uncertain to be used in forecasts.

Not possible to compile discard data to include this in F's, so SSB and (low) recruitment are the main drivers of the assessment. Discards are needed to improve on this.

The use of different assessment models for VIIa and VIa cod is hard to explain, since both methods accomplish the same in a different way. The RG recommends a future benchmark for both stocks to be done together.

VIa Whiting Experimental just Surba assessed, no targeted fisheries

Experimental assessment: Indicative on trends only

Forecast: not presented

The RG notes the huge amount of discards for this stock and thinks it wise to emphasize this point more in the report. Since discards are not yet included in the data (Scottish data under revision, and Irish to be included), no analytical assessment is possible. As last year, the assessment is based only on surveys information.

The RG notes that internal (in)consistency of survey results causes trouble for assessment possibilities.

The IBTSWG is stimulated to investigate the inconsistencies for whiting within surveys.

VIIa Whiting Monitoring just Surba assessed, no targeted fisheries

Monitoring assessment: Indicative on trends only

Forecast: not presented

Situation similar to VIa (heavy discarding) but quite a number of young fish are found.

Review group comments

The RG found some discrepancies between survey results and trends which were dealt with outside the meeting (see Annex 1).

VI Megrim Monitoring short time series, misreporting issues

Monitoring assessment: no analytical assessment

Forecast: no forecast

Substantial misreporting (VI → IV) has been corrected by the WG. Extra strata were added to the Irish groundfish survey to improve the data availability in the future.

Review group comments

The RG invites the WG to investigate links between Megrim fisheries and other fisheries (Anglerfish surveys for example).

The RG notes that the landing statistics in the WG report as well as in the summary sheet are unclear and need clarification on which area they are derived from and what total landing figure has been used by the WG.

VIIa Sole Benchmark considerable revision from 06

Benchmark assessment: Accepted

Forecast: accepted

There were serious assessment problems in 2006, due to problems with 2004 data and different XSA settings. A new assessment was presented to the RG in 2006, which was accepted.

Review group comments

The RG appreciates the work that has been done by the WG, and has only few comments.

It is unclear for the RG what the main cause of the observed differences in assessment results these lasts years.

The critical change in the benchmark assessment is a change in the q plateau. The RG agrees with the rationale behind the setting of the q plateau at 7, but would have liked to have seen the different options set out in a plot.

There seems to be a change in the age structure of the catches (fig 12.6.14). A first conclusion is drawn that this might be caused by changed exploitation pattern of the fisheries, though no considerable changes in fisheries practices are known. The RG would like the WG to investigate the influence of the age structure of the total stock and changes in the data collection sampling scheme, before drawing final conclusions on this subject.

VIIa Plaice Update pure update

Update assessment: accepted

Forecast: accepted

Discards are high but not included in the assessment because of difficulties with the raising procedure and the absence of a full series.

Even though some trends in residuals were perceived, the assessment was treated as a (tuned) update assessment.

Review group comments

The RG noticed that there is no good explanation for the trends in survey residuals (that were apparent last year as well even though not noticed or commented). It might be useful to compare residuals leaving out some surveys.

Trends in residuals appear to be higher for ages 3 and 4, making the lack of discards difficult to explain alone this apparent discrepancy between landings at age and surveys data.

Inclusion of discard data would be good for the assessment, the methods WG has looked into this. The WG is invited to explore this point further next year.

VIa Haddock Elaborate Update assessment

Update assessment: accepted

Forecast: accepted partly (redone during the RG meeting)

TSA based assessment as for cod in this area.

Since the 1999 yearclass moves into the + group now this creates some problems for this assessment.

Review group comments

Despite last years Review Group remarks, a Ricker SRR is still in use: the RG retains the same doubts about the influence of the 1982 year class here, but in the light of the low SSB situation this part of the SRR is not very influential. The RG asks the WG to look into this at the next benchmark.

The RG notes that the discard ogive estimation is still weak.

Weights at age for the 1999 and 2000 year-class are forecasted. The RG accepts the linear fit assumed, but doubts the assumed reduced growth for the year classes after 2000. New short term forecasts were redone during the RG meeting using revised/corrected weights at age for 99 and 00 year classes. The new input and outputs are given in Annex 2.

The RG would like to see more clear labelling of F and Z, Reference to any reference F from a yield per recruit analysis should be avoided since in this assessment they refer to removals [assumed to be catch in that case] but not split between landings and discards. A (historic) ratio for unallocated catches/discards should be provided in this case.

The RG agrees with the F *status quo* assumption because no trend in F is apparent. However, F is influenced by haddock available in area VIb, making *status quo* assumptions for 2007 less realistic.

The RG agrees with the WG that the downward trends in SSB and low recruitment are indicators for mgt advice, but it is not possible to reach conclusions amounting to a catch forecast table, only a removals forecast table. Analogue to cod advice a split-up of the removals into catch/discards will be presented.

An updated Yield per recruit table is not possible, and the remarkable change in estimated and observed catch (fig 4.1.22) makes repetition of the old information in the summary sheet not wanted.

VIb Haddock Update assessment

Update assessment: accepted

Forecast: accepted

XSA assessment appears to behave well. 2005 year class seems quite high.

Review group comments

The RG recommended that for the next benchmark assessment, exclusion of age 0, and the use of a power model in the case of huge amount of discards not so well estimated, should be looked into further, and t.

The RG recognises discrepancies in the report due to the way discards were estimated in the earlier years of the assessment (see difference in Surba/XSA outcomes in fig 4.2.32).

The rationale behind the choice for recruitment estimates is unclear. In this case of an update assessment there is no reason to change this, but this should be part of the next benchmark.

The lack of equal mgt for the fisheries in the area causes problems for estimates Y/R since this includes discards. Maximum yield could be reached with another exploitation pattern.

IIa/IIIa/IV/VI Anglerfish Monitoring

No assessment

Landings (official and estimated) show a decreasing trend since 1996 while the TAC has been reduced since 2000. There are only relatively short time series of the different surveys.

Review group comments

The RG felt that trends in CPUE should be presented with caution. No information on the data coverage of the data used these CPUE was provided. Furthemore, the outputs of the GAM presented in the report did not show the effect of a possible change in fishing grounds (within the same area) and depth. In the case of serial depletion, resulting CPUE without taking these factors into account may lead to the conclusion of an increasing stock while it is actually in decline.

The RG sees the CPUE changes within the light of changes in fisheries/seasonal patterns. Trends in abundance of the stock could be influenced by spatial distribution and the depth of fisheries or observer density. The RG asks the WG to look into this at the next benchmark assessment.

VIIa Haddock Experimental difficulties with data

Experimental assessment	accepted for trends only
Forecast	not presented

The assessment suffers from poor data quality with short time series. A number of trial assessments were tried and the proposed final assessment is a Surba with two combined surveys.

Review group comments

The RG agrees with the WG that this assessment is doubtful since the residuals of this assessment show poor convergence and noisy patterns. Combining the March and October surveys seems to be the main cause of these problems. It might be more accurate to use a single fleet March Surba to increase consistency (based on ages 1-3).

The RG asks the WG to work on this basis in the coming year.

Recommendations

More work is needed on disaggregating the total mortality from potential trends in predation mortality. The allocation or partitioning of extra mortality should be looked into.	The RG recommends a separate SG (possibly the Multi Species Study Groups?) or WGHARP to look into this question.
The WG signals a requirement for further training in advanced assessment techniques (XSA, ICA, TSA, SURBA, B-Adapt).	A separate SG is recommended for this.
The RG recommends that the discard data are included in the stock data file in the future, even when data series are short.	To be taken up in the InterCatch development.
The RG felt that IBTS-WG should be stimulated to work with Surba themselves, analyse the data and give recommendations to WGs.	IBTS-WG
There are clear inconsistencies within surveys for whiting stocks in the Northern Shelf area.	The IBTSWG is stimulated to investigate this
The RG is of the opinion that the maturity ogive for cod in VIIa needs to be revised.	

Annex 1

VIIa Whiting SURBA analyses

The RG noted that the recruitment estimates from the single fleet SURBA analyses for both the NIGFS March and NIGFS October both show a decline in recruitment in the most recent years, but that the multi-fleet SURBA run shows an increase in recruitment in 2006. The single fleet runs were conducted using SURBA 2.2 (for which a fixed reference age is employed) whilst the multi-fleet run used SURBA 3.0. The March survey provides estimates of recruitment at age 1 whilst the October survey provides estimates at age 0.

The RG re-ran the single fleet analyses but could not replicate the results using SURBA 3.0. The results of the single fleet analyses and multi-fleet SURBA 3.0 analyses are shown below in figures 1 to 3. Figure 4 shows a comparison of the mean standardised estimates of fishing mortality, SSB and recruitment for the single fleet and multi-fleet runs. It shows that estimates of SSB and fishing mortality are generally consistent but that some differences remain for estimates of recruitment. Note that the October survey series has missing values in some years.

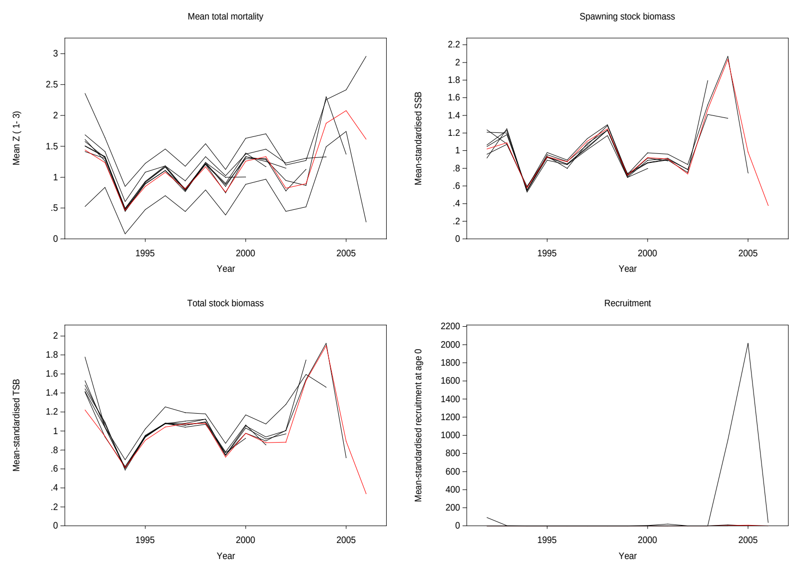

Figure 1. NIGFS-Oct – Ages 0-5, RefAge=2, Zbar 1-3, lambda=1, catchability=1.

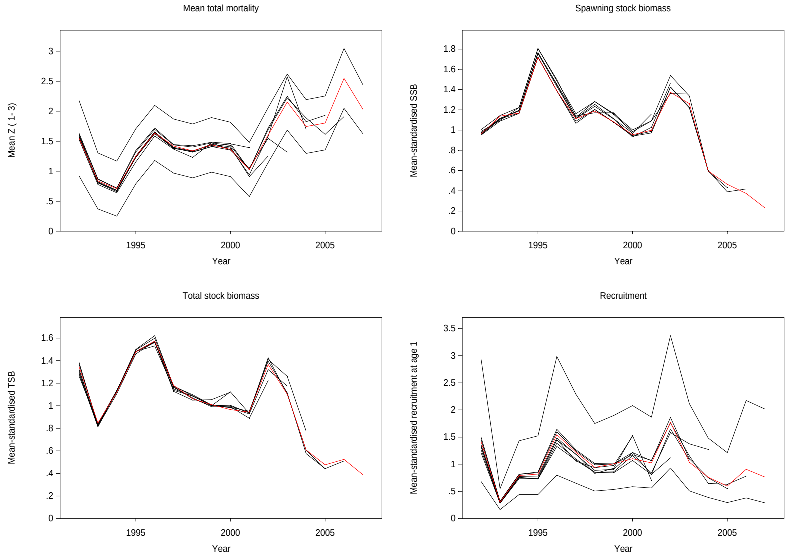

Figure 3. NIGFS-Mar – Ages 1-5, RefAge=2, Zbar 1-3, lambda=1, catchability=1.

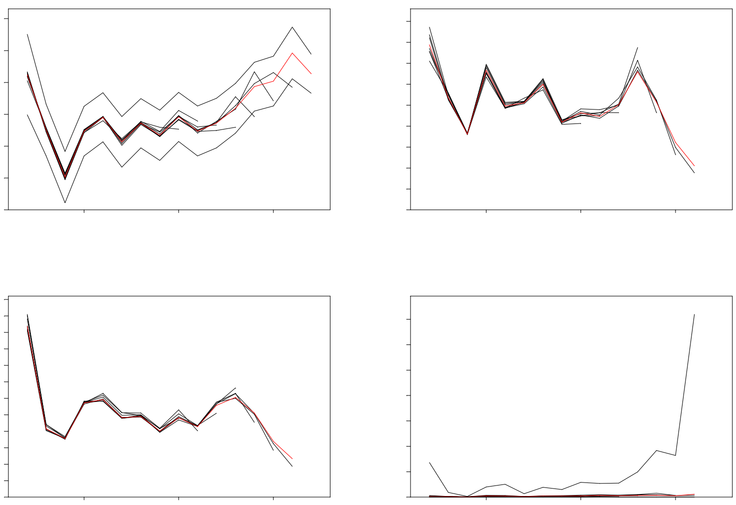

Figure 3. Combined – Ages 0-5, RefAge=2, Zbar 1-3, lambda=1, catchability=1.

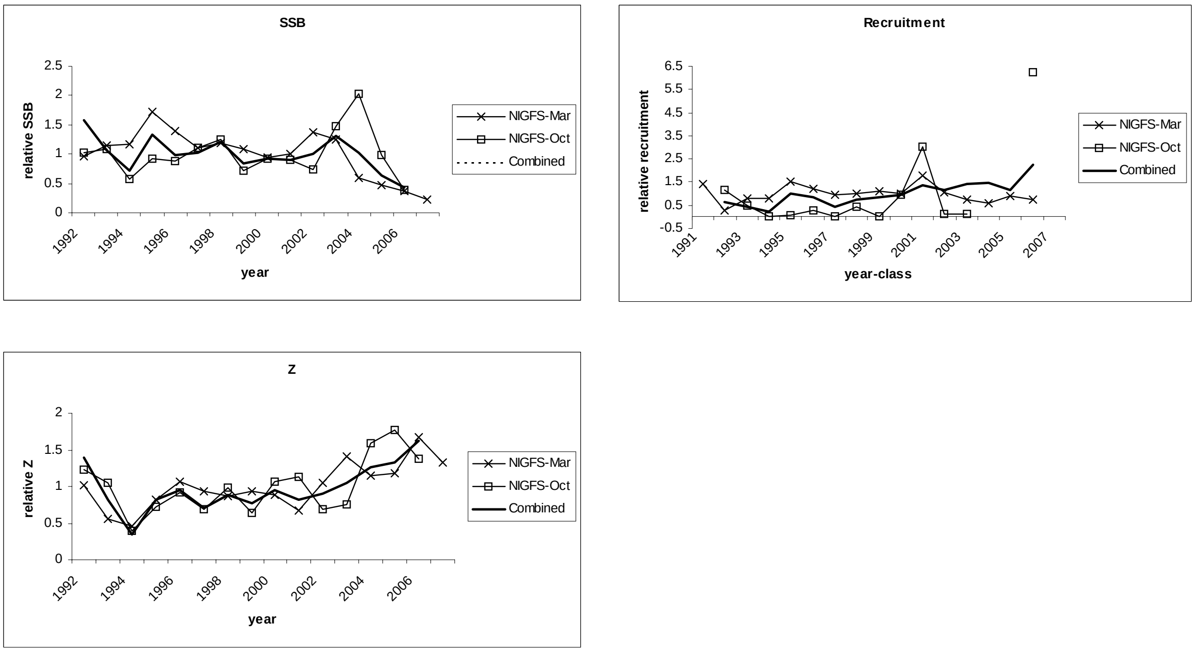

Figure 4. Mean standardised SSB, Z and recruitment estimates from combined SURBA – Ages 0-5, RefAge=2, Zbar 1-3, lambda=1, catchability=1.

Annex 2

VIa Haddock – short term forecast

The weights at age assumed by the working group for the short term forecast were derived from a combination of 3-year means, for the younger ages, and extrapolations of the linear growth model for the older ages. This approach enabled the appropriate estimation of future catch and stock weights for the slower growing year-classes. The review group considered that the 1999 and 2000 year-classes are growing at a slower rate, but that this is not the case for other year-classes and concluded that a mean of recent weights at age should be used in these cases. Importantly, the values used to calculate the mean weight at age should not include any observations for either of the slow growing year-classes. The forecasts have therefore been re-calculated using revised estimates for catch and stock weights at age. The revised weights at age have been calculated as follows.

Table XX. Catch and stock weights used in the revised short-term forecast. Weights for the 1999 and 2000 year-classes, calculated from a linear model, are shown in bold.

Age	Old Value	New Value			Derivation of New Values
		2007	2008	2009	
1	0.12	0.1224	0.1224	0.1224	mean(2002-06)
2	0.21	0.2200	0.2200	0.2200	mean(2002-06)
3	0.3	0.3037	0.3037	0.3037	mean(2002-06)
4	0.43	0.4533	0.4533	0.4533	mean(2002,05-06)
5	0.47	0.5763	0.5763	0.5763	mean(2002-03,06)
6	0.59	0.6070	0.6070	0.6070	mean(2002-04)
7	0.57	0.5680	0.8555	0.8555	linear model mean(2002-05)
8	0.67	0.6660	0.6910	0.7590	Linear model & pg calcs

The initial forecast conducted by the working group used the MarLab short term forecast software, WGFRANSW. However, in order to accommodate the changing weights at age in the forecast the revised short term forecast has been conducted using MFDP. MFDP conducts a deterministic projection, consequently confidence intervals about the predicted values are not available for the revised forecast.

Inputs to the revised forecast are given in table XX and the results are shown in tables XX and XX. The revised forecast gives predicted values of landings and SSB that are slightly higher than those estimated by the working group. Estimates of landings in 2007 and 2008 are approximately 6% higher and estimates of SSB in 2009 are between 8% and 10% greater (depending on the level of F in 2008). At status quo F, SSB in 2009 is predicted to be around 22,500 t. which is just above B_{lim} whereas the forecast conducted during the working group estimated SSB in 2009 to be 20,800 t, just below B_{lim}.

Table XX. Haddock VIa: Inputs to revised short term forecast

MFDP version 1a

Run: new

Time and date: 22:19 05/09/2007

Fbar age range: 2-6

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	23425	0.2	0	0	0	0.1224	0.2	0.1224
2	40094	0.2	0.57	0	0	0.213667	0.37	0.22
3	14961	0.2	1	0	0	0.303667	0.59	0.303667
4	8476	0.2	1	0	0	0.384	0.6	0.4533
5	10350	0.2	1	0	0	0.424333	0.62	0.5763
6	3820	0.2	1	0	0	0.520667	0.65	0.607
7	4294	0.2	1	0	0	0.568	0.64	0.568
8	3146	0.2	1	0	0	0.666	0.63	0.666

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	107895	0.2	0	0	0	0.1224	0.2	0.1224
2	.	0.2	0.57	0	0	0.22	0.37	0.22
3	.	0.2	1	0	0	0.303667	0.59	0.303667
4	.	0.2	1	0	0	0.4533	0.6	0.4533
5	.	0.2	1	0	0	0.5763	0.62	0.5763
6	.	0.2	1	0	0	0.607	0.65	0.607
7	.	0.2	1	0	0	0.855	0.64	0.855
8	.	0.2	1	0	0	0.691	0.63	0.691

2009

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	107895	0.2	0	0	0	0.1224	0.2	0.1224
2	.	0.2	0.57	0	0	0.22	0.37	0.22
3	.	0.2	1	0	0	0.303667	0.59	0.303667
4	.	0.2	1	0	0	0.4533	0.6	0.4533
5	.	0.2	1	0	0	0.5763	0.62	0.5763
6	.	0.2	1	0	0	0.607	0.65	0.607
7	.	0.2	1	0	0	0.855	0.64	0.855
8	.	0.2	1	0	0	0.759	0.63	0.759

Input units are thousands and kg - output in tonnes

Table XX. VIa Haddock: Short term forecast – management options table

MFDP version 1a
Run: new
stf1MFDP Index file 05/09/2007
Time and date: 22:19 05/09/2007
Fbar age range: 2-6

2007

Biomass	SSB	FMult	FBar	Landings
30147	23596	1	0.566	11892

2008					2009	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
35211	20519	0	0	0	56266	34703
.	20519	0.1	0.0566	1351	54571	33173
.	20519	0.2	0.1132	2636	52958	31722
.	20519	0.3	0.1698	3859	51422	30346
.	20519	0.4	0.2264	5022	49960	29040
.	20519	0.5	0.283	6130	48568	27800
.	20519	0.6	0.3396	7185	47241	26623
.	20519	0.7	0.3962	8189	45976	25505
.	20519	0.8	0.4528	9147	44771	24443
.	20519	0.9	0.5094	10059	43621	23434
.	20519	1	0.566	10930	42524	22476
.	20519	1.1	0.6226	11760	41477	21564
.	20519	1.2	0.6792	12552	40477	20697
.	20519	1.3	0.7358	13308	39522	19872
.	20519	1.4	0.7924	14030	38610	19088
.	20519	1.5	0.849	14719	37738	18341
.	20519	1.6	0.9056	15378	36905	17630
.	20519	1.7	0.9622	16008	36107	16953
.	20519	1.8	1.0188	16610	35344	16308
.	20519	1.9	1.0754	17187	34614	15693
.	20519	2	1.132	17738	33915	15107

Input units are thousands and kg - output in tonnes

Table XX VIa Haddock : Short term forecast – detailed output

MFDP version 1a

Run: new

Time and date: 22:19 05/09/2007

Fbar age range: 2-6

Year:	2007	F multiplier:	1	Fbar:	0.566				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.2	3861	473	23425	2867	0	0	0	0
2	0.37	11308	2488	40094	8567	22854	4883	22854	4883
3	0.59	6102	1853	14961	4543	14961	4543	14961	4543
4	0.6	3501	1587	8476	3255	8476	3255	8476	3255
5	0.62	4379	2524	10350	4392	10350	4392	10350	4392
6	0.65	1673	1015	3820	1989	3820	1989	3820	1989
7	0.64	1859	1056	4294	2439	4294	2439	4294	2439
8	0.63	1347	897	3146	2095	3146	2095	3146	2095
Total		34029	11892	108566	30147	67901	23596	67901	23596

Year:	2008	F multiplier:	1	Fbar:	0.566				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.2	17785	2177	107895	13206	0	0	0	0
2	0.37	4428	974	15702	3454	8950	1969	8950	1969
3	0.59	9249	2808	22674	6885	22674	6885	22674	6885
4	0.6	2804	1271	6790	3078	6790	3078	6790	3078
5	0.62	1611	929	3809	2195	3809	2195	3809	2195
6	0.65	1996	1212	4558	2767	4558	2767	4558	2767
7	0.64	707	604	1633	1396	1633	1396	1633	1396
8	0.63	1381	954	3226	2229	3226	2229	3226	2229
Total		39962	10930	166287	35211	51640	20519	51640	20519

Year:	2009	F multiplier:	1	Fbar:	0.566				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.2	17785	2177	107895	13206	0	0	0	0
2	0.37	20397	4487	72324	15911	41225	9069	41225	9069
3	0.59	3622	1100	8880	2697	8880	2697	8880	2697
4	0.6	4250	1927	10291	4665	10291	4665	10291	4665
5	0.62	1291	744	3051	1758	3051	1758	3051	1758
6	0.65	734	446	1677	1018	1677	1018	1677	1018
7	0.64	844	721	1948	1666	1948	1666	1948	1666
8	0.63	904	686	2111	1603	2111	1603	2111	1603
Total		49828	12288	208178	42524	69183	22476	69183	22476

Input units are thousands and kg - output in tonnes